INTERNATIONAL

**Designation: E2432 − 23**

# Standard Guide for General Principles of Sustainability Relative to the Built Environment[1]

This standard is issued under the fixed designation E2432; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 There are three general principles of sustainability: environmental, economic, and social. This guide covers application of the fundamental concepts and associated characteristics for each of the general principles of sustainability to the built environment.

1.2 This guide identifies general methodologies associated with the decision-making process used in pursuing sustainability.

1.3 The general principles identified in this guide are applicable to all life-cycle stages of design and construction within the built environment.

1.4 A variety of tools and standards exist that qualify and quantify impacts of the built environment in terms of the general principles of sustainability. It is not within the scope of this standard to recreate or replace these tools.

1.5 This guide does not provide direction as to the specific implementation of the general principles; nor does it provide direction as to the specific weighting of principles necessary for achieving balance between competing goals.

1.6 Applying the principles in this guide will require professional judgment. Such judgment should be informed by experience with environmental, economic, and social issues as appropriate to the use, type, scale, and location.

1.7 This guide offers an organized collection of information or a series of options but does not recommend a specific course of action. This document cannot replace education, experience, or community dialogue. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems

E2114 Terminology for Sustainability

2.2 *ISO Standard:*[3]

ISO 14040 Life Cycle Assessment



## 3. Terminology

3.1 *Definitions:*

3.1.1 For terms related to building construction, refer to Terminology E631.

3.1.2 For terms related to sustainability, refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *built environment, n*—structures, infrastructure, and landscapes constructed or modified for human purposes.

3.2.1.1 *Discussion*—The built environment includes all structures and other areas manipulated for the purposes of human activity including, but not limited to, housing, commerce, manufacturing, and recreation. The built environment includes all infrastructure, utility, and other systems

[1] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.01 on Buildings and Construction.

Current edition approved April 1, 2023. Published May 2023. Originally approved in 2005. Last previous edition approved in 2019 as E2432 – 19. DOI: 10.1520/E2432-23.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

designed or otherwise installed for the service and support of structures and areas accommodating human activity.

3.2.2 *carbon sinking, n*—an approach to offset carbon dioxide emissions through the absorption potential of forests and other vegetation.

3.2.3 *Design for the Environment (DfE), n*—the systemic consideration of design performance with respect to environmental, health, and safety objectives over the full product life cycle.

3.2.4 *external costs/benefits, n*—economic impact associated with the action of a party that is not borne by that party, but rather by a third party or parties.

3.2.4.1 *Discussion*—This is intended to include economic costs and benefits associated with environmental and social impacts arising out of the action.

3.2.5 *green roof system, n*—an assembly that supports an area of planting/landscaping, built up on a waterproofed substrate at any level that is separated from the natural ground by a human-made structure.

3.2.6 *heat island effect, n*—a phenomenon in which urban air and surface temperatures are higher than nearby rural areas due to the replacement of natural land cover with pavement, buildings, and other infrastructure.

## 4. Significance and Use

4.1 The built environment has environmental, economic, and social impacts. These impacts occur at all life-cycle stages in multiple ways and on local, regional, and global scales. It is imperative to understand the nature of these impacts and their relationship to the general principles of sustainability in order to address the opportunities and challenges they present.

4.1.1 It is necessary to identify the environmental impacts in order to promote the positive and mitigate the negative.

4.1.2 It is necessary to quantify the economic impacts in order to improve life-cycle costs and benefits.

4.1.3 It is necessary to identify the social impacts in order to contribute to a positive quality of life for current and future generations.

4.2 The general principles of sustainability—environmental, economic, and social—are interrelated. Decisions founded on the opportunities and challenges of any of the principles will have impacts relative to all of the principles. However, to facilitate clarity in the presentation of the general principles, they are discussed individually in Section 5.

4.3 The practical application of the general principles of sustainability relies upon balancing environmental, economic, and social impacts and committing to continual improvement. Section 6 discusses this balancing of environmental, economic, and social impacts in pursuit of sustainability.

4.4 This guide provides an overview of sustainability, as it is applicable to the built environment. This guide provides general guidance but does not prescribe a specific course of action.

4.5 This guide is intended to inform professionals associated with the building industry.

4.5.1 The general principles identified in this guide are intended to assist users in making decisions that advance sustainability.

4.5.2 The general principles identified in this guide are intended to inform the development and refinement of tools and standards to qualify and quantify impacts of the built environment.

## 5. Principles of Sustainability Relative to the Built Environment

5.1 *Environmental Principles*—Raw materials sourcing, production of components, construction, day-to-day operations, periodic maintenance, and the final disposition of the components, impact on the environment. Environmental impacts affect ecosystems, biodiversity, and natural resources. In order to advance sustainability, it is necessary to identify environmental impacts, mitigate negative environmental impacts, and promote positive environmental impacts.

5.1.1 *Fundamental Concepts:*

5.1.1.1 *Ecosystems*—Ecosystems provide critical services that support life on the earth and the continued viability of a large range of flora and fauna. Sustainability protects existing ecosystems and strives to restore damaged ecosystems.

5.1.1.2 *Biodiversity*—Biodiversity provides environmental options, both known and unknown, that contribute to the genetic resilience of the earth's flora and fauna. Sustainability protects or enhances the biodiversity and interdependencies of species.

5.1.1.3 *Natural Resources*—Natural resources provide the basic requirements of life and the material/energy from which all human-made material/energy is derived. Sustainability balances the use of earth's renewable, non-renewable, and perpetual resources in order to preserve these resources for future generations.



5.1.2 *Associated Characteristics:*

5.1.2.1 *Ecosystems*—Sustainable construction integrates features that protect or enhance local, regional, and global ecosystems. For example, energy efficiency features, both active and passive, can reduce the amount of energy used by a building. This approach can reduce the regional impacts associated with air emissions from electric power generation facilities and reduce the local impacts of the heat island effect.

5.1.2.2 *Biodiversity*—Sustainable construction integrates features that protect or enhance species' habitats. For example, a green roof system can retain and utilize stormwater through the use of climate-appropriate plants. This approach can reduce the amount of polluted stormwater runoff and creates new habitats within the built environment.

5.1.2.3 *Natural Resources*—Sustainable construction maximizes effective use of resources by maintaining or improving the balance between resources and their rate of consumption. For example, water resource stewardship approaches such as water-efficient, native landscaping, and permeable surfaces can reduce the use of water and help to naturally filter contaminants. These approaches can assist in recharging groundwater resources. Similarly, wood building products obtained from sustainably managed forests can contribute to the preservation of forests for future generations. This approach can support biodiversity and contribute to carbon sinking.

5.2 *Economic Principles*—The built environment has both inherent direct and indirect economic impacts. Direct costs/benefits are typically evaluated using life-cycle cost (LCC) methods. Indirect economic impacts are those associated with external costs/benefits. In order to advance sustainability, it is necessary to quantify and optimize direct and indirect economic impacts to the greatest extent possible.

5.2.1 *Fundamental Concepts:*

5.2.1.1 *External Costs/Benefits*—Sustainable practices may reduce external costs while promoting external benefits associated with social and environmental impacts.

*(1) Social Costs/Benefits*—Sustainability promotes economies with diverse job opportunities, equitable distribution of resources, and educated, healthy workers.

*(2) Environmental Costs/Benefits*—Sustainability promotes healthy, functioning ecosystems that provide services that support local, regional, and global economies. Such services include pollination of crops, cleansing of water and air, the decomposing of detritus for food, and the regulation of disease and pests.

5.2.1.2 *Life-Cycle Costs/Benefits*—Sustainability recognizes the costs/benefits associated with all stages of the full life cycle. Economic evaluation is based on the procedures delineated in Practice E917.

*(1) First Costs/Benefits*—First costs/benefits include costs associated with design, acquisition of land, and construction. Sustainable practices rely on first costs/benefits being evaluated with consideration of associated cost/benefits for operation, deconstruction, and reuse or disposal.

*(2) Operating Costs/Benefits*—Operating costs/benefits include utility costs, maintenance and repair costs, and costs associated with replacement of component materials and systems. Sustainable practices rely on full accounting of life-cycle operating costs/benefits during initial program planning. Operating costs/benefits can be significant and can outweigh first costs/benefits and future end use cost/benefits. Building components and systems are operated, maintained, and replaced possibly many times over the life cycle.

*(3) End Use Costs/Benefits*—End use cost/benefits for deconstruction and reuse or disposal will accrue in the future, when new information relative to potential environmental/social impacts may be available. Sustainable practices consider end use costs/benefits when reliable data is available as well as future costs/benefits including the potential risks and liabilities associated with incorporated materials and methods.

5.2.2 *Associated Characteristics:*

5.2.2.1 *External Costs/Benefits*—Sustainable practices seek to identify associated external costs/benefits, minimize associated external costs, and maximize external benefits. These costs/benefits tend to be specific to regions, programs, and combinations of circumstances unique to the structure under consideration.

*(1) Social Costs/Benefits*—Sustainable construction can enhance the building industry and create and provide healthy and productive workplaces. For example, low-VOC building products may reduce construction worker exposure and improve indoor environmental quality of a finished building. Improved indoor environmental quality may contribute to worker productivity.

*(2) Environmental Costs/Benefits*—Sustainable construction can reduce environmental costs and provide environmental benefits to society. For example, landscaping with indigenous plants can contribute to wildlife corridors. This approach can support both local ecosystems and migratory species, many of which are pollinators vital to the economic foundation of the agricultural industry.

5.2.2.2 *Life-Cycle Costs/Benefits*—Sustainable practices strive to provide the best comprehensive value over the life cycle of a structure.

*(1) First Costs*—Sustainable construction does not need to be more costly when measured on a first cost basis. Integrating features early in the planning and design process controls initial costs. For example, native landscaping techniques incorporate water-efficient plants. This approach can negate the necessity for supplemental watering and the costs associated with labor and materials to install an irrigation system.

*(2) Operating Costs*—Sustainable practices apply efficiencies of operation, reducing associated operating costs. For example, selecting durable materials can reduce the need for repair and replacement. This approach cannot only minimize costs associated with labor and materials for repair/replacement but also the costs associated with possible disruption in the operations and services of a structure.

*(3) End Use Costs/Benefits*—DfE (Design for the Environment) guidelines can reduce potential regulatory and liability costs. For example, mechanically fastened systems can facilitate future deconstruction. This approach can advance the reclamation of materials and reduce costs associated with landfilling.

5.3 *Social Principles*—To contribute to a positive quality of life for current and future generations, it is necessary to identify, without imposing interpretive cultural prejudice, the potential health, safety, and welfare impacts of the built environment.

5.3.1 *Fundamental Concepts:*

5.3.1.1 *Health, Safety, and Welfare*—Sustainability maintains or improves health, safety, and welfare.

5.3.1.2 *Transparency*—Sustainability requires ample opportunity for affected parties to access information and actively participate in the decision-making process.

5.3.1.3 *Equity*—Sustainability is founded upon intergenerational ethics, which emphasize that current actions will impact the quality of life of current and future generations.

5.3.2 *Associated Characteristics:*

5.3.2.1 *Health, Safety, and Welfare*—Sustainability protects and enhances the human health, safety, and welfare. For example, locating a building outside limits of a flood plain can reduce the potential for flooding of the structure while supporting the natural function of the ecosystem.

5.3.2.2 *Transparency*—Sustainability demands inclusiveness and transparency of purpose and method by providing information and the means to contribute to the decision-making process. For example, engaging building occupants in the design process contributes to a broader, more informed