Designation: E2728 – 19

Standard Guide for Water Stewardship in the Design, Construction, and Operation of Buildings[1]

This standard is issued under the fixed designation E2728; 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 This guide is intended to inform sustainable development in the building industry. It outlines ideal sustainability and applied sustainability for water management, consistent with Guide E2432. Both ideal sustainability and applied sustainability should inform decisions regarding water management.

1.1.1 Ideal sustainability is patterned on the hydrological cycle. This provides the concept goals and direction for continual improvement.

1.1.2 Applied sustainability outlines current best practices. This identifies available options considering environmental, economic, and social opportunities and challenges. The most appropriate option(s) are likely to vary depending on the location of the project.

1.2 Water management challenges differ enormously depending on the type of built environment and the available water resources.

1.2.1 The general demands of the built environment vary from very low density rural development to crowded urban development. Large cities present a particular challenge, with 400 cities worldwide housing over 1 million inhabitants.

1.2.2 Successfully meeting the challenges of uneven distribution of water around the world, depletion of groundwater, changing rainfall patterns, and other water industry trends requires sustainable solutions for the effective management of the entire water cycle.

1.2.3 Sustainable design, construction, and operation of water and wastewater services for the built environment are critical components of water stewardship and global sustainable water management.

1.3 Water stewardship encompasses both pollution prevention (quality issues) and conservation (quantity issues).

1.4 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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 to determine the applicability of regulatory limitations prior to use.*

1.6 *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]

E2114 Terminology for Sustainability Relative to the Performance of Buildings

E2348 Guide for Framework for a Consensus-based Environmental Decision-making Process

E2432 Guide for General Principles of Sustainability Relative to Buildings

E2635 Practice for Water Conservation in Buildings Through In-Situ Water Reclamation

2.2 *Other Reference Documents:*

WaterSense [3]

WWAP World Water Assessment Programme[4]

3. Terminology

3.1 *Definitions*—For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114.

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[1] This guide is under the jurisdiction of ASTM Committee E60 on Sustainability and is the direct responsibility of Subcommittee E60.07 on Water Use and Conservation.

Current edition approved May 1, 2019. Published May 2019. Originally approved in 2011. Last previous edition approved in 2011 as E2728–11. DOI: 10.1520/E2728–19.

[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 United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov/watersense.

[4] United Nations Educational, Scientific, and Cultural Organization (UNESCO), 7 place Fontenoy, 75007 Paris, France, http://www.unesco.org/water/wwap.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *effluent, n*—wastewater, treated or untreated, that flows out of a treatment plant, sewer, industrial facility, or constructed source.

3.2.2 *emerging pollutants, n*—substances that have been recently discovered or determined to contaminate the environment.

3.2.3 *Environmental Management System (EMS), n*—procedures for identifying, managing, and improving the environmental impacts of an organization, facility, product, or service, or a combination thereof.

3.2.3.1 *Discussion*—Fundamental to an EMS is implementation of a plan-do-check-act approach that documents current performance levels and facilitates continual improvement.

3.2.4 *green infrastructure, n*—an array of products, technologies, and practices that use natural systems, or engineered systems that mimic natural processes, to enhance overall environmental quality and provide utility services.

3.2.4.1 *Discussion*—As a general principal, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, or recycle stormwater runoff, or a combination thereof; examples include: green roofs, porous pavement, rain gardens, and vegetated swales.

3.2.5 *hydrologic cycle, n*—the continuous circulation of water on, under, and over the Earth's surface.

3.2.6 *nonpotable water, n*—water that has not been treated for human consumption in conformance with applicable drinking water quality regulations.

3.2.7 *Persistent Organic Pollutant (POP), n*—an organic compounds of natural or anthropogenic origin that resists photolytic, chemical, and biological degradation and is characterized by low water solubility and high lipid solubility, resulting in bioaccumulation in fatty tissues of living organisms.

3.2.7.1 *Discussion*—POPs are transported in the environment in low concentrations by movement of fresh and marine waters and they are semi-volatile, enabling them to move along distances in the atmosphere, resulting in wide-spread distribution across the earth, including regions where they have never been used. The United Nations Environment Programme (UNEP) Governing Council, at its nineteenth session in February 1997, identified 12 POPs: Aldrin, Chlordane, Dieldrin, DDT, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, PCBs, Dioxins, and Furans.

3.2.8 *potable water, n*—water that does not endanger the lives or health of human beings and that conforms to applicable regulations for drinking water quality.

3.2.9 *wastewater, n*—the spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.

3.2.10 *water efficiency, n*—refers to measures, practices, or programs that reduce the water used by specific devices and systems, typically without affecting the services provided.

3.2.11 *water stress, n*—refers to consumption of water that exceeds available water resources.

3.2.11.1 *Discussion*—UNEP considers countries where consumption exceeds 10 % of total supply to be in a water-stressed condition.

3.2.12 *watershed, n*—the land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

3.2.13 *watershed approach, n*—coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically-defined geographic areas taking into consideration both ground and surface water flow.

4. Significance and Use

4.1 Supply of fresh water is limited and demand is increasing.

4.1.1 The United Nations Population Fund estimates that only 2.5 percent of the water on the Earth is fresh, and only about 0.5 percent is accessible ground or surface water.

4.1.2 While world population tripled in the 20th century, the use of water increased six-fold. The United Nations estimates that in the year 2017, close to 70 percent of the global population will have problems accessing fresh water. Additionally, more than 2 billion people around the world lack basic sanitation facilities.

4.1.3 According to WWAP, agriculture use accounts for 70 percent of annual worldwide water use, industrial use accounts for 22 percent and domestic use accounts for 8 percent (**1**).[5]

4.2 Increased demand has put additional stress on water supplies and distribution systems, threatening both human health and the environment.

4.3 Increased demand has intensified energy use and the associated greenhouse gas emissions. Significant energy is expended for treatment and distribution of water. According to WaterSense, American public water supply and treatment facilities consume about 56 billion kilowatt-hours (kWh) per year—enough electricity to power more than 5 million homes for an entire year. In California, an estimated 19 percent of electricity, 32 percent of natural gas consumption, and 88 billion gallons of diesel fuel annually power the treatment and distribution of water and wastewater (**2**).

4.4 The building industry diverts an estimated 16 percent of global fresh water annually (**3**). It is imperative that design and construction address water efficiency. The estimate of annual usage of available fresh water by the building industry accounts for the quantity of water that is required to manufacture building materials and to construct and operate buildings. It does not reflect the impact of the building industry on the quality of water.

4.5 This guide provides information regarding ideal sustainability and water use.

4.6 This guide provides general options for applied sustainability and water use.

[5] The boldface numbers in parentheses refer to a list of references at the end of this standard.

5. Ideal Sustainability

5.1 *Stewardship*—Ideal stewardship would pattern use on natural cycles and processes.

5.1.1 *Quantity*—While water may be temporarily diverted from the hydrologic cycle, no measurable difference in total inflows and outflows to a site would be made.

5.1.2 *Quality*—While water may be temporarily contaminated, such contamination would not exceed the natural purification capacity of the hydrologic cycle. No measurable degradation of water quality leaving a site would be made.

5.2 *Hydrologic Cycle:*

5.2.1 The Earth's water is continuously moving into and out of various reservoirs, including the atmosphere, land, surface water, and groundwater. The water moves from one reservoir to another by the physical processes including; evaporation, condensation, precipitation, infiltration, surface flow, and subsurface flow. In so doing, the water goes through different phases: liquid, solid, and gas. (See Fig. 1.)

5.2.2 The amount of time it takes to change the physical state of water can take less than a second or more than a million years. (See Fig. 2.)

5.2.3 Although many processes exist in nature to transform the physical state of water, the quantity of water remains the same as it is transported through the environment in a continuous cycle.

5.3 *Natural Purification*—As water moves through the hydrologic cycle it tends to be purified. Many separate processes contribute to this purification, including:

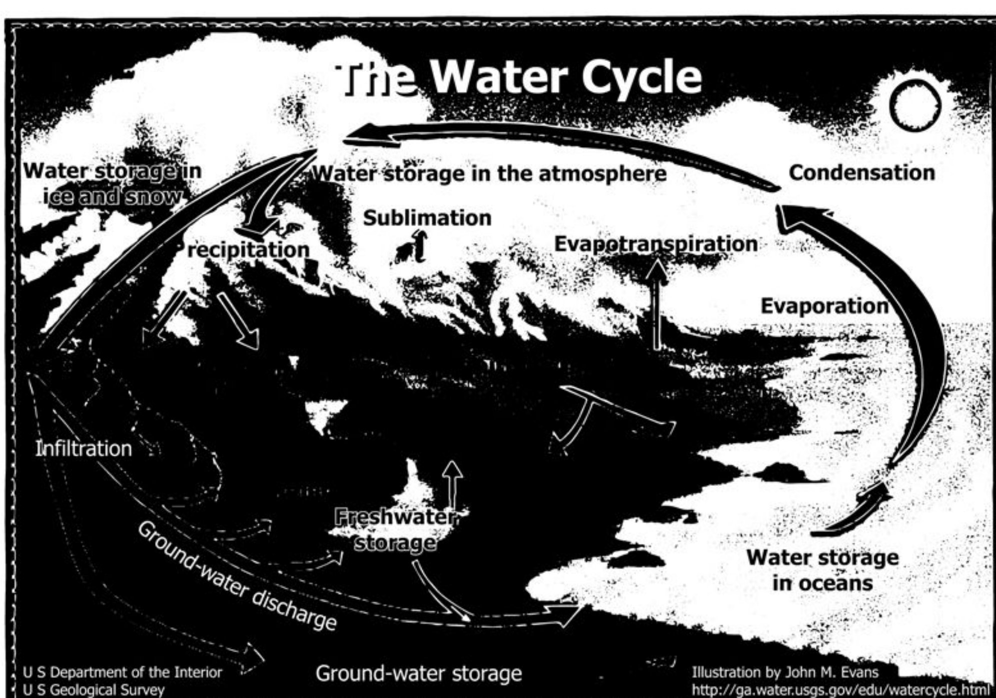
5.3.1 *Distillation*—Evaporation of sea water leaves salts behind. This world-wide distillation process results in rain water containing only traces of nonvolatile impurities, along with gases dissolved from the air.

5.3.2 *Aeration*—Surface flow that trickles over rocks allows volatile impurities, previously dissolved from mineral deposits or other sources, to be released into the air. Aeration also promotes rapid growth of microscopic plant and animal organisms that use certain water contaminants for food and energy.

5.3.3 *Sedimentation*—Solid particles settle to the bottom of slow moving or deep waterbodies, or both. Wetlands and streamside (riparian) forests are particularly important for removing fine sediments from runoff. As sediment-laden water moves across and through these ecosystems, 80 to 90 percent of the fine particles settle to the bottom or are filtered out. Other pollutants such as organics, metals, and radionuclides (radioactive elements) are often adsorbed by (stuck onto) silt particles. Settling of the silt removes these pollutants from the water.

5.3.4 *Filtration*—When water moves through sand, suspended matter such as silt and clay is removed.

5.3.5 *Dilution*—Dilution with relatively pure water can reduce the concentration of many pollutants to harmless levels. However, small amounts of some pollutants can contaminate large quantities of water. For example, a single quart of hydraulic fluid can contaminate 250 000 gallons of ground water. Chemicals that leach into groundwater can remain there long after the chemical is no longer used. The pesticide dichlorodiphenyltrichloroethane (DDT) is still found in groundwater in the United States even though its use was banned more than 30 years ago. Like pesticides, volatile organic compounds (VOCs) are pervasive and commonly found in groundwater supplies. Twenty-nine percent of wells



NOTE 1—U.S. Geological Survey, *The Water Cycle*, http://ga.water.usgs.gov/edu/watercycle.html (accessed January 1, 2011).

FIG. 1 The Water Cycle