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DoD Sustainability Application Guide for Historic Properties

Julie L. Webster and Kathleen S. McQuiggan,
ERDC-CERL
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Hardlines Design Company

May 2007

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Construction Engineering Research Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

DoD Legacy Resource Management Program

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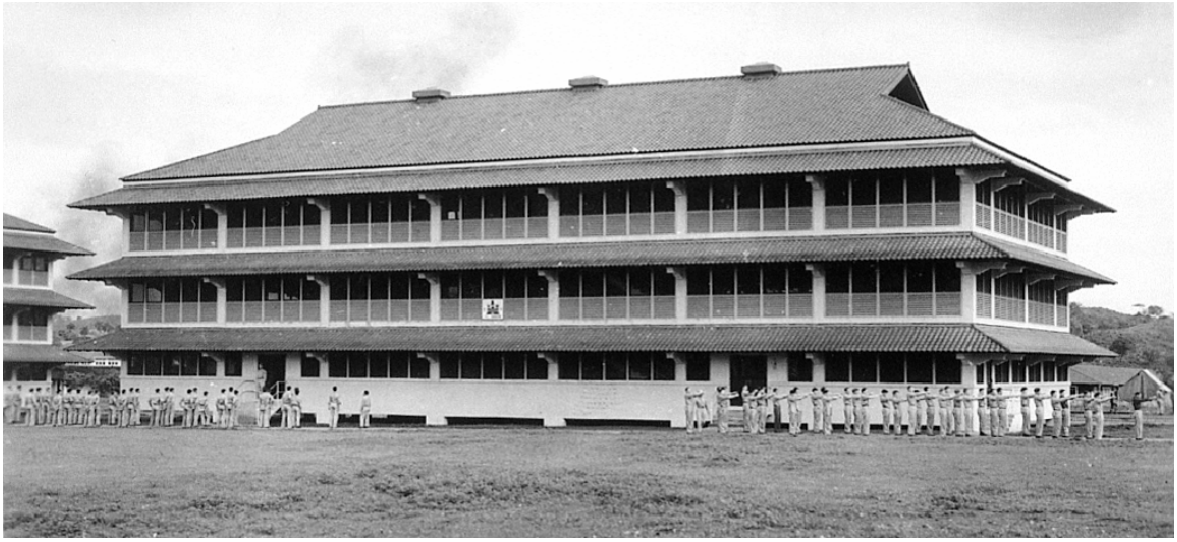

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Management Program

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DoD Sustainability Application Guide for Historic Properties

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Abstract: This report presents technical information to incorporate sustainable design principles into historic buildings owned by the Department of Defense (DoD). The study follows the U.S. Green Building Council's Leadership in Energy and Environmental Design rating system for Existing Buildings (LEED-EB), Version 2.0, June 2005, and provides specific discussion and strategies relevant both to historic preservation and sustainable design and development. The intent is to provide technical, feasible ways that the DoD can utilize LEED-EB criteria on historic buildings.

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Preface

This study was conducted by the U.S. Army Engineer Research and Development Center (ERDC) for the Office of the Deputy Under Secretary of Defense for Environmental Security under the DoD Legacy Resource Management Program, Project Number 04-220, Reimbursable Order 97/0100/701/A/W31RYO41533805/PO, Sustainability Guide for Historic Properties, dated 23 July 2004. The technical monitor was L. Peter Boice, ODUSD (ES) EQ-EQLP.

The work was performed by the Land and Heritage Conservation Branch (CNC) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL). The project manager was Julie L. Webster. Michael L. Denight was Chief (acting), CEERD-CN-C, and Dr. John T. Bandy was Chief, CEERD-CN during preparation of this report. Dr. William D. Severinghaus was the Technical Director of the Military Lands business area. Dr. Kirankumar V. Topudurti was the Deputy Director of CERL, and Dr. Ilker R. Adiguzel was Director.

Sustainable design and development consultations and review were provided by Richard L. Schneider and Annette L. Stumpf of the Engineering Processes Branch (CFN) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). Landscape architecture consultations were provided by Suzanne F. Loechl and Megan W. Tooker of the Land and Heritage Conservation Branch (CNC) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL).

The Commander and Executive Director of ERDC was COL James R. Rowan, and the Director was Dr. James R. Houston.

Introduction

Background

In 2002, the Office of the Federal Environmental Executive (OFEE), a task force of the White House Council on Environmental Quality, adopted sustainable construction as one of its six priority areas. Emphasis was placed on energy consumption, materials use, waste, water, and air quality. The scope of interest included siting, design, construction, operation, maintenance, and removal of federal buildings. An OFEE report, *The Federal Commitment to Green Building: Experiences and Expectations* (OFEE n.d.), reviews and assesses federal government policies and activities that promote sustainable construction. It identifies barriers to progress related to budget, education, research, and metrics, and it provides recommendations on how federal agencies can make further progress. Many of report's findings and recommendations directly pertain to, and may be supported by, reuse of historic properties owned by the Department of Defense (DoD).

Federal budget preparation guidelines (OMB 2006) require construction project decisions to incorporate life-cycle cost analysis, but decisions are often made on the basis of first cost without considering valuable opportunities to advance the sustainability of DoD infrastructure. Decisions based primarily on first-cost generally overlook the considerable economic benefits of appropriate historic infrastructure reuse. OFEE cites the lack of emphasis on life-cycle cost analysis in construction project planning as the main barrier to progress in sustainable government infrastructure. DoD has major roles and responsibilities in advancing OFEE goals because military activity accounts for two-thirds of all federal building utilization and floor space. The cost of energy used to support this inventory exceeded $2.6 billion in Fiscal Year 2002.

A unique potential DoD resource for promoting federal sustainability goals is the large inventory of military buildings listed or eligible for listing in the National Register of Historic Places (NRHP). Section 110 of the National Historic Preservation Act (NHPA) requires federal agencies to use their historic properties to the maximum extent feasible for heritage reasons, and a significant number of resources are already dedicated to this activity. However, it is now apparent that there are compelling economic

reasons to investigate the reutilization of historic infrastructure (i.e., building rehabilitation promotes DoD goals for transformation to sustainable installations). By preserving or renovating significant historic property characteristics and features in accordance with the Secretary of the Interior's (SOI) Standards, installations can revitalize a building's original passive energy-conservation features such as skylights, operable windows, transoms, etc. These renovations can restore the integrity of a historic building while improving daylighting, indoor air exchange, and the like, for better energy management, healthier indoor environments, and reduced life-cycle costs.

Various military directives provide basic guidance on incorporating sustainability principles into the design, construction, and operation of new facilities. However, these emphasize new construction rather than rehabilitation of existing facilities. A compelling argument can be made that appropriate rehabilitation and reuse of existing facilities, rather than new construction, is the single most important way for an installation to improve its sustainability rating while meeting current and developing mission requirements.

Reuse promotes sustainability by reducing virgin materials consumption and processing energy, waste production, and ecological degradation. Building reuse exploits yesterday's investment in materials and construction-related energy to reduce today's construction bills and extract new value from buildings long-since paid for. When viewed from this perspective, it is easy to see that the rehabilitation of historic and vintage buildings can help DoD execute sustainability initiatives and comply with NHPA Section 110 while concurrently advancing OFEE's mission.

But while the SOI Standards and sustainability design principles significantly reinforce each other, they may also pose conflicting demands. New guidance clearly identifying and addressing such conflicts could help to better integrate DoD's cultural resources and sustainability goals while cross-educating both cultural resource managers and building designers.

Objective

The primary objective of this research is to produce guidance that concurrently advances OFEE, DoD, and NHPA Section 110 priorities by comparing and aligning federal heritage and sustainability requirements, methodologies, and metrics in order to identify where they are mutually

supportive. The guidance uses the Leadership in Energy and Environmental Design–Existing Building (LEED-EB) rating system to validate the informed retention, reuse, and rehabilitation of historic DoD buildings instead of demolishing them. The intended users of this guide are installation cultural resources and public works personnel, project planning and design teams, and user groups and tenants who can use this guide to identify and implement viable sustainability strategies for DoD historic building projects.

Approach

The research objective was accomplished by:

1. investigating inherent features of historic buildings and sites that support sustainability objectives;
2. conducting a survey of existing LEED-EB qualifying historic building projects and assessing them to determine the best ways of obtaining LEED-EB credits without significantly impacting historic character-defining features;
3. compiling a comprehensive list of sustainable design and development strategies for achieving LEED-EB credits, and developing guidelines for implementing heritage and sustainability design; and
4. providing resource lists for obtaining [a] cost issues associated with sustainable design, [b] green products and materials for LEED point accumulation, and [c] information on the LEED certification process.

Scope

This document is organized to parallel the LEED-EB rating system and addresses the following primary topics:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation in Upgrades, Operations and Maintenance (creative solutions that allow properties to perform above the requirements set by LEED-EB)

This study was based on the LEED-EB rating system instead of LEED-NC (New Construction) because LEED-EB is less invasive to historic buildings, and it offers ways to earn LEED credits through sustainable operations as an alternative to major renovations.* LEED-EB can also be implemented on a building at any time without being driven by a construction project or other major capitol investment.

Benefits of sustainable design and development

The basics

Sustainability is generally defined as "...development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (The Brundtland Commission 1987). Sustainable development is a specific strategy to balance environmental protection with continued economic growth (Benson, Roe, and Millard 2000). Sustainable development ideally resolves environmental issues within a development so that the products and energy systems of urban processes are beneficial instead of degrading (Hough 1990). But successful sustainable development requires monitoring and maintenance of properties after construction completion. The maintenance of properties should target these three goals: to keep the living parts of sites healthy, to keep the constructed parts repaired and maintained, and to balance the first two goals with human use (Thompson and Sorvig 2000).

Leadership in Energy and Environmental Design (LEED)

The United States Green Building Council (USGBC) has developed a framework for assessing the environmental benefits of building within sustainable guidelines. The framework, Leadership in Energy and Environmental Design (LEED), is intended to publicize and define standards for achieving these goals. The LEED Green Building Rating System is a voluntary, consensus-based, market-driven building rating system that is based on accepted energy and environmental principles. It strikes a balance between established practices and emerging concepts (LEED-NC Reference Guide 2003). The rating system has been tailored to specific project types, including new construction (NC), existing buildings (EB), commercial interiors (CI), etc. The system functions as a checklist of prerequisites and

* General consensus among the sustainable design and development community is that once a decision is made to replace an existing building's HVAC system, it may be more appropriate to use the LEED-NC rating system.

credits, with each one reflecting an aspect of sustainability. Each credit is worth one or more points, with maximum possible point totals varying by rating system. (A total of 80 points is possible under LEED-EB.) A LEED certified building reaches one of four levels of sustainability: certified, silver, gold, or platinum (Malin 2003). The levels provide a method for determining the degree to which a building achieves commonly accepted environmental standards. Buildings significantly impact human lives and the environment, and the USGBC developed LEED to facilitate minimizing this impact and preventing further ecological damage.

Resource conservation

One of the primary goals in sustainable design is the conservation of resources. Sustainable design practices target reducing both construction waste and building occupant waste. Credits are also given to reusing existing materials and using new materials with high recycled content. The reuse of an existing building maximizes resource conservation. By avoiding any demolition associated with new construction, the renovation project reduces materials destined for a landfill and reuses substantial portions of the existing building.

Likewise, historic buildings are inherently sustainable because their preservation maximizes the use of existing materials and infrastructure, reduces waste, and preserves the historic character of older installations. In addition to reducing construction waste and demolition waste that would otherwise go to a landfill, reusing existing buildings often prevents the development of other land that would otherwise remain green space. Furthermore, historic buildings were traditionally designed to conserve energy in a time when electricity and air conditioning was not widely available. Many of their sustainable features responded to climate and site conditions, including:

- site components and vegetation that reduce solar energy gains during the cooling season while providing northerly windbreaks and passive solar heating during the heating season;
- thick masonry walls that provide insulation to prevent excessive temperature changes;
- user-operable windows, transoms, shutters, blinds, shades, awnings, and vents, that provide energy neutral ways to tailor temperature, lighting, and ventilation to the differing needs of occupants in different zones of the building;

- cupolas, monitors, skylights, sunrooms, porches, tall windows, and transoms that admit natural light into interior spaces and reduce the daytime demand for artificial lighting; and
- high ceilings which, in conjunction with historically compatible ceiling fans, exploit convection and thermal stratification to comfortably condition the occupied space while moving seasonally uncomfortable temperatures up and away from the occupants.

Putting these types of features back into use can conserve material and energy resources, and fulfill several LEED credits.

Cost savings

Sustainable design and development can result in first-cost savings, reduced regulatory delays during permitting processes, improved leasing and occupancy rates, higher property values, reduced operating costs, reduced liability risk, and better health and higher productivity of building occupants (Rocky Mountain Institute et al. 1998). Renovating an existing building can result in fewer site preparation and infrastructure costs over constructing a new building at a remote edge of the cantonment. Managing construction waste and implementing aggressive building recycling programs reduce fees paid to landfills and postpones the cost of constructing a new landfill when the old ones are at capacity. Utilizing daylighting and control systems can reduce the size and cost of mechanical systems.

The most obvious cost savings of a sustainably designed building is in lower energy costs. Likewise, prudent fixture selection results in a substantial reduction in water use, which is especially valuable for installations located in drought-prone areas. Green buildings are also designed for overall life-cycle costs, which translates to greater durability and fewer repairs. Many sustainable design credits also target reducing the cost associated with cleaning and maintenance.

During building assessments, one of the primary complaints of building tenants is poorly functioning HVAC systems. A sustainably designed HVAC system is meant to maintain occupant comfort and provide direct controls. As a result, there are fewer tenant complaints, fewer maintenance runs, and ease in attracting paying tenants. A well-designed building also reduces the government's exposure to liability from sick-building syndrome and assists the installation in maintaining a positive image in the community.

The DoD owns a total of 344,950 buildings in the United States and Territories; of these, 109,595 are 50 years of age or older (as of 30 September 2005). In the coming years, an additional 32,814 will reach 50 years of age (through 2015) (Sullivan 2006). Since all buildings 50 years of age or older are subject to NHPA requirements, effectively 67% of the DoD's buildings could be considered historic (i.e., eligible or potentially eligible for the NRHP) by 2015. Even with adjustments for new construction, demolition, and other disposal activities, over half of the DoD's real property inventory consists of older, existing buildings. As a result, it only makes economic sense to develop solutions to renovate existing and historic buildings for effective long-term use.

A well-rehabilitated historic building can become a showpiece for the installation, with tenant groups eager to use it. But historic materials and craftsmanship are virtually impossible to duplicate today without significant cost. Therefore, utilizing existing historic building stock and their components (e.g., high ceilings, architectural ornament, abundant windows, and rich finishes) is typically less expensive than constructing a new building of similar material and features.

Quality of life

Since Americans spend 85–95% of their time indoors, a key goal in sustainable design and development is improving the health of building occupants by controlling moisture, reducing pollution and contaminants, and implementing ventilation strategies. Sustainable design also results in enhanced comfort for building occupants by empowering them with direct environmental controls. Improving the health and comfort of workers ultimately results in reduced absenteeism, better productivity, documented improvement of learning, and faster recovery from illnesses.

Comply with federal mandates

Integrating sustainable design into DoD construction projects has been the subject of federal mandates for the past several years. These include the 2002 adoption of sustainable construction as one of six priority areas by OFEE. The Energy Policy Act of 2005 extends previous Congressional direction with even greater goals of energy efficiency improvements in both existing and new facilities. Chief among the provisions are increased use of renewable energy sources, advanced utility metering, and procurement of energy efficient equipment and building systems in all applicable con-

tracts. The goal of the act continues to be reducing energy consumption in federal buildings, and includes funding for items such as the establishment of a photovoltaic energy commercialization program in federal buildings.

In January 2006, over 150 top federal facilities managers and decision makers came together at the White House Conference Center for the first-ever *White House Summit on Federal Sustainable Buildings*. This historic event included the following milestones:

- Signing of the Memorandum of Understanding *Federal Leadership in High Performance and Sustainable Buildings* by 17 agencies, at which these agencies pledged to make their facilities more sustainable in specific, measurable ways;
- Strong support for the greening of federal buildings expressed by top officials from agencies including Council on Environmental Quality (CEQ), Department of Health and Human Services (HHS), DoD, General Services Administration (GSA), Environmental Protection Agency (EPA), Department of Energy (DOE), Department of the Interior (DOI), National Aeronautics and Space Administration (NASA) and others;
- Introduction of OMB's new Executive Management Scorecards for environment, energy, and transportation.

Also in January 2006, the Army released a Sustainable Design and Development Policy Update memorandum that formally stated all new construction would transition from the Army's Sustainable Project Rating Tool (SPiRiT) system to LEED. In addition, for FY08, all new building construction would meet the LEED-NC Silver rating.

Ultimately, DoD's transition to sustainable design and development is being made to minimize the impacts and ownership costs of military systems, material, facilities, and operations.

How to use this document

This document is organized to parallel the LEED-EB rating system as closely as possible to aid in LEED point accumulation. Each chapter begins with a select list of mandates and guidelines pertinent to the chapter topic. Each prerequisite or credit within a chapter is introduced in a text box that quotes the LEED-EB intent and requirements. This method of organiza-

tion is intended to facilitate pre-design charrettes* that are commonly used for sustainable design and development projects. The text box is followed by credit-specific sustainability and historic preservation overviews that provide background and context for each subtopic.

A comprehensive list of credit-specific sustainable design and development strategies follows, any one of which may or may not be suitable for a particular historic property based on field conditions.† Individual or categories of strategies were interpreted for probable historic preservation impacts. These impacts, expressed by SOI Standard number (see Table 6.4), are shown in brackets throughout the document (example: [SOI Standards: 2, 6.]). Since the nature of these impacts is often shared by other strategies within a credit, users should read the entire credit to get a general understanding of impact consequences.

Each chapter ends with a chapter-specific reference list, table of military Unified Facilities Guide Specifications (UFGS) that may be invoked during the design of chapter-relevant property systems or components, and additional resources for supplementary information on chapter subtopics.‡ Additional general resources are provided in the appendices to guide historic property rehabilitation projects that may benefit from costing, green products and materials, and LEED certification assistance.

Only a small number of LEED-EB points apply directly to sites, but site management or modification can contribute to the achievement of more than half of the total available points within the LEED systems. For this reason, how a site is defined is critical to LEED point accumulation. The project team must define the project site area and then apply all credits consistently using the defined boundaries. The site area will typically be less than the entire installation, cantonment area, and distance from the project location to any adjacent buildings. It is recommended that the site boundary include the subject building, any site features attributable to it

* A charrette is a collaborative session in which a group of designers drafts a solution to a design problem. Charrettes often take place in multiple sessions in which the group divides into sub-groups by professional specialty. They serve as a way of quickly generating a design solution while integrating the aptitudes and interests of a diverse group of people.

† Strategies with little or no historic preservation impact were included to facilitate design decisions (i.e., these strategies may be good choices for use on historic properties).

‡ Following the research phase of this project, DoD adopted the MasterFormat 2004 specification system. To convert the UFGS MasterFormat 1995 references in this document to the new format, see http://www.wbdg.org/ccb/browse_org.php?o=70. Note that there is not a one-to-one mapping of specifications, as some were added, deleted, or combined during the conversion.

(e.g., parking lots), and half the distance between adjacent buildings and their associated site features. Following a 'municipal' model, the street-side boundary line should be inside any sidewalks (LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects, October 2005).

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White House, Office of the Environmental Executive. n.d. *The Federal Commitment to Green Building: Experiences and Expectations*.

1 Sustainable Sites (SS)

Sustainable Sites—Select Mandates and Guidelines
40 CFR 122.26, The Clean Water Act, and State Regulations
7 USC 136 et seq., Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (amended 1996)
42 USC 13101 et seq., Pollution Prevention Act of 1990
AR 11-27, Army Programs: Army Energy Program (DA, 3 February 1997)
AR 200-1, Environmental Protection and Enhancement (DA, 21 February 1997) (to be replaced by AR 200-1 Environmental Sustainability and Stewardship)
AR 200-2, Environmental Effects of Army Actions
AR 200-5, Pest Management
AR 210-20, Master Planning for Army Installations (DA, 16 May 2005)
AR 420-10, Management of Installation Directorates of Public Works
Army Installation Design Standards (DA, 3 May 2004)
Army Technical Instruction 811-16, Lighting Design (HQUSACE, 3 August 1998)
ASHRAE/IESNA Standard 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential Buildings, Section 9, Lighting (ASTM, 2004)
ASTM C 1549, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer (ASTM)
ASTM E 408-71, Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques (ASTM, 2002)
ASTM E 1084, Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight (ASTM, 2002)
ASTM E 1918, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field (ASTM)
Cool Roof Rating Council Directory of Rated Products
DA PAM 200-1, Environmental Protection and Enhancement (DA, 17 January 2002)
DODD 3200.15, Sustainment of Ranges and Operating Areas (DoD, 10 January 2003)
DODD 4165.6, Real Property (DoD, 13 October 2004)
DODD 4715.1E, Environment, Safety, and Occupational Health (DoD, 19 March 2005)
DODI 4150.7, DoD Pest Management Program (22 April 1996)
DODI 4170.11, Installation Energy Management (DoD, 22 November 2005)
DODI 4715.3, Environmental Conservation Program (DoD, 3 May 1996)
EO 12191, Federal Facility Ridesharing Program (White House, 1 February 1980)
EO 12873, Federal Acquisition, Recycling, and Waste Prevention (White House, 20 October 1993)
EO 13101, Greening the Government through Waste Prevention, Recycling and Federal Acquisition (White House, 14 September 1998)

EO 13112, Invasive Species (White House, 3 February 1999)

EO 13149, Greening the Government through Federal Fleet and Transportation Efficiency (White House, 21 April 2000)

Engineering Pamphlet 1110-1-16 Engineering and Design - Handbook for the Preparation of Storm Water Pollution Prevention Plans for Construction Activities (HQUSACE, 28 February 1997)

EPA 832-R-92-005, Stormwater Management for Construction Activities, Chapter 3, Sedimentation and Erosion Control (EPA Office of Water, 1992) OR local erosion and sedimentation control standards and codes

EPA 832-R-92-006, Stormwater Management for Industrial Activities: Developing Pollution Plans and Best Management Practices (EPA Office of Water, September 1992)

EPA 840-B-92-002, Guidance Specifying Management Measures for Sources of Non-Point Pollution in Coastal Waters (EPA, January 1993)

EPA Comprehensive Procurement Guidelines, found in 40 CFR 247 (EPA, April 2004)

EPA ENERGY STAR Rated Products

EPA ENERGY STAR–compliant, high-reflectance and high emissivity roofing materials

EPA Greening Your Purchase of Cleaning Products: A Guide For Federal Purchasers

EPA National Pollutant Discharge Elimination System (NPDES) Permit Program

Green Seal GS-02, Green Seal Standard 02, Alternative Fueled Vehicles (GC-02) (Green Seal, 10 March 1994)

PWTB 200-1-13, Source Information for Petroleum, Oil, and Lubricant (POL) Spill Containment and Cleanup Materials

PWTB 200-1-18, Guidance for Non-Native Invasive Plant Species on Army Lands: Western United States

PWTB 200-1-35, Construction Discharge and National Pollutant Discharge Elimination System (NPDES) Requirements

PWTB 200-1-37, Method to Estimate Vegetative Cover on Army Training Lands

PWTB 200-3-29, Sources of Plant Materials for Land Rehabilitation

PWTB 200-3-30, Current Technologies for Erosion Control on Army Training Lands

PWTB 200-3-33, Regional Cost Estimates for Rehabilitation and Maintenance on Army Training Lands

PWTB 420-49-14, Composting for Army Installations

UFC 2-000-02AN, Installation Master Planning (by reference TM 5-803-1 Installation Master Planning) (DA, 1 March 2005)

UFC 3-210-01A, Design - Area Planning, Site Planning, and Design (by reference TI 804-01 Area Planning, Site Planning, and Design) (DoD, 16 January 2004)

UFC 3-210-06A, Site Planning and Design (by reference TM 5-803-14 Site Planning and Design) (DA, 16 January 2004)

UFC 3-210-10, Design: Low Impact Development Manual (HQDA, 25 October 2004)

UFC 3-230-14A, Evaluation Criteria Guide for Water Pollution Prevention Control and Abatement Programs (DA, 16 January 2004)

UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings, Change 1 (DoD, 22 January 2007)

Whole Building Design Guide (WBDG), Tools, LEED-DoD Antiterrorism Standards Tool

Prerequisite 1 — Erosion and Sedimentation Control (Required)

Intent—Control Erosion to reduce negative impacts on water and air quality.

Requirements—Develop and implement a site erosion and sedimentation control policy that incorporates best management practices. The policy shall address ongoing maintenance of the facility's site to prevent soil erosion and sediment transfer under ongoing operation, as well as addressing erosion and sedimentation control for any future infrastructure repairs or other construction activities. The policy provisions shall address restoring eroded soil areas and eliminating conditions that result in erosion or sedimentation. The provisions addressing erosion and sedimentation control for additions and repairs shall require a sediment and erosion control plan specific to the site that conforms to U.S. Environmental Protection Agency (EPA) Document No. EPA 832/R-92-005 (September 2000), Storm Water Management for Construction Activities, Chapter 3, OR local erosion and sedimentation control standards and codes, whichever is more stringent. The person responsible for its ongoing implementation will sign on the facility sedimentation and control policy. The plan shall meet the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse,
- Prevent sedimentation of storm sewer or receiving streams,
- Prevent polluting the air with dust and particulate matter, and
- Log building operations and maintenance activity to ensure that plan has been followed.

Sustainable design and development overview

Erosion is the breakdown and transport of surface materials that results from precipitation and wind. It leads to degradation of property and sedimentation of local water bodies. The accumulation of sediment affects water quality by disrupting and polluting stream and estuary habitats. Additionally, suspended sediment contributes to a decline in water quality by blocking sunlight, reducing photosynthesis, decreasing plant growth, and carrying attached pollutants such as phosphorous (Maryland Department of the Environment 2002). Contributors to erosion problems include destruction of vegetation that previously slowed runoff and reconfiguration of natural site grading.

> Erosion on existing sites typically results from foot traffic killing the vegetation, steep slopes where stormwater sheet flow exceeds vegetation holding power, or point stormwater outflow that exceeds vegetation holding power (USGBC, LEED-EB Reference Guide 2005, 24).

Reduction of sedimentation and erosion through appropriate site planning, design, and maintenance can reduce the size, complexity, and cost of stormwater management measures.

Historic preservation overview

Soil erosion can potentially damage or destroy historic fabric on the site. At the same time, some interventions to prevent erosion can have the same effect. For instance a retaining wall designed to curtail erosion may severely alter the spatial comprehension of the site. The challenge then is to find erosion control measures that are most compatible with the physical and historic constraints of the site. In some cases, a suitable compromise of interventions is most effective, like hydroseeding or geotextiles with increased vegetation (see Strategies for more information).

Prior to implementing any sediment and erosion control plan, measures should be taken to protect and preserve historically significant site features. If an erosion control strategy requires new construction, the materials, size, placement, and visual effect should be compatible with the historic character of the site. While military installations have typically conducted archaeological surveys, all proposed ground-disturbing activities located in areas with high probability of archaeological resources should be monitored for unexpected discoveries.

Strategies

Topsoil

Topsoil is vital to all vegetation because most vegetation root activity occurs in the first few inches of soil. Topsoil, composed of billions of organisms, can be easily lost or damaged from erosive events and is expensive to restore or replace (Thompson and Sorvig 2000, 45). For this reason, it is important to review erosion and sediment control measures in military installation design guides (IDGs) and other applicable site design guides. Military service requirements typically defer to EPA guidance on the topic. However, some localities may have more stringent erosion and sediment control requirements than needed to achieve this credit, so it is important to determine if any local or regional mandates are applicable or appropriate for the project. [SOI Standards: None.] Typically, efforts to protect this soil layer are consistent with protecting the quality and integrity of historic sites.

Conduct a site survey to classify the different types and composition of soil, and to identify potential erosion site problems (USGBC, LEED-EB Reference Guide 2005, 24). [SOI Standards: None.]

Develop sediment and erosion control plans, pollution prevention plans, and monitoring systems that reflect best management practices for stormwater management (USGBC, LEED-NC Reference Guide 2003). Plans should include stringent erosion and sedimentation control requirements for construction drawings and specifications (USGBC, LEED-EB Reference Guide 2005, 24). These plans should be consolidated with vegetation and stormwater management plans (see SS Credits 5.1 & 5.2) because uncontrolled stormwater flows, impervious surfaces, and inadequate vegetation significantly contribute to erosion. Development of plans does not involve physical changes to historic sites, but action items within plans can impact historic integrity. [SOI Standards: None, unless noted otherwise below.]

- Plan to use temporary plantings during construction and to install historically appropriate vegetation as soon as possible after any kind of site clearing for maintenance or construction.
- Plan drainage methods that allow infiltration as outlined in UFC 3-210-10. 'Hard' erosion and flood control structures deflect and concentrate the force of water onto other surfaces like nearby soft soil. This can increase erosive undercutting and can undermine the structure itself (Thompson and Sorvig 2000, 74). Therefore, hard structures are not recommended unless they were part of the historic site design. In this case, careful consideration should be given to effectively resolving erosion problems associated with hard structures. [SOI Standards: 2, 6, 9, 10.]
- Plan for new grading in the future; use structures that allow for water to drain more slowly (e.g., detention areas and gentle slopes). Note that regrading may not be possible due to constraints within the historic site design and affected viewsheds. [SOI Standards: 2, 6, 7, 9, 10.]
- Plan for use of existing grade. Stabilize soil and reduce weeds by depriving them of sunlight with organic filtration barriers (e.g., straw bale dams, filter-fabric fences, and earth dikes), soil cells, starch-based soil tackifiers, vegetated geo-grids, jute netting, mulch, or more permanent geotextiles (i.e., fabrics designed to filter soil from water) (Mendler and Odell 2000, 61-62). Soil stabilizers typically fall under two types: temporary biodegradable control structures or more permanent geotextiles (Figure 1.1) that become masked by vegetation. Note that long-term slope stabilization comes from biotechnical erosion control (using plants that sprout from a fresh cut twig stuck in soil), or hydroseeding with quick-sprouting plants like annual ryegrass. Temporary soil stabi-

lizers should not conflict with historic preservation requirements; however, there may be temporary incompatibilities between appropriate stabilizing vegetation and historic vegetation. [SOI Standards: 2, 6, 7, 9, 10.]

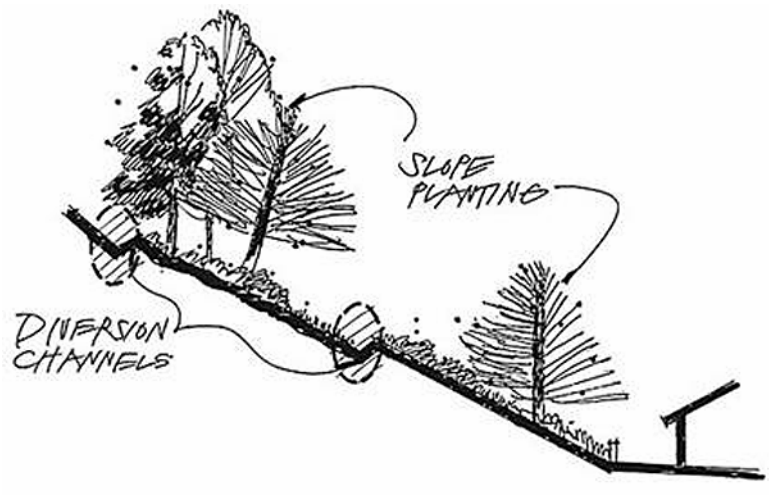

Figure 1.1. Stabilize soil with diversion channels and plantings (USAF 1998, para 18.5.2).

- Plan for situations where the use of crib, block, gabion, mesh (Figure 1.2), or retaining walls (Mendler and Odell 2000, 62) or stepped slopes are necessary for steep grades to slow erosive stormwater and increase infiltration (Thompson and Sorvig 2000, 72). Note that stepped slopes or retaining walls are inappropriate if they are located in primary historic viewsheds. If they prove necessary, plans should be made to disguise their presence as much as possible. [SOI Standards: 2, 6, 7, 9, 10.]

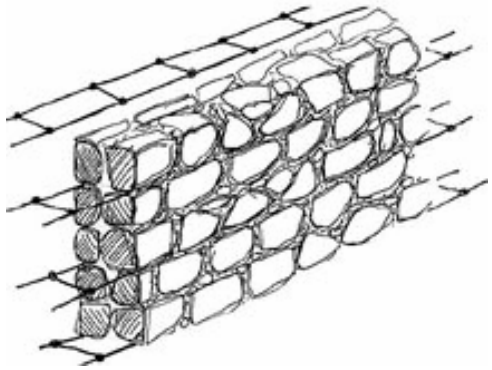

Figure 1.2. Galvanized wire mesh wall reinforcement (ICIMOD).

- Avoid plans for drainage towards structures and avoid erosion around foundation walls (Fournier and Zimnicki 2004, 9). Soil erosion can lead to unstable foundations and loss of structural integrity, and can require expensive repairs (Thompson and Sorvig 2000, 45).

Air quality is an important concern inside and outside of the building. On windy days, unprotected soil can become a significant air pollution issue. The Dust Bowl of the 1930's is an extreme example of how airborne soil can cause unexpected and damaging results. Therefore, schedule grading and construction activities as appropriate for weather conditions (USGBC, LEED-NC Reference Guide 2003, 12). [SOI Standards: None.]

Sedimentation

Sedimentation can affect both storm conveyance systems and natural streams. Sedimentation in storm sewers can be a maintenance issue, depending on the frequency of cleanout needed to keep the drains from clogging. Downstream water bodies have to contend with the additional soil buildup and pollutants. For these reasons, monitor erosion and sedimentation control activities during construction and maintenance phases to ensure that erosion and sedimentation guidelines are being followed (Paladino 2001, 1). [SOI Standards: None.]

Minimize terrain disturbance on the site thus eliminating potential erosion and secondary pollution (Fournier and Zimnicki 2004, 9). This includes reducing foot traffic on more sensitive areas to avoid destruction of vegetation. [SOI Standards: None.]

Develop and use maintenance practices that respect infrastructure; for example, clean out debris from drainage systems (Fournier and Zimnicki 2004, 9). [SOI Standards: None.]

Use construction phasing to reduce sedimentation. An example would be to postpone some land clearing activities until necessary, thereby minimizing the amount of disturbed soil at any one time. [SOI Standards: None.]

Keep the staging area close to the construction site, reduce land clearing if possible, and temporarily seed in areas that will not be built upon for a period of time.

Install temporary structural controls like earth dikes, silt fences, oil grit separators, sediment traps, sediment basins, or straw bales (Figure 1.3) prior to grading and construction to minimize washout of topsoil and to filter water (Mendler and Odell 2000, 62). [SOI Standards: 2, 7, 9, 10.] Install and remove all temporary erosion control measures so they do not adversely impact historic site features and plantings.

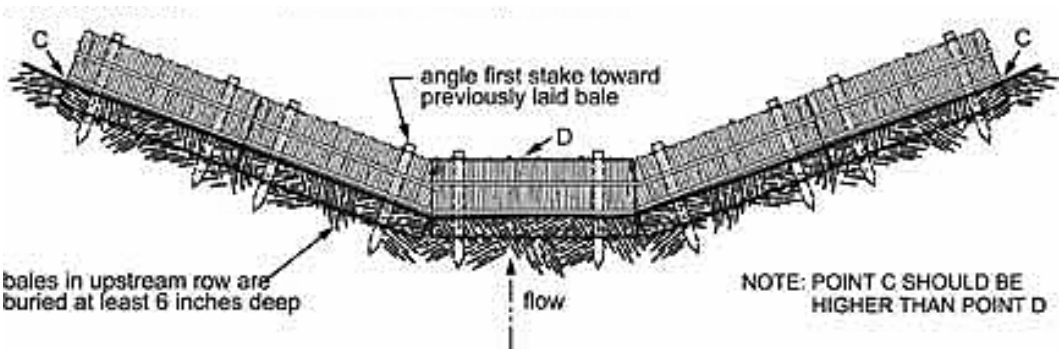

Figure 1.3. Straw bale check dams minimize washout of topsoil (USDA).

Sediment traps and basins, if regularly dredged of sediment buildup, can continue to provide places for settling of sediment. [SOI Standards: 2, 9, 10.] On a historic site, they can be located out of site in an existing pond. This would entail excavating a deeper area within the pond near the water release structure for sediment to settle. However care needs to be taken to avoid damaging the site during implementation and maintenance.

Shorten flow-lines to reduce the speed of water and reduce maintenance costs for silting structures installed to prevent sedimentation (Thompson and Sorvig 2000, 157). Shorter flow-lines require lower water pressure, while longer flow-lines have more joints (i.e., potential locations for line breakage and leakage). [SOI Standards: 2, 7, 8, 9, 10.] If flow-lines are underground conveyance, take care to protect historic features and plantings when digging and replacing piping. Note that ground-disturbing activities must be carried out in accordance with SOI Standard 8 on archeological resources. If new flow-lines include on-grade swales or ditches, avoid adversely affecting the site's historic design and viewsheds.

If additional soil is required for the site, acquire recycled soil. An example would be using sediment dredged from local lakes or streams. [SOI Standards: None.]

Scarify or till soils before mulching to increase water retention capacity and soil permeability (Mendler and Odell 2000, 63). Till the subgrade on the entire surface to 8 inches. [SOI Standards: 7.] Take care to not harm historic features or plantings when tilling.

Mulch with hay, grass, woodchips, straw, or gravel to control erosion. (Note that these methods may not be as effective as hay bails or seeding in a hard or wind-driven rain.) Mulching near plant roots cools soil temperature; helps to retain soil moisture; deters growth of competing weeds; and reduces erosion, soil compaction, and plant damage from maintenance equipment (especially from lawn mowers). Mulching should occur annually and the application should be 2-4 in. deep depending on plant type and geographical location. Organic materials are preferred as rock or stone reflect sunlight, retain heat, and may cause plant stress (USAF, Landscape Design Guide, "Maintenance" 1998, 3.3). [SOI Standards: 2, 6, 7, 9, 10.] Mulching may not have been part of the historic site design; however it is now a widely accepted practice on historic sites because it provides many benefits. The kind of mulch chosen should either follow historic precedent for the site (i.e., mulch with straw if straw was used historically) or have a limited visual impact. Some mulch alternatives such as brightly colored recycled plastic may be inappropriate for the historic site.

Use the newest technology vacuum-assisted dry sweepers to remove sediment and pollutants from streets and parking lots, potentially achieving a 50-88% overall reduction in the annual sediment loading (EPA, National Pollutant Discharge Elimination System 2005). [SOI Standards: None.]

Ongoing building operations and maintenance activity

As mentioned previously, erosion and sedimentation control measures should be addressed in an Erosion Control Plan in accordance with EPA Document 832/R-92-005 (September 2000). This plan often covers stormwater management because stormwater is the primary cause of erosion and sedimentation. It should include (1) objectives of erosion control and stormwater control, (2) descriptions of all temporary and permanent erosion control and stormwater control measures, and (3) descriptions of the type and frequency of erosion control maintenance activities required. Careful documentation of erosion control operations (1) ensures implementation, (2) provides a record and a standard to be followed in the future, and (3) affords an opportunity to document existing (and historic) stormwater solutions to determine what (if any) adjustments need to be

made to the site to maintain an efficient stormwater management plan (USGBC, LEED-NC Reference Guide 2003, 12).

- During building occupancy, schedule stormwater system inspections annually, before forecasted storm events, and after storm events to ensure proper operation of stormwater controls (USGBC, LEED-NC Reference Guide 2003, 12). [SOI Standards: None.]
- Inform construction and maintenance workers of provisions in the erosion control plan, and require they adhere to the plan (USGBC, LEED-NC Reference Guide 2003, 12). [SOI Standards: None.]

Prerequisite 2 — Age of Building (Required)

Intent—Provide a distinction between buildings that are eligible to apply for LEED-NC certification and buildings that are eligible to apply for LEED-EB certification.

Requirements—Buildings that have not been certified under LEED-NC must be at least two years old before they can achieve certification under LEED-EB.

- Buildings that are more than two years old can register to participate in LEED-EB and apply for LEED-EB certification as soon as they are prepared to do so.
- LEED-NC Certified buildings that are less than two years old can also register to participate in LEED-EB and apply for LEED-EB certification or re-certification as soon as they are prepared to do so.
- Buildings that are less than two years old that have not been certified under LEED-NC can register to participate in LEED-EB but must reach two years of age before LEED-EB certification will be awarded by USGBC.

Sustainable design and development overview

Project managers may consider whether to apply for LEED-Existing Building (LEED-EB) or LEED-New Construction (LEED-NC) certification based on the type of project anticipated. For *minor rehabilitation* of a historic building, use the LEED-EB standards.

For *major rehabilitation* of a historic building, use LEED-NC standards. The U.S. Green Building Council encourages use of LEED-NC for projects that involve total replacement of mechanical, electrical, and plumbing systems. LEED-NC offers more credits in energy savings through these building systems than the LEED-EB standards.

For construction of *new additions* to a historic building, use the LEED-NC standards for initial construction of the addition. After two years, recertify the ongoing operation and maintenance of the facility under the LEED-EB standards. Early implementation of sustainable operations and maintenance strategies, coupled with data collection and documentation of performance, allows for the development of a body of building performance data needed to achieve LEED-EB certification once the building is two years old.

For projects that involve both construction of a *new addition* and *rehabilitation* of a historic building, take a hybrid approach. Apply the LEED-EB or LEED-NC standards to the original building depending on the level of work involving the building systems listed above. Apply the LEED-NC standards to the new addition. After two years, recertify the entire building under LEED-EB.

Historic preservation overview

Most historic sites will automatically qualify for this prerequisite. Properties less than 50 years old are generally excluded for listing to the National Register due to the lack of historical perspective necessary to accurately assess their significance. However, a set of exceptions, called Criteria Considerations, modify the various National Register Criteria for Evaluation in narrowly defined circumstances. Properties that have not reached the typical 50-year National Register threshold may be eligible if they meet the test of Criteria Consideration G. Criteria Consideration G states that properties younger than 50 years old may be eligible for listing on the National Register only if it is determined that they have exceptional significance (National Register Bulletin 15 2002, 41; National Register Bulletin 22 1995).

Thus a building two years old or less can be historic (i.e., eligible for listing on the National Register) if it has been determined to be of exceptional importance. For example, Olympic Sites can become significant and historic as soon as the games begin. Nonetheless, the site must be two years old before being qualified for LEED-EB certification. In extremely rare circumstances where the site is less than two years old, apply for certification under LEED-NC.

Strategies

None; the age of the property will either be two years old or not. While it is possible for historic properties to be less than two years old, it is not likely. Most historic military properties already meet the requirements of this prerequisite. No further strategies are required.

Credit 1.1 & 1.2 — Plan for Green Site and Building Exterior Management (1-2 Points)*

Intent—Encourage grounds/site/building exterior management practices that have the lowest environmental impact possible and preserve ecological integrity, enhance diversity and protect wildlife while supporting building performance and integration into surrounding landscapes.

Requirements—Have in place over the performance period a low-impact site and green building exterior management plan that addresses the topics listed below. One point is earned for each four items addressed.

1. Maintenance equipment
2. Plantings
3. Animal and vegetation pest control
4. Landscape waste
5. Irrigation management
6. Fertilizer use
7. Snow removal (where applicable)
8. Cleaning of building exterior
9. Paints and sealants used on building exterior
10. Other maintenance of the building exterior

Sustainable design and development overview

Maintenance is an important component of management practice and communication of maintenance policies is vital to ensuring long-term site integrity (Hitchmough 1994). However maintenance policy is not simply a matter of implementation; it involves complex biological and social systems that require educated personnel (Hitchmough 1994). Green maintenance procedures are similar to traditional procedures, with the difference being a matter of focus rather than technique (Ashkin et al. 2000). One primary focus is protecting the health of site occupants. Executive Order 13101, Section 201 defines 'environmentally preferable' products as "[p]roducts or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, rescue, operation, maintenance, or disposal of the product or service." Composting, for example, targets many of these processes and hence contributes to several of the ten LEED-EB-specified management topics listed above. Compost can act as soil amendment, mulch, or topdressing (thus

* A maximum of 2 points can be earned under this credit. If all ten topics can be addressed, consider applying for Innovation credit for excess points.

reducing water needs) while reducing erosion and weed control. It reduces energy waste, maintenance costs, and negative environmental impacts.

Historic preservation overview

For preservation purposes, while management plans alone do not impact historic sites, implementation of plans can. Therefore, preservation issues presented here address execution aspects of the plan rather than the plan itself.

Site and building exterior management strategies are broad in scope and applicability, and therefore they can affect historic sites in countless ways. It is generally understood that they should not damage, alter, or destroy historically significant site features. Measures should be taken to protect and preserve these features *before* implementing any management strategies. If the potential for damage is high, alternative strategies should be employed. However, if negative impacts are unavoidable, minimize their effects with appropriate repairs or replacements. If any management strategies require new construction, the materials, size, placement, and visual effects of the new site additions should be taken into consideration to address historic integrity and character concerns.

Acquiring points under this credit can be relatively easy for historic sites since many of the strategies involve preventative maintenance or restorative efforts that protect site integrity. Furthermore, if properly implemented, many of these strategies have no visual component that could degrade historic site character.

Subtopics

A low-impact green site and building exterior management plan should include: overall site management practices, planting/wildlife plans, chemical/fertilizer use, pest management/snow removal practices, and building exterior cleaning and maintenance practices. The plan should also consider the interdependence and interconnectivity of the site and surrounding ecosystem (Fournier and Zimnicki 2004, 4). The grounds manager and staff tasked with implementing the plan should be well trained in chemical use and application, and should be licensed where applicable (Ashkin et al. 2000, 16). Green site and building exterior management plans should be updated at least every five years.

1. *Maintenance equipment*

Most historic preservation conflicts related to maintenance equipment will fall under SOI Standard 7 on treatments. [SOI Standards: 2, 7.] This standard promotes the use of gentle, appropriate chemical or physical treatments so that maintenance in no way damages, alters, or otherwise impacts historic materials. For example, chemicals leaking from equipment can cause erosive damage and/or stain significant historic site features and thus may constitute a conflict with SOI Standard 7.

Strategies

Develop a policy on the use of maintenance equipment. The primary objective is to reduce exposure of site users and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants, which adversely impact air quality, health, material finishes, and the environment. This can be accomplished through the development and implementation of a policy for the use of site equipment that effectively reduces environmental impacts. A written equipment policy is the best way of ensuring that quality work is executed cost-effectively on a continuing basis. The policy should provide a framework for the successful integration of staff, landscape, and equipment (Hitchmough 1994).

Develop an equipment and vehicle maintenance plan. This plan would address waste and pollution reduction by introducing safer alternative practices including the dry clean up of spills, proper washing procedures, regular equipment inspection and repair, recycling of solvents, and elimination of connections to the sanitary sewer from drains (EPA, NPDES 2005).

Prevent site contamination from maintenance equipment (e.g., spilling gasoline). In 2005 the EPA produced a report in conjunction with the National Agriculture Compliance Assistance Center that outlines the main categories of concern for vehicle and equipment maintenance repair. These categories include: used oil, spent fluids, batteries, and machine shop wastes. Without proper handling, storage, and protection from weather, these wastes can be released into the environment causing contamination of surface waters, groundwater, and soils, as well as toxic releases to the air (EPA, *Vehicle and Equipment Maintenance and Repair* 2005). In addition, PWTB 200-01-13, *Source Information for Petroleum, Oil, and Lubricant (POL) Spill Containment and Cleanup Materials*, out-

lines EPA oil spill regulations and provides information on items that might be included in oil spill cleanup kits for use in POL storage areas.

Place fuel tanks over drip pans that can contain 110% of tank volume. Cover tanks and pans in inclement weather and when work is not in progress (UFGS-01355A 2005, 26). Tanks can leak over time and should be outfitted with drip pans to prevent spillage. Fuel can cause fires, contaminate soil and ground water, kill plant material, and stain manmade site features.

Maintain the safety and proper operation of onsite refueling stations (USGBC, LEED-EB Reference Guide 2005, 61).

Follow manufacturer recommendations for proper operations and maintenance of building/site systems and equipment including warranty requirements. Systems and equipment need regular monitoring and maintenance for efficiency, and to avoid damage or failure. Proper maintenance and use of equipment not only saves money and time, but it often reduces environmental impacts (e.g., leaking gas, oil, or lubricant) on the landscape. Though it may seem obvious to maintain and monitor equipment for quality performance, too often machines are expected to operate like they did when purchased without intervention (Thompson and Sorvig 2000, 276-77). Green Seal has standards for site equipment that are intended to reduce the negative impacts of maintenance equipment.

Keep a log for all powered equipment to document the date of equipment purchase, use (date and hours), fuel and lubricants used, problems encountered, name of operator, and all repair and maintenance activities. Include vendor cut sheets for each type of equipment in use in the logbook.

Regularly inspect permanent site equipment, mechanical apparatus, and water quality of fountains, pools, and ponds (USAF, *Landscape Design Guide*, “Maintenance” 1998, 3.4).

Reduce the size and use of power equipment to save the site from noise pollution, abusive mower blades, soil compaction, emissions, and also to save money (Thompson and Sorvig 2000, 276-77). The age of equipment is also important; the newest handheld power tools produce 70% lower emissions and some models consume 30% less fuel (Thompson and Sorvig

2000). Use equipment made after 1997 that meets higher EPA emissions standards.

Plan for eventual machinery use in the site design to reduce the impacts of machines on built and natural site features. For instance, if turf is planted immediately adjacent to a tree, larger mowing and maintenance equipment can damage the tree trunk, inviting diseases and risking the health of the tree.

Purchase/use powered small spark-ignition engine equipment that has been regulated by the EPA Phase 1 rule (low-emissions) and is equipped with vacuums, guards and/or other devices for capturing fine particulates. The Agency requires that the engine manufacturer label the equipment with: "this engine conforms to Phase 1 U.S. EPA regulations for small non-road engines" or language that indicates compliance with both EPA and California regulations.

Choose electric or propane instead of gas-powered machines. Gasoline has a lot of negative environmental effects, both in production and use. For example, choose electric instead of gas-powered mowers. The Green Seal report entitled *Lawn Care Equipment* states that "[t]he average gasoline mower tested by the EPA emits in 1 hour of operation the same amount of hydrocarbons that a 1992 Ford Explorer emits over 23,600 miles" (Green Seal, *Lawn Care Equipment*, 1998). Alternatively, using reel mowers is an energy-free option that provides the added benefits of reduced noise (no motor), mulch (from the clippings), and waste reduction (not sending the clippings to a landfill).

Reduce the use of electric- and gas-powered maintenance equipment to decrease power and fuel consumption. Use battery-powered equipment that is equipped with environmentally preferable gel batteries or rechargeable batteries. Powered equipment should be ergonomically designed to minimize vibration, noise, and user fatigue.

Do not use weed eaters in mulched beds or around younger trees. Guards are available for trees; however there is no protection for herbaceous ground plants (Ashkin et al. 2000, 23).

Use newest technology vacuum-assisted dry sweepers to remove sediment and pollutants from streets and parking lots, potentially achieving a 50-

88% overall reduction in the annual sediment loading (EPA, *NPDES* 2005).

Use the most efficient tool for the job. If possible, select a tool with low horse-power and fuel consumption. Consider manual tools if speed is not an issue (Thompson and Sorvig 2000).

Use the lightest equipment possible to avoid soil compaction and site damage. This strategy benefits both preservation and sustainability goals by reducing destructive habits on the site.

Use hand labor when it is reasonable to do so (Thompson and Sorvig 2000). Despite advances in machinery, human labor is still often the most energy efficient way to accomplish certain tasks. This is especially true when dealing with awkward terrain, irregular materials, or artistic care (Thompson and Sorvig 2000). Human labor can be estimated at about 300 Btu/hr or 2,500 Btu/day, comparable to only a few electric motors that manage to run on fewer than 500 Btu/hr and petroleum-fueled machines using 10,000 Btu per hour or more (Thompson and Sorvig 2000). Human effort is renewable energy, while virtually all machine energy comes from nonrenewable resources.

Clean equipment responsibly. Follow federal, local, and state regulations for spill notification, cleanup, and disposal. Use hoses that turn off when not in use. Use biodegradable soaps.

Clean all previously used equipment prior to bringing them onsite to avoid the threat of soil residuals (e.g., cross-contamination by eggs from pests and by seeds from noxious weeds and non-native plants) (UFGS-01355A 2005, 26). Preemptive cleaning can circumvent the introduction of intrusive and historically incompatible plant material onto the historic site that may conflict with SOI Standard 9.

Change oil and clean or replace air filters regularly. Use the proper fuel/oil mixture in two-stroke equipment. Get periodic tune-ups, maintain sharp mower blades, and keep the underside of the deck clean. Winterize equipment each fall (EPA, *Your Yard and Clean Air*, 1996). Contact local state environmental agencies for information about local oil recycling programs.

Recycle old equipment (EPA, *Your Yard and Clean Air*, 1996).

Buy or rent equipment, large or small, that has low fuel consumption, pollutant emission, and ground pressure. Insist on getting information about fuel consumption per hour, pollutant emission, and ground pressure (Thompson and Sorvig 2000). Ground pressure is the pressure exerted on the ground by the tires or tracks of a motorized vehicle; it can indicate potential mobility, especially over soft ground (Wenger 1984, 499).

Cut down travel miles and fuel costs to the site through car pooling and regular tune-ups of maintenance vehicles.

Involve the maintenance contractor to help spot maintenance issues that require redesign, and to prepare a maintenance calendar (Mendler and Odell 2000, 63-64).

Educate occupants and staff on green design and how to ensure benefits of a high performance workspace (Mendler and Odell 2000, 63-64). Use the EPA listings of pollution prevention equipment, products, and services found at http://es.epa.gov/vendors/.

2. Plantings

On military installations, the comprehensive historic site layout or design is typically more significant than the component plant specimens. However, the plant material itself may be considered significant as a character-defining feature if a planting design was done by a notable landscape designer or landscape architect. Nonetheless, replacing non-sustainable plant material with ecologically compatible species is acceptable under the SOI Standards as long as the substitutes maintain the original character (habit, form, color, texture, bloom, fruit, fragrance, scale, and context) of the historic plantings (Birnbaum and Peters 1996, 66). Maintaining these characteristics with turfgrass alternatives (e.g., native grasses) is more problematic. [SOI Standards: 2, 3, 6, 8, 9, 10.]

Strategies

Develop a site plan based on historic site design using plants tolerant of soils, climate, and water availability. Maximize the use of native plants and plant variety (Mendler and Odell 2000, 43). The planting plan should address site conditions such as dryness, slope, shadiness, soil texture (clay, loam, or sand), estimated soil depth, and direction of exposure (Ashkin et al. 2000, 11). Choosing plants appropriate to a region may conflict with

historic site design if exotics were used during the historical period of significance. Yet exotic and inappropriate plant material is often cumbersome and expensive to maintain due to irrigation, fertilizers, and pesticides requirements, and will still suffer in harsher climates. Therefore use plants that maintain overall historic site character while thriving in specific site conditions.

Include in the planting plan best management practices for new and existing vegetation, especially trees. Proper planting, watering, pruning, and general care of plants and trees provide long-term health and vitality, and maintain their aesthetic and energy conservation value (USAF, *Landscape Design Guide*, "Maintenance" 1998, 3.3). Since different types of plants require different types of care, best management practices (BMPs) can involve many aspects of plant care such as: where and how vegetation is planted and irrigated, sun exposure, partial and rejuvenation pruning, winter protection, grass mowing, bush sculpting, and prairie burning. Vegetation BMPs can get complicated when there are multiple species varieties (especially exotics) located on the site. For large-scale sites it is important to have someone trained in horticulture or a related field to properly care for the needs of different plants.

Include in the planting plan proper soil preparation procedures. Soil cultivation, subsoiling (or deep tillage), removal of pest plants, and improving soil texture and nutrition help plant survival and vigor, reduce later maintenance, and make for a more attractive site (Ashkin et al. 2000, 13).

Provide soil testing for organic, inorganic, metals, and microbiology concentrations including fecalfolia, polychlorinated biphenyls (PCB), hydrocarbons, dichlorodiphenyltrichloroethane (DDT), lead, arsenic, vinyl chloride, and mercury. Remediation can involve soil cleansing or removal that can adversely affect the ground plane of the historic site and disturb archeological resources.

Procure soil testing every 6 months to determine the pH and nutrient requirements of plant material. Use the test to determine what (if any) amendments are needed.

Implement the site plan using native and regionally appropriate plants suitable for the site conditions. Identify those that naturally occur together and plant according to these groupings. Choose species that not only can

survive the region and onsite microclimates, but also form dense clumps and/or do well on heavily disturbed soils (Ashkin et al. 2000, 11). Cluster the species groups by water use to promote large root systems, prevent erosion, and reduce water waste. University ecology, botany, and forestry departments and botanical gardens are good sources for acquiring native plants (Ashkin et al. 2000, 11-12).

Eliminate high input decorative lawns and reduce the negative environmental and human impacts from poorly managed turfgrass. “In the United States, 1,400 species of 170 genera of grass are indigenous. Of the 14 species that the Lawn Institute claims are suitable for turf, only two are native—buffalo grass (Buchloë dactyloides), and red fescue (Festuca rubra)” (Daniels 1999). Traditional lawn maintenance utilizes a lot of resources and if done improperly can cause poor lawn performance. Since the grass planted often is inappropriate for the regional climate, large amounts of water are used to keep it alive and hazardous chemicals are applied to prevent disease and improve color. Furthermore, gasoline-powered machines are typically utilized in its care, thus polluting the air.

Make practical use of turfgrass. Provide a planting plan with contour lines that shows no turfgrass on slopes in excess of 25%, in shady areas (less than 70% sunlight), or within 50 ft of creeks and wetlands. Also provide a turfgrass management plan that includes turfgrass BMPs and fertilizer and pesticide use plans.

Plant turfgrass alternatives such as native or drought tolerant grass mixes adapted to the particular region (Daniels 1999). Work with the appropriate National Resources Conservation Service (NRCS) Plant Materials Center to establish native grass plots or meadows. This minimizes mowing, fertilizer use, and weed control while increasing wildlife habitat, seasonal variability, and water infiltration (Ashkin et al. 2000, 17). This may not be possible on historic sites where meadows are not consistent with historical design precedents.

Leave grass clippings on the lawn to replenish nitrogen in the soil and reduce organic waste.

Consult a Pest Control Adviser (PCA) or equivalent before utilizing any pesticides as defined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Aerate turfgrass areas that receive heavy traffic (i.e., areas that receive compaction from more than 50 people or 1 vehicle per day) every fall to reduce compaction and water saturation (USAF, *Landscape Design Guide*, "Maintenance" 1998). Aerating in the spring can invite weed seeds to germinate. Aerate areas less than 100 square feet with a hand aeration tool. When aeration is complete, apply a thin layer of organic matter (e.g., composted manure and/or peat moss mixed with sand and/or topsoil) to the entire surface of the lawn to encourage new turf growth while discouraging weeds.

Cut grass no shorter than 2.5 in. Taller grasses develop have deeper roots and are less susceptible to erosion, drought, and pests (Mendler and Odell 2000, 43).

Keep turf at least 12 in. away from the trunks of young trees to minimize growth-retarding effects and to avoid trunk damage from string trimmers and mowers.

Use only fertilizers made with materials approved and recommended by the Ecological Landscape Association (ELA).

Properly calibrate spreaders for any chemical applications. To determine how much is released in a specific area by a particular spreader, spread out a tarp, run the spreader over the entire tarp area once, and weigh the amount of chemical that is collected on the tarp. Adjust the spreader to apply the appropriate amount per manufacturer instructions (Sachs 1996).

3. Animal and vegetation pest control

Pesticide use is problematic because (1) it can be harmful to on-site humans, plants, and animals and (2) pesticide-polluted runoff can adversely affect downstream aquatic life. Many unnatural chemicals are found in the human body, which is not surprising considering pesticides have been found in drinking water and in household dust. For DoD, issues related to pesticides are addressed in DODI 4150.7 and DODD 4715.1, reference (a). [SOI Standards: None.] The reduction of these harmful chemicals should have no preservation impacts, except the benefit of protecting historic fabric from potentially damaging chemicals.

Strategies

Establish a safe, effective, and environmentally sound integrated pest management (IPM) program to prevent or control pests and disease vectors that may adversely impact readiness or military operations by affecting the health of personnel or damaging structures, material, or property (DODD 4715.1 para 4.1).

Establish an installation pest management plan that addresses achieving, maintaining, and monitoring compliance with all applicable Executive Orders and federal, state, and local statutory and regulatory requirements (DODD 4715.1 para 4.2).

Incorporate sustainable IPM philosophies, strategies, and techniques in all aspects of pest management planning, training, and operations. This includes installation pest management plans and other written guidance to reduce pesticide risk and prevent pollution (DODD 4715.1 para 4.3).

4. Landscape waste

A significant portion of our landfills is composed of organic waste. Of the total tonnage of municipal solid waste generated in 2001, 12% was vegetation materials (EPA, *Municipal Solid Waste*, 2005). Grass clippings, branches, leaves, and other kinds of natural accumulation should be removed from the waste stream to reduce landfill tonnage. Excess plant material can be reused in the landscape with practices such as chipping and composting. [SOI Standards: 1, 2, 9, 10.] Onsite holding areas for excess plant material should be placed in areas that do not interfere with historic site features and the visual integrity of the site.

Strategies

Conduct a waste stream audit of the ongoing organic waste stream (not specific upgrade project waste) to establish a current site landscape waste baseline. Organic waste includes all kinds of vegetative waste (e.g., grass clippings, pruning waste, fallen leaves, fruit, and dead trees and branches). Then evaluate how each type of waste identified in the waste stream can be reduced through composting.

Develop a management policy and plan for reducing the site waste stream that includes on- and off-site reuse where possible.

Implement the site waste stream plan to reduce the waste stream through on-site or off-site compost strategies and maintenance education. Compost organic waste onsite or deliver organic waste to a local composting facility or equivalent.

Use organic waste as compost; it encourages better plant growth, works as effective erosion control and slope stabilization, reduces the landfill volume, improves water-holding and drainage, and reduces weeds and the need for herbicides and fertilizers (Thompson and Sorvig 2000, 81). Public Works Technical Bulletin 420-49-14, *Composting for Army Installations*, provides information on composting technology and procedures that can be implemented at military installations.

Chip dead branches and trees for landscape border mulch.

Seek a location with easy access and correct environmental conditions for on-site composting. Review local requirements (Mendler and Odell 2000, 58).

Leave grass clippings on the lawn to decompose and return nutrients back to the soil, rather than bagging and disposing of them (EPA, *Municipal Solid Waste*, 2005).

Use reel or mulching mowers to reduce yard waste, fertilizer needs, and water consumption (USGBC, LEED-EB v. 2 2005, 17). Reel mowers can provide mulch without noise or gasoline use.

For off-site composting, identify local composting facilities. Then locate a temporary holding area with easy access for pickup (Mendler and Odell 2000, 60).

5. Irrigation management

Waterwise Site Design (a site designed and constructed to use water efficiently), offers many strategies to effectively reduce water use at the site (Thompson and Sorvig 2000, 159). Creating a more efficient site conserves water, labor, and equipment use, thus reducing resource costs. Furthermore, reducing excessive water use onsite reduces the burden on the water supply, as well as the treatment and delivery systems (USGBC, LEED-EB Reference Guide 2005, 35).

Strategies

Develop an irrigation management plan that (1) outlines when and how to irrigate, (2) reduces potable water use for irrigation, (3) encourages the planting of drought tolerant plant species, and (4) utilizes advanced irrigation systems. Also include provisions for the maintenance and monitoring of irrigation systems and their performance over time. [SOI Standards: 2, 6, 9, 10.] Note that poor plant substitutions can negatively impact historic site integrity. The installation of mechanical irrigation systems should be carefully planned to avoid damaging historic site features during digging.

6. Fertilizer use

Non-agricultural lands used at least 6% or over 2,650,000 tons of fertilizer in the United States in 1997 according to those states reporting data to the Association of American Plant Food Control Officials (AAPFCO) (Battelle 1999). Soil-amending fertilizers are overused, and they often encourage weak and weedy species to replace hardy natives. Artificial fertilizers involve hazardous chemicals and nonrenewable resources in production and have considerable energy costs. Use of compost, organic fertilizers, and manures reduces the need for fertilizer and leads to healthier and sturdier plants (Thompson and Sorvig 2000, 80-81). As with pest management, fertilization requirements are site- and species-specific. [SOI Standards: None, unless noted otherwise.] Fertilizer use is a maintenance-based action that should have no negative impact on historic sites if applied properly.

Strategies

Plan for fertilizer use onsite. Consider organic fertilizers. Reduce the use of unnecessary fertilizers, which can adversely affect environmental health.

Utilize appropriate regional vegetation to reduce the need for fertilizer application. Choose plants that maintain historic site character (i.e., massing, shape, etc.) but that also have fewer maintenance demands. [SOI Standards: 2, 3, 6, 9, 10.]

Know your local conditions (regional weather) and soil components to inform any soil amending (Thompson and Sorvig 2000, 80).

Test soil (lawn and garden separately) every two years to determine pH and soil fertility. Use test results to determine what (if any) amendments are needed. The standard soil test provides the status of phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), pH, exchange capacity, lime requirement index, and base saturation. Additional tests are also available for iron (Fe), zinc (Zn), manganese (Mn), soluble salts, and nitrates (Ohio State University Fact Sheet, *Soil Testing*, 2001).

Use only fertilizers made with materials approved and recommended by the Ecological Landscape Association.

Apply all fertilization in compliance with the 1998 American National Standards Institute (ANSI) report A300 (Part 2), *Tree, Shrub, and Other Woody Plant Maintenance-Standard Practices (Fertilization)*. This report provides guidance in preparing maintenance specifications, including information (the interrelationship among plants, soil, nutrients, and water) that should be considered when planning, developing, and managing plant nutrition programs (Harris et al. 2004).

Document all fertilizer applications, including: date, time, wind condition, temperature, humidity, volume applied, and method of application.

For sites larger than 1 acre, follow the Association of American Plant Food Control Officials' model Uniform State Fertilizer Bill or state regulations about (1) required registration and/or licensing of each brand and grade of fertilizer and (2) a guaranteed analysis, whichever is more stringent.

Eliminate fertilizer use after the first year of vegetation establishment.

Avoid over-fertilization, especially on relatively undisturbed and healthy native soils, and avoid exotic plants that require excessive fertilization (Thompson and Sorvig 2000, 80-81).

Use organic fertilizers on a regular schedule. Irregular fertilization can cause more harm than good (USAF, *Landscape Design Guide*, "Maintenance" 1998, 3.3).

Limit the use of nitrogen fertilizers; plants can only take in so much and the rest becomes pollutant. Nitrogen is the most expensive macronutrient

in fertilizer and the most polluting to manufacture (Ashkin et al. 2000, 14).

Any nitrogen fertilizer used should be coated with a time-release substance such as SCU (sulfur coated urea) to increase effectiveness and reduce nitrogen waste (Ashkin et al. 2000, 15).

Never apply more than 250 lbs/ac nitrogen active ingredient at one time, and never apply nitrogen fertilizer more than three times a year (Ashkin et al. 2000, 15).

Use compost to decrease the need for fertilizer (Thompson and Sorvig 2000, 80-81).

Apply fertilizers around the specific rooting zone or base of target plants as much as possible (Ashkin et al. 2000, 14).

Do not apply fertilizers before a rain event.

Apply each nutrient separately. Phosphorous and potassium need application only every 3 to 5 years, even in soil originally deficient. In forested areas, one application after planting is usually all that is needed. If nitrogen is needed based on the soil test, once per year is sufficient for regular growth in most soils. Refer to the soil test for deficiencies before applying fertilizers.

7. Snow removal (where applicable)

Though not applicable in every region or season, conventional efforts to remove snow can have serious environmental consequences. Chemical deicers including sodium chloride are toxic to animals and plants, can irritate the paws of pets, and pollute the environment. Sodium chloride has been used to 'salt' roads since the 1930s; by the 1970s, 8 million tons were applied annually to roads in the United States (Forman et al. 2003). In addition to sodium chloride, road salt can also include doses of heavy metals and essential plant nutrients (such as iron), which travel to water bodies as contaminated road runoff (Forman et al. 2003). Other problems caused by this road runoff include groundwater contamination, corroded bridges (adding heavy metals to streams), attraction by certain animals to roadways (increasing road-kill rates), severe losses of roadside plant

communities (especially during droughts), and soil compaction that reduces soil permeability (causing erosion) (Forman et al. 2003).

Strategies

Create a plan for snow removal on the site. Include provisions that reduce both chemical use and mechanical means when possible. Include best management practices for chemical use that reduce pollutant levels along roadways with either pollutant mitigation (trapping and detaining runoff to allow pollutants to settle out or be filtered) or source control (land use planning, chemical storage, and bridge maintenance) (Forman et al. 2003). [SOI Standards: None.]

Calculate contaminant load for site based upon meltwater analysis and volume estimates. [SOI Standards: None.]

Use no salt for snow removal. Avoid salt and salt additives altogether by using mechanical controls and/or environmentally friendly chemicals. This can reduce exposure of site users and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants that adversely impact air quality, health, material finishes, and the environment. [SOI Standards: None.]

Use snow removal methods appropriate to the weather conditions and the situation. Shoveling, ice crackers, and brooms are the most environmentally healthy options for snow removal. [SOI Standards: 7.] Gentle shoveling or sweeping is necessary on or near historic structures and materials.

Do not use clay cat litter or ash. Although they offer some traction, they do not melt snow and are difficult to clean up. [SOI Standards: 7.]

Plant grass ‘snow fences’ to reduce snow drifts on roadways. [SOI Standards: 2, 9, 10.] If they have no historical precedent on the site, keep snow fences outside of historic viewsheds.

For filtering constructs, choose fine-grained loamy soils with a sufficient organic contact that will trap potential contaminants, such as metals. Do not construct filtering systems in sandy soil and avoid siting filters in areas with shallow bedrock. [SOI Standards: 2, 9, 10.]

Optimize chemical use. [SOI Standards: 7.]

- If chemicals must be used, check standards for minimizing use and proper storage to avoid polluting local soil and groundwater (EPA, *Manual for Deicing Chemicals*, 1974). [SOI Standards: None.]
- Remove snow and ice in a timely manner to avoid traffic compaction and to decrease the need for chemicals (Ashkin et al. 2000, 27).
- For more severe weather conditions, apply an ice melter before precipitation to maximize effectiveness (Ashkin et al. 2000, 27).
- Use calcium magnesium acetate (CMA). CMA is made from limestone and acetic acid. It is reported as being biodegradable, having no toxic effects on terrestrial or aquatic animals, and having no negative impacts on soils or vegetation (Wyatt 1989). Although CMA is more expensive than salt, the costs of repairing roadway structural damage and ecological impacts caused by salt make it a worthwhile alternative (South Dakota Department of Water and Natural Resources 1990).
- In addition to CMA, use sand, potassium chloride, or magnesium chloride ice-melting products instead of sodium chloride or calcium chloride. They are less damaging to plants, concrete, carpeting, and hard surface flooring. However, since these alternatives have their own pollution concerns, use as little as conditions will allow (Ashkin et al. 2000, 27).
- Reduce the need for de-icing chemicals through selective closing of redundant stairs, sidewalks, and roads (Ashkin et al. 2000, 27).
- Proper calibration of the spreader can minimize overuse (EPA, *Storm Water Management Fact Sheet*, 1999).
- Store deicing chemicals properly. Store salt in an enclosed structure with a foundation that is higher than the surrounding terrain. The floor must be impervious and strong enough to withstand the weight of the loading equipment. Brine runoff from the storage container should be contained in a lined collection basin.

Optimize use of machinery.

- If a snow removal machine is needed, use those that run on electricity instead of gasoline. [SOI Standards: None.]
- Improve mechanical removal strategies by increasing the frequency of shoveling, brushing, or plowing (Ashkin et al. 2000, 27). Use machines that do not overly compact soil. [SOI Standards: 7.] Mechanical snow

removal can damage historic features (e.g., paving materials or vegetation) if not performed in a responsible way.

- Designate a place to pile removed snow that will not be damaged from the snow load. Consideration should also be made for snowmelt in terms of the concentration of water on the site. [SOI Standards: 1, 2, 9, 10.] Consider only locations for snow piling that avoid damage to historic features including plant material.
- Minimize chemical release onto the site and into the local watershed from the snow piles. Select snow piling sites with adequate filtering capabilities. Snow disposal sites must be located in areas where there is enough top soil depth (approximately 2 ft between the ground surface and water table) to act as a filter. If the disposal site drains to a surface water body, the meltwater must drain first into a detention area (minimum depth of 2 ft) with a filter berm (minimum height of 1.5 ft) and cross a gravel or erosion-resistant buffer zone between the filter berm and surface water. Disposal sites must not be located in areas designated for wellhead protection and should be located down gradient. The disposal site must be at least 100 feet from surface water bodies. Enclose all disposal sites with grass snow fencing. Disposal sites should not be located in areas susceptible to erosion, in sections of parks or playgrounds that will be used for direct contact recreation after the snow season, on sanitary landfills, in wetlands, or in quarries. [SOI Standards: 2, 9, 10.]
- Workers operating machinery should be properly trained and wear safety goggles and ear protection (Ashkin et al. 2000, 27). [SOI Standards: None.]

8. Cleaning of building exterior

Cleaning products can be toxic to humans, animals, and vegetation in proximity to them. Cleaning chemicals can also pollute groundwater. Common cleaning products can damage the material integrity of site features. They can also damage vegetation directly or by leaching into the soil.

Strategies

Utilize an environmentally responsible exterior building cleaning plan to ensure positive air quality and occupant health (Fournier and Zimnicki 2004, 56). Environmentally safe cleaning and maintenance products may cost more. However, the human and environmental benefit from their use

is typically thought to outweigh this cost in terms of quality of life.* [SOI Standards: 7.] To minimize the impact on historic features, choose responsible cleaning products that have little or no impact to historic materials, surfaces, and finishes.

9. Paints and sealants used on building exterior

Paints, finishes, and sealants often contain Volatile Organic Compounds (VOCs). Also until 1978, paint containing lead was commonly used on building interiors and exteriors (EPA, *Lead in Paint, Dust, and Soil*, 2005).

Strategies

Develop a building exterior maintenance plan that emphasizes the use of durable coatings with fewer negative environmental impacts. Include in the plan provisions for the storage and disposal of chemicals. [SOI Standards: None.]

Reduce or eliminate the toxic impact of paints, finishes, and sealants. [SOI Standards: 6, 7.] Most historic buildings predate 1978 and therefore were originally painted with lead-based paint. Historic preservationists have since had to find safer paint alternatives. Note that some of these alternatives may not be available in historically correct colors or effects.

10. Other maintenance of the building exterior

Proper planning for the site and its maintenance is essential to reducing wasteful and toxic practices. Planning is also critical to maintaining historic site character. Educating those involved is the only way to ensure that environmentally friendly and preservation friendly practices are implemented and maintained.

Strategies

Include in the building exterior management plan green maintenance practices and materials that minimize environmental impacts. Greenseal

* According to an April 1998 report by the Massachusetts Department of Public Health, more than 10% of its reported work-related asthma cases listed cleaning agents (e.g., bleach, chlorine, floor stripper, ammonia, sodium hydroxide, muriatic acid, detergents, and disinfectants) as the suspected asthma agent (EPA, Cleaning National Parks 2000).

recommends and certifies green products and equipment that may be appropriate for the site. [SOI Standards: None]

Design a Historic Site Management Plan to protect and maintain historic site features. [SOI Standards: None] The plan should include provisions for using the least degree of intervention possible when maintaining historic features (e.g., repairing brick pavements or masonry walls, regrading a silted swale, or replacing deteriorated features in part or whole) (Birnbaum and Peters 1996). The plan should also address protecting historic features from damaging situations, materials, and processes. Examples may include: avoiding heavy materials or machinery on historic paving, testing cleaning chemicals before use on historical features, and protecting historic site furnishings from damage during maintenance.

Credit 2 — High Development Density Building and Area (1 Point)

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

Requirements—Occupy a building that has a density of at least 60,000 square feet of building floor space per acre located within an area with a density of at least 60,000 square feet of building floor space per acre (two-story downtown development). The goal is to encourage the occupancy of high development density buildings in high development density areas. Once earned and for subsequent re-certifications, the only requirement is that the building itself have the required density.

Sustainable design and development overview

The farther a site is located from urban cores and infrastructure, the more the building occupants become dependent on automobiles, increasing air and water pollution. Urban development is a way to confine sprawl, utilize existing infrastructure, and conserve dissipating greenfields, local habitat, and natural resources (USGBC, LEED-NC Reference Guide 2003, 20). Not only does this credit promote new construction in urban areas, but it also encourages the use of existing high density buildings in the form of adaptive reuse. Reuse can be extended to include preexisting site features, utility infrastructure, and transportation systems, thereby drawing development away from undeveloped areas, protected lands, and nature preserves.

Although DoD installations vary from dense urban to remote rural environs, many were initially sited in isolated areas for safety and security reasons. Today the typical military installation is comprised of one or more cantonments, large tracts of training lands, and security buffers. The result is generally a low overall development density (Paladino 2001, SSc2). In keeping with the intent of this credit, development on DoD installations should be focused in urban areas or on cantonments where higher concentrations of facilities and infrastructure exist. Point accumulation for this credit will depend on the existing or planned density per acre. Buildings that meet the requirements of this credit will typically be two or more stories in height located in an area of other multi-story facilities. The LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects offers an alternative to density requirements and submittals of this credit by reconsidering the site from a multi-building perspective (USGBC, LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects 2005).

Project managers must also consider the pros and cons of upgrading existing buildings to meet UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*. These standards, depending on building occupancy and size, can require structural reinforcement against progressive collapse, blast-resistant windows, and vehicle access limitations to meet minimum standoff distances in high-density areas. However, existing buildings, depending on occupancy, also qualify for exemptions from some standoff distance requirements if an adequate level of protection is provided. As a result, a new building on the site of an existing building may be forced into a smaller footprint in order to meet standoff distance requirements that the existing building would not.

Historic preservation overview

Many, though not all, historic properties on military installations are located in high-density areas. Section 110 of the National Historic Preservation Act encourages government agencies to reuse historic properties to the fullest extent feasible (NHPA 1966). This federal mandate supports point accumulation for this credit where historic properties are located in high density areas. However, since the site location of historic buildings is pre-determined, there may be limitations to attaining this credit. If a choice exists between multiple sites for sustainable rehabilitation, preference should be given to higher density historic sites.

DoD project managers can encounter obstacles when considering a historic building for renovation. Many project managers cite the unwritten "75% rule" where a renovation is deemed unfeasible if the costs exceed 75% of the cost to construct a new facility of similar size and occupancy. However, installation cultural resource managers will counter that the "75% rule" is not valid with buildings determined to be historically significant. The MILCON requirement of removing an equal amount of existing building square footage in order to obtain approval and funding to construct a new facility often results in historic buildings being the first on an installation demolition list. Older installations with a dense cantonment area are also likely to experience complaints about parking shortages. In response, project managers often historic target buildings for demolition in order to free up land for parking to service other historic buildings. Finally, most military architectural projects are designed by firms previously selected for a multi-discipline indefinite delivery type contract. Firms selected for these contracts are more likely to be familiar with new building design and construction than historic building rehabilitation.

Nonetheless, active and proper management of historic properties can help to reduce impacts to greenfields and natural resources by removing non-historic buildings and structures in historic districts, restoring historic vegetation, reducing impervious areas, and restoring historic buildings and/or original site density. Regrettably, the reuse of historic properties in denser areas can increase the need for parking or driving alternatives (see SS Credits 3.1, 3.2, and 3.4 in this document for more information on parking in historic districts).

Ill-conceived adaptive reuse plans can compromise historic property use and/or integrity. Care should be taken to preserve to the maximum extent feasible those qualities, both exterior and interior, that convey the property's historic character. This treatment should extend to areas surrounding the building, to show relationships between densely developed historic properties that form districts.

Though site alterations may be necessary to adapt individual properties to new uses, modifications should be compatible with the existing historic property. Incompatible uses (those that necessitate extensive modification of the site and thus compromise historic integrity) must be avoided. The construction of new building additions should be constrained to the original building footprint when possible to protect the historic site. Site modifications should ensure a balance between improved environmental conditions and the preservation of historic features, materials, and finishes (Birnbaum and Peters 1996, 88). Consider removing or replacing (i.e., tearing down and building in footprint) any structures (e.g., buildings, storage facilities, or unused site features) that detract from or do not contribute to the significance of a historic property. If replacing a noncontributing structure (instead of just removal), the new structure should be built in the vacated footprint and be in keeping with the historic character of the property without conveying a false sense of history.

Strategies

Avoid construction of buildings and vertical structures in greenfields, protected areas, and nature preserves. [SOI Standards: None.]

Avoid construction of expansive site features such as parking in greenfields, protected areas, and nature preserves. [SOI Standards: None.]

Reduce the need for and amount of parking to limit resource and greenfield use (see SS Credit 6.1 in this document). [SOI Standards: 1, 2.] Reduction or removal of noncontributing parking areas will promote sustainability principles and help to restore the historic integrity of the site. However, paved areas that contribute to the comprehension of a historic site should be preserved.

Put new parking structures on pre-disturbed areas (USGBC, LEED-EB v. 2 2005, 30). [SOI Standards: 1, 2, 9, 10.] An exception is if pre-disturbed areas are historically significant and such structures have no precedent on the site.

Cluster underground utilities in the same or nearby conduits to minimize site disturbance and preserve open space (Mendler and Odell 2000, 52). [SOI Standards: None.] This works in conjunction with historic preservation by reducing the likelihood of damage to historic site features from digging.

Minimize interference with and disturbance and damage to fish, wildlife, and plants, including their habitat. Protect any endangered or threatened species onsite or in the area (UFGS-01355A 2005, 24-25). [SOI Standards: 2, 6.] The impact of biodiversity loss typically outweighs concern for historic plantings, though every attempt should be made to maintain plants that mimic the texture and consistency of historic plantings.

Avoid demolition of contextually appropriate buildings (e.g., historic properties) to make room for surface parking lots in densely developed areas. This is contrary to sustainable design practices and undermines the intent of this credit. [SOI Standards: 1, 2.]

Credit 3.1 — Alternative Transportation: Public Transportation Access (1 Point)

Intent—Reduce pollution and land development impacts from automobile use.

Requirements—Meet the criteria of at least one of the following three options:

- Option A—the building is located within ½ mile of a commuter rail, light rail or subway station.
- Option B—the building is located within ¼ mile of two or more public or campus bus lines usable by building occupants.
- Option C—building occupants are provided with a conveyance (shuttle link) that supplies transportation between the building and public transportation meeting the criteria in Option A or Option B above.

Sustainable design and development overview

Increased use of public transportation can reduce traffic congestion, energy consumption, and vehicular pollution. Consider both current conditions and long-range planning for the region (Mendler and Odell 2000, 9, 46). Alternative transportation also reduces the amount of impervious surface necessary on a site, thus reducing heat island effects (Fournier and Zimnicki 2004, 13).

This credit could either be easy or difficult to achieve on a site, depending on its distance from public transportation. If the site is located in a rural area, it may be difficult or impossible to earn this credit due to a lack of mass transit infrastructure or potential ridership (Paladino 2001, SSc41). DoD installations are often located in areas not serviced by public transport. However some DoD personnel have no personal vehicles and require a mass transit system, and so some installations offer transportation programs (Paladino 2001, SSc41). These programs typically include shuttle bus service that connects personnel with amenities throughout the installation as well as to the neighboring communities. This type of transportation setup could meet the intent of the credit. However it is feasible only if there are enough users for the system.

Regrettably, security issues after 9/11 have reduced the number and frequency of public transportation opportunities on military installations. Some installations may find it more convenient to utilize Option C, which allows public transportation vehicles to remain off the installation.

Historic preservation overview

Many military installations, especially those historically associated with flying fields, weapons storage, manufacturing, or training, were deliberately constructed far away from population centers. Although some of these historic installations have been surrounded by subsequent development, many remain in rural countryside or outlying desert areas. These isolated installations will likely not be able to meet any options in this credit. But for installations in proximity to mass transit systems, careful consideration should be given to viewsheds and overall site design when installing alternative transportation infrastructure on historic sites. Such infrastructure must be integrated with historic vehicular roadways, pedestrian pathways, and building footprints.

Preventing access of mass transit vehicles for security reasons may protect historic resources by limiting construction on the installation of transit-related infrastructure. However, this may simply move construction activities to installation access points such as historic gatehouses. Since 9/11, guard houses, pass and identification buildings, and visitor parking lots have undergone extensive renovation to allow for adequate vehicle approach, turnaround, and search. In many cases, the existing sequence of roads and buildings was completely demolished to make way for new screening complexes. New pavement often encroached on historic districts and nearby historic buildings. Guard house canopies that span multiple access lanes can be out of scale and character with the historic context. Many historic gatehouses have been demolished or moved to a different location. Ultimately, project designers (with input from installation cultural resource managers) must weigh the pros and cons of constructing alternative transportation infrastructure on historic sites within or just outside installation fencelines, with the objective being to minimize impacts to these sites.

Strategies

Planning and operations

Planning for public transportation can save money up front and prevent future capacity problems by negating the need to construct unnecessary additional parking structures. Determine the feasibility of public transportation by calculating the current and projected future ridership, and cur-

rent and potential proximity to public transportation. [SOI Standards: None.]

Work with the existing transportation plan to create an alternative transit strategy and plan for current and long-term needs. Include public transit, bicycle commuting, alternative fuel vehicles, and parking reduction and car pooling strategies. [SOI Standards: 1, 2, 9, 10.] The plan itself will not impact historic sites; however, the plan needs to reflect consideration for historically significant pedestrian and vehicular transportation systems. Avoid designating bus/large vehicle access points adjacent to historic buildings or within historic districts. Use installation access points near historic buildings and districts for egress only, or as secondary entrances that do not require multiple turn lanes, guard houses, and canopies.

Survey building occupants and determine if available mass transportation options meet their needs, especially if parking space is reduced (USGBC, LEED-EB v. 2 2005, 15). [SOI Standards: None.]

Engage public transportation link service providers in the planning and implementation stages (USGBC, LEED-EB v. 2 2005, 120). [SOI Standards: None.]

Explore the possibility of sharing facilities with other nearby sites for transportation link services (USGBC, LEED-EB v. 2 2005, 120). [SOI Standards: None.]

Educate building occupants on options available and encourage the use of alternative transportation. [SOI Standards: None.]

Encourage building occupants to utilize public transit through positive reinforcement techniques, like incentives and pedestrian-friendly linkages. Incentives could include transit subsidies (e.g., free or discounted transit passes). The authorized amount can be determined based on actual cost to commute. Promote the mental and physical health benefits of walking between linkages. [SOI Standards: None.]

Implementation

Provide pedestrian-friendly physical links to subway, bus, or trolley stops or stations (Mendler and Odell 2000, 52). Plan the route to include visual interest at a walking scale. Provide covered or enclosed waiting areas

(Figure 1.4). [SOI Standards: 1, 2, 6, 9, 10.] The location and size of the historic site will determine whether or not new pedestrian links to transportation are possible, helpful, or realistic. If the historic site is isolated, the links could lead to and from the site.

Figure 1.4. Historic bus shelters can fit into the historic context (ERDC-CERL).

If there is no direct link to public transportation on site, provide shuttles to the local transportation systems (Mendler and Odell 2000, 52). The schedule and frequency of shuttle services must be adequate to serve building occupants during standard commuting times for all shifts, as well as periodic service at other times (USGBC, LEED-EB Reference Guide 2005, 47). [SOI Standards: 1, 2, 6, 9, 10.] If shuttles are to be provided, consideration needs to be made for any necessary changes to the historic site involving (1) new construction, (2) new site amenities, and (3) wear and tear in pick up/drop off locations and shuttle fleet areas (i.e., where shuttles rest when not in use). If appropriate for the historic site, add shuttles or pedestrian-friendly walks in a manner that minimizes negative impacts to the site. Generally, use of public transit results in an overall reduction of vehicles and parking on the site. This in turn reduces the invasiveness of vehicles and their associated infrastructure on the historic site (e.g., blocked viewsheds and extensive paving).

Use existing transportation networks to minimize the need for new transportation lines. [SOI Standards: 1, 2, 6, 9, 10.] Care should be given if historic pathways need to be changed to facilitate the use of mass transit or alternative transportation. New pedestrian pathways should be designed

using original pedestrian circulation patterns to maintain the historic building/site relationship (Fournier and Zimnicki 2004, 16). If the relationship between the building and site will change through the introduction of mass transit infrastructure, new pathways added should be in a material differentiating them from the historic pathways. New signage and shelters should be historically compatible in design and materials.

Credit 3.2 — Alternative Transportation: Bicycle Storage & Changing Rooms (1 Point)

Intent—Reduce pollution and land development impacts from automobile use.

Requirements—

- For commercial or institutional buildings, provide secure bicycle storage with convenient changing/shower facilities (within 200 yards of the building) for regular building occupants. Maintain bike storage and shower capacity that is sufficient for the greater of 1% of the building occupants or 125% of peak demand for these facilities.
- For residential buildings, provide covered storage facilities for securing bicycles for 15% or more of building occupants in lieu of changing/shower facilities. These facilities may be provided incrementally as long as the capacity of the facilities supplied exceeds the demand for these facilities.
- In campus settings, if secure bicycle storage and showers are provided for all building occupants on a campus-wide basis, the maximum distance from individual buildings to showers requirement can be replaced with a requirement that two lines be drawn at 90 degrees to each other through the center of the campus on a campus map and that it be documented that the bicycle storage and showers requirements are met for all building occupants within each quadrant.

Sustainable design and development overview

As mentioned previously, increased use of alternative transportation reduces traffic congestion, energy consumption, vehicular pollution, and impervious surfaces on a site (Fournier and Zimnicki 2004, 13). Bicycles are a great alternative option to vehicles for both recreation and transportation activities. Besides the environmental benefit, the exercise from biking leads to a healthier lifestyle. Biking is a popular recreation activity that is enhanced and encouraged by the availability of a safe and well-planned system of bike trails (Army Installation Design Standards 2004, 4.13.1).

Due to the isolated locations of many military installations and the distance between the entry gate and workplace, the commute from home to the installation is often too long to be feasible. However, many installations have been successful in promoting the use of bicycles by staff that regularly visit multiple on-base buildings in the course of a day. This type of bicycle use also requires space where bicycles can be secured overnight and for long periods of time. DoD facilities already have slow vehicular speeds, and with limited cost and planning could make the sites conducive for biking with the addition of bike lanes and safe crossing areas. Military sites are typically made up of multiple buildings with functional relationships between them, and they are relatively self-sufficient like educational and corporate campuses. The campus-like military setting can provide a good framework and rational to introduce bike trails and racks.

Historic preservation overview

The benefits to alternative transportation should be carefully considered in any transportation planning for historic sites. This point should be easily attainable for most historic sites since not only is bicycle use and storage generally less costly and energy intensive than automobile use and parking, but it is also less intrusive. Nonetheless, the footprint of a historic site or building should not be significantly altered to facilitate the use of alternative transportation, and new bicycle racks and pathways introduced should be unobtrusive and designed to maintain the historic building-site relationship (Fournier and Zimnicki 2004, 16). Bike paths, bike racks, and bike storage structures are typically not historic; therefore the introduction of these amenities into a historic site can impact historic integrity.

Providing changing/shower facilities and covered bicycle storage may pose greater challenges on historic sites. The construction of freestanding structures in historic districts or extensive interior modifications to historic buildings may be necessary. Fortunately, historic quarters already provide changing rooms and showers within the homes. But non-housing facilities will likely need building additions or interior rehabilitation. Changing/shower facilities are typically designed to be adjacent to restroom cores for plumbing efficiency. These bike-related amenities could be added when historic building restrooms are expanded to meet Americans with Disabilities Act (ADA) clearances and code-compliant fixture counts. Note that additional space added to an expanded restroom may impact historic rooms adjacent to the original restroom. Furthermore adding dressing rooms and shower facilities in spaces not originally intended for this use may require special treatment of existing windows.

Strategies

Map the existing traffic patterns for pedestrians, bicycles, automobiles, public transit, and other modes of transportation on site and at neighboring locations (Mendler and Odell 2000, 50). [SOI Standards: None.]

Create a Transportation Access Guide, or a document or set of documents that provide concise, customized information on how to access a particular destination by various travel modes, with special consideration of efficient modes such as walking and cycling (Victoria Transport Policy Institute 2005). [SOI Standards: None.]

Encourage site occupant utilization of bicycle transportation and recreation by providing safe and pleasant linkages through the site, connecting to off site trails or pathways.

- Make on site trails or trail segments visually attractive and provide pedestrian amenities like benches, tables, waste receptacles, drinking fountains, and signage in appropriate locations (Army Installation Design Standards 2004, 4.13.5). When these locations are within historic sites, choose amenities and trail design methods that are appropriate to the historic nature of the site. [SOI Standards: 2, 9, 10.]
- Onsite bikeway systems should link to existing routes and destinations within the installation, and be designed using original circulation patterns to the maximum extent feasible (Fournier and Zimnicki 2004, 16). Minimize conflicts between bikes, pedestrians and vehicles (Army Installation Design Standards 2004, 4.13.2). In order to minimize conflicts between varied uses and increase site efficiency, it may be necessary to impact or change historic circulation patterns. If changes occur, it should be made obvious that the additions or changes are not part of the historic site design; new pathways should be constructed in a material differentiating them from the historic pathways. [SOI Standards: 2, 9, 10.]
- Provide a designated right-of-way for bike traffic, separate from vehicular and pedestrian routes (Army Installation Design Standards 2004, 4.13.4.1 and 4.13.4.3) (Figure 1.5). Widening streets or designating part of the roadway for bicycle traffic may not be possible depending on the narrowness of historic streets. When constructing a separate bike trail or enlarging existing roadways to accommodate bicycles, consider how this may negatively affect the historic design. Make new additions to the site distinguishable from historic components. [SOI Standards: 2, 6, 9, 10.]

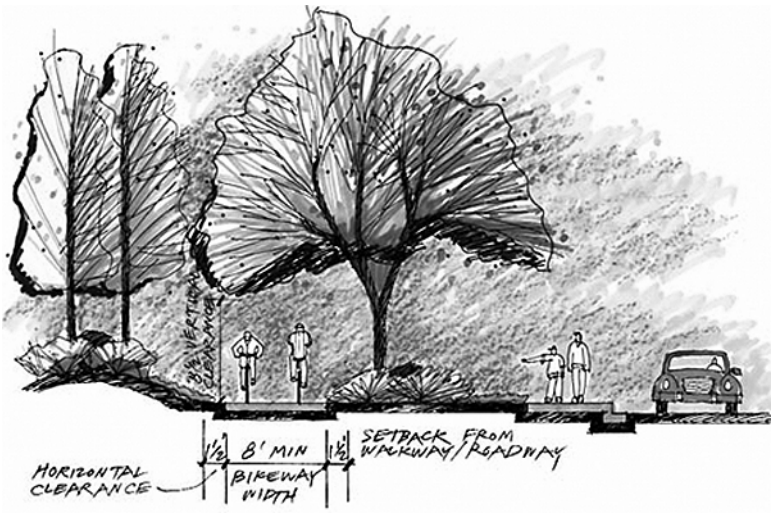

Figure 1.5. A designated bike lane can encourage utilization of bike transportation (EPA n.d.).

- For shading, visual interest, and route definition, use trees that are appropriate for the site (Army Installation Design Standards 2004, 4.13.6). (See the plantings section of SS Credit 1.1 & 1.2 in this document.) [SOI Standards: 2, 6, 8, 9, 10.] If the historic site did not have trees along the pathways or roadways during the period of significance it is still possible to include them for the environmental benefit. However, avoid poor plant selection and over planting with dense or understory plant material. The plantings along a well-designed path will not detract from the historic site design; nor will it block from view important historical site amenities and vistas.

Because bicycle storage by itself can provide an opportunity to reduce more visually disruptive and environmentally detrimental forms of vehicular parking, provide convenient bicycle racks and storage (Mendler and Odell 2000, 52). Consider that bicycles may require secure, overnight or long-term storage. Conceal bicycle storage in the basement of a building or integrate it into parking lot or vehicular garage design. Bicycle storage areas can be designated within these locations, but care should be given to avoid conflicts with pedestrian circulation (National Institute of Building 2005). Bicycle storage areas should be covered (especially at barracks) and easily accessible from buildings (Army Installation Design Standards 2004, 9.13.6). However, bicycles and racks near military building entrances are generally discouraged for security reasons. On military installations this credit may be satisfied by provisions from nearby buildings (see the *LEED-NC Application Guide for Multiple Buildings and On-*

Campus Building Projects for more information). [SOI Standards: 2, 9, 10.]

Provide convenient changing/shower facilities. [SOI Standards: 2, 6, 8, 9, 10.] Ideally showers and changing rooms should be located within existing buildings. If this is not an option, freestanding changing/shower facilities should be designed and located to minimally impact historic site features, including historic views to and from the property.

Consider the reuse of historic outbuildings or unused utility buildings as changing rooms and bicycle storage. [SOI Standards: 1, 2, 6.]

Credit 3.3 — Alternative Transportation: Alternative Fuel Vehicles (1 Point)

Intent—Reduce pollution and land development impacts from automobile use.

Requirements—Have a communication program in place over the performance period that promotes the use of alternative fuel vehicles for building occupants. In addition, meet the criteria of at least one of the following three options:

- Option A—Alternative fuel refueling station(s) for 3% of the total vehicle parking capacity of the site. NOTE: liquid or gaseous fueling facilities must be separately ventilated or located outdoors.
- Option B—Provide (or achieve result in some other way) alternative fuel vehicles or hybrid vehicles for 3% of building occupants and provide preferred parking for these vehicles.
- Option C—Provide preferred parking programs for hybrid or alternative fuel vehicles for at least 3% of the total vehicle parking capacity and increase as necessary the amount of preferred parking to meet the demand for preferred parking up to 10% or more of the total vehicle parking capacity.

Sustainable design and development overview

Increased use of alternative transportation reduces mobile source air emissions and the reliance on foreign petroleum. Alternative fuels for vehicles currently include biodiesel (B20), ethanol (E85), electricity, hydrogen, compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), methanol, and propane. Acquisition and use of Alternative Fueled Vehicles (AFVs) is required for all federal agencies by Executive Order and by the Energy Policy Act of 1992 (EPACT). Part 2, Section 201 of Executive Order 13149 (2000), Greening the Government Through Federal Fleet and Transportation Efficiency, states:

> Each agency operating 20 or more motor vehicles within the United States shall reduce its entire vehicle fleet's annual petroleum consumption by at least 20 percent by the end of fiscal year (FY) 2005, compared with FY 1999 petroleum consumption levels.

The strategy an agency develops to comply with EO 13149 should include provisions fulfilling the acquisition requirements for AFVs established by Section 303 of EPACT. Note, however, that subsections allow exemptions for vehicles acquired and used for military purposes that the Secretary of Defense has certified must be exempt for national security reasons (Office of the Under Secretary of Defense 1997).

Dense cantonments with minimal parking may not be able to assign prime spaces for private hybrid or alternative fuel vehicles since these spaces are

typically assigned by military rank or for government vehicles only. In these situations, the best that can be achieved for private vehicles is to assign them the best of the remote parking spaces, such as those closest to the crosswalk or access drive. Dense cantonments may also have difficulty assigning areas for refueling; refueling stations may have to be located at a remote/common fueling station. The *LEED-NC Application Guide for Multiple Buildings & On-Campus Building Projects* offers an alternative way to satisfy this credit's requirements in multi-building settings.

Historic preservation overview

This AFV credit can be achieved without negatively impacting the historic site or its component features. Careful consideration of historic and existing site conditions is needed to determine how to avoid or minimize any impacts from adding refueling stations or reconfiguring parking to accommodate AFVs. Electrical charging stations are typically discreet units similar in size to a utility meter that are mounted on a wall. These units are easily integrated into historic exteriors, especially if they are located on service elevations. Liquid/gaseous stations, however, may require larger pumps and site area.

Strategies

Planning, communication, and operations

Poll building occupants to determine which alternative fuel type is in highest demand (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]

Compare the environmental and economic cost and benefits of different alternative fuel types to determine which alternative fuel type would provide the highest benefit (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]

Investigate local codes and standards for refueling stations in the area (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]

Compare different fuel station equipment options and fuel availability. The type of alternative fuel determines expense, installation complexity, and whether or not the particular fuel is acquirable for the site (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]

Develop a communication program to convey to building occupants the rewards of any incentive programs, as well as the environmental benefits of alternative vehicles (USGBC, LEED-EB Reference Guide 2005, 61). Positive reinforcement techniques include incentives and preferred parking for AFVs to use.

Train personnel in operation and maintenance of refueling stations (USGBC, LEED-EB Reference Guide 2005, 61). Emphasize safety considerations, including fuel handling, use, safety, and facility maintenance procedures (DoE, Alternative Fuels Data Center 2005). [SOI Standards: None.]

Provide long-term maintenance to assure optimum performance of the refueling station and to ensure that soil around the refueling station does not become contaminated. Procedures for maintaining the safety and proper operation of refueling stations should be included in the Plan for Green Site and Building Exterior Management if applicable (USGBC, LEED-EB Reference Guide 2005, 61). Follow any federal, state, or local regulations regarding alternative fueling stations. These mandates often include (1) notification and registration of any new storage tanks or a change in the use of existing tanks; (2) specific leak detection requirements; (3) leak monitoring tests; and (4) corrosion protection tests (DoE, Alternative Fuels Data Center 2005). [SOI Standards: 7.] Contaminants that come in contact with historic materials can cause physical damage.

The site operator must keep thorough records of the site's design, equipment installations or conversions, maintenance, containment area evaluations, tank monitoring, and inspections. The operator must also conduct a daily 'walk-by' to make certain the equipment is functioning properly and to ensure no leaks are present (DoE, Alternative Fuels Data Center 2005). [SOI Standards: None.]

Replace filters used on fuel dispensers regularly, based on the volume of fuel being pumped through the system (usually every 3 to 6 months) (DoE, Alternative Fuels Data Center 2005). [SOI Standards: None.]

Option A—Provide alternative fuel refueling station(s)

Retrofit existing refueling stations to accommodate alternative fuels. Currently, many DoD installations operate conventional gas stations that

could also dispense alternative fuels (Paladino 2001, SSc43). [SOI Standards: None.]

Build new alternative fuel refueling stations (which may be necessary in isolated locations) taking into consideration existing codes and standards, and finding the right fueling appliances (DoE, Alternative Fuels Data Center 2005) (Figure 1.6). [SOI Standards: 2, 9, 10.] Refueling stations can negatively impact historic sites if located in major viewsheds. Fortuitously, off-site AFV refueling stations (those located elsewhere on the installation) can be utilized (USGBC, LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects 2005).

Figure 1.6. Alternative fuel station (left) and electric refueling station (right) (Texas Department of Transportation; McQuiggan 2005).

Provide electric refueling stations (Figure 1.6). [SOI Standards: 2, 9, 10.] These stations feature an electric plug that would not be invasive on a historic site if the exterior power source was discreetly placed.

Option B—Provide AFVs or advanced technology vehicles (ATVs) and preferred parking for these vehicles

Federal and local incentives are becoming more common for AFVs and ATVs (Advanced Technology Vehicles), especially hybrid vehicles. The American Council for an Energy Efficient Economy (ACEEE) recently produced a list of estimated tax credits for 2005 models and the 'best-available' information online (ACEEE Estimates of Light-Duty Vehicles Tax Credits 2005). San Jose, California, offers free metered and public garage parking to hybrid drivers who purchased their car in the city (Miller 2005). Private incentives have included cash bonuses to employees who purchase hybrids (Hyperion offers $5000; Timberland offers $3000),

while other companies offer preferred parking in company lots or parking coupons for employees commuting in a hybrid (Miller 2005).

- Create an alternative transit strategy for alternative fuel vehicles. [SOI Standards: None.]
- Provide company-owned alternate fueled or hybrid vehicles to building occupants (USGBC, LEED-EB v. 2 2005, 24). [SOI Standards: 1, 2, 9, 10.] AFVs do not negatively impact historic sites unless they require the construction of new onsite facilities to house them.
- Provide preferred parking for AFVs. Preferred parking for AFVs may not be possible on sites with no or limited available parking. Expanding the size of an existing lot to accommodate preferred parking may affect other LEED-EB credits (e.g., SS Credit 4, *Reduced Site Disturbance*; SS Credit 5, *Stormwater Management*; and SS Credit 6, *Heat Island Reduction*) (USGBC, LEED-EB Reference Guide 2005, 62). [SOI Standards: 1, 2, 9, 10.] AFV parking provisions do not impact historic sites if existing parking can simply be redesignated for preferred use. However, if AFV parking must be added to the site, this undertaking could negatively impact various aspects of a historic site.

Option C—Preferred parking programs for hybrid or alternative fuel vehicles

This option targets the perks of preferred parking. However if no available parking can be designated for hybrid or alternative vehicles, new parking may need to be constructed to meet this credit. Considering the number of credits and strategies throughout the sustainable sites section that promote the reduction of parking lots, this credit could potentially work against other sustainability efforts.

- Use employee newsletters, postings, signs, or other forms of communication to inform occupants about the preferred parking (USGBC, LEED-EB Reference Guide 2005, 61) (Figure 1.7). [SOI Standards: None.]

Figure 1.7. Signage designates parking for electric vehicles only (McQuiggan 2005).

- Perform quarterly checks of the total vehicle parking capacity to verify that preferred parking for alternative fuel vehicles continues to be provided and that it continues to meet the demand (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]
- Provide incentive programs to encourage private ownership of ATVs or AFVs. This could include monetary purchasing grants (USGBC, LEED-EB Reference Guide 2005, 61). [SOI Standards: None.]

Credit 3.4 — Alternative Transportation: Car Pooling & Telecommuting (1 Point)

Intent—Reduce pollution and land development impacts from single-occupancy vehicle use.
Requirements—

- Option A—Provide preferred parking and implement/document programs and policies for car pools or van pools capable of serving 5% of the building occupants and add no new parking.
- Option B—Operate an occupant telecommuting program over the performance period that reduces commuting frequency by 20% for 20% or more of the building occupants and provides the necessary communications infrastructure in the building to accommodate telecommuting.

Sustainable design and development overview

Car pooling and telecommuting are viable alternatives for reducing negative impacts from excessive vehicular use such as urban air pollution. The regular commute of vehicular traffic causes significant environmental impacts. According to the EPA, each gallon of gas burned by a vehicle releases 20 pounds of CO2 into the atmosphere (EPA, Global Warming: Actions—Transportation, 2005). Car pooling provides benefits such as maximizing use of employee parking, encouraging sociability between employees, reducing employee stress, and improving institutional image. The benefits of car pooling are so compelling that Executive Order 12191, Federal Facility Ridesharing Program, instructs executive agencies to promote the use of ridesharing. The intent is to conserve petroleum, reduce traffic congestion, improve air quality, and provide an economical alternative for federal employees commuting to work.

Alternatively, telecommuting reduces fuel consumption or eliminates it altogether, depending on whether employees are telecommuting from home or a location close to home such as a telecenter. A study by the International Telework Association and Council (ITAC) revealed that telecommuting reduced average staff turnover figures by 20%, increased worker productivity by 22%, and cut absenteeism by 60% (OPM, Telework Handbook 2004). Additional telework trials indicate similar results related to productivity and absenteeism, while also showing reduced service delivery time and costs and increased employee motivation and morale (EPA, Global Warming: Actions—Transportation 2005). Employees telecommuting on an occasional or regular basis are able to reduce their commute travel and manage their work outputs more effectively. In addition, telecommuting means fewer individuals on site, resulting in a decrease in onsite energy consumption.

DoD Directive 4165.6, *Real Property Acquisition, Management, and Disposal*, gives installation commanders the freedom to obtain goods and services that best satisfy their requirements whenever they can get quality, responsiveness, and lowest cost. It also allows installation commanders to retain and decide on the use of a share of money they save. From this directive, multiple instructions, including ridesharing programs, were created to save money for installations.

As was the case for dedicated AFV parking in the previous credit, dense military cantonments with minimal parking may not be able to assign prime spaces for car pools since these spaces are often assigned by military rank or for government vehicles only. The best that can be achieved in these situations is to assign the best of the remote parking spaces to car pools, such as those closest to the crosswalk or access drive.

Historic preservation overview

This credit should be easily attainable for historic sites since it requires no physical changes to the property. Car pooling and telecommuting reduce the number of vehicles entering the site, thus lowering the need for parking structures and amenities that often negatively impact historic sites.

Strategies

Option A—Car pooling

Rideshare programs usually consist of car pool matching, van pool sponsorship, marketing programs, and incentives to reduce driving. Ridesharing is a common and cost-effective alternative mode of transportation, especially in areas that are not well served by public transit (Victoria Transport Policy Institute 2005).

> Because they have significant economies of scale (the more people who register, the more effective they are at successfully matching riders), it is helpful if one well-publicized ridematching program serves an entire geographic region (Victoria Transport Policy Institute 2005).

A geographic region could easily include a military installation. Van pools are often self-supporting with operating costs divided among members, and the van drivers are often allowed to commute for free and use the ve-

hicle for personal use. Ewing (1993) concludes that ridesharing programs can reduce daily vehicle commute trips to specific worksites by 5-15%, and up to 20% or more if implemented with parking incentives. The most effective programs tend to have paid parking, subsidies for alternative modes of transportation, and other incentives to encourage reduced automobile commuting (Victoria Transport Policy Institute 2005). [SOI Standards: None.]

- Survey potential building occupants and determine if available mass transit options meet their needs (USGBC, LEED-EB v. 2 2005, 20).
- Offer alternative work schedules (also called variable work hours) including flextime, compressed workweek (working fewer days but longer shifts), and staggered shifts (Victoria Transport Policy Institute 2005). This strategy reduces the need for onsite parking by reducing the number of spaces needed at any given time.
- Encourage car pooling through initiatives for high-occupancy vehicles (HOV) such as preferred parking areas, parking fee discounts, awards, and HOV highway lanes (USGBC, LEED-EB v. 2 2005, 26; Victoria Transport Policy Institute 2005).
- Provide intersection controls that give priority to HOVs, such as a traffic light set to stay green for several extra seconds if that allows an HOV to avoid stopping (Victoria Transport Policy Institute 2005).
- Consider financial incentives such as a standard reimbursement rate for employees who car pool, or a voucher that covers van pool fees (Victoria Transport Policy Institute 2005).
- Pre-register motorists and riders to increase security (Victoria Transport Policy Institute 2005).
- Utilize 'dynamic ridesharing.' or match passengers with drivers for individual trips (as opposed to regularly scheduled trips) (Behnke 1996; Seattle Smart Traveler 1997).
- Eliminate parking subsidies for non-car pool vehicles, or offer the cash equivalent if the commuters use alternative travel modes (USGBC, LEED-EB v. 2 2005, 26; Shoup 2005).
- For van pools, consider offering empty seat subsidies when the van has less than its full potential of paid passengers (Victoria Transport Policy Institute 2005).

Option B—Telecommuting

Public Law 106-346 (FY 2001 Department of Transportation and Related Agencies Appropriations Act), Section 359 states that,

> "Each executive agency shall establish a policy under which eligible employees of the agency may participate in telecommuting to the maximum extent possible without diminished employee performance." The law defines *telecommuting* as "any arrangement in which an employee regularly performs officially assigned duties at home or other work sites geographically convenient to the residence of the employee," and eligible employee as "any satisfactorily performing employee of the agency whose job may typically be performed at least one day per week at an alternative workplace" (OPM, Telework Handbook 2004).

Federal agencies with telework programs have found a decreased need for additional office space, while employees save money from reduced commuting, improve morale, and are more productive (OPM, Telework Handbook 2004). Other positives of teleworking programs include (1) enhanced ability for an agency to recruit and retain a wider variety of quality employees, including those with disabilities; (2) decreased costs for road construction and public transportation; (3) decreased costs for fuel, transportation, and heating and air conditioning of office space; (4) reduction of impact employees have on traffic congestion; and (5) limits on disruption of work in the event of emergencies (OPM, Telework Handbook 2004). [SOI Standards: None.]

- Identify positions appropriate for teleworking one day [or more] each week and offer those employees the option of participating in such an arrangement (OPM, Telework Handbook 2004).
- Provide alternative worksites, or telecenters, to reduce employee commute time and inconvenience while allowing employees to accomplish their work effectively (OPM, Telework Handbook 2004).
- Implement a telecommuting strategy similar to the EPA's Flexiplace including regular, episodic, and medical arrangements (EPA, Flexiplace Policy 1997).
- Provide incentives for telecommuting, encouraging occupants to reduce vehicle miles traveled (USGBC, LEED-EB v. 2 2005, 26).
- Include the option of telecommuting in the building design and size facilities appropriately (USGBC, LEED-EB v. 2 2005, 26).
- Encourage off-site work to reduce office space requirements and employee facilities (USGBC, LEED-EB v. 2 2005, 28).

Credit 4.1 & 4.2 — Reduced Site Disturbance: Protect or Restore Open Space (1-2 Points)

Intent—Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirements—Have in place over the performance period, native or adapted vegetation or other ecologically appropriate features:

- SS Credit 4.1—Covering a minimum of 50% of the site area excluding the building footprint (1 point).
- SS Credit 4.2—Covering a minimum of 75% of the site area excluding the building footprint (1 point).

Improving/maintaining off-site areas with native or adapted plants or other ecologically appropriate features can count toward earning both SS Credit 4.1 and 4.2. Every 2 square feet off-site will be counted as 1 square foot on-site. Off-site areas must be documented with a contract with the owner of the off-site area that specifies the required improvement and maintenance of the off-site area.

Native/Adapted Plants are those that are indigenous to a locality or cultivars of native plant materials that have adapted to the local climate and are not considered invasive species or noxious weeds. Such plants require only limited irrigation water for sustenance once established, and do not require active maintenance such as mowing. Native/Adapted Plants should provide habitat value and promote biodiversity through avoidance of monoculture plantings.

Other ecologically appropriate features are natural site elements beyond vegetation that maintain or restore the ecological integrity of the site, and may include water bodies, exposed rock, un-vegetated ground, or other features that are part of the historic natural landscape within the region and provide habitat value.

Sustainable design and development overview

Biodiversity, the variety and variability of living organisms and the environment in which they occur, is proving to be important to sustainable systems and has become a focus for natural resource managers. Diversity of ecosystems, species, and genetic characteristics provide the means for communities to adapt to change (USAEC, Defending our Natural Heritage). Unfortunately, biodiversity is currently threatened by excessive development; in the United States, sprawling development is occurring at a non-sustainable rate. Facts from the American Farmland Trust include:

- From 1982-1997, the U.S. population grew by 17%, while urbanized land grew by 47%.
- Over the past 20 years, acreage-per-person figures for new housing almost doubled.
- Since 1994, 10-plus-acre housing lots have accounted for 55% of developed land (American Farmland Trust 2006).

The inability to regulate the amount of developed land creates fragmented areas of natural space, destroying ecosystems and endangering biodiver-

sity. Furthermore, widespread disturbances of natural areas have resulted in drastic reductions of native plant populations. The natural areas that do remain are increasingly degraded by invasive alien species (North American Native Plant Society). Thus conservation of natural areas protects remaining native plants and maintains functional ecosystems.

Military installations often have a significant amount of undeveloped land that could satisfy this credit if restored or preserved as natural areas. In an effort being led by the Air Force, DoD (with the assistance of The Nature Conservancy and The Keystone Center) is developing a biodiversity conservation policy to enhance and protect biological diversity and further reduce any adverse impacts of military training and testing missions (USAEC, Defending our Natural Heritage). Open areas on military installations can be used for activities such as recreation and stormwater management. They can also provide a connection and transition between installation facilities and the natural surroundings (Paladino 2001, SSc51).

Historic preservation overview

Vast areas of a military installation may be considered part of a historic landscape. This credit may not be achievable for large historic landscapes that include extensive paving or areas of monocultures (e.g., turfgrass) as character-defining features. However for sites that historically included native areas over at least 50% of the site, this credit supports proper management of these historic sites. Reduction of existing non-historic paving areas can also improve the historic integrity of sites while increasing natural areas and stormwater infiltration. However, if paving areas are replaced with turfgrass, infiltration rates will increase, but the grass monoculture will do little for habitat or biodiversity.

When considering alterations to the landscape to recreate the natural site ecology, project managers must first consider whether the overall design and component plantings are character-defining features of a historic site. Water bodies, exposed rock, trees, unvegetated ground, and other features may be part of the natural historic landscape. These provide habitat value and should be retained. Reverting designed historic landscape resources to a natural state is typically not an option for historic preservation reasons. Instead, it is desirable to preserve the visual and spatial integrity of any designed open spaces. Substituting ecologically and environmentally sound plant material at the site is acceptable as long as the material or feature is visually compatible with its designed historic counterpart. Note that

the provision in this credit for off-site cultivation of native or adapted plants works in favor of historic sites by allowing preservation of these areas while providing ecological benefits elsewhere.

Strategies

Any effort to conserve or restore natural areas needs to be planned at various scales, beginning at a bioregional level. This allows sites to be considered as part of a larger eco-fabric. For the military, considerations cannot end at the fenceline. Efforts should also emphasize minimized site disturbances to reduce landscaping needs and site repair activities after rehabilitation activities are completed (Paladino 2001, SSc51).

Preserving natural areas

Perhaps the most important ecological consideration for sites is the preservation of areas that have not already been severely impacted by human development. This is true because…"[w]hile restoration methods can repair many site injuries, there is a point of no return, beyond which restoration is neither cost-effective nor ecologically sufficient" (Thompson and Sorvig 2000). Protecting a site before heavy human impacts occur preserves intact or functioning ecosystems that may be difficult to impossible to repair after development. For sites that have already been subjected to heavy impacts, it is necessary to access the extent of damage. PWTB 200-1-37, *Method to Estimate Vegetative Cover on Army Training Lands*, describes a method for estimating percent ground cover and environmental damage caused by off-road vehicle traffic at U.S. Army installations.

- Perform a site survey to identify site elements including existing water bodies, soil conditions, ecosystems, trees, and other vegetation. [SOI Standards: None.]
- Preserve and enhance existing natural areas such as prairie, wetland, floodplain, and woodland areas as essential components of site planning (EPA, Green Landscaping for Native Plants 2005) (Figure 1.8). [SOI Standards: 2, 3, 6.] Depending on the nature of a site's historic vegetation, its re-establishment may conflict with the promotion of plant diversity. As historic plantings deteriorate, such as from overcrowding by invasives, they can be replaced with historically compatible environmentally friendly alternatives. It is important to make substitutions with plants that are consistent with the historic landscape design. For example, if the area originally had mass plantings of only a

few species, it should not be replanted with a large variety of species that significantly alter the appearance of the vegetation. Plant substitutions must be carefully considered, especially in areas of formal plantings and planting beds within important viewsheds.

Figure 1.8. Restored natural areas provide habitat and promote biodiversity (McQuiggan 2005).

- Restore or reuse brownfields to minimize the use of greenfields. Greenfields (areas never built upon) are vital to ecosystem health. Their protection and preservation should be promoted whenever possible for ecological and historic preservation reasons (Thompson and Sorvig 2000). [SOI Standards: 8.] This strategy is not likely to pose any historic preservation concerns unless reuse of the site reveals historic or industrial archeological artifacts. The restoration or reuse of brownfields to their historic use is consistent with SOI Standard 1.
- Establish and clearly mark construction and disturbance boundaries on any construction site. Protect the tree dripline and delineate laydown, recycling, and disposal areas. Use existing paved areas as temporary staging areas, being careful not to damage historic paving (Fournier and Zimnicki 2004, 7). In addition, any onsite storage must be temporary, with all long term storage occurring offsite or out of historic viewsheds. [SOI Standards: 1, 2, 9, 10.] This strategy reinforces historic preservation efforts by protecting the historic site and its significant features with clearly marked work areas and storage boundaries.
- Avoid heavy machinery and vehicles in areas where it can disturb or damage natural areas, site vegetation, and existing site conditions. This

includes keeping machinery and vehicles away from tree driplines (Fournier and Zimnicki 2004, 7). [SOI Standards: None.] This credit works to protect existing or restored natural areas, historically significant site features, and archeological resources.

- Establish contractual penalties for disturbance of protected site areas, and destruction of trees and other noteworthy vegetation (Fournier and Zimnicki 2004, 7). [SOI Standards: None.]

Creating natural areas

The establishment of ecologically friendly areas should be performed whenever feasible to counteract land development elsewhere. It is one way of sustaining and protecting the diversity of nature and reestablishing an ecologically healthy relationship between nature and culture. PWTB 200-3-29, *Sources of Plant Materials for Land Rehabilitation*, provides information regarding sources of native plant materials for the United States that can be utilized at military installations for creating natural areas and maintaining them.

- Create prairie, wetland, and woodland areas as part of a campus (EPA, Green Landscaping for Native Plants 2005) (Figure 1.9). [SOI Standards: 1, 2, 9, 10.] If the natural area is incompatible with the historic site, construct it outside of historic viewsheds. Ensure that visual integrity is preserved to the maximum extent possible. For instance, a historically forested area converted to other uses can be improved by preserving buffer areas around the woodlands to preserve key views.

Figure 1.9. Constructed prairie sustains and protects nature diversity (McQuiggan 2005).

- Work with local horticulturalists or native plant societies to select and maintain appropriate plant material for the natural area (USGBC, LEED-EB v. 2 2005, 28). [SOI Standards: 2, 3, 6, 9, 10.] Plant substitutions are allowed if historic plant material and vegetative features are not environmentally feasible (Birnbaum and Peters 1996). However, the plant material chosen must be compatible with the historic vegetation in form, massing, and texture.
- Across a site, connect wooded areas with wooded corridors (Ashkin et al. 2000, 17). Wildlife corridors are contiguous tracts of land intended to help maintain biodiversity by allowing animals to move between otherwise isolated natural areas. Wooded corridors may also aid in plant propagation in the same way (Science Daily 2005). [SOI Standards: 1, 2, 3, 9, 10.] Connecting wooded areas and corridors can change the character, integrity, and viewsheds of historic sites. Minimize these impacts with careful planning and design.
- Develop riparian (i.e., vegetated streamside) corridors 100 ft wide or more if possible (Ashkin et al. 2000, 17) (Figure 1.10). These corridors preserve water quality by filtering sediment from runoff before it enters rivers and streams. They also protect stream banks from erosion while providing a storage area for flood waters, and food and habitat for fish and wildlife. In addition, riparian corridors preserve open space and provide aesthetically pleasing environs (County of Santa Cruz Planning Department). [SOI Standards: 1, 2, 3, 9, 10.] This strategy may impact the historic site if stream areas were historically heavily wooded or if the implementation of vegetated streamside corridors affects historic viewsheds.

Figure 1.10. Riparian corridors preserve water quality by filtering sediment (McQuiggan 2005).

- Replace unneeded turf grass with native/adapted plant material. [SOI Standards: 1, 2, 9, 10.] Turf grass replacement may not be possible if turf areas are historically significant or within historic viewsheds. However a more credit-appropriate groundcover substitution can be made if it is consistent in height, density, and durability with its historic counterpart.
- Replace excessive and unnecessary paving with vegetated areas. [SOI Standards: 1, 2, 6, 8, 9, 10.] The removal of non-contributing paving areas from a historic site not only helps to achieve this credit, but also assists in restoring historic site integrity. However, if the paving areas represent historic circulation patterns and materials, then they should not be removed.

Reducing site disturbances

- Evaluate preexisting site resources to ascertain how each can enhance the proposed project and vice versa (Fournier and Zimnicki 2004, 5). Use this knowledge to inform the careful planning of new site additions or repairs. [SOI Standards: None.]
- Maximize the use of free site energy; plan facility reuse, parking, roadways, and stormwater infrastructure to 'fit' existing site contours. This limits soil cut and fill during construction projects. [SOI Standards: None.] Limiting new site disturbances is consistent with historic preservation tenants.

Credit 5.1 & 5.2 — Stormwater Management: Rate and Quantity Reduction (1-2 Points)

Intent—Limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements—Have a stormwater management plan in place over the performance period that is designed to mitigate runoff from the site. This mitigation can be accomplished through a variety of measures including perviousness of site, stormwater management practices (structural and nonstructural), capture of rainwater for reuse or other measures.

- SS Credit 5.1—Have measures in place on the site that mitigate at least 25% of the annual stormwater falling on the site (1 point).
- SS Credit 5.2—Have measures in place on the site that mitigate at least 50% of the annual stormwater falling on the site (1 point).

Sustainable design and development overview

Prudent stormwater management can significantly lessen the negative impacts of the built environment, especially on natural water flows by reducing stream degradation. Stream degradation is caused by two main forces: "[1] the channelization, culverting, and burial of streams to make them fit into human development patterns; and [2] the massively increased stormwater runoff that results from roofs, paving, and other impervious aspects of urbanization" (Thompson and Sorvig 2000, 146). The volume and frequency of runoff from pervious surfaces can cause stream channels to expand two to five times their original size (Hammer 1972, Moriwasa and LaFlure 1979, Allen and Narraore 1985, and Booth 1990). Multiple differing approaches to water flow protection have been suggested by experts, however insufficient data exists on the long-term capacities of these approaches to protect channels from accelerated channel erosion (Stormwater Manager's Resource Center).

U.S. landscape architecture practice typically involves removal of onsite water as quickly as possible. Intricate piping systems move the water into downstream flows to prevent basement flooding and onsite water collection. Furthermore, fears of the mosquito-born West Nile Virus have fed the belief that pooling water and wetlands spell disaster. Ironically the function of wetlands includes the capture and slow release of water. The removal of wetlands with the introduction of increasingly impervious surfaces causes higher and faster rates of excess water flowing downstream.

Stormwater flow reduction measures commonly include stormwater reuse onsite, infiltration of stormwater volumes, specification of pervious paving materials for hard surfaces, reduction of impervious surfaces, and construction of garden roofs. The reintroduction of water retention and infil-

tration onsite can deter most stream disruption and pollution. Stormwater reuse opportunities depend on precipitation volumes, building form, site constraints, and local and military codes and regulations (Paladino 2001, SSc61).

Because stream degradation is also a function of pollutants entering the stream, improving water quality is also an important aspect of this credit. However, for some projects, stormwater treatment is not possible due to site constraints or is not cost effective due to existing storm sewer infrastructure (Paladino 2001, SSc62). Conventional stormwater infrastructure (e.g., culverts, pipes, and detention basins) is costly, so it is often more cost effective to encourage water infiltration and treatment via bioswales, retention and detention ponds, riparian areas, and constructed wetlands that can also provide site amenities (Paladino 2001, SSc62).

> The functions of wetlands and riparian areas include water quality improvement, aquatic habitat, stream shading, flood attenuation, shoreline stabilization, and ground-water exchange. Although wetlands and riparian areas reduce NPS [nonpoint source] pollution, they do so within a definite range of operational conditions. When hydrologic changes or NPS pollutants exceed the natural assimilative capacity of these systems, wetland and riparian areas become stressed and may be degraded or destroyed. Therefore, wetlands and riparian areas should be protected from changes that would degrade their existing functions. Furthermore, degraded wetlands and riparian areas should be restored, where possible, to serve an NPS pollution abatement function (EPA, Polluted Runoff, Nonpoint Source Pollution 2005).

In the military context, stormwater runoff is primarily a problem in cantonments. Cantonments function like urban areas and have facilities and operations that can generate a lot of runoff and contaminants (e.g., oils, fuels, and chemicals) (Loechl 2005). Typically, limited space is available within cantonments to create new ponds and basins for water retention and infiltration. In addition, stormwater pipes are often too old and undersized for any additional new flow. Despite these constraints, solutions to stormwater control can be space and size conscious. For a Fort Bragg classroom and parking lot project, the Army Corps of Engineers dealt with stormwater runoff with pervious paving and bioswales. This was done to

avoid piping runoff to the existing sewer, which could handle no more water (Loechl 2005). Ultimately, the use of a combination of Low Impact Development retrofits, stream restoration, and pollution prevention can address stormwater peak flow mitigation, water quality improvement, and reduction of inflows into the wastewater system.

Historic preservation overview

Natural or constructed stormwater runoff strategies can considerably impact, alter, or damage historic sites. Potential conflicts include possible changes to historic site usage; disturbances to existing site conditions caused by the installation of stormwater management infrastructure; and site additions that destroy or damage historic materials, features, or spatial relationships (e.g., the construction of historically inaccurate water containment areas or systems). Any one of these strategies could result in the overall degradation of historic site character, so careful planning is necessary to minimize impacts.

Strategies

Effective stormwater runoff retention is necessary to avoid downstream flooding. However, without careful planning, flow from stormwater ponds may join downstream creating a delayed flood and destroying bank restoration efforts. In order to prevent such stream disruption and pollution, water needs to be not just slowed, but re-infiltrated into the ground quickly in multiple on-site locations. On-site infiltration is generally quite simple, cost effective, and can typically be achieved without problematic side effects. It includes two basic principles: increased soil permeability and slowing of water flow or water retention (Thompson and Sorvig 2000, 157). An alternative to infiltration, the practice of harvesting onsite water was at one time a traditional practice in the United States. Around 1900, homes in the United States often had water-harvesting systems supplying a cistern in the basement (Thompson and Sorvig 2000, 154). Historic sites may still retain their original cisterns and these could be rejuvenated for modern day use.

Stormwater management plan

Develop a watershed-wide stormwater management plan that includes the considerations listed below. [SOI Standards: None.] This plan should include provisions on how to place infiltration or retention devices to mini-

mize impacts to historic site integrity. Careful planning can ensure exploitation of credit-appropriate historic site features while avoiding any damage to the historic fabric.

- Identify the hundred-year floodplain, wetlands, stream corridors, vegetated or natural buffers, and groundwater recharge zones (Mendler and Odell 2000, 9; EPA, Polluted Runoff, Nonpoint Source Pollution 2005).
- Determine the proper locations for ponds and other infiltration or retention devices to minimize the disruption to existing hydrological features, such as creeks, streams, ponds, lakes, and wetlands (Mendler and Odell 2000, 52). Planning for increased infiltration can reduce the amount of stormwater retention needed in other areas of the site, reducing over-all cost.
- Consider the impact of the stormwater management plan to the water flows when locating any new buildings, roadways, and site infrastructure to limit disruption to existing natural site drainage patterns (Mendler and Odell 2000, 8).

Implementation

Preserve existing natural areas to encourage stormwater cleansing and infiltration. If natural areas were once on the historic site but have since been removed, site maintenance should include their restoration over time to the maximum extent feasible. [SOI Standards: None.]

Consider groundwater recharge (see bioengineering techniques below) and stream channel protection methods [e.g., imbricated rip-rap and lunkers (see *Glossary of Terms*)] resulting in no net increase of stormwater runoff from existing to developed conditions (Mendler and Odell 2000, 53). Information on predevelopment rates may not be available for a specific site or region depending on who first developed the site, what kind of analysis was performed, and documentation kept. Often the approach is to use runoff rates for a region type (e.g., forest or prairie). U.S. Department of Agriculture Technical Release 55 (TR-55) outlines procedures for calculating storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small watersheds, especially urbanized U.S. watersheds. Because the procedures are simplified, there are limitations for their use (Stormwater Manager's Resource Center). [SOI Standards: 1, 2, 3, 6, 8, 9, 10.] This strategy can impact historic sites in a myriad of ways depending

on the specific method and where it is implemented. Any new site additions, alterations, or related new construction must not destroy character-defining aspects of the property. Methods implemented inside stream channels may be outside of historic viewsheds.

Design grading to encourage sheet (rather than channel) flow and lengthen flow paths (DoD, LID Manual 2004, 3). [SOI Standards: 1, 2, 6, 9, 10.] Introduction of a new water feature needs to be compatible with the historic site. Locate any new retention basins, vegetated swales, or wetlands outside or out of view of historic sites (Fournier and Zimnicki 2004, 10).

Install stormwater planters to treat roof runoff (Medina et al. 2005) (Figure 1.11). Some such planters are nothing more than concrete surface drains with permeable bottoms filled with plant material. [SOI Standards: 1, 2, 9, 10.]

Figure 1.11. Stormwater planters can be used to treat water runoff (City of Portland 2007).

Provide signage and education to minimize contaminants entering waterways (Medina et al. 2005). [SOI Standards: None, provided signage is not permanently affixed to historic site features.]

Pervious/impervious surfaces

Increase permeability by reducing the amount of impervious surface area. This increases the infiltration capabilities of the site, allowing more water to seep into the ground. Avoid expansive parking areas that create concentrations of contaminated runoff (Mendler and Odell 2000, 53). Naturalize concrete channels (Medina et al. 2005). [SOI Standards: 1, 2.] It may or may not be possible to reduce impervious surfaces depending on whether or not they have historic significance. On some historic sites, early gravel paving or brick pavers have been covered or replaced with impervious asphalt or concrete paving. Reverting back to the historic pervious paving can improve both historic site integrity and stormwater infiltration. On the contrary, the addition of new parking on historic sites negatively impacts historic integrity. Consequently, new impervious surfaces can be undesirable for both sustainability and historic preservation reasons.

Replace existing impervious surfaces with permeable alternatives over an underground water retention area (Figure 1.12). Porous paving can double as a stormwater system, thus eliminating storm drains and substituting for open stormwater detention basins. These paving systems can be 12-38% cheaper to install over basins and drains, and more land is available for other uses (Thompson and Sorvig 2000, 185). Use products like paving blocks and porous concrete or asphalt, open-celled pavers, reinforced turf, concrete or plastic grids, or stabilized aggregate (Mendler and Odell 2000, 53). Note that constructed pervious surfaces like permeable pavers can allow infiltration where the water falls (instead of piping the water away); however the infiltration rate is lower than in densely vegetated areas. [SOI Standards: 1, 2, 3, 9, 10.] Pavement replacement may not be a viable option depending on whether the existing impervious surfaces are character-defining features of the historic site. Some impervious surfaces (such as gravel paving) are historically accurate and should be preserved or restored. Any new permeable alternatives introduced need to be compatible with historic site character.

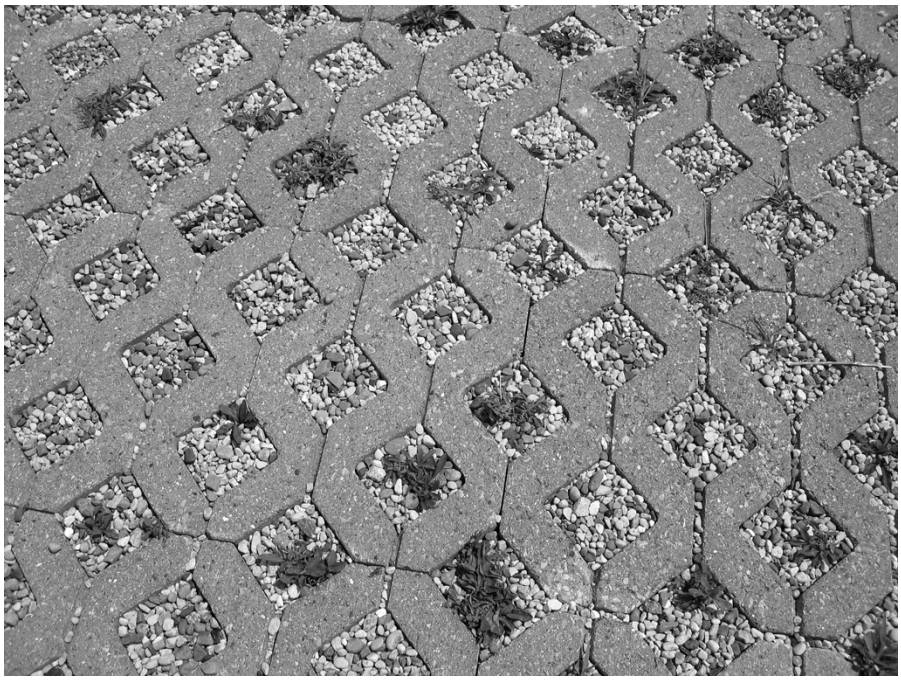

Figure 1.12. Improve stormwater management with a pervious parking lot (McQuiggan 2005).

Use water-permeable materials for pedestrian pathways, such as loose aggregate, wooden or recycled plastic decks, mulch pathways, or paving stones (Mendler and Odell 2000, 53) (Figure 1.13). [SOI Standards: 1, 2, 3, 9, 10.] Such materials may or may not be compatible on historic sites depending on historical precedents, functional impacts of material substitutions, and disruptions to historic viewsheds.

Figure 1.13. Various forms of permeable pathways (McQuiggan 2005).

Capture rainwater from impervious areas of the building for reuse within the building or on the site (USGBC, LEED-EB v. 2 2005, 30). [SOI Standards: 1, 2, 6, 8, 9, 10.] Rain catchment systems were often utilized on historic sites. These should be retained and/or enhanced. New methods for

capturing rainwater may not interfere with historic preservation efforts if they are located below grade or outside of important site lines.

Use green/vegetated roofs (USGBC, LEED-EB v. 2 2005, 30). [SOI Standards: 2, 7, 9, 10.] While generally not appropriate for historic sites, green roofs can be implemented in such a way so as not to disrupt the historic character of a building. This typically means keeping the green roof outside of significant viewsheds. It is also important that the architecture can withstand the added weight and moisture. A LEED Gold certified historic building that features a successfully implemented vegetated roof is the Jean Vollum Natural Capital Center in Portland, Oregon (Cascadia Region Green Building Council). For more information on green/vegetated roofs, see SS Credit 6.2 of this report.

Infiltration methods

Following the tenants of Low Impact Development (LID), infiltration should occur at or close to where the rain falls. The most effective water infiltration solutions utilize multiple strategies and/or multiple site locations to absorb water runoff. Ultimately, water that retains sheet flow characteristics has a greater chance of infiltrating while reducing negative impacts from cumulative water runoff such as erosion. [SOI Standards: 1, 2, 3, 6, 8, 9, 10.] The solutions to infiltration can vary widely in their visual impact. On historic sites, it is important to first exploit any historic solutions to stormwater infiltration. New infiltration methods introduced can alter the use of portions of the site and negatively impact historic site character, especially if large or obvious additions are located within major viewsheds. For instance, features like bioswales are visually subtle when compared to larger wetland areas. However bioswales cannot hold as much water, so a larger number of them may be needed. New features that require extensive excavation may be inappropriate for sites with archeological significance.

- Utilize bioengineering or site engineering techniques for water cleansing and infiltration. Examples include: constructed wetlands, riparian zones, check dams, terracing, raingardens, bioswales, bioretention basins or filters, or vegetated filterstrips (USGBC, LEED-EB v. 2 2005, 30) (Figure 1.14). These features can provide low-cost alternatives to conventional stormwater management and they can also filter gasoline, oil and grease, herbicides, fertilizers, and other pollutants suspended in stormwater runoff (Mendler and Odell 2000, 54). One technique listed

above that has a reduced visual impact on the site is the raingarden. Raingardens are small depressions in the landscape that are attractively planted and infiltrate stormwater. Unlike large scale infiltration or detention basins, raingardens are small and can have much less impact on the visual comprehension of a historic property if properly sited.

Figure 1.14. Use vegetated swales for water cleaning and infiltration (McQuiggan 2005).

- Install an infiltration pond or stormwater wetland near the headwaters of the stream, or at strategic points along the stream (like at large parking areas) (Thompson and Sorvig 2000, 148).
- Maintain natural drainage divides to keep flow paths dispersed (DoD, LID Manual 2004, 3).
- Use French drains, soakaways, or permeable paving for infiltration in areas with limited undeveloped land and where above-ground structures should be left in place (Figure 1.15). These methods can be ideal for historic sites where larger interventions are overly disruptive.

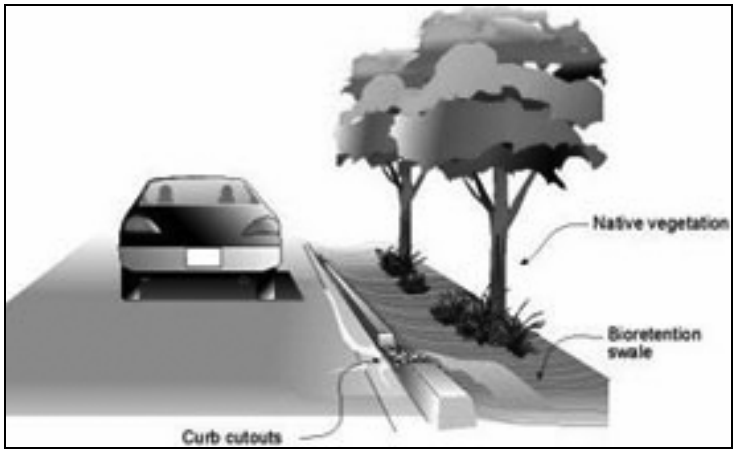

Figure 1.15. French drain (left) and permeable curb (right) (McQuiggan 2005; WBDG).

- Introduce permeable gutters and curbs that feature multiple openings for water to flow through, and make on-grade gutters out of brick on sand (Thompson and Sorvig 2000, 182) (Figure 1.15).

Maintenance

In order for a stormwater management plan to be successful, system maintenance must be as important as initial design. If the system stops working as initially intended, temporary issues may arise (e.g., flooding or clogging) that reduce the overall effectiveness of the system. [SOI Standards: 7.] If necessary, removal and replacement of system components should be done with care to avoid damage to nearby historic structures and site features. If heavy maintenance equipment is used, take measures to prevent damage caused by the movement of machines through the site.

- Establish a program to conduct inspections and perform maintenance on stormwater management systems (EPA, Post-Construction Storm Water Management in New Development & Redevelopment 2005, 8-1). Inspect basins and ponds after every major storm for the first few months after construction or renovation and check all ponds and basins annually (EPA, National Management Measures 2005).
- Maintain transportation and storm drain infrastructure to reduce loads at their source (EPA, Post-Construction Storm Water Management in New Development & Redevelopment 2005, 8-1). Maintenance of storm drain infrastructure includes the quarterly cleaning of storm drains and water quality inlets, and periodic removal of sediments in infiltration devices to prevent premature failure due to clogging (EPA, Na-

tional Pollutant Discharge Elimination System 2005; EPA, National Management Measures 2005). Mow grass filter strips and swales at a frequency adequate to prevent woody growth and promote dense vegetation (EPA, National Management Measures 2005). Periodically remove and replace filter media from infiltration trenches and filtration ponds. Deep till infiltration basins to maintain their infiltrative capability (EPA, National Management Measures 2005).

- Vacuum or jet hose porous pavements or concrete grid pavements on at least a quarterly basis (EPA, National Management Measures 2005). Use nonpotable water or electric machines if possible.

Credit 6.1 — Heat Island Reduction: Non-Roof (1 Point)

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

Requirements—Choose one of the following options:

- Option A—Provide (from existing canopy or within five years of landscape installation) shade on at least 30% of non-roof impervious surfaces on the site, including parking lots, walkways, plazas, etc.
- Option B—Use/maintain light-colored/high-albedo materials (reflectance of at least 0.3) for 30% of the site's non-roof impervious surfaces on the site, including parking lots, walkways, plazas, etc.
- Option C—Place/maintain a minimum of 50% of parking space underground.
- Option D—Use/maintain an open-grid pavement system (net impervious area of LESS than 50%) for a minimum of 50% of the parking lot area.

Sustainable design and development overview

The United States paves about 30,000 linear miles each year, an amount exceeding that which the Roman Empire accomplished in its entire existence (Thompson and Sorvig 2000, 173). Approximately 435,000 acres of the U.S. is currently covered with parking, and the U.S. road network may be the largest object ever built (Thompson and Sorvig 2000, 173). Impervious surfaces directly affect the overall climates of cities, creating elevated temperatures in urban areas up to 10 degrees warmer than surrounding rural areas. Often called heat islands, this warming effect is primarily an urban concern where constructed surfaces have a measurable effect on the microclimate (Paladino 2001, SSc71) (Figure 1.16). Heat absorbing materials (especially dark colors) cause thermal gradient differences between developed and undeveloped areas, heating the developed areas by several degrees. The reduction of impervious and dark surfaces results in lower microclimate temperatures, thus lowering building energy consumption and cost, and reducing the temperature stress on plant and wildlife habitat (Fournier and Zimnicki 2004, 14). The amount of paved surface on a site should be minimized to reduce heat islands and encourage alternatives to private automobile use.

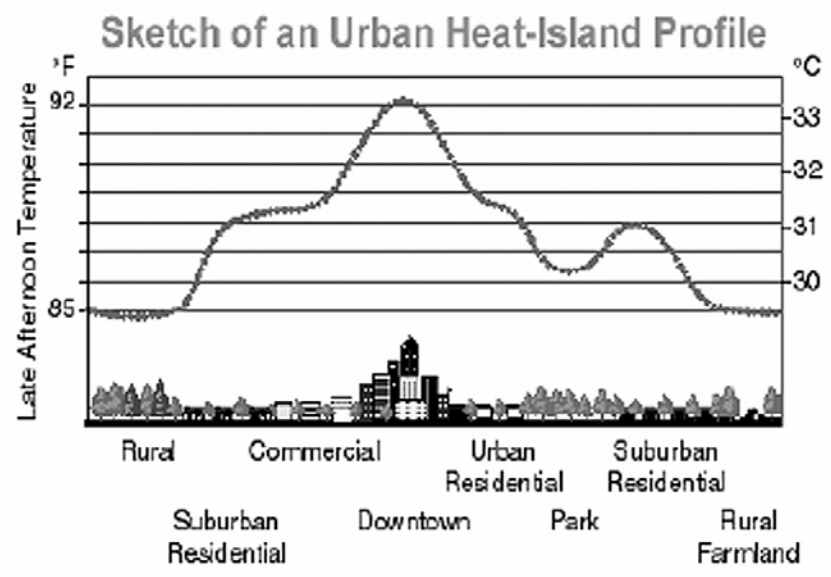

Figure 1.16. An urban heat island profile for late afternoon temperatures (EPA 1992a).

Military installations are often located outside of urban areas, so heat island effects may not be a pressing issue. For installations in urban areas, DoD has the opportunity to affect a larger area in terms of heat island effect because a typical cantonment consists of multiple buildings and large areas of impervious surfaces. Incorporating the rest of the installation into this initiative may earn innovative points for going above and beyond the requirements of the credit.

Historic preservation overview

The SOI Standards advocate retaining historic relationships between buildings and sites while avoiding the introduction of new features that negatively impact historic site patterns or vistas. The SOI Standards also warn against destroying or damaging site features during new construction. Solutions to reducing heat island effects may compromise historic open space and planting design. Since open space is often integral to historic site design, it should not be significantly altered to accomplish Option A (the shading provision) of this credit. Conversely, historic shade trees, vegetation, pergolas, and trellises should be retained for shading purposes.

The use of light-colored materials and coatings for non-roof surfaces may conflict with the site's character if they have no historical precedence. However, if historical non-roof materials are light-colored or high-albedo,

then the preservation or restoration of those surfaces will fulfill this credit while preserving the historic integrity of the site.

Underground parking, if not historically present, must be sited to avoid adverse impacts associated with deep excavation. If well sited and executed without damaging nearby historic fabric, underground parking can be an asset both historically and environmentally, by preserving historic viewsheds and site relationships while eliminating impervious surfaces. Furthermore, below-grade historic military facilities that do not contribute to heat island effects should be utilized when feasible in lieu of constructing new above-grade facilities that do contribute to heat island effects.

Strategies

This credit offers several options for dealing with the heat island effects of paved surfaces; however, the primary focus of these strategies is to encourage the reduction of impervious surface on the site. This can be achieved through various planning approaches such as density zoning, cluster development, combined land uses, and impervious surface limits (e.g., paving, parking, and street width limits). Site density may already be determined; however considerations to increase density and reduce impervious surfaces (through pavement sharing) can both protect historic site character and reduce heat island effects. For example, low-speed roads are often unnecessarily wide, leading to wasteful use of material resources and capital. Where appropriate, narrower streets are generally considered safer and more aesthetically pleasing, and they reduce paving and utility infrastructure costs. Furthermore, most parking lots plan for one-year events and otherwise remain partially empty the rest of the year. Planning ahead for the few times in a year extra parking will be required can reduce the waste, cost, and negative impacts of excessive parking. Furthermore, there is a significant reduction in construction and repair costs if excessive or unnecessary roads are removed or not implemented in the first place. Ultimately, life cycle cost analyses can help determine the overall costs and benefits if pavement is minimized, temperatures are reduced, and less stormwater infrastructure is necessary.

Planning

Employ a streetscape planning process that is logical and comprehensive. It should include the investigations listed below. All paved surfaces should be part of the process, including parking lots, streets, paths, etc. Associ-

ated planting plans should be included and address unobstructed space requirements of UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*. [SOI Standards: None.]

- corridor identification analysis
- existing conditions survey
- adequacy analysis
- streetscape corridor plan (USAF, Landscape Design Guide 1998, 9.2)

Pavement

Design and implement roads following traffic calming techniques. Reducing lane width and introducing roadside 'friction' features like street trees can reduce speeds while also reducing impervious surfaces and providing shade to the paved surfaces (Thompson and Sorvig 2000, 177). [SOI Standards: 2, 3, 6, 9, 10.] Reducing lane width and introducing additional features may negatively impact the historic site. Consequently, traffic calming techniques must be designed and implemented in accordance with the SOI Standards.

Reduce excessive or replace existing paving. [SOI Standards: 2, 3, 6, 9, 10.] Removing excessive paving can positively impact historic sites if the paving is not a character-defining feature. On the contrary, this strategy can negatively impact historic sites where paving contributes to site significance. If historic surface materials are not appropriate for current use, a sustainable substitution may be made as long as it does not significantly degrade historic site integrity. Consider alternatives to impervious paving that preserve to the greatest extent possible the historic spatial organization, land patterns, and size, scale, design, material, color, and texture of paving elements (Fournier and Zimnicki 2004, 15). For example, the predominate surface material on historic frontier forts was earthen for pedestrian, horse, and carriage circulation. If it is necessary to pave these earthen surfaces for contemporary use, employ permeable paving that follows the historic circulation layout.

Minimize the amount of new parking on the site by sizing parking to minimum capacity. This may not be feasible for sites where there is no plan or space for overflow for one-year parking events. Also provide alternatives to private automobile use, including bike paths, walkways, and mass transit (Fournier and Zimnicki 2004, 14). [SOI Standards: 2, 3, 6, 9, 10.]

Consider shared parking among several buildings to minimize the amount of paving (Fournier and Zimnicki 2004, 14). [SOI Standards: 2, 3, 6, 9, 10.] This may benefit historic preservation efforts by reducing the need to create new parking.

Scatter new parking to reduce tree removal, break up impervious surface areas, and reduce disturbances to the site and its pre-existing features (Thompson and Sorvig 2000, 179). [SOI Standards: 2, 3, 6, 9, 10.] Avoid parking dispersal schemes that conflict with the historic layout of the site.

Eliminate blacktop, or use coatings or integral colorants for asphalt to achieve light-colored surfaces (USGBC, LEED-EB v. 2 2005, 32) (Figure 1.17). Alternatively, use concrete; it typically has a higher first cost, but requires less maintenance and has a longer lifespan than asphalt (Paladino 2001, SSc71). [SOI Standards: 2, 3, 6, 7, 9, 10.] As mentioned previously, choose substitute surface materials that minimize adverse impacts to the historic site.

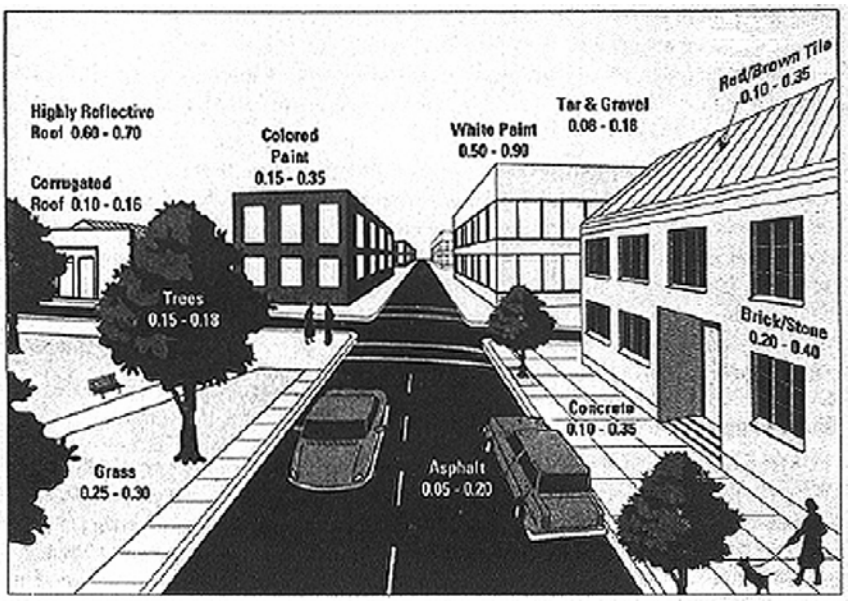

Figure 1.17. Albedo values for various materials (EPA 1992b).

Use an open-grid pavement system with a net impervious area of less than 50%. [SOI Standards: 1, 2, 3, 6, 9, 10.] Open-grid pavement can reduce heat island effects, but can conflict with historic site character if used inappropriately. If new paving is a necessary addition to the site, then paving existing turfgrass areas with vegetated open grid pavement would be more compatible with the historic context than traditional paving.

Construct underground parking. [SOI Standards: 1, 2, 8, 9, 10.] Design parking, loading docks, and ramps to be as unobtrusive as possible to minimize negative effects to the historic setting (Fournier and Zimnicki 2004, 14). Clean up underground tanks and other subterranean environmental hazards prior to construction.

Shading

Shade impervious surfaces. Providing shade along streets can reduce ambient temperatures while also providing relief from the sun, aesthetic improvements, and wildlife habitat (Figure 1.18). Although shading heat-retaining surfaces is important, when combined with a reduction of impervious pavement, shading greatly increases stormwater infiltration as well. Photovoltaic cells, street trees and vegetation, canopies, roof structures, and planted parking islands are all possible methods for implementing this strategy. [SOI Standards: 1, 2, 3, 6, 9, 10.] Any of these methods can negatively impact historic views or be incompatible with historic site character if poorly executed. Historic plant design consistent with the intent of this credit should be preserved, protected, or restored over time to maintain both the vegetation's effectiveness against heat island effects and historic site integrity. For example, historic rows of street trees that shade roadways should be preserved or restored. In contrast, adding planting areas near roads and parking lots that were not present historically will likely conflict with historic site character and should be avoided.

Figure 1.18. Shade trees along roadways can reduce heat island effects (McQuiggan 2005).

Credit 6.2 — Heat Island Reduction: Roof (1 Point)

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

Requirements—

- Option A—Have in place over the performance period ENERGY STAR-compliant, high-reflectance and high emissivity roofing material that has a minimum emissivity of 0.9 when tested in accordance with ASTM 408 for a minimum of 75% of the roof surface. Provide records and results of quarterly inspections over the performance period to determine that these features are being maintained.
- Option B—Install/maintain a "green" (vegetated) roof for at least 50% of the roof area. Provide records and results of quarterly inspections over the performance period to determine that these features are being maintained.

Combinations of roofing area that meets the requirements of Option A and Option B can be used providing they collectively cover 75% of the roof area.

Sustainable design and development overview

Heat islands develop as cities replace natural land cover with pavement, buildings, and other infrastructure, thus increasing the urban temperature several degrees higher than nearby rural environments. Increased urban temperatures negatively affect public health, the environment, and energy use. Heat islands can amplify extreme hot weather events, causing heat stroke and physiological disruption, organ damage, and even death (especially among the elderly). Heat islands also strain the energy demand for air conditioning and raise power plant emissions of harmful pollutants. Higher temperatures accelerate the chemical reaction that produces ground-level ozone (or smog) threatening public health, the environment, and sometimes making it more difficult to meet federal air quality goals. Homes and buildings absorb the sun's energy, increasing the demand for summertime cooling and energy needs. For every 1° F (0.6° C) increase in summertime temperature, peak utility loads in medium and large cities increase by an estimated 1.5–2.0% (EPA, Global Warming: Actions—Heat Island Effects 2004).

Historic preservation overview

Replacing roofing material with 'greener' alternatives can alter visual integrity (and thus the historic character) of a building, structure, or historic site. 'Green' roof design should not compromise the qualities that make a property historic; attempts should be made to minimize visual impacts from the ground level. For example, greening an out-of-sight roof with a low groundcover that minimally impacts how a site is understood may be

acceptable, but using visible trees and shrubs on a roof would not be appropriate.

Green roof strategies work especially well on historic buildings with flat roofs that cannot be seen. On the contrary, the installation of a high-albedo (i.e., reflective) or vegetated roof would not be appropriate on a historic building with a highly visible roof. Historic slate or copper roofs should be retained during rehabilitation. In cases where historic roofing has been replaced with incompatible materials, the replacement roofing should ideally be removed so the roof may be rehabilitated using appropriate materials. In cases where restoration of the original material would be cost prohibitive, the use of a comparable and compatible material can be a suitable compromise.

Strategies

Both categories of strategies, reflective and green roofs, can help reduce heat island effects while also providing additional benefits as listed below. Note that this credit can be achieved over time by carrying out piecemeal roof repair and replacement in a way that contributes to the eventual achievement of the credit (USGBC, LEED-EB Reference Guide 2005, 100).

Compliant Roofing Material

Light-colored reflective coatings on roofs can reduce building energy absorption normally caused by solar heat gain, while also extending the life of the roof (ultraviolet rays in sunlight break down many roofing materials). Reflective roofs (also known as ‘cool roofs’) can provide a building with energy savings up to 50% and reduce peak cooling demand by 10-15% (Ashkin et al. 2000, 29-30) (Figure 1.19).

Figure 1.19. Applying a light-colored reflective coating (EPA 2006).

- Use a light-colored reflective coating on all roof surfaces. [SOI Standards: 2, 6, 9, 10.] Light coatings will have no detrimental effect on historic views when the roof is above visual sight lines. However if a roof is peaked or angled enough to be seen from the ground, consideration should be made for how light colored roofing impacts the visual integrity of the historic property.
- Paint existing rooftop equipment with light-colored paint (Ashkin et al. 2000, 29). [SOI Standards: 2, 6, 9, 10.] If rooftop equipment is not historically significance or is out of visual sight lines, then painting the equipment will have no impact on a historic property. However if the equipment is historically significant and visible, do not paint it as this will undermine visual integrity.

Vegetated Roofs

The vegetated roof strategy presented here is based on a relatively new technology that allows plant material to grow on roof surfaces in what is called an 'extensive' or thin soil layer. Traditional roof gardens, or 'intensive' roofs, often require additional irrigation, are significantly deeper, and often require structural reinforcement to support the additional weight on the roof. Unlike conventional (intensive) roof gardens, the significantly lighter and energy efficient green roofs or extensive roof gardens (also known as ecoroofs) can be implemented on existing structures with little to no modification to their superstructure. This facilitates their application on historic structures. An example is the green roof utilized at the historic Jean Vollum Natural Capital Center in Oregon, a LEED-EB Gold project (Figure 1.20).

Figure 1.20. A green roof on the historic Jean Vollum Natural Capital Center building (Green Building Services).

Green roofs have excellent insulative values, absorb the sun's heat, provide cooling though evapotranspiration (reducing the surface temperature of the roof), and absorb up to 75% of rainfall (Thompson and Sorvig 2000, 112). Green roofs also reduce building energy loads, reduce and stabilize indoor humidity and temperature, minimize contribution to urban heat islands, produce oxygen, absorb carbon dioxide, and store carbon to filter air pollution (Thompson and Sorvig 2000, 112). Green roofs do not require a flat surface like conventional roof gardens. They can be installed onto roofs with slopes of up to 30 degrees (Figure 1.21). Green roofs can, to some extent, substitute for lost open space and provide wildlife habitat for birds. They also provide a creative and attractive aesthetic (Mendler and Odell 2000, 56). [SOI Standards: 1, 2, 9, 10.] A green roof should be located out of major views to avoid negatively impacting the visual integrity of a historic property. A green roof will almost never convey the appropriate material sense of a historic period, so its use on sloped roofs should be limited to minor elevations. In addition to considering historic viewsheds, the structural integrity of a historic building should be carefully analyzed before installing a green roof.

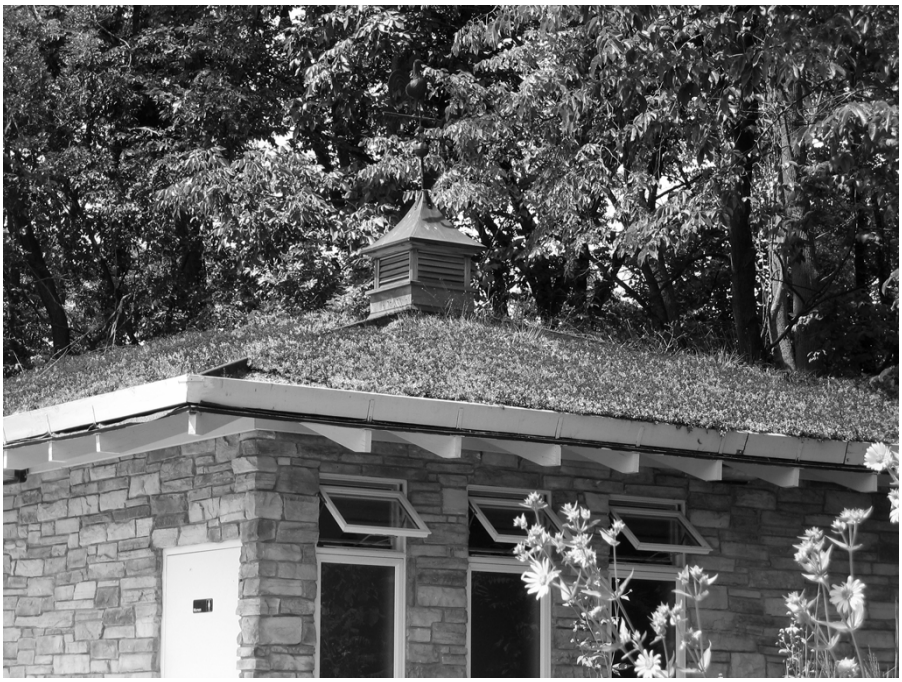

Figure 1.21. Extensive green roofs on sloped surfaces may not be appropriate for historic properties (McQuiggan 2005).

When installing green roofs to reduce heat island effects, contract the installation services from a green roof provider or ensure that in-house in-

stallation personnel have a thorough understanding of waterproofing, insulation, and other structural requirements (Thompson and Sorvig 2000, 115). Some green roof systems have been designed modularly so they can be installed in a single day. [SOI Standards: None.]

In most regions, green roofs should be designed to be self-sustaining with local average rainfall alone. If irrigation is needed, utilize graywater, treated effluent, or captured rainwater (Thompson and Sorvig 2000, 115). [SOI Standards: None, unless irrigation infrastructure is needed.]

Credit 7 — Light Pollution Reduction (1 Point)

Intent—Eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments.

Requirements—

Option A:

- Light to the Night Sky: Shield all outdoor luminaries 50 watts and over so that they do not directly emit light to the night sky…or…provide calculations showing that less than 5% of light emitted by all outdoor lighting reaches the night sky on an annual basis.
- Light Trespass: With the building interior, exterior and site lights on and off, measure the illumination levels at the same locations at regular intervals around the perimeter of the property. At least eight measurements are required with documentation that the measurements made are sufficient in quantity to be representative of the illumination levels on the perimeter of the property. The property perimeter illumination levels measured with the lights on must not be more than 10% above the levels measured with the lights off.
- Performance: Provide records and results of quarterly inspections to determine if required features are being maintained.

Option B:

- Light to the Night Sky: Shield all outdoor luminaries 50 watts and over so that they do not directly emit light to the night sky…or…provide calculations showing that less than 5% of light emitted by all outdoor lighting reaches the night sky on an annual basis.
- Light Trespass: Provide calculations showing that the maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property.
- Performance: Provide records and results of quarterly inspections to determine if required features are being maintained.

Sustainable design and development overview

> Many of the effects of artificial light may resonate up and down food chains, dragging whole ecosystems into imbalance. And by modifying the playing field on which nocturnal organisms develop, interact, and reproduce, artificial light may sculpt not only their individual lives but also the biological evolution of their species (Harder 2004).

There are four main ways that unnecessary lighting can contribute to light pollution: non-essential lighting especially after hours, energy inefficient equipment, lights directly or indirectly illuminating the atmosphere, and over or poor lighting (Ashkin et al. 2000, 60). Many states and municipalities have developed outdoor lighting codes to address reduction of 'sky glow', glare, light trespass onto adjacent properties, and energy consumption (Ashkin et al. 2000, 60).

Historic preservation overview

When evaluating lighting systems on a site, it is important to understand which system components are historically significance and which may have been added over time. Considerations range from the number and type of fixtures to the kind and wattage of light bulbs. Historic fixtures may need to be augmented to meet today's Life Safety Code and accessibility standards, but in many cases may be relamped or rewired and reused. This credit may be difficult to achieve on sites that were brightly illuminated historically or if shading of light fixtures degrades historic site character considerably.

Strategies

Effective outdoor and interior/exterior lighting design often incorporates careful consideration of many variables such as overall visibility, safety and security, and energy efficiency (Ashkin et al. 2000, 60). The primary objective under this credit is to implement site lighting that maintains safe light levels while avoiding off-site lighting and night sky pollution (USGBC, LEED-EB v. 2 2005, 36). Designers can use the pre-existing historic lighting system to determine the density of lighting necessary to maintain historic site character.

Light Level

The following strategies involve modulating light levels to achieve the desired end effect:

- Review military policy and local ordinances that may influence exterior lighting options. [SOI Standards: None.]
- Evaluate existing exterior lighting systems and identify non-critical lighting (Ashkin et al. 2000, 63). Conduct a photometric study to ensure that existing light distribution on site is adequate (Mendler and Odell 2000, 60). Model the site lighting using a computer model to predict impacts when changing lighting (USGBC, LEED-EB v. 2 2005, 36). [SOI Standards: None.] It is useful when modeling historic lighting conditions and any proposed changes to understand how the historic character may be impacted by light reduction. Determine whether or not extant historic lighting is critical to the historic character of the site. Avoid removal of historically significant lighting fixtures.

- Meet or provide lower light levels and uniformity ratios than those recommended by ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting, as amended and subsequent versions (USGBC, LEED-NC 2.2 2005, 25). Though this standard is referenced in LEED-NC and not in LEED-EB, it is relevant to all new exterior lighting additions to the site. [SOI Standards: 2, 3, 9, 10.] When altering light levels, care should be taken to preserve the ambience of the historic property if important to conveying its significance.

Light Fixtures

- Historic light fixtures should not be removed, but rather repaired (if necessary) and retrofitted with more credit-appropriate and efficient lamp-ballast systems (Fournier and Zimnicki 2004, 17). If historically significant fixtures are unnecessary for illumination, turn off power to the light but keep the fixture in place. If such fixtures are necessary to maintain historic ambiance, cut power to the fixtures when building is not in use. Remove any unnecessary non-historic lighting to benefit sustainability and historic preservation efforts. [SOI Standards: None.]
- Replace inefficient light sources (e.g., mercury vapor, incandescent, halogen) with energy efficient lamp technologies (e.g., metal halide, induction lamps, high-pressure sodium, and linear and compact fluorescent sources*) wherever possible. Avoid using fluorescent sources that are not suited for low temperature operation. Use incandescent sources only if they are integrated with a control mechanism that significantly limits the time that they operate. Employ quality prismatic or opaque lens materials to reduce the brightness of the light source. Use photovoltaic (PVs) for all outdoor lighting when possible (Figure 1.22). PVs are especially suitable for illuminating parking lots, walkways, and garages (Ashkin et al. 2000, 63). [SOI Standards: 2, 3, 6, 9, 10.] Care needs to be taken to ensure any changes in light sources fit with the historic character of the site to the greatest extent possible. Fixture replacement should be a last resort.

* When replacing lamps, handle them with care and set aside a location to collect them for recycling. Lamps utilizing mercury (e.g., fluorescents and mercury vapor lamps) need special handling. County, state, and EPA regulations exist regarding the handling and disposal of mercury. For more information, see the Resource Conservation and Recovery Act (RCRA) and MR Prerequisite 2, *Toxic Material Source Reduction*, in this document.

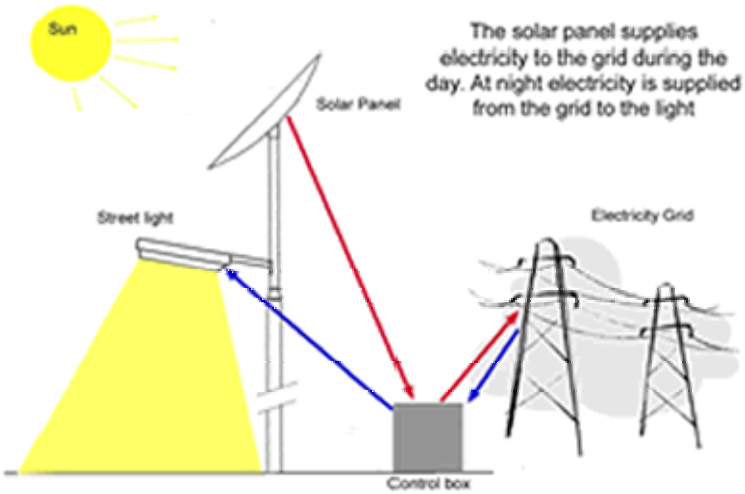

Figure 1.22. The solar panel supplies electricity to the grid during the day; at night electricity is supplied from the grid to the light (Local Government Energy Toolbox).

- Use efficient light sources that have a lighting cut-off angle that prevents light spill to the sky (Mendler and Odell 2000, 60) (Figure 1.23). [SOI Standards: 2, 3, 6, 9, 10.] Note that directional changes to light fixtures may negatively impact historic site character.

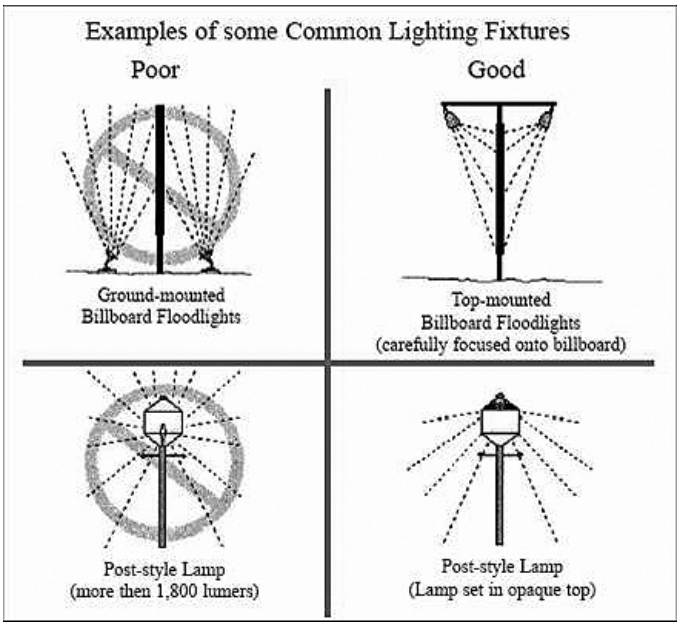

Figure 1.23. Examples of poor and good lighting (Ashkin et al. 2000).

- Do not illuminate exterior site and building architectural features simply for enhancement (Fournier and Zimnicki 2004, 17). [SOI Stan-

dards: 2.] However, if site or building features were illuminated historically, reducing or eliminating the light on these features may negatively impact comprehension of the historic site.

- Reduce the height of exterior light fixtures to reduce overall lighting output (Mendler and Odell 2000, 60). [SOI Standards: 2, 3, 6, 9, 10.] Note that this may conflict with historic lighting heights.
- Check and adjust fixtures regularly so that lights are aimed where needed for visibility and safety (Ashkin et al. 2000, 60). [SOI Standards: None.]

Energy management systems and timers

The following strategies can be used to optimize the use of light:

- Use energy management systems and time clocks to limit lighting to certain operating hours. To minimize operating hours and maximize savings, check system settings and adjust time clocks with time of year (Ashkin et al. 2000, 60). [SOI Standards: 2, 9, 10.] If additional panels or controls are required for such systems, place them to minimize impacts to the historic site or building.
- After business hours, lower lights to minimal levels, just enough to detect movement and provide sufficient security (Ashkin et al. 2000, 64). [SOI Standards: None.]
- Adjust timer switches and sensors to turn on lights for short durations, especially for non-essential or non-security lights (e.g., loading docks) (Ashkin et al. 2000, 60). [SOI Standards: 2.] For historic sites with ambient or specialty lighting, this may be possible only after business hours.
- Use motion sensors or daylight controls so that site light is used only when needed (Mendler and Odell 2000, 60). Incandescent, fluorescent, and induction lamps are effective for motion sensors, though incandescent types should only be used in limited timeframes. Avoid sources that require a period of time to achieve full brightness like High Intensity Discharge (HID) sources (e.g., Metal Halide or High Pressure Sodium) (Ashkin et al. 2000, 64). [SOI Standards: 2.]
- Clearly label all switching devices to save time and help employees identify which lights should be shut off at specific times (Ashkin et al. 2000, 60). [SOI Standards: 2, 9, 10.] Labels must be posted without causing adverse effects to the historic fabric.

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SS-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) covering sustainable sites are listed in Table 1.1 below:

Table 1.1. UFGS sections relevant to SS prerequisites and credits.

SS Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 1, Credit 1.1 & 1.2, 2, 4.1 & 4.2, 5.1 & 5.2, 6.1, 6.2	01355A	Environmental protection
Prerequisite 1, Credit 5.1 & 5.2	01356A	Storm water pollution prevention measures
Prerequisite 1, Credit 1.1 & 1.2, 4.1 & 4.2, 5.1 & 5.2	01575N and 01576	Temporary environmental controls
Prerequisite 1, Credit 2, 4.1 & 4.2, 5.1 & 5.2	Division 02	Site construction
Credit 7	Division 15	Mechanical
Prerequisite 1	15005A	Speed reducers for storm water pumps

Additional SS resources

American Concrete Pavement Association. www.pavement.com

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2 Water Efficiency (WE)

Water Efficiency—Select Mandates and Guidelines
42 USC 13101 et seq., Pollution Prevention Act of 1990
AR 11-27 Army Programs: Army Energy Program (DA, 3 February 1997)
AR 200-1, Environmental Protection and Enhancement (21 March 1997)
AR 420-1 Facilities Engineering: Army Facilities Management (HQDA, Final Pending 2006)
DODD 3200.15, Sustainment of Ranges and Operating Areas (10 January 2003)
DODD 4715.1E, Environment, Safety, and Occupational Health (19 March 2005)
ECB 2006-7 Army Standard for Urinals (HQUSACE, 07-03-2006)
EPA National Pollutant Discharge Elimination System (NPDES)
Federal Energy Policy Act of 2005 (8 August 2005) Fixture Performance Requirements
Memorandum, DAIM-ZA, Subject: The Army Standard for Urinals (05 April 2006)
MOU, Federal Leadership in High Performance and Sustainable Buildings (24 January 2006)
PWTB 200-1-35, Construction Discharge and National Pollutant Discharge Elimination System (NPDES) Requirements (30 September 2005)
UFC 3-440-02N, Operations and Maintenance: Water Conservation (NAVFAC, 16 January 2004)
UFGS 220000, Plumbing: General Purpose (NAVFAC, July 2006)

WE Prerequisite 1 — Minimum Water Efficiency (Required)

Intent—Maximize fixture water efficiency within buildings to reduce the burden on potable water supply and wastewater systems.

Requirements—Reduce fixture potable water usage to a level equal to or below water use baseline, calculated as 120% of the water usage that would result if 100% of the total building fixture count were outfitted with plumbing fixtures that meet the Energy Policy Act of 1992 fixture performance requirements. If the building does not have separate metering for each water use (fixture use, process use, irrigation and other uses), the water use reduction achievements can be demonstrated with calculations. At least one meter for the overall building water use is required and metering for cooling towers and other process water uses are encouraged but not required.

Sustainable design and development overview

Water use in the United States tripled between 1950 and 1995 (Davis 2003). To address the excessive water use issue, the Energy Policy Act of 1992 set forth a water-efficiency standard that required all U.S. plumbing manufacturers to reduce water waste. Plumbing technology has advanced significantly since enactment of the Act, thus providing fixtures that afford a significant reduction in water use. Lower potable water use provides the following benefits:

- lowers the demand the building places on the available water supply, ultimately minimizing impacts on the natural environment by reducing the total amount of water withdrawn from rivers, streams, underground aquifers, and other water bodies (USGBC, LEED-EB Reference Guide 2005);
- lowers the demand the building places on water treatment plants;
- helps to reduce energy use associated with heating water, thus lowering building operating costs (USGBC, LEED-EB Reference Guide 2005); and
- helps to reduce pollution associated with heating water (USGBC, LEED-EB Reference Guide 2005).

UFC 3-440-02N, *Operations and Maintenance: Water Conservation*, provides guidance for military installations for establishing water conservation programs.

Historic preservation overview

Older buildings typically contain plumbing fixtures or equipment that use higher water volumes than newer plumbing fixtures. Replacing or retrofit-

ting these with fixtures (e.g., water closets, showers, faucets, and flush valves) that meet or exceed current code requirements is one way to reduce building water consumption. Although historic plumbing fixtures may exist in buildings, these are often not a significant feature that needs to be retained, especially when they do not meet modern plumbing and accessibility codes.

In some circumstances, historic bathrooms or kitchens remain intact (such as in officers quarters, early- to mid-century buildings, or long-vacant facilities). In these cases, non-plumbed features such as porcelain or ceramic tile, built-in cabinets, and porcelain lavatories should be retained for their architectural qualities, although consideration for handicap accessibility may require their upgrade or construction of accessible facilities elsewhere in the building. It may be possible to retrofit some historic faucets with energy-saving devices. Introducing plumbing fixtures into areas of the building where they previously did not exist can also pose problems where the slope required for piping forces the alteration of floors and ceilings.

Strategies

Water use planning

Plan for reduced on-site water usage. Like many sustainable strategies, planning ahead can save money and ease transitions. Establish a plan that sets water use reduction goals and determine the most practical and efficient ways to achieve the goals. [SOI Standards: None.] The following aspects can be included in the plan:

- Designate a water efficiency coordinator (EPA, Water Use Efficiency Program).
- Develop a mission statement and a plan for maximized building water efficiency (EPA, Water Use Efficiency Program).
- Search for government, utility, and private-sector incentive programs to conserve water and reduce discharge to sewage treatment facilities (Mendler and Odell 2000, 108).
- Educate and involve employees in water efficiency efforts (EPA, Water Use Efficiency Program).
- Document all water-conserving devices and systems. Ensure that future modifications to plumbing fixtures and building systems follow low-water-use goals (Mendler and Odell 2000, 116).

Fixtures and equipment

From 1980 to 1995 the amount of freshwater withdrawn per U.S. citizen fell by 21% (Hawken et al. 1999). Some of this water use efficiency can be attributed to more efficient plumbing systems that reduced leaks both at the city and home levels. To maximize water use efficiency, install (where feasible) water-conserving plumbing fixtures that meet or exceed Energy Policy Act fixture requirements in combination with ultra high efficiency or dry fixture and control technologies (USGBC, LEED-EB 2005, 35). [SOI Standards: 2, 3, 5, 6, 9, 10.]

Use of high-efficiency plumbing fixtures, appliances, and other equipment can yield substantial savings on water, sewer, and energy bills (EPA, Water Use Efficiency Program). However, applicable state and local codes should be checked prior to design for 'approved fixture' lists because some alternative fixtures (including waterless urinals and low-flow toilet technologies) have not been approved in all states and localities (Grumman 2003). Also, maintenance of these specialty fixtures is typically nonstandard and requires special training of staff (Grumman 2003).

- Flushing of conventional toilets is the largest single use of water in U.S. buildings. On a daily basis, flushing uses approximately 20 gallons per person per day (American Water Works Association 2005). Therefore it stands to reason that toilet flow reduction is the single most cost-effective water use measure. For maximum efficiency, install high-efficiency toilets, or retrofit water-saving devices onto existing toilets (EPA, Water Use Efficiency Program). Use dual-flush toilets that use either a low- or ultra-low-flush setting (Mendler and Odell 2000, 170).*
- Reduce fixture potable water usage through automatic water control systems including flow-restricting or metered faucets (USGBC, LEED-EB 2005, 35). Consider self-closing, slow-closing, or electronic faucets, particularly in high-use public areas (Mendler and Odell 2000, 169).
- Install faucet and showerhead aerators that introduce air into the water stream and restrict flow rates, thus resulting in reduced water usage (EPA, Water Use Efficiency Program).

* Ultra-low-flush toilets often require more maintenance than standard toilets, so their use is best suited in regions where water conservation is especially important. Water Management, Inc. (a company that has conducted numerous tests of various types and makes of toilets) asserts that certain models by different manufacturers work better than others under specific site conditions. Similarly, they assert that all models work inefficiently when not properly maintained or repaired (toiletology.com). Both the National Association of Home Builders Research Center and Seattle Public Utilities performed comparable testing with similar results.

- Consider composting toilets and waterless urinals as zero-water-use alternatives (Mendler and Odell 2000, 170).

Specify water-saving appliances. Require that commercial dishwashers (conveyer type) use 120 gallons per hour or less and washing machines use 10 gallons a cycle or less (Grumman 2003, 113). Use water-conserving ice makers (EPA, Water Use Efficiency Program). As appliances and equipment wear out, replace them with water-saving models (EPA, Water Use Efficiency Program). [SOI Standards: None.]

Eliminate 'once-through' cooling of air conditioning equipment with municipal water by recycling water flow to cooling tower or replacing with air-cooled equipment (EPA, Water Use Efficiency Program). Consider closed cooling towers on air conditioners (to eliminate drift) and filters for cleaning the water (Grumman 2003, 113). Use water-efficient cooling tower systems. Consider the use of automated chemical dosing or ozone treatment to conserve water and reduce chemical use (Mendler, Odell and Lazarus 2005). [SOI Standards: 2, 6, 9, and 10 for cooling towers.] Electric chillers have smaller cooling towers that may be less conspicuous on historic properties.

Consider eliminating all in-sink garbage disposals and provide for composting of organic waste as an alternative. Some garbage disposals filter and separate organic material so that it can be collected for composting from a holding tank under the sink (Mendler and Odell 2000, 115). [SOI Standards: None.]

Use graywater volumes captured from showers, sinks, and lavatories for use in water closets. [SOI Standards: 2, 6.] The size of reservoir tanks determine the extent of impacts to historic interiors.

Operations and maintenance

The average circa 1940's military facility loses more than 10% of total water production and purchases to system leaks (DOE 2004). A water distribution system audit, leak detection, and repair program can help facilities reduce water losses and make better use of limited water resources. [SOI Standards: None.] The program should include the following aspects:

- Increase personnel knowledge of the distribution system. As personnel become more familiar with the system (including knowing the location

of mains and valves), they are able to respond more quickly to emergencies such as main breaks (DOE 2004).

- Inspect existing plumbing and repair all leaks (EPA, Water Use Efficiency Program). Repairing system leaks can prevent damage to property and safeguards public health and safety. Establish water leak detection programs (Mendler and Odell 2000, 116).
- Minimize the water used in space cooling equipment in accordance with manufacturers' recommendations. Shut off cooling units when not needed (EPA, Water Use Efficiency Program).
- Develop a schedule for regular water meter readings and maintenance of irrigation systems, plumbing, and equipment to maintain efficiency (Mendler and Odell 2000, 116). For more information, see Credit 1.1 and 1.2, *Water Efficient Landscaping: Reduce Water Use*.

WE Prerequisite 2 — Discharge Water Compliance (Required)

Intent—Protect natural habitat, waterways and water supply from pollutants carried by building discharge water.

Requirements—

- Option A: If regulated by EPA National Pollution Discharge Elimination System (NPDES) Clean Water Act requirements, demonstrate NPDES permit compliance including use of any required oil separators, grease interceptors and other filtration for in-building generated discharges and proper disposal of any wastes collected.
- Option B: If the facility is not regulated by a NPDES Permit, this prerequisite is achieved.

Sustainable design and development overview

Only one-third of our rivers, lakes, and coastal waters were considered fishable and swimmable in 1972. That year an early version of the Clean Water Act was enacted by Congress to reduce source pollution. Subsequent amendments further refined the Act. Thirty years later the Act has proven successful in reducing pollution in waterways, with approximately two-thirds of U.S. waters considered healthy (EPA, Protecting the Nation's Waters through Effective NPDES Permits 2001).

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into U.S. waters. Today, more than 400,000 facilities are required to have NPDES permits and the number is expected to grow as policies get more stringent (EPA, Protecting the Nation's Waters through Effective NPDES Permits 2001). The types of facilities covered by the NPDES program include municipal wastewater systems, municipal and industrial storm water systems, industries and commercial facilities, and Concentrated Animal Feeding Operations. For sites not under NPDES control, reducing environmental impact from discharge water will help improve conditions for on-site vegetation, soil, water, and wildlife, in addition to improving downstream water quality.

Existing buildings may contain pollutants that are conveyed from the site as building discharge water. In addition, water that runs across parking lots, construction sites, and industrial facilities picks up contaminants that can collectively cause serious pollution concerns for U.S. waterways. This LEED-EB prerequisite is intended to examine and address potential pollutant sources to minimize their environmental impact.

In addition to the Clean Water Act, the Pollution Prevention Act of 1990 states that pollution should be stopped at the source whenever feasible, and when not feasible should be recycled or treated with environmental safety or disposed of as responsibly as possible. Public Works Technical Bulletin No. 200-1-35 (2005), *Construction Discharge and National Pollutant Discharge Elimination System (NPDES) Requirements*, identifies current compliance requirements and supporting information for stormwater runoff from construction activities and related NPDES requirements for all U.S. Army facilities and USACE districts. As mentioned previously, DODD 3200.15 requires installations to identify and address environmental issues. This would include pollutants in building discharge water. DODD 4715.1E, *Environment, Safety, and Occupational Health* (ESOH), also supports pollution prevention and maximizing existing resource capacity. UFC 3-440-02N, *Operations and Maintenance: Water Conservation*, provides guidance for military installations for establishing water conservation programs.

Historic preservation overview

This credit is asking for proof of NPDES compliance for commercial or industrial sites that already must comply by law. Although proof of compliance has no physical impact on historic properties, sustainable strategies implemented on historic sites must comply with provisions of the Clean Water Act and NPDES permitting. For instance, where installation of interceptors requires site excavation, significant historic landscape features and archaeological resources need to be considered.

Strategies

Determine if discharge waste from building requires a NPDES permit. NPDES permits are issued by states that have obtained EPA approval to issue permits, or by EPA Regions in states without such approval. If no permit is required, provide supporting documentation. If building currently holds a NPDES permit, verify permit is valid, covers all pollutants discharged from the site, and no additional permits are necessary. [SOI Standards: None.]

Establish a discharge monitoring report (DMR) process to bring and keep the NPDES permit into compliance. Monitoring requirements are set forth in the NPDES permit. This is typically the responsibility of installation wastewater and stormwater management personnel; however the services

of private sector laboratories are typically necessary for water sample analyses. [SOI Standards: None.]

Take the necessary actions to comply with NPDES and EPA obligations. If oil, grease, or other interceptors are required, major site excavation may be needed to create discharge water tie-ins (Figure 2.1). [SOI Standards: 2, 8.] Such ground-disturbing activities must not impact historic landscape features and archaeological sites.

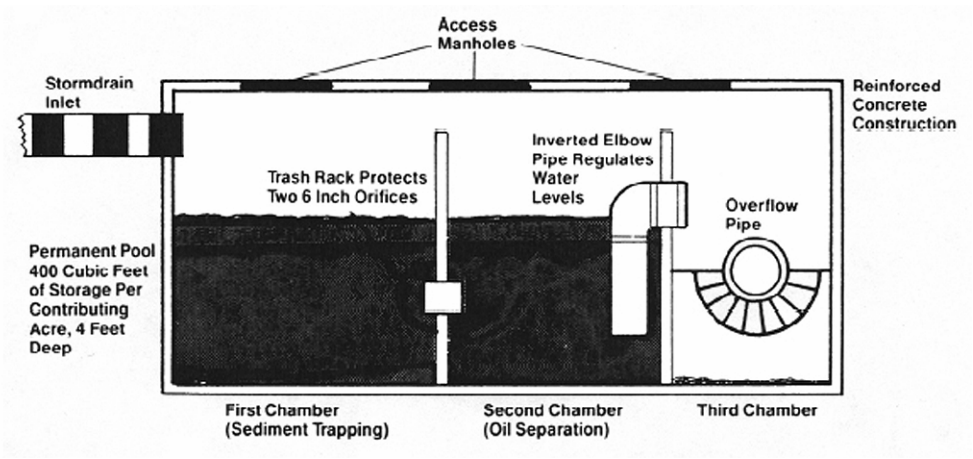

Figure 2.1. Diagram of an oil grit separator (Metropolitan Council).

WE Credits 1.1 and 1.2 — Water Efficient Landscaping: Reduce Water Use (1 – 2 Points)

Intent—Limit or eliminate the use of potable water for landscape irrigation.

Requirements—Use high-efficiency irrigation technology OR use captured rain/recycled site water to reduce potable water consumption for irrigation in comparison to conventional means of irrigation. If the building does not have separate metering for each water use (fixture use, process use, irrigation and other uses), the water use reduction achievements can be demonstrated with calculations. At least one meter for the overall building water use is required and metering for cooling towers and other process water use is encouraged but not required. In urban settings, where there is no lawn, credits can be earned by reducing the use of potable water for watering any roof/courtyard garden space or outdoor planters.

- WE Credit 1.1—50% reduction in potable water use for irrigation over conventional means of irrigation (1 point).
- WE Credit 1.2—95% reduction in potable water use for irrigation over conventional means of irrigation (1 point).

Sustainable design and development overview

A comprehensive water conservation approach significantly reduces demand on municipally supplied water and its source, while reducing consumer cost and environmental pollution. During hot seasons, landscape irrigation consumes 75% of residential water use, mostly from municipal supplies that have been treated for drinking water standards (Thompson and Sorvig 2000). Furthermore, existing buildings might contain outdated or inefficient irrigation systems that consume large quantities of potable water. Reducing potable water use reduces dependency on municipally supplied water (postponing the construction of new water treatment plants or delaying the expansion of existing plants) and conserves energy. Wells have to pump less water throughout the system, less water treatment is necessary, and as a result fewer chemicals are used.

Water conservation techniques to reduce the use of potable water for irrigation typically include technologically superior irrigation systems, rainwater harvesting, and waterwise landscape design. These multi-faceted systems operate most effectively when organized by a comprehensive plan that integrates the various techniques. Plan development requires an understanding of site water needs and practices, and knowledge of regional water availability. An understanding of design, installation, maintenance, and monitoring of conservation technologies plays a vital role for the success of any water conservation program.

DODD 3200.15 indirectly addresses the need to reduce wasteful water use that depletes aquifers, taps energy resources, and costs money. UFC 3-

440-02N, *Operations and Maintenance: Water Conservation*, provides guidance for military installations for establishing water conservation programs.

Historic preservation overview

Water-harvesting (i.e., the collection and storage of rainwater from roofs, paved surfaces, and the landscape) has strong historical precedence both in the United States and around the world. Israeli archaeologists have found evidence of water harvesting in the Negev Desert as early as 1500 B.C. (Christopher 1994). Similarly, water harvesting techniques may already have historical precedence on a historic military site, and could be preserved, restored, or reconstructed as part of a historic rehabilitation. In addition some historic sites already incorporate or should be rehabilitated to include historically compatible native or adapted plants that do not require additional irrigation. In general, the strategies associated with this credit share historic preservation issues with SS Credits 1.1 and SS 1.2. Since standard irrigation systems are typically just below grade and not visible in the landscape, their impacts to a historic site are generally limited to archeological concerns. However, some alternative irrigation methods that utilize collected rainwater may have historic preservation impacts related to the siting of storage tanks.

Strategies

Exploit site characteristics

Perform a soil/climate analysis to understand the site conditions, both existing and manmade. Soil texture (amount of clay, sand, and silt), topography, wind characteristics, and soil amendments and mulch will determine the amount of water that can be retained in the soil and for how long. This will also help to determine the appropriate plant material for the site. [SOI Standards: None.]

Irrigation systems

Install high-efficiency irrigation technology. Approximately 100 gallons of potable water are consumed per capita on a daily basis, and 25% to 33% of this total is used to water lawns, plants, and gardens (Vickers 2002). How much water is used for irrigation depends on the type of irrigation used (drip irrigation or sprays). Sprinkler systems waste 25% to 35% of distributed water depending on the type (fixed, rotary, impulse, or oscillating)

and model (Christopher 1994). Drip irrigation is considered by many to be one of the most effective irrigation solutions; however it has just as much potential to waste water when not carefully implemented and monitored. Proper design, installation, monitoring, and maintenance of high efficiency irrigation technology are all equally important factors that contribute to the system working as intended. If not properly installed, water may be getting to the wrong plants in the wrong amounts. If not monitored, changes in weather and temperature will not be taken into account. If not maintained, leaks or breakdowns in the system can undermine all careful efforts at water conservation. [SOI Standards: 2, 8, 9, 10.] Note that the installation of excessive onsite water meters could impact the visual comprehension of a historic site.

- Design irrigation systems tailored to the site that consider system efficiency and water reuse (Thompson and Sorvig 2000, 160) to reduce excessive piping and water waste. Also consider visual impacts to the historic site and design a system that minimizes negative visual impacts, both of the system itself and its effects on historic plant material.
- Design irrigation systems to supplement precipitation. Assess soil conditions for properties that will affect infiltration rates: soil structure, texture, degree of compaction, and organic content. Design to accommodate microclimates and weather conditions (Becker et al. 1996).
- Break the site into irrigation zones (Becker et al. 1996). Identify an optimum range of application rates for each zone and design the system to achieve these rates. Base zones on (1) type of use, and (2) species culture. A sports field or golf course green, for example, may need more water than a typical residential lawn to assure health and viability of vegetation under heavy traffic. Designate separate zones for turf, seasonal color plantings, shrubs, and trees. Look at plant needs and design to meet (not exceed) those requirements.
- Consider soil infiltration rate, slope, and design precipitation rate when selecting sprinkler heads to reduce the potential for runoff.
- Specify ‘pressure compensating’ and ‘matched precipitation rate’ nozzles for individual zones (Becker et al. 1996). The pressure compensating type has a screen in the nozzle that reduces water pressure fluctuations and eliminates water waste caused by high water pressure. The matched precipitation type ensures that all sprinklers in a particular zone are placing about the same amount of water on a given area.
- Select irrigation components according to supply pressure, soil properties, slope, wind conditions, and desired application rates. Remember

that plant water need is dynamic (i.e., optimal irrigation rates and volumes will not remain constant) (Becker et al. 1996).

- Install irrigation systems with separate valves that allow separate irrigation of turf, flowers, ground covers, trees, and shrubs (Becker et al. 1996).
- Use low-angle sprinkler heads to mitigate the effects of wind and to avoid high wind and dirt.
- Select a water meter that has (or is upgradeable with) an electronic flow rate output signal for interfacing to (1) controllers that can perform leak detection, and (2) water management sensors (Becker et al. 1996).
- Specify environmental sensors on automatic sprinkler systems that allow for shutdown in excessive wind, and during rain events. The controller should interface with rain and wind sensors to avoid watering during rainy or windy weather, and allow cyclic 'set day' watering schedules to meet regulatory requirements during drought periods. In addition, choose a controller that schedules water application through historical or real-time use data and soil moisture sensors (Becker et al. 1996). Smart irrigation systems with rain shut-off devices, flow meters, and soil moisture sensors not only save water, but can avoid over or under watering of vegetation.
- Local plumbing authorities may require a backflow prevention device. Specify an insulated housing for this assembly to prevent freeze damage. Place any pressure reducing apparatus downstream of the backflow valve (Becker et al. 1996).
- Include a valve before the irrigation backflow device to allow emergency water shut off, and drain valves on all irrigation zones to drain the system for winter. All valves should be American Society of Sanitary Engineers (ASSE) or International Association of Plumbing and Mechanical Officials (IAPMO) approved and insulated to protect from freeze damage (Becker et al. 1996).
- Specify swing joints with pop-up spray heads, and check valves on all sprinkler heads to prevent low head drainage. Be aware that check valves will require the use of an air compressor to appropriately expel water for winterization (Becker et al. 1996).
- Ensure that all valves in below-grade boxes have a device allowing them to be located by metal detectors (Smith, Texas WaterWise Council).

- Do not irrigate in the middle of the day due to evaporation loss. Use drip irrigation or bubbler systems to reduce water waste from evaporation (Mendler and Odell 2000, 151).
- Install low-volume irrigation in long narrow strips, small irregular-shaped areas, and vegetation beds to reduce evaporation losses and to avoid applying water on hardscapes such as patios, decks, sidewalks, parking areas, and roadways (Smith, Texas WaterWise Council).
- Create a 'design performance report' of the irrigation system that outlines how the system will perform. The report should include individual zone precipitation rates in inches per hour (Smith, Texas WaterWise Council).
- Require that a certified qualified professional design and install the irrigation system.
- Provide maintenance personnel 'as-built' drawings of the irrigation design that specify locations and types of all devices, pipelines, wiring, control valves, backflow prevention devices, and rain shut-off equipment (Smith, Texas WaterWise Council).
- Maintain irrigation systems regularly for efficiency. Poor maintenance can cause significant water loss and undermines the value of irrigation systems (Becker et al. 1996).
- Periodically adjust sprinkler output by testing actual performance with a rain-gauge (Becker et al. 1996).
- Inspect irrigation system for vandalism, accidental damage, sinkage, malfunctions, leakage, and blockage every six months (Becker et al. 1996). Reset sprinkler heads flush with the ground as necessary (Becker et al. 1996).
- Drain the system for winter and flush it when reactivating. Modern systems are typically self-cleaning, but older ones may require flushing to remove sediment (Becker et al. 1996).

Feed irrigation systems with rainwater

Feed irrigation systems with harvested rainwater, graywater (site or municipal) or on-site treated wastewater (USGBC, LEED-EB 2005, 38). Rainwater harvesting collects the roof rainwater, channels the water into cisterns above or below ground, and uses the water for exterior non-potable uses. These water storage and reuse systems can be part of an initial site design or readily retrofitted onto any site or structure. Water harvesting techniques are appropriate for any scale project from a small yard to a large development. Housing, schools, recreational areas, parking lots, barracks complexes, and commercial facilities are all sites where rainwater

could be effectively harvested. Simple cistern systems provide water for hand watering or nearby irrigation. To irrigate larger sites, submersible pumps are required to provide enough pressure to carry water longer distances. Other water distribution components include hoses, constructed channels, pipes (solid and perforated), and manual drip systems. Most of these components can be incorporate successfully into the landscape design, installed below grade, or screened with plants or other structures. [SOI Standards: 2, 8, 9, 10.]

Feed irrigation systems with direct watering systems. Direct systems guide water to and collect it in planted depressions or small swales that then drain water into planted areas. These systems generally require manipulation of site grading and contours for water runoff, with considerations given to plant choice, drainage, and slope. Nonetheless, direct watering systems can be quite simple, and most sites are able to accommodate them for little cost or effort. [SOI Standards: 2, 8, 9, 10.]

Exploit the nutritional benefits of rainwater. An advantage of utilizing rainwater for irrigation (via harvesting or direct watering systems) is that it provides plant life with nutrients. Rain picks up nitrogen, sulfur, and other compounds that are beneficial to plants. These compounds are lacking in municipally supplied water. Nitrogen makes plants green and sulfur is an important constituent in the formation of plant amino acids (Harris et al. 2004). [SOI Standards: None.]

Improve the efficiency of existing site features through nondestructive means, like recycling water for a fountain instead of sending the water downstream after one cycle through the fountain (Fournier and Zimnicki 2004, 18). [SOI Standards: None.]

Feed irrigation systems with graywater

Feed irrigation systems with graywater from an on-site wastewater treatment system (Thompson and Sorvig 2000, 160). For graywater irrigation, sub-surface distribution systems are often required by local Health Departments. Sub-surface systems are typically not as effective as aboveground spray systems for turf areas, but are highly conserving and effective for providing root zone irrigation of plant beds, shrubbery, and trees (City of Austin 1995). The depth of these systems typically ranges from 4 ft to 30 ft. If installed without soil compaction by machinery or damage to the surrounding vegetation, site disturbances should be temporary. Plant-

ings can be removed and reinstalled, and grass can be replanted. [SOI Standards: 2, 8, 9, 10.] This strategy may be more appropriate for areas to be re-vegetated to limit the possibility of damaging existing and historic plantings.

Bank water for later use

Collect and store rainwater for use at a later time. Banking water (i.e., accumulating reserves) promotes self sufficiency by reducing dependency on water supplied by others. Rainwater storage can be an especially important strategy for sites with low or periodic rainfalls because it provides an available water supply during dry spells. By holding water on site, there is less runoff, and less potential for erosion and flooding. In addition, water stored at remote locations can serve as a backup source for water in case a municipal system is compromised. [SOI Standards: 2, 9, 10.] Some methods that utilize collected rainwater may have historic preservation issues related to the placement of storage tanks.

- The water storage container should be carefully selected and installed to ensure its storage capabilities and water cleansing systems are appropriate for the intended use of the collected water.
- Storage containers should be opaque and protected from sunlight to prevent the growth of algae, and they should be placed four to six feet away from building foundations in case of leaks (Waterfall 2004).
- Water containers should be covered to prevent mosquito breeding and the entry of debris. Containers should be secured from children and clearly labeled as unfit for drinking (Waterfall 2004).
- Storage containers should be installed close to where the water will be used, however the higher off the ground the better the water pressure. On a sloped lot, consider locating water storage at the highest elevation possible (Waterfall 2004).
- For any water containment system, it is important to have an overflow pipe located at least an inch below the lip of the container and move the excess water away from the building foundation (preferably into a depressed area of the landscape where the water can percolate into the soil) (Waterfall 2004).
- For large storage needs, several containers can be connected together.

Waterwise landscape design

Implement waterwise landscape design on the site. Waterwise landscape design, also known as xeriscaping, incorporates a variety of plant-appropriate choices and landscaping techniques to reduce or eliminate irrigation requirements and stormwater runoff. Planting and properly maintaining waterwise plant material on the site will go a long way toward reducing overall water use on the site. [SOI Standards: 1, 2, 3, 6, 7, 8, 9, 10, unless noted otherwise.] Tenets of waterwise landscape design are listed below:

- Avoid implementing and operating an irrigation system (USGBC, LEED-EB 2005, 38).
- Use native or appropriate plantings that do not require irrigation except during their establishment period (Mendler and Odell 2000, 43).
- Irrigate in early morning or late afternoon to avoid evaporation. [SOI Standards: None.]
- Encourage root growth and drought tolerance by watering plants with a higher quantity less often. [SOI Standards: None.]
- Specify water-efficient, native or adapted, climate-tolerant plantings. New plantings need to fit the historic character of the site in texture and massing.
- Reserve water-intensive plants for areas where they will have maximum effect.
- Reduce water-intensive plantings like turf grass. Removal of turf can negatively impact the comprehension of a historic site design. There are slow-growth alternatives to traditional turf grass (e.g., fescue, buffalo grass, and other short ornamental grasses) that could be used as alternatives. Options depend on climate and annual precipitation, so check with local EPA offices, horticultural departments, botanical gardens, etc. for viable options.
- Cluster species groups by water use to promote large root systems, prevent erosion, and reduce water waste. Group water-needy plants together and located closer to the water source.
- Contour land so stormwater is directed across the site/plants. Re-contouring can negatively impact site lines and disturb the historic fabric and character of a site. If this is an issue, select re-contouring locations away from historic viewsheds and features, minimize regrading so it is subtle but effective, or select a different stormwater strategy altogether.

- Use mulch, compost, and alternative mowing to reduce water evaporation and maintain plant health. Onsite storage of mulch and compost can negatively impact the historic character of the site if not concealed.
- Calculate the evapo-transpiration reference rate (ET_O) to determine the amount of water used by an 'average' plant in the particular region and season (Thompson and Sorvig 2000, 160). [SOI Standards: None.]

WE Credit 2 — Innovative Wastewater Technologies (1 Point)

Intent—Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Requirements—

- Option A: Reduce use of potable water for building sewage conveyance by 50%, based on water use baseline calculated for WE Prerequisite 1.
- Option B: Treat 100% of wastewater on site to tertiary standards.

Sustainable design and development overview

Conventional wastewater systems waste a lot more potable water than necessary to perform basic functions. 'Graywater' reuse systems recycle water that has been used for certain functions such as washing machines, showers and sinks, and stores this water for certain interior or exterior uses. Graywater systems are modifications of septic system technology and, thereby, use components standard to septic systems. An important feature of a graywater system is the isolation of blackwater (or sewage) to a separate system, leaving the graywater available for reuse (City of Austin 1995).

The excessive amounts of potable water used to convey waste from buildings carries waste to energy-intensive treatment facilities. A more efficient method is to treat wastewater on site with constructed wetlands that cleanse the wastewater before releasing it. Wetlands also provide valuable wetland habitat for waterfowl and other wildlife, increasing habitat diversity and providing opportunities for public education and recreation. Although land intensive, these systems offer an effective means of integrating wastewater treatment and resource enhancement, often at a cost that is competitive with conventional wastewater treatment alternatives (EPA, Constructed Wetlands 1993).

Another benefit of water collection and recycling is that it provides security of supplies in regions subject to water use restrictions or concerns about terrorist attacks on local water supplies.

As mentioned in WE Prerequisite 1, DODD *3200.15* requires installations to address environmental issues, including the reduction of potable water use that depletes aquifers, taps energy resources, and costs money to acquire and treat. UFC 3-440-02N, *Operations and Maintenance: Water*

Conservation, provides guidance for military installations for establishing water conservation programs.

Historic preservation overview

Original and existing plumbing fixtures are often not considered character-defining historic building features and can be replaced to meet code, increase efficiency, and meet accessibility requirements. Innovative technologies that involve landscape construction must consider historic landscape features and be executed in compliance with the SOI Standards.

Strategies

Reduce initial water use

Install non-water using or high efficiency plumbing fixtures. New fixtures should replace historic fixtures only in spaces (1) where plumbing fixtures are not significant historic features, (2) where historic interiors have been heavily modified, (3) in non-historic building additions, or (4) where retention of historic fixtures violates building codes. [SOI Standards: 2, 6, 9, 10.]

Reuse graywater/blackwater

Plumbing codes for innovative technologies like rainwater harvesting or graywater reuse vary by state and region. For instance, in Chicago rainwater harvesting can be used for irrigation, but graywater cannot be used for subsurface irrigation purposes or reuse within a building. In contrast, the State of Illinois Department of Public Health has no existing regulations for graywater; it is governed under experimental systems. In jurisdictions that allow the use of graywater for non-potable use, blackwater and graywater waste lines in a building must be kept separate. Though not a difficult task for new construction, providing separate plumbing can be problematic (i.e., invasive) in existing buildings (City of Austin 1995). [SOI Standards: 2, 6, 9, 10.] Strategies for graywater/blackwater reuse include:

- Identify potential sources of graywater (sinks, showers, dishwashers, condensate from cooling towers, drinking fountains, etc.) and group those that generate greater quantities of water to minimize piping requirements and maximize water reuse (Mendler and Odell 2000, 110).
- Utilize systems that, collect, recirculate, and reuse water to reduce water consumption (USGBC, LEED-EB 2005, 40).

- Use treated graywater for irrigation (Mendler and Odell 2000, 110).
- Recycle rainwater as well as graywater for building reuse. After simple filtration, water can be reused for toilet flushing, irrigation, and other nonpotable uses (Mendler and Odell 2000, 105). These systems can vary in size and location. Graywater systems often have smaller storage requirements but high levels of filtration and treatment. On the contrary, stormwater collection systems require larger storage tanks but less filtration. These storage tanks can be located either above or below grade. Above-ground tanks require careful placement and design so as to not detract from the historic character of the property. Below-grade work requires consideration of buried archaeological resources.

Ecological wastewater treatment

Providing advanced wastewater treatment by employing innovative, ecological, on-site technologies can be highly beneficial. This is especially true when treatment minimizes energy use and disposes of treated effluent by applying it to the land, either by surface application or subsurface dispersal. However, it is important to choose treatment methods appropriate to the requirements of state and local regulatory authorities for effluent disposal (USGBC, LEED-EB 2005, 40). Ground-disturbing activities associated with subsurface dispersal have the potential to impact historic landscape features and buried archaeological sites. [SOI Standards: 1, 2, 8, 9, 10.] Ecological wastewater treatment methods include the following:

- Employ constructed wetlands as a method of wastewater treatment. Natural wetlands (e.g., swamps, bogs, marshes, fens, and sloughs) are recognized as providing many benefits, including: food and habitat for wildlife; water quality improvement; flood protection; shoreline erosion control; and opportunities for recreation and aesthetic appreciation (EPA, Constructed Wetlands 1993). Public Works Technical Bulletin (PWTB) 200-1-21, *Applicability of Constructed Wetlands for Army Installations*, is a military resource that outlines how the Army is utilizing constructed wetlands on installations for waste and stormwater treatment.
- Treat wastewater with a mechanical recirculating sand filter. These filters remove contaminants through physical, chemical, and biological processes, but primarily biological. They are chemical-free, with bacteria playing the chief role in contaminant removal.
- Use an aerobic biological treatment reactor to treat wastewater. This process introduces air to settled wastewater, creating enough turbu-

lence to force liquids through biomedia that promotes biomass growth. This growth in turn leads to a reduction of impurities in the water.

- Educate staff and site users in the benefits of ecological wastewater treatment methods.

WE Credits 3.1 and 3.2 — Water Use Reduction (1 – 2 Points)

Intent—Maximize fixture potable water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements—Have in place over the performance period strategies and systems that in aggregate produce a reduction of fixture potable water use from the calculated fixture water usage baseline established in WE Prerequisite 1. If the building does not have separate metering for each water use (fixture use, process use, irrigation and other uses), the water use reduction achievements can be demonstrated for WE 3.1 with calculations. At least one meter for the overall building water use is required and metering for cooling towers and other process water use encouraged but not required. To earn WE 3.2, measured fixture water use demonstrating required level of efficiency must be provided.

- WE 3.1—10% reduction in fixture water use from the baseline (1 point).
- WE 3.2—20% reduction in fixture water use from the baseline (1 point).

Sustainable design and development overview

Toilet flushing is the largest single use of water in buildings, consuming 4.8 billion gallons of water per day (EPA 2005). Irrigation, toilets, sinks, and showers all utilize unnecessary water. For that reason, potable water use reduction is an important strategy for reducing water waste from building use. These credits are structured to allow additional LEED points by further reducing potable water consumption from the baseline requirements of WE Prerequisite 1.

UFC 3-440-02N, *Operations and Maintenance: Water Conservation*, provides guidance for military installations establishing water conservation programs.

Historic preservation overview

See WE Prerequisite 1.

Strategies

Create a water use reduction plan that includes the following, and select appropriate options for the building budget, upgrade schedule, or planned renovations. [SOI Standards: None, but the plan should include provisions for SOI Standards compliance during implementation of the plan.]

- Develop a water use inventory by expected use that identifies and evaluates significant potable water demands in terms of minimum acceptable quantity and quality.

- Identify water-reducing opportunities in or around building, and methods to minimize or eliminate the demands.

Low-flow plumbing fixtures and low-flow retrofits are long-term conservation measures that can be implemented with little or no additional lifecycle costs (Jensen 1991). Some high-efficiency equipment is widely available, such as waterless urinals, faucet aerators, and low-flow toilets. Look for referrals from those who have previously used or specified the equipment. [SOI Standards: 2, 6, 9, 10.]

- Use or replace conventional toilets with water reduction fixtures. Low-flow toilets come in several varieties from dual flush (which use either 1.6 or 0.8 gallons by user choice) to dry toilets that use no water at all. Dual-flush versions use 40% less water than the currently mandated 1.6 gallons per flush (EPA, Water-Saving Tips 2005).
- Use low-flow showerheads, faucet aerators, and/or pressure reduction valves to reduce water use (EPA, Water-Saving Tips 2005).
- Install self-closing or sensor operated fixtures where faucets might be carelessly left running.
- Plastic containers (such as plastic milk jugs) can be filled with water or pebbles and placed in a toilet tank to reduce the amount of water used per flush (EPA, Water-Saving Tips 2005). [SOI Standards: None.]

Utilize non-potable water systems from toilet flushing, janitorial tasks, and irrigation, through graywater or rainwater collection systems. [SOI Standards: 2, 6, 8, 9, 10.] Graywater or rainwater storage systems can be located on rooftops or at or below grade. Choose a location that minimizes impacts to the historic property. Note that below-grade systems may impact buried archaeological deposits.

When letting the water run for hot water, retain the unused water in a container for watering plants, etc. [SOI Standards: None.]

Sweep sidewalks and driveways instead of hosing them down or use non-potable water. [SOI Standards: None.]

Educate building occupants, staff, and site users about water conservation goals and special instructions for using high-efficiency fixtures or non-conventional systems. General information signage should be located where it does not detract from historic features, and fastened in such a way

that does not involve adhesives, which can permanently mark historic surfaces. [SOI Standards: 2, 9, 10.]

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WE-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) that address water efficiency are shown in Table 2.1 below:

Table 2.1. UFGS sections relevant to WE prerequisites and credits.

WE Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 2	01355A	Environmental protection (relevant submittals include SD-01 Pre-construction Submittals and Environmental Protection Plan)
Credit 2	02510	Water distribution
Prerequisite 2 and Credit 2	02531 and 02531S	Sanitary sewers
Prerequisite 2	11350 through 11393	Various sludge and sewage provisions
Credit 2	11377	Advance oxidation processes (AOP)
Prerequisite 2	11393	Filtration systems
Prerequisite 1, Credit 2, 3.1, and 3.2	13290	Composting toilets
Prerequisite 1, Credit 3.1 and 3.2	13401 through 13451	Various water control systems
Credit 2	13401	Flow measuring equipment (sewage treatment plant)
Credit 1.1 and 1.2	Division 02	Site construction (multiple applicable documents)
Prerequisite 2 and Credit 2, 3.1, and 3.2	15102S	Plumbing
Credit 2	15400 through 15411N	Various plumbing provisions
Prerequisite 1 and 2	15400	General purpose plumbing
Credit 3.1 and 3.2	15405A	Plumbing, hospital
Credit 3.1 and 3.2	15410S	Residential plumbing fixtures
Credit 3.1 and 3.2	15411N	Hospital plumbing fixtures
Prerequisite 2	15445S	Sump pumps

Additional WE resources

American Rainwater Catchment Systems Association. www.arcsa-usa.org

American Water Works Association. Water Wiser: The Water Efficiency Clearinghouse. www.awwa.org/waterwiser/

California Department of Water Resources, Office of Water Use Efficiency. 2005. http://www.owue.water.ca.gov/.

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WBDG, Project Management - Building Commissioning
WBDG, Project Management - Project Planning & Development - Building Commissioning

EA Prerequisite 1 — Existing Building Commissioning (Required)

Intent—Verify that fundamental building systems and assemblies are performing as intended to meet current needs and sustainability requirements.

Requirements—Verify and ensure that fundamental building elements and systems are installed, calibrated and operating as intended so they can deliver functional and efficient performance. Carry out a comprehensive existing building commissioning including the following procedures:

1. Develop a comprehensive building operation plan that meets the requirements of current building usage, and addresses the heating system, cooling system, humidity control system, lighting system, safety systems and the building automation controls.
2. Prepare a commissioning plan for carrying out the testing of all building systems to verify that they are working according to the specifications of the building operation plan.
3. Implement the commissioning plan documenting all the results.
4. Repair or upgrade all systems components that are found to be not working according to the specifications of the building operation plan.
5. Re-test all building components that required repairs or upgrades to verify that they are working according to the specifications of the building operation plan.

OR

Submit a 1-to 5-Year Plan for continuous improvements of these aspects of commissioning requirements 1-5 until all aspects are completed. During the implementation of the continuous improvement plan, demonstrate continuous improvement on a yearly basis until all aspects are completed. All low-cost and no-cost measures must be implemented in the first two years of the implementation program.

Sustainable design and development overview

The purpose of EA Prerequisite 1 is to examine existing building systems through a systematic commissioning process, by checking systems performance, and making repairs as needed to ensure the building's operational needs. The commissioning process optimizes energy and water use, thereby minimizing related environmental impacts at all levels.

Other credits affected by commissioning include: EA Credit 3.3 (Building Systems Monitoring), EA Credit 5.1 5.3 (Performance Measurement and Enhanced Metering), EQ Prerequisite 1 (Outside Air Introduction and Exhaust Systems), EQ Credit 1 (Outdoor Air Delivery Monitoring), EQ Credit 7.1 – 7.2 (Thermal Comfort Compliance and Monitoring), and EQ Credit 9 (Contemporary IAQ Practice).

Historic preservation overview

Commissioning does not directly affect historic building features. However, lack of commissioning can accelerate the decline of building systems, and thus degrade the historic building fabric. Commissioning, therefore,

can be a tool to extend the service live of historic buildings and should be part of all construction projects.

Strategies

The existing building commissioning process starts with preparing a *Building Operation Plan* that specifies the current operational needs of the building and how to meet them, followed by testing and repairing systems and equipment as necessary per a *Performance Testing Plan*. [SOI Standards: none. The plan itself has no impact, but it must include provisions for recommended operations tailored to the historic building.]

Building Level Performance is documented in a Building Operation Plan and Performance Testing Plan for each of the following space environmental conditions:

- Space temperature.
- Space pressurization.
- Building envelope. Items to test can include whether the building is sealed adequately to reduce infiltration, whether the filters have been changed on schedule, and any other maintenance item that may affect systems performance. [SOI Standards: none, as long as testing recommendations cover historic features.]

System Level Performance is documented in a Building Operation Plan and Performance Testing Plan for each of the following building systems:

- Primary HVAC systems (central heating/cooling systems): equipment sequencing, supply temperature reset, and variable air volume pumping modulation.
- Air handling units: economizers, discharge air temperature reset, and variable air volume modulation.
- Water systems.
- Lighting systems.
- Building control systems. [SOI Standards: none, as long as testing recommendations cover historic features.]

Test and repair or replace building systems and equipment as necessary to ensure they meet the plans above. Update outdated systems as necessary for efficiency and performance in accordance with the SOI Standards. [SOI Standards: 2 and 6.]

Provide documentation that commissioning has been completed, or provide a 5-year plan for completing the process. [SOI Standards: none, as long as the plan contains provisions for avoiding impacts to historic features.]

EA Prerequisite 2 — Minimum Energy Performance (Required)

Intent—Establish the minimum level of energy efficiency for the building and systems.

Requirements—Demonstrate that the building has achieved an EPA ENERGY STAR rating of at least 60 utilizing the EPA's Portfolio Manager tool for building types addressed by ENERGY STAR.

OR

For building types not addressed by ENERGY STAR, demonstrate that the building has energy performance equivalent to an ENERGY STAR rating of at least 60, as calculated using the alternate method described in the *LEED-EB Reference Guide*.

Sustainable design and development overview

Building systems use excessive amounts of energy. Reducing energy consumption will decrease operating costs and environmental degradation. Well designed energy-efficiency upgrades can typically pay for initial upgrade investments in energy savings over time.* The EPA's Portfolio Manager is a tool for assessing energy performance. It currently addresses eight primary building types. Table 3.1 shows the DoD building types that fit within the various ENERGY STAR building categories.† Verification of ENERGY STAR building type compatibility is recommended before extensive calculations.

Table 3.1. Mapping DoD building types to EPA Portfolio Manager building categories.

DoD Building Types	Potential ENERGY STAR Building Equivalent
Administration buildings	Offices (general offices, financial centers, bank branches, and courthouses)
DODD schools	K-12 schools
Military hospitals	Hospitals (acute care and children's)
VOQs and transient quarters	Hotels and motels
Health clinics	Medical offices
Commissaries	Supermarkets
Barracks	Residence Halls/Dormitories
Military warehouses and general storage buildings	Warehouses (refrigerated and non-refrigerated)

* Payback periods vary. Examples could range from one year with the use of low/no water fixtures, to 20 years with the installation of a vegetative roof. More costly capital investments are appropriate for historic buildings DoD intends to maintain over long periods or in perpetuity (e.g., the Pentagon); less costly capital investments are suitable for buildings with a shorter service life.

† Many military building types (e.g., garages, aircraft hangars, and museums) have no counterparts in the ENERGY STAR Portfolio Manager. In this case, refer to LEED-EB for calculation strategies.

Historic preservation overview

The equivalent of an ENERGY STAR rating of at least 60 may be possible using the alternate calculation method described in the *LEED-EB Reference Guide*. Because energy efficiency is affected by everything from building envelope construction to equipment selection, strategies for satisfying EA Prerequisite 2 should be selected to minimize negative impacts on historically significant property features.

Attempts should be made to exploit any preexisting passively sustainable aspects of the property. For example, traditional buildings often included design features that reduced solar heat gain, took full advantage of cooling breezes, and facilitated air exchange. Historic buildings were most often sited to take advantage of local sunlighting angles and prevailing winds, depending on the climate (see discussion under EQ Credits 8.1 and 8.2). The siting of historic buildings also frequently made use of natural land forms as well as vegetation to provide natural shelter from wind and summer sunlight.

Historic buildings often were designed with features intended to provide interior comfort against harsh climate conditions. Such features included deep eaves/overhangs, awnings, operable shutters, deep-set fenestration, operable casement, awning, and jalousie windows, and raised first floor levels with vented basements or crawl spaces below (Figure 3.1). Historic interior features serving to reduce cooling requirements include louvered doors, vented transoms, interior vents, high ceilings and ceiling fans to mix warm and cool air as needed for comfort, vented attic space, and cupolas. Those traditional architectural features and designs can be exploited again today to reduce the need for energy-driven mechanical systems, and they may count toward achieving EA Prerequisite 2 using the alternative calculation method.

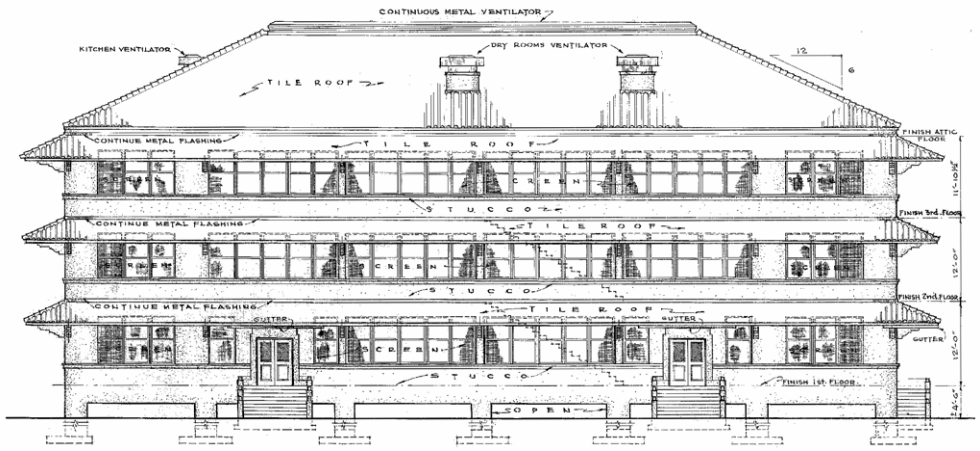

Figure 3.1. Historic building with features for harsh climate conditions (ERDC-CERL).

Strategies

Use ENERGY STAR website resources to determine current building energy performance. [SOI Standards: none.]

- For buildings correlating to an ENERGY STAR building category, enter data into the Portfolio Manager for all types of energy used to establish an energy use benchmark.
- Based on benchmark information, assess the building's energy performance.

For buildings not covered by ENERGY STAR, use calculation procedures established in LEED-EB to determine building energy performance baseline. The LEED-EB process includes the following steps (refer to LEED-EB for further detail). [SOI Standards: none.]

- Step 1: Find the historical average energy use of the building. This requires averaging three consecutive years within 6 years of the beginning of the certification process.
- Step 2: Compare current energy use with historical energy use by applying the equations found in the *LEED-EB Reference Guide*. If the building is 10% more efficient or greater, the prerequisite is met. To credit points toward EA Credit 1, refer to the Point Scale for Energy Efficiency table in the *LEED-EB Reference Guide*.
- Step 3: If the current energy use is greater than 30% more efficient than the historical energy use, the building must be compared with similar buildings in the same climate conditions. To achieve more than

5 points toward EA Credit 1, use equations from the *LEED-EB Reference Guide* to determine the modified historical data.

Implement energy-efficient retrofits, effective building and equipment maintenance, and other energy-saving techniques to reduce energy use. [SOI Standards: 2, 6, 9, and 10.] See EA Credit 1 for examples of potential retrofit work and its impacts on historic features. It should be noted that adding air conditioning to an existing building will automatically increase energy consumption, which makes EA Prerequisite 2 difficult to achieve for historic buildings for which there is no prior air conditioning system. In such a case, it may be possible to earn this credit by comparing energy costs of the retrofitted building with another building of similar size, construction, and mechanical systems.

EA Prerequisite 3 — Ozone Protection (Required)

Intent—Reduce ozone depletion.

Requirements—Zero use of CFC-based refrigerants in HVAC&R base building systems unless a third party (as defined in the *LEED-EB Reference Guide*) audit shows that system replacement or conversion is not economically feasible.

Definition of required economic analysis: The replacement of a chiller will be considered to be not economically feasible if the simple payback of the replacement is greater than 10 years. To determine the simple payback, divide the cost of implementing the replacement by the annual cost avoidance for energy that results from the replacement and any difference in maintenance costs. If CFC-based refrigerants are maintained in the building, reduce annual leakage to 5% or less using EPA Clean Air Act, Title VI, Rule 608 procedures governing refrigerant management and reporting and reduce the total leakage over the remaining life of the unit to less than 30% of its refrigerant charge.

Sustainable design and development overview

Older building chiller systems may contain CFC-based refrigerants that cause ozone depletion. Those refrigerants, and equipment that requires them, are scheduled to be phased out of production in accordance with the Montreal Protocol. The treaty was originally signed in 1987 and then substantially amended through 1999. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere are to be phased out by 2010 and 2030, respectively, and replaced with HCFCs (Montreal Protocol 1989).

EA Prerequisite 3 requires that mechanical equipment be replaced or retrofitted to use environmentally acceptable refrigerants. The use of CFC-based refrigerant will of necessity continue until all older equipment has been replaced. Until then, CFC supplies will be stockpiled and refrigerant from discarded equipment will be captured for reuse.

Historic preservation overview

Replacing refrigerant or chiller equipment typically does not affect significant historic building features, except as noted below. Equipment modifications will generally be confined to mechanical spaces that are not usually considered historically significant.

Strategies

Specify only non-CFC-based refrigerants in all new Heating, Ventilating, Air Conditioning and Refrigerating (HVAC&R) systems. [SOI Standards: none.]

Identify existing systems that use CFCs, and retrofit or replace these systems to HCFC or HFC refrigerant systems if economically feasible. [SOI Standards: 2, 6, 9, and 10.] Replacement may have historic preservation impacts if wall demolition is required for equipment access. Temporary modification of buildings may be required to allow new equipment to be installed, such as removing windows or doors. In some cases, the equipment being removed may be considered historic, such as systems associated with military research and development clean rooms and missile launch and guidance computer coolant systems. HABS/HAER recordation can mitigate the adverse effects associated with equipment removal.

For existing systems, specify procedures to meet annual refrigerant loss minimization standards and reporting requirements in accordance with "Complying with Section 608 Refrigerant Recycling Rule" (Clean Air Act 1990). Note that LEED-EB leakage requirements are much lower than the values used in Section 608. [SOI Standards: none.]

If upgrading the equipment to LEED-EB standards is not feasible, provide a third-party analysis confirming that. If replacement is not feasible, then either EPA or LEED-EB leakage levels noted immediately above must be achieved. [SOI Standards: none.]

Verify that all equipment, such as electric water coolers and built-in refrigerators, also complies with these requirements. [SOI Standards: none.]

EA Credit 1 — Optimize Energy Performance (1 – 10 Points)

Intent—Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirements—Demonstrate the EPA ENERGY STAR energy performance that the building has achieved. Utilize ENERGY STAR's Portfolio Manager tool for building types addressed by ENERGY STAR,

OR

For building types not addressed by ENERGY STAR, demonstrate the ENERGY STAR equivalent rating for the building energy use, calculated using the alternate method described in the *LEED-EB Reference Guide*.

ENERGY STAR Rating	LEED-EB Points
63	1
67	2
71	3
75	4
79	5
83	6
87	7
91	8
95	9
99	10

Sustainable design and development overview

EA Credit 1 establishes additional LEED-EB points for achieving energy efficiency beyond prerequisite levels. Improving energy efficiency beyond the minimum performance levels helps to further reduce operating costs and provide a comfortable indoor environment. In existing buildings, these upgrades can return energy cost savings that exceed the initial cost of the equipment. Because the Energy Policy Act of 2005 (Public Law 109-58) requires a 30% increase in energy efficiency over ASHRAE standards, all DoD agencies must implement some form of this EA Credit 1.

Historic preservation overview

Strategies for obtaining points under this credit should be selected to minimize negative impacts on historically significant property features. The building envelope and modifications related to equipment replacement are two areas of potential impact. The equivalent of an ENERGY STAR rating of 63 or greater may be possible using the alternate calcula-

tion method to achieve these credits, as described in the *LEED-EB Reference Guide*. (Also see discussion under EA Prerequisite 2.)

Strategies

Improve ENERGY STAR score beyond EA Prerequisite 2 requirements by implementing major efficiency upgrades, employing additional energy-saving strategies beyond those currently in place, or improving effectiveness of current strategies. [SOI Standards: 2, 6, 9, 10.] Many upgrades can potentially affect historic building features, such as placement of intakes and registers, location of ductwork, replacement of plumbing fixtures, and replacement of light fixtures.

Encourage change in building occupant behavior to promote energy saving contributions, such as lighting or hot water conservation practices. [SOI Standards: None, unless activities involve the posting of signage with adhesives, which can permanently damage/mark historic materials (2, 10)].

When purchasing new mechanical systems and appliances, acquire high-efficiency models. [SOI Standards: 2, 9, 10.]

- Ensure that people responsible for purchases understand energy efficiency goals.
- Coordinate atmosphere quality and water/energy efficiency goals by considering how design choices in one area can impact other areas. For instance, installing electric sensors on faucets to reduce water use may increase energy use. Similarly, increasing the number of air handler filters typically results in cleaner air, but more energy is needed to force air through the added filters.
- Ensure that the placement of new equipment does not conflict with historic site or landscape features, or adversely impact significant building features.

Site features

Develop site features to conserve energy. Trees and shrubs can be intentionally positioned to block direct solar radiation in the summer, thereby reducing cooling energy consumption by up to 40% annually (EPA, Heat Island Effect: Energy Savings from Trees and Vegetation 2005). [SOI Standards: 2, 3, 6, 8, 9, and 10.] Any new vegetation should be selected for visual compatibility with historic site design. New plantings should be

planned to avoid obscuring historic views of the building or grounds. However, some areas of the property may fall outside of historic viewsheds, and those may be appropriate for new stands of larger vegetation to reduce energy needs. Additionally, planting activities that disturb the soil may affect historic property features or buried archaeological deposits.

- Use landscaping to protect buildings from wind and provide shade. Shade the south and west sides of buildings with deciduous trees, and use native evergreens to act as all-season wind barriers (Ashkin et al. 2000, 17). The growth and loss of foliage in deciduous trees helps to balance energy requirements throughout the year. Summer foliage cools buildings by blocking direct solar radiation, and winter leaf loss allows solar energy to pass through branches and help to heat buildings (EPA, Heat Island Effect: Energy Savings from Trees and Vegetation 2005).
- Take maximum advantage of the site's solar and wind attributes, using site design to optimize conditions and harness free energy (Fournier and Zimnicki 2004, 5).
- Use regionally-appropriate landscaping to reduce or eliminate irrigation requirements. For strategies, refer to WE Credit 1, *Water Efficient Landscaping*, in this report.
- Avoid dense plantings near buildings that will conflict with Installation Design Standards (Army 2004, 10-14) or the 'unobstructed space' requirements stated in UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*.
- Use site lighting only where necessary for safety or security. Avoid directing lighting toward the sky. Where exterior light fixtures are character-defining features of a site, do not alter the fixtures to reduce light pollution; replace the bulbs with those that put out less light and use less energy.

Building shell

- Use reflective roofing materials to reduce heat island effects and ambient temperatures, thus minimizing space cooling requirements. [SOI Standards: 2, 6, 9, 10.] Light-colored roofing may not be suitable where darker roofing materials, such as slate, have been used. Reflective roofing can usually be installed without adverse impacts to historic buildings with low-slope roofs visually concealed by parapets.

- Improve window performance to reduce heating and cooling loads. [SOI Standards: 2, 5, 6.] Historic single-pane windows are constructed of relatively simple parts that can easily be replaced, and wood windows can last 75 years with proper paint maintenance. In contrast, modern insulated windows are machine made or extruded as integral pieces units. Repair costs are high because repair often requires another full replacement. A typical upgrade for historic windows is a new, insulated unit with grilles that replicate the historic appearance of divided lights. The weakest part of any insulated window is the gasket between the panes which, at best, is made of butyl elastomer and will last about 15 years. Before considering full replacement, and the extra energy inputs associated with product shipping and installation, it may be better sustainability practice to restore historic windows and supplement with an interior storm window to improve thermal insulation. A window upgrade or restoration project also provides an opportunity to eliminate previous replacement units that were historically inappropriate.
- Incorporate or restore historically appropriate daylighting features to reduce mechanical lighting systems. [SOI Standards: 2, 6, 9, 10.] See EQ Credits 8.1 – 8.4 for strategies related to daylighting.

EA Credits 2.1 – 2.4 — Onsite and Offsite Renewable Energy (1 – 4 Points)

Intent—Encourage and recognize increasing levels of onsite and offsite renewable energy in order to reduce environmental impacts associated with fossil fuel energy use.

Requirements—Over the performance period, meet some or all of the building's total energy use through the use of onsite or offsite renewable energy systems. Points are earned according to the following table. The percentages shown in the table are the percentage of building energy use over the performance period that is met by renewable energy.

Offsite renewable energy sources are as defined by the Center for Resources Solutions (CRS) Green-e products certification requirements or the equivalent. Green power may be procured from a Green-e certified power marketer, a Green-e accredited utility program, or through Green-e certified Tradable Renewable Certificates or the equivalent. At least 25% of any offsite green power or Green Certificates used to earn this credit needs to be from new sources (sources constructed after 1997). For onsite renewable energy that is claimed for LEED-EB credit, the associated environmental attributes must be retained or retired and cannot be sold.

Up to the four-point limit, any combination of individual actions will be awarded the sum of the points allocated to those individual actions. For example, one point would be awarded for implementing 3% of onsite renewable energy. Two additional points would be awarded for meeting 30% of the building's energy load with renewable power or certificates over the performance period.

LEED-EB Points	Onsite Renewable Energy		Offsite Renewable Energy/Certificates
1	3%	or	15%
2	6%	or	30%
3	9%	or	45%
4	12%	or	60%

Sustainable design and development overview

Adapting existing buildings to renewable energy sources such as wind turbines, solar panels, or geothermal energy, largely depends on available onsite resources, such as proximity to groundwater. Geographic location also has major impacts on the types of renewable energy equipment appropriate for each site; specific regions will provide substantially faster returns on investments than other regions. If renewable energy resources are available and feasible to exploit, it is important to identify sources early so that project funding application forms include appropriate line items.

Historic preservation overview

Using existing offsite (Green-e certified or equivalent) energy sources will not impact the building's historic features. New onsite sources, such as solar heating and photovoltaic (PV) panels, need to be carefully placed in order to avoid detracting from the appearance of historic building elevations

and roof forms. A compromise may be to locate new energy sources on minor building elevations. If the construction of a large structure such as a wind turbine is part of the project but located elsewhere, the project must also consider the impact of the turbines on any adjacent historic properties or archaeological sites. This offsite scenario is especially suited to land-locked installations.

Any existing historic hydropower sources (e.g., waterwheels and raceways) and wind power sources (e.g., windmills) should be restored if feasible.

Strategies

Acquire onsite nonpolluting renewable technologies that contribute to building energy requirements.

- Photovoltaic (PV) panels produce electricity from solar radiation, and can be linked into a building's electrical systems. 'Net metering' can be supplied whereby power is supplied back to a utility grid when local demand is less than PV production. Net metering enables customers to use their self-generated electricity to offset their consumption over a billing period by allowing their electric meters to turn backwards when they generate electricity in excess of their demand. This offset means that customers receive retail prices for the excess electricity they generate. Without net metering, a second meter is usually installed to measure the electricity that flows back to the provider, with the provider purchasing the power at a rate much lower than the retail rate. [SOI Standards: 2, 6, 9, 10.] Photovoltaic panels installed on a low-slope roof visually concealed by a parapet do not affect the appearance of historic building features from ground level.
- Install solar water heating technology. [SOI Standards: 2, 6, 9, 10.] The solar energy collection panels should be installed on a secondary roof elevation or mounted on a concealed portion of a low-slope roof in order to avoid affecting building appearance.
- Where available, utilize 'naturally occurring geothermal energy' to contribute to building energy needs. An example of naturally occurring geothermal energy would be readily available groundwater for geothermal piping systems. [SOI Standards: 2, 6, 8, 9, 10.] Ground disturbing activities can impact historic landscape features and buried archaeological deposits.
- Use plant biomass (i.e., organic waste) as fuel for a boiler or gasifier to drive an electric generator or to provide heat for space conditioning.

Biomass gasifiers are reactors that heat biomass in a low-oxygen environment to produce a fuel gas that contains from one fifth to one half (depending on the process conditions) the heat content of natural gas. The gas produced from a gasifier can drive highly efficient devices such as turbines and fuel cells to generate electricity. In the United States, biomass fuel is most commonly used in manufacturing and rural areas where there is a plentiful supply of biomass source (e.g., farm animal manure, wood and agricultural waste, and sewage sludge) from nearby industrial or agricultural operations. [SOI Standards: 2, 6, 9, 10.] Storage areas for biomass material may impact historic features or viewsheds.

- Use wind turbines to generate electricity. [SOI Standards: 2, 6, 8, 9, 10.] However, even when located off site, wind turbines can adversely affect historic views, and foundations for the supporting towers can impact archaeological sites.
- Hydropower is an excellent source of renewable energy if the site allows for it. Be aware that hydro power systems can be high in upfront costs and often have many EPA restrictions. [SOI Standards: 2, 6, 8, 9, 10.] Construction activities and placement of equipment could impact above ground and below ground historic resources.
- Purchase renewable energy generated offsite, or renewable energy trade certificates to meet some or all of the building's energy requirements. [SOI Standards: None.]

EA Credit 3.1 — Building Operations and Maintenance: Staff Education (1 Point)

Intent—Support appropriate operations and maintenance of buildings and building systems so that they continue to deliver target building performance goals over the long term.

Requirements—Have in place over the performance period a building operations and maintenance staff education program that provides each staff person primarily working on building maintenance with at least 24 hours of education each year over the performance period. The education program should provide information on building and building systems operation, maintenance and achieving sustainable building performance. Training must be of high quality and relevant to building operations and maintenance.

Sustainable design and development overview

Periodic training of building operations and maintenance (O&M) staff improves their capability to continually optimize building energy use. Continuing education will reduce incidents of negligence or uninformed decision-making. Staff education at DoD installations comes out of general operating funds, which are often depleted for higher-profile requirements. However, it may be possible to include a specific number of staff training hours per year for a period of several years in the bid documents for individual projects.

Historic preservation overview

Staff training typically does not affect historic buildings unless it does not adequately address specific O&M issues for aging buildings or it involves the posting of visual information on a building's character-defining features.

Strategies

Arrange a minimum of 24 hours of onsite or offsite training per building O&M staff member. Focus training on specific LEED-EB principles and credits. Educational sessions may be organized internally or externally by outside consultant or trade association. [SOI Standards: None.]

Address building and mechanical system O&M, groundskeeping, and achievement of sustainable and historic building and site requirements. [SOI Standards: 2, 10.] In order to avoid damaging historic materials, educational signage should not be posted on significant building features using mechanical fasteners or adhesives.

EA Credit 3.2 — Building Operations and Maintenance: Building Systems Maintenance (1 Point)

Intent—Support appropriate operations and maintenance of buildings and building systems so that they continue to deliver target building performance goals over the long term.

Requirements—Have in place over the performance period a comprehensive Best Practices Equipment Preventive Maintenance Program that provides in-house resources or contractual services to deliver post-warranty maintenance.

Sustainable design and development overview

Inadequate preventive maintenance plans in existing buildings often result in excessive energy use and operating costs. Proactive maintenance increases the service life of building systems and postpones replacement expenditures.

Historic preservation overview

Maintenance strategies for equipment typically do not affect historic buildings. However, use chemicals and lubricants that will not have a negative impact on historic equipment or the facility.

Strategies

Schedule preventive maintenance for all building equipment and document that maintenance tasks are carried out according to schedule. Include procedures to check for energy efficiency, including controls evaluation. Preventive maintenance can be performed by internal staff or contractor. Compile a spreadsheet tracking scheduled maintenance activities. [SOI Standards: None.] Include:

Common preventive maintenance tasks that can improve or restore equipment efficiency include the following [SOI Standards: None]:

- Filter replacement
- Belt tightening and replacement
- Building control configuration
- Air balancing reports
- Bearing lubrication and timely replacement
- Mechanical system water chemical treatment
- Duct sealing
- Insulation repair
- Duct, grille, and diffuser cleaning

- Cleaning of heat transfer equipment (e.g., heat exchangers cooling towers, air handling unit coils, chillers, condensing units, etc.)

EA Credit 3.3 — Building Operations and Maintenance: Building Systems Monitoring (1 Point)

Intent—Support appropriate operations and maintenance of buildings and building systems so that they continue to deliver target building performance goals over the long term.

Requirements—Have in place over the performance period a system for continuous tracking and optimization of systems that regulate indoor comfort and the conditions (temperature, humidity and CO2) delivered in occupied spaces. The system must include:

- Continuous monitoring of system equipment performance and of the indoor environmental conditions delivered in the building
- Alarms for performance or conditions that require repair.
- A system in place that delivers prompt repairs to problems identified.

Sustainable design and development overview

Installation of equipment to continually monitor and control building temperature, humidity, and carbon-dioxide conditions can save energy and improve the productivity of building occupants.

Historic preservation overview

Monitoring building systems typically does not affect historic buildings. However, wherever monitoring devices are required, designers should take into account the size and number of devices, and select mounting locations that minimize impacts to historic features.

Strategies

Develop a system to continuously track and optimize mechanical systems that regulate indoor climate. [SOI Standards: 2, 9, 10.] Consider the total number of devices, existing and new, when proposing a location. Devices that must be located on the walls or ceilings of significant historic interiors should be integrated into decorative finishes such as paneling and paint patterns). Conceal devices in cabinets or shelving when feasible.

EA Credit 4 — Additional Ozone Protection (1 Point)

Intent—Reduce ozone depletion and support early compliance with the Montreal Protocol.

Requirements—

Option A: Do not operate base building HVAC, refrigeration or fire suppression systems that contain CFCs, HCFCs or halons.

Option B: Do not operate fire suppression systems that contain CFCs, HCFCs or halons,

AND

Reduce emissions of refrigerants from base building HVAC and refrigeration systems to less than 3% of charge per year over the performance period using EPA Clean Air Act, Title VI, Rule 608 procedures governing refrigerant management and reporting and reduce the leakage over the remainder of unit life to below 25%.

Sustainable design and development overview

Existing building systems that conform to the current requirements of the Montreal Protocol may operate on HCFC refrigerants. These are less destructive to ozone than CFCs, but they are scheduled to be phased out of production by 2030. EA Credit 4 is earned by replacing or modifying HVAC equipment to use more environmentally friendly refrigerants.

Historic preservation overview

Upgrading or replacing HVAC systems could affect historic building features if reconfigured ductwork and relocated registers are poorly placed. Equipment replacement can be an opportunity to improve conditions if an existing unit was poorly sited (e.g., visible on a prominent historically significant building façade). This work may require temporary removal of historic windows, doors, or skylights to provide access for large HVAC components. These features must be carefully removed, stored, and reinstalled.

Strategies

Identify use of HCFCs and halons in all existing systems. Consider HVAC, refrigeration, plastic foam insulation, and fire protection equipment.

Modify or replace identified systems to eliminate ozone-depleting chemicals. Choose substitutes that impose the smallest possible environmental impacts, considering tradeoffs across a range of important potential impacts (i.e., worker safety, ozone layer impact, energy efficiency, and climate change). [SOI Standards: 2, 9, 10.] Avoid damage to existing historic features during removal work and incorporate new systems appropriately into the historic architectural context. Historically appropriate implemen-

tation might include high-velocity HVAC systems that do not require dropped ceilings that change the character of interior spaces and obscure historic windows.

If all ozone-depleting equipment cannot be replaced or modified, implement a program to minimize refrigerant leakage to meet the credit requirements and EPA Section 608 standards. [SOI Standards: None, although provisions should be included in the plan to ensure that historic features are part of the decision-making process.]

EA Credits 5.1 – 5.3 — Performance Measurement: Enhanced Metering (1 – 3 Points)

Intent—Demonstrate the ongoing accountability and optimization of building energy and water consumption performance over time and add incentives for additional energy reduction.

Requirement—Have in place over the performance period continuous metering for the following items: (Up to 3 points can be earned—one point is earned for each four actions implemented/maintained)

- Lighting systems and controls.
- Separate building electric meters that allow aggregation of all process electric loads (Process electric loads are defined in the *LEED-EB Reference Guide*).
- Separate building natural gas meters that allow aggregation of all process natural gas loads (Process natural gas loads are defined in the *LEED-EB Reference Guide*).
- Separate meters that allow aggregation of all indoor occupant's related water use for required fixtures.
- Separate meters that allow aggregation of all indoor process water use (Process water uses are defined in the *LEED-EB Reference Guide*).
- Separate meters that allow aggregation of all outdoor irrigation water use.
- Chilled water system efficiency at variable loads (kW/ton) or cooling loads (for non-chilled water systems).
- Cooling load.
- Air and water economizer and heat recovery cycle operation.
- Boiler efficiencies.
- Building specific process energy systems and equipment efficiency.
- Constant and variable motor loads.
- Variable frequency drive (VFD) operation.
- Air distribution, static pressure and ventilation air volumes.

For each item metered, prepare, implement and maintain a program for using the data gathered to improve building performance over time.

Sustainable design and development overview

Measuring a building's ongoing energy and water consumption allows for improvement of building system and equipment performance over the service life of the facility. The environmental impacts of energy and water use can be minimized to reduce air and water pollution and conserve natural resources. It may not be feasible to earn these credits at this time because most DoD buildings are not metered individually.

Historic preservation overview

Metering of central building systems typically does not affect historic properties, but utility meters should be located in secondary mechanical or electrical spaces rather than on exterior elevations. If meters are already located on a prominent exterior historic building facade, use the project as

an opportunity to relocate them to a less visible location such as a utility room.

Strategies

Use automated systems to measure and track system performance. [SOI Standards: None.]

Prepare, implement, and maintain a program to monitor system performance, identify improvement goals, and track action items. [SOI Standards: None.]

EA Credit 5.4 — Performance Measurement: Emission Reduction Reporting (1 Point)

Intent—Document emission reduction benefits of building efficiency actions, retire a portion of the reductions and reduce emissions in the supply chain.

Requirements—Identify building performance parameters that reduce energy use and emissions:

- Track and record emission reductions delivered by energy efficiency, renewable energy and other building emission reduction actions.
- Report emission reductions using a third-party voluntary certification program.
- Retire at least 10% of the reported emission reductions through a third-party voluntary certification program. (To meet this requirement, the third-party voluntary emission reduction certification and retirement programs must be programs of credible organizations. Third-party programs shall notify any applicable local or regional emission reduction registries of the reported emission reductions.)
- Ask the suppliers of goods and services for the building to do the same by implementing actions of tracking, reporting, retiring emission reductions and asking their suppliers to do the same.

Sustainable design and development overview

By quantifying steps taken to reduce energy and water consumption, especially buildings using gas-fired and coal-fired equipment, facility managers can document installation progress toward sustainable operations.

Historic preservation overview

Implementing measures to reduce emissions by 10% can involve replacement of aged coal-fired and gas-fired equipment. Such renovations may produce large penetrations in the building, and these must be repaired using methods that are visually compatible with the historic material. Modern high-efficiency furnaces typically do not use the large chimneys and vents installed for the original equipment. Those elements are often prominent features of the historic building, so project plans must include provisions for retaining and stabilizing them even if they are no longer needed for building utilities (Figure 3.2).

Figure 3.2. Retain nonfunctioning historic chimneys, flues, and smokestacks (Hardlines).

Strategies

Track whole building energy use, energy use reductions, renewable energy usage, and other actions that reduce emissions (e.g., carbon dioxide, sulfur dioxide, nitrogen oxides, mercury, small particulates, large particulates, and volatile organic compounds). Use this information to establish a baseline and track subsequent data. [SOI Standards: None.]

Use a third-party emissions reduction reporting program or programs that help building owners (1) calculate and report all different types of emission reductions delivered by their energy efficiency, renewable energy, and other emission reduction actions, and (2) eliminate at least 10% of these emission reductions. Ensure that the upgrade project includes plans to repair damaged historic building materials and envelope in a visually appropriate manner. Retain historic chimneys and vents that are no longer functional and seal them to prevent energy loss. [SOI Standards: 2, 6, 9, 10.]

Ask suppliers of goods and services to the building to also meet the requirements of EA Credit 5.4. In the government procurement system, this action item will not be achieved unless it is written into the procurement specifications. [SOI Standards: None.]

EA Credit 6 — Documenting Sustainable Building Cost Impacts (1 Point)

Intent—Document sustainable building cost impacts.

Requirements—Document overall building operating costs for the previous 5 years (or length of building occupancy, if shorter), and track changes in overall building operating costs over the performance period. Document building operating costs and financial impacts of all of the aspects of LEED-EB implementation on an ongoing basis.

Sustainable design and development overview

Documenting the costs and benefits of implementing sustainable building operations (1) provides proof that sustainable design and development saves money, (2) encourages greater participation, and (3) promotes higher building sustainability achievements. However, because DoD buildings are usually not individually metered, this credit may be difficult to achieve.

Historic preservation overview

Cost documentation does not affect historic properties except to the extent to which documentation may help to justify the reuse, preservation, or restoration of historic properties. Their passively sustainable features can have financial advantages over new construction.

Strategies

Track building operating costs and benefits to identify impacts related to sustainable building and operations performance improvements. [SOI Standards: None.]

For each LEED-EB prerequisite and credit earned, determine the costs and benefits of implementation over the period. [SOI Standards: None.]

Establish a pre-sustainability cost benchmark and then track costs and benefits as sustainable practices accrue. [SOI Standards: None.]

EA references

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U.S. Environmental Protection Agency. 2007. *Heat Island Effect: Energy Savings from Trees and Vegetation*. http://www.epa.gov/heatisland/images/extra/level3_treesavings.html

U.S. Environmental Protection Agency. 2006. *Stationary Air Conditioning: Complying with the Section 608 Refrigerant Recycling Rule*. http://www.epa.gov/ozone/title6/608/608fact.html

EA-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) that address energy and atmosphere are shown in Table 3.2 below:

Table 3.2. UFGS sections relevant to EA prerequisites and credits.

EA Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 2; Credit 1	01721	Mineral fiber blanket insulation
Prerequisite 1, 2; Credit 1, 3.1, 3.2, and 3.3	01781	Operation and maintenance data
Prerequisite 1	01830	Operation, maintenance, and process monitoring for soil vapor extraction (SVE) systems
Prerequisite 2; Credit 1	07214	Board and black insulation
Prerequisite 2; Credit 1	07216	Loose fill thermal insulation

EA Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 2; Credit 1	07220	Roof and deck insulation
Prerequisite 2; Credit 1	07240	Exterior insulation and finish systems
Prerequisite 2; Credit 1	08800	Glazing
Prerequisite 2; Credit 1	08805S	Glass and glazing
Credit 1	08810S	Glass
Prerequisite 2; Credit 1	08900S	Glazed curtain wall
Prerequisite 2; Credits 1 and 2.1-2.4	13600A	Solar water heating equipment
Credits 2.1-2.4	13610N	Solar liquid flat plate collectors
Prerequisite 1 and 2; Credit 1	Division 15000	All equipment sections may apply depending on HVAC system type
Prerequisite 2; Credit 1	15080	Thermal insulation for mechanical systems
Prerequisite 2; Credit 1	15081N	Exterior pipe insulation
Prerequisite 2; Credit 1	15083S	Duct insulation
Prerequisite 2; Credit 1	15085S	Piping insulation
Prerequisite 3; Credit 4	15182	Refrigerant piping
Prerequisite 3; Credit 4	15185S	Refrigerant piping and specialties
Prerequisite 3; Credit 4	15601N	Central refrigeration equipment for air conditioning
Prerequisite 3; Credit 4	15602N	Refrigeration equipment for cold storage
Prerequisite 3; Credit 4	15610S	Refrigeration compressors
Prerequisite 3; Credit 4	15620A	Liquid chillers
Prerequisite 3; Credit 4	15625S	Chilled water air conditioning
Prerequisite 3; Credit 4	15626S	Centrifugal water chillers
Prerequisite 3; Credit 4	15627S	Reciprocating water chillers
Prerequisite 3; Credit 4	15652A	Cold storage refrigeration systems
Prerequisite 3; Credit 4	15675S	Air cooled condensers
Prerequisite 3; Credit 4	15700A	Unitary heating and cooling equipment
Prerequisite 3; Credit 4	15700S	Heating/ventilation/air conditioning systems
Prerequisite 3; Credit 4	15702N	Computer room air conditioning units
Prerequisite 3; Credit 4	15730N	Unitary air conditioning equipment
Prerequisite 3; Credit 4	15732S	Packaged air conditioning units
Prerequisite 3; Credit 4	15736S	Computer room air conditioning units
Prerequisite 3; Credit 4	15740S	Heat pumps
Prerequisite 3; Credit 4	15741N	Water source heat pumps

EA Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 2; Credit 1	15895	Air supply distribution ventilation and exhaust removal systems
Prerequisite 1 and 2; Credits 1, 3.1, 3.2, and 3.3	15901N	Space temperature control systems
Prerequisite 1 and 2; Credits 1, 3.1, 3.2, and 3.3	15902S	Control systems
Prerequisite 1; Credits 3.1, 3.2, and 3.3	15910N	Direct digital control systems
Prerequisite 1; Credits 3.1, 3.2, and 3.3	15915S	Electric control systems
Prerequisite 2; Credit 1	15940A	Overhead vehicle tailpipe exhaust removal systems
Prerequisite 1	15950S	Testing, adjusting, and balancing
Prerequisite 1 and 2; Credit 1	15950N	HVAC testing/adjusting/balancing
Prerequisite 1	15951N	Testing, industrial ventilation systems
Prerequisite 1 and 2; Credit 1	15990A	Testing, adjusting, and balancing of HVAC systems
Prerequisite 1 and 2; Credit 1, 3.1, 3.2, 3.3, 5.1-5.3, and 5.4	15995A	Commissioning of HVAC systems
Credits 2.1-2.4	16311A	Main electrical supply station and substation
Prerequisite 2; Credit 1	16510	Interior lighting
Prerequisite 2; Credit 1	16511S	Fluorescent lighting
Prerequisite 2; Credit 1	16512S	High intensity discharge luminaries
Prerequisite 2; Credit 1	16513S	Incandescent lighting

Additional EA resources

Advanced Buildings Technologies and Practices. www.advancedbuildings.org

American Bioenergy Association. www.biomass.org

American Council for an Energy Efficient Economy. www.aceee.org

American Society of Heating, Refrigeration and Air Conditioning Engineers. ASHRAE Guidelines. www.ashrae.org

American Wind Energy Association. www.awae.org

Building Owners and Managers Association International. 1993. The Refrigerant Manual: Managing the Phase Out of CFC's.

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Building Owners and Managers Association International. n.d. Training and Education. www.boma.org/TrainingAndEducation/

California Commissioning Collaborative. www.cacx.org

Chartered Institution of Building Services Engineers. 2000. CFC's, HCFC and Halons: Professional and Practical Guidance on Substances that Deplete the Ozone Layer.

Cleaner and Greener Certification Program. www.cleanerandgreener.org

Coping with the CFC Phase-out. www.facilitymanagement.com

Database of State Incentives for Renewable Energy. www.dsireusa.org

ENERGY Guide. www.energyguide.com

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International Facility Management Association. www.ifma.org

International Performance Measurement and Verification Protocol. www.ipmvp.org

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Low Impact Hydropower Institute. Low Impact Hydropower Certification Program. www.lowimpacthydro.org

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National Center for Photovoltaics. www.nrel.gov/ncpv/

National Renewable Energy Laboratory. www.nrel.gov

New Building Institute. www.newbuildings.org

Oak Ridge National Laboratory and Portland Energy Conservation, Inc. A Practical Guide for Commissioning Existing Building. http://eber.ed.ornl.gov/commercialproducts/retrocx.htm

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U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Green Power Network. www.eere.energy.gov/greenpower

U.S. Department of Energy. Phase-Out of Ozone Depleting Substances Information. www.epa.gov/ozone/title6/phaseout/index.html

U.S. Environmental Protection Agency. Benefits of CFC Phase-Out. www.epa.gov/ozone/geninfo/benefits.html

U.S. Environmental Protection Agency. Buildings Upgrade Manual. www.energystar.gov/index.cfm?c=business.bus_upgrade_manual&layout=print

U.S. Environmental Protection Agency. Building Owners Save Money, Save the Earth, Replace Your CFC Air Conditioning Chiller. www.epa.gov/ozone/title6/608/chiller107.pdf

U.S. Environmental Protection Agency. ENERGY STAR Building Manual. www.energystar.gov

U.S. Environmental Protection Agency. ENERGY STAR Portfolio Manager, Tools for calculating the ENERGY Star performance rating. www.energystar.gov

U.S. Environmental Protection Agency. EPA's Significant New Alternatives Policy (SNAP). www.epa.gov/ozone/snap/index.html

U.S. Environmental Protection Agency. Green Power Partnership. www.epa.gov/greenpower/index.htm

U.S. Environmental Protection Agency. Ozone Depleting Substances. www.epa.gov/ozone/ods.html

U.S. Environmental Protection Agency. Schedule of refrigerant phase-out dates. www.epa.gov/ozone/title6/phaseout/

U.S. Environmental Protection Agency. Stratospheric Ozone Protection: Moving to Alternative Refrigerants. http://es/epa.gov/program/epaorgs/oar/altrefrg.html

U.S. Green Building Council. Workshops. www.usgbc.org

4 Materials and Resources (MR)

Materials & Resources—Select Mandates and Guidelines
AR 200-1, Environmental Protection and Enhancement (DA, 21 February 1997) (to be replaced by AR 200-1 Environmental Sustainability and Stewardship)
AR 420–49, Facilities Engineering: Utility Services (HQDA, 28 April 1997)
Army Installation Design Standards (DA, 3 May 2004)
DA PAM 200-1, Environmental Protection and Enhancement (DA, 17 January 2002)
EO 12873, Federal Acquisition, Recycling, and Waste Prevention (White House, 20 October 1993)
EO 13101, Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition (White House, 14 September 1998)
EPA Comprehensive Procurement Guidelines found in 40 CFR 247 (EPA, April 2004)
EPA Environmentally Preferable Purchasing (EPP) Program
EPA Greening Your Purchase of Cleaning Products: A Guide For Federal Purchasers
EPA Total Mercury by Cold Vapor Absorption Method 7471A
FAR Part 23.4, Use of Recovered Materials
FAR Part 23–52.223-4, Recovered Material Certification
FAR Part 23–52.223-9, Estimate of Percentage of Recovered Material Content for EPA-Designated Products
FAR Part 23–52.223-10, Waste Reduction Program
Forest Stewardship Council, Forest Stewardship Council Principles and Criteria
Green Seal GS-03, Green Seal Standard 03 - Anti-Corrosive Paints (Green Seal, 07 January 1997)
Green Seal GS-08, Green Seal Standard 08 - Household Cleaners (Green Seal, 02 November 1993)
Green Seal GS-11, Green Seal Standard 11 - Paints (Green Seal, 20 May 1993)
Green Seal GS-36, Green Seal Standard 36 - Commercial Adhesives (Green Seal, 19 October 2000)
Green Seal GS-37, Green Seal Standard 37 - Green Seal Environmental Standard for General-Purpose, Bathroom, Glass, and Carpet Cleaners Used for Industrial and Institutional Purposes (Green Seal, 27 January 2006)
Green Seal GS-40, Green Seal Environmental Standard for Floor-Care Products: Finishes and Compatible Strippers Used for Industrial and Institutional Purposes (Green Seal, 12 November 2004)
IESNA LM-40-01, Standard for Life of Tubular Fluorescence (IESNA, 01 December 2001)
IESNA LM-47-01, Standard for Life of HID Lamps (IESNA, 01 December 2001)
IESNA LM-60-01 Standard for Life of Single-Ended Compact Fluorescent Lamps (IESNA, 01 December 2001)
Memorandum, DAIM-FD, Subject: Management of Construction & Demolition (C&D) Wastes (31 August 2001)
Memorandum, DAIM-FD, Subject: Requirements for Sustainable Management of Waste in Military Construction, Renovation, and Demolition Activities (13 January 2006)

Memorandum, DAIM-ZA, Subject: Sustainable Management of Waste in Military Construction, Renovation, and Demolition Activities (06 February 2006)

Mercury Alternatives (http://www.noharm.org/us/mercury/alternatives)

MOU Federal Leadership in High Performance and Sustainable Buildings (24 January 2006)

Recovered Materials Advisory Notice

Resource Conservation and Recovery Act, Section 6002

South Coast Rule #1113, Architectural coatings

South Coast Rule #1168, Amendment by the South Coast Air Quality Management District (SCAQMD, 03 October 2003)

UFC 1-900-01, Selection of Methods for the Reduction, Reuse, and Recycling of Demolition Waste (DoD, 01 December 2002)

UFGS 016235, Recycled/Recovered Materials (USACE, July 2006)

UFGS 017419, Construction and Demolition Waste Management (USACE, April 2006)

MR Prerequisite 1.1 — Source Reduction and Waste Management: Waste Management Policy and Waste Stream Audit (Required)

Intent—Establish minimum source reduction and recycling program elements and quantify current waste stream production volume.

Requirements—Conduct a waste stream audit of the ongoing waste stream (not specific upgrade project waste) to establish a current building waste stream baseline that identifies the types of waste making up the waste stream and amounts of each type of waste in the waste stream. At a minimum, the audit should determine the amounts for paper, glass, plastics, cardboard and metals in the waste stream. Identify opportunities for source reduction and diversion. Operate over the performance period a waste stream reduction policy to reduce waste stream through source reduction purchasing strategies, collection station equipment, recycling and occupant education.

Sustainable design and development overview

Reducing human consumption is an effective way to reduce the amount of waste that must be discarded, handled, and treated. Methods for reducing waste generation include the purchase of durable and repairable products, elimination of excess materials through better calculations during design and ordering, use of non-toxic products, avoidance of products with excessive packaging, conserving water and energy, and implementing in-process recycling (EPA, Why Should You Care About Preventing Waste? 2004). Waste hauling and disposal is a significant cost for both new construction and maintenance of existing property. Where toxic or hazardous materials are used in operations, reducing the amount of hazardous output diminishes environmental impacts and provides a safer environment for facility occupants.

DoD has a comprehensive waste management program that is required at all installations. The DoD plan is incorporated into the installation's solid waste management program.

Historic preservation overview

Recommended measures primarily involve evaluation of purchasing and disposal methods to reduce waste, which typically would not have a negative impact historic properties. The benefits of diverting demolition waste from a landfill by reusing historic properties are covered in subsequent MR credits.

Strategies

Audit the installation waste stream and perform a waste reduction assessment. Trade associations and government regulatory agencies can often provide technical assistance, and consultants are available to help develop effective waste prevention measures (EPA, Small Business Guide 2005). [SOI Standards: None.]

- Examine all installation waste streams; including process wastes, hazardous wastes, nonhazardous wastes, solid wastes, and office waste. Look in trash cans and dumpsters to determine what materials are being discarded and identify liquid wastes being poured down drains, such as rinse or process waters (EPA, Small Business Guide 2005).
- Characterize each waste stream by determining where the waste comes from, what processes generate it, and how much is being discarded (EPA, Small Business Guide 2005).
- Evaluate how each type of waste identified in the waste stream can be reduced through source reduction, reuse, and recycling (USGBC, LEED-EB 2005).

Develop a waste reduction policy for the building (Table 4.1). Waste management options typically following the following hierarchy: reduce (the most desirable), reuse, recycle, compost, burn, and landfill (the least desirable). [SOI Standards: None.]

- Develop and implement a building waste reduction policy that includes (1) procurement and management policies to reduce the waste stream through source reduction purchasing strategies, (2) reuse (where possible) and recycling (including collection station equipment and hauling agreements), and (3) occupant education about waste reduction goals (USGBC, LEED-EB 2005).
- In buildings that house maintenance, repair, and operations activities, identify potential production changes that would improve efficiency, including process, equipment, piping, and layout changes (EPA, Small Business Guide 2005).
- Investigate opportunities for using new products, components, or materials that avoid waste generation (EPA, Small Business Guide 2005).
- Implement an employee incentive program such as earning a share in the savings resulting from waste reduction (EPA, Small Business Guide 2005).

- Prioritize waste prevention opportunities by considering cost, ease of implementation, payback, and improved employee safety (EPA, Small Business Guide 2005).
- Start with opportunities that are easy to implement, require low capital investment, produce cost savings, and significantly reduce waste volumes (EPA, Small Business Guide 2005).
- Set specific goals that are attainable, such as reducing office paper waste by 25% or reducing waste hauling and disposal costs by $5,000 annually (EPA, Small Business Guide 2005).
- Teach personnel how to prevent waste. Explain the installation's waste prevention policies and goals, and train employees to change the way they handle materials (EPA, Small Business Guide 2005).
- Promote installation- and building-level waste prevention activities. Hold a kickoff event to describe goals and highlight the benefits for the installation. Use posters or signs to get the word out to employees and place the signs in areas where waste prevention activities should happen (EPA, Small Business Guide 2005). Avoid affixing signs to historic materials or posting signage in conspicuous locations that negatively impact historic views.
- Monitor process and waste production changes. Track items such as waste volume, hauling frequency, energy consumption reductions, and the amount of raw materials used (EPA, Small Business Guide 2005).
- Calculate savings in terms of handling, treatment, and disposal costs as well as reductions in raw material and energy usage (EPA, Small Business Guide 2005).
- Identify indirect benefits such as improved public image, improving process productivity or efficiency, improvements in employee morale or safety, etc. (EPA, Small Business Guide 2005).
- Purchase durable, repairable products and materials (EPA, Small Business Guide 2005).
- Eliminate or reduce interim raw materials that are not incorporated into your final product or service (EPA, Small Business Guide 2005). Raw materials can include anything from wastewater and air emissions to dimensional/directional finish items. Using carpeting as an example, reduce the amount of extra carpet ordered by calculating the most efficient direction of laying a 12-foot wide broadloom carpet rather than simply using the room size as a guide. Another example is sizing ceiling grids, sheet flooring, and wall panels to fit the room while minimizing cuts and excess material.

- Use products that do not contain toxic materials (EPA, Small Business Guide 2005).
- Avoid products with excessive packaging (EPA, Small Business Guide 2005).
- Implement in-process recycling (EPA, Small Business Guide 2005).
- Reevaluate management efforts on a regular basis. As new raw materials, supplies and processes are introduced, waste streams change. Conduct regular assessments of the installation to identify additional waste prevention opportunities. (EPA, Small Business Guide 2005).

Table 4.1. Sample waste management plan (AFCEE Appendix I).

Material	Qty.	Disposal Method	Handling Procedure
New Construction			
Concrete	2 tons	Recycled-Puget Sound Concrete	Break up any wastes or mistakes and put in "concrete" dumpster. Rebar OK.
Forming boards		Reuse as many times as possible, then recycled-Wood Recycling NW	Stack next to supply of new form boards for reuse. Recycle clean unusable forms in "clean wood" recycling dumpsters.
Clean wood scrap	12 tons	Scraps reused for form work, fire-breaks etc. Recycled-Wood Recycling NW	Stack reusable pieces next to dumpster for reuse. Separate unusable clean wood into "clean wood" recycling dumpsters.
Scrap metal	5 tons	Recycled-Seattle Metals	Deposit all metals in "metal" Dumpster.
Drywall	10 tons	Subcontractor will recycle and submit reports to waste coordinator	Either provide container or collect in vehicle for recycling.
Electric/plumbing subcontractors' metal and other recyclables		Subcontractor will recycle and submit reports to waste coordinator	Either provide container or collect in vehicle for recycling.
All other waste	14 tons	Garbage-Sound Disposal	Dispose in "trash" dumpster.

MR Prerequisite 1.2 — Source Reduction and Waste Management: Storage and Collection of Recyclables (Required)

Intent—Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills or through incineration.

Requirements—Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling. The recycling area needs to include (at a minimum) space for paper, glass, plastics, cardboard and metals. Recycling area capacity needs to be designed to accommodate at a minimum the potential recycling volumes identified in the waste stream audit for paper, corrugated cardboard, glass, plastics and metals.

If it can be documented for an existing building that there are no public or private recycling services available within the region where the building is located (within 50 miles of the building) for one or more of the identified materials, the building will be granted an exception to the requirement in this prerequisite for the identified material.

Sustainable design and development overview

The intent of MR Prerequisite 1.2 is to create a dedicated space in the building that is easily accessible for recycling collection, sorting, and removal. In accordance with the installation's waste management plan, most buildings on military installations already practice some form of minimal recycling, typically separating white paper from other paper. Most recycling areas are located in a common area (copier area or hallway) and not in a dedicated space. Dedicated central recycling areas are best located near loading docks or entryways where personnel can easily remove the materials to take to the recycling plant. In larger buildings, recycling points are scattered throughout convenient common areas, such as kitchenettes, lounges, copy rooms, and corridors near these areas.

Historic preservation overview

The addition of space or the modification of existing space to create a dedicated recycling area may impact historic features of the property. Interior impacts could involve historic doors and wall configurations. Because dedicated recycling areas should be located near loading areas, exterior features also may be affected. Recycling containers should not be placed in prominent locations where they detract from the appearance of historic interior and exterior spaces.

Strategies

Provide recycling collection areas throughout the building along with a central collection point from which the materials can be taken to recycling

centers. [SOI Standards: 2, 9, 10.] Both interior and exterior historic features may be impacted by poor placement of signage and collection containers.

Identify local public and private recycling enterprises that provide service within 50 miles of the building. For remote installations such as training ranges, this strategy may be impossible to reach. Nonetheless, the installation is encouraged to have some sort of in-house recycling program even if it only targets one of the LEED-specified recyclables. [SOI Standards: None.]

MR Prerequisite 2 — Toxic Material Source Reduction: Reduced Mercury in Light Bulbs (Required)

Intent—Establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into buildings through purchases of light bulbs.

Requirements—

Maintain mercury content of all mercury-containing light bulbs below 100 picograms per lumen hour, on weighted average, for all mercury-containing light bulbs acquired for the existing building and associated grounds.

The weighted average mercury content of these mercury-containing light bulbs is calculated by: 1) adding up the total weight of mercury in all mercury-containing light bulbs acquired during the performance period (picograms of HG); and then 2) dividing total mercury content (picograms of HG) by the sum of the lumen hour output of all the light bulbs (lumen hours: calculated by multiplying the rated hours (life) of each light bulb by the mean light output in lumens).

- Rated hours of life are defined as stated by the manufacturer based on consistent testing (three hours on/20 minutes off for linear fluorescents and compact fluorescents; 11 hours on for HID light bulbs) and are based on the design or mean light output of the light bulbs (in lumens, fluorescent light bulbs measured with a ballast having a ballast factor of 1.0 and measured using instant-start ballasts except for T-5s, which are measured using program start ballasts).
- The mean light output in lumens is the light output at 40% of light bulb life.
- These calculations need to show for all acquired mercury containing light bulbs:
- The total mercury content in the light bulbs.
- The total lumen hours of light output for all the light bulbs.
- The number of light bulbs of each type.
- The overall weighted average mercury content in picograms/lumen hour.
- If the mercury content documentation shows a range of mercury contents in milligrams, use the highest value in the range in these calculations.

Sustainable design and development overview

The intent of MR Prerequisite 2 is to encourage the use of high-efficiency, long-life light bulbs with reduced mercury content. Mercury can migrate from landfills and enter ground water, accumulating in the tissues of wildlife and fish. When mercury is ingested by humans it can cause neurological and developmental problems in infants and children.

Fluorescent lighting fixtures are common in military buildings. Both T-5 and T-8 tubes are now widely used because they offer longer life and require fewer maintenance personnel hours to replace.* In high-bay buildings, such as aircraft hangars, building occupants are not permitted to

* T-5 and T-8 tubes are types of high-efficiency fluorescent tubes. The number designation corresponds to diameter in eighths of an inch. For instance, T-5 tubes are 5/8 in. in diameter and T-8 tubes are 8/8 in. (or 1 in.) in diameter. The smaller the number the more efficient the bulb.

change bulbs themselves due to safety restrictions, so longer-lasting, low-mercury tubes are almost always used.

Historic preservation overview

In some cases it is feasible to use long-life bulbs or tubes in historic fixtures. For example, historic street lamps or warehouse-type fixtures using mercury vapor bulbs may be retrofitted to use high-pressure sodium bulbs. However, there are cases where such a change is unacceptable, such as using screw-base fluorescent bulbs to replace incandescent bulbs in a decorative historic chandelier, or upgrading utilitarian 1950s fluorescent tube fixtures to take newer and thinner T-5s. In buildings where light fixtures are not significant historic features, it may be most expedient to replace entire fixtures, but that approach will require proper disposal of any mercury-containing tubes.

Strategies

Purchase long-life bulbs and tubes with low mercury content and higher light output per watt. [SOI Standards: 2.] Avoid using inappropriate bulbs in character-defining lighting fixtures, and do not use bulbs that produce light which significantly alters the ambience of historically significant spaces.

Train maintenance personnel to properly handle mercury-containing products to avoid breakage or spills. [SOI Standards: 2, 10.] Instructional signage should be mounted to avoid the use of adhesives, which can permanently mar historic materials.

Recycle all mercury-containing light bulbs through an appropriate facility. The National Electric Manufacturer Association (NEMA) maintains the LampRecycle.org website which lists bulb recycling companies by lamp type and state. [SOI Standards: None.]

Establish a light bulb purchasing program that keeps the weighted average mercury content below the LEED-EB-specified level of picograms per lumen-hour for mercury-containing light bulbs purchased during the performance period. [SOI Standards: 2.] Select bulbs and tubes specifically for compatibility of appearance and light output with contributing fixtures and spaces.

MR Credits 1.1 and 1.2 — Construction, Demolition, and Renovation (1 – 2 Points)

Intent—Divert construction, demolition and land-clearing debris from landfill and incineration disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements—Develop and implement a Waste Management Policy covering any future building retrofit, renovation or modification to the site. Quantify diversions of construction, demolition and land-clearing debris from landfill and incineration disposal by weight or volume.

- MR Credit 1.1: Divert at least 50% of construction, demolition and land-clearing waste from landfill and incineration disposal (1 point).
- MR Credit 1.2: Divert at least 75% of construction, demolition and land-clearing waste from landfill and incineration disposal (1 additional point).

Sustainable design and development overview

These credits are intended to reduce the amount of waste deposited in landfills or incinerators, and to encourage recycling of construction and demolition debris. Using materials salvaged from off site, such as concrete, can usually save money. Salvaging materials on site for reuse can also save money depending on the application. For example, reusing salvaged brick in landscaping or as a base material in construction is typically cost-effective, but salvaging brick for reuse in walls can be expensive due to the labor required to select undamaged brick and remove mortar from them. The DoD has used a no-cost deconstruction approach in which the contractor retained ownership of salvaged materials. MR Credits 1.1 and 1.2 create a focus to help installation planners develop a practical plan that takes into account the types, quantity, and quality of materials that can be salvaged.

Several federal regulations support this credit, including the Waste Reduction Program in FAR Part 23 and various Department of the Army Assistant Chief of Staff for Installation Management (ACSIM) memoranda on sustainable management in building activities and construction waste management.

Historic preservation overview

During a historic property renovation project in which the contractor is directed to salvage materials from demolition waste, ensure that significant historic features to be salvaged are clearly identified in the building scheduled for demolition. On the contrary, contractors should not assume features on remaining historic buildings are available for salvage.

When historic buildings are proposed for demolition, military installations negotiate with the State Historic Preservation Office (SHPO) on appropriate mitigation measures. Increasingly, SHPOs are asking for more than the conventional HABS/HAER documentation. Some Memoranda of Agreement (MOAs) specify that key historic features from the demolished buildings be salvaged for future reuse, such as in the repair or restoration of similar historic buildings on the installation. Some MOAs have included provisions that the installation construct a museum exhibit using salvaged materials or restore a similar historic building according to the SOI restoration standards. Deconstructed historic properties provide building stock that may be used in a historically appropriate way to restore or rehabilitate other historic properties while diverting debris from landfills.

Strategies

Develop and adopt a waste management policy for construction projects. The policy should address reuse and recycling of corrugated cardboard, metals, concrete, brick, asphalt, cleared vegetation, clean dimensional lumber, plastic, glass, gypsum board, carpet, and worker-generated debris such as beverage containers. [SOI Standards: None, although the policy should contain language of how to avoid impacts to historic properties during implementation, such as inadvertent demolition of historic features.]

Identify deconstruction and salvage opportunities, licensed haulers and processors of recyclable materials, and potential markets for salvaged materials. [SOI Standards: 2, 4.] During renovation projects, significant historic features to be retained must first be identified so they are not inadvertently demolished during construction. Similarly, features not associated with the original construction period of the building but potentially significant in their own right (per SOI Standard 4) should be retained.

Consider retaining salvaged high-quality historic building materials on the installation for reuse on other historic buildings, museum displays, or for sale to offset construction costs (Figure 4.1). [SOI Standards: 2, 3, 4, 5, 6, 9, 10.] Only salvage features from historic buildings that have been approved for demolition in coordination with the SHPO and installation cultural resource managers. Salvaging features from historic buildings to remain deprives them of their historic character. Furthermore, using historic features from one era on a building constructed in another is inappropri-

ate both historically and aesthetically per SOI Standard 3. Salvaged items should be reused in a similar architectural context on historic buildings retained from the same era. In all cases, the construction documents should record where new or salvaged building components are used so they can be identified in the future and removed or reused if needed. Salvaged materials need to be properly stored before reuse. If salvaged items cannot be used onsite, project managers may identify other sustainable rehabilitation projects where the materials could be used.

Figure 4.1. High quality historic fireplace mantels may be salvaged for reuse on other historic buildings (Hardlines).

For waste volumes generated in construction and rehabilitation projects, establish reuse, salvage and recycling activities where economically and logistically feasible. [SOI Standards: None, although as with any policy, it should contain language on how to avoid impacts during implementation.]

On the construction site, designate an area to recycle construction and demolition waste. Train workers on the recycling protocols and label recycling containers, such that they are readily identifiable, for onsite reuse, salvage, or storage. [SOI Standards: 2, 6, 9, 10.] The designated recycling area should be located so that collection and sorting activities do not damage the building or landscape. New construction associated with onsite re-

cycling areas also must be easily reversible per SOI Standard 10. Require the contractor to restore the site to its pre-construction condition. See discussion in SS Credit 4.1.

If exterior staging areas for recycling are limited, create a designated area inside the building. [SOI Standards: 2, 6, 9, 10.] These temporary areas must be located to avoid impact on interior historic features and should be easy to dismantle when construction is complete.

Include a copy of the installation construction and waste management policy in the project documents for bidding. [SOI Standards: None, although the documents should clearly identify historic features that are to remain.]

Research and specify manufacturers that will remove and recycle their products, such as carpet or ceiling tiles, when these products need replacement. [SOI Standards: None, since typically these products are limited to suspended acoustical ceiling grids and tiles, broadloom carpets, and carpet tile that are rarely found to be historic.]

MR Credits 2.1 – 2.5 — Optimize Use of Alternative Materials (1 – 5 Points)

Intent—Reduce the environmental impacts of the materials acquired for use in the operations, maintenance, and upgrades of building.

Requirements—Maintain a sustainable purchasing program covering at least office paper, office equipment, furniture, furnishings and building materials for use in the building and on the site. A template calculator will be provided for LEED-EB MR Credit 2.1-2.5. One point (up to a maximum of five) will be awarded for each 10% of total purchases over the performance period (on a dollar basis) that achieve at least one of the following criteria:

- Contains at least 70% salvaged material from off site or outside the organization.
- Contains at least 70% salvaged material from on site through an internal organization materials and equipment reuse program.
- Contains at least 10% post-consumer or 20% post-industrial material.
- Contains at least 50% rapidly renewable materials.
- Is Forest Stewardship Council (FSC) certified wood.
- Contains at least 50% materials harvested and processed or extracted and processed within 500 miles of the project.

Note: In calculating the percentage of purchases over the performance period conforming to the requirements, each purchase can only receive credit against a single requirement (i.e., a purchase that contains both 10% post-consumer recycled content and is harvested within 500 miles of the project counts only once in this calculation.

Sustainable design and development overview

The intent of MR Credits 2.1 – 2.5 is to encourage the ongoing acquisition of environmentally preferable materials to minimize environmental burdens related to conventional materials. Over the past 5 years, the number of sustainable building products has grown rapidly. Almost every category of construction offers sustainable products of equal grade and similar price to conventional products.

Federal regulations supporting the use of alternative materials include the Resource Conservation and Recovery Act (RCRA) and Executive Order 13101.

Historic preservation overview

Any renovation of historic properties should maximize the use of salvaged historic materials (see MR Credits 1.1 and 1.2). Historic properties often feature materials of local origin because, at the time of construction, builders lacked the means to transport non-local materials to the site. On the contrary, showcase historic properties may feature non-local materials or exotic specialty items that are unavailable locally. Similarly, for some restoration projects, sustainable alternative materials may not be acceptable

if those materials do not match original material appearance characteristics.

For a typical historic rehabilitation project, compatible replacement materials may be less expensive, more readily available, and more sustainable than salvaged materials. One example is wood from responsibly harvested forests to replace damaged items originally made from old-growth wood. Some areas of a building may have non-contributing features (such as newer cabinets in break rooms) that may readily be upgraded with alternative materials to provide sustainability benefits without degradation of historic details.

Strategies

Recycle landscape waste material produced during sitework. Trees cut during sitework (i.e., unseasoned wood) can be used for mulch, landscaping timbers, fence posts, and pilings in new construction, and can also be used for temporary project fencing. Stockpile topsoil for reuse onsite or elsewhere. [SOI Standards: 8.] All ground-disturbing activities must be cleared or monitored for adverse impacts on any archaeological resources present.

Incorporate salvaged building materials into the project (Figure 4.2). They are often of higher quality and more durable than modern equivalents. [SOI Standards: 2, 3, 4, 5, 6, 9, 10.] See MR Credits 1.1 – 1.2 for discussion of salvaging historic features for reuse in other construction or renovation.

Figure 4.2. Bench (left) and trellis (right) of reclaimed redwood (McQuiggan 2005).

When rehabilitating building finishes, use rapidly renewable materials where appropriate to the architectural context. Examples include bamboo

flooring, cork flooring, sunflower seed board, wheatgrass, and wool carpet. [SOI Standards: 2, 3, 5, 6, 9, 10.] One high-quality material based on renewable raw components is authentic linoleum, which is made from linseed oil, wood and stone products, and agricultural fibers. It is also a historic building material, having been invented in the 1860s.

Before considering alternative materials, first determine whether historic features can be repaired and not replaced. If replacement is necessary, the alternative material must be evaluated for appearance, texture, color, and workability by historically compatible methods. Additions must be compatible with in-place historic materials per SOI Standard 9 and readily removable in accordance with SOI Standard 10.

Some rapidly renewable materials, such as wool carpeting and linoleum, were common in original historic construction. These materials are historically compatible, but must not be used to convey a false sense of historic authenticity. The property's as-built records must be clear, and signage may be used to distinguish authentic historic materials from modern treatments that use traditional materials.

Research and purchase supplies from product manufacturers that offer alternative recycled products at low additional cost (Figure 4.3). [SOI Standards: 2, 3, 5, 6, 9, 10.] See discussion above.

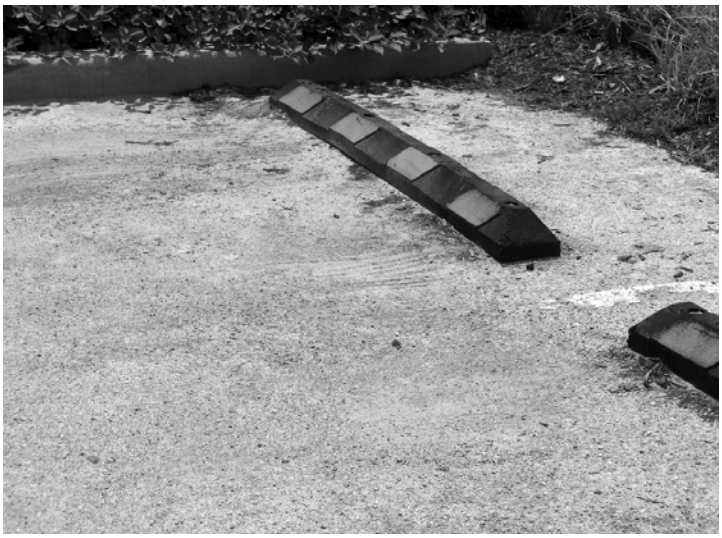

Figure 4.3. Parking block of recycled rubber; paving of concrete-soy mix (McQuiggan 2005).

Use locally and regionally manufactured materials whenever possible to reduce transportation energy inputs, costs, and environmental impacts (Figure 4.4). [SOI Standards: 2, 5, 6, 9, 10.] Historically compatible materials or components for repairing or replicating historic features may not be available locally. For example, acceptable repair of a slate roof or stone veneers may require obtaining replacement material from the original quarry. If material from the original source is depleted, it may be necessary to obtain material from similar geological formations located elsewhere to ensure the colors or other physical attributes are compatible.

Figure 4.4. Pavilion columns of local stone (McQuiggan 2005).

MR Credits 3.1 and 3.2 — Optimize Use of IAQ Compliant Products (1 – 2 Points)

Intent—Reduce the indoor air quality (IAQ) impacts of the materials acquired for use in the operation, maintenance and upgrades of buildings.

Requirements—Optimize use of air quality compliant materials inside the building to reduce the emissions from materials used in the building. Points are awarded for the existence of product purchasing policies for the building and site addressing the requirements of this credit and documentation of purchasing during the performance period in conformance with those policies, as described below. Subsequent recertification is tied to both policies and purchasing performance, as described below. At a minimum, these policies must include the following product groups: paints and coatings, adhesives, sealants, carpet, composite panels, and agrifiber products. The building materials covered include any building upgrades, retrofits, renovations or modifications, inside the building.

One point shall be awarded, up to a maximum of 2 points, for each 45% of annual purchases calculated on a cost basis that conform with one of the following sustainability criteria:

- Adhesives and sealants with a VOC content less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, or sealants used as fillers that meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

OR

- Paints and coatings with VOC emissions that do not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements.

OR

- Carpet that meets the requirements of the CRI Green Label Plus Carpet Testing Program,

OR

- Carpet cushion that meets the requirements of the CRI Green Label Testing Program,

OR

- Composite panels and agrifiber products that contain no urea-formaldehyde resins.

Sustainable design and development overview

The intent of MR Credits 3.1 and 3.2 is to reduce the use of products that contain volatile organic compounds (VOCs), which contribute to smog, air pollution, and unhealthy indoor working environments. The EPA's Environmentally Preferable Purchasing program provides information to help federal personnel to consider many environmental factors, such as toxicity and VOC content, in their purchasing decisions. In 1997, the Federal Acquisition Regulation (FAR), which provides broad purchasing guidance to federal employees, was amended to support government procurement of environmentally benign products and services. Studies have also shown that low-VOC paint may cost less than conventional paint when purchased in large quantities, and when disposal costs are considered. Potential tradeoffs can include a reduction in coating durability with the removal of VOC additives (Johnson and Stumpf 2002). However, an interior application in a low-traffic area (such as a private office) would be comparatively more durable than an exterior application.

Historic preservation overview

Use of reformulated low-and zero-VOC adhesives, sealants, paints, and coatings (as well as items like certified sustainable carpet cushion) will usually have minimal impact on historic properties. These paints now have excellent performance characteristics, are available for both indoor and outdoor applications, and are comparable to standard interior and exterior paint formulations. Casein-based renewable alternatives, such as milk paint, are more expensive, but may actually be a more authentic, preferred choice in an interior historic application.

Paints that meet the Green Seal certification standards (Green Seal 1993) for environmentally preferable paint — called GS-11 — are suitable for use on historic architecture, particularly for exterior applications due to their ability to breathe, allowing free passage of water vapor out of the substrate. For painting exterior concrete or stucco, silicate paints may be acceptable as a solvent-free alternative to conventional paints. They are often historically accurate in color and tint. There are exterior applications of silicate paint dating from the 19th century that are in excellent condition today (Parker 2003). Silicate paints are odorless, vapor-permeable, resistant to fungi and algae, noncombustible, and colorfast. They will not spall or flake off, and they will crack only if the substrate is damaged. Silicate paints are expensive, but their long-term durability may be justifiable in terms of life-cycle cost and process energy inputs. Similarly, paints and stains made with vegetable dyes and other plant products are inherently sustainable and have historical precedent.

While the use of sustainable alternative materials (e.g., bamboo casework and certified sustainable carpet) may be appropriate for a historic *rehabilitation* project, their use may not be acceptable in a highly-accurate historic *restoration*. In the later, unless the alternative material casework can be made to exactly replicate the historic appearance of surviving components, then using traditional stained wood may be a better option from a preservation standpoint. Similarly, certified sustainable carpet lines that replicate historic patterns and materials may not be available.

Strategies

Investigate and specify construction materials with VOC levels that fall within the range of the referenced standards. [SOI Standards: 2, 3, 5, 6, 9, 10.] Consider historic salvaged materials that may not contain any VOCs.

Ensure that specified products will not compromise the appearance or craftsmanship of historic features that must be repaired or replaced. All new materials must be historically compatible and readily removable.

Investigate and specify coatings containing VOC levels that fall within the range of the referenced standards [SOI Standards: 2, 6, 7.]:

- Consider use of GS-11 paints that meet Green Seal certification standards. Ensure that specified paints are appropriate for the application. For example, if historic masonry must be repainted, specify a high (95 – 99) permeability rating to allow the masonry to breathe.
- Use paints made from natural raw components such as water, plant oils, resins, and dyes, or water-based low-VOC (<50 lbs/gal) latex paints and primers (Mendler and Odell 2000, 165). Consider casein-based alternatives, such as milk paint (for interior applications) and silicate paint (for exterior concrete or stucco applications) as they have historic precedents.
- Specify that water-based paints not be formulated with aromatic hydrocarbons, formaldehyde, halogenated solvents, mercury, lead, cadmium, chromium VI, antimony, or heavy metal oxides (Mendler and Odell 2000, 165).
- Avoid paints formulated with methylene chloride, toluene, ethyl benzene, vinyl chloride, naphthalene, 1,2-dichlorobenzene, phthalates, isophorone, 1,1,1-trichloro-ethane, methyl ethyl ketone, methyl isobutyl ketone, acrolein, acrylonitrile, and ethylene glycol, all of which pose varying threats to human health (Mendler and Odell 2000, 165).
- Use solvent-based paints only where necessary for high resistance to weathering, with VOC content not exceeding 250 g/l) (Mendler and Odell 2000, 165).
- Consider using paints and primers with 50 – 100% recovered (i.e., recycled) content where indoor air quality and color selection are not concerns (Mendler and Odell 2000, 165). These paints should not be used where they negatively impact the look and feel of historic spaces.
- Paints, finishes, or sealants should be tested on a small portion of the historic feature to ensure that it does not damage or discolor the substrate. Protect adjacent historic features that are not scheduled for recoating.
- Use natural (plant- or insect-based oils and resins) or water-based stains and varnishes. When conventional stains or finishes are specified choose products with the following VOC content: stains – 200 g/l;

transparent finishes – 250 g/l; and floor coating 300 g/l (Mendler and Odell 2000, 166). For decorative finishes, specify a water-based multi-color finish that has less than 130 g/l VOCs and low hazardous chemical content (Mendler and Odell 2000, 166).

- Minimize the use of toxic paint or solvent maintenance and cleaning products (Mendler and Odell 2000, 165).
- Use low-VOC paint strippers without dichloromethane or caustic soda. Turpentine is safer than many other strippers, such as those that contain methylene chloride, a suspected carcinogen, and/or phenol. Both are chemicals that have been limited by the EPA on the allowable concentration of Total Toxic Organics (Reinbold et al.). Paint strippers made with citrus oil are an alternative to turpentine, to which some people are sensitive. They consist of a mix of water and extracts from the peel of an orange, which, for this purpose, can be grown without pesticides. Citrus paint strippers are immiscible with water but are known to evaporate quickly, are biodegradable, and should not cause long term effects. Related chemicals are also biodegradable and the ultimate decomposition products are carbon dioxide and water (MSDS for Citrus Solvent).

Request emissions test data from product manufacturers and compare test data for similar products. Note that Material Safety Data Sheets (MSDSs) may not include information on VOC content. [SOI Standards: None.]

Establish and enforce a procurement policy that clearly states acceptable VOC limits for adhesives, sealants, coatings, carpets, and composite woods. [SOI Standards: None, as long as the policy also includes recommendations on how historic materials should be treated.]

Monitor VOC emissions during materials application and monitor periodically emission levels over the lifetime of the building via air quality testing. [SOI Standards: None.]

Develop a long-term plan for the handling, recycling, and other means of disposal for solvent-based paints and adhesives, finishes, sealant, waterproofing, and other materials (Mendler and Odell 2000, 149). [SOI Standards: None.]

MR Credits 4.1 – 4.3 — Sustainable Cleaning Products and Materials (1 – 3 Points)

Intent—Reduce the environmental impacts of cleaning products, disposable janitorial paper products and trash bags.

Requirements—Implement sustainable purchasing for cleaning materials and products, disposable janitorial paper products and trash bags. Cleaning product and material purchases include building purchases for use by in house staff or used by outsourced service providers. Calculate the percentage of the total sustainable material and product purchases that meet at least one of the specified sustainability criteria. The percentage of the total sustainable cleaning product and material purchases determine the number of points earned, up to a total of 3 points. One point will be awarded for each 30% of the total annual purchases of these products (on a cost basis) that meet one of the sustainability criteria:

- Cleaning products that meet the Green Seal GS-37 standard if applicable, OR if GS-37 is not applicable (e.g., for products such as carpet cleaners, floor finishes or strippers), use products that comply with the California Code of Regulations maximum allowable VOC levels.
- Disposable janitorial paper products and trash bags that meet the minimum requirements of U.S. EPA's Comprehensive Procurement Guidelines.

Sustainable design and development overview

The intent of MR Credits 4.1 – 4.5 is to encourage use of sustainable janitorial and housekeeping products that have reduced VOC and carcinogenic content.

Historic preservation overview

With a few possible exceptions, the use of commercial cleaning products that meet the Green Seal GS-37 standard will be too strong for most historic building materials and details. Green Seal-37 has a list of prohibited ingredients as well as requirements for carcinogens, fragrances, concentrates, and packaging. A product can meet Green Seal-37 requirements and still be harsher than the recommended cleaning method for buildings, which is often simply a water mist. Similarly, chemical products can meet Green Seal-37 but will still damage old delicate features, such as flaking gold leaf. Architectural conservators have developed gentle cleaning methods for delicate and unstable materials, and these must be tested and customized for each building. As a result, research should first be done to determine the best method to clean historic building materials prior to issuing housekeeping bid documents and cleaning product purchase orders.

Sustainable cleaning and historic building cleaning methods may be compatible. For example, the best cleaning method for marble is often using a

fine water mist with no chemical additives. Alternatively, harsh chemicals like ammonia (and common cleaning products that contain ammonia) can permanently etch bronze and brass and cloud up Plexiglas. One of the best methods for maintaining historic interiors is to frequently and systematically dust. Note that infrequent dusting can cause debris to eventually bond to materials like metal, which then require cleaners to remove.

Strategies

Research and use recycled and chlorine-free janitorial paper products (e.g., toilet tissue and paper towels). Consider changing to hand dryers versus paper towels, which are more cost effective from an embodied energy perspective. Hand dryers are considered more sustainable because they eliminate the use and disposal of paper products over a period of several years, if not decades. The energy used to manufacture and operate a hand dryer may negate the energy used to manufacture paper products, but the use of raw materials and the generation of waste products are reduced, if not eliminated. [SOI Standards: None, since most bathrooms have been modified for code compliance.]

Use recycled-content plastic or bioresin-based trashcan liners. Eliminate liners where there would be no negative impact on trash collection or sanitation. [SOI Standards: None.]

Use specific cleaning methods targeting historic features (Minnesota Historical Society 2000). [SOI Standards: 7.] Examples include:

- Floors: wash with diluted vegetable oil-based soap and wax as needed every 6 – 12 months.
- Finished woodwork: clean with vegetable oil-based soap according to instructions and tepid distilled or deionized water and dry thoroughly. Wash twice a year. For stubborn grime add 2 – 4 drops of ammonia per gallon of water.
- Painted woodwork: clean with vegetable oil-based soap according to instructions and tepid distilled or deionized water and dry thoroughly. Wash twice a year. For stubborn grime add 2 – 4 drops of ammonia per gallon of water. Do not clean tortoise shell, lacquered, japanned, or papier-mâché surfaces.
- Glass: clean with a solution of distilled water (50%), alcohol (50%), and a few drops of ammonia per gallon of water. Avoid getting the cleaning solution on the putty that holds the glass in place.

- Carpets and rugs: correct maintenance and cleaning of historic carpets is sustainable in that no harsh chemicals or excessive machine-assistance is recommended. Vacuum historic carpets with nozzle through screen every 3-4 months. Never vacuum historic carpets with a power head/beater brush. In addition, the head of the vacuum should never be dragged or rubbed back and forth on historic carpets. Wool and cotton area rugs, after having been first tested for colorfastness, may be washed in place or sent to a reputable oriental rug cleaning service. Cleaning should include a prewash inspection for problems or weakened areas that may require extra care when cleaning; gentle removal of dust and soil with a non-mechanized vacuum cleaner head; cold-water mild shampoo bath using only soft brushes for gentle agitation; a cold water rinse and squeegee (or wringer machine) if the rug can tolerate it; and flat drying with cool air fans (no-heat drying).
- Ceramics: dust or clean with damp cloth.
- Marble or terrazzo floors: vacuum gently about every 2 weeks. Wash one time per year with a weak solution of ammonia and distilled water. Never use a chlorinated cleaner on marble, terrazzo or limestone surfaces.
- Metal: the preferred method for cleaning heavily used metal features (such as railings, plumbing fixtures, and doorknobs) is a weekly swipe with magnetic cloth that is composed of 98% polyethylene fibers and 2% nylon (similar to Tyvek). The difference in fibers gives the cloth a net negative static charge and makes them dust attractants without having to add additional volatile or liquid chemicals. When cleaning in a warm environment where perspiration is an issue, use vinyl gloves to avoid touching surfaces with bare hands. Do not polish metal surfaces, as the protective patina may wear off. Wipe brass with a soft cloth. Generally metals should be dusted only three times per year without rubbing.

MR Credits 5.1 – 5.3 — Occupant Recycling (1 – 3 Points)

Intent—Facilitate the reduction of waste and toxins generated by building occupants and building operations that are hauled to and disposed of in landfills or incineration.

Requirements—Have in place over the performance period a building occupant waste reduction and recycling program that addresses the separation, collection and storage of materials for recycling, including (at a minimum) paper, glass, plastics, cardboard/OCC, metals, batteries, and fluorescent light bulbs and diversion from landfill disposal or incineration. Each time reusable architectural panels are moved and reinstalled, they can be counted as part of the total waste stream and included in the recycled component of the waste stream.

Collect and recycle at least 95% of the batteries used, and collect and recycle at least 95% of the fluorescent light bulbs used.

AND

- Divert/Recycle 30% of total waste stream (by weight or volume) (1 point).
- Divert/Recycle 40% of total waste stream (by weight or volume) (2 points).
- Divert/Recycle 50% of total waste stream (by weight or volume) (3 points).

Sustainable design and development overview

The intent of MR Credits 5.1 – 5.3 is to encourage recycling by building occupants and the reuse of systems furniture and modular panels. These activities are typically organized in accordance with the installation's pollution prevention plan.

Historic preservation overview

Collecting standard recycled materials and reusing systems furniture panels will generally not affect the design or methods used in historic building projects. Areas designated for the collection of batteries, which may leak acid, and fluorescent light bulbs, which may contain mercury, must include precautions to protect historic materials.

Strategies

Provide protection when designating a collection area for batteries and fluorescent bulbs. Protection refers to any method for protecting historic fabric from the corrosive effects of mercury and acid found in fluorescent bulbs and batteries respectively. This could include floor mats, containers, or protective constructs. [SOI Standards: 2, 9, 10.] Ensure that new protective constructs do not detract from and are compatible with existing historic features, and are easily removed without damage to underlying historic materials.

Use the building waste audit conducted for MR Prerequisite 1.1 to identify opportunities for source reduction, reuse and recycling. Activities may in-

clude arrangements with businesses that collect and recycle occupant waste such as computers, digital media discs, jewel cases, videotapes, audiocassettes, ink and toner cartridges, cell phones, pagers, digital cameras, media players, and other small electronics. [SOI Standards: None.]

Make education of maintenance staff and building occupants a significant focus. Training and outreach must be repeated periodically because military personnel and families are transient as assignments change. [SOI Standards: 2, 10.] See MR Prerequisite 1.2 for discussion of mounting signage and instructional posters in historic buildings.

Provide information on recycling procedures and a specific list of recyclable materials and collection locations. [SOI Standards: 2, 10.] See MR Prerequisite 1.2 for discussion of mounting signage and instructional posters in historic buildings.

Encourage occupants to use coffee mugs and tumblers instead of disposable paper products. Stock reusable drinking vessels for the benefit of building guests. [SOI Standards: None.]

MR Credit 6 — Additional Toxic Material Source Reduction (1 Point)

Intent—Establish and maintain a toxic material source reduction program to reduce the amount of mercury brought into buildings through purchases of light bulbs.

Requirements—Maintain mercury content of all mercury-containing light bulbs below 80 picograms per lumen hour of light output (picogram/lumen hour), on weighted average, for all mercury-containing light bulbs acquired for the existing building and associated grounds. (The weighted average mercury content of these light bulbs is calculated as described in MR Prerequisite 2).

Sustainable design and development overview

The intent of this credit is to encourage toxic material source reduction beyond the goals specified in MR Prerequisite 2.0.

Historic preservation overview

This credit involves placing long-life light bulbs in historic light fixtures or compatible replacement fixtures. Preservation concerns are the same as those listed in MR Prerequisite 2.0. The number and size of replacement fixtures and switches should be determined through careful consideration of the historic architectural context. Replacement luminaries should be selected to preserve the visual characteristics of the historic ambient lighting and spaces.

Implementing this credit can be an opportunity to correct past lighting updates that were incompatible with the historic architecture. For example, poorly placed fixtures and switches can be moved to locations that are more convenient and less visually prominent. Any corrective actions should include the repair of damaged historic fabric.

Strategies

See MR Prerequisite 2.0.

MR references

Green Seal. 1993. *Green Seal Standards and Certification: Paints (GS-11)*. http://www.greenseal.org/certification/standards/paints.cfm

Johnson, Eric and Annette Stumpf. 2002. *Specifying Environmentally Friendly Paint*. Engineering Automation Research Update. Champaign, IL: ERDC-CERL. www.cecer.army.mil/EARUpdate/NLFiles/2002/LowVOCPaints.cfm

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U.S. Environmental Protection Agency. 2006. *Pollution Prevention (P2): Why Should You Care About Preventing Waste? Small Business Guide*. http://www.epa.gov/p2/pubs/assist/sbg.htm

U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics. 2001. *EPA742-E-01-001: Why Should You Care About Preventing Waste?* http://www.epa.gov/opptintr/p2home/pubs/MainBooklet.pdf

U.S. Green Building Council. 2005. *LEED for Existing Buildings Version 2.0 (July)*.

MR-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) sections covering materials and resources are listed in Table 4.2 below:

Table 4.2. UFGS sections relevant to MR prerequisites and credits.

MR Prerequisite or Credit	UFGS Section	Section Title
Credits 1.1 and 1.2	01500A	Temporary construction facilities
Credits 1.1 and 1.2	01572	Construction and demolition waste management
Credits 1.1 and 1.2	01670	Recycled/recovered materials
Credits 3.1 and 3.2	09900	Paints and coatings
Prerequisite 2	13286N	Handling of lighting ballasts and lamps containing PCBs and mercury
Prerequisite 2 and Credit 6	16510	Interior lighting

Additional MR resources

ASTM International. 1997. ASTM D5116-97, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products. ASTM.

California Integrated Waste Management Board. Business Resource Efficiency and Waste Reduction. www.ciwmb.ca.gov/bizwaste

California Integrated Waste Management Board. Construction and Demolition Waste Recycling Information. www.ciwmb.ca.gov/ConDemo

California Integrated Waste Management Board. Recycled Content Product Directory. www.ciwmb.ca.gov/rcp

Carpet and Rug Institute. www.carpet-rug.com

Code of Federal Regulations 40 CFR 247, Comprehensive Procurement Guidelines. http://www.washingtonwatchdog.org/documents/cfr/title40/part247.html

Diaz, Luis et al. 2003. Composting and Recycling Municipal Solid Waste. CRC Press.

Earth 911. In conjunction with Home Depot, Hewlett Packard, and ESRI. http://www.earth911.org/

EcologyAction. Green Building Materials Guide. www.ecoact.org/Programs/Green_Building/green_Materials/paint.htm

Environmental Building News. 1999. Paint the Room Green. Volume 8, Number 2.

Executive Order 13101. Greening the Government Through Waste Prevention Recycling, and Federal Acquisition. http://www.ofee.gov/eo/13101.htm

Federal Acquisition Regulations Part 23.4. Use of Recovered Materials. http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/23.htm#P71_7824

Federal Acquisition Regulations Part 52.223-4. Recovered Materials Certification. http://www.arnet.gov/far/current/html/52_223_226.html#wp1168826

Federal Acquisition Regulations Part 52.223-9. Estimate of Percentage of Recovered Material Content for EPA-Designated Products. http://www.arnet.gov/far/current/html/52_223_226.html#wp1168826

Forest Stewardship Council. www.fsc.org/fsc

Greenspec Menu. www.greenspec.com

INFORM, Inc. 2006. Waste at Work: INFORM—Strategies for a Better Environment. www.informinc.org/wasteatwork.php

LampRecycle.org. www.nema.org/lamprecycle/

Levin, Hal. Best Sustainable Indoor Air Quality Practices in Commercial Buildings. www.buildinggreen.com/elists/halpaper.html

Lund, Herb. 2000. McGraw-Hill Recycling Handbook. McGraw-Hill.

Master Paint Institute. www.paintinfo.com

Mercury Awareness Program. http://www.in.gov/idem/your_environment/mercury/

National Recycling Coalition. www.nrc-recycle.org/

Northeast Waste Management Officials' Association. Interstate Mercury Education and Reduction Clearinghouse: Mercury Added Products Database. http://www.newmoa.org/prevention/mercury/imerc/notification/

Recycler's Exchange. www.recycle.net/exchange

Recycling at Work. www.usmayors.org/USCM/recycle

Resource Conservation and Recovery Act, Section 6002, Solid Waste Disposal. www.ornl.gov/adm/ornlp2/sec6002.htm

Salvaged Building Materials Exchange. www.greenguide.com/exchange/search.html

Steven Winter Associates, Inc. 2005. Ready Mixed Concrete Industry LEED Reference Guide. Ready Mixed Concrete Research Foundation and the Portland Cement Association.

Thiel, Trish. Turning Glass into Aggregate Opens New Markets. American Recycling. http://www.americanrecycler.com/04glass02.html

Thompson, J. William and Sorvig, Kim. 2000. Sustainable Landscape Construction. Island Press.

U.S. Air Force. Construction and Demolition Waste Management Guide. http://www.afcee.brooks.af.mil/eq/programs/summary.asp?rscID=870

U.S. Army Corps of Engineers. 2001. Public Works Technical Bulletin 420-49-18, Direct Sale of Recyclables (24 May). www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_420_49_18.pdf

U.S. Environmental Protection Agency. 2000. Cleaning National Parks: Using Environmentally Preferable Janitorial Products at Yellowstone and Grand Teton National Parks. http://www.epa.gov/opptintr/epp/pubs/cleaning.pdf

U.S. Environmental Protection Agency. 2001. Recovered Materials Advisory Notice. http://www.epa.gov/EPA-GENERAL/2001/August/Day-28/g21568.htm

U.S. Environmental Protection Agency. 2005. Waste Control: Construction and Demolition Debris. http://www.epa.gov/epaoswer/non-hw/debris-new/index.htm

U.S. Environmental Protection Agency. 2005. Waste Wise Program. www.epa.gov/wastewise/about/index.htm

U.S. Environmental Protection Agency. n.d. Building Savings: Strategies for Waste Reduction of

Construction and Demolition Debris from Buildings. www.ilsr.org/recycling/buildingdebris.pdf

U.S. Environmental Protection Agency. n.d. Comprehensive Procurement Guidelines. www.epa.gov/cpg/

U.S. Environmental Protection Agency. n.d. Mercury Web Site. www.epa.gov/mercury/

U.S. Environmental Protection Agency. Resource Conservation and Recovery Act. http://www.epa.gov/rcraonline/

5 Indoor Environmental Quality (EQ)

Indoor Environmental Quality—Select Mandates and Guidelines
10 CFR Part 434, Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings
ANSI/ASTM-779-03, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization (ASTM, 2003)
AR 420-1, Facilities Engineering: Army Facilities Management (HQDA, Final Pending 2006)
Army Energy Campaign Plan (Final Pending)
ASHRAE Standard 52.2 – 1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ASHRAE, 1999)
ASHRAE Standard 55 – 2004, Thermal Environmental Conditions for Human Occupancy (ASHRAE, 2004)
ASHRAE Standard 62.1 – 2004, Ventilation for Acceptable Indoor Air Quality (ASHRAE, 2004)
California Energy Commission Publication P 400-01-022, Residential Manual for Compliance with California's 2001 Energy Efficiency Standards (CEC, 01 June 2001)
Carbon Trust Good Practice Guide 237, Natural Ventilation in Non-Domestic Buildings – A Guide for Designers, Developers and Owners (Carbon Trust, 21 June 1999)
Carpet and Rug institute, Green Label Testing Program – Vacuum Cleaner Criteria
Chartered Institution of Building Services Engineers, Applications Manual 10: 2005, Natural ventilation in Non-Domestic Buildings (CIBSE, 2005)
DODI 1010.15, Smoke-Free DoD Facilities Management (DoD, 02 Jan 2001)
EO 13058, Protecting Federal Employees and the Public From Exposure to Tobacco Smoke in the Federal Workplace (White House, 13 August 1997)
EPA 402-F-91, Building Air Quality: A guide for Building Owners and Facility Mangers (EPA, December 1991)
EPA 600/S4-90-010, Compendium of Methods for the Determination of Air Pollutants in Indoor Air (EPA, May 1990)
EPA Comprehensive Procurement Guidelines, found in 40 CFR 247 (EPA, April 2004)
EPA Greening Your Purchase of Cleaning Products: A Guide For Federal Purchasers
ER 1110-345-723, Systems Commissioning Procedures (HQUSACE, 31 July 1995)
Sheet Metal and Air Conditioning National Contractors Association, IAQ Guideline for Occupied Buildings under Construction (SMACNA, 1995)
UFC 3-410-01FA, Heating, Ventilating, and Air Conditioning (DoD, 15 May 2003)
UFC 3-440-06, Cooling Buildings by Natural Ventilation (DoD, 16 January 2004)
UFGS 230923, Direct Digital Control for HVAC and Other Local Building Systems (HQUSACE, April 2006)
UFGS 230953, Space Temperature Control Systems (NAVFAC, April 2006)
UFGS 230954, Direct Digital Control Systems (NAVFAC, April 2006)
UFGS 251010, Utility Monitoring and Control System (USACE, April 2006)
WBDG Design Guidance - Design Objectives - Sustainable - Enhance Indoor Environmental Quality

EQ Prerequisite 1 — Outside Air Introduction and Exhaust Systems (Required)

Intent — Establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the health and well being of the occupants.

Requirements —

Modify or maintain existing building outside-air (OA) ventilation distribution system to supply at least the outdoor air ventilation rate required by ASHRAE 62.1-2004. If this is not feasible due to the physical constraints of the existing ventilation system, modify or maintain the system to supply at least 10 cubic feet per minute (CFM) per person.

Implement and maintain an HVAC System Maintenance Program to ensure the proper operation and maintenance of HVAC components as they relate to IAQ.

Test and maintain the operation of all building systems, including bathroom, shower, kitchen, and parking exhaust systems.

Sustainable design and development overview

Existing buildings may be operating at IAQ levels below current standards, reducing occupant comfort and productivity levels. Additional energy use required from increased outdoor air ventilation rates can be offset by various energy recovery and economizer strategies. ANSI/ASHRAE 62.1-2004 (2004), *Ventilation for Acceptable Indoor Air Quality*, provides guidelines for minimum acceptable ventilation levels. The standard also aims to minimize the potential for adverse health effects due to inadequate ventilation rates and air quality.

Historic preservation overview

Modifying outside air ventilation often results in enlarging or moving the placement of visible grilles. If the system is being overhauled, replacement provides the opportunity to relocate grilles to more discreet locations if the current locations negatively impact historic building features. Compliance with ANSI/ASHRAE 62.1-2004 may require that greater volumes of air be introduced to the interior, creating the need for larger or additional air ducts and grilles. Specific attention may be required to ensure that duct modifications comply with the SOI rehabilitation standards.

Most historic buildings constructed before the mid-20th century were not designed for air conditioning. They were built with passive ventilation features such as operable windows, screens (Figure 5.1), louvered doors, convective high ceilings, operable transoms over interior doors, and ceiling fans. Retaining such energy-conserving ventilation features and restoring

them to operating condition can be an important step toward achieving EQ Prerequisite 1.

Figure 5.1. Screens and operable windows can enhance indoor air quality (ERDC-CERL).

Strategies

The extent of required HVAC work typically determines whether a project falls under LEED-EB or LEED-NC standards. The strategies listed below are intended for projects that fall under the LEED-EB standards.

Modify or replace ventilation systems to comply with ANSI/ASHRAE 62.1-2004. [SOI Standards: 2, 6, 9, 10.] Modifications may be required in the size, location, or number of air intakes, or changes in the size of exterior equipment. In addition to ensuring that new work does not impact historic features, modification may also be an opportunity to mitigate previous poor placement of air intakes and exterior equipment in historic viewsheds. Other modification strategies include ducted systems, through-wall systems, and high-velocity systems, each of which must be carefully designed to avoid affecting historic interior, exterior, or landscape features. When adding air conditioning to an existing forced heat system, consider the impact on historic building materials, especially those predating the 20th century. Air conditioning dehumidifies interior air, which can cause outdoor humidity to migrate through masonry and plaster to areas of lower moisture. The HVAC upgrade project should therefore consider the permeability of any paints or other coatings on masonry and plaster surfaces to prevent trapping of moisture inside the structure.

Adding new ventilation devices may be acceptable and necessary for historic buildings with no central HVAC system (Figure 5.2). [SOI Standards: 2, 6, 9, 10.] New ventilation features should be carefully designed to avoid compromising the historic character of the building. For example, placing four ridge ventilators on a building that originally had three is less intrusive than adding several windows to a storage facility that originally had none. However, restoring the operability of historic windows (including windows previously filled in), transoms, and roof-top ventilators may be the most sustainable and affordable ventilation upgrade. Restoring original ventilation features can help a building meet ASHRAE standards as well as restore the building's historic function and appearance.

Figure 5.2. Automated window openers at Naval Station Great Lakes, IL (Hardlines).

Identify site activities that may contaminate the outdoor air source, and implement operational and functional changes that eliminate the contaminants. Such activities may include loading docks used by idling trucks, designated smoking areas, busy street corners, exhaust from adjacent buildings, bus stops and taxi stands, and helicopter landing pads. [SOI Standards: 2, 6, 9, 10.]

If air intakes cannot be moved and the source of contaminants cannot be eliminated, install filters that prevent contaminants from entering the building. [SOI Standards: None.]

Implement an operations and maintenance plan to protect HVAC systems from contaminants. [SOI Standards: None.]

Professionally clean existing air distribution systems (ducts, grilles, and diffusers) (Figure 5.3). [SOI Standards: None.]

Figure 5.3. Before and after duct cleaning (Clean Care 1997).

Use ventilation to eliminate conditions such as excessive humidity that may promote mold growth. [SOI Standards: 2, 9, 10.] New penetrations must be designed and placed to minimize impact on historic features.

Locate new outdoor air intakes away from sources of indoor air contamination. [SOI Standards: 2, 6, 9, 10.] The key to reducing historic preservation impacts is coordinated design and placement of intakes away from historic viewsheds.

EQ Prerequisite 2 — Environmental Tobacco Smoke (ETS) Control (Required)

Intent — Prevent or minimize exposure of building occupants, indoor surfaces and systems to Environmental Tobacco Smoke (ETS).

Requirements —

Option A. Prohibit Smoking in the building:

- Prohibit smoking in the building.
- Locate any exterior designated smoking areas at least 25 feet away from building entries, outdoor air intakes and operable windows.

Option B. Establish negative pressure in the rooms with smoking:

- Prohibit smoking in the building except in designated smoking areas.
- Locate any exterior designated smoking areas at least 25 feet away from building entries, outdoor air intakes and operable windows.
- Provide one or more designated smoking rooms designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors, away from air intakes and building entry paths, with no recirculation of ETS-containing air to the non-smoking area of the building and enclosed with impermeable deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least an average of 5 Pa (0.02 inches water gauge) and with a minimum of 1 Pa (0.004 inches water gauge) when the door(s) to the smoking room are closed.
- Verify performance of the smoking room differential air pressures by conducting 15 minutes of measurement, with a minimum of one measurement every 10 seconds, of the differential pressure in the smoking room with respect to each adjacent area and in each adjacent vertical chase with the doors to the smoking room closed. The testing will be conducted with each space configured for worst-case conditions of transport of air from the smoking rooms to adjacent spaces.

Option C. Reduce air leakage between rooms with smoking and non-smoking areas in residential buildings:

- Prohibit smoking in all common areas of the building.
- Locate any exterior designated smoking areas at least 25 feet away from building entries, outdoor air intakes and operable windows.
- Minimize uncontrolled pathways for ETS transfer between individual residential units by sealing penetrations in walls, ceilings and floors in the residential units by sealing penetrations in walls, ceilings and floors in the residential units, and by sealing vertical chases adjacent to the units. In addition, all doors in the residential units leading to common hallways shall be weather-stripped to minimize air leakage into the hallway. Acceptable sealing of residential units shall be demonstrated by a blower door test conducted in accordance with ASTM-779-03, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization, and use of the progressive sampling methodology defined in Chapter 7 (Home Energy Rating Systems (HERS) Required Verification and Diagnostic Testing) of the California Residential Method Approval Manual. Residential units must demonstrate less than 1.25 square inches leakage area per 100 square feet of enclosure area (i.e., sum of all wall, ceiling and floor areas).

Sustainable design and development overview

The intent of the prerequisite is to discourage or isolate smoking within buildings in an effort to maintain healthy air quality for all building occupants. Because second-hand smoke has strongly been linked with health

risks, prohibiting smoking in all indoor areas is one way to minimize adverse impacts on worker health and productivity. A no-smoking policy can decrease expenses and liability for building owners, operators, and insurance companies.

Historic preservation overview

Prohibition of indoor smoking is the simplest method for minimizing ETS and it does not create any adverse impacts to the building interior. Smoking is prohibited inside most federal buildings. Highly secure or large facilities may opt to designate a separately ventilated indoor smoking area in order to reduce worker loss of productivity and unnecessary activation of security procedures related to smoking breaks. Establishing an indoor smoking area may impact a historic building by lowering ceilings and adding ventilation penetrations. If necessary, the design team may install exhaust grilles along minor exterior elevations to minimize impacts on key historic features. In addition, the historic interior finishes of smoking areas will become discolored unless dedicated maintenance is scheduled. One widely cited product for cleaning ETS stains is a dry chemical sponge (CleaningPro 2000).

Strategies

Prohibit smoking entirely within the building (including common areas). [SOI Standards: None.]

Provide designated smoking rooms in negatively pressurized space with a separate ventilation system. Locate designated indoor smoking areas in places where exhaust grilles and other required ventilation penetrations do not adversely impact a primary façade or roofline. Also, locate smoking areas so that no historic interior finishes are negatively impacted by lowered ceilings for ventilation ducts or discoloration from exposure to smoke. [SOI Standards: 2, 9, 10.] The ventilation requirements for separate smoking rooms involve penetrations for air intake and exhaust, which may impact the historic character of the building. Any alterations should be compatible and reversible.

In residential buildings such as barracks, family housing, and lodges, another option is to provide very tight construction with sealed penetrations and weather stripping on all doors leading from units to common spaces, with smoking prohibited in all common areas. Some installations have also

opted to provide individual HVAC units in barracks and lodges to provide direct occupant control, which has the benefit of further isolating the air supply of residential units from common areas. [SOI Standards: 2, 9, 10.] Individual HVAC units require air intake directly from the outside, so penetrations may be visible from historic elevations. Care must be taken in selecting systems with minimal air intake size requirements, locating penetrations discreetly, and ensuring that their removal does not permanently affect historic materials. In addition, older barracks with private and common areas on the same HVAC system will have to be upgraded, creating possible impacts on historic features.

To discourage smokers from congregating in convenient but inappropriate locations, designate a specific outdoor smoking area with signage, benches, and disposal containers that is at least 25 feet from building entrances, outdoor air intakes, and operable windows (Figure 5.4). [SOI Standards: 2, 7, 9, 10.] Smoking area components must comply with the unobstructed space requirements of DoD minimum antiterrorism standards (UFC 4-010-01). New items placed along historic exterior elevations, even if temporary in nature, must be selected and placed to avoid negative impacts on the historic character of the building. Items that must be secured to the building or site should be fastened so that no permanent damage is done to the property when they are removed.

Figure 5.4. An outdoor smoking shelter (Columbia Equipment Company).

If a shelter is provided to serve as a designated smoking area, ensure that its location is selected to avoid impact on historic views and elevations. If presence in a historic setting is unavoidable, one approach would be to design a completely modern glass structure that is as inconspicuous and discernable as possible. The shelter must be designed to be easily removable without additional disturbance of the historic site. [SOI Standards: 2, 8, 9, 10.] In addition to being visually compatible and easily removable, any structures requiring ground disturbance for slab or utility work must ensure that no archaeological sites are disturbed.

EQ Prerequisite 3 — Asbestos Removal or Encapsulation (Required)

Intent — Reduce the potential exposure of building occupants to asbestos and prevent associated harmful effects of asbestos in existing buildings.

Requirements —

- Have in place an asbestos management program.
- Identify the applicable regulatory requirements.
- Have survey records that identify where asbestos is located in the building and on the site so that the asbestos present can be addressed appropriately in the ongoing asbestos management program. If the existing survey records do not cover all areas of the building, conduct a survey to identify where asbestos-containing materials are present in the remaining areas of the building.

Sustainable design and development overview

The intent of EQ Prerequisite 3 is to manage any asbestos found in existing buildings through identification and control, encapsulation, or removal. The goal is to eliminate or minimize the potential health risks to building occupants and maintenance workers.

Historic preservation overview

Asbestos is a naturally occurring fire resistant and pliable mineral that has been used in various building applications since the late 19th century. Any historic building that has not been completely renovated is likely to contain asbestos, especially in floor tile, insulation, and plaster. Asbestos-containing materials (ACM) can be identified with minimal impact to historic features. Only small samples of floor tile, plaster, and insulation are required by a hazardous material survey and testing team. The decision of how to manage the ACM can range from minimal (encapsulation) to significant (wholesale removal of historic plaster). Building managers must weigh factors such as the condition of the ACM, the cost to remove and replace it, and whether children will frequently occupy the facility.

Strategies

Prepare an asbestos management program that identifies regulatory requirements and how the program will address any asbestos remaining in the building on an ongoing basis. [SOI Standards: None, although the plan should address coordination of placement of future sample tests and restoration of tested areas.]

Hire accredited professionals to conduct any required follow-up surveys. The surveys may include additional asbestos sampling, sample testing, and

an asbestos management plan update. [SOI Standards: 6.] Because samples are often taken from finished interior surfaces such as wall plaster, asbestos workers must be directed to collect samples from inconspicuous locations, and must be provided a clear specification on how to restore the historic finish after extraction.

Hire accredited professionals to conduct any recommended asbestos immobilization work. [SOI Standards: 2, 6, 7, 9, 10.] Asbestos that crumbles easily and releases small fibers into the air (called *friable* asbestos) can remain in place if immobilized properly. Typical immobilization treatments include encapsulation and encasement. *Encapsulation* involves the application of a clear spray-on coating or acrylic or alkyd (oil-based) paint. *Encasement* involves the construction of a cladding layer to conceal and isolate ACM. Encasement work must be compatible with the historic character of the building and be easily removable, both for historic purposes as well as for future asbestos mitigation activities.

Hire accredited professionals to conduct any recommended abatement and monitoring. The management plan may recommend removal for certain areas or buildings either because the ACM is highly deteriorated or because the building is used by children, such as a day care facility, family housing, or a school. [SOI Standards: 2, 5, 6, 7, 9, 10.] If the management plan recommends removal of ACM, it must take into consideration whether the material is historic and the cost to replace it with visually similar materials. If the ACM is, for example, historic plaster crown molding, then the cost to carefully remove samples so that replicas can be made and/or cast from the original must be factored into the project cost. Historic ACM of this nature should only be removed if its condition is so poor that repair and encapsulation are not feasible.

EQ Prerequisite 4 — Polychlorinated Biphenyl (PCB) Removal (Required)

Intent — Reduce the potential exposure of building occupants to PCBs and PCB combustion by products in case of fire in the building.

Requirements —

- Have in place a PCB management program.
- Identify the applicable regulatory requirements.
- Have a current survey that identifies where PCBs are located in the building and on the site so that the PCBs present can be addressed appropriately in the ongoing PCB management program.

Sustainable design and development overview

The intent of EQ Prerequisite 4 is to reduce or eliminate the variety of adverse health effects from PCBs that have been documented in animals and humans. These include serious effects on the immune, reproductive, nervous, and endocrine systems in animals, and potential cancer-causing effects in humans.

Historic preservation overview

PCBs were first discovered and synthesized in the late 19th century, with industrial manufacture starting in the late 1920s. Early use was limited to weapons casings, but the widespread availability of electricity introduced PCBs into buildings. In historic buildings that have not been recently renovated, PCBs are most likely to be found in electrical equipment, paints, plastic and rubber products, and hydraulic equipment. Building features that contain PCBs are not typically considered to be significant historic features in most buildings, so removing them does not usually impact other historic features. Sampling and testing to identify PCBs in a building can usually be done in inconspicuous locations with little or no impact on historic features. Examples where PCBs may be present in historic engineering sites include wind tunnels, motors and generators for historic testing facilities, and conveying equipment in historic warehouses and assembly plants.

Strategies

Survey the building and the site to identify PCBs. Common sources of PCBs in historic buildings include fluorescent light ballasts manufactured from roughly 1929 – 1978, the transformers in neon signs, old building transformers and capacitors used for the startup of large motors (used

commonly with water pumps for large air conditioning systems or lift stations). Other sources of PCB-containing materials in historic buildings (that may contain unreasonable risk concentrations of 50 ppm or greater) include: building and window caulking prior to 1977, some ceiling tiles, floor tile mastics, cloth and paper insulation material, coal-tar enamel coatings, fiberglass insulation, fire-retardant coatings, foam insulation, grout, insulating materials in electric cable, plastics and plasticizers, processed cork materials, ventilation system and window gasket material, roofing and siding materials, paint (including marine paint), and thermal insulation used around piping. [SOI Standards: 6.] Any materials testing performed during the survey process must be done in discreet locations, with a requirement to repair or restore the test site after removal.

Document that any PCB-containing materials identified in the building or on the site (that test at 50 ppm or greater) have been removed and disposed of appropriately, or are being managed properly under a PCB management program. [SOI Standards: 6.] All historically significant materials removed must be replaced with material that is compatible in appearance and not chemically reactive with the environment or other building materials.

Review the PCB management program and prepare a detailed description of each item that explains how the program will address PCBs remaining in the building and on the site, and identifies the applicable regulatory requirements. [SOI Standards: None, although the program must contain provisions for placement of test locations and repair/restoration after removal.]

Update the PCB survey with current information through additional sampling and testing, if necessary. If a survey identifies any new locations with PCBs, add these to the management plan. [SOI Standards: None, although the program must contain provisions for placement of test locations and repair/restoration after removal.]

EQ Credit 1 — Outdoor Air Delivery Monitoring (1 Point)

Intent — Provide capacity for ventilation system monitoring to help sustain long-term occupant comfort and well being.

Requirements — Install permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain minimum ventilation rates.

Option A. For mechanical ventilation systems that predominantly serve densely occupied spaces (spaces with a design occupant density greater than or equal to 25 people per 1,000 square feet (40 square feet per person)), do the following:

- Provide a CO2 sensor or sampling location for each densely occupied space, and compare with outdoor ambient CO2 concentrations.
- Test and calibrate CO2 sensors to have an accuracy of no less than 75 ppm or 5% of the reading, whichever is greater. Sensors must be tested and calibrated at least once every five years or per manufacturer's recommendation.
- Monitor CO2 sensors by a system capable of and configured to trend CO2, concentrations on no more than 30-minute intervals.
- Configure system capability to generate an alarm visible to a system operator and, if desired, to building occupants if the CO2 concentration in any zone rises more than 15% above that corresponding to the minimum outdoor air rate required by ASHRAE Standard 62 (see IEQ Prerequisite 1).
- CO2 sensors may be used for demand-controlled ventilation provided the control strategy complies with ASHRAE Standard 62 (see IEQ Prerequisite 1), including maintaining the area-based component of the design ventilation rate.

Option B. For all other mechanical ventilation systems:

- An outdoor airflow measurement device must be provided that is capable of measuring (and, if necessary, controlling) the minimum outdoor airflow rate at all expected system operating conditions within 15% of the design minimum outdoor air rate.
- The outdoor airflow measurement device shall be monitored by a control system capable of and configured to trend outdoor airflow on no more than 15-minute intervals for a period of no less than six months.
- The control system shall be capable and configured to generate an alarm visible to the system operator if the minimum outdoor air rate falls more than 15% below the design minimum rate.

Option C. For natural ventilation systems, provide the following:

- CO2 sensors located in the breathing zone of every densely populated room.
- CO2 sensors located in the breathing zone of every natural ventilation zone.
- CO2 sensor(s) located outdoors.
- CO2 sensors shall provide an audible or visual alarm to the occupants in the space and building management if CO2 conditions are greater than 530 parts per million above outdoor CO2 levels or 1,000 parts per million absolute. The alarm signal should indicate that ventilation adjustments (i.e., opening windows) are required in the affected space.
- Operable windows areas must meet the requirements of ASHRAE 62.1-2004, section 5.1.

Sustainable design and development overview

A permanent air monitoring system will require equipment and installation expenditures for existing buildings. The expenditures may be offset, however, by reduced sick leave usage and improved employee productivity. Air monitoring provides the evidence that the work performed under EQ Prerequisite 1.0 is functioning properly.

Historic preservation overview

The placement of permanent air monitoring devices may impact historic features. New equipment must be installed inconspicuously and integrated into the historic fabric if feasible.

Strategies

Install a CO_2 monitoring system. [SOI Standards: 2, 9, 10.] Sensors are typically located in corridors, such as those outside bedrooms. Care must be taken in selecting the units and carefully placing them so they do not detract from historic features. Avoid haphazard placement of multiple new devices such as monitors, thermostats, and lighting controls.

If possible, place the CO_2 monitoring sensor in a common return air duct. [SOI Standards: None.]

Make existing windows operable and restore previously blocked historic windows to meet ASHRAE 62.1-2004, Section 5.1 (2004). Section 5.1, *Natural Ventilation*, describes the acceptable methods to provide ventilation by natural means. Natural ventilation may be provided via operable windows, louvers, or vents that communicate directly with the outdoors. Control of the natural ventilation must be available to the building occupants. [SOI Standards: 5, 9.] Replacement windows should be of compatible style, materials, and level of craftsmanship as the historic windows.

EQ Credit 2 — Increased Ventilation (1 Point)

Intent — Provide additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well being and productivity.

Requirements —

Option A. For Mechanically Ventilated Spaces:

- Increase outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum required by ASHRAE 62.1-2004

Option B. For Naturally Ventilated Spaces:

- Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the "Good Practice Guide 237: Natural ventilation in non-domestic buildings" (1998). Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 2.8 of CIBSE Applications Manual 10: 2005, "Natural ventilation in non-domestic building."

OR

- Use a macroscopic, multi-zone, analytic model to predict that room-by-room airflows will effectively naturally ventilate at least 90% of occupied spaces.

Sustainable design and development overview

Improving ventilation system design to take advantage of regional climate characteristics can help to reduce energy loads. Installations located in less temperate climates will not greatly benefit from EQ Credit 2 when ambient temperatures fall beyond the bounds of thermal comfort. The intent of this credit is to go above and beyond the minimum ventilation required under EQ Prerequisite 1.

Historic preservation overview

Modification of an existing system could impact historic building features if original system components such as grilles, air handlers, chillers, cooling towers, or ductwork were poorly sited. Increasing the ventilation rate by 30% will generally require increased equipment size, which could impact both interior and exterior historic features. However, an HVAC system replacement presents the opportunity to correct the problem of equipment or grilles visible from prominent elevations or impacting historic landscape features.

As noted previously, most historic buildings were not designed with air conditioning. Instead, they used passive building features to facilitate ventilation and include operable windows, screens, louvered doors, high ceilings, operable interior transoms and wall vents (Figure 5.5), and ceiling fans. Restoring the functionality of such historic features can help in obtaining EQ Credit 2.

Figure 5.5. Slatted wall vents facilitate airflow between interior spaces (ERDC-CERL).

Strategies

See EQ Prerequisite 1 for a list of strategies to introduce outside air into a building and their potential impacts on historic buildings. Increasing the level of outside air ventilation involves using more of these strategies, or implementing some of them more widely.

EQ Credit 3 — Construction IAQ Management Plan (1 Point)

Intent — Prevent indoor air quality problems resulting from any construction/renovation projects in order to help sustain the comfort and well being of construction workers and building occupants.

Requirements — Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and occupancy phases of the building as follows:

- During construction, meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings Under Construction, 1995, Chapter 3.
- Protect stored on-site or installed absorptive material from moisture damage.
- If air handlers must be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill, as determined by ASHRAE 52.2-1999.
- Replace all filtration media immediately prior to occupancy.
- Remove contaminants that may be remaining at the end of the construction period.
- Conduct a minimum two-week building flush out with new filtration media with 100% outside air after construction ends and prior to occupancy of the affected space. After the flush out, replace the filtration media with new media, except for filters solely processing air.

OR

- After construction ends conduct a baseline indoor air quality testing procedure for the affected space in the building that demonstrates that the concentration levels for the chemical air contaminants are below specified levels. For each sampling point where the maximum concentration limits are exceeded conduct a partial building flush-out, for a minimum of two weeks, then retest the specific parameter(s) that were exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met.

Chemical Contaminate	Maximum Concentration
Formaldehyde	0.05 parts per million
Particulates (PM10)	20 micrograms/m^3 above outside air conditions
Total Volatile Organic Compounds (TVOC)	500 micrograms/m^3
4-Phenylcyclohexene (4-PCH)	3 micrograms/m^3
Carbon Monoxide (CO)	9 parts per million

The air sample testing shall be conducted as follows:

- Air samples collected for every 25,000 square feet, or for each contiguous floor area, whichever is greater.
- Measurements conducted with the building ventilation system starting at normal daily start time and operated at the minimum outside airflow rate for the occupied mode throughout duration of the air testing.
- Building shall be fully finished and unoccupied. Furniture can be included in the testing if desired but it is not required.
- Test with time weight values of four hours with data logging.
- When re-testing non-complying building areas, take samples from the same locations as in first test.
- Copies of the IAQ testing results should describe the containment sampling and analytical methods, the locations and duration of containment samples, the field sampling log sheets and laboratory analytical data, and the methods and results utilized to determine that the ventilation system was started at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode through the duration of the air testing.

Sustainable design and development overview

Building renovation can generate airborne contaminants that migrate beyond the work areas, negatively affecting indoor air quality for the service life of the building. IAQ management strategies during construction can minimize the impact of such contamination.

Historic preservation overview

Construction management techniques related to IAQ typically do not affect historic properties.

Strategies

Implement a construction IAQ management plan to control contaminants during construction. [SOI Standards: None.] The plan should address the following items:

- Protection of HVAC equipment and air distribution systems from debris, moisture, and contaminants during construction.
- Controlling sources of contaminants.
- Housekeeping procedures and schedules.
- Sequencing of construction activities that are sources of contaminants.

Clean the building's air distribution systems (see Figure 5.3). [SOI Standards: None.]

Perform building IAQ testing. If the building fails the test, then perform a building flush out prior to occupancy. A flush out involves forcing large amounts of outdoor air through a recently completed building for a period of three to 90 days to remove construction-related pollutant emissions from building materials, finishes, and furnishings.* [SOI Standards: None.]

* The recommended minimum volume of outdoor air needed for flush out is the amount needed to ventilate the full building at least once each hour (1 ACH, or air change per hour), 24 hours a day, seven days a week. At a minimum, all mechanical ventilation systems should be set to provide the largest amount of outdoor air as practical from the final construction stages when floor products and paints are applied through the first few days of building occupancy.

EQ Credit 4.1 — Documenting Productivity Impacts: Absenteeism and Healthcare Cost Impacts (1 Point)

Intent — Document absenteeism, healthcare cost and productivity impacts of sustainable building performance improvements.

Requirements — Document the history of absenteeism and healthcare costs for building occupants for the previous five years (or length of building occupancy with a minimum of 12 months) and track changes in absenteeism and healthcare costs (claim costs must be provided and any reductions in premium costs should be provided if available) for building occupants over the performance period relative to sustainable building performance improvements.

Sustainable design and development overview

The intent of EQ Credit 4.1 is to document the known health benefits associated with green building design and operation in an effort to promote green building practices. The result of improved occupant health is increased productivity, better performance, and lower expenses related to health-related absences.

Section 5(a)(2) of the Occupational Safety and Health Act of 1970, often referred to as the General Duty Clause, requires employers to provide "employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." The General Duty Clause also requires employers to "comply with occupational safety and health standards promulgated under this Act" (OSHA Standards).

It may not be feasible for military installations to earn EQ Credit 4.1. The Privacy Act of 1974 prohibits DoD employers from disclosing personnel information, except with the prior written consent of the individual (Privacy Act 1974). Employees can also select and change health plans during open enrollment periods, making it difficult to establish a consistent benchmark for healthcare expenses.

Historic preservation overview

The work associated with EQ Credit 4.1 consists of documentation and analysis only, and would not impact historic property design or construction.

Strategies

Track medical absences and healthcare costs for building occupants to identify quantifiable positive impacts related to sustainable performance improvements to building Indoor Air Quality and operations. [SOI Standards: None.]

Work with the organization's human resource department and health insurance provider to get verifiable statistics that factor in national increases in healthcare costs. [SOI Standards: None.]

EQ Credit 4.2 — Documenting Productivity Impacts: Other Impacts (1 Point)

Intent — Documentation of the other productivity impacts (beyond those identified in IEQ Credit 4.1) of sustainable building performance requirements.

Requirements — Document the other productivity impacts (beyond those identified in IEQ Credit 4.1) of sustainable building performance improvements for building occupants. Address and track changes in the impact on the amount of work done and errors made or other productivity impacts for the building occupants over the performance period relative to sustainable building performance improvements. This documentation needs to be provided for the previous five years (or length of the building occupancy with a minimum of 12 months).

Sustainable design and development overview

The intent of the credit is to challenge building owners, managers, and consultants to devise valid quantitative measures of building occupant performance impacts in buildings. DoD could feasibly track turnover but is not likely to have resources to track other indicators. Some work tasks may lend themselves better to record keeping, such as at hospitals, schools, assembly plants, shops, and places where repetitive work is done, such as data entry.

Historic preservation overview

The work associated with this credit consists of documentation and analysis only and will not impact building design or construction.

Strategies

Set up a system to track productivity impacts over the performance period for one or more buildings and compare the productivity performance with the LEED-EB ratings levels achieved for the building or buildings in the studies. Examples of items to track include amount of work done, errors made, volume produced, and employee turnover. [SOI Standards: None.]

EQ Credit 5.1 — Indoor Chemical and Pollutant Source Control: Non-Cleaning System – Reduce Particulates in Air Distribution (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous particle contaminants, which adversely impact air quality, health, building finishes, building systems and the environment.

Requirements — Have filters with particle removal effectiveness MERV 13 or greater in place over the performance period for all outside air intakes and for the re-circulation of inside air. Establish and follow a regular schedule for maintenance and replacement of these filters.

Sustainable design and development overview

The intent of EQ Credit 5.1 is to encourage the use of air filtration that reduces the exposure of building occupants to airborne contaminants such as lint, dirt, carpet fibers, dust particles, dust mites, mold, bacteria, pollen and animal dander.

Commitment to aggressive maintenance of filters may be difficult on military installations where maintenance funds are stretched across hundreds of facilities. In some buildings, concerned occupants perform filter changes themselves. Filter maintenance can and should be part of the ongoing commissioning process described in EA Prerequisite 1.

Historic preservation overview

This credit focuses on selecting the type of air filter and its frequency of replacement, so it will generally not impact historic building design or construction. However, where strategies include the use of oversized filtration components, negative impacts are possible as noted below.

Strategies

Install and maintain filters with a particle removal effectiveness of Minimum Efficiency Rating Value (MERV) 13 or greater for all outside air intakes and indoor recirculation filters. [SOI Standards: 2, 6, 9, 10.] The higher the MERV rating, the more dense the filter. With 16 possible ratings, a MERV 13 filter is at the higher end of the density scale. Denser filters require more energy to circulate air through the HVAC system. In addition, systems that use a higher-rated filter often employ lower-rated prefiltration elements to hold down the cost of replacing the higher-rated filters. A prefiltration system often adds 24 in. to the air handler length. That extra length could impact historic building features by obscuring historic exteriors, or requiring construction to enlarge a utility room into ad-

jacent historic spaces. Table 5.1 shows ASHRAE MERV values and their typical applications.

Table 5.1. ASHRAE MERV values (ANSI/ASHRAE 52.2-1999).

Group Number	MERV Rating	Arrestance	Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
1	MERV 1 MERV 2 MERV 3 MERV 4	<65% 65—70% 70—75% 75—80%	>10 Microns Part. Size Pollen Spanish moss Dust mites Sanding dust Textile fibers Carpet fibers	Minimum filtration residential Window air conditioners	**Throwaway** Disposal fiberglass or synthetic panel filters **Washable** Aluminum mesh, latex coated animal hair, or foam rubber panel filters
2	MERV 5 MERV 6 MERV 7 MERV 8	80—85% 85—90% >90% >90%	3 -10 Microns Part. Size Mold Spores Hair spray Dusting aids	Better residential Commercial buildings Industrial workplaces	**Pleated Filters** Disposable, extended surface **Cartridge Filters** Pocket filters or panel filters **Throwaway** Disposable synthetic media panel filters
3	MERV 9 MERV10 MERV11 MERV12	>95% >95% >95% >95%	1 -3 Microns Part. Size Legionella Humidifier Dust Leed dust Auto emissions Nebulizer drops	Superior residential Better commercial buildings Hospital laboratories	**Bag Filters** Flexible microfine fiberglass or synthetic media **Box Filters** Rigid style cartridge filters
4	MERV13 MERV14 MERV15 MERV16	>98% >98% n/a n/a	0.3-1 Microns Part. Size All bacteria Most tobacco smoke Cooking oil Most smoke Insecticide dust Most face powder	Hospital inpatient care General surgery Smoking lounges Superior commercial buildings	**Bag Filters** Flexible microfine fiberglass or synthetic media **Box Filters** Rigid style cartridge filters

Based on the information provided by the filter manufacturer, establish and follow a regular schedule for filter maintenance and replacement. Higher-quality filters may not need to be changed as often as lower-quality ones. [SOI Standards: None.]

EQ Credit 5.2 — Isolation of High-Volume Copying/Print Rooms/Fax Stations (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants, which adversely impact air quality, building finishes, building systems and the environment.

Requirements — Have in place over the performance period structural deck-to-deck partitions with separate outside exhausting, no air re-circulation and negative pressure to contain and isolate high volume copying/print rooms/fax stations. High volume means any copy machine, print or fax station with a monthly copy usage of more than 40,000 pages. This credit can also be earned by putting all copiers, printers, and fax machines exceeding a lower monthly capacity or usage threshold (selected by the building owner) in isolated separately ventilated rooms.

Sustainable design and development overview

The intent of the credit is to limit building occupant exposure to volatile organic compounds (VOCs), ozone, dust and other particles that can affect occupant well-being and worker productivity. VOCs are a principal component in atmospheric reactions that form ozone and other photochemical oxidants. The term VOC is defined in federal rules as a chemical that participates in forming ozone (Minnesota Pollution Control Agency 1997).

Historic preservation overview

This credit can be earned by constructing a new separate room (or repurposing an existing one) with an independent exhaust system for high-volume equipment. In historic buildings, this room should be located so that the exhaust system does not result in new penetrations or grilles on primary exterior elevations; or in lowered ceilings along perimeter walls with high windows. In addition to lowered ceilings affecting historic interiors, construction of a separate room could also result in new or relocated walls that could impact the building's historic layout and details such as millwork.

Strategies

Contain and isolate air from high-volume photocopy areas, print rooms, and fax stations. [SOI Standards: 2, 6, 9, 10.] Air containment renovations can create additional penetrations, ductwork, intakes, and registers that can impact historic interior and exterior features.

Calculate the benefits of creating a dedicated, separately vented print and copy room based on the volume of copies produced and the cost of renovation work and implement if the results support a dedicated room. [SOI

Standards: 2, 6, 9, 10.] Construction of a dedicated room can create the need to reconfigure historic plan layouts, including walls or partitions that impact historic interior features.

Develop a plan to minimize use of convenience printers and copiers with service agreements for larger jobs to facilities that are better equipped to properly handle high-volume copying and printing. [SOI Standards: None.]

EQ Credit 6.1 – Controllability of Systems: Lighting (1 Point)

Intent — Provide a high level of lighting control by individual occupants or specific groups in multi-occupant spaces (e.g., classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements — Provide lighting controls, for at least 50% of building occupants, enabling adjustments to suit individual task needs and preferences, or those of a group sharing a multi-occupant space or workgroup area.

Sustainable design and development overview

The intent of EQ Credit 6.1 is to improve the quality of space through localized control of lighting systems. Many buildings were designed with no occupant-accessible controls for overhead lighting, resulting in occupant discomfort. Providing individual lighting controls can improve the comfort and productivity of building occupants. A growing trend in military buildings is to install motion-detection sensors to control lighting in infrequently used spaces such as washrooms and copy rooms. Most buildings, however, do not have both furniture systems with individual task lighting and overall room lighting. Renovation projects need to address both task and ambient lighting to earn this credit. Note that specialty lighting controls (e.g., dimmers, additional switches, and individual task lighting at workstations) add cost to a project.

Historic preservation overview

Providing the recommended lighting control may impact historic building features, but this may be avoided if new switches, fixtures, and receptacles can be located away from historic features and millwork.

EQ Credit 6.1 also can be achieved by restoring the functionality and operability of historic windows and openings so occupants can supplement or substitute electric lighting with daylighting.

Strategies

Provide a system that allows occupants to control both ambient and task lighting for either preference or a specific task. [SOI Standards: 2, 6, 9, 10.] The impact of multiple new switches, gauges, controls, panels and outlets must be considered with respect to design, location, and integration into the historic fabric. Controls include:

- Simple switches, ideally with dimming capability.

- Individual workstation controls for built-in or plugged-in task lighting.
- Multi-level lighting controls for ambient lighting.

Provide individual or integrated control systems for lighting in individual rooms and/or work areas. [SOI Standards: 2, 6, 9, 10.]

Educate building occupants about individual control of their office space lighting controls and responsibilities, (e.g., turning off task lights as they leave for the day). [SOI Standards: 2, 7, 9, 10.] If using signage for communication, ensure that these items are secured in such a way that no permanent damage is done to the building when they are removed.

EQ Credit 6.2 — Controllability of Systems: Temperature and Ventilation (1 Point)

Intent — Provide a high level of temperature and ventilation control by individual occupants or specific groups in multi-occupant spaces (e.g., classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements — Provide individual temperature and ventilation controls, for at least 50% of building occupants, enabling adjustments to suit individual task needs and preferences, or those of a group sharing a multi-occupant space or workgroup area. Operable windows may be used in lieu of individual controls for occupants in spaces near the windows (20 feet inside of and 10 feet to either side of the operable part of the window), and where the operable windows meet the requirements of ASHRAE 62.1-2004 paragraph 5.1.

Sustainable design and development overview

The intent of EQ Credit 6.2 is to save energy through localized control of heating and air-conditioning systems to eliminate unnecessary space conditioning in areas that are not continuously occupied. Many buildings were designed as sealed environments with no occupant-usable controls, often resulting in occupant discomfort due to temperature or humidity. Allowing occupants to control their individual spaces may lead to higher productivity.

Currently, many DoD installations secure temperature controls in a central location and install inoperable windows to prevent occupants from defeating the controls. This credit may soon no longer be readily achievable by DoD if ventilation system controls are fully automated for purposes of antiterrorism standards compliance.

Historic preservation overview

Projects that involve retaining and restoring operable historic windows and openings reutilize the exterior building envelope as it was originally designed. They support occupant controllability by allowing individuals to control temperature and ventilation in their areas by simply opening and closing windows rather than using HVAC controls. Historic buildings typically do not have extensive floor and ceiling plenums, so using under-floor HVAC systems can be problematic if ceiling height and historic moldings will be affected. Similarly, overhead systems will be exposed or concealed with a dropped ceiling, either of which option can affect interior features such as tall windows, crown molding, and ceiling details.

Strategies

Evaluate how to provide localized and individual occupant temperature and ventilation controls. Consider environmental control capabilities already present in the building, such as operable windows that may require installing a control interface with the building's existing HVAC system and air distribution systems. [SOI Standards: 2, 6, 9, 10.] As with any series of controls, care must be taken to design and locate them to integrate well with interior historic features. Raised floor and overhead systems can adversely impact interior features such as base and crown molding and the overall historic character of a room. Control interfaces can be installed so that the system recognizes when exterior conditions (temperature and humidity) are ideal for natural ventilation, and either automatically opens windows or informs occupants to open windows.

Consider improvements that can be added over the course of future building upgrades such as operable replacement windows, systems furniture, or HVAC distribution systems with individualized diffusers. [SOI Standards: 2, 6, 9, 10.]

Educate building occupants about individual control of their office space environment. A monitoring system can be implemented to maintain proper system operation, and signage can help to remind occupants of their building responsibilities (e.g., turning down the thermostat at night and closing windows). [SOI Standards: 2, 7, 9, 10.] If using signage for communication, ensure that these items are secured in such a way that no permanent damage is done to the building when they are removed.

EQ Credit 7.1 — Thermal Comfort: Compliance (1 Point)

Intent — Provide a comfortable thermal environment that supports the productivity and well being of building occupants.

Requirements — Comply with ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy.

Sustainable design and development overview

Proper incorporation of existing design features with modern systems controls in existing buildings can provide optimal thermal conditions and building operation, which increases occupant productivity and reduces illness-related absences. ANSI/ASHRAE 55-2004 provides thermal condition guidelines that should provide comfort for 80% of the building occupants.

Historic preservation overview

Setting HVAC system operating parameters for thermal comfort (e.g., air temperature, radiant heat exchange, air velocity, and humidity) typically does not affect historic building features. However, the installation of a new system into a historic building requires special attention to ensure that ceiling heights, significant interior features, and exterior elevations are not significantly compromised.

Several features of historic buildings can contribute to achieving ANSI/ASHRAE 55-2004 standards and reduce the air conditioning and dehumidification load. Exterior examples include deep eaves and overhangs (Figure 5.6), awnings, porches, and other building envelope features that reduce solar heat gain during warmer months. Interior features such as high ceilings, ceiling fans, and space configurations that facilitate natural convection can also contribute to thermal comfort and humidity control, and reduce the dependence on cooling equipment. In addition to individual features, some historic masonry buildings can exploit the principle of thermal mass to reduce heating costs. By using their building mass (i.e., heavy, thick masonry walls), they can retain solar heat gain during the day and radiate it into occupied spaced at night. In addition, site orientations that seasonally optimize solar gains and wind effects also can significantly contribute to achieving thermal comfort standards in historic buildings.

Figure 5.6. Deep, bracketed eaves and brise-soleils can reduce solar heat gain (ERDC-CERL).

Strategies

Determine compliance of the HVAC systems with ANSI/ASHRAE 55-2004. Maximize the use of all passive sustainable historic property features. [SOI Standards: None.]

Establish the parameters and conditions used to determine compliance. [SOI Standards: None.]

Survey occupants to determine satisfaction with comfort levels. [SOI Standards: None.]

Implement a plan for corrective action if more than 20% of the building occupants are dissatisfied. [SOI Standards: 2, 6, 9, 10.] Corrective actions can include a range of testing, maintenance and upgrade activities covered under EA Prerequisite 1, EA Credit 3.2, EQ Prerequisite 1, and EQ Credit 6.2.

EQ Credit 7.2 – Thermal Comfort: Permanent Monitoring System (1 Point)

Intent — Provide a comfortable thermal environment that supports the productivity and well being of building occupants.

Requirements — Provide a permanent monitoring system to ensure building performance to the desired comfort criteria as determined by IEQ Credit 7.1, Thermal Comfort: Compliance.

Sustainable design and development overview

Thermal comfort monitoring will provide feedback to building engineers and managers necessary for proper adjustments to be made to maintain occupant comfort. Although the DoD can achieve EQ Credit 7.2 for monitoring, it may be difficult to achieve related EQ Credit 6.2 on temperature controls that allow users to correct deficiencies noted in the monitoring system. Many DoD installations centralize temperature control systems specifically to prevent users from changing them.

Historic preservation overview

Although monitoring does not affect historic buildings, the installation of permanent wall-mounted devices must be carefully designed and integrated into the historic fabric to avoid adverse impacts.

Strategies

Provide documentation of thermal comfort that includes (1) comfort criteria and (2) a process for corrective action. [SOI Standards: None.]

Provide a permanent monitoring system to indicate when temperatures are out of range of the design comfort criteria. [SOI Standards: 2, 6, 9, 10.] Consider the use of direct digital control systems and locate them in mechanical or secondary rooms. Avoid placing them in significant interior spaces that are more likely to have historic features and finishes that may be negatively impacted by such installations. Any exterior monitors, such as those tied to operable window notification, should also be concealed to avoid affecting historic views.

EQ Credit 8.1 and 8.2 — Daylight and Views: Daylight (1 – 2 Points)

Intent — Provide a connection between indoor spaces and the outdoor environment through introduction of daylight and views into the occupied areas of the building

Requirements — Achieve a minimum Daylight Factor of 2% (excluding all direct sun penetrations) in space occupied for critical visual tasks, not including copy rooms, storage areas, mechanical, laundry and other low-occupancy support areas. Exceptions include those spaces where tasks would be hindered by the use of daylight or where accomplishing the specific tasks within a space would be enhanced by the direct penetration of sunlight. Provide glare control for all windows where direct penetration of sunlight would interfere with normal occupant activities.

Achievement of a 2% daylight factor in:

- EQ Credit 8.1: 50% of all spaces occupied for critical visual tasks (1 point).
- EQ Credit 8.2: 75% of all spaces occupied for critical visual tasks (1 point).

Sustainable design and development overview

The intent EQ Credits 8.1 and 8.2 is to conserve energy costs for buildings by providing natural solar lighting (i.e., daylighting) and to reduce space-cooling loads by minimizing the amount of heat generated by lights. Studies have demonstrated that productivity increases for building occupants working in daylit areas (Boyce et al. 2003).

Historic preservation overview

Many historic military buildings were constructed before the widespread use of electricity, and were designed to maximize the use of available natural daylight in all building areas. These buildings use large exterior windows, skylights, clerestories, and a plan configured to include light wells and courtyards. Comparable historic interior features include glass doors, interior windows, sidelights, and transoms that allow light to penetrate deep into the building. Restoring such historic building features to their original working condition can often satisfy this credit. Some buildings may also have been sited to take maximum advantage of solar orientation, such as placing windows on the south in cool climates and on the north in warm climates, south-facing clerestories, and an east-west orientation. It is desirable to retain or restore these historic features and attributes.

Many historic military buildings were constructed with an abundance of tall windows along exterior walls to maximize daylighting. However, military buildings originally designed for high security or volatile contents have minimal fenestration. Depending on a building's original function, major renovations that can impact historic features may be necessary to provide natural daylight to as many occupants as possible. For this reason,

it is important to align building use and occupancy with an accommodating building configuration that minimizes the need for major alterations.

If the original floor plan consisted of small rooms along the perimeter, providing daylighting past these rooms may require demolition of partition walls to make larger rooms for use by multiple people. Many historic buildings were designed with light wells that have been covered up in subsequent renovations. Light wells could be restored to assist in bringing daylight to interior rooms. Wall demolition may not be desirable if there are historic moldings, finishes, or if the walls are integral to the original floor plan. Conversely, partitioning large historic rooms into smaller offices can not only reduce access to daylighting but also obstruct historic details, such as continuous ceiling or wall features.

On many military installations, administrative offices have been placed in buildings not originally designed for that purpose, such as warehouses or workshops. If the original building did not have extensive windows, adding windows would adversely impact the exterior elevations. High-security facilities that typically require windows to be blocked may be a more suitable use for such a building.

Note that some highly significant interiors should not be exposed to daylighting to prevent fading and damage to artwork and finishes. Such interiors may not allow for achieving these credits, although UV-blocking glass or historically compatible window treatments may be an option.

DoD antiterrorism standards may require the replacement of historic windows with blast resistant units of similar configuration and aesthetics. Ensure that window profiles and glazed areas of these specialty windows are compatible with the historic design. Use such window replacement projects to reverse previous inappropriate window replacements.

Strategies

Consider retaining and repairing historic wood windows over replacing with new units. Retaining historic wood windows can be more cost effective than new replacement units. Historic wood windows consist of multiple simple parts that can be replaced or replicated as needed. With regular painting, historic wood windows may last 75 years. Thermal insulation can be added with a simple, removable interior storm sash of compatible aesthetics. Typical replacement windows are usually double-paned; they re-

quire more material to manufacture and reduce vision glazing (i.e., transparent glazing). The gasket between panes lasts about 15 years and is not easily repaired, resulting in another round of replacement costs. [SOI Standards: 2, 5, 6, 9, 10.]

Restore original window openings enclosed by previous renovations. Future rehabilitation projects can be designed so that as many original window openings as feasible are restored, bringing more daylighting to the occupants. [SOI Standards: 2, 5, 6, 9, 10.] The challenge in this situation is to acquire new windows that match remaining historic ones, or to install all new windows that are compatible with the building's historic character.

Ensure that trees and shrubs do not block windows. [SOI Standards: 2, 8.] Do not remove historic landscape features, such as mature trees, unless they are damaging the historic fabric. When considering plantings, take into account the mature size of the landscape in the climate zone; some plants described as a certain size will grow larger than average in warm climates.

Carefully consider the removal of exterior features such as awnings and canopies. [SOI Standards: 2, 4, 6.] Those features may have been original to the building or later additions that have achieved significance in their own right. They may also have been placed on specific elevations to reduce solar heat gain prior to the widespread use of air conditioning. Removal will result in holes that need to be repaired in a manner appropriate to the historic material, and not just filled with caulk.

Incorporate reflective interior color schemes, direct sun beam penetration, and integration with the electric lighting systems as part of the overall daylighting strategy. [SOI Standards: 2.] Original dark color schemes that contribute to a historic feature should be retained, however.

Consider incorporating photo-responsive controls for electric lighting to maintain consistent light levels. These controls result in energy savings by reducing electric lighting in high daylight conditions while preserving foot-candle levels on the task surface. [SOI Standards: 2, 9, 10.] Adding controls for existing historic light fixtures may result in switches/panels on the wall, which should be designed to be compatible with the historic character of the space and be reversible. Sensors added to the fixture itself must be discreet and easily reversed.

Implement renovation strategies to provide access to daylight from the outdoors in a glare-free way that will not affect historic exteriors, such as employing interior vision panels and low partitions. [SOI Standards: 2, 9, 10.] New construction in historic spaces should be compatible in design and easily reversible.

Use window treatments that are consistent in appearance so historic exterior facades retain a historic appearance. [SOI Standards: 2, 9, 10.] Window treatments should be consistent with the historic period of the building (such as horizontal blinds versus vertical ones, as appropriate) (Figure 5.7).

Figure 5.7. WWII-era blinds (left) and 1950s jalousie windows (right) allow users to control daylight levels and views (ERDC-CERL).

Do not use exterior sunshades on primary historic elevations or interior light shelves (i.e., passive architectural devices that reflect daylight deep into interior space) where they can be seen from outside a primary historic elevation or if they impact historic interior features. These techniques would be best employed on west-facing or southern-facing rear elevations and on non-contributing buildings in historic districts. [SOI Standards: 2, 9, 10.] New construction of this nature, even if placed on a less conspicuous elevation, must be visually compatible and be easily removable.

When partitioning large spaces into smaller ones, use low, removable partitions to allow both light and the feel of the historic space to remain. Another option is to construct the top portion of the new partition walls with glass, allowing historic ceiling features to be continually visible and to share daylighting. [SOI Standards: 2, 6, 9, 10.]

Add skylights on flat or low-slope roofs to bring daylight to interior spaces without impact on historic building elevations. [SOI Standards: 2, 6, 9, 10.] Consider impacts to historic interiors caused by the addition of ceiling apertures and to ambient lighting quality.

Use existing interior courtyards and light wells according to their original intent rather than infilling them for other uses. If necessary to enclose such exterior spaces, use glazed roofing applications that allow the infiltration of abundant daylighting. [SOI Standards: 2, 6, 9, 10.]

When replacing windows, use units that duplicate historic sightlines. Avoid window framing materials and extrusions that require more material to meet code and thus reduce glazing area per unit. [SOI Standards: 2, 5, 9, 10.]

EQ Credit 8.3 and 8.4 — Daylight and Views: Views (1-2 Points)

Intent — Provide a connection between indoor spaces and the outdoor environment through introduction of daylight and views into the occupied areas of the building.

Requirements — Develop and adopt a space churn renovation plan and policy that specifies the goal of achieving direct line of sight to vision glazing for building occupants from 90% of all regularly occupied spaces (not including copy rooms, storage areas, mechanical, laundry and other low-occupancy support areas.)

- EQ Credit 8.3: Achieve direct line of sight to vision glazing for building occupants from 45% of regularly occupied spaces (1 point).
- EQ Credit 8.4: Achieve direct line of sight to vision glazing for building occupants from 90% of regularly occupied spaces (1 point).

Regularly occupied spaces are considered as having access to views if they provide direct line of sight to vision glazing, where horizontal view angles to the vision glazing are not less than 10 degrees (must include partition base and glazing frame if appropriate). Vision glazing is vertical windows between 2'6" and 7'6" above the floor. Views to vision glazing may be direct or through interior windows.

Sustainable design and development overview

The intent of EQ Credits 8.3 and 8.4 is to increase occupant well-being and productivity by providing a direct line of sight to vision glazing, such as that provided in windows. A secondary benefit of increased vision glazing is an increase in daylighting and corresponding decrease in need for electrical lighting. If these windows are also operable, then a third benefit is the use of ventilation to reduce summer energy consumption.

Several studies (e.g., Baird and Bell1995, Finnegan and Solomon 1981, and Ulrich 1984) have demonstrated that the presence of windows in the workplace can contribute to increased job satisfaction and higher productivity, both in terms of views and daylighting. Another benefit is the increased value of tenant space that has vision glazing over those that do not. A list of studies has been included at the end of this chapter.

Historic preservation overview

Many historic buildings incorporate large exterior windows, skylights, and a plan configured to include light wells and courtyards. Historic interior features that often allow for direct line of sight to vision glazing include, glass doors, interior windows, and sidelights that allow light to penetrate deep into the building. Restoring these existing building features to their original condition often results in increased views for building occupants. Similarly, providing windows and doors with vision glazing can support a historic rehabilitation project where glazed window and door openings

had been previously blocked, or poorly designed replacement units had been installed.

Renovating the interior of a historic building to ensure that occupants have views of a window can have adverse impacts on historic features as some existing walls may be historic or include historic details.

Strategies

Determine if direct line of sight to the outdoors is feasible and appropriate for the building. Cases where this many not be feasible include low occupancy use (warehouse, laundry, etc.) high-security use, or a building that historically had few or no windows. [SOI Standards: None.]

If direct line of sight is feasible, develop and implement a space renovation plan and policy that specifies the goal of achieving direct line of sight to vision glazing from 45 – 90% of all regularly occupied spaces within the building. [SOI Standards: None, but the plan must consider the impact of recommended activities on historic features.] Specific actions could include:

- Rearrange partitions, walls, and furnishings to maximize access to views from occupant workspaces. [SOI Standards: 2, 6, 9, 10.] Moving or removing interior walls could impact the historic configuration of the building. If the walls affected are modern additions, care must be taken to make sure that the remaining historic fabric is properly repaired and restored.
- Evaluate the feasibility of restoring blocked windows to the building envelope during renovation projects. Size, spacing, glazing, energy efficiency, and views are all factors that should be given consideration during the renovation design. [SOI Standards: 2, 5, 6, 9, 10.] Restored windows should match original windows scheduled to remain. If all windows are to be replaced, the new units should be similar to the originals in configuration, architectural profile, and sightlines.

EQ Credit 9 – Contemporary IAQ Practice (1 Point)

Intent — Enhance IAQ performance by optimizing practices to prevent the development of indoor air quality problems in buildings, correcting indoor air quality problems when they occur, and maintaining the well being of the occupants.

Requirements — Develop and implement on an ongoing basis an IAQ management program for buildings based on the EPA document "Building Air Quality: A Guide for Building Owners and Facility Managers, " EPA Reference Number 402-F-91-102, December 1991, which is available on the EPA Web site, www.epa.gov/iaq/largebldgs/graphics/iaq.pdf.

Sustainable design and development overview

The intent of EQ Credit 9 is to promote superior IAQ and reduce the need for ventilation flush-outs and other IAQ strategies that may require additional energy use and be detrimental to the environment. Contaminant reduction in the indoor environment can also reduce illness-related absences and improve productivity. This credit is related to other LEED-EB prerequisites and credits, including:

- SS Credit 1: Plan for Green Site and Building Exterior Management
- EA Prerequisite 1: Existing Building Commissioning
- EA Prerequisite 2 and Credit 1: Energy Performance
- MR Credit 3: Optimize Use of IAQ Compliant Products
- MR Credit 4: Sustainable Cleaning Products and Materials
- EQ Prerequisite 1: Outside Air Introduction and Exhaust Systems
- EQ Prerequisite 2: Environmental Tobacco Smoke Control
- EQ Credit 1: Outdoor Air Delivery Monitoring
- EQ Credit 2: Increased Ventilation
- EQ Credit 3: Construction IAQ Management Plan
- EQ Credit 5: Indoor Chemical and Pollutant Source Control
- EQ Credit 6: Controllability of Systems
- EQ Credit 10: Green Cleaning

Historic preservation overview

For this credit, the impact on historic building features does not surface until corrective actions are actually taken. Actions that involve moving HVAC equipment have the potential to adversely impact historic building features if poorly placed. If existing equipment is to be moved or new equipment installed. Take advantage of equipment location as a means to correct previous problems of poor placement on prominent elevations.

Strategies

Survey the building and its occupants and evaluate systems to identify potential IAQ problems and their solutions. [SOI Standards: None, but any identified solutions should take historic features into account.]

Determine compliance of the HVAC systems with ASHRAE 55-2004, *Thermal Environment Conditions for Human Occupancy*. The intent of the standard is to specify the combination of thermal environmental factors and personal factors that will produce thermal environmental conditions that are acceptable to at least 80% of the occupants in the space. Thermal factors include temperature, humidity, direct sunlight, cold surfaces, air drafts, and other factors. Personal Factors include clothing type and activity level of the occupant. [SOI Standards: None.]

Establish the parameters and conditions used to determine compliance. [SOI Standards: None.]

Operate a program to enhance and maintain IAQ performance in the building over the performance period. The plan should take into consideration the other LEED-EB prerequisites and credits listed above. [SOI Standards: see individual sections cited.]

Include in the program a plan for preventing moisture accumulation and mold in the building. [SOI Standards: 2, 6, 7.] Steps may include conducting a moisture test to determine the source of moisture, increasing ventilation to reduce humidity, repairing leaks, and ensuring that masonry and plaster are still in a breathable condition.

Implement a plan for corrective action if more than 20% of the building occupants are dissatisfied. [SOI Standards: 2, 6, 7, 9, 10.] Actions may include removal and replacement of mold-damaged interior and exterior features and alterations to the HVAC system.

EQ Credit 10.1 — Green Cleaning: Entryway Systems (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological and particle contaminants, which adversely impact air quality, health, building finishes, and the environment.

Requirements — Utilize over the performance period entryway systems (grills, grates, mats etc.) to reduce the amount of dirt, dust, pollen and other particles entering the building at all entryways, and develop the associated cleaning strategies to maintain those entryway systems, as well as the exterior walkways.

Sustainable design and development overview

The intent of EQ Credit 10.1 is to address the consequences of dust and dirt tracked into buildings at exterior entryways, which may account for up to 80% of such contamination. Cleaner indoor air will result from reducing these contaminants. It has been demonstrated that cleaner indoor air improves worker productivity.

Historic preservation overview

Recommended measures primarily involve the selection and maintenance of entry mats, which typically would not impact historic building features, unless they are recessed into the floor. Entry mats can often migrate around the floor, which tempts building managers to find some method to adhere them to the floor. Care should be taken to make sure that any attachment method is temporary and does not damage historic finishes.

Some historic buildings were designed with metal grates built into entryways that allow dirt and soil to drop into a cleanable floor recess. Also, some historic sites feature boot scrapes outside the entry doors of their historic buildings. Such historic features should be retained and utilized.

Strategies

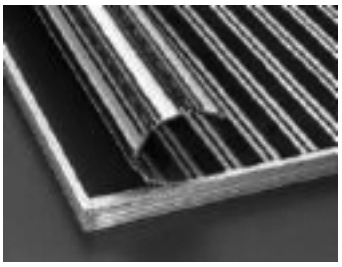

Figure 5.8. Example roll-up entryway mat (Cartwheel Factory).

Equip all building entrances with interior entryway systems (grilles, grates, mats, etc.) to catch and hold dirt particles and to prevent further contamination of the building interior (Figure 5.8). [SOI Standards: 2, 3, 9, 10.] Do not construct new recessed entryway systems on historic floors. Use surface applications such as mats, but do not use adhesives to secure them to the floor, as adhesives can leave permanent

marks that are impossible to remove chemically or physically.

Use entryway systems outside entry doors to reduce dust and pollution that can be brought indoors. Since these systems (e.g., mats) may not be part of the historic site design, if used, they should be as unobtrusive as possible. [SOI Standards: 2, 3, 9, 10.]

Verify that matting systems being installed are appropriate to the climate and properly fire-rated per governing codes and regulations. [SOI Standards: None.]

Size matting systems such that each foot hits the mat two times (approximately 12 feet in length) for optimum performance. The length can also be achieved by using multiple smaller mats if a single mat cannot fit the existing entry space. [SOI Standards: None, as long as there is no construction work and surface applications do not use adhesives.]

Provide mats with an electrostatic propensity value of 2.5 kV or less that are constructed with recycled content and rubber backings. [SOI Standards: None, as long as they are not installed using adhesives.]

Clean exterior outside walkways leading toward the facility, entryways, and matting regularly, especially in inclement weather (Ashkin et al. 2000, 70). [SOI Standards: None.] Wash walkways with a high-pressure hose, preferably with rainwater instead of potable water, at least four times annually to reduce buildup of sediment that can be brought inside the building (USAF, Landscape Design Guide, “Maintenance” 1998, 3.4).

Develop, document, and record maintenance practices that keep entryway grates and mats clean. The cleaning plan should include strategies for both indoor and outdoor maintenance of entryways as well as temporary replacement and drying strategies. Specifications and frequency for cleaning entryways can be a specific line item on custodial contracts. Alternately, building managers can send in work orders for entryway cleaning on a regular basis, which will provide documentation. [SOI Standards: None.]

EQ Credit 10.2 – Green Cleaning: Isolation of Janitorial Closets (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological and particle contaminants, which adversely impact air quality, health, building finishes, building systems, and the environment.

Requirements — Have in place over the performance period structural deck-to-deck partitions with separate outside exhausting, no air re-circulation and negative pressure in all janitorial closets. Provide hot and cold water and drains plumbed for appropriate disposal of liquid waste in areas where janitorial equipment and chemicals are stored and/or water and cleaning chemical concentrate mixing occurs.

Sustainable design and development overview

The intent of EQ Credit 10.2 is to protect building occupants from exposure to hazardous substances that are commonly stored and mixed in janitorial closets.

Historic preservation overview

If an isolated janitorial closet is already part of a historic building, it should be retained and used for janitorial supplies and activities. Otherwise, this credit can be earned by constructing a new, separate janitorial room with an independent exhaust system. In historic buildings, this room should be located so that the exhaust system does not require penetrations or grilles on primary exterior elevations or in lowered ceilings along perimeter walls with high windows. Designers must avoid unsympathetic floor plans that adversely impact the historic configuration of the building, or result in new walls impacting historic interior features.

Strategies

Physically isolate activities associated with janitorial chemical storage and use by using structural deck-to-deck partitions with separate outside exhausting, no air recirculation, and negative pressurization of all janitorial closets over the performance period. [SOI Standards: 2, 6, 9, 10.] Modifications such as ductwork, vent pipes, and plumbing chases must be carefully designed and detailed so they do not affect historic building features such as moldings/millwork, historic plan configuration and ceiling heights.

Provide hot and cold water and drains plumbed for appropriate disposal to sanitary sewer lines of liquid waste in areas where staff mixes water and

cleaning chemical concentrate. (If dilution equipment is installed, institute appropriate measures to prevent backflow of chemicals into potable water lines.) [SOI Standards: 2, 6, 9, 10.] The adding of plumbing lines may require demolition work that affects historic features.

Implement policies, procedures, and mixing systems that minimize exposure of cleaning staff to concentrated cleaning chemicals. [SOI Standards: None.]

Establish O&M training programs on chemical usage and storage for building occupants and custodial staff. [SOI Standards 2, 7, 9, 10.] Any signage must be secured so that no permanent damage is done to the building when they are removed.

EQ Credit 10.3 — Green Cleaning: Low Environmental Impact Cleaning Policy (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants, which adversely impact air quality, health, building finishes, building systems, and the environment.

Requirements — Have in place over the performance period a low-impact environmental cleaning policy addressing:

- Sustainable cleaning systems.
- Use of sustainable cleaning products.
- Use of chemical concentrates and appropriate dilution systems.
- Proper training of maintenance personnel in the hazards, use, maintenance, and disposal of cleaning chemicals, dispensing equipment and packaging.
- Use of hand soaps that do not contain antimicrobial agents (other than as a preservative system), except where required by health codes and other regulations (i.e., food service and healthcare requirements).
- Use of cleaning equipment that reduces impacts on IAQ.

Sustainable design and development overview

The intent of EQ Credit 10.3 is to reduce use of cleaning agents that contain VOCs, which diminish air quality; and phosphates and nitrates, which harm water bodies and their wildlife. Common green cleaning supplies include reusable cloths, low-acid products, chlorine-free products, and ammonia-free products.

Historic preservation overview

With a few possible exceptions, the use of cleaning products that meet the Green Seal GS-37 standard will be too strong for most fragile historic building materials and details (e.g., wallpaper, cloth, and early painted finishes). The recommendation is to use natural products or extreme dilutions instead.

Strategies

Effectively manage a green cleaning program:

- Develop a low-impact cleaning policy based on the efficient use of chemicals and supplies that will meet hygiene and appearance goals while protecting building occupants, systems, and finishes from toxins and contaminants. [SOI Standards: Refer to MR Credits 4.1, 4.2, and 4.3 for strategies and recommended procedures and products that will

not normally harm historic materials or finishes.] Applicable cleaning methods should be included in custodial contracts, as appropriate.

- Educate and train janitorial service personnel in the use, maintenance, and proper disposal of cleaning chemicals, dispensing equipment, and packaging. Green disposal requirements should also be part of custodial contracts. [SOI Standards 2, 7, 9, 10.] Training signage must avoid permanent damage to historic surfaces.
- Log and detail all housekeeping chemicals used or stored on the premises, and include the manufacturer's MSDSs and technical bulletins as attachments. [SOI Standards: None.]

Use green cleaning practices. [SOI Standards: 7.] Harsh cleaning methods that are unsuitable for historic materials should not be used.

- Provide more frequent and intensive cleaning in building entryways, washrooms, and food preparation and dining areas.
- Consider cleaning more frequently with low-impact methods versus using harsher chemicals at longer intervals. For example, dust eventually bonds to metals and becomes very difficult to remove. Frequent dusting, which does not impact historic features, helps to avoid the use of metal cleaners, which clean by removing metal oxide deposits (thus degrading historic metallic surfaces).

Use green cleaning products and fixtures. [SOI Standards: None, unless noted otherwise.]

- Use high-efficiency micro-fiber cleaning cloths instead of disposable towels.
- If disposable cleaning products are used, make sure they are biodegradable.
- If paper products are used, provide dispensers that hold two rolls. Single roll dispensers encourage janitorial staff to replace rolls before they are completely depleted, in order to prevent the partial roll from running out before the next scheduled maintenance visit. Double roll dispensers allow janitorial staff to replace only the roll that is empty. [SOI Standards: 2, 9, 10.] Dual roll dispensers are larger than single roll dispensers, and should not be used if fitting the larger dispenser means damaging historic building fabric.
- Use coreless rolls of paper products where practicable.

- Consider using recycled and chlorine-free janitorial paper products (e.g., toilet tissue and paper towels).
- Consider replacing manual dispensers with ones that are hands-free, such as air drying machines instead of paper towels and automatic hand washing soap dispensers. Hands-free dispensers have the added benefit of avoiding cross contamination. The electrical needs of dispenser are fairly modest — a 110 volt circuit per manufacturer. Multiple products from the same manufacturer can be run off the same circuit. [SOI Standards: 6.] The removal of obsolete dispensers can result in damage to historic materials such as marble bathroom walls that must be properly repaired.
- Change to using recycled content plastic or trashcan liners made from renewable materials. Eliminate liners where practicable.

Avoid toxic cleaning solutions. [SOI Standards: 7, unless noted otherwise.] Harsh chemicals unsuitable for historic materials should not be used.

- Avoid cleaners with ethylenediaminetetraacetic acid (EDTA) or nitrilotriacetic acid (NTA). Instead choose cleaners with sodium citrate, sodium bicarbonate, sodium carbonate, or sodium silicate components. Look for ingredients containing terms such as lauryl, amides, and glycosides. Choose products with a phosphate concentration of 0.5% by weight or less and with a VOC concentration no more than 10% of the weight of the product (when diluted for use as directed). Avoid products containing chlorine bleach or sodium hypochlorite. Avoid ingredients derived from petroleum or which contain nonyl phenol ethoxylates, glycol ethers, sodium hydroxide, potassium hydroxide, sodium metasilicate, phosphates. Choose surfactants derived from vegetable oil and look for d-limonene and pine oil solvents (Greenseal 1998).
- Products should have a neutral pH, be concentrated and be able to work in cold water (Greenseal 1998). Steps should be taken to reduce exposure to the concentrate by personnel, either from off-gassing or direct contact.
- Use floor-coating products that are zinc-free. Testing should first be conducted to ensure that a coating product is acceptable for historic materials.
- Choose cleaning products packaged in recycled containers with recyclable high density polyethylene (HDPE) or polyethylene terephthalate (PET) plastics, and which are shipped in recyclable and refillable containers (Greenseal 1998).

- Avoid products that have dyes and fragrances, which are often the cause skin irritation (Ashkin et al. 2000, 84).
- If a toxic material must be utilized, use sparingly and follow proper procedure for disposal.
- Use cleaners that are nontoxic to aquatic life. [SOI Standards: None.]

EQ Credit 10.4 and 10.5 — Green Cleaning: Low Impact Environmental Pest Management Policy (2 Points)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants, which adversely impact air quality, health, building finishes, building systems, and the environment.

Requirements — Develop, implement and maintain a low environmental impact integrated indoor pest management policy. Any cleaning products included in the integrated pest management policy must meet the requirements identified in MR Credit 4.1-4.3.

Sustainable design and development overview

The intent of EQ Credits 10.4 and 10.5 is to carefully select and reduce the need for toxic pesticides that can be particularly harmful to small children, the elderly, and the environment. DoD mandates on pest management can be found in DoD Instruction 4150.7 (DoD Pest Management Program) and Defense Logistics Agency (DLA) Instruction 4145.31 (Integrated Stored Products Pest Management).

Historic preservation overview

One method of reducing pests is to eliminate habitat in the immediate area of the building. These may include plantings and structures that are part of a historic landscape. A complete reworking of landscape features such as raised beds, sunken gardens, and terraces may not be possible in order to maintain the historic setting of the building. Even partial reworking can involve disturbing historic site/landscape features and buried archeological sites.

Strategies

Pest managers should look at the total picture. Identify the insect, disease, or growing condition that may be causing the problem; monitor the situation; and act appropriately (Figure 5.9). If pests are identified inside the building, use least toxic removal alternatives first. While not desirable in buildings, note that only 3 – 5% of insects are harmful and that most species have natural predators such as other insects, birds, bats, or toads that keep them in check (EPA Mid-Atlantic Region Green Landscaping website).

Figure 5.9. Groundhog or gopher hole damage at Wright-Patterson AFB, OH (Hardlines).

Develop an integrated pest management (IPM) program that has low environmental impact such as environmentally friendly recommendations for eliminating various building pests. [SOI Standards: None.] An IPM is already mandated by DoD and individual agency regulations, but should be amended to incorporate environmentally friendly methods.

Organic control methods include:

- Control weeds with shovels, hoes, spades, or by hand. Implement weed control during the most appropriate times of the year for a species and geographical region to maximize effectiveness (Mendler and Odell 2000, 62-64). [SOI Standards: None.]
- Control invasive plants.
- Along forest edges with turf, mow under the canopy of the outer most trees to eliminate pest plant habitat (Ashkin et al. 2000, 17). Avoid detrimental impacts to tree trunks. [SOI Standards: 2, if trunk damage causes the loss of character-defining trees on a historic site.]
- Design and reconstruct landscape features to eliminate safe havens for pests and rodents, maintaining plants and shrubs at least 18 in. from the building and filling the space with small stones or gravel. If the landscape design, but not the actual plants, is historic, then the plantings can be changed to ones that are less likely to harbor pests due to density, aroma, etc. In addition, Antiterrorism mandates may require the elimination of landscape features like trees and dense shrubs close

to a building. [SOI Standards: 2, 6, 8.] Any ground-disturbing activities can impact historic property features and buried archaeological deposits, and therefore require proper site restoration.

Mechanical control methods include:

- Seal cracks and crevices, and periodically inspect the seals around doors and windows.
- Install barriers to keep pests from entering the building (e.g., bird spikes, chimney caps, and soffit screens). [SOI Standards: 2, 6, 7, 9, 10.] Screens placed on historically clear openings should be inconspicuous and removable. Pigeon eradication can be very difficult because bird spikes, electric shocks, and noise machines are only temporarily effective. Pigeons eventually find a way around the barrier (dropping materials on spikes, using pigeon carcasses as a base, and adjusting to noise). Historic building managers have even resorted to using a nesting pair of falcons, which keep the live pigeon population down but result in pigeon carcasses that can lodge in gutters and fall to the ground. The most successful pigeon management strategy involves changing pigeon behavior by eliminating access into openings and *random* noise or water generators.

Biological control methods include the following (Mendler and Odell 2000, 62 – 64). [SOI Standards: None.]

- Know pest biology and habits. For example, mice typically have a range of 10 – 30 ft, fit through ¼ in. gaps in walls and baseboards, drop 40 to 100 fecal pellets and 3,000 urine droplets per day, produce up to 60 young per year, and will chew on wires.
- Reduce sources of food and water for pests in buildings and on the grounds. Educate staff to dispose of food and crumbs, and clean up food spills.
- Create favorable environments for natural predator insects.
- Apply natural pesticides like pyrethrum or organic hot foam.
- Use pheromones, snap traps, live traps or glue boards instead of poisons. Poisons are dangerous to humans and the contaminated pest carcass can become food for other vermin.
- Apply pest controls during the most effective times of day or year based on pest behavior and biology.
- Use pest-specific deterrents (Table 5.2):

Table 5.2. Most effective deterrents by pest type.

Pest	Deterrent
Rabbits	Hot pepper spray
Deer	Organic repellent spray
Mice/rats	Peppermint oil, spearmint oil repellent, or digital pest repellers
Bats	Humane traps or electronic ultrasonic and sonic sound wave devices
Raccoons/squirrels	Hot pepper spray, traps, garlic oil based repellents
Voles/moles	Non-chemical repellant spray
Groundhogs/muskrats	Humane traps or vibrasonic, supersonic devices
Snakes	Organic snake repellent

Chemical control methods (if necessary) include the following. [SOI Standards: None.]

- When use of pesticides is necessary, use the least toxic pesticides and notify building occupants at least 72 hours in advance so high-risk or sensitive individuals may make other work arrangements.
- Do not schedule routine pesticide applications; apply only when pests are present.
- Look for labels with caution, not danger or warning, labels. Caution labels are chemicals that should are dangerous to humans mainly in larger quantities.
- Avoid nerve toxins, carcinogens, developmental or reproductive toxins, endocrine disruptors, prohibited inerts on EPA's *List 1 of Inert Ingredients of Toxilogical Concern*, pelleted rodenticides, concentrated formulations, groundwater contaminants, and non-target effects.
- Ensure the safe handling, storage, and transport of pesticides and other chemicals according to manufacturer's instructions, and keep them under lock and key (UFGS-01355A 2005, 26). Pets and small children are especially susceptible to chemical poisoning.
- Make sure that all prime movers used for fogging, misting, dusting, and ultra-low volume application have enclosed cabs and internal recycling air-conditioners to protect the operator from excessive pesticide exposure (USAF AFI 32-1053, Pest Management Program 1999, 11).
- Provide appropriate protective gear for anyone handling chemical applications.
- Do not apply pesticides when rain is expected soon afterward.

EQ Credit 10.6 — Green Cleaning: Low Environmental Impact Cleaning Equipment Policy (1 Point)

Intent — Reduce exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants, which adversely impact air quality, health, building finishes, building systems, and the environment.

Requirements — Implement a policy for the use of janitorial equipment that maximizes effective reduction of building contaminants with minimum environmental impact.

- Vacuum cleaners meet the requirements of the Carpet & Rug Institute's (CRIs) "Green Label" Testing Program – Vacuum Cleaner Criteria and are capable of capturing 96% of particulates 0.3 microns in size and operate with a sound level less than 70dBA.
- Hot water extraction equipment for deep cleaning carpets is capable of removing sufficient moisture such that carpets can dry in less than 24 hours.
- Powered maintenance equipment including floor buffers, burnishers, and automatic scrubbers is equipped with vacuums, guards and/or other devices for capturing fine particulates, and shall operate with a sound level less than 70 dBA.
- Propane-powered floor equipment has high efficiency, low emissions engines.
- Automated scrubbing machines are equipped with variable-speed feed pumps to optimize the use of cleaning fluids.
- Battery-powered equipment is equipped with environmentally preferable gel batteries.
- Where appropriate, active micro fiber technology is used to reduce cleaning chemical consumption and prolong life of disposable scrubbing pads.
- Equipment has rubber bumpers to reduce potential damage to building surfaces.
- A log will be kept for all powered housekeeping equipment to document the date of equipment purchase and all repair and maintenance activities and include vendor cut sheets for each type of equipment in use in the logbook.

Sustainable design and development overview

The intent of EQ Credit 10.6 is to minimize waste production, energy use, and harmful impacts to IEQ (e.g., noise pollution and indoor air degradation) through the careful purchase and use of janitorial equipment.

Historic preservation overview

The work associated with EQ Credit 10.6 consists of the selection and use of some janitorial equipment and techniques that could impact historic building construction. Poorly selected or maintained cleaning equipment can impact historic building features. For example, hot water extraction equipment for deep cleaning historic carpets is not recommended. Also, the use of powered maintenance equipment, including floor buffers, burnishers, and automatic scrubbing machines, may also damage historic finishes. Alternative methods of cleaning are recommended below and under MR Credits 4.1, 4.2, and 4.3. If power equipment must be used for purposes of practicality in large buildings, then other issues must be considered. The weight of heavy equipment such as buffers, especially at contact

points, must take into account the bearing capability of historic floor materials. The size of this equipment must also not be too large to maneuver around corners and door openings. Bumper guards must be maintained so equipment does not dent, scratch, or break historic features. Cleaning equipment must also be checked for fluid leaks that could stain historic materials.

Strategies

Establish a policy for the use of janitorial equipment that most effectively reduces contaminants, and has minimal environmental impact and injury risks to equipment users. Typically avoid the use of powered equipment when maintaining historic floors and finishes, although upright vacuums are generally acceptable for cleaning historic carpets if a beater brush is not used. [SOI Standards: 6, 7.] The policy must cover equipment type, storage, and maintenance. Maintenance equipment should not be stored where it can mark or stain historic building materials.

Evaluate the equipment that is currently in use, and make a plan to upgrade equipment when replacements are necessary or financially feasible. [SOI Standards: 6, 7.] Ensure that replacement equipment is not too large or too heavy for the building, and that appropriate specifications are included in custodial contracts. Larger or heavier cleaning equipment is often preferred by users because it covers more square footage with each pass or allows users to ride the equipment rather than push it.

Develop a maintenance plan that addresses where equipment is stored when not in use, preventing deterioration of protective guards, and preventing cleaning fluid or mechanical fluid leaks. [SOI Standards: 6, 7.]

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EQ-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) covering indoor environmental quality are listed in Table 5.3 below:

Table 5.3. UFGS sections relevant to EQ prerequisites and credits.

EQ Prerequisite or Credit	UFGS Section	Section Title
Prerequisite 3 and 4	01150	Special project procedures
Prerequisite 3	13208A	Asbestos hazard control activities
Credit 2	01575N	Temporary environmental controls
Credit 2	01576	Temporary environmental controls (GTMO)
Credit 8.1 and 8.2	08510	Steel windows
Credit 8.1 and 8.2	08550	Wood windows
Credit 8.1 and 8.2	08581	Blast resistant tempered glass windows
Credit 8.1 and 8.2	08590	Wood windows — repair and rehabilitation
Credit 8.1 and 8.2	08600	Skylights
Prerequisite 3	13281N	Engineering control of asbestos containing materials
Prerequisite 4	13284	Removal & disposal of PCBs
Prerequisite 4	13286	Handling of lighting ballasts & lamps containing PCBs
Credit 10.2	15400	Plumbing, general purpose
Prerequisite 2	15720N	Air handling units
Prerequisite 1 and 2; Credit 1, 2, 5.1, 5.2, 7.1, 7.2, 9 and 10.2	15895	Air supply, distribution, ventilation & exhaust systems
Credit 7.1, 7.2 and 9	15901N	Space temperature control systems
Credit 6.2	15902S	Electric & electronic control system for HVAC
Credit 6.2	15910N	Direct digital control systems
Credit 6.2	15915S	Electric control system for HVAC
Prerequisite 1	15940A	Overhead vehicle tailpipe (and welding fume) exhaust removal
Prerequisite 1; Credit 1, 7.1, 7.2 and 9	15950N	HVAC testing/adjusting & balancing
Prerequisite 1; Credit 1, 7.1, 7.2 and 9	15950S	Testing, adjusting & balancing
Credit 6.2	15951	Direct digital control for HVAC & other local

EQ Prerequisite or Credit	UFGS Section	Section Title
		building systems
Credit 6.2	15951N	Testing industrial ventilation systems
Prerequisite 1; Credit 1	15995A	Commissioning of HVAC systems
Credit 6.1	16510	Interior lighting
Credit 6.1	16512	High intensity discharge (HID) luminaires
Credit 6.1	16513S	Incandescent lighting

Additional EQ resources

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6 Innovation in Upgrades, Operations and Maintenance (IUOM)

The intent of Innovations in Upgrades, Operations and Maintenance (IUOM) is to provide building operation and upgrade teams with the opportunity to be awarded points for additional environmental benefits achieved beyond those already addressed by LEED-EB. Requirements for innovations typically include providing documentation of each proposed innovation credit, including a description of the achievement, the additional environmental benefits delivered, and the performance metrics used to document the additional environmental benefits delivered over the performance period. The following IUOM credits are suggested (not required) credits. Building operation and upgrade teams may propose the following or other innovations for additional points. Applicable policy mandates, guidelines, benefits, performance requirements, and documentation will vary by proposed innovation.

IUOM Credit 1 — Stormwater Design: Water Quality (1 Point)

Intent—Limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements—Implement a stormwater management plan that promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs):

- BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports.
- BMPs are considered to meet these criteria if (1) they are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards, or (2) there exists in-field performance monitoring data demonstrating compliance with the criteria.
- Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

Sustainable design and development overview

Water quality is an important consideration, both for onsite water that flows above or below grade, and for any subsequent downstream impacts. Water quality has been significantly degraded by nitrogen and phosphorous loads from agriculture and lawn care chemicals. In addition, industrial pollution from PCBs, mercury, and lead has created water quality problems for humans and wildlife. IUOM Credit 1 is based on water quality aspects of LEED-NC SS Credit 6.2, *Stormwater Design: Quality Control*, because this sustainability issue is important for existing sites, not just new construction.

Historic preservation overview

Above-grade solutions for polluted runoff must be carefully considered and integrated into the design of historic sites to avoid negative impacts to historic character and integrity. Associated signage must also be located with care. Installation of below-grade filtration solutions must avoid affecting archeological sites.

Strategies

Isolate and plan for areas with pollutant runoff, including paving at gas stations, car washes, dumpster pads, and other point sources of concentrated pollutants so they do not add to downstream pollution (Thompson and Sorvig 2000, 175). [SOI Standards: None.]

Inspect, maintain, and restore existing aquatic buffers to reduce water pollutants and to preserve stream quality and habitat (EPA, Post-

Construction Storm Water Management in New Development & Redevelopment 2005, 8-1). Aquatic buffers are vegetated zones adjacent to streams and wetlands that are used to reduce nitrogen levels in groundwater and streams. [SOI Standards: None.]

Install runoff filtering systems. [SOI Standards: 1, 2, 3, 7, 9, 10.] The following methods can minimize impacts to historic sites.

- Dechlorinate water from treated water reserves such as pools and fountains before discharging or infiltrating. High concentrations of chlorine are toxic to wildlife and fish, and dioxin, a byproduct of the manufacturing of chlorine, causes cancer in humans (EPA, National Pollutant Discharge Elimination System 2005). Dechlorinators are chemical additives that reduce chlorine agents, so historic preservation impacts are unlikely.
- Make sure filter backwash drains to the sewer system and not into the street. Backwash water has a heavy concentration of chlorine and other chemicals (City of Oceanside).
- Install small stormwater treatment systems below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain (UFC 3-210-10, 3). Since these systems are small, below grade, and implemented on previously disturbed sites, historic preservation impacts are minimal.

Control dumping by implementing an illegal dumping control plan. Use educational outreach, signs, and waste control orders to discourage diaper disposal and encourage pet waste collection where applicable (EPA, Pollution Prevention/Good Housekeeping for Municipal Operations). [SOI Standards: 2, 9, 10.] New signage should be sensitively designed and discreetly placed so as to not degrade historic views.

Label storm drain inlets. Knowledge of where pavement runoff goes can decrease public dumping of pollutants onto pavement and into drains (Thompson and Sorvig 2000, 175). [SOI Standards: 2, 9, 10.] The labels should be subtle to avoid interfering with the historic character of the site.

Discourage gulls, pigeons, and other wildlife from roosting near water bodies to reduce fecal contamination. For birds, use grape-flavored sprays and harassment devices that emit bursts of light and sound as deterrents. [SOI Standards: None.]

Limit land disturbance activities, such as clearing, grading, and cut-and-fill, to reduce erosion and sediment pollution from stormwater (EPA, Polluted Runoff, Nonpoint Source Pollution 2005). A majority of such erosion occurs during rainfall when soil is disturbed or exposed. [SOI Standards: None.] Limiting land disturbance preserves historic landforms and benefits historic preservation efforts.

IUOM Credit 2 — Additional Toxic Material Source Reduction (1 Point)

Intent—Exceed the requirements for MR Prerequisite 2. Establish and maintain a toxic material source reduction program to reduce the amount of mercury in and brought into buildings.

Requirements—Document existing materials that contain mercury and implement a program to eliminate them.

Sustainable design and development overview

In addition to light bulbs, other materials found in historic buildings that may contain mercury include electro-mechanical thermostats, pilot light sensors, gauges containing silver-colored liquid, switches and relays, batteries, lamp ballasts, silent light switches, and paint (latex manufactured before 1990 and some oil base-paints). The objective of IUOM Credit 2 is to further reduce toxic material beyond that contained in fluorescent tubes.

Historic preservation overview

Recommended measures primarily involve evaluation of purchasing and disposal methods to reduce waste, which typically would not impact historic building features. However, some historic fixtures and devices may pose special problems as noted below.

Strategies

Document items in addition to light bulbs that may contain mercury and develop a plan to replace them with modern equivalents that do not contain toxic materials. [SOI Standards: None.]

Remove mercury-containing fixtures and devices and recycle them through an appropriate facility. Train maintenance personnel to properly handle mercury-containing products to avoid breakage or implosion. [SOI Standards: 2, 6.] Some historic industrial facilities (wind tunnels, testing labs, etc.) may contain historic electronics still in working order. Replacement of these mercury-containing switches and gauges for newer versions is not recommended for historic preservation reasons, but measures should be taken to ensure operator safety.

IUOM Credit 3 — Indoor Chemical and Pollutant Source Control, Non-Cleaning System: Reduce Common Hazardous Indoor Air Pollutants (1 Point)

Intent—Reduce exposure of building occupants and maintenance personnel to potentially hazardous indoor air pollutants, which adversely impact the air quality and health of building occupants. These air pollutants may include asbestos, radon, carbon monoxide, VOCs, formaldehyde, and organic gases.

Requirements—Have a building checklist prepared and a testing program in place that will aid in the identification of indoor chemical and pollutant sources within a building, as well as a mitigation plan to eliminate or reduce exposure to building occupants.

Sustainable design and development overview

The intent of IUOM Credit 3 is to encourage comprehensive identification of hazardous indoor air pollutants and eliminate the sources wherever possible, or mitigate their effects. Commitment to aggressive eliminating the sources of indoor air pollutants requires continual vigilance. These pollutants may not be perceptible but are deleterious to building occupants. This credit goes above and beyond the particulates requirements set forth in EQ Credit 5.1 by addressing hazardous pollutants.

Historic preservation overview

Work associated with IUOM Credit 3 may involve the elimination of any gasoline-powered equipment or devices, and the addition of vents in some instances. Work could also involve the elimination of historic finishes, such as asbestos floor tiles, that may need to be replicated using materials that are not hazardous to building occupants. This would typically be the extent of the impact on historic building design or construction.

Strategies

Utilizing a radon ventilation contractor, test and eliminate (by permanently caulking) any foundation wall or slab cracks where radon gases may be seeping into the structure and building to unacceptable levels. Install a radon ventilation system if necessary per testing data, and retest every 2 years to maintain system efficacy. This is especially important in the basements of older historic buildings located where radon is present. [SOI Standards: 2, 7.] Sealants must be carefully selected and applied to avoid detracting from the historic property. Before starting the work, planners must also consider the characteristics of wall materials and whether com-

prehensive sealing may be detrimental, as is the case with historic brick masonry that must breathe.

Eliminate or restrict the use of products containing VOCs, which can cause temporary health problems (headaches, dizziness, and nausea), potential long-term damage to the liver and central nervous system, and elevated cancer risks. These products include paints and lacquers, paint strippers, wood preservatives, aerosol sprays, some cleaners and disinfectants, pesticides (such as moth repellents), air fresheners, stored fuels, correction fluids, permanent markers, photographic solutions, hobby supplies, and dry-cleaning chemicals. [SOI Standards: None.]

Eliminate or restrict the use of products containing formaldehyde or made containing urea-formaldehyde (UF) resins. Common sources of formaldehyde include cabinetry or furniture made of medium density fiberboard or pressed-wood products and hardwood plywood paneling. UF resin was developed in the 1920s and became a popular plastic in the 1930s. Initial uses were for electrical fittings, telephone handsets, radio and other electrical housings, lampshades, and tableware (Plastics Historical Society). [SOI Standards: 2, 6, 9, 10.] First inventory and identify historic building features, including furnishings, to ensure that no historic items are eliminated. Then replace non-historic features with safer products. This work can benefit historic buildings by installing historically compatible replacements in place of inappropriate previous replacements that contain formaldehyde or UF.

Identify lead-based paint (LBP) on painted surfaces, and make plans to eliminate it in future renovation projects. Highest priority should be assigned to building types occupied by children, such as youth centers, day-care center, clinics, and family housing. Buildings constructed or painted before 1978 probably contain LBP, which may be concealed under several coats of modern paint. Painted surfaces in good condition are not considered a hazard. However, peeling, chipping, chalking, or cracking paint is a hazard and needs immediate attention. Lead in soil can be a hazard when children play in bare soil or when people bring soil into the house on their shoes. Areas in good condition that are subject to considerable wear can also pose a hazard, such as windows, doors, and frame components, stairway components, porches, and fences (EPA Lead 2006). [SOI Standards: 6, 7.] Paint sampling requires removing small pieces of paint for analysis, preferably from areas that are deteriorating, so it usually has no serious

impact on historic features. Abatement strategies, however, should be carefully evaluated. Lead dust can form when lead-based paint is dry scraped, dry sanded, or heated. Dust also forms when painted surfaces bump or rub together. Lead chips and dust can get on surfaces and objects that people touch. Settled lead dust can re-enter the air when people vacuum, sweep, or walk through it (EPA Lead 2006). As a result, abatement should be done with a “peel away” product that removes sections of paint in large pieces, typically adhered to the removal product. Several applications may be necessary to remove the earliest coats of paint. The sampling and abatement process is also an opportunity to determine the original historic paint color scheme by sending a paint core sample to a color laboratory. When painting historic soft-brick masonry, use a breathable paint with a minimum rating of 95 PERMS to prevent deterioration of the masonry.

IUOM Credit 4 — Additional Polychlorinated Biphenyl (PCB) Removal (1 Point)

Intent—Exceed the requirements for EQ Prerequisite 4. Reduce the potential exposure of building occupants to PCBs and PCB combustion byproducts in case of fire in the building.

Requirements—

- Establish a PCB management program for all building materials, not just light bulbs and electrical devices.
- Identify the applicable regulatory requirements.
- Maintain a current survey that identifies where PCBs are located in the building and on the site so that the PCBs present can be addressed appropriately in the ongoing PCB management program.

Sustainable design and development overview

The intent of IUOM Credit 4 is to reduce or eliminate the variety of adverse health effects from PCBs that have been documented in both animals and humans. These include serious health effects on the immune, reproductive, nervous, and endocrine systems in animals and additional potential carcinogenic effects in humans.

Historic preservation overview

In addition to light bulbs, PCBs can also be found in electrical equipment, paints, coatings, plastics, rubber products, and hydraulic equipment in historic engineering sites such as wind tunnels, motors and generators in historic testing facilities, and conveying equipment in historic warehouses and assembly plants.

Strategies

Survey the building and the site to identify any remaining PCBs. Common sources of PCBs in historic buildings include fluorescent light ballasts manufactured about 1929 – 1978, the transformers in neon signs, old building transformers, and capacitors used for the startup of large motors (used commonly with water pumps for large air conditioning systems or lift stations). Other sources of PCB-containing materials in historic buildings that may contain unreasonable risk concentrations of 50 ppm or greater, include caulking produced before 1977, some ceiling tiles, floor tile mastics, cloth and paper insulation material, coal tar enamel coatings, fiberglass insulation, fire-retardant coatings, foam insulation, grout, insulating materials in electric cable, plastics, plasticizers, processed cork materials, ventilation system and window gasket material, roofing, siding,

paint (including marine paint), and thermal insulation used around piping. [SOI Standards: None, although any testing involved during the survey process must be done in discreet locations, with provisions to repair/restore the areas after removal.]

Document that any PCB-containing materials in concentrations of 50 ppm or greater have been removed and disposed of appropriately, or are being managed properly under a PCB management program. [SOI Standards: 2, 6.] All materials removed must be replaced with material that is compatible in appearance and not chemically reactive with building materials. Historic machinery that is still in use should not be removed, but operational measures should be taken to ensure operator safety. Minor alterations to repair or replace PCB-containing parts may be undertaken as long as the historic character and function of the machinery is not compromised.

Review the PCB management program and prepare a detailed description of each item that explains how the program will address PCBs remaining in the building and on the site, and identifies the applicable regulatory requirements. [SOI Standards: None, although the program must contain provisions for discrete testing locations and repair/restoration after sample removal.]

Update the PCB survey with current information, including additional sampling and testing if necessary. If the survey identifies any new locations with PCBs, add these to the management plan. [SOI Standards: None, although the program must contain provisions for discrete testing locations and repair/restoration after sample removal.]

IUOM Credit 5 — Document Ergonomics Impacts: Absenteeism and Healthcare Cost Impacts (1 Point)

Intent—Document absenteeism, healthcare cost and productivity impacts of ergonomics program improvements.

Requirements—

- Document the history of absenteeism and healthcare costs for building occupants for the previous five years (or length of building occupancy with a minimum of 12 months). Claim costs must be provided.
- Track changes in absenteeism, worker injury, and healthcare costs for building occupants over the performance period relative to ergonomics related improvements. Claim costs must be provided and any reductions in premium costs should be provided if available.

Sustainable design and development overview

The intent IUOM Credit 5 is to document the known health benefits associated with ergonomics design in an effort to promote green building practices. The result of improved occupant health is increased productivity, better performance, and lower expenses associated with medical absences. This credit exceeds the scope of sustainable design and operation impacts targeted in EQ Credit 4.1 by addressing ergonomics.

Section 5(a)(1) of the Occupational Safety and Health Act, often referred to as the General Duty Clause, requires employers to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees". Section 5(a)(2) requires employers to "comply with occupational safety and health standards promulgated under this Act" (OSHA Standards).

DoD may find that it is not feasible to earn this credit. The Privacy Act of 1974 prohibits DoD employers from disclosing personnel information, except with the prior written consent of the individual (Privacy Act 1974). Employees can also select and change health plans during annual open enrollment periods, so it would be difficult to establish a baseline of healthcare costs.

Historic preservation overview

The work associated with this credit consists of documentation and analysis only and will not impact historic building design or construction.

Strategies

Establish programs or practices that will help to reduce the risk of ergonomic injuries or will produce other positive outcomes. [SOI Standards: None.]

Develop a workplace educational program that reviews and promotes proper workstation ergonomics including monitor, chair, and keyboard placement, regular stretching and movement, task alternating and sharing, scheduled breaks, and exercises in the workplace. [SOI Standards: None.]

Make use of OSHA cooperative programs that support outreach and assistance efforts. These programs include alliances, strategic partnerships, voluntary protection programs, and onsite consultation programs. [SOI Standards: None.]

Track absences and healthcare costs for building occupants to identify quantifiable positive impacts related to ergonomics education, work-related ergonomic improvements to employee jobs, and the ergonomic design of individual workstations. [SOI Standards: None.]

Work with the organization's human resource department and health insurance provider to get verifiable statistics that factor in national increases in healthcare costs. [SOI Standards: None.]

IUOM Credit 6 — Historic Building Feature Retention and Reuse (1 Point)

Intent—Extend the life cycle of existing historic building stock, conserve resources, reduce waste, and reduce environmental impacts of new construction as they relate to materials manufacturing and transport.

Requirements—Maintain at least 75% (based on surface area) of the building's original historic features, such as windows, doors, cornices, roof, wall material, trim, porches, stoops/porches, stairs. Maintain at least 75% (based on surface area) of the building's original interior historic features, such as millwork, casework, floor finishes, wall finishes, furnishings, window treatments, interior doors, hardware, lighting fixtures, plumbing fixtures, stairways, and wall configuration.

Sustainable design and development overview

The intent of IUOM Credit 6 is to promote the retention and rehabilitation of historic buildings and their features instead of gutting and replacing historic features with modern items. This credit is meant to offset other LEED-EB credits that promote use of new materials, such as those associated with eliminating hazardous materials (EA Credit 4, MR Credit 6, EQ Credit 5.1), using alternative materials (MR Credit 2.1-2.5 and MR Credit 3.1-3.2) and reducing energy consumption (WE Credit 2, WE Credit 3.1-3.2 and EA Credit 1).

Historic preservation overview

Work associated with retaining, repairing, or restoring historic building features directly supports all of the Secretary of the Interior's Standards for Rehabilitation. Generally, it is easier to meet the SOI Standards if the historic building has been properly maintained because historic features can usually be retained and reused with minimal repair. Buildings that have not been properly maintained tend to have features that are too deteriorated to reuse, and must be replaced.

If not used to achieve SS Credits 4.1 – 7, then retention of existing historic natural landscape features (e.g., water bodies, exposed rock, trees, and unvegetated ground) can be used to achieve IUOM Credit 6. Likewise, surviving historic manmade items such as trellises, paving, exterior light fixtures, dry wells, swales, and rainwater retention basins can be used to achieve this credit. In other words, IUOM Credit 6 awards a LEED point for preserving historically significant natural and designed property features.

LEED-New Construction (NC) MR Credits 1.1 – 1.3 award points for retaining structural features such as floors, walls, and roofs as well as non-structural components such as interior partitions, doors, floor coverings, and ceiling systems, all of which are calculated by area. Decorative features such as light fixtures, plasterwork, millwork, casework, do not contribute significantly to square footage in comparison with components such as walls and floors, but they are often key historic features that should be retained. This IUOM Credit 6 promotes the retention of decorative items that have been identified as contributing features to a historic building.

If not used to achieve EQ Credits 8.1 – 8.4, then retention or restoration of historic windows, skylights, clerestories, light wells, courtyards, glass doors, interior windows, sidelights, and transoms can be used to achieve this IUOM credit.

Strategies

Consult the installation's Integrated Cultural Resources Management Plan, historic preservation database, state historic inventory form, National Register nomination, and other sources of information to assist in identifying significant historic features that should be retained. If the information has not been collected or is incomplete, consider having a historic structures report completed. [SOI Standards: None.]

Assess the condition of the building and its historic features. [SOI Standards None, assuming nondestructive testing and sampling techniques are employed.]

Identify appropriate treatment for the identified historic features. [SOI Standards: 6.] These typically incorporate gentle and non-abrasive techniques. Verify methods with professionals at state and federal preservation offices, or consult with preservation or conservation professionals.

Incorporate the historic structures report or other preservation information into the design-build documents, architect/engineer contract, or construction bidding documents. [SOI Standards: None.]

IUOM Credit 7 — Additional Existing Building Commissioning (1 Point)

Intent—Verify that other building systems and assemblies not part of EA Prerequisite 1 are performing as intended to meet current needs and sustainability requirements.

Requirements—On a regularly scheduled basis, conduct infrared scans to locate deficiencies in the HVAC distribution system.

Sustainable design and development overview

Many problems associated with historic buildings are related to temperature differentials and moisture penetration. Temperature problems are often the result of several iterations of small HVAC repairs and upgrades, office partition placement that blocks airflow, and outdated HVAC equipment. Moisture problems are often the result of continuous leaks, rising dampness, and improper coatings on historic materials.

Historic preservation overview

Testing procedures for assessing temperature and moisture fluctuations is not invasive and does not impact historic resources. However, repair activities can result in new envelope penetrations, material treatments, and reconfiguration of visible HVAC components such as intakes, registers, and ductwork.

Strategies

Perform an infrared scan every 5 years to locate deficiencies in the HVAC distribution system, and address any problems identified. [SOI Standards: 2, 6, 9, 10.] Corrective actions may include changes to air intake locations or sizes; size or placement of ductwork; and size or location of interior registers. These items must be modified or designed to avoid negative impacts on historic features.

Conduct a moisture scan every 5 years to locate areas of excessive moisture penetration, and address any problems encountered. [SOI Standards: 2, 6, 7, 9, 10.] Corrective work may include repairing leaks and deteriorated materials, increasing ventilation to eliminate excess moisture buildup, and removing impermeable coatings that are causing masonry dampness problems.

IUOM Credit 8 — LEED Accredited Professional (1 Point)

Intent—To support and encourage the operation, upgrade, and project team integration required for LEED-EB implementation in buildings, and to streamline the application and certification process.

Requirements—At least one principal participant of the project team is a LEED Accredited Professional.

Sustainable design and development overview

The intent of IUOM Credit 8 is to ensure the participation of a LEED Accredited Professional on installation design teams.

Historic preservation overview

For any successful historic building renovation project, principal participants on the project design team should consist of architects, engineers, and preservation professionals with experience in applying the SOI Standards to the rehabilitation of historic buildings. Many DoD projects are solicited under design-build contracts or multi-discipline architect/engineer contracts. Design-build contracts often stress the contractor's ability to complete the project for a set budget rather than its historic preservation or sustainable design expertise. Similarly, many multi-discipline design contracts involve project team members with experience in constructing new buildings, not historic building rehabilitation.

Strategies

In the request for qualifications (RFQ) for either design-build contracts or A/E contracts, require that at least one principal is a LEED Accredited Professional. [SOI Standards: None.]

In the RFQ for either design-build contracts or A/E contracts, require that principals in each of the key disciplines has experience with historic buildings. The principals with historic building experience can also be LEED Accredited Professionals. [SOI Standards: None.]

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IUOM-related DoD guide specifications

Unified Facilities Guide Specifications (UFGS) related to the innovation credits above are listed in Table 6.1 below:

Table 6.1. UFGS sections relevant to IUOM credits.

IUOM Credit	UFGS Section	Section Title
Credit 3	01150	Special project procedures
Credit 1	01355A	Environmental protection
Credit 1	01356A	Storm water pollution prevention measures
Credit 1	01575N and 01576	Temporary environmental controls
Credit 1	Division 02	Site construction
Credit 3	02226	Removal and salvage of historic building materials
Credit 4	13284	Removal & disposal of PCBs

Additional IUOM resources

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Mercury Awareness Program. www.in.gov/idem/ctap/mercury/

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Weeks, Kay D. and David W. Look. Exterior Paint Problems on Historic Woodwork. National Park Service Technical Preservation Services. http://www.cr.nps.gov/hps/tps/briefs/brief10.htm

Conclusions

Table 6.2 below represents the likelihood of historic preservation impacts by LEED-EB credit and SOI Standard. Each prerequisite and credit was assigned a value that reflects both the number of strategies and number of times those strategies can potentially impact a given SOI Standard. A value of 00 is color-coded green for no likely impacts; values of 01-03 are yellow for possible impacts; and values 04 and greater are red for probable impacts.* Green entries are considered easily attainable with few historic preservation conflicts. Yellow entries are regarded as attainable with careful consideration for the historic fabric. Red entries are also thought to be attainable, but extreme care must be taken to ensure SOI Standards compliance.

Green >	00	Yellow >	01-03	Red >	04 up

Table 6.2. Likelihood of historic preservation impacts by LEED-EB credit and SOI Standard.

	Use	Character	Conjectural Features	Significant Changes	Craft	Match Features	Treatments	Archeology	Compatible Additions	Removable Additions
SOI Standards	1	2	3	4	5	6	7	8	9	10
Sustainable Sites										
Pr 1 Erosion & Sedimentation Control	00	08	00	00	00	05	07	01	08	08
Pr 2 Age of Building	00	00	00	00	00	00	00	00	00	00
Cr 1 Plan for Green Site & Building Exterior Management	02	09	02	00	00	04	07	01	08	08
Cr 2 High Development Density Building & Area	03	04	00	00	00	01	00	00	01	01
Cr 3.1 Alternative Transportation: Public Transportation Access	04	04	00	00	00	03	00	00	04	04
Cr 3.2 Alternative Transportation: Bicycle Storage/Changing Rooms	01	07	00	00	00	04	00	02	06	06

* Due to the large number of potential Sustainable Sites strategies available to achieve LEED-EB point accumulation, values for Sustainable Sites credits are as follows: 00 are green, 01-05 are yellow, and 06 and up are red.

	Use	Character	Conjectural Features	Significant Changes	Craft	Match Features	Treatments	Archeology	Compatible Additions	Removable Additions
SOI Standards	1	2	3	4	5	6	7	8	9	10
Cr 3.3 Alternative Transportation: Alternative Fuel Vehicles	02	03	00	00	00	00	01	00	03	03
Cr 3.4 Alternative Transportation: Car Pooling & Telecommuting	00	00	00	00	00	00	00	00	00	00
Cr 4.1-4.2 Reduced Site Disturbance	06	08	04	00	00	03	00	02	07	07
Cr 5.1-5.2 Stormwater Management: Rate & Quantity Reduction	08	09	04	00	00	04	02	03	08	08
Cr 6.1 Heat Island Reduction: Non-Roof	03	09	08	00	00	08	01	01	09	09
Cr 6.2 Heat Island Reduction: Roof	01	03	00	00	00	02	00	00	03	03
Cr 7 Light Pollution Reduction	00	09	04	00	00	03	00	00	06	06
Water Efficiency										
Pr 1 Minimum Water Efficiency	00	03	01	00	01	03	00	00	02	02
Pr 2. Discharge Water Compliance	00	01	00	00	00	00	00	01	00	00
Cr 1.1-1.2 Water Efficient Landscaping: Reduce Water Use	01	06	01	00	00	01	01	05	06	06
Cr 2 Innovative Wastewater Technologies	01	03	00	00	00	02	00	01	03	03
Cr 3.1-3.2 Water Use Reduction	00	03	00	00	00	02	00	01	03	03
Energy & Atmosphere										
Pr 1 Existing Building Commissioning	00	01	00	00	00	01	00	00	00	00
Pr 2 Minimum Energy Performance	00	01	00	00	00	01	00	00	01	01
Pr 3 Ozone Protection	00	01	00	00	00	01	00	00	01	01
Cr 1 Optimize Energy Performance	00	06	01	00	01	05	00	01	05	05
Cr 2.1-2.4 On-Site & Off-site Renewable Energy	00	06	00	00	00	06	00	03	06	06
Cr 3.1 Building Operations & Maintenance: Staff Education	00	01	00	00	00	00	00	00	00	01
Cr 3.2 Building Operations & Maintenance: Building Systems Maintenance	00	00	00	00	00	00	00	00	00	00

	Use	Character	Conjectural Features	Significant Changes	Craft	Match Features	Treatments	Archeology	Compatible Additions	Removable Additions
SOI Standards	1	2	3	4	5	6	7	8	9	10
Cr 3.3 Building Operations & Maintenance: Building Systems Monitoring	00	01	00	00	00	00	00	00	01	01
Cr 4 Additional Ozone Protection	00	01	00	00	00	00	00	00	01	01
Cr 5.1-5.3 Performance Measurement: Enhanced Metering	00	00	00	00	00	00	00	00	00	00
Cr 5.4 Performance Measurement: Emissions Reduction Reporting	00	01	00	00	00	01	00	00	01	01
Cr 6 Documenting Sustainable Building Cost Impacts	00	00	00	00	00	00	00	00	00	00
Materials & Resource										
Pr 1.1 Source Reduction & Waste Management: Waste Management Policy/Waste Stream Audit	00	00	00	00	00	00	00	00	00	00
Pr 1.2 Source Reduction & Waste Management: Storage & Collection of Recyclables	00	01	00	00	00	00	00	00	01	01
Pr 2 Toxic Material Source Reduction: Reduced Mercury in Light Bulbs	00	03	00	00	00	00	00	00	00	01
Cr 1.1-1.2 Construction, Demolition & Renovation Waste Management	00	04	01	02	01	03	00	00	03	03
Cr 2.1-2.5 Optimize Use of Alternative Materials	00	04	03	01	04	04	00	01	04	04
Cr 3.1-3.2 Optimize Use of IAQ Compliant Products	00	02	01	00	01	02	01	00	01	01
Cr 4.1-4.3 Sustainable Cleaning Products & Materials	00	00	00	00	00	00	01	00	00	00
Cr 5.1-5.3 Occupant Recycling	00	03	00	00	00	00	00	00	01	03
Cr 6 Additional Toxic Material Source Reduction: Reduced Mercury in Light Bulbs	00	00	00	00	00	00	00	00	00	00
Indoor Environmental Quality										
Pr 1 Outside Air Introduction & Exhaust Systems	00	05	00	00	00	04	00	00	05	05
Pr 2 Environmental Tobacco Smoke (ETS) Control	00	04	00	00	00	00	01	01	04	04

	Use	Character	Conjectural Features	Significant Changes	Craft	Match Features	Treatments	Archeology	Compatible Additions	Removable Additions
SOI Standards	1	2	3	4	5	6	7	8	9	10
Pr 3 Asbestos Removal or Encapsulation	00	02	00	00	01	03	02	00	02	02
Pr 4 PCB Removal	00	00	00	00	00	02	00	00	00	00
Cr 1 Outside Air Delivery Monitoring	00	01	00	00	01	00	00	00	02	01
Cr 2 Increased Ventilation	00	00	00	00	00	00	00	00	00	00
Cr 3 Construction IAQ Management Plan	00	00	00	00	00	00	00	00	00	00
Cr 4.1 Documenting Productivity Impacts: Absenteeism & Healthcare Cost Impacts	00	00	00	00	00	00	00	00	00	00
Cr 4.2 Documenting Productivity Impacts: Other Impacts	00	00	00	00	00	00	00	00	00	00
Cr 5.1 Indoor Chemical/Pollutant Source Control: Reduce Particulates in Air Distribution	00	01	00	00	00	01	00	00	01	01
Cr 5.2 Indoor Chemical/Pollutant Source Control: High Volume Copying/Print Rooms/Fax Stations	00	02	00	00	00	02	00	00	02	02
Cr 6.1 Controllability of Systems: Lighting	00	03	00	00	00	02	01	00	03	03
Cr 6.2 Controllability of Systems: Temperature & Ventilation	00	03	00	00	00	02	01	00	03	03
Cr 7.1 Thermal Comfort: Compliance	00	01	00	00	00	01	00	00	01	01
Cr 7.2 Thermal Comfort: Permanent Monitoring System	00	01	00	00	00	01	00	00	01	01
Cr 8.1-8.2 Daylighting & Views: Daylighting 50%/75% of Spaces	00	13	00	01	03	06	00	01	10	10
Cr 8.3-8.4 Daylighting & Views: Views for 45%/90% of Spaces	00	02	00	00	01	02	00	00	02	02
Cr 9 Contemporary IAQ Practice	00	02	00	00	00	02	02	00	01	01
Cr 10.1 Green Cleaning: Entryway Systems	00	02	02	00	00	00	00	00	02	02
Cr 10.2 Green Cleaning: Isolation of Janitorial Closets	00	03	00	00	00	02	01	00	03	03
Cr 10.3 Green Cleaning: Low Environmental Impact Cleaning Policy	00	02	00	00	00	01	03	00	02	02

	Use	Character	Conjectural Features	Significant Changes	Craft	Match Features	Treatments	Archeology	Compatible Additions	Removable Additions
SOI Standards	1	2	3	4	5	6	7	8	9	10
Cr 10.4-10.5 Green Cleaning: Low Environmental Impact Pest Management Policy	00	03	00	00	00	02	01	01	01	01
Cr 10.6 Green Cleaning: Low Environmental Impact Cleaning Equipment Policy	00	00	00	00	00	03	03	00	00	00
Innovation & Design Process (5 possible points)										
Cr 1 Stormwater Design: Water Quality	01	03	01	00	00	00	01	00	03	03
Cr 2 Additional Toxic Material Source Reduction	00	01	00	00	00	01	00	00	00	00
Cr 3 Indoor Chemical & Pollutant Source Control: Reduce Common Hazardous Indoor Air Pollutants	00	02	00	00	00	02	02	00	01	01
Cr 4 Additional PCB Removal	00	01	00	00	00	01	00	00	00	00
Cr 5 Document Ergonomics Impacts: Absenteeism & Healthcare Cost Impacts	00	00	00	00	00	00	00	00	00	00
Cr 6 Historic Building Feature Retention & Reuse	00	00	00	00	00	01	00	00	00	00
Cr7 Additional Existing Building Commissioning	00	02	00	00	00	02	01	00	02	02
Cr 8 LEED Accredited Professional	00	00	00	00	00	00	00	00	00	00

Abbreviations and Acronyms

Acronyms and Abbreviations appearing in this document include:

AAPFCO	Association of American Plant Food Control Officials
AATCC	American Association of Textile Chemists and Colorists
ACEEE	American Council for an Energy Efficient Economy
ACM	Asbestos Containing Materials
ACSIM	Army Assistant Chief of Staff for Installation Management
ADA	Americans with Disabilities Act
AFI	Air Force Instruction
AFV	Alternative Fueled Vehicle
AIA	American Institute of Architects
ANSI	American National Standards Institute
AR	Army Regulation
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASLA	American Society of Landscape Architects
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
ATV	Advanced Technology Vehicles
BEQ	Bachelor Enlisted Quarters
BMP	Best Management Practice
CDL	Construction, Demolition and Land Clearing
CEQ	Council on Environmental Quality
CERL	Construction Engineering Research Laboratory
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act

CFC	Chlorofluorocarbons
CFM	Cubic Feet Per Minute
CFR	Code of Federal Regulations
CI	Commercial Interiors
CIBSE	Chartered Institution of Building Services Engineers
CMA	Calcium Magnesium Acetate
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
COTE	Committee on the Environment
CRI	Carpet and Rug Institute
CRS	Center for Resources Solutions
CTC	Closing the Circle
DA	Department of the Army
DAIM	Office of the Department of the Army, Assistant Chief of Staff for Installation Management [office symbol]
DA PAM	Department of the Army Pamphlet
dBA	Decibel Adjusted
DDT	Dichlorodiphenyltrichloroethane
DF	Daylight Factor
DLA	Defense Logistics Agency
DMR	Discharge Monitoring Report
DoD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction
DOE	Department of Energy
DOI	Department of the Interior
EA	Energy and Atmosphere
EB	Existing Building

ECB	Engineering and Construction Bulletin
EDTA	Ethylenediaminetetraacetic acid
ELA	Ecological Landscape Association
EMS	Environmental Management System
EO	Executive Order
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
EPP	Environmentally Preferred Product/Purchasing
EQ	Environmental Quality
ER	Engineer Regulation
ERDC	Engineering Research and Development Center
ESOH	Environment, Safety and Occupational Health
ET_o	Evapo-Transpiration Reference Rate
ETS	Environmental Tobacco Smoke
FAR	Federal Acquisition Regulation
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FSC	Forest Stewardship Council
FTE	Full Time Equivalent
GS	Green Seal
GSA	General Services Administration
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HCFC	Hydrochlorofluorocarbons
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
HERS	Home Energy Rating System
HG	Mercury

HHS	Department of Health and Human Services
HID	High Intensity Discharge
HOV	High-Occupancy Vehicle
HQDA	Headquarters, Department of the Army
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HVAC	Heating, Ventilating and Air Conditioning
HVAC&R	Heating, Ventilating, Air Conditioning and Refrigerating
IAPMO	International Association of Plumbing and Mechanical Officials
IAQ	Indoor Air Quality
ICBO	International Council of Building Officials
IDG	Installation Design Guide
IEQ	Indoor Environmental Quality
IESNA	Illuminating Engineering Society of North America
ID	Innovation in Design
IPC	International Plumbing Code
IPM	Integrated Pest Management
ISP	Installation Sustainability Program
ITAC	International Telework Association and Council
IUOM	Innovations in Upgrades, Operations, and Maintenance
LBP	Lead-Based Paint
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MERV	Minimum Efficiency Reporting Value
MILCON	Military Construction
MOA	Memorandum of Agreement

MOU	Memorandum of Understanding
MR	Materials and Resources
MSDS	Material Safety Data Sheets
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NC	New Construction
ND	Neighborhood Development
NEMA	National Electric Manufacturers Association
NHPA	National Historic Preservation Act
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTA	Nitrilotriacetic Acid
OA	Outside Air
OCC	Old Corrugated Cardboard
OFEE	Office of the Federal Environmental Executive
OMB	Office of Management and Budget
OSB	Oriented Strand Board
OSHA	Occupational Safety and Health Administration/Act
PCA	Pest Control Advisor
PCB	Polychlorinated Biphenyl
PERM	Permeability
PET	Polyethylene Terephthalate
POL	Petroleum, Oil and Lubricant
ppm	parts per million
PV	Photovoltaic

PWTB	Public Works Technical Bulletin
RCRA	Resource Conservation and Recovery Act
RFQ	Request for Qualifications
SCAQMD	South Coast Air Quality Management District
SCU	Sulfur Coated Urea
SHPO	State Historic Preservation Office/Officer
SMACNA	Sheet Metal and Air Conditioning National Contractors Association
SOI	Secretary of the Interior
SPiRiT	Sustainable Project Rating Tool
SS	Sustainable Sites
TAG	Technical Advisory Group
TARP	Technology Acceptance Reciprocity Partnership
TI	Technical Instruction
TM	Technical Manual
TR	Technical Report/Release
TSS	Total Suspended Solids
UF	Urea formaldehyde
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
UPC	Unified Plumbing Code
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Center
USAF	United States Air Force
USC	United States Code
USDA	United States Department of Agriculture
USGBC	United States Green Building Council
UV	Ultraviolet

VAV	Variable Air Volume
VFD	Variable Frequency Drive
VFS	Vegetated Filter Strip
VOC	Volatile Organic Compounds
VOQ	Visiting Officers Quarters
WBDG	Whole Building Design Guide
WE	Water Efficiency

Glossary of Terms

The following is a glossary of terms appearing in this document. Definitions are from the U.S. Green Building Council's LEED-EB Reference Guide (2005) unless noted otherwise.

Advanced Technology Vehicles (ATVs) – A type of alternative vehicle that uses advanced technologies for powertrains, emissions controls, and other vehicle features that allow for improved environmental performance. Electric hybrid vehicles and fuel cell vehicles are examples of ATVs.

Agrifiber Products – Products made from agricultural fiber. To qualify for the LEED-EB MR Credits 3.1 & 3.2, the agrifiber products must contain no added urea-formaldehyde resins.

Albedo – Synonymous with solar reflectance.

Alternative Fuel Vehicles (AFVs) – A type of alternative vehicle that uses low-polluting fuels such as electricity, propane or compressed natural gas, liquid natural gas, methanol and ethanol.

Aquatic (Riparian) buffers – Vegetated zones adjacent to streams and wetlands that are effective at reducing nitrogen levels in groundwater and streams (Mayer 2005).

Aquatic systems – Ecologically designed treatment systems that utilize a diverse community of biological organisms (e.g., bacteria, plants and fish) to treat wastewater to advanced levels.

Aquifer – A water-bearing geological formation of permeable material, such as gravel or sand, which is capable of providing large quantities of water to springs and wells (Harris 1975).

Aromatic Compounds – Hydrocarbon compounds containing one or more 6-carbon benzene rings in the molecular structure (Green Seal Standard GS-11 1993).

Bicycle Racks – Include outdoor bicycle racks, bicycle lockers or indoor bicycle storage rooms.

Bioaccumulants – Substances that increase in concentration in the living organisms exposed to them because they are very slowly metabolized or excreted.

Biomass – Any plant derived organic material, particularly those materials available on a renewable basis. The Department of Energy cites the following items as examples of biomass materials: "dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials" (DOE, Energy Sources: Bioenergy).

Bioremediation – The use of microorganisms and vegetation to remove contaminants from water and soils. Bioremediation is generally a form of in-situ remediation, and can be a viable alternative to landfilling or incineration (USGBC, LEED-NC Reference Guide 2003).

Bioretention Basin – A stormwater control device that contains stormwater as it first sheets off impervious surfaces and infiltrating the majority, releasing a more stable, predictable flow of water downstream. Same goal as an infiltration pond or stormwater wetland (Thompson and Sorvig 2000, 146).

Bioretention Filter – Areas that consist of an excavation backfilled with a sand/soil mixture and planted with native vegetation, oriented to receive and filter storm runoff from impervious areas and lawns (Blick et al. 2004).

Bioswales – Grassed or vegetated linear drainage channels that move stormwater runoff as slowly as possible along a gentle incline, keeping the rain on the site as long as possible and allowing it to soak into the ground (Thompson and Sorvig 2000, 182).

Blackwater – There is no single definition acceptable nationwide. Wastewater from toilets and urinals is always considered blackwater. Wastewater from kitchen sinks (perhaps differentiated by the use of a garbage disposal), showers, or bathtubs may be considered blackwater by state or local codes. Project teams should comply with blackwater definition as established by the authority having jurisdiction in their areas.

Brownfield – With certain legal exclusions and additions, the term “brownfield site” means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant (Public Law 107-118, H.R. 2869, Small Business Liability Relief and Brownfields Revitalization Act).

Building Density – The floor area of the building divided by the total area of the property (square feet per acre).

Building Energy Performance Baseline – Includes the average building performance for a specific type of building. For building types covered by ENERGY STAR, this is a score of 50. For building types not covered by ENERGY STAR, the building energy performance baseline is established with historic building energy use data and/or energy use data from other, similar buildings.

Building Envelope – The virtual shape of a building indicative of its maximum volume. The building envelope is used to assess the building plan and zoning restrictions such as set-backs (Harris 1975).

Building Footprint – The area on a project site that is used by the building structure and is defined by the perimeter of the building plan. Parking lots, landscapes and other non-building facilities are not included in the building footprint (USGBC, LEED-NC Reference Guide 2003).

Building Operation Plan – A plan describing the system/equipment requirements of a building’s current us-age. The plan covers the heating system, cooling system, humidity control system, lighting system, safety systems, and the building automation controls.

Building Shell – The outer structure or framework of a building that has not been completed (Harris 1975).

Cantonment – A camp, usually of large size, where personnel are trained for military service. The term typically refers to the central (administrative) portion of a military installation.

Casein-Based Paint – A paint that uses a milk protein as the binding agent. Casein-based paint is an environmentally friendly alternative to latex or oil paints and helps reduce indoor air pollutants such as VOCs (Harris 1975).

Chain-of-Custody – A tracking procedure for documenting the status of a product from the point of harvest or extraction to the ultimate consumer end use.

Check Dams - Small, temporary dams constructed across a swale or channel. They can be constructed using gravel, rock, gabions, or straw bales. They are used to reduce the velocity of concentrated flow and, therefore, to reduce erosion in a swale or channel (EPA National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas 2000).

Chemical Component Restrictions – A set of restrictions set by Green Seal Standard GS-11. The standard requires that the manufacturer demonstrate that the chemical compounds included on the Chemical Component Restrictions list are not used as ingredients in the manufacture of the product.

Chlorofluorocarbon (CFC) – A non-toxic compound made up of the elements chlorine, fluorine, and carbon. CFCs are commonly used as refrigerants, particularly in air conditioning units. When CFCs degrade they release chlorine which depletes the ozone layer of the atmosphere (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

CO2 Monitoring – Carbon Dioxide (CO2) monitoring is an indicator of ventilation effectiveness in-side buildings. CO2 concentrations greater than 530 parts per million (ppm) above outdoor CO2 conditions are generally considered an indicator of inadequate ventilation. Absolute concentrations of CO2 greater than 800 to 1000 ppm are generally considered an indicator of poor breathing air quality.

Commissioning – The process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the owner's project requirements (USGBC, LEED-NC Reference Guide, 2005).

Composite Panels – Panels made from several materials. Plywood and OSB (oriented strand board) are two examples of composite panels. To qualify for the LEED-EB MR Credits 3.1 & 3.2, composite panels must contain no added urea-formaldehyde resins.

Composting toilet systems – Dry plumbing fixtures that contain and treat human waste via microbiological processes.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Commonly known as Superfund. CERCLA addresses abandoned or historical waste sites and contamination. It was enacted in 1980 to create a tax on the chemical and petroleum industries and provided federal authority to respond to releases or hazardous substances (USGBC, LEED-NC Reference Guide 2003).

Community – An interacting population of individuals living in a specific area (USGBC, LEED-NC Reference Guide 2003).

Concentrate – A product that must be diluted by at least eight parts by volume water (1:8 dilution ratio) prior to its intended use (GS-37 2006).

Constructed Wetlands – See wetlands.

Construction, Demolition, and Land Clearing (CDL) Debris – Includes waste and recyclable generated from construction, land clearing (e.g., vegetation, but not soil), renovation, and demolition or deconstructing of pre-existing structures.

Construction IAQ Management Plan – A document specific to a building project that outlines measures to minimize contamination in the building during construction, and procedures to flush the building of contaminants prior to occupancy.

Conventional irrigation – Refers to the most common irrigation system used in the region where the building is located. A common conventional system uses pressure to deliver water and distributes it through sprinkler heads above the ground.

Crib Wall – Concrete or wood elements stacked log-cabin style (Thompson and Sorvig 2000, 106).

Constructed Wetland – Wastewater treatment systems designed to simulate natural wetland functions for water purification by removing contaminants form wastewaters.

Curfew Hours – Locally determined times when greater lighting restriction are imposed.

Daylight Factor (DF) – The ration of exterior illumination to interior illumination and is expressed as a percentage. The variables used to determine the daylight factor include the floor area, window area, window geometry, visible transmittance (Tvis) and window height.

Daylighting – The controlled admission of natural light into a space through glazing with the intent of reducing or eliminating electric lighting.

DD Form 1391 – DD Form 1391, Military Construction Project Data, is the form used to notify Congress of MILCON projects in excess of $1.5 million. These projects are part of the annual budget process and broken out as separate line items in the President's budget (DoD Dependents Schools-Europe 2004).

Design-Build Contract – A design-build contract combines architectural and engineering design services with construction services under one contract agreement instead of separating the project into phases covered by multiple agreements with individual vendors (Construction Management Association of America 2002).

Design Light Output – The light output of light bulbs at 40% of their useful life.

Detention Pond – Ponds that capture stormwater runoff and allow pollutants to drop out before release to a stormwater or water body. A variety of detention pond designs are available, with some utilizing only gravity while others use mechanical equipment such as pipes and pumps to facilitate transport. Some ponds are dry except during storm events and other ponds permanently store water volumes.

Development Footprint – The areas on the project site that has been impacted by any development activity. Hardscape, access roads, parking lots, non-building facilities and building structure are all included in the development footprint (USGBC, LEED-NC Reference Guide 2003).

Dyke (Earth Dyke) – An earthen wall constructed to control or confine water (Merriam-Webster Online).

Ecosystem – A basic unit of nature that includes a community of organisms and their nonliving environment linked by biological, chemical, and physical process (USGBC, LEED-NC Reference Guide 2003).

Electrostatic Propensity Level – The tendency of carpet to generate static, as determined by AATCC Test Method 134-2001. This test method assesses the static-generating propensity of carpets developed when a person walks across them by using controlled laboratory simulation of conditions, which may be encountered in practice. The simulation is focused on the use of those conditions, which are known from experience to be strong contributors to excessive accumulation of static charges (American Association of Textile Chemists and Colorists 2006).

Embodied Energy – The amount of energy required by all activities associated with a production process.

Emissivity – The ratio of the radiation emitted by a surface to the radiation emitted by a blackbody at the same temperature.

Endangered Species – Animal or plant species that are in danger of becoming extinct throughout all or a significant portion of their range due to harmful human activities or environmental factors (USGBC, LEED-NC Reference Guide 2003).

ENERGY STAR Rating – The rating a building earns using the ENERGY STAR Portfolio Manager to com-pare building energy performance to similar buildings in similar circumstances. A score of 50 or above represents average building performance.

Environmental Tobacco Smoke (ETS) or Second Hand Smoke – Airborne particles from the burning end of cigarettes, pipes, and cigars, and ex-haled by smokers. Elemental Mercury – Pure mercury rather than a mercury containing compound, the vapor of which is commonly used in fluorescent and other light bulb types.

Erosion – A combination of processes by which materials of the Earth's surface are loosened, dissolved, or worn away, and transported from one place to another by natural agents.

Eutrophication – The process by which lakes and ponds age. Water, through natural or human sources, becomes rich in nutrients and promotes the proliferation of plant life (especially algae) that reduces the dissolved oxygen content of the water and often causes the extinction of other organisms within the water body.

Ex-Situ Remediation – The removal of contaminated soil and groundwater. Treatment of the contaminated media occurs in another location, typically a treatment facility. A traditional method of ex-situ remediation is pump-and-treat technology that uses carbon filters and incineration. More advanced methods of ex-situ remediation include chemical treatment or biological reactors (USGBC, LEED-NC Reference Guide 2003).

Existing Building Commissioning – The development of a building operation plan that identifies current building operation requirements and needs, conducting tests to proactively determine if the building and fundamental systems are operation in accordance with the building operation plan, and finally making any repairs needed so that the building and fundamental systems are operating according to the plan.

Filtration Basin – Basins that remove sediment and pollutants from stormwater runoff using a filter media such as sand or gravel. A sediment trap is usually included to remove sediment from stormwater before filtering to avoid clogging.

Fixture sensor – Motion sensors that automatically turn on/off lavatories, sinks, water closets and urinals.

Footcandle (fc) – A unit of light intensity that is equal to the quantity of light falling on a one-square foot area from a one candela light source at a distance of one foot.

French Drain – A pit or trench, filled with size graded rubble or gravel, and ideally lined with filter fabric to reduce sedimentation (Thompson and Sorvig 2000, 157).

Friable – The term used in the asbestos industry to describe asbestos that can be reduced to dust by hand pressure.

Forest Stewardship Council (FSC) Certified Wood – Wood that comes from a source that has been certified by the FSC according to ten principles and 57 criteria that address legal, economic, social, and environmental concerns associated with sustainable commercial forestry (Forest Stewardship Council, Principles and Criteria).

Full-Time Equivalent Building Occupants – Refers to the total number of hours all building occupants spend in the building during the peak 8-hour occupancy period divided by 8 hours. For buildings used for multiple shifts each day, the shift with the greatest number of FTE building occupants sets the overall FTE building occupants for the building.

Gabion Walls – Constructed of wire baskets filled with stones to provide a strong but permeable wall or dam (Thompson and Sorvig 2000, 106).

Geogrid – Products that look almost exactly like plastic construction fencing, with open-square grid patterns (Thompson and Sorvig 2000, 106).

Geotextile – Woven or felt-like synthetic fabrics also used for their water filtration capacities (Thompson and Sorvig 2000, 106).

Glare – Any excessively bright source of light within the visual field that creates discomforts or low in visibility.

Grassed Swale – Consist of trenches or ditches covered with vegetation and encourage subsurface infiltration, similar to infiltration basins and trenches. They utilize vegetation to filter sediment and pollutants from stormwater.

Graywater – Defined by the Uniform Plumbing Code (UPC) in its Appendix G, titled "Gray Water Systems for Single-Family Dwellings" as "untreated household waste water which has not come into contact with toilet waste. Graywater includes used water from bathtubs, showers, bathroom wash basins, and water from clothes-washer and laundry tubs. It shall not include waste water from kitchen sinks or dishwashers." The international Plumbing Code (IPC) defines graywater in its Appendix C, titled "Gray Water Recycling Systems" as "waste water discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks." Some states and local authorities allow kitchen sink wastewater to be included in graywater. Other differences with the UPC and IPC definitions can probably be found in state and local codes. Project teams should comply with graywater definitions as established by the authority having jurisdiction in their areas.

Grease Interceptor – A grease interceptor (also called a grease trap) is a device that removes grease from waste water through a system that allows the liquid to cool and the grease to solidify so that it can be separated from the water (Harris 1975).

Green Cleaning – The use of cleaning products and practices that have reduced environmental impacts in comparison with conventional products and practices.

Greenfield – Undeveloped land or land that has not been impacted by human activity.

Halon – Any compound containing carbon and fluorine and/or chlorine which is used as a fire extinguishing agent. Halons also typically contain bromine, an element which is more destructive to the ozone layer than chlorine (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

Hazardous Waste – Waste material made up of hazardous components that present a risk to human or environmental health.

Heat Island Effect – Refers to urban air and surface temperatures that are higher than nearby rural areas. Principal contributing factors include additions of dark, non-reflective surfaces, elimination of trees and vegetation, waste heat from vehicles, factories, and air conditioners and reduced airflow from tall buildings and narrow streets.

HEPA Filters – High Efficiency Particulate Air (HEPA) filters have a filtration efficiency of at least 99.97% for 0.3 microns particles.

High Pressure Sodium Lamp – A sodium-vapor lamp (where electric current flows through sodium vapor) in which the partial pressure of the vapor during operation is about 0.1 atmosphere; produces a yellowish light having a wide spectrum, in contrast to the light produced at low pressures, which is characterized by sodium emission lines (Harris 1975).

High-Velocity HVAC System – A small duct, high velocity system means a heating and cooling product that contains a blower and indoor coil combination that: (1) is designed for, and produces, at least 1.2 inches of external static pressure when operated at the certified air volume rate of 220-350 CFM per rated ton of cooling; and (2) when applied in the field, uses high velocity room outlets generally greater than 1000 fpm which have less than 6.0 square inches of free area. These systems are typically used in renovations where ductwork must fit between existing structural members (DOE, SDHV Systems Standards Rulemaking 2002).

HVAC Systems – Heating, ventilation and air conditioning (HVAC) systems used to provide thermal comfort and ventilation for building interiors.

Hybrid Vehicle – Vehicles that use a gasoline engine to drive an electric generator and use the electric generator and/or storage batteries to power electric motors that drive the vehicle's wheels.

Hydrochlorofluorocarbon (HCFC) – A HCFC is a non-toxic compound made up of the elements hydrogen, chlorine, fluorine, and carbon. HCFCs have been used as replacements for CFCs because they do not deplete the ozone layer to the degree to which CFCs do (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

Hydrofluorocarbon (HFC) – HFCs are non-toxic compounds made up of the elements hydrogen, fluorine, and carbon. HFCs have been used as replacements for CFCs because they do not deplete the ozone layer (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

Hydroseeding, Hydromulching – An effective and potentially economical grass planting process that includes mixing mulch, seed, fertilizer, and water in the tank of a hydro-mulching machine then the slurry is sprayed onto the ground creating a micro-environment beneficial to seed germination (www.turfmaker.com 2000).

Imbricated Rip-Rap – Imbricated rip-rap consists of large two to three foot-long boulders arranged like building blocks to stabilize the entire streambank. This practice requires boulders that are generally flat or rectangular in shape to allow them to be stacked with structural integrity (Stormwater Manager's Resource Center, Stream Restoration: Bank Protection Practices).

Impervious Surface – Surfaces that promote runoff of precipitation volumes instead of infiltration into the subsurface. The imperviousness or degree of runoff potential can be estimated form different surface materials.

Imperviousness – Resistance to penetration by a liquid and is calculated as the percent of area covered by a paving system that does not allow moisture to soak into the earth below the paving system.

Incinerator – A furnace or container for burning waste materials.

Indoor Air Quality (IAQ) – The nature of air that affects the health and well-being of building occupants.

Infiltration Basins, Ponds, and Trenches – Used to encourage subsurface infiltration of runoff volumes through temporary surface storage. Basins are ponds that can store large volumes of stormwater. They need to drain within 72 hours to maintain aerobic conditions and to be available for the next storm event. Trenches are similar to infiltration basins except that they are shallower and function as a subsurface reservoir for stormwater volumes. Pre-treatment to remove sediment and oil may be necessary to avoid clogging of infiltration devices. Infiltration trenches are more common in areas where infiltration basins are not possible.

Infrared Emittance – A parameter between 0 and 1 that indicates the ability of a material to shed infrared radiation. The wavelength of this radiant energy is roughly 5 to 40 micrometers. Most building materials (including glass) are opaque in the part of the spectrum, and have an emittance of roughly 0.9. Materials such as clean, bare metals are the most important exceptions to the 0.9 rule. Thus clean, untarnished galvanized steel has low emittance, and aluminum roof coatings have intermediate emittance levels.

Infrared Scan – A test with equipment using the region of the electromagnetic spectrum at wave-lengths immediately above the visible spectrum. Infrared equipment therefore can graphically show the temperature of scanned surfaces, which can differ due to a variety of external influences, such as water. Infrared scans are often used in roof inspections to detect areas of moisture build-up (Harris 1975).

Investment Maintenance – Another term for preventative maintenance, which stresses the positive result of maintenance rather than the initial effort. Investment (preventive) maintenance is regularly scheduled repair and maintenance needed to keep building components, such as heating-ventilation-air-conditioning (HVAC) systems, roofs, plumbing, and electrical systems, operating efficiently and to extend their useful life. In-vestment (preventive) maintenance includes periodic inspections, lubrication, calibrations, and equipment replacement (State of Minnesota 2000).

IPM – Integrated Pest Management: “is an approach to pest control that utilizes regular monitoring to determine if and when treatments are needed and employs physical, mechanical, cultural, biological, and educational tactics to keep pest numbers low enough to prevent intolerable damage or annoyance. Least-toxic chemical controls are used as a last resort” (USAF IPM program).

Landfills – Waste disposal sites for the deposit of solid waste from human activities.

Landscape area – The area of the site equal to the total site area less the building footprint, paved surfaces, water bodies, patios, etc.

Life Cycle Cost – The life cycle cost of a building includes all costs associated with planning, de-sign, construction, operation, maintenance and demolition. The life cycle cost is based on the life expectancy of a building (Construction Management Association of America 2002).

Light Bulb Life – The useful operating life of light bulbs.

Light Bulbs – Devices that produce illumination, and include glass bulbs or tubes that emit light produced by electricity (as an incandescent bulb or fluorescent bulb).

Light Pollution – Waste light from buildings sites that produces glare, compromises astronomical research, and adversely affects the environment. Waste light does not increase nighttime safety, utility, or security and needlessly consumes energy and natural resources.

Local Zoning Requirements – Local government regulations imposed to promote orderly development of private lands and to prevent land use conflicts (USGBC, LEED-NC Reference Guide 2003).

Lumen – A unit of luminous flux equal to the light emitted in a unit solid angle by a uniform point source of one candle intensity.

Lunker – Lunkers are crib-like, wooden structures installed along the toe of a stream bank to create overhead bank cover and resting areas for fish. These structures were originally developed in Wisconsin for trout stream habitat improvement projects, but have been found to work well in Midwestern streams as bank protection devices. A lunker consists of two planks with wooden spacers nailed between them. Additional planks are nailed across the spacers perpendicular and a crib like structure is formed (Stormwater Manager's Resource Center “Stream Restoration: Bank Protection Practices” website).

Mass Transit – Transportation facilities designed to transport large groups of persons in a single vehicle such as buses or trains.

Mercury Vapor Lamp – A lamp consisting of an electric arc in mercury vapor in a sealed tube, which in turn may be enclosed in an outer glass envelope; the light produced appears to be blue-white, but contains only violet, blue, green, and yellow components. The lamp is said to be “low pressure” if the partial pressure of the vapor is below 0.001 atmosphere, and “high pressure” if about 1 atmosphere (Harris 1975).

MERV – Minimum Efficiency Reporting Value (MERV) is a filter efficiency rating system based on a test method established by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). The MERV categories range from 1 to 16 (very low to very high efficiency).

Methylmercury – The term used to describe any of various toxic compounds of mercury containing the complex CH_3Hg that often occur as pollutants and that bioaccumulate in living organisms, especially in higher levels of a food chain.

Micro-Irrigation – Involves irrigation systems with small sprinklers and microjets or drippers designed to apply small volumes of water. The sprinklers and microjets are installed within a few centimeters of the ground, while drippers are laid on or below grade.

MILCON – A MILCON (Military Construction) project is any construction project where the cost of new work, defined as construction, development, conversion, or extension of a military installation, exceeds $750,000. It includes all construction work necessary to produce a complete and usable facility or a complete and usable improvement to an existing facility. This is not to be confused with renovation work which can total several million dollars, but does not add to the footprint or area of the facility, or provide a new feature or system it does not currently possess. MILCON projects are especially sensitive because they are defined by public law and approved by Congress. For this reason there are legislated milestones that must be met and the timeline for completion can be lengthy (Department of Defense Dependents Schools-Europe 2004).

Mitigated Stormwater – Equal to the volume of precipitation falling on the site that does not become runoff. Runoff is defined as stormwater leaving the site via means of uncontrolled surface streams, rivers, drains, or sewers. Factors affecting stormwater mitigation include site perviousness, stormwater management practices (structural and non-structural), and onsite capture and reuse of rainwater.

Montreal Protocol – The Montreal Protocol, properly termed the Montreal Protocol on Substances That Deplete the Ozone Layer, is an international treaty concerning the depletion of the Earth's ozone layer. The treaty controls the use and phase-out of com-pounds such as CFCs and halons that deplete the ozone layer (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

Native/Adapted Plants – Plants indigenous to a locality or have adapted to the local climate and are not invasive. Such plants do not require irrigation or fertilization once root systems are established in the soil (USGBC, LEED-NC Reference Guide 2003).

Natural Ventilation – The process of supplying and removing air by natural means in building spaces by using openings such as windows and doors, wind towers, non-powered ventilators, and infiltration processes.

Non-roof Impervious Surface – All surfaces on the site with a perviousness of less than 50%, not including the roof of the building. Examples of typically impervious surfaces include parking lots, roads, sidewalks and plazas.

Non-water using urinal – A urinal that uses no water, but instead replaces the water flush with a specially designed trap that contains a layer of buoyant liquid that floats above the urine layer, blocking sewer gas and urine odors from the room.

Oil/Grit Separators – Also called oil and water separators, this is a system of chambers designed to remove trash, debris, and some amount of sediment, oil and grease from stormwater runoff. Grit chambers and deep sump catch basins have limited storage capacity and detention time and so cannot be expected to have significant water quality treatment capabilities (Minnesota Urban Small Sites BMP Manual).

Old Growth Wood – New wood harvested from trees that are considered "old growth" or salvaged/antique wood harvested from trees that would have also been considered "old growth." One criterion for old growth is age, which has been defined as exceeding at least 50% of the projected maximum attainable age for that species. This translates to about 150-200 years for typical eastern trees and over 200 years for some long-lived western ones (McCarthy 1995).

On-site wastewater treatment – Using localized treatment systems to transport, store, treat and dispose of wastewater volumes generated on the project site.

Open Space Area – The property area minus the development footprint. Open space must be vegetated and pervious, thus providing habitat and other ecological services (USGBC, LEED-NC Reference Guide 2003).

Ozone Layer – The portion of the upper atmosphere containing the bulk of Earth's atmospheric ozone. The ozone layer absorbs much of the ultraviolet B rays from the sun. As the ozone layer is depleted so is its ability to block harmful UVB rays (EPA, Ozone Depletion: Ozone Depletion Glossary 2006).

Paints and Coatings – Liquid, liquefiable or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer. These coatings are intended for on-site application to interior or exterior surfaces of residential, commercial, institutional or industrial buildings (Green Seal Standard GS-11). The Green Seal Standard (GS-11) does not include stains, clear finishes, or paints sold in aerosol cans within this category.

Performance Testing Plan – A plan to test space environmental conditions such as space temperature, space pressurization, and building envelope. Specific items to test can include whether the building is properly caulked to reduce infiltration, whether the filters have been changed on schedule, and any other maintenance item that may impact systems performance.

Perm – A unit of measure for a material's resistance to water-vapor transmission. A perm rating indicates how well a material will maintain its resistance to vapor transmission. The lower the perm rating the better a material will resist vapor transmission (Harris 1975).

Permeable Surfaces – Used as a substitute for impermeable surfaces to allow runoff to infiltrate into the subsurface. These surfaces are typically maintained with a vacuuming regime to avoid potential clogging and failure problems. Porous pavement is one type of permeable surface.

Perviousness – The percent of area covered by a paving system that is open and allows moisture to soak into the earth below the paving system.

Photovoltaic – A term used to refer to any material or technology that converts the sun's energy into electricity (DOE, Solar FAQs 2007).

Photovoltaic Cell (or Solar-electric Cell) – Solar power storage systems that supply power in relatively small doses over long periods (Thompson and Sorvig 2000, 265).

Picogram – One trillionth of a gram.

Picograms Per Lumen Hour – A measure of the amount of mercury in a light bulb per unit of light delivered over its useful life.

Point Source – A discrete conveyance of a pollutant, such as a pipe or man-made ditch. As stated in the NPDES Permit Program Basics: Frequently Asked Questions, a point source is "any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container".

Pollutant – "Any type of industrial, municipal, and agricultural waste discharge into water" Those regulated in the NPDES program include conventional pollutants (such as BOD5, total suspended solids, pH, fecal coliform, and oil and grease), toxic pollutants (such as metals and manmade compounds), and non-conventional pollutants (such as ammonia, nitrogen, phosphorus). The definition of "pollutant" as it pertains to the Clean Water Act and NPDES permitting is subject to change based on ongoing litigation and increased understanding about the environmental affects of discharged substances. An agent of the NPDES should be consulted regarding the pollutant status of discharge from specific buildings.

Polychlorinated Biphenyl (PCB) – PCBs are a group of non-flammable, chemically stable, man-made compounds that were used in numerous industrial and commercial applications, including hydraulic fluids, lubricants, paints, and adhesives, until concerns were raised about their impact on human health through ground water exposure (EPA, Consumer Factsheet: Polychlorinated biphenyls 2006).

Porous Pavement – Allows runoff to infiltrate into the subsurface through gaps in the surface (EPA, Guidance Specifying Management Measures for sources of Non-point Pollution in Coastal Waters 1993).

Post-Consumer Materials – Material in a product that is made from consumer waste following consumer use of the products containing these materials.

Post-Consumer Recycled Content – The percentage of material in a product that is recycled from consumer waste.

Post-Consumer Waste Recycling – The recycling of materials collected from consumer waste following consumer use of the products containing these materials.

Post-Industrial Materials – Material in a product that is made from waste from industrial processes within the same manufacturing plant or from another manufacturing plant.

Post-Industrial Recycled Content – The percentage of material in a product that is recycled from manufacturing waste.

Post-Industrial Waste Recycling – The recycling of materials collected from industrial processes. This includes the collection and recycling of waste from industrial processes within the same manufacturing plant or from another manufacturing plant.

Potable water – Water that is suitable for drinking and is supplied from wells or municipal water systems.

Preferred Parking – Parking that is preferentially available to particular users.

Preventative Maintenance – See Investment Maintenance.

Process Electricity – Electricity used for industrial processes and building systems (Hardlines Design Company).

Process Natural Gas – Natural Gas used for industrial processes and building systems (Hardlines Design Company).

Process water – Water used for industrial processes and building systems such as cooling towers, boilers and chillers.

Property Area – The total area within the legal property boundaries of a building and includes all areas of the site including constructed areas and non-constructed areas.

Rapidly Renewable Materials – Materials that are planted and harvested in less than a 10-year cycle.

Rain Garden – Small depressions planted with wet/dry tolerant vegetation designed to cleanse and infiltrate stormwater.

Recycling – The collection, reprocessing, marketing and use of materials that were diverted or recovered from the solid waste stream. Recycling provides two categories of environmental benefits: 1) diversion of waste from landfilling or incineration and 2) reduces the need for virgin materials for the manufacture of new products.

Refrigerants – The working fluids of refrigeration cycles that absorb heat from a reservoir at low temperatures and reject heat at higher temperatures.

Remediation – The process of cleaning up a contaminated site by physical, chemical or biological means. Remediation processes are typically applied to contaminated soil and groundwater (USGBC, LEED-NC Reference Guide 2003).

Renewable Energy – Energy from sources that are renewed on an ongoing basis. This includes energy from the sun, wind and small hydropower.

Retention Basin – See bioretention basin.

Return Air – Air removed from conditioned spaces that is either re-circulated in the building or exhausted to the outside.

Reuse – A strategy to return materials to active use in the same or a related capacity.

Riparian Areas - Vegetated ecosystems along a water body through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent water body. These systems encompass wetlands, uplands, or some combination of these two land forms. They will not in all cases have all of the characteristics necessary for them to be classified as wetlands (EPA Polluted Runoff, Nonpoint Source Pollution 2005).

Salvaged Materials (Offsite) – Building materials recovered from an offsite source that are reused in the existing building seeking LEED-EB certification.

Salvaged Materials (On-site) – Building materials recovered from and then reused at the same building site.

Sediment Basins – A pond constructed with a controlled water release structure to allow for settling of sediment from stormwater volumes.

Sediment Traps – An excavated pond area or constructed earthen embankment constructed to allow for settling of sediment from stormwater volumes.

Sedimentation – The addition of soil particles to water bodies by natural and human-related activities. Sedimentation often decreases water quality and can accelerate the aging process of lakes, rivers and streams.

Semi-Volatile Organic Compounds – A term frequently used to refer to potential environmental contaminants such as pesticides. By nature pesticides are toxic and have known health side effects for both the intended targets and the unintended victims like humans and family pets (EPA, Indoor Air Quality: An Introduction to Indoor Air Quality—Pesticides 2007).

Sick-Building Syndrome – Building whose occupants experience acute health and/or comfort effects that appear to be linked to time spent therein, but where no specific illness or cause can be identified. Complaints may be localized in a particular room or zone, or may spread throughout the building (EPA, Terminology Reference System 2006).

Silicate Paint – A paint that uses sodium silicate as the binding agent (Harris 1975).

Silt Fence – Filter fabric media held up and in place with posts to remove sediment from stormwater volumes flowing through the fence.

Soakaway – Similar to French drains, but they receive water from a small pipe rather than overland flow. Some soakaways are rubble-filled; others, called dry wells, are empty (Thompson and Sorvig 2000, 157).

Soil Cell – A 3-D cellular soil reinforcement and confinement system manufactured from high density polyethylene (HDPE); used under topsoil to stabilize slopes.

Soil Tackifier – A versatile starch based product useable as a mulch tackifier, straw/hay overspray binder or as a soil stabilizer/dust abatement agent. Unlike guar, plantago and other synthetic tackifier products, starch tackifiers are a 100% active polymer that contains 7 – 8% natural nitrogen, which acts as a slow-release fertilizer to help increase the seed germination and plant establishment process. The polymers have high moisture retention helping to improve seed germination rates and reduce irrigation requirements (Carlson, Tackifiers Put to the Test: Erosion and Sediment Control Comes to a Natural Conclusion 2003, http://www.landandwater.com/features/vol47no4/vol47no4_1.html).

Soil Waste – Unneeded or unusable soil from construction, demolition or renovation projects.

Solar Reflectance – A measure of the ability of a surface material to reflect sunlight – including the visible, infrared, and ultraviolet wavelengths – on a scale of 0 to 1. Solar reflectance is also called albedo. White paint (titanium dioxide) is defined to have a solar reflectance of 1 while black paint has a solar reflectance of zero.

Source Reduction – Anything that is done, typically through design, manufacturing practices, purchase or reuse of materials, to reduce the amount of waste materials or the toxicity of waste materials. Source reduction practices are intended to reduce pollution and conserve resources. Commonly cited examples of source reduction practices include reuse and recycling of previously utilized materials, reduction in packaging, rehabilitation of an item to extend its life, and minimization of the use of materials with toxic properties (EPA, Consumer Handbook for Reducing Solid Waste: Reusable Vocabulary 2006).

Space Churn Renovation Plan – In facilities management, "churn" is a term used to describe the process of recon-figuring space and moving people within the building. A space churn renovation plan describes how people will be moved and furniture configured in current and future renovation projects, often in order to maximize access to vision glazing and/or daylighting (Greener Facilities Newsletter 2003).

Square Footage (in terms of buildings) – The total floor area in square feet of all rooms, including corridors, elevators stairwells and shaft spaces.

Stormwater Runoff - Consists of water volumes that are created during precipitation events and flow over surfaces into sewer systems or sewer systems or receiving waters. All precipitation waters that leave project site boundaries on the surface are considered to be stormwater runoff volumes.

Supply Air – Air delivered to conditioned spaces for use in ventilating, heating, cooling, humidifying and dehumidifying those spaces.

Sustainable Forestry – The practice of managing forest resources in a manner that meets the long-term forest product needs of humans while maintaining the biodiversity of forested landscapes.

Sustainable Purchasing Policy – The preferential purchasing of products that meet sustainability standards. For LEED-EB MR Credits 4.1-4.3, the sustainable purchasing policy for cleaning products and materials should include all cleaning products, paper products and trashcan liners included in the EPA's Comprehensive Procurement Guidelines.

Sustainable Purchasing Program – Includes the development, adoption and implementation of an organizational policy that outlines the types of materials that will be targeted to meet the sustainability criteria of LEED-EB MR credits 2.1-2.5. Per the credit requirements, this program at a minimum must include office paper, office equipment, furniture, furnishings, and building materials for use in the building and on the site.

Tertiary treatment – The highest form of wastewater treatment that includes the removal of nutrients, organic and solid material, along with biological or chemical polishing (generally to effluent limits of 10 mg/L BOD_5 and 10 mg/L TSS).

Thermal Comfort – A condition of mind experienced by building occupants expressing satisfaction with the thermal environment.

Thermal Emittance – The ratio of the radiant heat flux emitted by a sample to that emitted by a blackbody radiator at the same temperature.

Threatened Species – Animal or plant species that are likely to become endangered within the foreseeable future (USGBC, LEED-NC Reference Guide 2003).

Tipping Fee – Fees charged by a landfill or incinerator for disposal of waste volumes (typically charged by the ton).

Tree Dripline – An imaginary line formed by projecting the edge of the tree's canopy onto the ground. The actual root zone around a tree is irregular and often two or more times the diameter of the dripline (Thompson and Sorvig 2000, 49).

Turbidity – The state of having sediment stirred up or suspended. Turbidity in lakes or estuaries affects water clarity, light penetration, and their suitability as habitat for aquatic plants and animals.

Underground Parking – A "tuck-under" or stacked parking structure that reduces the exposed parking surface area.

Uniform Building Code – A model building code published by the International Council of Building Officials (ICBO) that provides complete regulations covering all major aspects of building design and construction relating to fire and life safety and structural safety.

Urea-Formaldehyde Resin – A compound commonly found in many wood products intended for indoor use such as particle board and plywood. Products containing urea formaldehyde resin negatively impacts indoor air quality through the emission of formaldehyde, a chemical with known health side effects (EPA, Indoor Air Quality: The Inside Story—A Guide to Indoor Air Quality 2007).

Variable Air Volume (VAV) – A type of HVAC system that varies the volume of conditioned air delivered to rooms.

Vegetated Filter Strip (VFS) - Created areas of vegetation designed to remove sediment and other pollutants from surface water runoff by filtration, deposition, infiltration, adsorption, absorption, decomposition, and volatilization. A vegetated filter strip is an area that maintains soil aeration as opposed to a wetland that, at times, exhibits anaerobic soil conditions (EPA Polluted Runoff, Nonpoint Source Pollution 2005).

Vegetated Geogrid – Alternating layers of live branch cuttings and compacted soil with natural or synthetic geotextile materials wrapped around each soil lift to rebuild and vegetate eroded stream banks.

Ventilation – The process of supplying and removing air to and from interior spaces by natural or mechanical means.

Visible Transmittance (Tvis) – The ratio of total transmitted light to total incidental light. In other words, it is the amount of light passing through a glazing surface divided by the amount of light striking the glazing surface. A higher Tvis value indicates a greater amount of incident light is passing through the glazing.

Vision Glazing – Glazing that provides views of outdoor landscapes to building occupants for vertical windows between 2'6" and 7'6" above the floor. Vegetated Buffer - Strips of vegetation separating a water body from a land use that could act as a nonpoint pollution source. Vegetated buffers (or simply buffers) are variable in width and can range in function from a vegetated filter strip to a wetland or riparian area. Vegetated buffers can be set aside or restored riparian areas, constructed strips of vegetation used to remove pollutants in runoff, or a transition zone between an urbanized area and a naturally occurring riparian forest providing wildlife as well as aesthetic value (EPA Polluted Runoff, Nonpoint Source Pollution 2005).

Volatile Organic Compound (VOC) – VOCs include a variety of chemicals that are emitted as gases from certain solids and liquids. VOCs are found in thousands of common household products such as painting materials, cleaning supplies, office supplies and equipment, building materials, and pesticides. In high concentrations, such as in indoor spaces, these compounds have been found to cause both short and long term health problems (EPA, Indoor Air Quality: An Introduction to Indoor Air Quality—Organic Gases 2007).

Waste Disposal – The process of eliminating waste by means of burial in a landfill, combustion in an incinerator, dumping at sea, or eliminating waste in some other way that is not recycling or reuse.

Waste Diversion – Waste management activities that divert waste from disposal through incineration or landfilling. Typical waste diversion methods are reuse and recycling.

Waste Reduction – The process of reducing waste through practices that result in less waste that needs to be disposed of through landfilling or incineration. Two components of waste reduction are source reduction and diversion.

Waste Reduction Policy – The policy includes: 1) A statement describing the organization's commitment to minimize waste disposal by using source reduction, reuse and recycling, 2) assignment of responsibility within the organization for implementation of waste reduction program, 3) a list of the general actions that will be implemented in the waste reduction program to reduce waste, and 4) a description of the tracking and review component in the waste reduction program to monitor waste reduction success and improve waste reduction performance over time.

Waste Stream Production – The total flow of solid waste from homes, businesses, institutions, and manufacturing plants that is recycled, burned, or disposed of in landfills. Waste stream production is a volumetric measurement of the solid waste stream (EPA, Terms of Environment: Glossary, Abbreviations and Acronyms 2006).

Weathered Radiative Property – The solar reflectance and thermal emittance of a roofing product after three years of exposure to the weather.

Wetland - Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands, including swamps, marshes, bogs, and similar areas, are ecological systems that perform a range of functions (e.g., hydrologic, water quality, or aquatic habitat), as well as a number of pollutant removal functions (EPA Polluted Runoff, Nonpoint Source Pollution 2005).

Wood Waste – Unneeded or unusable wood from construction, demolition or renovation projects.

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Appendix A: LEED-NC Credits Not Covered by LEED-EB

According to sustainability practitioners, LEED-NC (for new construction) may be more appropriate for existing building rehabilitation projects that include HVAC installation, refurbishment, or replacement. If it is unclear which LEED rating system is more appropriate, military installations can rate their existing building projects using both the –EB and –NC systems and opt for the system that allows them to achieve a higher sustainability rating. To facilitate this comparison, see Table 6.3 below.

Table 6.3. LEED-NC credits not covered by LEED-EB.

Sustainable Sites	
Prerequisite 1 Construction Activity Pollution Prevention	Not Covered
Cr 1 Site Selection	Not Covered
Cr 2 Development Density & Community Connectivity	Not Covered
Cr 3 Brownfield Redevelopment	Not Covered
Cr 4.1 Alternative Transportation, Public Transportation Access	LEED-EB SS 3.1
Cr 4.2 Alternative Transportation, Bicycle Storage & Changing Rooms	LEED-EB SS 3.2
Cr 4.3 Alternative Transportation, Low Emitting & Fuel Efficient Vehicles	LEED-EB SS 3.3
Cr 4.4 Alternative Transportation, Parking Capacity	Not Covered
Cr 5.1 Site Development, Protect or Restore Habitat	LEED-EB SS 4
Cr 5.2 Site Development, Maximize Open Space	Not Covered
Cr 6.1 Stormwater Design, Quantity Control	LEED-EB SS 5.1 & 5.2
Cr 6.2 Stormwater Design, Quality Control	Not Covered
Cr 7.1 Heat Island Effect, Non-Roof	LEED-EB SS 6.1
Cr 7.2 Heat Island Effect, Roof	LEED-EB SS 6.2
Cr 8 Light Pollution Reduction	LEED-EB SS 7
Water Efficiency	
Cr 1.1 Water Efficient Landscaping, Reduce by 50%	LEED-EB WE 1.1 & 1.2
Cr 1.2 Water Efficient Landscaping, No Potable Use or No Irrigation	LEED-EB WE 1.1 & 1.2
Cr 2 Innovative Wastewater Technologies	LEED-EB WE 2

Cr 3.1 Water Use Reduction, 20% Reduction	LEED-EB WE 3.2 (Note: EB 3.1 only covers 10%)
Cr 3.2 Water Use Reduction, 30% Reduction	Not Covered
Energy & Atmosphere	
Prerequisite 1 Fundamental Commissioning of the Building Energy Systems	LEED-EB EA Prerequisite 1
Prerequisite 2 Minimum Energy Performance	LEED-EB EA Prerequisite 2
Prerequisite 3 Fundamental Refrigerant Management	LEED-EB EA Prerequisite 3
Cr 1 Optimize Energy Performance	LEED-EB EA 1
Cr 2 On-Site Renewable Energy	LEED-EB EA 2.1-2.4
Cr 3 Enhanced Commissioning	Not Covered
Cr 4 Enhanced Refrigerant Management	LEED-EB EA 4
Cr 5 Measurement & Verification	LEED-EB EA 5.1-5.3
Cr 6 Green Power	Not Covered
Materials & Resource	
Prerequisite 1 Storage & Collection of Recyclables	LEED-EB Prerequisite 1.2
Cr 1.1 Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	Not Covered
Cr 1.2 Building Reuse, Maintain 95% of Existing Walls, Floors & Roof	Not Covered
Cr 1.3 Building Reuse, Maintain 50% of Interior Non-Structural Elements	Not Covered
Cr 2.1 Construction Waste Management, Divert 50% from Disposal	LEED-EB MR 1.1
Cr 2.2 Construction Waste Management, Divert 75% from Disposal	LEED-EB MR 1.2
Cr 3.1 Materials Reuse, 5%	LEED-EB MR 2.1-2.5
Cr 3.2 Materials Reuse, 10%	LEED-EB MR 2.1-2.5
Cr 4.1 Recycled Content, 10% (post-consumer + 1/2 pre-consumer)	LEED-EB MR 2.1-2.5
Cr 4.2 Recycled Content, 20% (post-consumer + 1/2 pre-consumer)	LEED-EB MR 2.1-2.5
Cr 5.1 Regional Materials, 10% Extracted, Processed & Manufactured Regionally	LEED-EB MR 2.1-2.5
Cr 5.2 Regional Materials, 20% Extracted, Processed & Manufactured Regionally	LEED-EB MR 2.1-2.5
Cr 6 Rapidly Renewable Materials	LEED-EB MR 2.1-2.5
Cr 7 Certified Wood	LEED-EB MR 2.1-2.5
Indoor Environmental Quality	
Prerequisite 1 Minimum IAQ Performance	LEED-EB EQ Prerequisite 1
Prerequisite 2 Environmental Tobacco Smoke (ETS) Con-	LEED-EB EQ Prerequisite 2

trol	
Cr 1 Outdoor Air Delivery Monitoring	LEED-EB EQ 1
Cr 2 Increased Ventilation	LEED-EB EQ 2
Cr 3.1 Construction IAQ Management Plan, During Construction	LEED-EB EQ 3
Cr 3.2 Construction IAQ Management Plan, Before Occupancy	LEED-EB EQ 3
Cr 4.1 Low-Emitting Materials, Adhesives & Sealants	LEED-EB MR 3.1 & 3.2
Cr 4.2 Low-Emitting Materials, Paints & Coatings	LEED-EB MR 3.1 & 3.2
Cr 4.3 Low-Emitting Materials, Carpet Systems	LEED-EB MR 3.1 & 3.2
Cr 4.4 Low-Emitting Materials, Composite Wood & Agrifiber Products	LEED-EB MR 3.1 & 3.2
Cr 5 Indoor Chemical & Pollutant Source Control LEED-EB IEQ 5.1	
Cr 6.1 Controllability of Systems, Lighting	LEED-EB EQ 6.1
Cr 6.2 Controllability of Systems, Thermal Comfort	LEED-EB EQ 7.1 & 7.2
Cr 7.1 Thermal Comfort, Design	Not Covered
Cr 7.2 Thermal Comfort, Verification	Not Covered
Cr 8.1 Daylight & Views, Daylight 75% of Spaces	LEED-EB EQ 8.2
Cr 8.2 Daylight & Views, Views for 90% of Spaces	LEED-EB EQ 8.4
Innovation & Design Process (5 possible points)	
Cr 1.1 Innovation in Design	LEED-EB IUOM 1
Cr 1.2 Innovation in Design	LEED-EB IUOM 1
Cr 1.3 Innovation in Design	LEED-EB IUOM 1
Cr 1.4 Innovation in Design	LEED-EB IUOM 1
Cr 2 LEED Accredited Professional	LEED-EB IUOM 2

Appendix B: Survey of DoD Sustainability Projects

The following survey was compiled using USGBC, WBDG, and OFEE award listings. It does not include projects involving recycling, solid waste, AFV, and education/outreach programs exclusively because these programs would not invoke use of the SOI rehabilitation standards.

Department of Defense

2005

LEED Certified Remote Delivery Facility (RDF), Pentagon Renovation (PENREN), Arlington, VA

> While the RDF project did not directly involve any part of the historic Pentagon structure, efforts were made to make new RDF construction compatible with the historic character of the site, including considerations for historic viewsheds (WBDG HPC 2004).

2004

LEED Certified Pentagon Athletic Center, PENREN, Arlington, VA

> The project maximizes natural air and light in a subterranean facility as well as uses building materials with low VOCs and recycled content, and that are regionally manufactured and/or rapidly renewable. A green roof, a construction waste management plan, a heat recovery system and energy modeling are also implemented strategies of this green design (Pentagon Renovation & Construction website).

2003

LEED Certified Pentagon Metro Entrance Facility (MEF), PENREN, Arlington, VA

> While the MEF project did not directly involve any part of the historic Pentagon structure, efforts were made to make new RDF

construction compatible with the historic character of the site, including considerations for historic viewsheds (WBDG HPC 2004).

Air Force

2002

LEED Certified Physical Fitness Center, Barksdale Air Force Base (AFB), Shreveport, LA

Sustainable features include natural day lighting, rain water collection and reuse, high efficiency mechanical and electrical systems, low maintenance finishes, healthy indoor air quality, and regulated energy consumption (OFEE 2005).

1999

White House Closing the Circle Winner for Sustainable Design/Green Buildings-Military, F15 E Squadron Operations Building, Seymour Johnson AFB, NC

The project included the recycling of construction waste, building materials created with least environmental impact, and reduced energy consumption with the successful goal of providing a green building without increasing the overall cost (OFEE 1999).

Army

2004

White House Closing the Circle Award for Sustainable Design/Green Buildings-Military, Energy Efficient Model Home, U.S. Army Yuma Proving Ground, AZ

An energy efficient model home that includes solar heating, insulated panel walls, architectural shading, energy star appliances, low-flow fixtures, and drought tolerant planting. This effort shows the monetary savings possible from reduced resource use while also reducing environmental impact (OFEE 2003, 2004).

White House Closing the Circle Winner for Sustainable Design/Green Buildings-Military, Golden Knights Headquarters and 16th Military Police

Barracks complex, Fort Bragg, NC

The new headquarters included increased recycling, various encouragements alternative transportation, heat island and light pollution reduction strategies, and a stormwater collection and treatment system (OFEE 2003, 2004).

2003

A Gold SPiRiT Green Building Project for Fort Carson and the Piñon Canyon Maneuver Site, Fort Carson, CO

Construction of a 2,800 square foot Fort Carson training facility considered sustainability in the building's design. This included energy efficient features, and recycled-content construction materials and interior furnishings (Army 2003).

White House Closing the Circle Winner for Sustainable Design/Green Buildings-Military, Water Resources Management Process and System, U.S. Army Intelligence Center and Fort Huachuca, AZ

Fort Huachuca implemented a water management plan that includes treated wastewater reuse, water saving devices, low water use landscapes, and refrigerated air cooling. In addition the "Water Mitigation Policy" requires any increases in water use must be offset with an equivalent water conservation activity (OFEE 2003, 2004).

Navy

2006

White House Closing the Circle Award for Sustainable Design/Green Buildings-Military, Naval Base Ventura County, Building 850, Public Works Department, Port Hueneme, CA

In 2006 Port Hueneme received a Closing the Circle Award for the design and construction of an addition to and renovation of the Public Works Building 850 to become an energy showcase facility. The building is designed to demonstrate energy efficiency and sustainability in design, construction, and operation including daylighting, alternative energy, natural and underfloor ventilation and air distribution, and high efficiency pulse

boilers. The building received a LEED Gold rating at completion in 2001, and the CTC award acknowledges the building's success over time (OFEE 2006).

2005

LEED Certified Silver Personnel Support Facility, Naval Facilities Engineering Command, Virginia Beach, VA

The NAVFAC personnel support facility achieved LEED Silver with strategies that included protecting open space, reducing light pollution, water efficient interior and exterior, energy performance optimization, improved indoor air quality, and use of recycled and local materials (USGBC 2006).

2004

LEED Certified Navy Federal Credit Union Remote Call Center, Pensacola, FL

This naval facility qualified for LEED Gold in 2004 for achieving many sustainable building activities including reduced site disturbance, stormwater management, optimization of energy performance, and optimized indoor air quality (USGBC 2006).

LEED Certified Bachelor Enlisted Quarters Building, Bremerton BEQ Building 1044, Naval Base Kitsap-Bremerton, Bremerton, WA

This multi-unit residential building was built as part of a navy base housing complex. Site restoration, porous pavement, hardscape reduction, construction waste recycling, and a green housekeeping plan for maintenance staff are some examples of ways it is sustainable (USGBC 2003).

2003

White House Closing the Circle Award for Sustainable Design/Green Buildings-Military, Naval Facilities Engineering Command, Headquarters Building, Building 33, and Quadrangle Buildings, Washington Naval Yard, DC.

This project included complete renovation of four existing historic industrial structures and construction of one new linking structure for office, conference, and support spaces. The ultimate goal was to reduce life cycle costs, waste, and pollution genera-

tion while enhancing the work environment for greater employee health and productivity (WBDG 2006).

The site incurred environmental damage caused by the building's industrial past, so environmental damage was reduced through soil and aquifer remediation. Since the building interiors were completely reconstructed for adaptive reuse purposes, the primary historic preservation goal was to protect the outward character of the building and site. Certain standards were followed, including preservation of the building footprint, façade, historic masonry, window, and roof integrity (WBDG 2006).

Conflicts occurred between historic preservation and sustainability principles. For example, single-paned windows were maintained to retain exterior building character even though they are less energy efficient. However, significant project successes include a less than 8-month payback period for the initial additional costs for sustainable strategies, and a project completed within the Navy's budget (WBDG 2006).

2001

Energy and Sustainability Showcase Building, NBVC Port Hueneme, CA

NBVC Port Hueneme Building 850 is a demonstration facility with a LEED-NC Gold rating. The 59% renovation project (non-historic) demonstrates passive energy-efficient strategies and sustainable facility design, construction, and operation. It also functions as a living laboratory and educational tool (AIA/COTE 2004).

Appendix B references

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Appendix C: Additional Sustainability Resources

Cost-benefit data

Cost analysis for sustainability can be challenging because of the inherent difficulty in quantifying many issues, and the means for determining the most ecological choices for materials are often uncertain, unknown, or infeasible (Malin 2003). Many environmental concerns are outside our economic system or local jurisdiction and therefore are rarely valued, priced, or properly reported (Benson, Roe, and Millard 2000). Despite such difficulties, the following resources are useful tools for sustainable design and development cost analyses:

Building Momentum: National Trends and Prospects for High-Performance Green Buildings

http://www.usgbc.org/Docs/Resources/043003_hpgb_whitepaper.pdf

A report based on an April 2002 roundtable convened by the U.S. Senate Public Works and Environment Committee in conjunction with the U.S. Green Building Council. This report highlights components of green building (i.e., environmental, economic, health, and productivity) and further outlines specific recommendations for broadening and expanding the movement including strengthening existing federal policies and programs.

California Integrated Waste Management Board's Sustainable (Green) Building: Project Design—Cost Issues

http://www.ciwmb.ca.gov/greenbuilding/Design/CostIssues.htm

The thorough website covers a variety of green building issues including the benefits of green building design, cost realities, environmental assessment tools, and budgeting for green building.

Costing Green

http://www.usgbc.org/Docs/Resources/Cost_of_Green_Full.pdf#search=%27Costing%20Green:%20Davis%20Langdon

Davis Langdon is a global consulting service that provides a range of risk management and consulting services for clients investing in infrastructure, construction and property. The company conducted an in-depth study of current projects to analyze the cost of sustainable buildings. Using detailed cost estimates, the report compares 45 LEED to 93 non-LEED projects.

Green Building: Project Planning & Cost Estimating

Book by Arthur Adler, John Albrecht, James Armstrong, et al. (R.S. Means Company, 2002). A practical guide for constructing sustainable buildings written by a team of green building experts. Includes cost data for green materials and systems.

Green Developments: Integrating Ecology and Real Estate

Book by Alex Wilson, Jenifer L. Uncapher, Lisa A. McManigal, L. Hunter Lovins, Maureen Cureton and William D. Browning (Wiley, 1998). It covers lessons learned based on 80 case studies drawn from the extensive worldwide research and consulting work of Green Development Services in ways to make building green ultimately more profitable.

GSA LEED Cost Study

www.fypower.org/pdf/gsaleed.pdf

Study by Steven Winter Associates, Inc. (GSA, 2004). The U.S. General Services Administration (GSA) commissioned this study to estimate the costs to develop “green” federal facilities using the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) Building Rating System, Version 2.1.

Green products and materials

Frequently green alternatives involve making a choice between options that offer different assets and liabilities. For example, using recycled plas-

tic for a deck could be viewed as an asset in that the plastic is recycled and reduces deforestation. However liabilities include the energy and resources required to recycle the plastic, and possibly the aesthetic compromise of using plastic instead of wood. The plastic may have a higher initial cost, but it does not have the upkeep requirements of wood (e.g., chemical protectors) and has a longer lifespan. The consumer may choose wood for its lower embodied energy and up front savings, or choose the plastic for its longevity and lower lifecycle cost. The best choice typically depends on the project and the needs of the buyer. The following resources are useful tools for sustainable design and development purchasing:

ENERGY STAR Business Improvement: Purchasing and Procurement

www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing

This U.S. Environmental Protection Agency website provides a resource list designed to assist procurement officials in smart purchase decisions including cost savings calculators and online training.

EPA Environmentally Preferable Purchasing

http://www.epa.gov/oppt/epp/index.htm

This EPA resource was developed in 2005 to address Environmentally Preferable Purchasing (EPP). EPP is a federal-wide program that encourages and assists Executive agencies in the purchasing of environmentally preferable products and services.

Green Building Materials: A Guide to Product Selection and Specification

Book by Ross Spiegel and Dru Meadows (John Wiley and Sons, 1999). Practical advice on how to select and use nontoxic, recycled, and recyclable products, and how to integrate them into the design process to capitalize on the many practical and economic advantages of "going green"—from reducing waste and improving energy efficiency to promoting proper code compliance and safeguarding against liability claims.

Green Building Products: The GreenSpec Guide to Residential Building Materials

Book by Alex Wilson, Mark Piepkorn, and Susan Susanka (New Society Publishers; 2Rev Ed edition. 2006). The guide includes descriptions and manufacturer contact information for more than 1,400 environmentally preferable products and materials from ag-fiber panels to zero-VOC paints. All phases of construction, from sitework to flooring to renewable energy, are covered.

Green Guide to Specification: An Environmental Profiling System for Building Materials (3rd Edition)

Book by Jane Anderson (Blackwell Science, 2002). An assessment of environmental performance of more than 250 materials and components using researched, quantitative data derived from the BRE Environmental Profiles Database. BRE is the trading name of the Building Research Establishment Limited. Environmental Profiles are a method of presenting impartial and creditable environmental data about construction products.

Manitoba Green Procurement Network's Business and Sustainable Development: A Global Guide—Green Procurement

www.bsdglobal.com/tools/bt_green_pro.asp

This resource by the International Institute for Sustainable Development assists in the development of a procurement program and includes case studies, resources, energy efficiency, and environmentally-conscious manufacturing information.

Sustainable Construction: Green Building Design and Delivery

Book by Charles J. Kibert (John Wiley and Sons, 2005). A complete introduction to the design and construction of high-performance green buildings using the U.S. Green Building Council's Leadership in Energy and Environmental Design suite of standards to explain the best practices in building procurement and delivery systems. This resource provides a detailed overview of green building, including the theory, history, state of the industry, and best practices in green building.

LEED certification process

LEED certification provides independent, third-party verification that a building project meets the performance standards of the United States Green Building Council. The basic steps are provided below. For information on why to LEED certify, see http://www.usgbc.org/DisplayPage.aspx?CMSPageID=64&.

Step 1: Project Registration. Registering establishes contact with the USGBC and provides access to information, software tools and communications.

Step 2: Project team prepares documentation and calculations to satisfy the prerequisite and credit submittal requirements.

Step 3: Request any necessary credit interpretations specific to project.

Step 4: Satisfy requirements. Satisfy prerequisites and a minimum number of points to attain a LEED rating level by going through the certification review process either online or on paper.*

Step 5: Certification. Within 30 days the USGBC issues a preliminary LEED review document noting credit achievement. In addition, up to six prerequisites and/or credits will be selected for audit. The project team has 30 days from the receipt of the preliminary review to provide corrections and/or additional supporting documents.

Step 6: Final LEED Review. Conducted within three weeks of receiving the resubmittal. Upon receipt of the LEED certification, the project team has 30 days to accept or appeal the awarded certification. (LEED Online Review is currently available for LEED-NC v2.1, LEED-NC v2.2, LEED-CI v2.0, and LEED-EB v2.0).

* The application will include (1) printed LEED letter template and requested submittals, (2) required fee, (3) LEED registration information, including project contact, type, size, etc., (4) overall project narrative with at least three highlights, (5) LEED project checklist/scorecard with a totaled score, and (6) drawings and photos illustrative of the project.

Appendix C references

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Appendix D: The Secretary of the Interior's Standards for Rehabilitation

The SOI rehabilitation standards, codified in 36 CFR 67, are design criteria applicable to historic properties that require alterations (i.e., repair and replacement of features) and additions for efficient contemporary use Table 6.4).

Table 6.4. The Secretary of the Interior's Standards for Rehabilitation.

Standard Number	Topic	Description
1	Find compatible use.	A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2	Preserve historic character.	The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3	Add no conjectural features.	Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4	Preserve significant changes.	Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5	Preserve examples of craft.	Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6	Repair or match features.	Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7	Use gentle, appropriate treatments.	Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8	Preserve, mitigate archeology.	Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9	Compatible new additions.	New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10	Reversible new additions.	New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

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This report presents technical information to incorporate sustainable design principles into historic buildings owned by the Department of Defense (DoD). The study follows the U.S. Green Building Council's Leadership in Energy and Environmental Design rating system for Existing Buildings (LEED-EB), Version 2.0, June 2005, and provides specific discussion and strategies relevant both to historic preservation and sustainable design and development. The intent is to provide technical, feasible ways that the DoD can utilize LEED-EB criteria on historic buildings.

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