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Planning, Engineering, and Design of Sustainable Facilities and Infrastructure

An Assessment of the State of Practice

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Executive Summary

The Army, Air Force, and Navy have developed policies that require sustainable design and development of their installations. These policies meet and, in many cases, exceed presidential directives on environmentally appropriate practices. In this context of military installations, "sustainability" means the ability to execute the current mission without compromising the ability of future generations to meet their needs. This applies locally to future military missions, regionally to community needs, and globally to the military's impact on mankind and the environment.

This report demonstrates that both the government and the private sector are moving ahead rapidly to develop and implement sustainable practices for facilities and the activities that take place within them. It identifies opportunities for the Corps of Engineers to be a major national source of expertise that carries the knowledge of what sustainability is, into engineering practice. The approach for accomplishing the practical realization of sustainable engineering is to develop engineering tools that capture rapidly developing knowledge about sustainable practices that spans all phases of a facility life cycle. The facility life cycle phases encompass planning, design, construction, commissioning, operation and maintenance, rehabilitation, re-use, and disposal.

The plan is to conduct the research necessary to bring together the issues of measuring sustainability, rating sustainability, identifying strategies that ensure sustainable delivery and management of installations, and determining life-cycle costs within direct research program of the ERDC. The plan is then to provide the tools that combine these decisions about sustainability in a medium that is easy to use for the end user. This will require:

- Expanding the constituency for delivering engineering products to designers and users of sustainable facilities
- Evolving the indices and metrics for sustainability of facilities during all phases of their life cycles
- Developing planning, design, design, construction, commissioning, operation and maintenance, rehabilitation, and disposal strategies for facilities that are sustainable, yet have a readily identifiable life cycle cost
- Developing accessible knowledge tools that support sustainable practices.

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Foreword

This study was conducted for the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE) under project 40162784AT45, "Energy Technologies Applied to Military Facilities"; Work Units CF-X50, "Program Integration and New Sustainable Design Strategic Planning (CRREL)"; CN-X20, "Greening through the Government through Waste Prevention, Recycling, and Federal Acquisition"; and CF-X30, "Greening the Government through Efficient Energy Management." The technical monitors were Harry Goradia, Henry Gignilliat, Joe McCarty, and Ray Navidi.

The work was performed by the Civil Engineering Research Division Branch (ERDC-RR), Cold Regions Research and Engineering Laboratory (CRREL), the Environmental Processes Branch (CN-E), of the Installations Division (CN), and the Engineering Processes Branch (CF-N) and the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CRREL Principal Investigator was Stephen N. Flanders. CERL researchers Richard L. Schneider (CN-E), Donald Fournier (CF-E), Brian Deal (CF-E), Annette Stumpf (CF-N), and Michael Case (CF-N). Michael Case is Chief, CECER-CF-N, and L. Michael Golish is Operations Chief, CECER-CF. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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1 Introduction

Background

The Earth has a limited ability to supply resources to civilization and to absorb its wastes. This fact has caused a continuing reassessment of the viability of our existing urban form, current development patterns, and construction practices. Inefficient and resource intensive buildings are major contributors to negative global environmental trends. It is essential to create a more energy-efficient urban landscape and buildings that populate it. For example, to stabilize atmospheric carbon and reverse global climate change, we must reduce our fossil energy use by about 70 percent. This will require a rapid and radical change in the energy consumption patterns of the built environment—including those facilities that the Department of Defense (DOD) owns and maintains. As conditions change, the DOD must transition its installations to a more sustainable and benign energy and environmental posture.

Current trends to deregulate utilities and improve the cost effectiveness of new renewable energy and distributed electrical generation technologies will fundamentally change the structure of the power grid (Flavin and Lenssen 1994). This technological transformation will significantly alter energy sources and flows and portends the end of the oil age. Credible sources believe that world oil consumption will surpass production within the next decade (Campbell and Laherrere 1998). Others feel that this event is still another 20 to 40 years in the future (Wood, Long et al. 2000). When this event occurs (and it will), the supply/demand crossover will produce an oil price rise that will overshadow the dislocations of the 1970s. Domestic oil production has been decreasing since 1970; oil imports represent over 50 percent of total consumption and their share is increasing. The nation has become increasingly dependent on foreign oil and is more vulnerable to shortages and supply disruptions (Romm and Curtis 1996). This vulnerability may make the crossover point less of a factor and U.S. vulnerability to cartel practices more important. Either way, the United States is ill equipped to deal with the coming economic and sociopolitical implications of sudden oil shortages and price shocks. Negative global impacts from the current resource consumption patterns, especially the use of fossil fuel, are rapidly becoming more serious. The realities of climate change and ecological overload are being felt worldwide (Vitousek, Mooney et al. 1997).

John Holdren, in the prologue to *Energy Efficiency and Human Activity*, states that we are now in transition to a higher cost energy supply system. The higher costs, although not currently reflected in the commodity price, result from resource depletion, unacceptable environmental impacts, and other sociopolitical ramifications (Schipper, Meyers et al. 1992). Holdren contends that although we are not running out of energy in the absolute sense, we are running out of the capacity to expand or continue our present energy supply patterns and technology at a low cost. Ignoring subsidies and externalities while focusing on a low energy commodity cost continues to be fundamental to the growth of material wealth in the United States. The resources required for U.S.-style consumption patterns worldwide simply are not available (Goodland, Daly et al. 1992). In fact, sustaining the current level of worldwide consumption may already exceed the Earth's capacity (Daly 1994). If action is not taken soon, ecological systems may fail in the foreseeable future (Meadows, Meadows et al. 1992).

The analyses outlined above indicate a break from the long-held assumption of indefinite growth. Industrial civilization is at a critical point in its reliance on the carrying capacity of the earth. The technological, lifestyle, and population choices we make in the next few decades will determine the course of the global ecosystem (McKibben 1998).

Military communities worldwide are among the dominant consumers within their societies. They, as much as any of us, must work to diminish their environmental impacts. One of the most productive areas to start is with the environmental impacts and energy consumption of military bases. In fact the President has ordered the entire Federal government to follow this more benign path with a series of Executive Orders (EOs) addressing the "greening of the government." They are EO 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition"; EO 13123, "Greening the Government through Efficient Energy Management"; EO 13148, "Greening the Government through Leadership in Environmental Management"; and EO 13149, "Greening the Government through Federal Fleet and Transportation Efficiency."

The U.S. Army can continue and augment its role as a national environmental leader by addressing these global issues and vigorously implementing those executive orders. That leadership starts with a coherent dialogue and increased awareness in the Army (and Department of Defense [DOD]) of the issues relating to sustainable development and includes a discussion of the basic terms and ideas of sustainable practices.

Objectives

The general goal of this study was to develop a coordinated sustainable design research agenda to identify the potential for improving the Corps of Engineers' effectiveness in providing sustainable facilities to its the Army, DOD, and the Nation; and to identify the technologies that can be developed or mobilized to attain that end. Specific objectives implicit in achieving that goal were: (1) to investigate the driving forces that cause elements of the Federal government to follow sustainable practices, (2) to specify the stakeholders that are pursuing sustainability, and (3) to specify the responders who are providing the tools to achieve sustainability and the approaches that they have devised.

Approach

The status of sustainable design was reviewed at multiple levels, beginning with the Army and the Corps of Engineers and extending outwards through DOD, the Federal government, into the state of practice in the private sector. Economic, technical, and policy factors affecting sustainable design were identified and evaluated, as were analysis tools for potential inclusion in the sustainable design methodology. Technologies that could establish and sustain Corps of Engineers leadership in sustainable design were assessed. Program linkages were established with other sources of expertise and funding. Public, private, and commercial organizations with an interest, involvement, or ability to contribute to the development of sustainable design, were investigated and evaluated for the possible role they may play in sustainable design.

Mode of Technology Transfer

This work will contribute to the development of engineering tools that capture rapidly developing knowledge about sustainable practices that spans all phases of a facility life cycle. The facility life cycle phases encompass planning, design, construction, commissioning, operation and maintenance, rehabilitation, re-use, and disposal.

2 The Concept of Sustainability

Understanding Sustainability

Sustainability became an issue of wide public concern and international debate during the 1980s. The Worldwatch Institute measured "progress toward a sustainable society" in its annual State of the World reports (Brown 1984). The U.S. Congress enacted the Food Security Act of 1985 that initiated a program in "Low Input Sustainable Agriculture" to help farmers use resources more efficiently, protect the environment, and preserve rural communities. The World Commission on Environment and Development (via the Brundtland Commission report 1987) called for Sustainable Development to "meet the needs of the present without compromising the ability of future generations to meet their own needs." The concept of sustainable manufacturing has also been given some attention recently (Geiser 1991). The published discussion about sustainability is growing rapidly (see especially Brown 1981, Costanza 1991, and Meadows 1992).

Some experts disagree regarding the precise meaning and implications of the concept of "sustainability." According to Charles Kidd (1992), the term sustainability first appeared in print in 1972 in the book *Blueprint for Survival*, which was concerned with creating a sustainable society and critical of the environmental destruction and the "ethos of expansion" in modern industrial societies. For some, the term sustainability is synonymous with "conservation," which seeks to reconcile preservation with technological progress and economic growth. For others, especially those who believe that technological progress and economic growth cannot be reconciled with preservation, sustainability requires us to transform our concepts of "progress" and the nature of industrial societies to be more harmonious with the balance of nature.

Daly and Cobb (1989) argue that one of our leading indicators of economic progress in the United States, the Gross National Product (GNP), does not appropriately account for the environmental and social costs of economic growth. Because economic expansion apparently gains at the expense of valued social arrangements, and environmental resources do not appear to be sustainable in the long-term, they proposed alternative indices of sustainable economic welfare that took such external costs into account.

Others have attempted to develop biophysical indicators of sustainable development and sustainability. Some others present a catalog of indicators that individuals or groups can choose from based on their interests, values, and ideas about sustainability. Some indicator systems focus on such narrowly defined aspects of sustainability as energy use or water quality, which allow them to be more precise and less ambiguous. Rather than specific indicators, William McDonnough and partners have articulated the Hanover Principles, which are general principles to be used in the process of sustainable design (McDonnough 1992). The conceptual vagueness and uncertainty of the term "sustainability" means that such indices reflect the values of their proponents in the absence of a societal consensus.

Defining Sustainability

As noted, the World Commission on Environment and Development included the concept of sustainable development in its report, *Our Common Future* (WCED 1987). Of primary concern in the report is the apparent conflict between the conventional growth model for development and the sustained maintenance of conditions for life on earth. The report underscores the need for economic development to alleviate poverty and limitations of opportunity experienced by most of the world's people. It attempts to outline alternative paths and conceptions of development that consider long-term social and environmental costs that result from conventional approaches to development.

The Brundtland Commission's widely quoted definition focuses on development to meet the needs of present and future generations. This definition may be augmented by explicit recognition that preserving environmental integrity will, in some settings, impose limits on "meeting human needs." For this reason, the Task Committee on Sustainability Criteria of the American Society of Civil Engineers (ASCE 1998) developed an alternative definition for sustainable water resource systems: "Sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity." They observed that demand management is every bit as important as supply management (ASCE 1998)

Norgaard (1988) proposes that sustainability involves the co-evolution of human societies with their natural environments on several different scales: local, regional, and global. Boulding (1991) presents several concepts of sustainability: static equilibrium, dynamic equilibrium, cybernetic equilibrium, and evolutionary equilibrium. He appears to favor the concept of evolutionary equilibrium

when describing social and ecological systems. However, he does not suggest criteria by which humans should interfere with or guide evolutionary processes. In his model, preventing irreversible changes to natural ecosystem processes is a critical aspect of sustaining the environment. Touman (1992) suggests that minimum standards be established for prohibiting irreversible damage to ecosystems.

In his review of the scientific literature supporting the idea of sustainability, Charles Kidd (1992) argued that, since the concept can be deduced from several different assumptions and scientific perspectives, there are likely to be legitimate differences of opinion regarding its meaning and interpretation for given situations. He concluded that the search for a single definition of sustainability would appear to be futile and suggested that people who use the term give an explicit definition for their use of it. However, since the biosphere is intricately and irreversibly interconnected, search for a consistent approach is warranted. Ecologist Garrett Hardin contends that

> No single way will suffice to administer the affairs of what some people call "Spaceship Earth." There must be some sort of fragmentation of administrative tasks, though a universal approach is needed for the protection of the commons of air and water (Kidd 1992).

In the long term, the fate of the earth's civilizations and ecosystems depends not on our definitions, but on our conduct.

Sustainability and the Built Environment

In the built environment, sustainability through sustainable development is viewed as a strategy by which communities seek to improve the natural environment and the communal quality of life. It has become an important guide to many communities that have discovered that traditional approaches to planning and development are creating, rather than solving, societal and environmental problems. Where traditional approaches can lead to congestion, sprawl, pollution, and resource depletion, the concept of sustainable development suggests more lasting solutions that have the ability to strengthen over time.

In "Toward Some Operational Principles of Sustainable Development," Herman Daly (Daly 1980) distinguishes between growth and development as the difference between expanded quantity and improved quality:

- *To grow*—to increase naturally in size by the addition of material through assimilation or accretion.
- *To develop*—to expand or reach the potential of bringing gradually to a fuller, greater or better state.

He states that "the human economy is a subsystem of a finite global ecosystem which does not grow, even though it does develop ... economic growth cannot sustain itself over long periods of time" (Daly 1980).

Buildings and communal structure are important components in the human evolutionary and domestication process (Wilson 1988). The building professions need to recognize the differences between growth, development, and the stability of a community. Builders can no longer focus only on individual buildings without consideration for the impacts that the construction, destruction or renovation these buildings have on the environment. The built environment should be viewed in terms of the quantitative (energy, disposal, material cycling etc.) and qualitative (neighborhood impacts, etc.) impressions that the structures make on the community.

The quantification of building impacts should start with the consequences of the acquisition of resources; the transportation of those resources; the processing of resources into usable materials, products, or equipment; the generation of wastes and toxins in these processes; the transportation of these manufactured goods; the assembly of those components into the building itself; the effect of the building as it sits on and alters the land; the flow of resources through that building during its life span, both to maintain the structure and the comfort and services we require, such as water and wastewater, electricity and gas, conditioning the air, etc.; the modifications that might be made to the building during its life; and finally the consequences of the eventual demolition and disposal or reuse of the materials that comprise the building (Eisenberg 1997). Current building and community development models exclude almost all of these impacts from their scope of concern.

Energy

The United States has always been a resource-rich nation. Virtually all of its vast resources of coal, oil, and natural gas were untapped until about 150 years ago. Until then, the major sources of energy were waterpower, wood for fuel, and muscle power. We were a nation short on people and long on resources. America's appetite for energy has always been great, roughly quadrupling from 1880 to 1918. For much of its history, the United States was self-sufficient for energy,

although small amounts of coal were imported from England in colonial times. Through the late 1950s, production and consumption of energy remained for the most part in equilibrium. The 1960s, however, bring a new and increased energy appetite and consumption begins to outpace production, creating a gap that continues to widen to present day.

The efficiency with which Americans use energy has improved over the years. This efficiency is measured as the amount of energy to produce a constant dollar's worth of gross domestic product (GDP). By this measure, efficiency increased 47 percent between 1949 and 1999—the energy required for a dollar of GDP (1992 dollars) fell from about 20.6 kBtu to about 10.9 kBtu. Yet, a growing population and economy drove up total annual consumption from 30 quadrillion Btu (quads) to 97 quads during the same time period, leading to a per capital energy consumption rise of 65 percent.

In 1999, the United States spent approximately $500 billion for 97 quads of energy. Unfortunately, 23 quads of this were imported, adding $71 billion to our negative balance of trade and thereby contributing to U.S. dependence on international energy trade. The sectoral breakout of total U.S. energy use is 34.2 quads for residential and commercial, 36.5 quads for industry, and 25.9 quads for transportation. About 85 percent of the U.S. energy supply is fossil fuel based. Fossil fuels are finite and nonrenewable on the time scale of human history (EIA 2000). The annual U.S. carbon emissions from fossil fuel usage are about 5.48 billion metric tons (carbon equivalent of 1.5 Billion metric tons).

In 1999, electric utility power generation required 32.6 quads of energy (22.6 quads as fossil fuels) to deliver 11.1 quads of electricity to customers. An amazing amount of the electrical system's consumption, 21.4 quads, was waste heat transferred to the environment. The losses from conversion, in-plant usage, transmission, and distribution add up to more than the fossil fuel input, representing extreme inefficiency (EIA 2000). In 1998, the electric power industry, through its inefficiencies and technical obsolescence, emitted about 550 million metric tons of carbon, two-thirds of which are from waste heat. In 1999, retail sales of electricity was 35 percent to residential, 30 percent to commercial, 32 percent to industrial, and 3 percent to other, e.g., transportation, etc. (EIA 2000).

The current system of energy supply and patterns of energy use in the United States offers many opportunities for economic and environmental improvement. The United States continues to use high-polluting energy sources such as coal and oil, and relatively inefficient technologies, which slows productivity advances, harms human health, and has been associated with global environmental impacts such as climate change (DiCicco, Lashof et al. 1997). We are us-

ing late 19th century energy system technology and philosophy to enter the 21st century. This is certainly a risky and environmentally hazardous endeavor. The capacity for local action to enhance the sustainability of the nation is immense (Allen, McKeever et al. 1996).

Most military installations are small cities; their building stock has energy use and efficiency patterns similar to their surrounding communities. One major difference between military installations and their civilian community counterparts in terms of energy use is that military installations tend to rely on central heating plants with distribution systems, which—unless they are properly maintained—may contribute to significant energy waste. This tendency can be offset by adopting a more environmentally "benign" posture for installations, which influences how land is used, how buildings are constructed, and how energy systems designed and operated. The built environment itself, along with the entire building design and construction community, has significant inertia to keep on its present path. Chances for changing our development pattern will remain low without tools and techniques to evaluate the true impacts of these patterns and show the benefits of integrating sustainable practices into the built environment.

3 Vanguards of Sustainable Development

Some of the private sector leaders in sustainable development (taken in alphabetical order) are the American Institute of Architects, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the Green Building Council, and the Natural Resources Council. These span the spectrum between conservative engineering societies to environmental activists.

American Institute of Architects

The Architectural profession, through the American Institute of Architects defines sustainable design as:

> In its broadest scope, sustainability refers to the ability of a society, ecosystem, or other ongoing system to continue functioning into the indefinite future, without being forced into decline through exhaustion or overloading of the key resources on which that system depends *(AIA 1996)*.

The AIA advocates:

- designing buildings so they are minimal consumers, and may even be generators of energy and other resources
- using building materials that have a benign impact on the environment throughout their life cycle in their acquisition, manufacture, placement, use, recycling, and eventual disposal
- constructing buildings with internal environments – air quality, lighting, spatial design, and aesthetics – that are health-giving and inspiring
- arranging buildings so that they foster community and so that most people, most of the time, can have high-quality lives at home, at work, while shopping and elsewhere within their community all within walking distance or cycling distance
- developing urban areas and regions so that they have natural environments, including parks, greenbelts, or countryside, within walking distance of every residence
- developing the infrastructure of public transit, roads, bike paths, utilities, and communications so that community at the human scale is enhanced, va-

riety is readily accessible, and the automobile is optional for most people, most of the time (AIA 1996).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

In their position paper on global climate change ASHRAE recognizes the importance of the environment as a point of comparison with economic considerations:

> ASHRAE will take a leadership role in promoting the use of life cycle, environmental, and economic impact assessments in building design and operation. The scientific evidence clearly suggests that responsible, cost-effective measures should be adopted in the building industry. Care must be taken to ensure that near-term economic concerns do not discount long-term environmental impact *(ASHRAE 1999).*

ASHRAE notes that buildings should be evaluated based on their projected energy requirements and emissions. Energy-related impacts are addressed by reducing the energy consumption of equipment, systems, and buildings and by modifying user behavior. Current technologies provide the tools (like TRANE Systems Analysis, BLAST, and DOE2) for the design and application of comprehensive energy-savings techniques in buildings and for the selection and proper use of energy efficient equipment and system integration. The engineering profession has also helped minimize harmful emissions of ozone damaging and greenhouse gasses to the environment, as a consequence of the design, manufacture, installation, and operation of equipment, and through the installation, recovery, and ultimate disposal of working materials.

ASHRAE standards now consider energy conservation and environmental impact in the design of buildings. Some of the new standards are written in code format and may be incorporated in local building codes. The selection and control of energy systems is the starting point for determining energy consumption during a building's lifetime. Intelligent use of other design options may permit reducing the size of energy systems and their energy consumption. These include alternative:

- building envelopes, types of insulating materials
- lighting and daylighting methods
- glazing and fenestration systems
- natural ventilation and energy-recovery opportunities
- operational control of temperature and environmental quality.

The manufacturing and delivery phases of building components and materials also have environmental and energy implications. (ASHRAE 1999).

Green Building Council

The Green Building Council (GBC) is a nonprofit coalition that represents leading international organizations including product manufacturers, environmental leaders, design professionals, retailers, and building owners. The mission of this coalition is to accelerate the adoption of green building practices, technologies, policies, and standards. The committee-based organization, is attempting to move the green building industry forward with market-based solutions and industry to government links. To accomplish these goals the GBC has formed partnerships and priority programs with key Federal agencies, including the Department of Energy (DOE), U.S. Environmental Protection Agency (USEPA), National Institute for Science and Technology (NIST), and General Services Administration (GSA) (GBC 1999).

The GBC's stated vision policy—"Green Buildings and Communities for a Healthy and Prosperous Planet"—includes three priority areas for its activities:

- Market Transformation (the LEED™ green building rating system)
- Integration and Education of Membership (website committee, ASTM green building committee, meetings/conferences)
- Government / Industry Partnership Programs (State and local green building initiatives committee, Federal government committee) (GBC 1999).

The Natural Resources Defense Council

Environmental groups like the Natural Resources Defense Council (NRDC) have been some of the main, long-term drivers of the sustainability movement. The NRDC's stated purpose is to:

> safeguard the Earth: its people, its plants and animals, and the natural systems on which all life depends. We work to restore the integrity of the elements that sustain life – air, land, and water – and to defend endangered natural places. We seek to establish sustainability and good stewardship of the Earth as central ethical imperatives of human society. The NRDC affirms the integral place of human beings in the environment. We strive to protect nature in ways that advance the long-term welfare of present and future generations. We work to foster the funda-

> mental right of all people to have a voice in decisions that affect their environment. We seek to break down the pattern of disproportionate environmental burdens borne by people of color and others who face social or economic inequities. Ultimately, NRDC strives to help create a new way of life for humankind, one that can be sustained indefinitely without fouling or depleting the resources that support all life on Earth *(NRDC 1999).*

The Environmental Defense Fund

Another national environmental group, the Environmental Defense Fund (EDF) describes sustainable development as – "a shared vision of a better tomorrow." The strength of a sustainable community is thought to be its ability to integrate economic, environmental, and social forces to forge innovative, enduring, and comprehensive solutions to current and future challenges (EDF 1999).

These concepts have led to the development of an environmental sustainability kit. The kit is a set of tools (ideas, procedures, and resources) to help local leaders, residents, and businesses work toward making their own communities more sustainable. The environmental sustainability kit focuses on the environmental and pollution prevention aspects of a sustainable community effort. According to the EDF:

> Pollution prevention has been shown to be a win-win solution for society, for the economy, and for the environment. In addressing and implementing pollution prevention opportunities in our communities, we can show real, demonstrable, and measurable successes. This can mean developing "Good Neighbor" agreements between residents and local industries, promoting policies that encourage pollution prevention, or creating community supported agriculture cooperatives. Building on initial success, the local community can turn to other problems-and take further steps toward the long-term goal, a sustainable community *(EDF 1999).*

4 The Federal Government's Role in Sustainable Design and Development

The executive branch of the Federal government has actively pursued issues of sustainable development. The President has appointed several commissions on the topic that have produced executive orders for his signature. At the same time most government agencies have been active in sustainable development, both as pioneers and in fulfillment of the executive orders.

Executive Orders

All Federal agencies, including the Department of Defense and the Army, cite the following Executive Orders (EO), issued during the past 6 years, as the source of direction for sustainable practices. They change the core business practices for design, construction, and operation of Federal facilities. These EOs include but are not limited to:

- EO 12873, "Federal Acquisition, Recycling, and Waste Prevention," 6 August 1993 (superceded by EO 13101)
- EO 12902, "Energy Efficiency and Water Conservation at Federal Facilities," March 8, 1994 (superceded by EO 13123)
- EO 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," 14 September 1998
- EO 13123, "Greening the Government Through Efficient Energy Management," 03 June 1999
- EO 13148, "Greening the Government Through Leadership in Environmental Management," April 22, 2000
- EO 13149, "Greening the Government Through Federal Fleet and Transportation Efficiency," April 21, 2000.

EO 12873 requires the incorporation of waste prevention and recycling in the daily operations and that efforts be made to give a preference and demand for recovered materials to support market expansion in recyclables. To actualize these requirements, the EO states in part:

> In developing plans, drawings, work statements, specifications, or other product descriptions, agencies shall consider the following factors: elimi-

> nation of virgin material requirements; use of recovered materials; reuse of product; life cycle cost; recyclability; use of environmentally preferable products; waste prevention (including toxicity reduction or elimination); and ultimate disposal, as appropriate. [Sec. 401. Acquisition Planning]
>
> ... each agency shall develop and implement affirmative procurement programs in accordance with RCRA section 6002 (42 USC 6962) and this order. Agencies shall ensure that responsibilities for preparation, implementation and monitoring of affirmative procurement programs are shared between the program personnel and procurement personnel. [Sec. 402. Affirmative Procurement Programs.]

EO 12902 mandates the improvement of energy efficiency and water conservation, and an increase in the investment in solar and other renewable energy types in Federal buildings, owned or leased. To actualize these requirements, the EO requires that, in part:

> Each agency shall develop and implement a program with the intent of reducing energy consumption by 30 percent by the year 2005. [Sec. 301. Energy Consumption Reduction Goals]

Each agency shall develop and implement comprehensive energy and water consumption facility audits. [Sec. 302. Energy and Water Surveys and Audits of Federal Facilities.]

Implement energy efficiency and water conservation projects within specified periods of time following auditing. [Sec. 303. Implementation of Energy Efficiency and Water Conservation Projects]

The development and implementation of appropriate programs to reduce the use of petroleum in buildings and facilities by switching to nonpetroleum-based energy source. [Sec. 305. Minimization of Petroleum-Based Fuel Use in Federal Buildings and Facilities]

That each agency involved in new facility construction, whether to be owned or leased, shall "design and construct such facility to minimize the life cycle cost of the facility by utilizing energy efficiency, water conservation, or solar or other renewable energy technologies; ... ensure that the design and construction of facilities meet or exceed the energy performance standards applicable to Federal residential or commercial buildings; ... implement a facility commissioning program that will ensure construction meeting energy and water requirements; ...

[and] ... utilize passive solar design and adopt active solar technologies where they are cost-effective." [Sec. 306. New Space]

EO 13101 requires that the head of each executive agency incorporate waste prevention and recycling in the agency's daily operations and work to increase and expand markets for recovered materials through greater Federal Government preference and demand for such products [Sec 101]. It further requires that agencies develop and implement cost-effective programs and procedures for the effective acquisition and use of environmentally preferable products and services favoring the purchase of environmentally preferable products.

EO 13123 addresses energy conservation mandating that the "The Federal Government, as the Nation's largest energy consumer, shall significantly improve its energy management to save taxpayer dollars and reduce emissions that contribute to air pollution and global climate change." It sets energy reduction goals, greenhouse gas reduction goals, and requires sustainable design principles be applied to the siting, design, and construction of new facilities.

EO 13148 requires Federal agencies to ensure that all necessary actions are taken to integrate environmental accountability into day-to-day decisionmaking and long-term planning processes. Environmental management must be a fundamental and integral component of policies, operations, planning, and management. Toxic releases and off-site transfers for treatment of toxic chemicals is to be reduced by 40 percent by the end of CY 2006. Pilot programs are to be established in life cycle assessments and environmental cost accounting. Pollution prevention is defined as the preferred way to meet compliance requirements.

EO 13149 requires agencies to reduce petroleum requirements for their vehicle fleets by 20 percent from 1999 to 2005. This is to be accomplished through the use of alternative fuels, the acquisition of vehicles with higher fuel economy, the use of hybrid vehicles, an increase in vehicle load factors, a decrease in vehicle miles traveled, and a decrease in fleet size.

Federal Agencies with Programs/Activities of Most Interest to Corps/Department of the Army

The following Federal Agencies programs and activities appear to have the highest level potential application by the Corps of Engineers and/or the Army for their programming, design, planning, and facilities operations and management activities. Refer to write-ups for the individual agencies for a more complete list of agencies and their activities as well as broader explanations.

U.S. Department of Commerce (DOC), Building for Environmental and Economic Sustainability (BEES), http://www.bfrl.nist.gov/oae/software/bees.html;

U.S. Department of Energy (DOE):

- Center of Excellence for Sustainable Development (CESD), http://www.sustainable.doe.gov/
- Office of Energy Efficiency and Renewable Energy (EERE), http://www.eren.doe.gov/
- PLACE^{3}S: The Energy Yardstick, http://www.sustainable.doe.gov/articles/place3s.htm
- DOE-2, http://gundog.lbl.gov/dirsoft/d2whatis.html, and Energy-10, http://www.nrel.gov/buildings/energy10/, Building Energy Use Analysis Software
- *Greening Federal Facilities,* http://www.eren.doe.gov/femp/greenfed/index.html
- *Sustainable Building Technical Manual,* http://www.sustainable.doe.gov/articles/ptipub.htm.

U.S. Department of the Interior, National Park Service (NPS), Guiding Principles of Sustainable Design, http://www.nps.gov/dsc/dsgncnstr/gpsd/toc.html.

U.S. Environmental Protection Agency (USEPA),

- Environmentally Preferable Purchasing (EPP) Program, http://www.epa.gov/opptintr/epp/
- ENERGY STAR Program, http://www.epa.gov/energystar.html
- Comprehensive Procurement Guidelines (CPG), http://www.epa.gov/cpg/.

Green/Sustainability Federal Agencies' Programs/Activities

A wide variety of "sustainable design" activities is occurring within agencies of the Federal Government. Sustainability is increasingly recognized and has been adopted both as an essential element of each agency's mission and as a way of doing business. All agencies cite as their principle drivers Executive Orders 13102 and 13123 (and their predecessors). The following information does not represent a comprehensive search for, identification of, or evaluation of Federal Agencies programs, rather it is the result a "quick" search and review of the situation as evidenced in the various Internet sites of the organizations. Agencies having some "sustainability" activities regardless of the type, depth and breadth are listed, along with whatever primary resources, guidance and references that have been identified. The following is a listing of Federal government agencies and their programs that are actively developing sustainable practices. Appendixes A and B to this report summarize, respectively, resources and offices

in the Federal government with activities related to sustainability. Appendix C lists documents that include regulatory guidance related to issues of sustainability.

- U.S. Department of Agriculture (USDA)
- U.S. Department of Commerce (DOC)
- U.S. Department of Defense (DOD)
- U.S. Department of Energy (DOE)
- U.S. Department of Housing and Urban Development (HUD):
- U.S. Department of the Interior, National Park Service (NPS)
- U.S. Department of Transportation (DOT)
- U.S. Environmental Protection Agency (USEPA)
- U.S. General Services Administration (GSA)
- U.S. Postal Service (USPS)
- Other Federal Agencies/Collaborations.

Non-DOD Programs

U.S. Department of Agriculture

Programs

The U.S. Department of Agriculture, through the extension service of the U.S. Forest Service,* aids in connecting people to resources, ideas and one another so they can better care for forests and sustain their communities. Three programs reflect their sustainability activities:

- Economic Action Programs, which help rural communities and businesses dependent on forest-based resources become sustainable and self-sufficient
- Landowner Assistance Programs, which help private landowners protect, improve, restore, and sustain forests
- The Urban and Community Forestry Program, which helps people in urban areas and community settings to sustain shade trees, forest lands, and open spaces.

* http://www.fs.fed.us/spf/coop/

Conclusions – U.S. Department of Agriculture

Activities of the U.S. Department of Agriculture have limited applicability to the Corps and Army sustainable development activities, however, ought to be considered in site, land, landscaping, and land management areas.

U.S. Department of Commerce

NOAA Office of Sustainable Development and Intergovernmental Affairs (SDIA)

The Office of Sustainable Development and Intergovernmental Affairs (SDIA)* is a policy office within the National Oceanic and Atmospheric and Administration (NOAA)† at the Department of Commerce (DOC),‡ created in 1993 to better serve as stewards of the nation's ocean and coastal resources. The SDIA partners§ inside and outside of the Federal government promote sustainable development solutions to advance NOAA's Strategic Goals, environmental stewardship and environmental assessment and prediction. This SDIA has been directly involved in staffing the President's Council on Sustainable Development (PCSD).** Most directly, NOAA is dedicated to Building Sustainable Fisheries and Sustaining Healthy Coasts. SDIA employs a working definition of Sustainable Development as public policies, which effectively integrate the concepts of economic development, environmental stewardship, and social equity. The SDIA has devised programs of economic relief and protection for threatened natural resources through the adoption of long-term strategies to rebuild sustainable fisheries in partnerships with governments, private industry, community, and environmental groups these areas.

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* http://www.nnic.noaa.gov/HQ/

† http://www.noaa.gov/

‡ http://www.doc.gov/

§ http://www.susdev.noaa.gov/partner.html

** http://www.whitehouse.gov/WH/EOP/pcsd/

Sustainable Communities Program

Run by the NOAA SDIA, the Sustainable Communities Program* fosters sustainable coastal communities and coastal brownfields redevelopment. In the United States, the development of sustainable coastal communities is critical. Sustainable development proposes that economics, the environment and social equity issues must be in balance if to serve the long-range interest of citizens.

Aquaculture and Economics

The NOAA SDIA,† is involved in efforts to rethink patterns of production and consumption, and to create the necessary markets, technologies, and institutional mechanisms to allow for the development of a more sustainable coastal economies. These efforts include developing new analytical tools for policy makers and planners, and support for the development of aquaculture through partnerships with the private sector, scientific researchers, and the development of a strong and practical regulatory framework to guide this growing sector of the fisheries industry. At the same time we have offered assistance to coastal communities to relieve the short-term economic pressures that are so often a barrier to promoting sustainability.

The Interagency Working Group on Brownfields

NOAA leads the Interagency Working Group on Brownfields,‡ which was established in July 1996 so that Federal agencies could exchange information on the subject and coordinate their activities to galvanize support for brownfields across the nation.

Brownfields are abandoned, idled, or underused industrial or commercial properties where expansion or redevelopment is complicated by real or perceived contamination. The redevelopment of brownfields offers a unique opportunity to revitalize urban areas using existing infrastructure and transportation modes while preserving valuable green space and natural resources. However, developers often choose the more rural fringes of urban areas as predictable and attrac-

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* http://www.susdev.noaa.gov/commun.html

† http://www.susdev.noaa.gov/aqucult.html

‡ http://www.susdev.noaa.gov/brwnflds.html

tive, in the process promoting urban sprawl and the depletion of green space. However, local, State, and Federal governments have recently been working hard to create incentives for redeveloping these blighted areas.

The Clinton Administration has been actively promoting sustainable development practices throughout the nation; recognizing partnerships that link environmental protection with economic development and social equity are key to improving communities. Redevelopment of brownfields embodies the principles of sustainable development.

National Institute of Standards and Technology – Building and Fire Research Laboratory

Performance Standards System for Housing (PSSH)

The Building and Fire Research Laboratory is developing performance standards for the housing industry. The Performance Standards System for Housing (PSSH)* is a suite of industry supported, national and international housing performance standards. These standards represent a system for the procurement and evaluation of housing that will more readily allow for and should encourage the use of innovative designs, products and processes leading to improved quality, lower life-cycle costs of housing to consumers and increased competitiveness for U.S. companies. The suite is to include in addition to the performance criteria, means for evaluating, measuring, and predicting housing performance. BFRL is developing the standards in partnership with other government agencies, industry volunteers, and consultants, including the National Association of Home Builders (NAHB) Research Center and the National Evaluation Service's Building Innovation Center (NES-BIC).

Current products within the suite include in part:

- a guide for preparation of performance standards
- pre-standard guides for structural safety and serviceability, fire safety, durability, functionality, and accessibility.

The most applicable component of PSSH for Army Sustainability applications is Building for Environment and Economic Sustainability (BEES).†

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* http://www.bfrl.nist.gov/860/ps98/pssh.htm

† http://www.bfrl.nist.gov/oae/software/bees.html

Building for Environmental and Economic Sustainability (BEES)

BEES * is a decision support software tool for designers, builders, and product manufacturers to effectively balance environmental and economic performance characteristics of building products when making selection decisions. Developed by the National Institute of Standards and Technology (NIST) Green Buildings Program, the Windows® tool uses consensus based standards and is designed to be practical, flexible, and transparent. It includes actual environmental and economic performance data for a number of building products.

BEES measures the environmental performance of building products by using the environmental life-cycle assessment approach specified in the latest versions of ISO 14000 draft standards. It analyzes all stages in the life of a product: raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Economic performance is measured using the ASTM standard life cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental and economic performances are combined into an overall performance measure using the ASTM standard for Multi-Attribute Decision Analysis. UNIFORMAT II, the ASTM standard classification for building elements, is used to classify building products in a BEES Analysis.

The Building and Fire Research Laboratory is refining and expanding the BEES methodology under the sponsorship of USEPA's Environmentally Preferable Purchasing (EPP) program to meet requirements of EO 13101.

Partnership for Advancing Technology in Housing (PATH) Cooperative Research Program (PATH-CoRP)

The National Evaluation Service, Inc. (NES), through its Building Innovation Center (NES-BIC) is implementing a new program† directed at innovators of housing technology. The program provides assistance in accelerating the widespread use of innovative housing technologies. This new NES-BIC Supplemental Evaluation Program (SEP) will assist technology developers by providing partially subsidized support for the evaluation and assessment of their technology. NIST supports the SEP through the Partnership for Advancing Technology in

* http://www.bfrl.nist.gov/oae/software/bees.html

† http://www.bfrl.nist.gov/info/pathcorp/pr_pathcorp.htm

Housing (PATH), a government-industry partnership to spur housing design and construction innovations.

Conclusions—U.S. Department of Commerce

Of the U.S. Department of Commerce sustainability activities, those of the Building and Fire Research Laboratory, have the highest potential application for the Corps and the Army. Their research is focused on tools to evaluate, measuring, and predicting the performance of housing. Their software tool, Building for Environmental and Economic Sustainability (BEES), has potential for measuring the environmental life-cycle performance for Army facilities.

U.S. Department of Energy

U.S. Department of Energy* conducts a wide range of sustainable activities at its laboratories and facilities, many focused on energy sustainability. They view sustainable development (SD) as a strategy by which communities seek economic development approaches that also benefit the local environment and quality of life. Sustainable Development is not a new concept. It is the latest expression of a long-standing ethic involving people's relationship with the environment, and the current generation's responsibilities to future generations. For a community to be truly sustainable, it must adopt a three-pronged approach that considers economic, environmental, and cultural issues. Communities must consider these needs not only in the short term, but also in the long term (DOE 1999). DOE appears to be positioning itself as the government leader in sustainable issues.

Programs

Center of Excellence for Sustainable Development (CESD)

The U.S. Department of Energy's Center of Excellence for Sustainable Development† is a national program operated by DOE's Denver Regional Support Office. The Center helps communities define and implement sustainable development strategies as part of their comprehensive community planning efforts. The Center introduces communities to a wide array of environmental technologies and

* http://home.doe.gov/index.htm

† http://www.sustainable.doe.gov/

sustainable redevelopment planning practices, and to programs that can help them implement sustainable development strategies.

The DOE Center of Excellence for Sustainable Development is prepared to support community development strategies that use economic development approaches that benefit the local environment and quality of life. Sustainable strategies have become important guides to many communities that have discovered that traditional approaches to planning and development are creating, rather than solving, societal and environmental problems. Where traditional approaches can lead to congestion, sprawl, pollution, and resource overconsumption, sustainable development offers real, lasting solutions that will strengthen our future.

Sustainable development provides a framework under which communities can use resources efficiently, create efficient infrastructures, protect and enhance quality of life, and create new businesses to strengthen their economies. It can help us create healthy communities that can sustain our generation, as well as those that follow us.

In summary, CESD supports the long-term recovery and redevelopment of community assets through assistance in definition and implementation of sustainable development community planning strategies. It strives to:

- provide resources and technical expertise to help solve energy related technical problems
- facilitate partnerships with communities with sustainable redevelopment experience
- organize and coordinate national experts design teams in their long-term recovery and redevelopment efforts
- conduct customized Internet searches for resource information.

PLACE^{3}S: The Energy Yardstick

PLACE^{3}S*I is an urban planning method designed to help communities discern an effective path toward sustainability. It employs energy as a yardstick to measure the sustainability of urban design and growth management plans. PLACE^{3}S uses a Btu-based accounting system to evaluate how efficiently an ur-

* http://www.sustainable.doe.gov/freshstart/articles/place3s.htm

ban area uses its land, provides housing and jobs, moves people and materials, operates buildings and public infrastructures, sites energy facilities, and uses other resources. PLACE^{3}S integrates public participation, planning, design, and quantitative measurement into a five-step process appropriate for regional and neighborhood-scale assessments.

Operation Fresh Start

Operation Fresh Start* helps individuals and communities incorporate sustainable principles and technologies into their plans when recovering from flood, earthquake, or other disasters. This initiative is coordinated by a partnership between DOE's Center of Excellence for Natural Disaster Remediation (CENDR) and the Center of Excellence for Sustainable Development (CESD).

CENDR assists communities with short-term response and recovery efforts using energy efficiency and renewable energy to reduce human suffering and economic loss. CESD assists communities in utilizing a wide array of sustainable development practices and technologies for long-term recovery and redevelopment. Operation Fresh Start is a gateway to information from a variety of Federal agencies responsible for support in disaster recovery. Operation Fresh Start offers a host of resources to communities to help them rebuild in a healthier, more energy efficient, less expensive, safer, and more livable sustainable fashion.

Center of Excellence for Natural Disaster Remediation

Short-Term Response and Recovery Activities—technologies to mitigate the initial loss, to aid in the immediate response to address vital needs, and to promote rapid recovery from disasters:

- emergency power management, and photovoltaic power generation
- solar thermal water heating for domestic hot water at emergency shelters
- biomass-based power generation equipment
- information and technical support for energy efficient and renewable energy technologies.

* http://www.sustainable.doe.gov/freshstart/index.htm

DOE's Center of Excellence for Sustainable Development*

Long-Term Recovery and Redevelopment Activities. Assistance in definition and implementation of sustainable development community planning strategies:

- Resources and technical expertise to help solve energy related technical problems
- Facilitate partnerships with communities with sustainable redevelopment experience
- Organize and coordinate national experts design teams in their long-term recovery and redevelopment efforts
- Conduct customized Internet searches for resource information.

Sustainable Building Technical Manual

A manual, the "Sustainable Building Technical Manual: Green Building Design, Construction, and Operations,"* produced jointly by the U.S. Department of Energy (DOE), Public Technology, Inc. (PTI), the U.S. Green Building Council (USBGC), and the U.S. Environmental Protection Agency shows how to design, operate, and maintain environmentally friendly buildings. This manual is one of the most comprehensive publications now available to help architects, developers, building owners, government officials, and others implement sustainable development practices. It contains practical, step-by-step advice on sustainable buildings written by some of the foremost experts in the field.

Pollution Prevention Information Clearinghouse

DOE operates a clearinghouse of centralized information on pollution prevention called EPIC or Pollution Prevention Information Clearinghouse.†

LBNL Environmental Energy Technologies Division

The Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory's Center for Building Science‡ develops technologies that use, convert and store energy more efficiently and with less environmental impact,

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* http://www.sustainable.doe.gov/

* http://www.sustainable.doe.gov/freshstart/articles/ptipub.htm

† http://epic.er.doe.gov/epic/HTML/DESIGN.HTM

‡ http://eetd.lbl.gov/

and studies the link between energy use and the environment. An important outcome of its work is the development of technologies and processes to mitigate the environmental effects of energy use. Established in 1973 in response to concerns about the cost, availability, and environmental effects of energy generation and consumption, major research thrusts today address making residential and commercial buildings more energy-efficient, and maximizing the health and productivity of building occupants.

Sustainability activities include:

- developing energy-efficient windows and energy-efficient ballasts for electronic lights, in cooperation with window and lighting industries
- creating major software tools for better building design
- understanding indoor air quality problems and developing solutions
- research on fuel cell technologies
- development of cleaner and more efficient combustion processes for water heaters and boilers.

DOE-2 Building Energy Use Analysis Software

DOE-2* is an up-to-date, unbiased, and well-documented public-domain computer program for building energy analysis for the building construction and research communities. It provides building designers with the capability to quickly determine the choice of building parameters that improve energy efficiency while maintaining thermal comfort. A user can provide a simple or increasingly detailed description of a building design or alternative design options and obtain an accurate estimate of the proposed building's energy consumption, interior environmental conditions, and energy operation cost. DOE-2 predicts the hourly energy use and energy cost of a building given hourly weather information and a description of the building and its HVAC equipment and utility rate structure.

DOE-2 is in its final release and will be superceded by EnergyPlus,™ which is scheduled for its first public release in early 2001. EnergyPlus™ has a website at http://www.eren.doe.gov/buildings/energy_tools/energyplus.htm, which is kept up to date with beta and release information.

* http://gundog.lbl.gov/dirsoft/d2whatis.html

The DOE-2 web site provides access to additional energy analysis software tools for buildings, with an emphasis on using renewable energy and achieving energy efficiency and sustainability in buildings*:

- Whole Building Systems—Energy simulation
- Load Calculation
- Renewable Energy
- Retrofit Analysis
- Sustainability/Green buildings
- Materials Components and Equipment Systems
- Envelope Systems
- HVAC Equipment and systems
- Lighting Systems
- Other Applications
- Codes and Standards.

The Simulation Research Group of Lawrence Berkeley National Laboratory (LBNL) developed and maintains DOE-2.†

DOE Design for Environment (DfE)

The U.S. Department of Energy, EM-77, Office of Pollution Prevention, *Pollution Prevention by Design* (P2 by Design) project‡ has developed an integrated set of tools to help engineers, designers, and planners incorporate pollution prevention strategies into the design stage of new products, processes, and facilities. The Pacific Northwest National Laboratory (PNNL)§ manages P2 by Design. The Oak Ridge National Laboratory has a new *Pollution Prevention by Design project* website http://p2.pnl.gov:2080/DFE/finldfe.html. The DOE's Office of Project and Fixed Asset Management has played a significant role in the current status of DOE's DfE efforts and the Savannah River Site has been involved as well.

The PNNL P2 by Design Project offers an integrated set of tools to help engineers and designers incorporate pollution prevention strategies during the de-

* http://www.eren.doe.gov/buildings/tools_directory/

† http://gundog.lbl.gov/

‡ http://p2.pnl.gov:2080/DFE/

§ http://www.pnl.gov/

sign of new products, processes, and facilities to reduce life cycle costs and increase materials and energy efficiency.

DOE Energy Efficiency and Renewable Energy Network (EREN)

The Office of Energy Efficiency and Renewable Energy (EERE)* develops and deploys efficient and clean energy technologies that meet our nation's energy needs, enhance our environment, and strengthen our national competitiveness.

Building Energy Efficiency

The U.S. Department of Energy's Office of Building Technology (BTS), State and Community Programs and Federal Energy Management Program† offers a wealth of information about energy-efficient building technologies at their web site http://www.eren.doe.gov/EE/buildings.html. Topics include energy-efficient lighting, appliances, and heating and cooling equipment; insulation and other weatherization retrofit materials; high-performance windows; automatic and "smart" controls; solar buildings; "whole buildings" that integrate these technologies; community programs; and related codes and standards. The Office of Building Technology (BTS) goals include:

- accelerating the introduction of highly efficient technologies and practices through research and development
- increasing the minimum efficiency of buildings and equipment through codes, standards and guidelines
- encouraging use of energy efficiency and renewable energy technologies and practices through technology transfer and financial assistance.

Federal Energy Management Program (FEMP)

The primary mission of the Federal Energy Management Program (FEMP)‡ is to reduce the use and cost of energy in the Federal sector by advancing energy efficiency, water conservation, and the use of solar and other renewable energy sources. FEMP accomplishes its mission§ by leveraging both Federal and private resources to provide technical and financial assistance to other Federal agencies.

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* http://www.eren.doe.gov/

† http://www.eren.doe.gov/buildings/

‡ http://www.eren.doe.gov/femp/

§ http://www.eren.doe.gov/femp/aboutfemp/fempoverview.html

These agencies then take actions and make investments to increase energy efficiency and renewable energy utilization, and reduce water consumption at their facilities. A sample of relevant FEMP programs includes:

Project Financing – FEMP assists agencies in choosing and implementing projects through funding partnerships with the private sector that augment the limited appropriations for Federal energy efficiency projects.

Energy Savings Performance Contracts (ESPCs) – allow energy service companies (ESCOs) to assume the capital costs of installing energy and water conservation equipment and renewable energy systems. The ESCO guarantees a fixed amount of energy savings throughout the contract life and is paid directly from those savings. The agency retains the remainder of the energy cost savings, and assumes full ownership of the equipment and all the savings after the contract expires.

The FEMP Service Network (FSN) provides one-stop technical support and procurement expertise and services to agencies when implementing alternatively financed energy project.

FEMP training, on-site audits, design assistance, and new technology applications help agencies identify the best, most cost-effective energy efficiency, water saving, and renewable energy projects.

FEMP New Technology Demonstration Program

FEMP's New Technology Demonstration Program* introduces new energy-efficient technologies to the Federal sector more quickly, narrowing the gap between private sector and Federal deployment of new technologies. The program also helps Federal agencies implement pollution prevention strategies and reduce operations and maintenance costs through the adoption of energy-efficient and renewable technologies. The program uses two strategies to accomplish its goals: technology demonstration programs, where technologies are installed and evaluated at a Federal facility, and information dissemination through Federal Technology Alerts, Technology Installation Reviews, and Technology Focuses.

* http://www.eren.doe.gov/femp/prodtech/newtechdemo.html

Greening Federal Facilities

*Greening Federal Facilities** is a resource guide for Federal facility managers to assist them in reducing energy consumption and costs, improving the working environment of the facilities they manage, and reducing the environmental impacts of their operations.

National Renewable Energy Laboratory (NREL)

The National Renewable Energy Laboratory (NREL)† is a national laboratory owned by the U.S. Department of Energy and managed by Midwest Research Institute, Battelle Memorial Institute and Bechtel National, Inc. NREL's mission is to lead the nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science and engineering, and facilitating commercialization of renewable technologies.

Congress established NREL through the Solar Energy Research Development and Demonstration Act of 1974. Originally called the Solar Energy Research Institute, NREL began operating in July 1977 and was designated a national laboratory of the U.S. Department of Energy in September 1991. Ongoing research programs address almost 50 areas of scientific investigation including energy and efficiency, photovoltaics, wind energy, biomass-derived fuels and chemicals, energy-efficient buildings, advanced vehicles, solar manufacturing, industrial processes, solar thermal systems, hydrogen fuel cells, superconductivity, geothermal, and waste-to-energy technologies.

Energy-10*

Energy-10 is a PC-based software design tool to help architects and building designers quickly identify the most cost-effective, energy-saving measures for small commercial and residential buildings. It can identify the best combination of energy-efficient strategies, including daylighting, passive solar heating, and high-efficiency mechanical systems. ENERGY-10 is the software component of Designing Low-Energy Buildings with ENERGY-10, a collaborative project of the

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* http://www.eren.doe.gov/femp/greenfed/index.html

† http://www.nrel.gov/

*, http://www.nrel.gov/buildings/energy10/,

National Renewable Energy Laboratory's Center for Buildings and Thermal Systems, the Sustainable Buildings Industry Council, Lawrence Berkeley National Laboratory, and the Berkeley Solar Group.

High-Performance Building Research

High-performance building research* at the NREL reduces energy consumption in residential and commercial buildings through development of whole-building design methods and computer programs that integrate passive solar, energy efficiency, and renewable energy technologies.

Pacific Northwest National Laboratory (PNNL)"P2 by Design" Project

The Pacific Northwest National Laboratory (PNNL) http://www.pnl.gov/ P2 by Design Project http://p2.pnl.gov:2080/DFE/finldfe.html offers an integrated set of tools to help engineers and designers incorporate pollution prevention strategies during the design of new products, processes, and facilities to reduce life cycle costs and increase materials and energy efficiency.

Conclusions – Department of Energy

Many activities of the U.S. Department of Energy have a high potential for immediate application for the Corps and/or Army or are already being put to use. The DOE's Center of Excellence for Sustainable Development and Office of Energy Efficiency and Renewable Energy (EERE) are continually developing tools and technologies of importance to Corps/Army sustainability efforts and are essential resources. DOE's PLACE^{3}S might be effectively used in installation master planning to assess sustainability at the "community" and regional levels. The *Sustainable Building Technical Manual* and *Greening Federal Facilities* would be excellent tools for Army implementation sustainable development and operational practices. DOE-2 Building Energy Use Analysis Software and Energy-10 are two of the many DOE developed energy analysis software tools that would help Army designers to quickly determine the appropriate choice of building parameters to optimize energy efficiency.

* http://www.nrel.gov/buildings/highperformance/

U.S. Department of Housing and Urban Development

Programs

Sustainable Communities

The U.S. Department of Housing and Urban Development's (HUD) primary focus in the area of "sustainability" from a quick scanning of available information on the Internet is on the promotion of sustainable communities in partnership with local community governments and organizations. *"The State of the Cities 1999, Third Annual Report,"* establishes HUD's directions for sustainability. "HUD recognizes that truly viable, sustainable communities are developed by the hard work, vision, and dedication of the people who live and work within them. HUD can support these efforts with critical resources and broad national objectives, but it is the community—government, nonprofit groups, residents, faith-based organizations, educators and others—with its own unique expertise and energy, which must design strategies that best address the needs and opportunities.

One major HUD partner in sustainability is *The Joint Center for Sustainable Communities*. The Joint Center for Sustainable Communities* is a collaboration between the U.S. Conference of Mayors (USCM)† and the National Association of Counties (NACo)‡ in support of our nation's communities. Its primary mission is to provide a forum for cities and counties to work together to develop long-term policies and programs that will lead to job growth, environmental stewardship and social equity – the three pillars of sustainable communities. The Joint Center is helping local elected officials build sustainable communities by promoting community leadership initiatives, providing technical assistance and training, and conducting community policy and educational forums.

While *"The State of the Cities 1999, Third Annual Report"*§ addresses broad HUD sustainability goals and objectives, those most pertinent to installations/facilities sustainable development, design and management are contained

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* http://www.usmayors.org/uscm/sustainable/

† http://www.usmayors.org/uscm/

‡ http://www.naco.org/

§ http://www.huduser.org:80/publications/polleg/tsoc99/contents.html

in Part Two, "The 21st Century Agenda for Cities and Suburbs," Chapter D. "Promoting Smarter Growth and Livable Communities."*

HUD's budget for FY00,†‡ "opening doors for more Americans," promotes partnering for sustainability and demolition of blighted abandoned buildings as major sustainability activities.

FY00 Challenge # 4 Finding Regional Solutions and Creating Sustainable Communities

- *Regional Connections* ($50 million) funds are "... competitive grant funds that states, partnerships of local governments, businesses, non profits, and community groups can use to develop smarter growth strategies across jurisdictional lines."
- *Redevelopment of Abandoned Buildings Initiative* ($50 million) funds are "... competitive grants to local Governments to support the demolition of blighted abandoned buildings as part of a comprehensive plan to redevelop properties for commercial or for residential use.

The HUD Office of *Community Planning and Development*§ is the central point of contact for HUD's sustainable development initiatives. They are the proponent office for management of and provision of guidance on Community Connections/Consolidated Planning, a "process" for community plan development and Federal grant distribution to support sustainable planning initiatives.

HUD's program for *Community Connections/Consolidated Planning* "enables communities to link environmental health, physical renewal, economic growth, and improved human services into a seamless community revitalization strategy. ... It provides a framework for undertaking community development that interconnects needs, determines priorities, identifies resources, and tailors a plan for meeting those particular needs." An overview of the planning process is provided at http://www.hud.gov/progdesc/conplan.html. Further information on these plans may be found at http://www.hud.gov:80/cpd/conplan.html and guidance on their development may be found at http://www.hud.gov:80/cpd/hud_ch1.html.

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* http://www.huduser.org:80/publications/polleg/tsoc99/part2-4.html

† http://www.hud.gov:80/bdfy2000/budgprev.html

‡ http://www.hud.gov:80/nofa/nofa99/suprnof3.html

§ http://www.hud.gov:80/cpd/cpdhome.html

Brownfields Redevelopment

HUD's *Brownfields Redevelopment Initiative* (BRI)* provides funds and loan guarantees to clean up and redevelop environmentally contaminated industrial and commercial sites, commonly known as "brownfields." BRI provides important "start-up" funds to attract private financing for brownfields cleanup and redevelopment. HUD is not alone in this endeavor. HUD, along with 15 other Federal agencies, is committed to focusing attention on brownfields redevelopment and to providing local governments with the tools to achieve this goal.

Innovative Homebuilding Technology, Design, and Development

HUD's *Building Innovation for Homeownership* (BIH) program is an initiative by the National Partners in Homeownership that identifies housing projects across America that employ innovative homebuilding technology, design, and development to make affordable housing and homeownership a reality. These "lessons learned" are then shared with others in the publication "Building Innovation for Homeownership," available from HUD's Office of Policy Development and Research, http://www.huduser.org/. The most recent publication recognizes 63 award-winning housing projects from across the United States chosen based on the ability of designers, developers, and contractors to adopt new technology when developing affordable housing projects. Costs of the homes in winning projects were below the median costs of new family housing.

Deconstruction/Demolition/Waste Management

HUD sustainability initiatives for FY00 include $50 million for the *Redevelopment of Abandoned Buildings Initiative* [see FY00 "challenges" above]. This new program will address one aspect of urban neighborhood blight, abandoned apartment buildings, single-family homes, warehouses, office buildings, and commercial centers. Competitive grants will be provided to local governments to support demolition or deconstruction as part of a holistic plan to redevelop properties for commercial use or for single and multifamily housing. These plans will require significant private-sector participation.

This program would provide an average of $30,000 per building to pay for demolition; deconstruction; debris removal; environmental remediation of soils; and

* http://www.hud.gov:80/progdesc/brownf.html

site preparation. The applications will require local governments to demonstrate a redevelopment plan with significant private sector and local government commitment. Applicants would be required to demonstrate that rehabilitation is not feasible or effective and that historic buildings would be protected. More information on the program may be found at:

http://www.hud.gov:80/bdfy2000/summary/cpd/rab.html

Military Base Reuse and Homeless Assistance

All Federal real property, land, and buildings that are owned and underutilized, unutilized, or deemed to be excess or surplus must be reported for screening for potential use as facilities to assist the homeless in accordance with the McKinney Homeless Assistance Act (10 USC 2546). Although there are many Federal agencies involved in the McKinney process, HUD is responsible only for the screening of excess facilities to determine their suitability to assist the homeless. HUD is the only agency with the authority to make suitability determinations.

HUD determines the suitability of a property for use as a facility to assist the homeless without regard to any particular use. The screening process addresses potential risks to individuals and the environment, siting issues, such as placement within airport safety zones, secured areas, flood zones, or within hazardous material safety zones, and documented deficiencies that represent a clear threat to personal physical safety that may include extensive deterioration or contamination. Once the screening process is complete, the General Services Administration (GSA) is responsible for any subsequent real property transaction, including disposal, if warranted.

More information on the McKinny program is available at:

http://www.hud.gov/cpd/titlev.html

and

http://www.hud.gov/cpd/mbrmain.html.

Conclusions – U.S. Department of Housing and Urban Development

Few of the HUD programs, activities and resources, are directly applicable to Corps' support for the Army. Of most use is the *Building Innovation for Homeownership* (BIH) program in that it provides lessons learned for any facility planning, design, construction, and/or operational changes that may be appro-

priate. Others are less applicable. Sustainable Communities activities may be pertinent in that Installations have a lot to learn when it comes to effectively partnering with communities in the provision of facilities, goods and services in a sustainable fashion. Similar lessons might be drawn from HUD's Brownfields Redevelopment Initiative (BRI) and demolition or deconstruction activities.

Design for the Environment (DfE) Program—little application, mostly important to modifications of manufacturing processes and materials for "sustainability, however, as end user, consumer, designer, should participate in processes.

U.S. Department of the Interior, National Park Service

Programs

Greening the National Parks Through Environmental Leadership

The legislation that established the National Park Service in 1916 mandated management of national parks, monuments and reservations "in such a manner that future generations will be able to enjoy them unimpaired." This 1916 definition is a close parallel to the Brundtland Commission's definition of sustainable development as, "... development which meets the needs of the present without compromising the ability of future generations to meet their own needs." On that basis, the NPS has been practicing sustainability for 83 years.

The National Park Service defines sustainable design as "a concept that recognizes that human civilization is an integral part of the natural world and that nature must be preserved and perpetuated if the human community itself is to survive." Design, therefore, is sustainable when it embodies the principles of conservation and encourages the application of those principles in our daily lives.

The National Park Service, like the Army, is the steward of vast areas of public land. Therefore; it views sustainability in a regional ecosystem context. Their definition of sustainability encompasses the concept of bioregionalism, "the idea that all life is established and maintained on a functional community basis and that all of these distinctive communities (bio-regions) have mutually supporting life systems that are generally self-sustaining. The concept of sustainable design holds that future technologies must function primarily within bioregional patterns and scales. They must maintain biological diversity and environmental integrity, contribute to the health of air, water, and soils, incorporate design and construction that reflect bioregional conditions, and reduce the impacts of human use." With a focus on the management of public lands "in such a manner that future generations will be able to enjoy them unimpaired" the NPS defini-

tion of sustainability is simply the "capability of natural and cultural systems being continued over time."

In the early nineties, the National Park Service initiated efforts to modify their planning, design and park operation processes to address sustainable practices. They authored the *"Guiding Principles of Sustainable Design,"** which became the foundation for all NPS sustainable practices. Further information on the NPS' view towards sustainable development may be found in Chapter 1 of the guide, *"The Concept of Sustainability."*†

In early 1999, NPS held an environmental leadership summit to develop a program to establish the National Parks as leaders in sustainability and environmental compliance through a "Greening of the National Park Service."‡ The NPS in partnership with the Department of Energy and the Department of Interior have established "Green Parks: Making the National Parks a Showcase for an Energy Efficient Future."§ A pan-NPS Sustainability Committee** is leading the implementation of sustainable practices throughout the National Park Service.

The NPS as result of the summit has established a "Green Toolbox" web site as a source of information to utilize in support the further "greening" of activities at the park level:

http://www.nps.gov/renew/toolbox.htm

Sustainable Practices and Opportunities Plan

The NPS *Sustainable Practices and Opportunities Plan* (SPOP) process†† is a collaborative and educational tool to aid park staff move to more sustainable practices in park operations. SPOP evaluations include all aspects of a park unit such as operations, maintenance, concession and visitor services, law enforcement, resource protection, employee and visitor facilities, procurement, waste

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* http://www.nps.gov/dsc/dsgncnstr/gpsd/

† http://www.nps.gov/dsc/dsgncnstr/gpsd/ch1.html

‡ http://www.nps.gov/renew/.

§ http://www.nps.gov/renew/mou.htm

** http://www.nps.gov/renew/committee.htm

†† http://www.nps.gov/sustain/spop/index.html

handling, and energy usage. Once park activities and operational practices along with resource-based parameters are understood, SPOP identifies ways to improve the health of the park's fiscal condition by strengthening its environmental balance sheet. This is accomplished by recommending "Best Management Practices" (BMPs) that will reduce environmental effects and costs. The goal is not to find fault with existing facilities or operations, but to explore ways the parks can incorporate sustainable practices into their daily activities.

National Park Service—Specification Development

The National Park Service's Denver Service Center is responsible for the technical development and continual updating of the National Park Service (NPS) Guide Specifications and Standard Details. Under their Specifications Development Program they are currently updating NPS Guide Specifications* to address the principles of sustainable design and construction.

Conclusions – National Park Service

Work of the National Park Service (NPS), with the highest immediate potential application is their *Guiding Principles of Sustainable Design* and other sustainable activities of the Denver Design Center.

U.S. General Services Administration

Congress established the GSA in 1949 through the Federal Property and Administrative Services Act. Its mission is to provide expertly managed space, supplies, services, and solutions to enable Federal employees to accomplish their missions. Recently the GSA has established a Planet GSA initiative that spotlights four areas wherein GSA has a Federal responsibility – buy green, build green, drive green, and save green. They hope that the initiative will inspire even greater efforts within GSA and to encourage other Federal agencies to work together to safeguard the environment for future generations.

The GSA's Build Green program is committed to: decreasing energy use in Federal buildings, reducing greenhouse gas emissions, and to saving taxpayers dollars. GSA is also committed to adopt sustainable design principles for new Federal buildings (GSA 1999).

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* http://www.nps.gov/dsc/specdev/

The U.S. General Services Administration (GSA), http://www.gsa.gov/, provides managed space, supplies, services, and solutions, to enable Federal employees to accomplish their missions. Facilities are a major component of the GSA mission and therefore their acquisition, management and disposal practices are of interest to the Corps and Army in achieving sustainability for their facilities.

Office of Government Wide Policy

The GSA Office of Governmentwide Policy (OGP), http://policyworks.gov/, was created in 1995 to consolidate all of GSA's policy activities within one office. Responsibilities include in part, development of policies and strategies for the Federal Governments annual facilities acquisition and maintenance. The GSA OGP Real Property Policy Division, http://policyworks.gov/org/main/mp/pmr.htm, has been instrumental in development and implementation of sustainable practices for GSA. One recent product was the "*Real Property Sustainable Development Guide*," recently published in partial response to Executive Order 13123, "*Greening the Government Through Efficient Energy Management.*" The guide is intended to provide Federal real property executives and professionals with an understanding of the principles of Sustainable Development. It identifies the financial, environmental, health and productivity benefits to be gained by Federal agencies, through the systematic integration of sustainable development principles in their organizations. It incorporates standards for Federal buildings design from the *Guiding Principles for Federal Architecture*, initially issued in 1962, and adds new principles for sustainable Federal facilities.

Public Building Service

The GSA Public Buildings Service, http://www.gsa.gov/pbs/pbs.htm, has the primary mission to provide facilities services to a wide range of Federal agencies. Created in 1949, they serve as a builder, developer, lesser, and manager of Federally owned and leased properties across the United States. In this capacity they provide real estate services including: real estate brokerage, property management, construction and repairs, security services, property disposal and overall portfolio management. They are ultimately responsible for the execution of GSA facilities programs in a sustainable fashion. GSA sustainable development activities primarily fall under their Architecture and Construction Services: http://www.gsa.gov/pbs/pc/mainpage.htm.

Whole Building Design Guide

Although developed initially and supported by the U.S. Naval Facilities Engineering Command, the Whole Building Design Guide (WBDG),

http://www.wbdg.org/, has been additionally resourced and enhanced by GSA's Public Buildings Service and the U.S. Department of Energy's Federal Energy Management Program (FEMP). The WBDG is listed as guidance information and hot-linked to GSA's Architecture and Construction Services web site. The WBDG is currently registered through the National Institute of Building Sciences (NIBS) and a NIBS advisory committee is forming to define/effect a WBDG to CCB (Construction Criteria Base) link. The goal is to create a single, highly accessible access point for all military, Federal and private-sector building criteria.

Center of Expertise for Urban Development and Livability

The GSA Center of Expertise for Urban Development and Livability, http://web2.xservices.com/goodnb/, has been recently established by GSA's Public Buildings Service to enhance the agency's contributions to the Federal Livable Communities Agenda. The Center will coordinate and expand GSA's efforts to leverage its urban real estate holdings in support of downtown revitalization, smart growth, and cultural vibrancy.

Federal Supply Service

The GSA Federal Supply Service, http://pub.fss.gsa.gov/ provides Federal supply and procurement, fleet management, excess property disposal, and travel and transportation services. The buying power of the Federal Government, provides GSA with leverage to demand a higher level of quality, which they have been using to their advantage in promoting sustainability in property acquisition activities.

FSS Environmental Programs—Think Green ... Buy Green Products from GSA!!!

GSA's FSS Environmental Programs, http://pub.fss.gsa.gov/environ/index.html, is supporting the Government's environmental initiatives by making available and promoting products that contain desirable environmental attributes, in the "THINK GREEN ... AND BUY GREEN PRODUCTS FROM GSA!" program. Products that possess environmentally beneficial characteristics or use federally recognized environmental symbols are highlighted in FSS catalogs and on-line systems. GSA schedule contractors are also asked to identify products that meet USEPA designated item criteria for recycled-content and ENERGY STAR product designations for efficiency on their individual catalogs and/or price lists.

PlanetGSA

PlanetGSA, http://www.gsa.gov/planetgsa/, is GSA's web site that is devoted to "Building (adopting sustainable building design and practices), Buying (reducing, reusing and using environmental products), Driving (making wiser transportation decisions) and Saving (promoting energy savings and renewable technologies) Green" and provides links to many valuable sustainable resources.

Conclusions—U.S. General Services Administration

Many activities of the U.S. General Services Administration have a high potential for immediate application for the Corps and/or Army. GSA's Office of Government Wide Policy and their Public Building Service are continually developing tools and technologies for the development and management of Federal facilities that have parallel applications of importance to Corps/Army sustainability efforts and are essential resources. The Real Property Sustainable Development Guide would be an excellent tool for Army implementation of sustainable development and operational practices

U.S. Department of Transportation

The U.S. Department of Transportation (DOT)* fully supports and promotes the principle of "Build Green." DOT is and working with the transportation industry and other Federal agencies to ensure that DOT projects employ sustainable design principles. DOT initiatives focus on local, regional, and national transportation planning strategies for sustainability. Regional planning focuses on sustainability.

DOT strategic goals include:

- Support to National Economic Growth and Trade and Human and Natural Environment by Advancing America's economic growth and competitiveness domestically and internationally through efficient and flexible transportation. [Accelerate desirable, sustainable, and cost-beneficial regional and local economic development through major transportation investments].
- Support to national Human and Natural Environment by Protecting and enhancing communities and the natural environment affected by transporta-

* http://www.dot.gov/

tion. Improve the sustainability and livability of communities through investments in transportation facilities and by investigating technological and behavioral implications of alternative transportation systems to determine those that minimize impacts on long-term environmental sustainability.

Programs

Transportation and Community and System Preservation Pilot Program.

The Transportation and Community and System Preservation Pilot program is a comprehensive initiative of research and grants to investigate the relationships between transportation and community and system preservation and private sector-based initiatives. States, local governments, and metropolitan planning organizations are eligible for discretionary grants to:

- plan and implement strategies that improve the efficiency of the transportation system
- reduce environmental impacts of transportation; reduce the need for costly future public infrastructure investments
- ensure efficient access to jobs, services, and centers of trade
- examine private sector development patterns and investments that support these goals.

A total of $120 million is authorized for this program for FY99-03.

The TCSP is a Federal Highway Works Administration (FHWA) program being jointly developed with the Federal Transit Administration, the Federal Rail Administration, the Office of the Secretary, and the Research and Special Programs/Volpe Center within the U.S. Department of Transportation, and the U.S. Environmental Protection Agency.

Sustainable Development Program

The Department of Transportation, Federal Transit Administration (FTA), supports sustainable development, a focus on environment, economy, and equity, through their local, regional and national transportation planning initiatives. Transportation planning practices promote sustainability, i.e., meeting the needs of the present without compromising the ability of future generations to meet their needs, if they focus on the long-term impacts and consequences of human

actions, recognize the interdependence of economic, environmental, and social well-being, and involve decisionmaking that is inclusive, participatory, and transparent. Three areas of research enhance the understanding of transportation's contribution to sustainable communities*:

- an investigation of the impact of urban site design on the livability of communities
- "Smart Growth," which is the continued study of the integration of land-use planning and transportation planning
- a detailed study of issues of intermodal connectivity, especially landside access to airports.

Livable Communities Initiative

FTA has developed the Livable Communities Initiative (LCI)† to strengthen the linkage between transportation services and the communities served. The LCI is an experiment in the use of sustainable design concepts such as transit-oriented development, community-sensitive transit services, mixed-use development near transit facilities, the provision of safe and secure pedestrian access, and transit-supportive parking management and traffic management techniques. The goal is to increase access to jobs, health care, education, and other social amenities and to stimulate community participation in the decisionmaking process that leads to these improvements.

Numerous projects have been built across the nation both with and without FTA financial assistance. The FTA has investigated innovative community involvement methods, such as Visual Preference Surveys, through the National Transit Institute, to generate LCI projects. Future initiatives will test and study the results. A rigorous evaluation in terms of LCI long-term effects on mobility, energy consumption, pollutant emissions, job accessibility, social equity, and other measures is needed. Evaluations will provide guidance on sustainable practices to other communities considering the adoption of LCI strategies and an empirical basis for analyzing additional linkages of site designs with transit facilities and services.

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* http://www.fta.dot.gov/research/polplan/susdev/susdev.htm

† http://www.fta.dot.gov/research/polplan/susdev/livcom/livcom.htm

Smart Growth Initiative

The Department of Transportation, Federal Transit Administration (FTA), is supporting research into the interaction between transportation investments, land-use, and decisionmaking within the context of sustainable development and global climate change. Desirable forms of land-use and institutional models that promote sustainability are being identified. Research is being conducted under the Smart Growth Initiative* to determine the impacts of zoning practices on transit ridership and to determine transit-supportive land-use patterns. The Smart Growth Initiative is a joint multi-phased project of FTA, the U.S. Department of Housing and Urban Development (HUD), the U.S. Environmental Protection Agency (USEPA), the Jackson Foundation, and the American Planning Association (APA). This project, designed to update urban and rural development planning and management statutes, will produce a guidebook for governors and legislators on the "best" of American planning and land development management law, and establish a clearinghouse on national planning statutes and a corresponding database of legislative materials.

Conclusions – U.S. Department of Transportation

Few of the U.S. Department of Transportation (DOT) programs, activities and resources, are directly applicable to Corps' support for the Army. Those that have potential use, however, are transportation network and modeling activities under the Livable Communities and Smart Growth Initiatives as they have potential applications in installation master planning regional sustainability analysis.

U.S. Environmental Protection Agency

The mission and principle drivers of the U.S. Environmental Protection Agency (USEPA), http://www.epa.gov/, is to protect human health and to safeguard the natural environment, the air, water, and land, upon which life depends. ETL 1110-3-491 equates "sustainable design," with "green building." It is similarly applicable to say that the USEPA's mission is synonymous with the precepts of sustainable design.

* http://www.fta.dot.gov/research/polplan/susdev/smgrow/smgrow.htm

Elements of USEPA's mission most pertinent to Corps' sustainability support to the Army, edited from the Corps'/Army's point of view, include:

- ensuring the protection of all soldiers, dependants and civilian employees from significant risks to human health in the environment where they live, learn and work
- ensuring that Service wide efforts to reduce environmental risk are based on the best available scientific information and engineering and design application
- ensuring that environmental protection is an integral consideration in Army policies concerning natural resources, human health, energy, and mission, and these factors are similarly considered in establishing environmental policy
- ensuring that all services have access to accurate information sufficient to effectively participate in managing human health and environmental risks
- ensuring that environmental protection contributes to making our installations and ecosystems diverse, sustainable, and economically productive.

The USEPA's goals for sustainable development are less of a program and more of an approach to managing environmental, economic, and social resources. In its simplest terms, it strives to add some new considerations or dimensions to everyday societal decisions. These considerations include:

- long-term impacts of decisions
- the sustainability of decisions at the local level
- whether economic, social, and environmental impacts have been incorporated into decisions.

The USEPA points to one of the goals established by the President's Council on Sustainable Development (PCSD); to "create full opportunity for citizens, businesses, and communities to participate in and influence the natural resource, environmental, and economic decisions that affect them" (USEPA 1999). The USEPA proposes collaborative decisionmaking processes that include: Federal, State, tribal, and local governments to set the standard for cooperation among communities, businesses, and governments.

Sustainable Development is beginning to emerge as an important focus for many USEPA programs. The organizational home for this effort is the Pollution Prevention (P2) Program, though several other programs also incorporate and promote some or all of the broad tenets of sustainable development. The P2 program will help to integrate other sustainability initiatives with the larger USEPA participation in the President's Council on Sustainable Development. Their regionally based sustainable development effort also includes:

- internal education and outreach
- the 1997 USEPA Sustainable Development Challenge Grant program
- several small sustainability projects; the USEPA Voluntary Standards Network
- Federal agency cooperation and coordination
- general public outreach and community education
- integration of sustainability into other programs via regional strategic plans (USEPA 1999).

Programs

Comprehensive Procurement Guidelines (CPG) Program

The USEPA's Comprehensive Procurement Guideline (CPG) program* is part of a continuing effort to promote the use of materials recovered from solid waste. Congress authorized this program under Section 6002 of the *Resource Conservation and Recovery Act (RCRA)* and *Executive Order 13101.* These require the USEPA to designate products that are or can be made with recovered materials, and to recommend practices for buying these products. Once a product is designated, procuring agencies are required to purchase it with the highest recovered material content level practicable. USEPA's CPGs are a key component of the government's "buy-recycled" program, which helps "close the recycling loop" by putting the materials we collect through recycling programs back to good use as products in the marketplace.

The USEPA issued the first CPG in 1995 with new products being added periodically. USEPA also issues guidance on buying recycled-content products in Recovered Materials Advisory Notices (RMANs). The RMANs recommend recycled-content ranges for CPG products based on current information on commercially available recycled-content products. RMAN levels are updated as marketplace conditions change.

Pollution Prevention Checklists

The environmental review process under the National Environmental Policy Act (NEPA) provides an opportunity for Federal agency NEPA/309 reviewers to incorporate pollution prevention and environmental impact reduction into actions

* http://www.epa.gov/cpg/

(or projects). NEPA's very purpose is "to promote efforts which will prevent or eliminate damage to the environment ..." (42 U.S.C 4321). Section 101 of NEPA stipulates that the Federal Government "use all practical means and measures ... to create and maintain conditions under which man and nature can exist in productive harmony ..." [42 U.S.C 4331(a)]. To carry out this environmental policy, Congress required all Federal agencies to act to preserve, protect, and enhance the environment [42 U.S.C. 4331(b)]. Guidance and checklists* provided by the USEPA assist reviewers in incorporating pollution prevention into each step of the environmental review process, including scoping, mitigation, monitoring, and enforcement. These NEPA processes provide significant opportunities for pollution prevention and are very appropriate models for sustainability review in facilities planning, programming, design, construction and operation. The NEPA "Checklist for Building/Housing Construction" is available through the URL:

http://es.epa.gov/oeca/ofa/pollprev/build.html

Pollution prevention, a critical component of sustainable development, refers to the use of materials, processes, and practices that reduce or eliminate the creation of pollutants at the source of generation through increased efficiency in the use of raw materials, energy, water, or other resources or through the protection of natural resources by conservation. Pollution prevention is an approach that reduces waste generation and the emission of pollutants released to land, air, and water without transferring pollutants from one medium to another. Pollution prevention techniques include:

- modifying equipment or technology
- modifying processes or procedures
- reformulating or redesigning products
- substituting raw materials
- improving operations, maintenance, training, or inventory control
- incorporating demand-side management when designing or renewing projects
- incorporating integrated resource planning into project planning.

* http://es.epa.gov/oeca/ofa/pollprev.html

Environmentally Preferable Purchasing (EPP) Program

The USEPA's Office of Pollution Prevention and Toxics operates the Environmentally Preferable Purchasing (EPP) Program.* EPP is a Federal-wide program that encourages and assists Executive agencies in the purchasing of environmentally preferable products and services. Executive Order 13101 defines these as "... products 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 web site and the EPP Program provide a comprehensive set of documents and links to related information about environmentally preferable purchasing specifically, and "green" purchasing in general.

ENERGY STAR Program

ENERGY STAR is a voluntary partnership between the U.S. Department of Energy (DOE), the USEPA, product manufacturers, local utilities, and retailers. Partners help promote efficient products by labeling with the ENERGY STAR logo and educating consumers about the unique benefits of energy efficiency products. ENERGY STAR labeled products include household appliances, home electronics, office equipment, heating and cooling equipment, windows, residential light fixtures, and more. Listings of ENERGY STAR certified products, manufacturers and retailers can be found on USEPA's website at:

http://www.epa.gov/energystar.html.

In addition to labeled products, ENERGY STAR offers voluntary partnerships that promote energy efficiency, and reduce air pollution. More focused ENERGY STAR programs include:

- ENERGY STAR Homes Program—promotes partnerships with homebuilders to construct highly energy-efficient new homes. An energy efficient, ENERGY STAR Home significantly lowers your utility bills, reduces air pollution, and increases resale value
- ENERGY STAR Small Business—success stories by and for small businesses and their advocates
- ENERGY STAR Buildings and Greenlights—promotes energy-efficient lighting, ventilation, heating and cooling technologies with U.S. businesses

* http://www.epa.gov/opptintr/epp/

- Methane Outreach—promotes profitable opportunities for reducing methane and other greenhouse gas emissions
- ENERGY STAR Label for Buildings—Certifies buildings based on a building's energy performance and compares them against similar use buildings in the United States.

Design for the Environment (DFE) Program

Building on the "design for the environment" concept pioneered by industry, the USEPA's Design for the Environment (DfE) Program* helps businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. Initiated by USEPA's Office of Pollution Prevention and Toxics (OPPT) in 1992, DfE forms voluntary partnerships with industry, universities, research institutions, public interest groups, and other government agencies.

Project partners' activities include broad institutional efforts aimed at changing general business practices, as well as cooperative projects with trade associations and businesses in specific industries. The DfE Program ensures that the information developed through these voluntary efforts reaches the people who make decisions, from managers to industrial design engineers, to materials specifiers and buyers. This information dissemination promotes the incorporation of environmental considerations into the traditional business decisionmaking process.

Sustainable Ecosystems and Communities

The USEPA maintains a web site on Community-Based Environmental Protection (CBEP) devoted to the integration of environmental management with human needs.

http://www.epa.gov/ecocommunity/

This "community" based approach to environmental protection considers long-term ecosystem health and highlights the positive correlation between economic prosperity and environmental well being. The site provides resources to support "integrated" community based environmental protection management.

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* http://www.epa.gov/dfe/

Sustainable development is a component of the community approach. The USEPA periodically offers "Sustainable Development Challenge Grants (SDCG)" to challenge communities to invest in a sustainable future that links environmental protection, economic prosperity and community well-being. These grants provide an opportunity to develop place-based approaches to problem solving that can be replicated in other communities. The program strongly encourages community members, business, and government entities to work cooperatively to develop flexible, locally-oriented approaches that link place-based environmental management and quality of life activities with sustainable development and revitalization. These grants are intended to catalyze community-based projects to promote environmentally and economically sustainable development; build partnerships that increase a community's capacity to take steps that will ensure the long-term health of ecosystems and humans, economic vitality, and community well-being; and leverage public and private investments to enhance environmental quality by enabling community efforts to continue beyond the period of USEPA funding.

Regulatory Guidance and Resources for Solid Waste Management

The USEPA's Office of Solid Waste operates a web site providing extensive information on regulatory guidance and resources for solid waste management:

http://www.epa.gov/epaoswer/osw/index.htm

This site is devoted to the protection of human health and the environment by providing guidance on the appropriate practices for the management of hazardous and nonhazardous household, industrial, and mining wastes.

Brownfields Initiative

Brownfields, abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination, are important national land assets that need to be effectively "recycled." The USEPA's Brownfields initiative* seeks to empower States, communities, and other stakeholders in economic development, to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields.

* http://www.epa.gov/swerosps/bf/

Enviroen

The USEPA operates a web site called "Enviroen,"* which is a single repository for pollution prevention, compliance assurance, and enforcement information and databases. The site provides easy access to pollution prevention and cleaner production resources on USEPA sites as well as search tools to access resources all around the World Wide Web.

Pollution Prevention Links

The USEPA maintains a web site with links to appropriate Pollution Prevention sites at http://www.epa.gov/region07/specinit/p2/links.htm. This site has pointers to both USEPA P2 activities. Sites listed worth mentioning amongst many others include:

- The Air Force Center for Environmental Excellence
- EPIC—U.S. Department of Energy's Pollution Prevention Information Clearinghouse
- The Joint Service Pollution Prevention (P2) Technical Library
- The U.S. Green Building Council.

Solar Initiative P2 Benefits

The USEPA's solar initiatives web site is devoted to promotion of the use of improved solar energy technologies as a means to reduce dependency on fossil fuels, contributions to global warming, and achieve substantial reductions in air emissions:

http://www.epa.gov/globalwarming/actions/solar/p2.html

USEPA-Waste Reduction Resource Center

The USEPA maintains a web site http://wrrc.p2pays.org/for the provision of technical P2 support to the states in USEPA Regions III and IV called The Waste Reduction Resource Center (WRRC). The site contains a searchable index of technical articles, fact sheets, and case studies on waste reduction technologies

* http://es.epa.gov/cooperative/

P2 Vendor Information (VendInfo)

USEPA maintains a web site called VendInfo http://es.epa.gov/vendors/, which contains information on the Vendors of pollution prevention equipment, products, and services to support the adoption of effective P2 management processes.

Recycling Market Development Support

USEPA actively supports recycling market development by serving up information on recyclables on the Internet:

http://www.epa.gov/epaoswer/non-hw/recycle/jtr/thirds/jtrnet/list.htm

Net Share at is an active Internet List Server for the recycling market. It provides a forum for people in the field to seek advice, swap ideas on hard to find markets for materials, give updates on their projects, and discuss issues regarding market development. The collection is organized by topics including in part: (1) Commodities; (2) Market Development Issues; (3) Financing and Economics; (4) Waste Generation and Composition; and (5) Materials Reuse.

Jobs Through Recycling (JTR) Grants Program

Another aspect of the USEPA's efforts to support recycling market development is their Jobs Through Recycling (JTR) program.* The USEPA's goal under this program is to stimulate economic growth and recycling market development by assisting businesses and entrepreneurs process recycled materials or manufacture recycled-content products. Manufacturing new products out of discarded materials helps to meet national recycling goals while spurring innovation, economic development, and creating jobs. The JTR program brings together the economic development and recycling communities through grants, networking, and information sharing. JTR builds recycling expertise within economic development agencies and places business development tools, technical assistance, financing, and marketing, in the hands of recycling professionals.

* http://www.epa.gov/jtr/index.htm

USEPA/Army Commonality

The mission and principle drivers of the U.S. Environmental Protection Agency (USEPA)* is to protect human health and to safeguard the natural environment, the air, water, and land, upon which life depends. ETL 1110-3-491 equates "sustainable design," with "green building." It is similarly applicable to say that the USEPA's mission is synonymous with the precepts of sustainable design.

Elements of USEPA's mission that are most pertinent to the Corps' delivery of sustainability support to the Army, as seen from the Corps' and Army's points of view, include:

- ensuring that the protection of all soldiers, dependants and civilian employees from significant risks to human health in the environment where they live, learn and work
- ensuring that Service wide efforts to reduce environmental risk are based on the best available scientific information and engineering and design application
- ensuring that environmental protection is an integral consideration in Army policies concerning natural resources, human health, energy, and mission, and these factors are similarly considered in establishing environmental policy
- ensuring that all Services have access to accurate information sufficient to effectively participate in managing human health and environmental risks
- ensuring that environmental protection contributes to making our installations and ecosystems diverse, sustainable, and economically productive.

Conclusions – U.S. Environmental Protection Agency

Many activities of the Environmental Protection Agency (USEPA), have a high potential for immediate application for the Corps and/or Army or are already being put to use. Although the majority of their activities have application, two that stand out are USEPA's Environmentally Preferable Purchasing (EPP) Program, and their ENERGY STAR Program. Both immediate application in the selection of appropriate green materials and energy saving equipment for incorporation in both new and renovation Army projects.

* http://www.epa.gov/

U.S. Postal Service

Discussion

The U.S. Postal Service is committed to being a good environmental neighbor in every community and to providing employees and customers with a safe and healthy environment. In 1993, USPS launched an effort to integrate environmental decisionmaking into its daily operations. Their "guiding principles" include a commitment to: meeting or exceeding environmental laws and regulations in a cost-effective manner; modification of their business planning processes to incorporate environmental considerations; fostering the sustainable use of natural resources by promoting pollution prevention, reducing waste, recycling, and reusing materials; and encouraging their suppliers, vendors, and contractors to comply with similar environmental protection policies.

A prime example of the UPS commitment is their Green Building program and their First Green Post Office at Eighth Avenue Station, Fort Worth, TX. This "Green Building" is built with ecologically superior products or systems and is one component of sustainable development that seeks to meet the needs of the present without jeopardizing the future. The "greening" of postal facilities focuses on two elements: increasing energy efficiency and improving environmental responsiveness (resource efficiency and raw material usage).

The USPS Green Building program, the Green Post Office, the national Design Standards program, and other environmental initiatives are the responsibility of the USPS office of Environmental Management.* This and other green showcase activities being conducted by the USPS test ecologically superior materials and systems for viability (cost, availability, performance and aesthetics). Project results will be tracked and successful initiatives "recycled" into new/revised national design standards and business practices.

Conclusions – U.S. Postal Service

Activities of the U.S. Postal Service have limited applicability to the Corps and Army sustainable development activities, however, offer another example of the

* http://www.usps.gov/environ/

incorporation of sustainability concepts into the design, construction and operation of Federal facilities.

White House

President's Council on Environmental Quality

The *Council on Environmental Quality* (CEQ)* leads the Administration's effort to reinvent the nations environmental and natural resource programs. Congress established the CEQ was established within the Executive Office through the National Environmental Policy Act (NEPA) of 1969. NEPA assigns CEQ the task of ensuring that Federal agencies meet their obligations under the Act.

CEQ functions include:

- advising and assist the President in the development of environmental policies and proposed legislation as requested by the President
- advising the President on national and international policies relating to the environment
- identifying, assess, and report on trends in environmental quality and recommend appropriate response strategies
- overseeing Federal agency implementation of the environmental impact assessment process and act as a referee for interagency disputes regarding the adequacy of such assessments
- reporting annually to the President on the state of the environment through preparation of the annual Environmental Quality Report
- providing general support and leadership to the coordination of activities of the Federal departments and agencies that affect, protect, and improve environmental quality
- supporting and participate in the government-wide effort to reinvent environmental regulation
- fostering cooperation between the Federal, State and local governments, the private sector and American citizens on matters of environmental concern
- interpreting NEPA and the CEQ regulations in response to requests from Federal, State and local agencies and citizens
- approving agency NEPA procedures and issue guidance to address systemic problems.

* http://www.whitehouse.gov/CEQ/

President's Council on Sustainable Development

President Clinton established the *President's Council on Sustainable Development*[*] (PCSD) in June 1993 to advise him on sustainable development and develop "bold, new approaches to achieve our economic, environmental, and equity goals." Formally established under Executive Order 12852, the PCSD is administered under the Federal Advisory Committee Act. "A sustainable United States," according to the PCSD "will have a growing economy that provides equitable opportunities for satisfying livelihoods and a safe, healthy, high quality of life for current and future generations. Our nation will protect its environment, its natural resource base, and the functions and viability of natural systems on which all life depends."

The Mission of the PCSD is to:

- forge consensus on Policy by bringing diverse interests together to identify and develop innovative economic, environmental, and social policies and strategies
- demonstrate Implementation of policy that fosters sustainable development by working with diverse interests to identify and demonstrate implementation of sustainable development
- get the word out about sustainable development
- evaluate and report on progress by recommending national, community, and enterprise level frameworks for tracking sustainable development.

Goals of the PCSD most applicable to Army sustainable development include:

- *Goal 1: Health and the Environment*—Ensure that every person enjoys the benefits of clean air, clean water, and a healthy environment at home, at work, and at play.
- *Goal 4: Conservation of Nature*—Use, conserve, protect, and restore natural resources – land, air, water, and biodiversity – in ways that help ensure long-term social, economic, and environmental benefits for ourselves and future generations.
- *Goal 5: Stewardship*—Create a widely held ethic of stewardship that strongly encourages individuals, institutions, and corporations to take full responsibility for the economic, environmental, and social consequences of their actions.

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[*] http://www2.whitehouse.gov/PCSD/

- *Goal 6: Sustainable Communities*—Encourage people to work together to create healthy communities where natural and historic resources are preserved, jobs are available, sprawl is contained, neighborhoods are secure, education is lifelong, transportation and health care are accessible, and all citizens have opportunities to improve the quality of their lives.

Office of the Federal Environmental Executive (OFEE) *

Task Force on Greening the Government through Waste Prevention and Recycling

The White House Council on Environmental Quality (CEQ)† chartered the *Task Force on Greening the Government through Waste Prevention and Recycling* under the requirements of EO 13101. The Task Force is directed by a steering committee comprising the Federal Environmental Executive (FEE), the Chair of the CEQ, and the Administrator of the Office of Federal Procurement Policy (OFPP) within the Office of Management and Budget (OMB). The purpose of the Task Force is to advise and assist the Steering Committee and the Federal agencies, make recommendations concerning policy, facilitate implementation, provide a centralized focal point for assistance and direction, and communicate and enhance knowledge of the provisions of EO 13101. In addition, there are other related activities such as pollution prevention, energy-efficient products and services, and climate change initiatives that are directly and indirectly related to, but not a part of, the immediate mission of the Task Force. The Task Force will coordinate, as appropriate, with other organizations and CEQ chartered Task Forces with respect to other *Greening the Government* activities.

Task Force Resources on Greening the Government:

- A guide to implementing Executive Order 12873‡
- USEPA issues Final Guidance on EPP§
- Federal Facilities Compliance Guidance**
- Strategic Plan—To Implement Executive Order 13101.*

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* http://www.ofee.gov/

† http://www.whitehouse.gov/CEQ

‡ http://www.ofee.gov/html/guide.htm.

§ http://www.ofee.gov/html/eppfinal.htm

** http://www.ofee.gov/html/rcra2.htm

Task Force Best Practices and Success Stories for Environmental Procurement, Recycling, and Waste Prevention:

- success stories from the Department of Defense†
- success stories from the Department of the Interior.‡

The National Science and Technology Council (NSTC)

The President established the National Science and Technology Council (NSTC)§ in 1993 by Executive Order to coordinate science, space, and technology and diverse parts of the Federal research and development enterprise. The President chairs the NSTC. Membership consists of the Vice President, Assistant to the President for Science and technology, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials. An important objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in areas including information technologies, health research, improving transportation systems, and strengthening fundamental research. The Council prepares research and development strategies that are coordinated across Federal agencies to form an investment package aimed at accomplishing multiple national goals.

NSTC Subcommittee on Construction and Building

The NSTC established a Subcommittee on Construction and Building (C&B)** in 1994 to coordinate and focus the work of 14 Federal agencies in enhancing the competitiveness of U.S. industry, public and worker safety, and environmental quality through research and development. The subcommittee works in cooperation with U.S. industry, labor, and academia for improvement of the life cycle performance, sustainability, efficiency, effectiveness, and economy of constructed facilities.

During FY95 C&B studied research priorities expressed by the construction industry in industry forums and in proposals for the advanced Technology Pro-

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* http://www.ofee.gov/html/strtpln2.htm

† http://www.ofee.gov/html/success1.htm#team

‡ http://www.ofee.gov/html/success1.htm#doi

§ http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/html/NSTC_Home.html

** http://www.bfrl.nist.gov/860/c_b/

gram of the Department of Commerce. Better constructed facilities and health and safety of the construction workforce were defined for focus of research, development, and deployment (RD&D) in the construction and building area.

C&B developed a plan to work with industry to identify technologies and practices capable of achieving the following seven goals available for general use in the construction industry by 2003.

Goals to be measured against the baseline of industry practice in 1994 are:

- 50 percent reduction in delivery time i.e., the time from the decision to construct a new facility to its readiness for service is vital to industrial competitiveness and project cost reduction
- 50 percent reduction in the cost of operation, maintenance and energy over the life of the facility
- 30 percent increase in productivity and comfort of the occupants of industrial facilities and in the processes housed by the facility
- 50 percent fewer occupant related illness and injuries caused by improper or poor building design, fire or natural hazards, slips and falls, and illnesses associated with a workplace environment
- 50 percent less waste and pollution at every step of the delivery process, from raw material extraction, the construction process, to final demolition and recycling of the shelter and its contents
- 50 percent more durability (the capability of the constructed facility to continue to function at its initial level of performance over its intended service life) and flexibility (the owner's capability to adapt the constructed facility to changes in use or users' needs)
- 50 percent reduction in construction work illnesses and injuries.

Other Federal Agencies and Collaborations

The Joint Center for Sustainable Communities

The Joint Center for Sustainable Communities currently funded by five Federal agencies, represents an important collaboration between the U.S. Conference of Mayors (USCM) and the National Association of Counties (NACo) on behalf of our nation's communities:

http://www.usmayors.org/uscm/sustainable/

Its primary mission is to provide a forum for cities and counties to work together to develop long-term policies and programs that will lead to job growth, environmental stewardship, and social equity, the three pillars of sustainable communities. The Joint Center helps local elected officials build sustainable communities by promoting community leadership initiatives, providing technical assistance and training, and conducting community policy and educational forums.

The overall goal of the Joint Center is to provide local elected officials with assistance in using the policies and tools necessary for creating sustainable communities. In particular, assistance in finding more cost-effective and comprehensive ways to address such issues as transportation management, brownfields revitalization, environmental protection, energy conservation, job training and public safety. To this end, the Joint Center is providing technical assistance, training, sustainable development literature and materials, and funding toward community visioning (or collaborative planning). While the Joint Center is not a repository of all relevant information on sustainable development, it acts as a catalyst to help local government officials find solutions to problems facing their communities.

Department of Defense and Sustainability

From an energy perspective, a building's energy efficiency is intertwined with many aspects of building design, not just selection of the mechanical systems. Building orientation, passive tempering, natural lighting, indoor air quality, use of renewables, HVAC technology, and sight microclimate all impact on energy consumption of a building. Sustainable design addresses all of these aspects in an integrated manner, including the embodied energy and emissions of the materials used in construction and other wastes throughout the life cycle of the building. Currently, energy use of a building during operational life far exceeds that used in its construction and demolition. As buildings become more efficient, the ratio between embodied energy and operational energy will grow larger and become more important.

Sustainable DOD

The importance of understanding sustainable systems is becoming paramount for some military installations. Extreme urban growth and the resultant sprawling patterns of development have begun to undermine the installation's ability to maintain its mission focus. Some installation's economic and environmental contributions to the local community are becoming outweighed by perceived incompatibilities. The incompatibilities (noise, dust, shared resources, land use, land

value and availability) arise as the local community expands and available resources become scarce. Eventually the installation's benefit to the community is surpassed by the community's need for the available resources. The installation can then be perceived as a barrier to continued local growth. The resulting friction between the community and the installation may interfere with the military's ability to effectively maintain its mission, operations, and land management goals. Therefore, a clearer understanding of the spatial interactions between the military community, its planning policies and the private sector community adjacent is an important step toward a more complete understanding of possible sustainable development strategies for both communities.

As noted, the private sector has initiated programs that have embraced some of the major tenets of the sustainability movement. A recently published executive order (EO13123) requires the Secretary of Defense to develop and issue sustainable design and development principles for the siting, design, and construction of new facilities. A proposed DOD directive (4270.1), states procedures for achieving excellence in planning and design "... includes the relationship to the surrounding community as well as the details of design that affect the users of the buildings ... attention will be given to ... compatibility with the surrounding environment, economy, energy conservation .... Sustainable design is referred to as "responsible stewardship of our natural, cultural, built and financial resources through a practical and balanced approach. Sustainability in planning design ... challenges to rethink the facility delivery process to ensure the best fit of the built environment to the natural environment."

The Army Corps of Engineers issued an Engineering Technical Letter (ETL) on Sustainable Design for Military Facilities (ETL 1110-3-491). It defines sustainable design form the USACE perspective as "Sustainable Design is the design, construction, operation and reuse/removal of the built environment (infrastructure as well as buildings) in an environmentally and energy efficient manner. ...it is an attitude about applying sound design principles and practices to create a built environment that optimizes functionality and operability of the total system ..." Although not addressing community scaled planning issues they do espouse sustainable design principles for their facilities and infrastructure. Clearly the rhetoric exists to require the production and maintenance of sustainable military facilities. The directives, executive orders, and technical letters all give credence to environmental sound design and planning principles.

A recent assessment on the current state of the DOD's sustainable land use planning policies titled – Sustainable Planning; A Multi-Service Assessment, was published in 1999 (EDAW 1999). Sponsored by the Office of the Secretary of Defense, it describes current DOD land use policies as limited to "those assets

found within the installation boundary; they do not strongly support planning with a regional perspective." The report goes on to describe "... sustainable development as most successful where cooperation between military and civilian communities is maximized." The goal of the assessment was not to be critical. The stated goal was to identify opportunities to enhance or expand the military land use management community through sustainable design principles. The report concludes by describing a shift that must take place in the military planning focus from growth based, project oriented analysis, and decisionmaking to a new more holistic and integrated approach that results in sustainable solutions and strategies that support mission needs.

The Department of the Army

The U.S. Army is like most customers of the construction industry. It tends to get what the rest of the nation is getting as far as quality, style, utility, efficiency, and functionality in our buildings. This is true of both the public and private sector (Lovins 1992). The architectural and engineering community is aware that the design paradigm is changing and is responding accordingly. Concepts of extreme efficiency and sustainability are not mainstream in the private sector yet, but are becoming increasingly popular and do affect the marketability of speculative construction.

The architectural community indicates the number of clients interested in "green" projects has grown in recent years, due to growing concern for environmental issues, increasing availability of sustainable products and technologies, the trendiness of Eco-anything, and the expanding awareness of the public relations benefits of good corporate citizenship (Gould 1999). The public sector and the Corps of Engineers are also responding for the very same reasons. Sustainable or green design for MCA projects is something that the customers expect as part of a competent design process (Krajewski 1999).

There are several key issues within the military family driving the requirement for better buildings. The main driver is simply a desire to provide quality working and living space for our land warriors and their families. Quality space must be adaptable to both the changing military environment and the changing expectations of the community served. Implicit in the specification of quality space is energy efficiency, excellent indoor air quality, high levels of natural light, effective building siting and orientation, and integration into the community. None of these requirements will explicitly appear in the DD1391 for the building project. They are simply expected by the building user communities. The requirement for better buildings is national in scope and is driving standards and

criteria both inside and outside of the Army. Appendix D lists sources of information on DA resources related to issues of sustainability.

Army Energy Perspective

The U.S. Army spent about $1 billion in 1999 for energy, $790 million for facility and industrial energy and $196 million for mobility energy. Consumption was a 76/24 split between facility/industrial energy and mobility energy. Facility energy consumption is about one third electricity (32 percent), one third natural gas (36 percent), and the final third split between district heat (9 percent), petroleum (13 percent), and coal (8 percent). The cost breakout is heavily weighted towards electricity (56 percent) with an annual bill of $442 million. Facility energy consumption is about 99 kBtu/sq ft/year and continues trending downward, showing that Army facilities are still achieving gains in energy efficiency. New buildings have energy consumption design goals based on the Code of Federal Regulations, 10CFR435, *Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings,* and the Corps Technical Instruction TI 800-1, Design Criteria, published by the Office of Chief of Engineers. The Design Criteria provides energy use budgets for different types of buildings in various climates.

Corps of Engineers Sustainability Guidance

Following are primary drivers, policies, and available guidance and references guiding Environmental Sustainability practices for the Army and the Corps of Engineers. In general, policy derives from a series of Executive Orders, and for the execution of the military construction program by the Corps of Engineers it is documented in ETL 1110-3-491. It is fairly apparent from this initial investigation that while the vision and goals for Corps of Engineers adoption of sustainable design practices are well established, all the tools are not in place for those that will have to execute military construction programs. The basic content and organization of this documents information is as follows:

- Executive Orders
- Corps of Engineers Sustainability Guidance
- U.S Army Corps of Engineers Green Building Criteria Update Program (GBCUP)
- Environmental Drivers/Requirements
- Tri-Services Sustainable Planning
- Regulatory Guidance and References
- Army/Corps Web Based Green/Sustainability Pointers/Sites/Resources.

The Corps of Engineers issued initial guidance on sustainable design in an engineering technical letter (ETL), dated 30 June 1998. ETL 1110-3-491, "Sustainable Design for Military Facilities," which communicates the Corps of Engineer's vision, goal, and objectives for sustainable design, and presents background information on actions leading to the ETL's publication. It provides designers with guidance on sustainable planning, design, and construction for both new Army facilities, and the rehabilitation/renovation of existing facilities. The ETL cites Executive Orders (EO) 12873 and 12902 as the primary drivers for sustainable design. Equally important to sustainability issues of the Corps and the Army, however, signed following the publication of the ETL, are Executive Orders 13101 and 13123 that supercede both of those Executive Orders (see above). These latter EO's are much clearer on the requirements for sustainable design.

The Corps' Definition of Sustainability – The Corps uses the definition of sustainability initially authored by the United Nation's World Commission on Environment and Development, commonly referred to as the Brundtland Commission. The Brundtland Commission simply stated that sustainable development, a definition that is widely accepted today, is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Translated in terms appropriate to the Corps' military construction missions, "Sustainable Design (or Green Building) is the design, construction, operation, and reuse/removal of the built environment (infrastructure as well as buildings) in an environmentally and energy efficient manner."

Corps Sustainability Goals – To be environmentally responsible in the delivery of facilities, and in their revision/alteration, is the overall USACE goal for Sustainable Design. Environmental responsibility includes: the efficient use of natural resources both in construction and renovation and as consumed during facility use; maximizing resource reuse; energy efficiency and moving from use of fossil fuels towards renewable energy sources; the creation of safe, healthy and productive work environment for all facility users; better performing, more desirable, more affordable infrastructure and buildings of long-term value; and where appropriate, restoration of the natural environment.

Corps Guidance on Sustainability – The ETL provides basic guidance and design criteria directly and via reference following sequentially through the design process (key references included in ETL 1110-3-491 are included below under "Regulatory Guidance and References"):

1. Establishment of the Project Design Team
2. Goal Setting and Design Charrette
3. Planning and Site Selection

- Installation Master Plan Review
- Installation Design Guide Review
- Environmental Impact Statement (EIS) Review

4. Site Development
5. Design and Construction of the Built Environment.
   - Maximizing User Health and Productivity
   - Designing for Energy Efficient Operation
   - Management of Water as A Limited Resource
   - Resource-Efficient Materials In Design and Construction.

Evaluation/Comment

ETL 1110-3-491 forms the basis for Corps of Engineers execution of the military construction program. It defines the overall vision, goals, and objectives for the Corps to achieve sustainable design for the Army and contains rudimentary steps for Corps designers/program managers to follow.

Additional tools and guidance need to be developed and/or selected from the myriad of those currently available for use. For example, while the ETL indicates that the designer should select materials with the lowest embodied energy for example, it neither provides guidance on how this is to be accomplished nor refers readers to appropriate resources. Again, citing a materials example, it cites that materials should be selected having the highest recycled content, but again offers no support in how selection is to be effected.

The ETL provides a list of "Sustainable Design and Green Building Organizations" for reference. This list is a good start, but could be enhanced. First, it is not clear why the references are provided. It would be helpful to document why each reference is important. Second, there are other organizations of more importance that are not listed, that do need to be referenced.

It is fairly apparent from this initial investigation that, while the vision and goals for Corps of Engineers adoption of sustainable design practices are well established, there are opportunities to provide better tools to help those they will have to execute military construction programs.

U.S Army Corps of Engineers Green Building Criteria Update Program (GBCUP)

In response to EO 12873 requirements that Federal agencies use "environmentally preferable products and services" and that they appropriate programs "favoring the purchase of these products and services," the Corps of Engineers ini-

tiated a program to incorporate sustainable design and construction practices in military construction. While other Government agencies concentrated on demonstration projects, the Corps philosophy has been to effect a fundamental and permanent change in the way all military projects are designed and constructed. This approach has required the revision of Corps of Engineers Guide Specifications (CEGS), which are the foundation of every military project the Corps executes for the Army and Air Force. The Corps has recently completed or is finalizing, the revision of nearly 60 construction guide specifications, and approximately 30 technical/engineering manuals, engineering technical letters, and instructions, to incorporate sustainable design and construction practices.

Environmental Drivers and Technology Requirements

The identification and documentation of the Army's environmental technology requirements are accomplished through an iterative process called AERTA (U.S. Army Environmental Requirement and Technology Assessments). The Office of the Directorate of Environmental Programs (ODEP) conducts AERTAs with support from the Army Environmental Center (AEC). The process had its seeds in meetings conducted to identify Army environmental requirements in January of 1994, and subsequent meetings to update Army environmental technology requirements, however, the process was not fully implemented until 1998. Now the AERTA process forms the basis for identification requirements and the establishment of funding and programs for execution.

Each service is required by DOD to submit its technology requirements to the Environmental Security Technology Requirements Group (ESTRG) to optimize research, development, test, and evaluation (RDT&E) funding across the services. AERTA identified requirements now represent the critical RDT&E needs for accomplishing the Army's mission with the least impact or threat to the environment for submission to the ESTRG. These requirements are Army-level, including installation specific needs only when that need is deemed critical to the execution of the Army's mission. In addition, identified requirements are utilized to prepare environmental technology management plans presented to the Program Evaluation Groups (PEGs) for funding.

Major Commands (MACOMs), major sub-commands (MSCs), the Office of the Deputy Chief of Staff for Operations (ODCSOPS), the Office of the Deputy Chief of Staff for Logistics (ODSCLOG), and the RDT&E community identify, evaluate, group, and validate requirements. They then transfer the requirements to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology—ASA (ALT)—and the technology teams for development of technology management plans for the program objective memorandum (POM).

The process organizes requirements by environmental technical areas, called pillars. The pillars are Restoration, Compliance, Pollution Prevention, and Conservation. Generally, each pillar addresses how it affects readiness and quality of life, impact, or threat to the environment, and timeliness for Army compliance with environmental regulations. They document cost and problem scope to define the level of funding being expended/required each year to address the problem; the MACOMs or installations being affected; and to facilitate return-on-investment (ROI) calculations in the environmental technology management plans.

The highest priority (ODEP) environmental technology requirements pertinent to sustainability grouped by environmental pillar are *Pollution Prevention Priority 1*—A (3.5.c) Non-Hazardous Solid Waste Reduction

Key Policy or Regulatory Drivers:

- Resource Conservation and Recovery Act (RCRA), as amended
- Executive Order (EO) 12856—"Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," August 3, 1993 (superceded by EO 13148)
- Executive Order (EO) 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," 14 September 1998
- Executive Order (EO) 13148, "Greening the Government Through Leadership in Environmental Management," 22 April 2000.

Requirement:

Army costs for handling, management, and disposal of nonhazardous solid wastes are significant and can be expected to increase further over the next 10 years. The Army needs new techniques, technologies, and processes to mitigate the costs for these wastes. These needed techniques and technologies should focus on all possible remedies such as source reduction, recycling, reuse, and innovative disposal methods.

The Army generated 2.7 million tons of solid waste in FY97 at a total disposal cost of $116 million or 2.5 percent of the Army facilities operation and maintenance budget. Of this less than 3.5 percent was recycled or reused to generate revenue. The Army is running out of landfill space, is not permitting new sites, and disposal costs are increasing. When space runs out, installations will be forced to contract with local industries and municipalities at a further increase in cost.

By volume, the greatest portion of nonhazardous solid waste, which is most applicable to sustainable facilities, is waste generated in the construction, use, renovation and demolition of building facilities. This waste stream is currently saturated and expected to remain so for the next 5 years as the Army facility reduction program continues. New technologies and policy are needed to enable and encourage the reduction, reutilization, and/or recycling of building wastes generated during construction, use, renovation, and demolition of buildings to reduce the volume of this large waste stream.

Pollution Prevention Priority 6—A (3.5.k) Pollution Prevention in Facility Construction, Operation, Repair and Demolition

Key Policy or Regulatory Drivers:

- Resource Conservation and Recovery Act (RCRA), as amended
- Executive Order (EO) 12856—"Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," August 3, 1993 (superceded by EO 13148)
- Executive Order (EO) 13148, "Greening the Government Through Leadership in Environmental Management," 22 April 2000.

Requirement:

Operation, repair, maintenance, and demolition of Army facilities cost $4.5 billion in FY97 or about 6 percent of the total Army budget. These expenditures reflect 30 percent of the actual requirements, as two-thirds are backlogged. The implementation of sustainable development practices would enable a decrease in life-cycle facility management costs allowing the Army to meet a higher percentage of actual requirements.

Examination of facility life-cycle sustainable design principles and the incorporation into appropriate guidance documentation / facilities business processes is needed.

Compliance Priority 9—A (2.3.k) Removal, Treatment, and Disposal Technologies for Lead-Based Paint (LBP) Contamination

Key Policy or Regulatory Drivers:

- Resource Conservation and Recovery Act (RCRA), as amended
- Clean Water Act (CWA), as amended
- Clean Air Act (CAA), as amended
- Occupational Safety and Health Act (OSHA)

- Residential Lead-Based Paint Hazard Reduction Act of 1992 (RLPHRA)
- AR 420-70, Buildings and Structures.

Requirement

Current LBP routine maintenance practices, interim controls, and abatement procedures are inefficient, costly, and can often result in exposure and environmental contamination. Further they are prohibitively expensive, especially given the large stock and wide variety of aging Army facilities that were constructed using lead-based paint primers and coatings.

The Army needs cost-effective technologies to control or abate sources of lead exposure and contamination. Standard methodologies are needed for LBP contamination assessment and management in place, as well as for safe and cost-effective removal and disposal techniques. This is especially true for high volume-low toxicity debris, which fails the Toxicity Characteristic Leaching Procedure (TCLP) for lead.

Complete Environmental Technology Requirement Information (current Army environmental technology requirements, with supporting data) is viewable at the AERTA website located on the DOD-restricted portion of the Defense Environmental Network and Information eXchange (DENIX) at:

http://www.denix.osd.mil/denix/DOD/Policy/Army/Aerta/tnstop.html.

Further information on the AERTA process is also available at this location.

Sustainable Planning

The Office of the Secretary of Defense sponsored a feasibility study* for implementing sustainable development concepts and principles into the Army, Navy, Air Force, and Marine Corps land and facilities planning processes and programs. This is the first service-wide attempt by the DOD to address sustainability and sustainable planning at a policy level. The purpose of the feasibility study is to establish a common understanding of sustainable development that can be applied to planning and to use that understanding to assess opportunities

* EDAW, Inc. "Sustainable Planning: A Multi-Service Assessment," 1999.

to include sustainability in military planning. Definitions of sustainability, sustainable development, and sustainable planning communicate a value system that is both universal and complicated.

The challenge of this effort was to find common ground among a diverse group of stakeholders who will eventually practice sustainable planning. A key issue for the DOD and the individual services is the practical application of sustainability within the unique culture of the military. While the basic truths underlying the concepts and principles of sustainability remain constant, their application must be tailored in a way that can be understood and then implemented. Addressing this challenge is an important goal of the Feasibility Study."

The Executive Summary of this study indicates it to only be the beginning and leaves open subsequent actions that will need to be accomplished by the individual services to identify the appropriate actions to make their own planning, programming, design, construction, and facility operations practices sustainable.

The Department of the Air Force

The U.S. Air Force has the Corps of Engineers as its primary construction agent. The Air Force maintains its own policy and requirements for the operation and maintenance of its facilities. They also promulgate some guidance for construction at Air Force bases. The most salient document regarding sustainability is the USAF Environmentally Responsible Facilities Guide. It defines the environmental challenges faced in planning, programming, designing, and constructing facilities. The Guide serves as a checklist of ideas and procedures to be used throughout the facility delivery process and the rest of the entire building lifecycle. It also provides appendices that can be downloaded from the web and inserted into building contracts and serve as guidance tools. Appendix E gives further details.

The Department of the Navy

After building several pilot projects using green building principles, the U.S. Navy has made such practices policy. The Naval Facilities Engineering Command's "Whole Building Guide" defines sustainability, details the principles involved, and lists 14 criteria to use when evaluating architectural and engineering firms, including energy-efficient design, life-cycle analysis, and indoor air quality. The Navy also has several planning and design policies that encompass design, criteria, procurement, and USEPA-designated products. Appendix F gives further details.

5 Discussion

The goal of this study was to identify the potential for augmenting the Corps of Engineers' effectiveness in providing sustainable facilities to its customers. This required understanding the driving forces that cause elements of the Federal government to follow sustainable practices, the stakeholders that are pursuing sustainability, the responders that are providing the tools to achieve sustainability, and the approaches that they have devised.

The forgoing discussion demonstrates that the Federal government is actively embracing sustainable development issues in response to a succession of executive orders. The current most active implementers of sustainable practices include the Navy, Air Force, and Army within the Department of Defense and the General Services Administration and the U.S. Postal Service in the nonmilitary branches of the Federal government. The leading government responders include the Department of Energy and Environmental Protection Agency who are providing such tools as Energy Star® and incentive programs that support sustainability. GSA provides information to its agency on how to acquire sustainable services. The Navy and Air Force have published design and planning guidance. The Corps of Engineers has updated its specifications to be more sustainable and issued a sustainable design directive.

Examination of the potential customer base for the Corps of Engineers to provide sustainability services revealed that the Air Force expects projects to be sustainable and the Assistant Secretary of the Army for Installations and Environment—ASA (I&E)—recently published a memo requiring the application of sustainable practices. The Navy has own procedures for acquisition, but also requires all of its projects to be sustainable.

Elsewhere in the Federal government, its largest property holder, GSA, has sustainable policies and principles, but no in-house engineering capabilities. This suggests that GSA will not be a competitor with the Corps for projects and may be a potential customer for larger projects.

For its part, the Corps has taken the following steps to enhance the sustainability of its services. Together with other elements of DOD, it has co-developed a training course and has conducted a series of train-the-trainer courses for its dis-

trict designers. It has briefed Corps Headquarters management on sustainable development.

To help USACE Districts benchmark their accomplishments, The Engineer Research and Development Center, USACE, and ACSIM have jointly developed a Sustainable Project Rating Tool (SPiRiT) that will help ACSIM, USACE, and their clients identify and measure sustainable principles in each project that they develop. SpiRiT is based on LEED 2.0 TM, Copyright © 2000 by U.S. Green Building Council. The Corps is currently meeting with its largest single military customer, the Army Chief of Staff for Installations Management (ACSIM) to identify projects that will demonstrate advanced technology and commence application of sustainable principles.

6 Conclusions

While sustainable principles are widely studied and understood, knowledge is very diffuse and difficult to apply. This is especially true for the Corps of Engineers, which must adhere to tight design and construction budgets and schedules. For the Corps of Engineers to become the sustainable engineers of choice to DOD and the nation, it can enhance its effectiveness through the following steps.

- Train the Corps Districts in sustainable planning, design, and construction principles to apply to themselves and their contractors
- Develop accessible knowledge products that support sustainable practices.

The Corps is expanding its military mission beyond the limits of design and construction in bringing services to the military throughout the life cycle of facilities. In the civil works arena, the Corps has long been responsible for maintaining a wide variety of facilities throughout their life cycles. Figure 1 illustrates the phases of a facility life cycle, planning, design, construction, commissioning, operation and maintenance, rehabilitation, recycling, and disposal. Table 1 lists bench-level tools that streamline and automate sustainable facility life-cycle processes. To support the development of such tools, the following steps are recommended as a roadmap.

The themes of measuring sustainability, addressing project life-cycle processes, the development of coordinated tools, the development of databases, and fielding of sustainable processes are themes that pave the way to successful implementation of sustainable services by the Corps of Engineers.

Addressing the project life cycle are, as shown in Figure 2.

Measuring Sustainability – The measurement of how sustainable a given practice is at any point within the project life cycle is key to success in understanding the status of existing situations and choosing among alternatives. Current methods incorporate such tools as Energy Star™, Place^{3}s, BEES, LEED, DOE-2 and Energy 10, and BREEAM (NA). The challenge is to adapt the principles incorporated in these products and adapt them to the entire facility life cycle for military and civil works facilities.

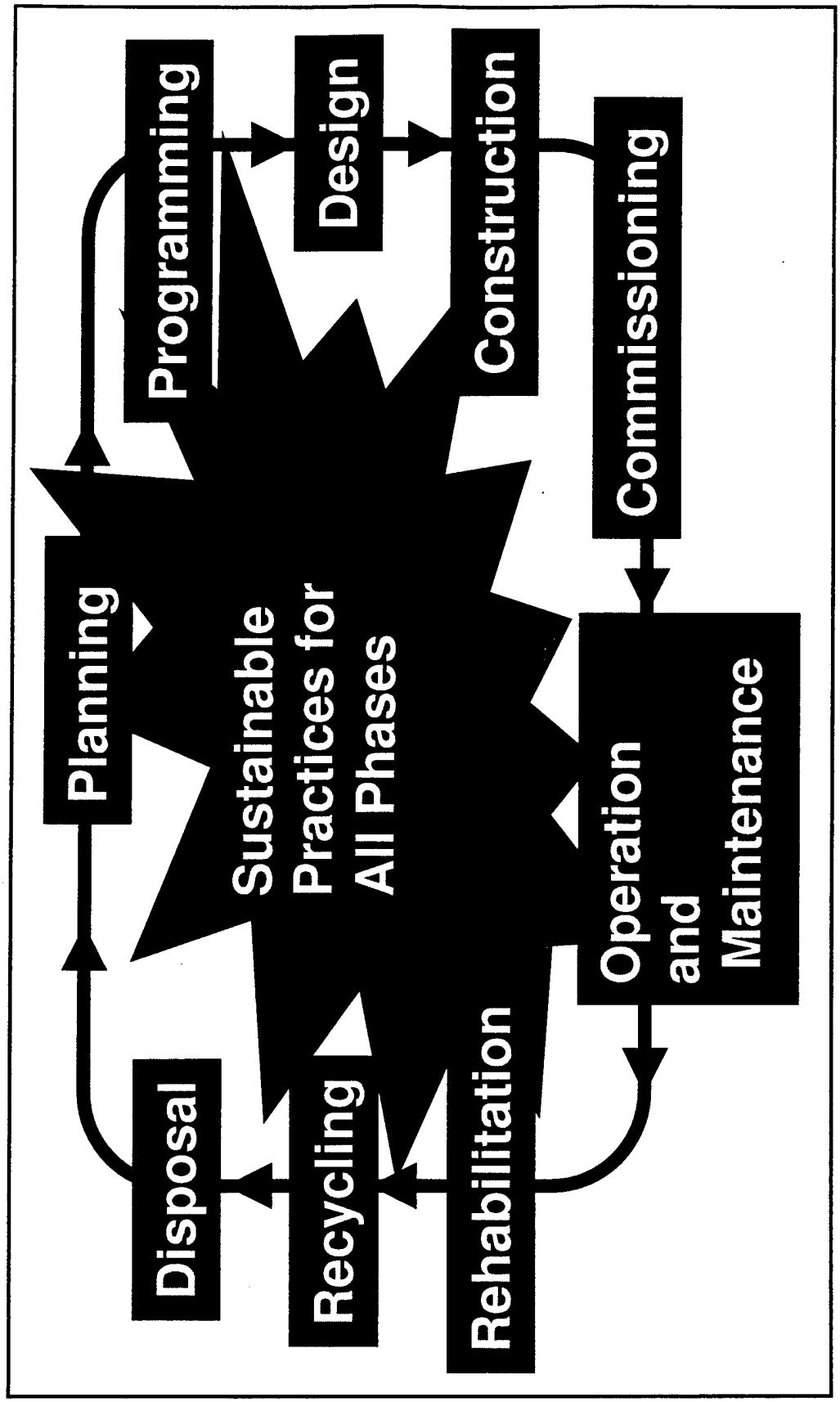

Figure 1. The phases of a facility life cycle.

Table 1. Principal responders and the approaches to sustainable practice that they offer.

Responder	Rating System	Guidelines	Standards
Corps of Engineers		ETL 1110-3-491	Green Building Criteria Updates
U.S. Air Force		Environmentally Responsible Facilities Guide	
U.S. Navy		Whole Building Design Guide	
EPA	ENERGY STAR™	Environmentally Preferable Purchasing Comprehensive Procurement Guidelines	
DOE	PLACE3S	Sustainable Building Technical Manual Building Energy Software Tools	
National Institute for Standardization and Technology	BEES		
DOI, National Park Service		Guiding Principles of Sustainable Design	
U.S. Green Building Council	LEED™		
Lawrence Berkeley Laboratory	DOE-2/Energy 10	Building Design Advisor Home Energy Saver Residential Ventilation	
Commonwealth of Massachusetts		Environmentally Preferable Products Procurement Program	
Hennepin County, Minnesota	Sustainable Design Guide and Rating System	Sustainable Design Guide and Rating System	
Geo Network		Geo Network Product Guide	

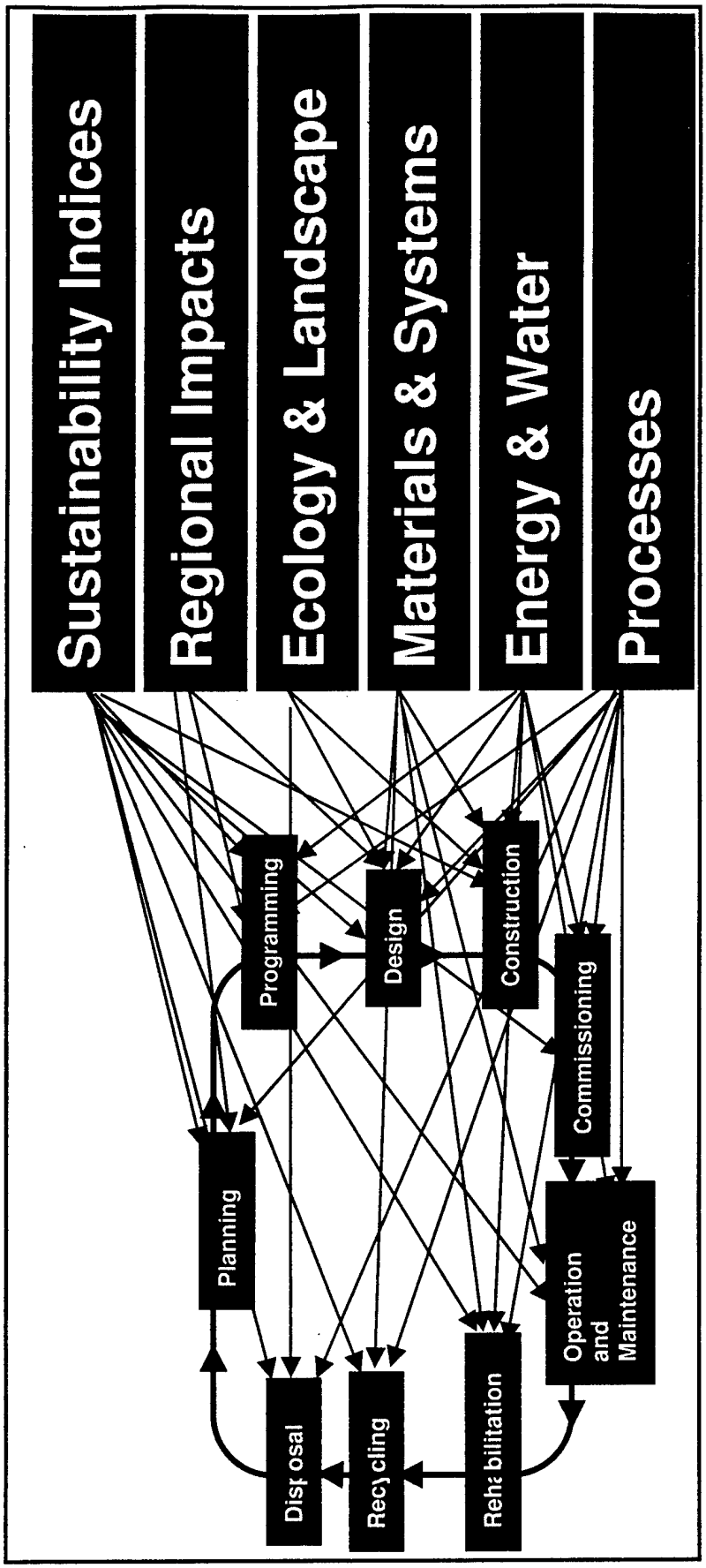

Figure 2. The major issues pertaining to the phases of a facility life cycle.

Project Life-Cycle Processes – Other tools are required to support the project delivery and infrastructure management phases of facility life cycles. Recently the Corps revised its guide specifications through the Green Building Criteria Update Program. To achieve sustainability throughout the life cycle, this process should start with project inception and development, architect/engineer selection, the creation of standard designs, and be infused into all aspects of the life-cycle. Centers of expertise need to incorporate tenets of sustainability into their functions and all other functions that the Corps performs in support of its customers.

Addressing Corps and Army processes are:

- *Coordinated Tools* – Currently the tools that support sustainable decisions are diverse and do not follow the facility through its life cycle. Furthermore, they are incompatible with each other. The development of coordinated tools would overcome the time-consuming implication of having to perform exhaustive research of alternatives to make an otherwise routine decision. In developing coordinated tools, one would build on what is available. Such tools would address client needs and expectations, yet respond to needs of the Corps. They would work seamlessly to deliver and support sustainable facilities on time and within budget.
- *Data Bases* – Current data on products, systems and materials are essential to support sustainable decisions. Such data pertain to environmental impact, energy performance, and life-cycle costs. Currently such data are the weak link in decisionmaking. Successful data development would draw on diverse sources that were developed for a wide variety of purposes. The challenge would be to assess what is available, decide how to adapt it, and how to restructure the collection of data, including how to automate it from such normal processes as scheduling, purchasing, testing.

In the final analysis, this effort extends beyond the interests of the Corps of Engineers. It points to obtaining co-funding of cooperative efforts with other agencies that are responding to the market for sustainable decision tools. Ideally there would be a national consortium for integrated decision tool development.

Fielding the sustainable processes described here, requires the Corps to assist clients in the development of projects with sustainable principles, to train design/delivery teams in sustainable facilities technology, and to assist Corps on how to streamline and augment the use of sustainable principles.

Planning

- *Regional Planning* – GIS-based models of transportation impact, commuting patterns, noise, and other environmental sensitivities that perform first-level EISs as the requirements become known.
- *Site Planning* – GIS-based model of site ecosystem, including drainage, biome descriptions, etc. that respond to movement of a project footprint with impacts and costs and allow automated optimization.

Project Development

- *Building Assessment* – For existing structures, a graphical profile of its sustainability potential, including its suitability, adaptability options, and corresponding costs.

Design

- *Regional Databases* – Databases for pre-qualified sustainable-qualified designers and contractors. Databases for regional factors addressing appropriated design, materials, vegetation, etc.
- *Sustainability Measurement* – DOD requires a standard means of measuring sustainability that recognizes issues that are particular to the military and that recognize the military's mission. Existing measurement tools, such as LEED, BEES, BREEAM, etc. may not be applicable.
- *Benchmark Assumptions* – In tools such as Building Composer, default assumptions in development of a project that already represent a reasonable degree of sustainability, e.g., LEED Bronze, establish benchmarks for subsequent refinements of the design to improve on.
- *Trade-off Tools* – Using energy and environmental measurements of materials and system performance and costs over the project life cycle create a tool that incorporates menu-driven or wizard-based exploration and comparison of alternatives.
- *Construction* – Tools for planning site impact, including parking, storage, work areas, cleaning areas, etc. and construction waste management that includes provision for, training in and enforcement of recycling and hazardous material control. Also tracking tools to ensure that material and system substitutions meet the sustainability and life cycle cost intent of the design.

Databases

- *Automated Life-Cycle Cost and Effectiveness Tracking* – Networked inventory and tracking system that tracks the performance of components and materials across an organization that is tied to the procurement system to obtain replacements, maintenance, or upgrades. Capitalize on OTS products, e.g., MAXIMO and Pack Rat

Operation and Management

- *Occupancy and Maintenance* – Operating manuals, training, integrated maintenance, recurring assessment of total resource usage. Continued monitoring of the indoor environment.

Recycling

- *Facility Reuse* – Development of building systems that lend themselves to effective salvaging and themselves maximize use of recyclable materials. Profiling alternative building uses for retired buildings.

7 Action Plan

The plan is to conduct research necessary to bring together the issues of measuring sustainability, rating sustainability, identifying strategies that ensure sustainable delivery and management of installations, and determining life-cycle costs within direct research program of the ERDC. The plan is then to provide the tools that combine these sustainable decisions in a medium that is easy to use for the end user. This requires the following steps.

- Expand the constituency for delivering engineering products to designers and users of sustainable facilities.
- Evolve the indices and metrics for sustainability of facilities during all phases of their life cycles.
- Develop planning, design, design, construction, commissioning, operation and maintenance, rehabilitation, and disposal strategies for facilities that are sustainable, yet have a readily identifiable life cycle cost.
- Develop accessible knowledge tools that support sustainable practices.

Constituency

The customer is the driving force in determining a valuable research product. The plan is to consult the following customers to shape the products that deliver and maintain sustainable facilities.

- *ACSIM* – The Army Chief of Staff for Installation Management is the headquarters-level specifier of facilities requirements. ACSIM has recently developed a requirement that all new facilities be sustainable. Further discussion should point to the need to address other phases of the installation life cycle.
- *MACOMs* – The Army major commands will have to perform planning for new facilities and the use and fate of existing facilities. It is important to understand the constraints that they work under.
- *Installations* – Installations must operate and maintain the facilities that are placed within their footprints. Much of the value of creating sustainable facilities can be defeated through nonsustainable operations and maintenance practices. The goal is to work with installations to help them value and implement such practices.
- *Corps Districts* – The Corps districts are responsible for the design, contracting, construction, and acceptance of new facilities. We must identify just how

the requirement for sustainable design and development challenges the districts ability to successfully meet this requirement.

- *Training Contractors* – The Corps has engaged several contractors to teach sustainability contractors. The Corps must integrate new sustainability principles into their curricula, as the principles arise.
- *Air Force* – The Air Force is a significant client of the Corps of Engineers that has been a vanguard in adopting sustainable practices. Coordinated technical and financial support from the Air Force would benefit all the services.
- *Navy* – The Navy also has been a vanguard in adopting sustainable practices. Coordinated technical and financial support from the Navy would benefit all the services.

Indices and Metrics

The technical objective of developing indices and metrics would be to develop a methodology for determining regionally based indicators of sustainability that reflect environmental and energy related impacts. These would apply to military sustainability rating tools and facility designs

The approach would be to model military installation land use and resource usage. This approach would use a geographical information systems-based geostatistical methodology, based on PLACE^{3}S, a product of DOE LEAM that addresses facilities impacts in site contexts, and, a product of ERDC-CERL and the University of Illinois that addresses dynamic phenomena. These tools would simulate energy and resource demands and flows in military installations infrastructure to test the impacts of typical military facilities and thereby derive sustainable indices. Appendix G describes academic resources that may help provide additional tools. The resulting indices would be incorporated into incorporated into sustainable rating and decision tools.

Sustainable Strategies

The technical objectives of the strategies for delivery and maintenance of sustainable facilities would be to assist USACE and ACSIM to:

- reduce life cycle costs
- enhance sustainability
- extend the life expectancy
- increase the productivity of occupants.

The approach would be to gather and assess technologies, strategies, and guidance that support sustainable building delivery, operation and maintenance. This would require coordination with the Corps, MACOMS, installations, other military services, public and private sector agencies on sustainable development guidance. The product would be to develop a Building Module, a Building Complex Module and adapt each to regional considerations.

Sustainable Tools

The technical objective to develop tools for delivering sustainable facilities is to mainstream Army Sustainable Design and Development (SD&D), strategies, indices, criteria and guidelines into the Corps' design process. The principal challenge is to keep pace with the rapidly moving SD&D field. A dominant focus in the delivery of SD&D facilities is to address the complex tradeoffs required to achieve a "silver" SD&D rating within the Sustainable Projects Rating Tool (SpiRiT).

The approach would be (a) to develop a web-based focal point for designers to keep abreast of SD&D trends and technology and (b) to develop a methodology for specifying customer and region-specific SD&D criteria for different military building archetypes. The Sustainable Design and Development website to help District designers is available at http://www.cecer.army.mil/SustDesign. The approach for (b) will be to develop a Sustainable Design Wizard, which will present a sustainable starting point for new facilities and then identify impact of suggested alternatives.

Operation and Maintenance

The technical objective to develop tools for operating and maintaining military facilities sustainably.

The approach is to identify the impacts and alternatives for sustainable practices in operation and maintenance of military facilities. Measurement and rating tools will be key to this process, as well as developing an information technology that keeps abreast of a rapidly changing field.

Master Planning

The technical objective to develop tools for master planning sustainable military that accomplish the mission, yet have minimal impact on the environment and their surrounding communities.

The approach would be to develop graphical information system tools that calculate the consequences of master planning actions and that incorporate Wizards that suggest recommended alternatives.

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Appendix A: Index of Federal Sustainability Resources

"The Road to Sustainable Development: A Snapshot of Activities in the United States," http://www.whitehouse.gov/PCSD/Publications/Snapshot.html The President's Council on Sustainable Development, March 1997.

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U.S. Department of Commerce, http://www.doc.gov/

National Institute of Standards & Technology (NIST), http://www.nist.gov/

National Institute for Standards and Technology, Manufacturing Extension Partnership, http://www.mep.nist.gov/ [Promoting community sustainability through promoting small business/manufacturing]

Building and Fire Research Laboratory, http://www.bfrl.nist.gov/

BEES [Building for Environmental and Economic Sustainability], By Barbara C. Lippiatt, http://www.bfrl.nist.gov/oae/software/bees.html

"BEES 1.0: Building for Environmental and Economic Sustainability, Technical Manual and User Guide" Lippiatt, Barbara C., http://fire.nist.gov/bfrlpubs/build98/art062.html.

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USEPA Offices of Principle Importance to Sustainable Design and Development, http://www.epa.gov/epahome/Offices.html

Appendix B: Index of Federal Sustainability Offices

Office of Research and Development National Center for Environmental Research and Quality Assurance, http://es.epa.gov/ncerqa/ncqwelc.html Office of the Director 401 M Street, S.W. Washington, DC 20460 Mail Code: 8701R	Responsible for the research and development needs of the USEPA's operating programs and the conduct of an integrated research and development program for the Agency.
USEPA-Office of Planning Policy & Evaluation http://www.epa.gov/oppe/oppe.html	Serves as USEPA's focal point for multimedia policy, planning, and evaluation functions and is primarily responsible for policy and economic analysis.
Office of Solid Waste (OSW) http://www.epa.gov/swerrims/ USEPA Waterside Mall (5101) 401 M Street, S.W. Washington, DC 20460	Provides policy, guidance, and direction for the land disposal of hazardous wastes, underground storage tanks, solid waste management, encouragement of innovative technologies, source reduction of wastes and the Superfund Program.
The U.S. Department of Agriculture U.S. Forest Service Cooperative Forestry PO Box 96090 Washington, DC 20090-6090 Phone (202) 205-1389 Fax (202) 205-1271 cf/wo@fs.fed.us	
Minority Business and Development Agency http://www.mbda.gov/ Minority Business Development Agency 14Th St & Constitution Avenue, NW Room 5055 Washington, DC 20230	Promoting community sustainability through promoting minority business development]
U.S. Department of Commerce (DOC) Economic Development Agency, http://www.doc.gov/eda/, Economic Development Administration U.S. Department of Commerce 14th & Constitution Avenue, Room 7800B Washington, DC 20230 (202) 482-5081	
Building and Fire Research Laboratory, http://www.bfrl.nist.gov/ Gaithersburg, MD 20899	

Center of Excellence for Sustainable Development http://www.sustainable.doe.gov/ U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy 1617 Cole Boulevard Golden, CO 80401 (800) 363-3732	
Center of Excellence for Natural Disaster Remediation U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Atlanta Regional Support Office 730 Peachtree Street, NE, Suite 876 Atlanta, GA 30308-1212 (404) 347-1047	
Federal Energy Management Program http://www.eren.doe.gov/femp/ 1000 Independence Ave., SW, EE-90 Energy Efficiency and Renewable Energy Clearinghouse (EREC) PO Box 3048 Merrifield, VA 22116 800-DOE-EREC E-mail: doe.erec@nciinc.com	
Simulation Research Group http://gundog.lbl.gov/ Bldg. 90, Room 3147 Lawrence Berkeley National Laboratory One Cyclotron Road Berkeley, CA 94720 USA Phone: 510.486.5711 Fax: 486.4089	
National Renewable http://www.nrel.gov/ Energy Laboratory 1617 Cole Boulevard Golden, CO 80401-3393	
U.S. Department of Energy (DOE) http://home.doe.gov/index.htm Washington, DC 20585 202-586-5772 Fax: 202-586-3000	
U.S. Department of the Interior, National Park Service http://www.nps.gov/ 1849 C Street, N.W. Washington, DC 20240	
National Park Service, Denver Service Center http://www.nps.gov/dsc/ 12795 W. Alameda Parkway PO Box 25287 Denver CO 80225-0287	

U.S. Department of Transportation (DOT) http://www.fta.dot.gov/research/ Office of Research, Demonstration and Innovation, TRI-1 Federal Transit Administration 400 7th Street, SW Washington, DC 20590 202-366-5646	Transportation Program Manager [Sustainable Development Program—Livable Communities Initiative, Smart Growth Initiative]
U.S. Postal Service Office for Environmental Management Policy: http://www.usps.gov/environ/ 475 L'Enfant Plaza SW Room 1P830 Washington, DC 20260-2810 Phone: 202-268-5955 Fax: 202-268-6016	
White House National Science and Technology Council http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/html/NSTC_Home.html 1600 Pennsylvania Ave, N.W Washington, DC 20502 202.456.6100	
Office of Science and Technology Policy http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/html/NSTC_Home.html 1600 Pennsylvania Ave, N.W Washington, DC 20502 202.456.6100	
Office of the Federal Environmental Executive (OFEE), http://www.ofee.gov/ Mail Code 1600 401 M Street, SW Washington, DC 20460 The President's Council on Sustainable Development http://www2.whitehouse.gov/PCSD/ 202-408-5296 202-408-6839 fax	
The Vice Presidents Task Force on Urban Sprawl http://www.susdev.noaa.gov/urbanspr.html (202) 260-1297	
Joint Center for Sustainable Communities U.S. Conference of Mayors 1620 Eye Street, NW Washington, DC 20006 phone: 202-861-6784; fax: 202-429-0422	
Joint Center for Sustainable Communities National Association of Counties 440 First Street, NW 8th Floor Washington, DC 20001 phone: 202-942-4224 fax: 202-737-0480	

Appendix C: Regulatory Guidance

American Society of Heating Refrigerating & Air-Conditioning Engineers (ASHRAE) Standard 62-1989, "Ventilation for Acceptable Indoor Air Quality."

Architectural and Engineering Instructions (AEI) -Design Criteria, 3 July 1994.

Architectural and Engineering Instructions (AEI) For Installation Support, 2d ed., 17 October 1996.

Army Regulation (AR) 200-1, *Environmental Protection and Enhancement*, 21 February 1997.

Army Regulation (AR) 420-70, *Buildings and Structures*, 10 October 1997.

Army Technical Manual (TM) 5-803-13, *Landscape Design and Planting Criteria*, 06 August 1988

Army Technical Manual (TM) 5-803-14, *Site Planning and Design*, 14 October 1994.

Clean Air Act (CAA), as amended (42 USC 7401, et seq.).

Clean Water Act (CWA), as amended.

Engineering Technical Letter (ETL) 1110-3-491. *Sustainable Design for Military Facilities*, 30 June 1998.

Executive Order (EO) 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*, 3 August 1993

Executive Order (EO) 12873, *Federal Acquisition, Recycling, and Waste Prevention*, 6 August 1993.

Executive Order (EO) 12902, *Energy Efficiency and Water Conservation at Federal Facilities*, 8 March 1994.

Executive Order (EO) 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition*, 14 September 1998.

Executive Order (EO) 13123, *Greening the Government through Efficient Energy Management*, 03 June 1999.

Executive Order (EO) 13134, *Developing and Promoting Biobased Products and Bioenergy*, 12 August 1999.

Illumination Engineering Society (IES) recommendations.

Naval Facilities Engineering Command (NAVFAC) / EDAW, Inc. *Sustainable Planning: A Multi-Service Assessment*. 1999.

National Environmental Policy Act (NEPA) of 1969, as amended (42 USC 321, et seq.).

Occupational Safety and Health Standards Act (OSHA)

Presentation, *Environmental Performance Indicators*, Maureen Sullivan, Office of the Deputy Under Secretary of Defense (Environmental Security), Spring 1999.

Residential Lead-Based Paint Hazard Reduction Act of 1992 (RLPHRA), Public Law 105-550.

Resource Conservation and Recovery Act (RCRA) of 1976, as Amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

U.S. Air Force Center for Environmental Responsibility (USAFCEE)/ Hellmuth, Obata + Kassabaum, Inc. (HOK), "United States Air Force Environmentally Responsible Facilities Guide."

U.S. Army Environmental Requirements and Technology Assessments (AERTA), "Environmental Technology Requirements for the 02-07 POM," April 26, 1999

U.S. Army Corps of Engineers Guide Specification (CEGS) 15400, *Plumbing, General Purpose.*

U.S. Army Corps of Engineers Guide Specification (CEGS) 15405, *Plumbing, Hospital.*

U.S. Army Corps of Engineers Guide Specification (CEGS) 15895, Air Supply and Distribution System."

U.S. Environmental Protection Agency (USEPA), "Energy Star Program, Buildings and Greenlights."

U.S. Environmental Protection Agency (USEPA), National Pollution Discharge Elimination System (NPDES) Permitting Program.

U.S. Green Building Council (USGBC), "LEED Green Building Rating System™1.0," Pilot Version, January, 1999.

Appendix D: Index of Army Sustainability Resources

Affirmative Procurement Program, http://aec-www.apgea.army.mil/prod/usaec/et/p2/app.htm, U.S. Army Environmental Center

American Society of Heating Refrigerating & Air-Conditioning Engineers (ASHRAE), http://www.ashrae.org/

Architectural and Engineering Instructions (AEI) For Installation Support, Second Edition, 17 October 1996, http://www.hq.usace.army.mil/cemp/E/INS_SPT.H™

Army Policy (DENIX) http://denix.cecer.army.mil/denix/DOD/Policy/component.html

Army Regulation (AR) 200-1, Environmental Protection and Enhancement, HQDA, Washington, DC. 21 February 1997, http://denix.cecer.army.mil/denix/DOD/Policy/Army/ar200-1.html

AR 420-70, Buildings and Structures, http://www.hqda.army.mil/acsimweb/fd/policy/ar420-70/index.htm

Army Technical Manual 5-803-14, "Site Planning and Design," 14 October 1994, http://www.usace.army.mil/inet/usace-docs/armytm/tm5-803-14/

Defense Environmental Information Exchange, http://denix.cecer.army.mil/denix/DOD/dod.html

Component Policy—Army, http://denix.cecer.army.mil/denix/DOD/Policy/component.html#army

News & Publications, Army [including Army Corps of Engineers], http://denix.cecer.army.mil/denix/DOD/News/news.html#army

Primary Applicable Environmental Sustainability Fora, http://denix.cecer.army.mil/denix/DOD/Discussion/discussion.html

Pollution Prevention Discussion Forum

Waste Management Discussion Forum

Environmental Knowledge Base (EnvKB), http://www.aro.army.mil/arowash/rt/shai.HTM, Army Research Office—Washington, Alexandria, VA.

Engineering Technical Letter (ETL) 1110-3-491, Engineering and Design—Sustainable Design for Military Facilities, CEMP-ET, 30 Jun 98, http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-3-491/toc.html

USEPA. "Energy Star Program, Buildings and Greenlights," http://www.epa.gov/buildings/

Executive Order (EO) 12856, Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements, Aug. 3, 1993, http://denix.cecer.army.mil/denix/Public/Legislation/EO/note15.html

EO 13123, "Greening the Government through Efficient Energy Management," 03 June 1999, http://denix.cecer.army.mil/denix/Public/Legislation/EO/note50.html

EO 13101, "Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," 14 September 1998, http://denix.cecer.army.mil/denix/Public/Legislation/EO/note45.html

Illumination Engineering Society (IES), Illuminating Engineering Society of North America (IESNA), http://www.iesna.org/

National Environmental Policy Act (NEPA) of 1969, As amended (42 USC 321, et seq.), http://denix.cecer.army.mil/denix/Public/Library/Planning/note1.html

Occupational Health & Safety Administration (OSHA), http://www.osha.gov/

U.S. Air Force Center for Environmental Responsibility (USAFCEE)/ Hellmuth, Obata + Kassabaum, Inc. (HOK), "United States Air Force Environmentally Responsible Facilities Guide." http://www.afcee.brooks.af.mil/green/

U.S. Army, Assistant Chief of Staff for Installation Management (ACSIM), http://www.hqda.army.mil/acsimweb/homepage.htm

U.S. Army Corps of Engineers, Environmental Division, http://www.environmental.usace.army.mil/hq/

U.S. Army Corps of Engineers, Environmental Guidance Program, current information for Environmental Programs, http://www.environmental.usace.army.mil/hq/library/guidance/guidance.html

U.S. Army Corps of Engineers, Professional Development Support Center, http://www.hnd.usace.army.mil/earc/

U.S. Army Environmental Center, http://aec.army.mil/

U.S. Army Environmental Policy Institute, http://www.aepi.army.mil/

U.S. Army Environmental Requirement Technology Assessments (AERTA), updated 23 November 1999, http://denix.cecer.army.mil/denix/DOD/Policy/Army/Aerta/tnstop.html

U.S. Army Materiel Command (AMC), Environmental Quality Division, http://www.amc.army.mil/amc/eng/a/

U.S. Army, Office of the Assistant Secretary of The Army (Installations, Logistics and Environment), OASA(IL&E), http://www.hqda.army.mil/asaile/index.htm

U.S. Army, Office of the Deputy Assistant Secretary of the Army (Environment, Safety & Occupational Health), http://www.hqda.army.mil/asaile/html/eso.htm

U.S. Army, Office of the Director Environmental Programs (ODEP), http://www.hqda.army.mil/acsimweb/env/env1.htm

U.S. Environmental Protection Agency (USEPA), National Pollution Discharge Elimination System (NPDES) Permitting Program, http://www.epa.gov/OWM/npdes.htm

U.S. Green Building Council (USGBC), "LEED Green Building Rating System™1.0," Pilot Version, January, 1999, http://www.usgbc.org/programs/leed.htm or http://www.usgbc.org/programs/LEED-RSv1.pdf

Appendix E: Index of Air Force Sustainability Resources

Look at http://dwww.cecer.army.mil/sd/af.cfm to update the following links.

The single most important Web Site for "sustainability" issues of the U.S. Air Force (USAF) is the Sustainable Development Web Site maintained by the U.S. Air Force Center for Environmental Excellence (AFCEE). AFCEE provides a complete range of environmental, architectural and landscape design, planning and construction management services and products. Those supporting USAF "sustainable development" are made available through this site.

Available on this site is the recently published U.S. Air Force Environmentally Responsible Facilities Guide in PDF format. The guide is a tool for making construction projects more environmentally responsible. It provides easy-to-follow procedures and strategies for implementing environmentally sustainable construction. General information on the Guide (Information) is available. You can also download Word Format versions of the various guide Appendices via the Guide's Table of Contents. (The guide is also available in its entirety for viewing on DENIX).

Other resources are available from the Sustainable Development Web Site by following the Case Studies, and Resources links.

Of related interest are sites for the AFCEE Environmental Quality and AFCEE Design and Construction Directorate Directorates. These two organizational elements are jointly responsible for USAFE sustainable development initiatives.

Two sites of immediate interest on the AFCEE Environmental Quality Directorate's Web site are the AFCEE—Affirmative Procurement Program and the AFCEE—Pollution Prevention (P2) Toolbox. The affirmative procurement site provides resources to aid the purchase of recycled-content products. The Toolbox provides access to a library of tools (e.g., handbooks, guides, training software, and videos) related to the USAF Pollution Prevention process.

Articles of general interest to Air Force sustainability include:

- Sustainable Design Q&A—Prepared by Hellmuth, Obata Kassabaum, Inc. (HOK), Architect-Engineer on contract to USAFE for preparation of the Environmentally Responsible Facilities Guide.

- U.S. Air Force "Aims High" in Sustainable Design—Article prepared by HOK.

- Air Force Sustainability Brochure - AFCEE brochure providing an overview of the Environmentally Responsible Facilities Guide.

- Air Force Sustainable Development Fact Sheet—An excellent AFCEE prepared Fact Sheet providing an overview of Air Force Sustainability activities and programs.

- U.S. Air Force MG Lupia's Testimony to the House Armed Services Committee (HASC) concerning USAF Infrastructure & Installations and the importance of "sustainable development.

Related sites of interest include:

- The U.S. Air Force Web Site
- The U.S. Air Force Environmental Web Site.

Appendix F: Index of Navy Sustainability Resources

Look at http://dwww.cecer.army.mil/sd/navy.cfm to update the following links.

The single most important Web site for "sustainability" issues of the U.S. Navy is the NAVFAC Criteria Office and Engineering Innovation Division (Code 15) of the Atlantic Division, Naval Facilities Engineering Command, Norfolk, VA. Their primary mission is the provision of engineering and architectural services, and technical guidance associated with facilities design and construction criteria.

Links from the NAVFAC Criteria Office and Engineering Innovation Division site point to the NAFAC "Whole Building Design Guide" (published July 1998)

The Division provides management, direction, coordination, and oversight for the search, assessment, development, and pursuit of innovative products and services throughout the Command.

The Criteria Office is responsible for the technical adequacy of all Navy shore facilities engineering design criteria, which includes NAVFAC Guide Specifications, Standard Drawings and Specifications, Design Manuals, Military Handbooks, P-Publications, Interim Technical Guidance and other forms of technical information. It is responsible for the management of the preparation of all design criteria on a world-wide basis. It further serves as a liaison with the Army, Air Force, other Federal agencies and industry standards societies on matters relating to facilities design criteria. It cooperates with Planning and Public Works Support Divisions to ensure proper coordination of planning and maintenance criteria.

Links from the NAVFAC Criteria Office and Engineering Innovation Division site also point to the Navy policy concerning sustainable design:

Planning and Design Policy Statement 98-01, "Design of Sustainable Facilities and Infrastructure," dated 18 June 1998. This policy identifies and establishes sustainability principles and concepts for the design of facilities and infrastructure accomplished by NAVFAC, both in-house and by means of A-E and related contracts.

Sustainable principles and concepts this policy defines, as reflected in NAVFAC criteria, guide specifications database, and other sources of facilities and infrastructure guidance, are indicated to be a major consideration in all facilities and infrastructure design decisions.

Planning and Design Policy Statement 98-02, "Criteria Supporting the Design of Sustainable Facilities and Infrastructure," dated 18 June 1998 This policy identifies and establishes criteria and other guidance in support of the design of sustainable facilities and infrastructure by NAVFAC. Sustainability principles and concepts this policy defines, as reflected in NAVFAC's guide specifications database, and as addressed in other sources of facilities guidance, are indicated to be incorporated into all facilities design decisions.

Planning and Design Policy Statement 98-03, "Procurement of Sustainable Facilities and Infrastructure through Architect-Engineer (A/E) Contracts," dated 18 June 1998. This policy provides for the utilization of A-E design services such that knowledge, skills and experience in the application of sustainable design principles and concepts is a major consideration in A-E or contractor selection. This policy applies to all A-E services, whether contracted for separately or in conjunction with construction services, as occurs when using design-build contracts.

Planning and Design Policy (PDP) Statement 98-04, "NAVFAC Participation in the Affirmative Procurement of USEPA Designated Products," dated 12 October 1998. This policy establishes NAVFAC participation in the Federal Affirmative Procurement Program for Environmental Protection Agency (USEPA) designated products and assists procuring agents in complying with regulations and DOD, SECNAV, and OPNAV policies during facilities acquisitions.

Articles of general interest to Navy sustainability include:

- ASHRAE Journal Industry News, October 1998, Navy Is First Federal Agency To Require Sustainable Design."
- The Department of the Navy Energy Awareness News, Vol. 3 Issue 7, " Department of the Navy is First Federal Agency to Adopt Sustainable Design."
- Environmental building News, Vol. 7, No. 10—November 1998, "Navy at the Leading Edge of Green Design" announcing Navy sustainable development policy.
- FEMP Focus Newsletter—October 1998, Department of the Navy First Federal Agency To Adopt Sustainable Design.

Of related interest are:

- The Naval Facilities Engineering Command, which is responsible for Navy Policy and Guidance on sustainability; The Naval Facilities Engineering Command, Environmental Directorate, Natural Resources Division

- The Department of the Navy Environmental Program

- The Department of the Navy Energy Web Site

- The Office of Naval Research (ONR), Arlington, VA, which coordinates, executes, and promotes the science and technology programs of the U.S. Navy and Marine Corps through universities, government laboratories, and nonprofit and for-profit organizations;

- The Navy Engineering Service Center, the Navy's center for specialized facilities engineering and technology established in 1993 to consolidate the missions of six NAVFAC components.

- The Shipboard Environmental Clearing House provides a central point of contact for shipboard environmental information.

- The "Whole Building Design Guide"

  - Resources Index

  - Using of the Whole Building Design Guide.

Appendix G: Index of Academic Resources

A wide variety of "sustainable design" activities is occurring at educational institutions, primarily in within traditional design programs such as architecture, landscape architecture, and urban and regional planning as well as in university environmental departments. In addition, "sustainability" is increasingly seen as a principal "theme" in the full range of university programs, from Commerce and Business Administration, through Engineering and Applied Sciences to Law. Beyond the integration of sustainability precepts in the academic arena, sustainability precepts are being incorporated into day-to-day business processes such as facilities acquisition, planning, design, and operation. For some institutions, "sustainability" is both an academic area to be taught and a way of operating on campus.

Upon review of the many design, planning and management programs and activities in colleges and universities across the United States, is clear the majority either is or is being reshaped with long term "sustainability" of our nation's buildings, communities, cities, and states in mind. John Meunier, Dean of the College of Architecture and Environmental Design at Arizona State University, might as well be speaking for all the universities when he echoes the definition of sustainability in setting the goals for his College.

> Architects, designers, and planners are agents of change in the environment. Change is not necessarily good or beneficial, in fact many members of our society have come to fear, or resent, change. It is, therefore, essential that a college such as this be committed to programs of education, research, and scholarship to ensure that the environmental changes which our faculty and our graduates help to conceptualize will prove to be optimally beneficial, serving both the current needs of our society and leaving a positive legacy for our successors. The environments that we help shape must be useful, affordable, beautiful, and sustainable.

Institutions with Programs/Activities of Most Interest to Corps/DA

Following are those programs and activities at the universities identified that appear to have the highest level of applicability to potential applications by the Corps of Engineers and/or the Army for their programming, design, planning, and facilities operations and management activities. Refer to write-ups for the individual institutions for a broader explanation of the particular activity.

- The Center for Environmental Design Research (CEDR), http://www-archfp.ced.berkeley.edu/cedr/, University of California, Berkeley.
- The Global System for Sustainable Development (MIT), http://gssd.mit.edu/Gssd/gssd.nsf, Massachusetts Institute of Technology, MIT.
- Sustainable Facilities and Infrastructure (SFI) Initiative, http://maven.gtri.gatech.edu/sfi/, Georgia Institute of Technology (Georgia Tech).
- Florida Center for Solid and Hazardous Waste Management, http://www.floridacenter.org/, University of Florida.
- Center for Construction and Environment, http://s14.cfaa.ufl.edu/centers/sustainable/, University of Florida.
- Institute for Sustainable Design, http://www.virginia.edu/~sustain/, University of Virginia.

Green/Sustainability University Programs/Activities

The following information does not represent a comprehensive search for, identification of, or evaluation of University programs, rather it is the result a "quick" search and review of the situation as evidenced in the various Internet sites of the organizations. Institutions having some "sustainability" activities regardless of the type, depth and breadth are listed, along with whatever primary resources, guidance and references that have been identified.

Arizona State University

Arizona State University has modified their educational programs to address sustainability and has a number of research activities and resources of moderate potential use by the Corps of Engineers and the Army. Sustainability programs at Arizona State University, http://www.asu.edu/, are conducted within the College of Architecture and Environmental Design, http://www.asu.edu/caed/. These programs are structured to educate Architects, designers, and planners in the manner by which environments may be shaped to be useful, affordable, beautiful, and sustainable. Recent research products at Arizona State have included

grants in the area of sustainable development from The Environmental Protection Agency and the National Aeronautics and Space Administration (NASA):

http://www.asu.edu/caed/research/index.html

The USEPA-Sustainable Development Challenge Grant produced guidelines for developing sustainable neighborhoods, measures for evaluating sustainable designs, as well as plans (model designs) for neighborhoods in Phoenix and Scottsdale, Arizona that incorporated principles of sustainable development. The project sought to balance the processes of economic, ecological, and community development as well as conflicting requirements of disparate stakeholders through facilitated design charettes.

Steiner, Frederick, David Pijawka and Bill Kasson, *"Sustainable Neighborhood Design for the Desert Southwest, Final Report: Project Summary and Design Charettes,"* prepared for the U.S. Environmental Protection Agency (USEPA) College of Architecture and Environmental Design, 29 November 1998.

The NASA / Scottsdale Sustainability Grant explored the applications of remotely sensed (RS) data in developing scenario based planning processes at the local/regional government level to provide long-term community vitality. RS environmental data for the McDowell Mountain Preserve in the City of Scottsdale, Arizona were obtained, cataloged, and interpreted to quantify linkages between global change and local decisions that cause change. Links between various scenarios of land cover/land use change and projections of regional/global climate change and local climate were developed to form the basis for an urban/global sustainability model. The models are to be used to help local, regional and State planning officials identify policies, ordinances, and regulations that can be amended to encourage sustainability. Professor Frederick Steiner is the principle investigator for this project, working within the Environmental Resources Program in the School of Planning and Landscape Architecture and the Department of Geography.

Boatwright, Nancy J., Chief Planner for the City of Germantown, TN, *"Sustainable Germantown Plan,"* http://www.asu.edu/caed/proceedings97/boatwrig.html.

College of Architecture and Environmental Design, http://www.asu.edu/caed/ Arizona State University, http://www.asu.edu/ Tempe, Arizona 85287-2005; Phone: (480) 965-7167 ; Fax: (480) 965-9656

Carnegie Mellon University

Carnegie Mellon University has modified their educational programs to address sustainability and has a number of research activities and resources of moderate potential use by the Corps of Engineers and the Army. Sustainability programs at Carnegie Mellon, http://www.cmu.edu/, are conducted within the College of Engineering, http://www.cit.cmu.edu/, Department of Civil and Environmental Engineering, http://www.ce.cmu.edu/.

The Green Design Initiative, is a campus-wide initiative begun in 1992 Carnegie Mellon University, http://www.ce.cmu.edu/GreenDesign/—to promote environmentally conscious engineering, product and process design, manufacturing, and architecture. The initiative involves forming partnerships with industrial corporations, foundations, and government agencies to develop joint research and education programs that improve environmental quality while encouraging sustainable economic development. A brief introduction to the initiative may be found at http://www.ce.cmu.edu/GreenDesign/about.html. Related Carnegie Mellon sponsored research and educational activities include *The Environmental Institute*, http://www.envinst.cmu.edu/, and *The Brownfields Center*, http://tbc.ce.cmu.edu/.

Carnegie Mellon University, http://www.cmu.edu/
College of Engineering, http://www.cit.cmu.edu/
Department of Civil and Environmental Engineering, http://www.ce.cmu.edu/
Green Design Initiative, Lester Lave, Director
Pittsburgh, PA 15213-3890 USA
Phone: (412) 268-2940
Fax: (412) 268-7813

The Environmental Institute, Cliff Davidson, Director, Phone: (412) 268-3864, Fax: (412) 268-7813

The Brownfields Center, Deborah Lange, Executive Director, Phone: (412) 268-7121, Fax: (412) 268-7813, E-mail: tbc@cmu.edu.

Colorado State University

Colorado State University has modified their educational programs to address sustainability and has a center of research activity with moderate potential use by the Corps of Engineers and the Army. Sustainability programs at Colorado State, http://www.colostate.edu/, are conducted within the Department of Design,

Merchandising, and Consumer Sciences, in the College of Applied Human Sciences. Research is conducted under the heading of "Sustainable Practices."

The Institute for the Built Environment (IBE), Colorado State University, http://lamar.colostate.edu/~dunbar/ibe.html, was established to foster stewardship and sustainability of the built environment through a research-based, interdisciplinary educational forum. Their goals include the optimization of the resources of the environment; the encouragement of human equality and cultural sensitivity in design processes and products of the built environment; facilitation collaboration among disciplines and allied professions that shape the built environment; and the creation of a multidisciplinary sustainability knowledge base. The center includes participants from disciplines including History, Interior Design, Historic preservation, Construction Management and Landscape Architecture, as well as individuals from private practice.

Sustainable Practices Introductory Teleconference, National Park Service Nationwide Training Conference, 6 May 1999: http://lamar.colostate.edu/~ibenpsdl. IBE has been very involved with the National Park Service in their sustainable activities and co-directed the recent NPS Sustainable Practices Teleconference.

Institute for the Built Environment, http://lamar.colostate.edu~dunbar/IBE.html
Brian Dunbar, Director:
251 Aylesworth Hall
Fort Collins, CO 80523
Phone: (970) 491-5041
Fax: (970) 491-4855
E-mail: dunbar@cahs.colostate.edu

Georgia Institute of Technology

Georgia Institute of Technology (Georgia Tech) has incorporated sustainability both as major drivers within their educational programs, and have developed curricula tracks focused on developing skills in sustainable planning and design. More importantly, they have developed special centers specifically devoted to sustainability issues and as a result have a substantial number of research activities and resources of major potential use by the Corps of Engineers and the Army. Specialized centers for sustainability are located within the Georgia Tech Research Institute, http://www.gtri.gatech.edu/.

Sustainable Facilities and Infrastructure (SFI) Initiative, at Georgia Tech Research Institute http://maven.gtri.gatech.edu/sfi/ is focused on increasing the sus-

tainability of built facilities and infrastructure around the globe. Their research basically asks what is sustainability, what does it mean for built facilities, and how can built facilities be more sustainable. Ongoing R&D activities seek the answers to these questions as well implement sustainable solutions in the built environment.

One key element of the SFI Initiative is their *Sustainable Facilities and Infrastructure Continuing Education Series*. Courses of interest to Corps and Army planners, architects, engineers and facilities managers include:

- Primer for Sustainable Facilities and Infrastructure
- Assessment Tools and Techniques for Sustainable Facilities and Infrastructure
- Economics of Sustainable Facilities and Infrastructure
- Sustainable Design Practices
- Sustainable Construction Practices
- Sustainable Real Estate Development
- Sustainable Facilities Management, Operations and Maintenance
- Georgia Tech Center for Sustainable Technology, http://maven.gtri.gatech.edu/cst/html/cst-home.html

Sustainable Facilities and Infrastructure (SFI) Initiative, Dr. Annie R. Pearce, Program Director

Sustainable Facilities and Infrastructure Program, Safety, Health, and Environmental Technology Div., Electro-Optics, Environment, and Materials Lab., Georgia Tech Research Institute
Atlanta, GA 30332-0837
Phone: (404) 894-8089
Fax: (404) 894-2184
E-mail: annie.pearce@gtri.gatech.edu

Augenbroe, Godfried, Annie R. Pearce and Charles J. Kibert, "*Sustainable Construction in the United States of America—A perspective to the year 2010*," CIB-W82 Report, Georgia Institute of Technology, College of Architecture, Construction Research Center, June 1998. http://www.arch.gatech.edu/crc/CIBW82Report.htm

Georgia Tech Construction Research Center (CRC), http://www.arch.gatech.edu/crc/, is a construction research and education institution founded to help create opportunities for business, government and industrial organizations involved in the A/E/C industry, at local, national and global levels. The center's primary goal is to generate benefits for society through the delivery of sustainable, cost-effective facilities and infrastructure that incorporate advanced standards re-

spective of future impacts. Primarily, the CRC conducts technological research for organizations with particular construction concerns. The center also develops and conducts continuing education courses, workshops and symposiums.

Environmentally Conscious Design and Construction (ECDC), There are many activities of interest in the area of sustainability within the center, however, the ECDC Group, http://www.arch.gatech.edu/crc/pro/ecdc.html, is of particular interest. This initiative supports research, development, testing, validation of policies, strategies, guidelines, and tools aimed at directly improving the environmental quality of built facilities and infrastructure projects.

Georgia Tech Construction Research Center (CRC)
Nicole Galea, CRC Managing Coordinator
Phone: (404) 894-2069
Fax: (404) 894-1989
E-mail: nicole.galea@arch.gatech.edu

Harvard University

Harvard University has incorporated sustainability as major drivers their educational programs related to the built environment and has a number of research activities and resources of moderate potential use by the Corps of Engineers and the Army. Sustainability programs at Harvard, http://www.harvard.edu/, are conducted within the Department of Urban Planning and Design (Urban Planning, Architecture and Landscape Architecture):

http://www.gsd.harvard.edu/depts/upddept/,

as graduate and undergraduate programs. The Harvard Graduate School of Design, http://www.gsd.harvard.edu/, also conducts continuing educational programs for professional development that include topics such as Architecture and Sustainability, Sustainable and Ecological Design and Green Urban Infrastructure, and Regionalism. Harvard also has directed programs on sustainability within the John F. Kennedy School of Government, http://ksgwww.harvard.edu/.

Center for Urban Development Studies, www.gsd.harvard.edu/cuds, within the Harvard Graduate School of Design, http://www.gsd.harvard.edu/, conducts outreach activities to provide professionals with current information on strategies and techniques being used around the world. The Center has established a network of regionally recognized experts and internationally experienced professionals who participate in action research and case study documentation activities as well as

technical assistance teams. Recent activities have included international programs to support Sustainable Community Development.

Center for Urban Development Studies, www.gsd.harvard.edu/cuds
48 Quincy Street, S202
Cambridge, MA 02138
Phone: 617.495.4964
Fax: 617.495.9347
E-mail: cuds@gsd.harvard.edu

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Fax: (617) 496-1292
E-mail: fkrieger@gsd.harvard.edu.

The Center for International Development at Harvard University (CID) was established in 1998 as Harvard's primary center for research on sustainable international development, http://www.cid.harvard.edu/. CID conducts research within an overall program focused on the challenges of sustainable development using a cross-disciplinary approach. Challenge areas include: preservation of biodiversity; limitation and management of climate change; control of emerging and re-emerging infectious disease; and limitation of environmental stresses resulting from population increase. CID draws upon staff and researchers across the university including the Harvard Institute for International Development (HIID), http://www.hiid.harvard.edu/, the Faculty of Arts and Sciences, the School of Public Health, the Medical School, the Graduate School of Education, the Law School and the Business School.

Center for International Development at Harvard University (CID), http://www.cid.harvard.edu/

Professor Jeffrey D. Sachs, Director
79 John F. Kennedy Street
Cambridge, MA 02138 USA
Phone: 617-496-9683
John F. Kennedy School of Government, http://ksgwww.harvard.edu/
Joseph S. Nye, Dean
Massachusetts Institute of Technology

Massachusetts Institute of Technology (MIT) has incorporated sustainability as a major driver within their educational programs but more importantly, they have developed centers of activity specifically devoted to sustainability issues and as a result have a substantial number of research activities and resources of major potential use by the Corps of Engineers and the Army.

The Global System for Sustainable Development (MIT) is a cross-referenced index to resources and materials on sustainability found on the Internet (http://gssd.mit.edu/Gssd/gssd.nsf) organized in an intuitive conceptual framework. The system is a project of the *Global Accords Consortium for Sustainable Development*, http://web.mit.edu/gssd/consortiuml, and is housed at MIT, http://web.mit.edu/. The GSSD Consortium is a MIT-led initiative with members representing three elements of the Technology Triangle: Governmental Institutions, Business and Industry Partners, and Research Institutions.

The GSSD is dedicated to sustainable development based on distributed networking principles and practices. Its major objective is to explore innovative responses to sustainability challenges at all levels of development, in all parts of the world, involve a wide range of public and private stakeholder communities in the process, and present resources in a globally accessible knowledge system.

Another GSSD related activity is the *Alliance for Global Sustainability (AGS)*, http://curricula.mit.edu/CEI/Research/AGS/. MIT through this "alliance" has extended their sustainability activities outside the Continental United States by partnering with the University of Tokyo, http://www.esc.u-tokyo.ac.jp/ags/index.html, and the Swiss Federal Institutes of Technology, [ETH] http://www.global-alliance.org/.

Global System for Sustainable Development, http://gssd.mit.edu/Gssd/gssd.nsf

Professor Nazli Choucri, Director
Massachusetts Institute of Technology, http://web.mit.edu/
77 Massachusetts Avenue, E53-490
Cambridge, MA 02139
Phone: (617) 253-5263
Fax: (617) 258-7989
E-mail: gssd@mit.edu

MIT Center for Technology, Policy, and Industrial Development (CTPID), http://web.mit.edu/org/c/ctpid/www/ has the mission to develop new knowledge, advanced technological strategies, and innovative partnerships that address global industrial and sustainability policy issues. The have the further role of building partnerships between academia, government, and industry to support global

economic growth and to advance policies that preserve the environment and benefit society at large.

One product of CTPID's Technology, Business, and Environment Program (TBE), http://web.mit.edu/org/c/ctpid/www/tbe.html, is their *Gallery of Environmentally Preferable Goods and Services*, http://tbe.mit.edu/gallery/, web site, which lists over 100 environmentally preferable products that set a new standard for sustainable goods and services, showcasing particularly innovative examples of environmental practices and green products in a range of industries

MIT Center for Technology, Policy, and Industrial Development (CTPID),
http://web.mit.edu/org/c/ctpid/www/
MIT E40-207, 1 Amherst Street
Cambridge, MA 02139-4307
Phone: (617) 253-8973
Fax: (617) 253-7140
E-mail: ctpidcom@mit.edu

Rochester Institute of Technology

Rochester Institute of Technology, http://www.rit.edu/, addresses sustainability within their educational curricula and has formed special resource centers to deal with sustainability issues. Although they have developed specialized centers, they are focused on materials and manufacturing processes of limited potential use by the Corps of Engineers and the Army's facilities sustainability applications.

The National Center for Remanufacturing and Resource Recovery, Provides technical assistance and applied research and development to the remanufacturing industry and manufacturers interested in remanufacturing and resource recovery techniques. http://www.reman.rit.edu/ The center's goal is to provide effective tools and solutions that are both economically and environmentally sound. The Center was formed in 1991 as a collaborative effort of RIT's College of Engineering, the remanufacturing industry and several Federal laboratories. It works under the Center for Integrated Manufacturing Studies (CIMS), a university-industry-government collaboration designed to increase the competitiveness of U.S. manufacturing companies in the global marketplace http://www.cims.rit.edu/.

National Center for Remanufacturing and Resource Recovery,
http://www.reman.rit.edu/
Rochester Institute of Technology, http://www.rit.edu/
133 Lomb Memorial Drive, CIMS Building 78

Rochester, NY 14623
Phone: (716) 475-5106

Rutgers University

Rutgers University, http://www.rutgers.edu/ as modified their educational programs to incorporate sustainability within the curricula and has a number of research activities and resources moderate potential use by the Corps of Engineers and the Army. Sustainability programs at Rutgers are conducted within the Mechanical and Aerospace Engineering, http://cronos.rutgers.edu/~mechaero/, and Landscape Architecture Departments, http://aesop.rutgers.edu/~landarch/index.html.

Office of Industrial Productivity and Energy Assessment (OIPEA), http://oipea-www.rutgers.edu/oipea.html—was established in 1992 to help industry with energy, waste, pollution prevention and productivity issues. Its mission is to provide a range of engineering extension services to the community through the creation and maintenance of partnerships among government, business, interest groups and educational facilities. Formed partnerships and resulting interactions are of mutual benefit to the community, as well as university students and faculty. Two major "products" include:

The Industrial Assessment Center (IAC) Program provides industrial energy assessments for small and medium sized manufacturing firms. Manufacturers are provided with audit reports that include information about the plant's energy use, processes and other operations as well Assessment Recommendations (ARs) written up with sufficient engineering design to provide for anticipated savings, implementation costs and simple payback. The program is funded out of the Office of Industrial Technology, http://www.oit.doe.gov/, of the U.S. Department of Energy, http://www.doe.gov/.

The Industrial Assessment Center (IAC) Database contains 63,600 Assessment Recommendations gleaned from 8,900 industrial site visits from nearly every State in CONUS. The data is available free of charge via the Internet to the general public at. http://oipea-www.rutgers.edu/documents/Dbman_70.html. Manuals on their use are at http://oipea-www.rutgers.edu/documents/arc_list_70.htmland.

Department of Mechanical and Aerospace Engineering,
http://cronos.rutgers.edu/~mechaero/
School of Engineering, http://www.engr.rutgers.edu/
Rutgers University, http://www.rutgers.edu/
98 Brett Road

Piscataway, NJ 08854-8058
Phone: (732) 445-2248/3514
Fax: (732) 445-3124

Center for Land Planning and Design, meets the needs at Rutgers for applied research on sustainable land planning and community design issues:

http://aesop.rutgers.edu/~landarch/landplan.html,

It brings together a variety of disciplines with expertise the areas of landscape architecture, land economics, natural resources, geographic information systems, remote sensing, urban planning, and human ecology to examine the linkage between land use policy and the resultant physical environment. Conversely, the Center investigates the influences that natural and cultural resources may have over land use policy decisions.

Center for Land Planning and Design
Department of Landscape Architecture:
http://aesop.rutgers.edu/~landarch/index.html
Rutgers University, http://www.rutgers.edu/
Blake Hall, Cook College
New Brunswick, NJ 08903
Phone: (908) 932-9317
Fax: (908) 932-1940

State University of New York at Buffalo

State University of New York at Buffalo has modified their educational programs to address sustainability but activities and resources at the university are of limited potential use by the Corps of Engineers and the Army. Sustainability is addressed in some of their Urban Planning, Landscape Architecture and Architecture curricula offerings within their School of Architecture and Planning, http://www.ap.buffalo.edu/index.html. The university does maintain, however, an excellent web site, called *Cyburbia*, with pointers to Internet resources relevant to planning, architecture, urbanism and topics relevant to the built environment.

Cyburbia, http://cyburbia.ap.buffalo.edu/ (formerly called *PAIRC*—The Planning and Architecture Internet Resource Center), Internet Resources for the Built Environment, University of Buffalo School of Architecture and Planning.

State University of New York at Buffalo
School of Architecture and Planning, http://www.ap.buffalo.edu/
Department of Planning, http://www.ap.buffalo.edu/planning/
Department of Architecture, http://www.ap.buffalo.edu/architecture/index.htm
Hayes Hall, 3435 Main Street
Buffalo, NY 14214-3087
Phone: (716) 829-2133
Fax: (716) 829-3256
E-mail: plandept@arch.buffalo.edu

University of California, Berkeley

University of California, Berkeley —has modified their educational programs to address sustainability and has a number of research activities and resources of substantial potential use by the Corps of Engineers and the Army, including special centers for environmental studies and research. "Sustainable" programs are conducted primarily within the Department of City and Regional Planning in the College of Environmental Design.

The Center for Environmental Design Research (CEDR), is an organized research unit of the University of California at Berkeley, located in the College of Environmental Design (http://www-archfp.ced.berkeley.edu/cedr/) and comprised of the departments of Architecture, City and Regional Planning, and Landscape Architecture. The center assists the research of faculty, students, and others interested in the design and planning of the built environment. The scope of "environmental planning and design" at CEDR is broad, ranging from the local environments of people within buildings to regional ecosystems, from the details of building construction to large-scale urban planning, from the history of the built environment to the design process itself. Relevant elements of CEDR include:

Building Science Group, http://www-archfp.ced.berkeley.edu/bldgsci/, which is dedicated to the energy efficiency and environmental quality of buildings.

Center for the Built Environment (CBE), http://www.cbe.berkeley.edu/, which is an industry/university cooperative research center focused on improving the design, performance, and operation of buildings for their occupants and owners. The center was established in 1997 under the sponsorship of industry partners and the National Science Foundation.

Geographic Information Systems and Land Use Planning programs REGIS (Research Program in Environmental Planning and Geographic Info Systems,

http://www.regis.berkeley.edu/) and AEGIS (Applied Environmental Geographic Information Science Research Lab, http://www.ced.berkeley.edu/aegis/). REGIS is a research program dedicated to the development and application of GIS tools for environmental planning, management, research, and teaching. AEGIS's mission is to develop models and methodologies for the use of GIS for group decision support applications.

The Center for Environmental Design Research (CEDR), http://www-archfp.ced.berkeley.edu/cedr/

College of Environmental Design, http://www.ced.berkeley.edu/
Department of City and Regional Planning, http://www-dcrp.ced.berkeley.edu/
University of California, Berkeley, http://www.berkeley.edu/
390 Wurster Hall, #1839,
Berkeley, CA 94720-1839.
Phone: (510) 642-2896

The Consortium on Green Design and Manufacturing (CGDM), was established in 1993 to encourage multidisciplinary research and education on environmental management and pollution prevention issues in critical industries. The consortium (http://greenmfg.me.berkeley.edu/green/Home/Index.html) includes faculty and students in Mechanical Engineering, Industrial Engineering, Architecture, Public Health, and Business, and related industrial and public partners. The consortium seeks to address issues of environmental management and pollution prevention, integrate green design and manufacturing issues into the educational curriculum and to facilitate the dissemination of green design and manufacturing information through collaboration with research and industry partners as well as with city, regional, State and Federal agencies.

University of California at Berkeley, http://www.berkeley.edu/
Department of City and Regional Planning, http://www-dcrp.ced.berkeley.edu/
College of Environmental Design, http://www.ced.berkeley.edu/
228 Wurster Hall,
Berkeley, CA 94720-1850
Phone: (510) 6642-3256
Fax: (510) 6642-1641
E-mail: jsbanks@uclink.berkeley.edu or dcrp-info@ced.berkeley.edu

University of Colorado

University of Colorado has modified their educational programs to address sustainability in both undergraduate and graduate study programs, but has few activities and resources of potential use by the Corps of Engineers and the Army. Sustainability programs at the University of Colorado, http://www.cudenver.edu/, primarily fall within the College of Architecture and Planning, in the Department of Planning and Design, http://www.cudenver.edu/public/AandP/, however, there are some activities in other departments, the Department of Economics, http://www.cudenver.edu/public/economics/, for example.

Communications for a Sustainable Future, http://csf.colorado.edu, was developed to enhance communications among disparate views and ideologies to support or facilitate the resolution of conflict and therefore secure a more promising or sustainable future. Contents of the web site most pertinent include:

Sustainable Development, http://csf.colorado.edu/casx/, a central information source for research activities germane to sustainable development encompassing the full spectrum of biological, social, and ecological economic issues;

Sources for Sustainability, http://csf.colorado.edu/sustainability/, pointers to additional information on sustainability;

Department of Planning and Design
College of Architecture and Planning, http://www.cudenver.edu/public/AandP/
University of Colorado, at Denver
Raymond G. Studer, Department Chair
Campus Box 126, PO Box 173364
Denver, CO 80217-3364
Phone: (303) 556-4867
Fax: (303) 556-3687

University of Florida

University of Florida has modified their educational programs to address sustainability within their Architectural, Urban and Regional Planning, Construction, Landscape Architecture, and Engineering curricula and has a number of research activities and resources with substantial potential use by the Corps of Engineers and the Army. Sustainability programs at the University of Florida are primarily conducted within or under the auspices of the Colleges of Architecture, http://www.arch.ufl.edu/, and Engineering, http://www.eng.ufl.edu/index.html. Spe-

cial Centers of interest include the Center for Construction and Environment, http://s14.cfaa.ufl.edu/centers/sustainable/, and the Florida Center for Solid and Hazardous Waste Management, http://www.floridacenter.org/.

Florida Center for Solid and Hazardous Waste Management, serves the citizens of Florida by providing leadership in the field of waste management research and by supporting the Florida Department of Environmental Protection in its mission to preserve and protect the state's natural resources:

http://www.floridacenter.org/

Universities of Florida A&M, Florida Atlantic, Florida State, Central Florida, Florida, Miami, South Florida, West Florida, and the Florida Institute of Technology.

Florida Center for Solid and Hazardous Waste Management:
http://www.floridacenter.org/.
2207-D NW 13th Street
Gainesville, Florida 32609
E-mail: center@floridacenter.org

Solid and Hazardous Waste Research and Education:

http://www.enveng.ufl.edu/homepp/townsend/default.htm

Construction and Demolition Waste

http://www.enveng.ufl.edu/homepp/townsend/Research/CD_Launch.html

University of Florida College of Engineering:

http://www.eng.ufl.edu/index.html
330 Weil Hall
PO Box 116550
Gainesville, FL 32611-6550
Phone: (352) 392-7047
Fax: (352) 392-0948

Department of Environmental Engineering Sciences, http://www.enveng.ufl.edu/
Center for Construction and Environment, http://s14.cfaa.ufl.edu/centers/sustainable/
University of Florida College of Architecture, http://www.arch.ufl.edu/

Dr. Jay M. Stein, Interim Dean
FAC 101, PO Box 115703
Gainesville, FL 32611-5703

Department of Architecture, http://www.arch.ufl.edu/architecture
Department of Landscape Architecture, http://www.arch.ufl.edu/landscape/
Department of Urban and Regional Planning, http://www.arch.ufl.edu/urp/
M.E. Rinker Sr. School of Building Construction, http://www.bcn.ufl.edu/

University of Illinois

University of Illinois, http://www.uiuc.edu/, has modified their educational programs to address sustainability and has a few research activities and resources with limited potential use by the Corps of Engineers and the Army.

University of Illinois Environmental Council, http://www.environ.uiuc.edu/, was established in 1997 to ensure leadership in environmental education, research, and service. The Council is chartered to facilitate and coordinate the pursuit of excellence in environmental education, research, and service across the UI.

The Environment Council, http://www.environ.uiuc.edu/
University of Illinois at Urbana-Champaign
1101 West Peabody Drive
Urbana, IL 61801
Phone: (217) 333-4178
Fax: (217) 333-8046

The Office of Solid Waste Research, http://www.environ.uiuc.edu/oswr/default.htm, administers a program of basic and applied research to help find innovative and long-range approaches to managing solid waste.

Illinois Waste Management and Research Center (IWMRC) helps Illinois industries, businesses, and citizens reduce and better manage generated solid and hazardous wastes released to air, water or land (http://www.wmrc.uiuc.edu/). WMRC is a nonregulatory agency and provides: publications and information on industrial activity, waste generation and disposal; GIS support for environmental assessments; engineering assessment pollution prevention and waste management needs; awards for organizations with successful pollution prevention activities; laboratory analysis and industrial pollution prevention technology testing; and student assistance. IWMRC is a division of the Office of Scientific

Research and Analysis in the Illinois Department of Natural Resources, http://dnr.state.il.us/

Waste Management and Research Center (WMRC)
One East Hazelwood Drive
Champaign, IL 61820
Phone: (217) 333-8940
University of Minnesota

University of Minnesota has modified their curricula to include sustainable approaches to the design of the built environment and has a number of research activities, centers and resources of moderate potential use by the Corps of Engineers and the Army. Sustainability activities found at the University of Minnesota are within the College of Architecture and Landscape Architecture (CALA), http://www.cala.umn.edu/, and the Hubert H. Humphrey Institute of Public Affairs, http://www.hhh.umn.edu/.

Hennepin County, Minnesota—Sustainable Design Guide and Rating System, http://www.cala.umn.edu/hennepin/draft11/. An interdisciplinary team of architectural consultants, University researchers, and other advisors is developing the Sustainable Design Guide and Rating System for medical, institutional and office buildings constructed by Hennepin County, MN to encourage environmentally responsible design practices. The guide provides a system of rating facility performance in areas such as energy efficiency, indoor air quality, and waste management. This research is being lead by Mary Guzowski, Associate Professor, of the Department of Architecture,:

http://www.cala.umn.edu/architecture/arch.html

The Design Center for American Urban Landscape (DC/AUL) is a research unit within the College of Architecture and Landscape Architecture (CALA) at the University of Minnesota (http://www.cala.umn.edu/design_center/dcaul.html). It develops interactive educational projects located in neighborhoods, communities, or affecting national urban design and planning issues. The center's mission is to educate public and private decisionmakers, professionals and citizens about the value of design as a strategic partner with economic and human interests in the making of community-based development strategies and sustainable urban landscapes. Current projects include "Green by Addition," a case study that looks at "green" renovation opportunities in suburbs built from 1945-1965:

http://www.cala.umn.edu/design_center/PROJECTS/SURDNA/DCAULGreenbyAddition.html,

Design Center for American Urban Landscape
Suite 222, 1313 Fifth Street SE
Minneapolis, MN 55414-1546

Sustainable Land Use Research is occurring within the Department of Landscape Architecture on the design and evaluation of sustainable land use patterns and on tools, GIS, to aid in decisionmaking for future land use with sustainability as the principal driver.

College of Architecture and Landscape Architecture (CALA), University of Minnesota, http://www.cala.umn.edu/

89 Church Street
Minneapolis MN 55455
Phone: (612) 626-1000
Fax: (612) 624-5743

Center for Nations in Transition (CNT), together with the Hubert H. Humphrey Institute of Public Affairs, is conducting research and institutional design for sustainable development, and educational activities in Poland and other Central and East European Countries (CEEC:

http://www.hhh.umn.edu/centers/cnt/index.htm,

Center for Nations in Transition (CNT)
Dr. Zbigniew Bochniarz, Director
230 Hubert H. Humphrey Center
301 19th Ave S., Minneapolis, MN 55455
Phone: (612) 625-3073
Fax: (612) 626-9860
E-mail: CNT@hhh.umn.edu

The Rural Development Council, http://www.hhh.umn.edu/centers/freeman/rdc/, University of Minnesota's is part of the Freeman Center for International Economic Policy within the Hubert H. Humphrey Institute of Public Affairs. It was established in 1992 to provide the University's expertise and services to support rural and community development. The council addresses sustainability issues for rural Minnesota where the CNT addresses international issues of sustainability.

Rural Development Council
Carla Carlson, Program Director
Humphrey Institute of Public Affairs

154 Humphrey Center
301 -19th Avenue South
Minneapolis, MN 55455
Phone: (612) 624-6250
Fax: (612) 624-9084

Hubert H. Humphrey Institute of Public Affairs, http://www.hhh.umn.edu/
301 Nineteenth Avenue South
Minneapolis, MN 55455
Professor Richard Bolan, Director
Phone: (612) 626-8910
Fax: (612) 625-3513
University of Oregon, Eugene

University of Oregon, Eugene has modified their educational programs to address sustainability and has a number of research activities and resources of moderate potential use by the Corps of Engineers and the Army. Sustainability programs at University of Oregon are conducted within the School of Architecture and Allied Arts, http://aaa.uoregon.edu/, both within the Departments of Architecture, http://arch-guest.uoregon.edu/windex.html, and Planning, Public Policy and Management, http://utopia.uoregon.edu/.

Institute for a Sustainable Environment, was established in 1994 to foster research and education on environmental issues at the University of Oregon and to address long-term sustainability issue associated with Earth's major environmental systems:

http://gladstone.uoregon.edu/~enviro/,

The ISE studies ways in which the biophysical world is being transformed by human actions; cultural, social, political, and economic forces causing these transitions; and ways in which the biophysical world can be sustained. Programs encompass environmental themes in the natural sciences, the social sciences, policy studies, humanities, and the professional fields.

Institute for a Sustainable Environment, http://gladstone.uoregon.edu/~enviro/

Dr. John Baldwin, Director
130 Hendricks Hall
5247 University of Oregon
Eugene, OR 97403-5247
Phone: (541) 346-3895
Fax: (541) 346-2040

E-mail: jbaldwin@oregon.uoregon.edu.

Design Integration Laboratory, University of Oregon, is a private nonprofit group for architectural education and research group, working to enable more practical, comfortable, and beautiful buildings by empowering architects with integrative design tools.

http://www.designlaboratory.com/index.html

The laboratory is operated under the direction of the University of Oregon's School of Architecture and Allied Arts. Artifice, Inc., a software developer/vendor, currently hosts their web site.

Design Integration Laboratory, http://www.designlaboratory.com/index.html
PO Box 1588
Eugene, OR 97440
Phone: (541) 345-7421
Fax: (541) 345-7438
Artifice, Inc.
PO Box 1588
Eugene, OR

http://www.artifice.com/index.html
Phone: 541-345-7421
Fax: 541-345-7438
E-mail: artifice@artifice.com

University of Oregon, Eugene
School of Architecture and Allied Arts, http://aaa.uoregon.edu/
Department of Planning Public Policy and Management, http://utopia.uoregon.edu/
119 Hendricks Hall, 1209 University of Oregon
Eugene, OR 97403-1209
Phone: (541) 346-3635
Fax: (541) 346-2040

University of Oregon, Eugene
School of Architecture and Allied Arts, http://aaa.uoregon.edu/
Department of Architecture, http://arch-guest.uoregon.edu/windex.html
210 Lawrence Hall, 1206 University of Oregon
Eugene, OR 97403-1209
Phone: (541) 346-3656

University of Oregon, Eugene
School of Architecture and Allied Arts, http://aaa.uoregon.edu/
5249 University of Oregon
Eugene OR 97403-5249
Phone: (541) 346-3631
Fax: (541) 346-3626

University of St. Thomas

University of St. Thomas has modified their educational programs to address sustainability and has a number of research activities and resources of limited potential use by the Corps of Engineers and the Army. Sustainability programs at St. Thomas, http://www.stthom.edu/, are conducted within the Department of Environmental Studies, http://www.stthom.edu/envr/.

The University of St. Thomas, Department of Environmental Studies, was founded in 1992 to provide environmental practitioners with an appreciation for ecology and an understanding of the ethical nature of human endeavors.

http://www.stthom.edu/envr/

There, they offer, under the area of environmental policy and management, a course (Environmental Studies 2347, Environmental Sustainability, http://www.stthom.edu/envr/ENVR_2347.html) that focuses on environmental sustainability as a guiding goal for national and international environmental policy. The course explores the interdisciplinary dimensions of environmental sustainability and the relevance and significance of concepts from the social sciences, including sociology, psychology, international studies, economics and communications, in realizing this goal. Resources compiled to support these studies are maintained on their web site.

Sustainable Development Resources On The Internet (Selected)
http://www.stthom.edu/envr/Instr_Materials/2347sp97.html

University of St. Thomas, Department of Environmental Studies, http://www.stthom.edu/envr/
Roberston Science Building
3800 Montrose Blvd.
Houston, TX, USA 77006-4696
Phone: (713) 525-3805

University of Virginia

University of Virginia, http://www.virginia.edu/, has deeply imbedded concepts of sustainability in most of their activities, in both academic and administrative arenas. On the academic side, sustainability precepts are included in the Schools of Architecture, Arts and Sciences, Commerce, Business Administration, Engineering and Applied Sciences and Law. Examples were also found in their colleges of Law and Nursing. On the administrative side, sustainability is a driver in their foundation activities as evidenced in programs for sustainable development in research parks as well as in facilities management as evidenced by activities of their Board of Visitors Office (Buildings and Grounds) and their University Architect's Office. For the purposes of this white paper, the most applicable programs, research and resources for sustainable design are within The School of Architecture, http://minerva.acc.virginia.edu/~arch/, and for sustainable environment are within The School of Arts and Sciences, http://www.virginia.edu/artsandsciences/.

Of these resources, The Institute for Sustainable Design, founded and directed by William A. McDonough, FAIA, is the most significant and the highest potential use by the Corps of Engineers and the Army: http://www.virginia.edu/~sustain/.

Institute for Sustainable Design, http://www.virginia.edu/~sustain/, was created in 1996 to "'render visible" viable alternatives to conventional design and practice in human production." The Institute "fosters the development of new creative tools for sustainable design, while advocating innovative design approaches and restorative action based on principles that recognize the interdependence of ecology, equity, and economy by facilitating creative interdisciplinary collaborations at the University and in the world." The Institutes goal is to educate current and future leaders—designers, policy makers, and corporate and community citizens—with the vision and processes needed to achieve a sustainable future, while seeking to define humanity's meaningful, rightful and responsible place in the natural world. Pertinent current ISD initiatives include:

Community Based Design Charettes—facilitated regional planning initiative applying a "designed charrette process" to develop a new sustainable cooperative regional planning model for Virginia;

New Laws Post-Mining Reclamation Standards—new rules are being developed to require environmentally rigorous reclamation practices in areas that have been destroyed by certain mining practices for approval and adoption by the State legislature regulating be enacted by the State. The new *D.I.R.T. (Design Investigations Reclaiming Terrain)*—research to build a resource base and ex-

plore innovative and aesthetic responses to the problems of land reclamation of urban brownfield sites; and *Design Strategies for a Sustaining Piedmont,* design and planning studio focusing on sustainability of the Piedmont region:

http://www.virginia.edu/~sustain/piedmont/

Also maintained on the ISD web site is the "Sustainable Indicators Toolkit," http://www.virginia.edu/~sustain/, which is a guide for finding "sustainable indicator projects" that are going on across the country. This "indicator of indicators" attempts to keep abreast and informed of new "sustainable indicator projects and research.

Also maintained on the ISD web site are pointers to resources for sustainable design. These include:

Guide to Sustainable Design, Development and Policy on the Web, http://www.lib.virginia.edu/fine-arts/sustain.html, maintained by the Fiske Kimball Fine Arts Library at the University of Virginia School of Architecture; and

The Library at the Institute for Sustainable Design, an extensive collection of bibliographical references an links to organizations pertinent to sustainable design;: http://www.virginia.edu/~sustain/resources-ISDLibrary.html, and

Institute for Sustainable Design ISD)
Diane M. Dale, Director
William A. McDonough, FAIA, ISD Founder
Campbell Hall
University of Virginia
PO Box 400122
Charlottesville, Virginia 22904-4122
Phone: (804) 924-6454
Fax: (804) 982-2678
E-mail: uva-isd@virginia.edu

The Institute for Environmental Negotiation, was established in 1981 to make mediation and consensus building services available to governments, citizen organizations and businesses dealing with conflicts and complex policy choices related to land use and the natural and built environments. The Institute's overriding goal is to help people create and agree upon solutions that are sustainable. IEN is affiliated with the School of Architecture Department of Urban and Environmental Planning and operates as a nonprofit organization:

plore innovative and aesthetic responses to the problems of land reclamation of urban brownfield sites; and *Design Strategies for a Sustaining Piedmont,* design and planning studio focusing on sustainability of the Piedmont region:

http://www.virginia.edu/~sustain/piedmont/

Also maintained on the ISD web site is the "Sustainable Indicators Toolkit," http://www.virginia.edu/~sustain/, which is a guide for finding "sustainable indicator projects" that are going on across the country. This "indicator of indicators" attempts to keep abreast and informed of new "sustainable indicator projects and research.

Also maintained on the ISD web site are pointers to resources for sustainable design. These include:

Guide to Sustainable Design, Development and Policy on the Web, http://www.lib.virginia.edu/fine-arts/sustain.html, maintained by the Fiske Kimball Fine Arts Library at the University of Virginia School of Architecture; and

The Library at the Institute for Sustainable Design, an extensive collection of bibliographical references an links to organizations pertinent to sustainable design;: http://www.virginia.edu/~sustain/resources-ISDLibrary.html, and

Institute for Sustainable Design ISD)
Diane M. Dale, Director
William A. McDonough, FAIA, ISD Founder
Campbell Hall
University of Virginia
PO Box 400122
Charlottesville, Virginia 22904-4122
Phone: (804) 924-6454
Fax: (804) 982-2678
E-mail: uva-isd@virginia.edu

The Institute for Environmental Negotiation, was established in 1981 to make mediation and consensus building services available to governments, citizen organizations and businesses dealing with conflicts and complex policy choices related to land use and the natural and built environments. The Institute's overriding goal is to help people create and agree upon solutions that are sustainable. IEN is affiliated with the School of Architecture Department of Urban and Environmental Planning and operates as a nonprofit organization:

http://www.virginia.edu/~envneg/IEN.html,

The Institute for Environmental Negotiation,
http://www.virginia.edu/~envneg/IEN.html
164 Rugby Road
Charlottesville, VA 22903.
Phone: (804) 924-1970
Fax: (804) 924-0231
E-mail: envneg@virginia.edu

School of Architecture,
http://minerva.acc.virginia.edu/~arch/
or
http://www.virginia.edu/~arch/
University of Virginia
http://www.virginia.edu/,

Karen Van Lengen, Dean
Campbell Hall
Charlottesville VA 22903
Phone: (804) 924-3715
Fax: (804) 982-2678

The Department of Architecture, http://minerva.acc.virginia.edu/~arch/dept/arch.html

Department of Landscape Architecture,
http://minerva.acc.virginia.edu/~arch/dept/land_arch.html

Department of Urban and Environmental Planning,
http://minerva.acc.virginia.edu/~arch/dept/urban.html or
http://urban.arch.virginia.edu/~plan/duep.html.
School of Arts and Sciences, http://www.virginia.edu/artsandsciences/
Melvyn P. Leffler, Dean
419 Cabell Hall
Charlottesville, VA 22903
Phone: (804) 924-3389
Fax: (804) 924-1317

Department of Environmental Science, http://www.evsc.virginia.edu/,

Ecology Online, http://ecology.evsc.virginia.edu/

Ecosystem Management and Sustainability,
http://ecology.evsc.virginia.edu/evsc120/ecosystem_management.htm

Virginia Coast Reserve, http://atlantic.evsc.virginia.edu/

School of Engineering and Applied Science, http://www.seas.virginia.edu/
Richard W. Miksad, Dean
Charlottesville, VA 22903
Phone: (804) 924-3593
E-mail: rwm3x@virginia.edu

Department of Mechanical, Aerospace, and Nuclear Engineering,
http://www.mane.virginia.edu/

The Virginia Laboratory for Engineering and Automated Design,
http://vlead.mech.virginia.edu/

Dr. Susan Carlson-Skalak, Director

Engineering an Approach to Sustainable Design,
http://vlead.mech.virginia.edu/seminars/

Materials, Design, Manufacturing and the Move to Sustainability,
http://vlead.mech.virginia.edu/seminars/matsci/tsld001.htm

Other activities and resources at the University of Virginia of interest to sustainability include in relative order of importance:

The Office of the Architect for the University is developing a 3D electronic master plan for the university that will include information on land use and projected growth as well as design guidelines and parameters for that growth, http://minerva.acc.virginia.edu/~architec/home.html including the establishment of energy conservation and sustainability policies;

Board of Visitors Office (Buildings and Grounds Committee), which has adopted and is applying sustainable practices in the planning, design, operation and management of university real property assets:

http://www.virginia.edu/~bovs/home.html

The University of Virginia Foundation, http://www.virginia.edu/researchparks/, which has adopted and is applying sustainable practices in the development of business parks associated with the University;

Graduate School of Business Administration Executive Programs, which incorporate an understanding of the issues surrounding environmental concerns and sustainable development, including sustainability by design; build relationships and management systems into their continuing education programs for executives http://r2d2.gbus.virginia.edu/execed/index.htm.

The LCLUC (Land Cover Land Use Change) Program, which seeks to develop the capability to perform repeated global inventories of land-use and land-cover from space, to develop models to simulate, evaluate and predict the consequences of land use changes observed: http://lcluc.gecp.virginia.edu/,

Internet Resources for Environmental Management, which are pointers to sites with a main focus on environmental sustainability, maintained by Mark White, Associate Professor of Commerce, McIntire School of Commerce;
http://www.people.virginia.edu/~maw3u/resources/internet-environment.html,

The Invention and Design (I&D) Project, which includes the exploration sustainability issues and principles in its promotion of a better understand the in the invention and design process;
http://repo-nt.tcc.virginia.edu/InventionAndDesign/home.html

The Institute for Advanced Technology in the Humanities, which explores the use of information technology as a tool for humanities research, and more specifically, aspect of sustainability associated with the humanities;
http://jefferson.village.virginia.edu/, and

Central African Regional Program for the Environment, which partners in the development and implementation of sustainable land use and developmental practices in the tropical forests of the Congo: http://carpe.gecp.virginia.edu/.

Washington State University

Washington State University, http://www.wsu.edu/, has incorporated a broad range of sustainability issues in their educational curricula. They are similarly the principal drivers for many of their activities and programs. Sustainability precepts are evident in the Colleges of Agriculture and Home Economics, Engineering and Architecture, and Sciences. For the purposes of this report, the most

applicable programs, research, and resources for sustainable design can be found under the source heading, College of Agriculture and Home Economics (CAHE), http://cahe.wsu.edu/index.html, Extension Program, http://ext.wsu.edu/, and the College of Engineering and Architecture's, http://www.cea.wsu.edu/, School of Architecture and Construction Management, http://www.cea.wsu.edu/. Of these, The Energy Program, http://www.energy.wsu.edu/, run by the university's Extension Services, has the highest potential use by the Corps of Engineers and the Army. Another interesting aspect of the approach to sustainability at Washington State is their Interdisciplinary Design Institute (IDI), which provides a mechanism for cross discipline, college and department (architecture, interior design, landscape architecture and construction management) collaboration in design of sustainable environments: http://www.spokane.wsu.edu/academic/design/idi_home.html.

WSU Cooperative Extension Energy Program, http://www.energy.wsu.edu/, established in 1996, provides energy programs and services within the transportation, residential, commercial, and industrial sectors. They supply energy information and solutions for business, government, and individuals to improve personal and global environmental quality and economic well being.

Energy Program, http://www.energy.wsu.edu/
WSU Cooperative Extension
925 Plum Street SE
PO Box 43165
Olympia, WA 98504-3165
Phone: (360) 956-2000
Fax: (360) 956-2217

The College of Agriculture and Home Economics (CAHE),
http://cahe.wsu.edu/index.html

Department of Horticulture and Landscape Architecture,
http://coopext.cahe.wsu.edu/~hortla/index.html

Landscape Architecture, http://coopext.cahe.wsu.edu/~hortla/la.html

Department of Crop and Soil Sciences, http://css.wsu.edu/index.htm

Department of Rural Sociology, http://www.ruralsoc.wsu.edu/

Cooperative Extension Program, http://ext.wsu.edu/
PO Box 646230
Hulbert Hall 411

Pullman, WA 99164-6230
Phone: (509) 335-2933
Fax: (509) 335-2926

WSU School of Architecture Community Sustainability demonstrates the integrated use of modeling methods and sustainable design strategies in the revitalization of existing communities to enhance their human, economic, social and environmental quality. Techniques developed evaluate "communities," at various scales, from a dwelling unit up to a regional level, to develop sets of sustainable design and planning strategies that place community systems in balance:

http://www.arch.wsu.edu/information/sustain/home.html.

The Architecture Library, http://www.wsulibs.wsu.edu/archit.htm, maintains information, both in their hard copy collection and available electronically, on sustainability.

College of Engineering and Architecture, http://www.cea.wsu.edu/

School of Architecture and Construction Management, http://www.arch.wsu.edu/
Washington State University
PO Box 642220
Pullman, WA 99164-2220
Phone: (509) 335-5539
Fax: (509) 335-6132
E-mail: soainfo@arch.wsu.edu

Program in Environmental Science and Regional Planning, coordinates studies in environmental science and regional planning in a joint degree program that provides the student with a holistic and interdisciplinary perspective and ecological understanding for roles in the study, planning, and management of resources and the environment: http://www.sci.wsu.edu/envsci/.

College of Sciences, http://www.sci.wsu.edu/

Program in Environmental Science and Regional Planning,:

http://www.sci.wsu.edu/envsci/.

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Wood, J., G. Long, et al. (2000). Long Term Oil Supply. Washington DC, Energy Information Administration.

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ATTN: Topographic Engineering Center, Alexandria, VA

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The Army, Air Force, and Navy have developed policies that require sustainable design and development of their installations, which refers to the ability to execute the current mission without compromising the ability of future generations to meet their needs. This report documents how the government and the private sector are moving to develop and implement sustainable practices for facilities. It identifies opportunities for the Corps of Engineers to be a major national source of expertise that carries the knowledge of what sustainability is, into engineering practice. This work proposes a plan to conduct the needed research and to provide the tools that will guide decisions that will help make sustainable installations a reality.

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