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Standard Practice for Assessment of Rainwater Quality[1]

This standard is issued under the fixed designation E2727; 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.

ε[1] NOTE—Table X1.1 alignment was editorially corrected in October 2014.

1. Scope

1.1 This practice provides a methodology for assessing rainwater quality.

1.1.1 This practice identifies a set of research and reporting requirements that will permit the intended user to assess the rainwater quality of a particular site.

1.1.2 This practice characterizes rainwater quality in general and identifies site conditions that may affect rainwater quality. Where site conditions affecting rainwater exist, additional assessment techniques may be required.

1.1.3 Objectives guiding the development of this practice are (*1*) to synthesize and put in writing good commercial and customary practice for rainwater quality assessment; (*2*) to facilitate high quality, standardized water stewardship protocols; and (*3*) to clarify a standard of due diligence that is practical and reasonable.

1.2 This practice does not establish design requirements for rainwater harvesting systems. However, it may provide information in support of decisions relative to design and implementation of rainwater harvesting projects.

1.3 This practice does not identify use(s) of rainwater, commercial or otherwise. However, it may provide information in support of decisions relative to evaluation of property conditions and development options.

1.4 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment.

1.4.1 Water laws vary among governing jurisdictions. It is the responsibility of the user of this practice to determine regulatory requirements applicable to rainwater quality assessment and potential use(s).

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process

E1528 Practice for Limited Environmental Due Diligence: Transaction Screen Process

E2114 Terminology for Sustainability Relative to the Performance of Buildings

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

2.2 *EPA Documents:*[3]

CERCLA Comprehensive Environmental Response, Compensation and Liability Act, commonly known as Superfund

3. Terminology

3.1 *Definitions:*

3.1.1 For terms related to sustainability relative to the performance of buildings, refer to Terminology E2114.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *adjacent site, n*—any property or properties the border of which is contiguous or partially contiguous with that of the property, or that would be contiguous or partially contiguous with that of the property but for a street, road, public thoroughfare, or other physical barrier separating them.

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

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[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), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

3.2.2 *brownfield site, n*—real property, the expansion, redevelopment, or reuse of whichmay be complicated by the presence or potential presence of a hazardous substance, pollutant, orcontaminant.

3.2.2.1 *Discussion*—The term "brownfield site" does not include a site described in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, Section 101(39)(B), even though this language tracks the definition of "brownfield site" in CERCLA Section 101(39)(A) and (B).

3.2.3 *building department records, n*—those records of the local government in which the property is located indicating permission of the local government to construct, alter, or demolish improvements on the property.

3.2.4 *catchment area, n*—surface, including hard roofs, from which rainwater may be collected.

3.2.5 *first flush filter, n*—device that automatically diverts the first flow of rainwater collected from the catchment area.

3.2.5.1 *Discussion*—A first flush filter device usually contains a temporary storage of 50–100 L (13.21–26.42 gal) (although size is determined by specific design objectives of the rainwater harvesting system) and a simple valve unit consisting of a ball and seat. The initial rainfall fills the storage and floats the ball until it rises up to the seat, blocking the opening to the storage.

3.2.6 *intended user, n*—individual or organization identified by the entity assessing rainwater quality as being the one who relies on that information to make decisions.

3.2.6.1 *Discussion*—The intended user could be the client, the responsible party, program administrators, regulators, the financial community or other affected stakeholders, such as local communities, governmental agencies, or non-governmental organizations.

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

3.2.8 *other contaminated site, n*—a facility that is described in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, Section 101(39)(B).

3.2.8.1 *Discussion*—A facility that is listed on the National Priorities List[4] or is proposed for listing would be an example of a contaminated site.

3.2.9 *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.

3.2.10 *rainwater harvesting, v*—collecting rainwater from a catchment area and storing it for future use.

3.2.11 *recognized environmental condition, n*—the presence or likely presence of any hazardous substances or petroleum products that may affect the catchment area.

3.2.11.1 *Discussion*—The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include *de minimis* conditions that generally do not present a threat to human health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies. Conditions determined to be *de minimis* are not recognized environmental conditions.

[4] The National Priorities List (NPL) is a list compiled by EPA pursuant to CERCLA 42 U.S.C. § 9605(a)(8)(B) of properties with the highest priority for cleanup pursuant to EPA's Hazard Ranking System. (See 40 C.F.R. Part 300.)

4. Significance and Use

4.1 As the world's population increases, so does the need for water to meet various needs. Rainwater harvesting offers a viable, sustainable approach to satisfying various water needs.

4.1.1 Rainwater harvesting may be the only source of water supply for many rural and remote households where no other water supply is available. In urban and suburban locations, rainwater harvesting may help public water systems reduce peak demands and help delay the need for expanding water treatment plants.

4.1.2 Rainwater harvesting can reduce storm water runoff, nonpoint source pollution, and erosion in urban environments.

4.1.3 Rainwater harvesting provides for redundancies and diversified systems that decrease security issues associated with centralized facilities.

4.2 An assessment of rainwater quality is necessary for determination of appropriate uses for water collected and stored in rainwater harvesting systems. This practice identifies a set of research and reporting requirements that will permit the intended user to assess the rainwater quality of a particular site.

5. Baseline Characterization of Rain Water Quality

5.1 *Assumptions:*

5.1.1 The following assumptions are utilized in delineating baseline rain water quality.

5.1.1.1 Rainwater is considered uncontaminated until it falls on a surface.

5.1.1.2 Proper maintenance is provided for the rainwater harvesting system in accordance with recommendations of the system manufacturer.

5.1.1.3 Rainwater that is collected (that is, harvested rainwater) through a leaf/debris screen of minimum 8 mm (0.32 in.) and an insect screen of minimum 1 mm (0.039 in.) stainless steel mesh, after a first flush filter, and does not have unique site considerations as identified in Section 6 shall be assumed to have the baseline quality characteristics listed herein.

5.2 *Baseline Quality Characteristics:*

5.2.1 *pH* — 6.0 – 7.0.

5.2.2 *Biochemical Oxygen Demand (BOD)* — ≤10 mg/L (0.00035 oz/0.26 gal).

5.2.3 *Nephelometric Turbidity Unit (NTU)* — ≤2.

5.2.4 *Fecal Coliform*—No detectable fecal *coli*/100 mL (0.027 gal).

5.2.5 *Sodium*—No detectable sodium/100 mL (0.027 gal).

5.2.6 *Chlorine*—No detectable chlorine/100 mL (0.027 gal).

5.2.7 *Enteroviruses*—No detectable entereoviruses/100 mL (0.027 gal).

6. Unique Site Considerations Review Process

6.1 The contents of rainwater may vary by geographical region and by unique site considerations. Water can collect and transport particulates and debris. Water can function as a solvent, absorbing contaminants and minerals. Thus, baseline rainwater quality may be affected by the surfaces and substances with which it comes in contact.

6.2 Review of the site considerations listed in Table 1 is intended to identify recognized environmental conditions. Recognized environmental conditions will affect water quality and may limit use of rainwater in potable water applications or non-potable water applications, or both.

6.2.1 *Accuracy and Completeness*—Accuracy and completeness of record information varies among information sources, including governmental sources. Record information is often inaccurate or incomplete. The entity providing an assessment is not obligated to identify mistakes or insufficiencies in information provided, but shall make a reasonable effort to identify mistakes or insufficiencies that are suspected or may be determined during review of site considerations.

6.2.2 *Reasonably Ascertainable/Standard Sources*—Availability of record information varies by source, including governmental jurisdictions. The entity providing an assessment is not obligated to identify, obtain, or review every possible record that might exist with respect to a property. Instead, this practice identifies record information that shall be reviewed from standard sources, and such that is reasonably ascertainable from those standard sources. Record information that is reasonably ascertainable means (*1*) information that is publicly available, (*2*) information that is obtainable from its source within reasonable time and cost constraints, and (*3*) information that is practically reviewable.

6.2.3 *Publicly Available*—Information that is publicly available means that the source of the information allows access to the information by anyone upon request.

6.2.4 *Reasonable Time and Cost*—Information that is obtainable within reasonable time and cost constraints means that the information will be provided by the source within 20 calendar days of receiving a written, telephone, or in person request at no more than a nominal cost intended to cover the source's cost of retrieving and duplicating the information. Information that can only be reviewed by a visit to the source is reasonably ascertainable if the visit is permitted by the source within 20 days of request.

TABLE 1 Site Consideration Review Questions

Question	Conclusion		Sources Supporting Conclusion		
	No	Yes	Observation	Documents	Interviews
Is the catchment in an urban environment?					
Is the catchment within 500 m (1640 ft) of a busy road or highway?					
Is the catchment within 500 m (1640 ft) of an agricultural property that is not fully organic?					
Is the catchment within 500 m (1640 ft) of an industrial facility?					
Is the catchment within 500 m (1640 ft) of a fueling station?					
Is the catchment within 500 m (1640 ft) of a railroad or 1 km (0.62 mi) of a rail yard?					
Is the catchment within 1 km (0.62 mi) of an airport?					
Is the catchment within 500 m (1640 ft) of a brownfield or other contaminated property?					
Has an environmental Site Assessment conducted in accordance with Practice E1527 or Practice E1528, or both, reported a recognized environmental condition within 500 m (1640 ft) of the catchment area?					
Is there evidence of recognized environmental conditions within 500 m (1640 ft) of the catchment area?					
Is the catchment area within 10 km (6.2 mi) of coastal waters?					
Are there any other unique site conditions, including recent events and temporary conditions, that indicate potential to contaminate the catchment area?					

6.3 Table 1 lists review questions for the site. Answers to the questions should be obtained from the following sources:

6.3.1 *Physical Observation*—Review site, including catchment area, and adjacent sites.

6.3.2 *Document Research:*

6.3.2.1 *Infrastructure*—Review water and wastewater infrastructure serving the site. Documents may include site plans and utility records.

6.3.2.2 *Context*—Review context of site, including catchment area. Documents may include maps, aerial photographs, zoning plans, and National Atmospheric Deposition Program—National Trends Network (NADP/NTN) data.

NOTE 1—The U.S. Geological Survey (USGS) is the lead federal agency for the monitoring of wet atmospheric deposition (chemical constituents deposited from the atmosphere via rain, sleet, and snow) in the United States. The USGS atmospheric deposition program provides:

(*1*) Participation and leadership in the NADP/NTN;[5] and

(*2*) Scientific research and assessment to evaluate the effects of atmospheric deposition on aquatic and terrestrial ecosystems.

The NADP monitors wet atmospheric deposition at over 250 NTN sites throughout the United States. The USGS supports 74 of the roughly 250 active NADP/NTN sites. A fundamental NADP program objective is to provide scientific investigators world-wide with a long-term, high-quality database of atmospheric deposition for research support in the areas of air quality, water quality, agricultural effects, forest productivity, materials effects, ecosystem studies, watershed studies, and human health.

6.3.2.3 *History*—Review historical uses of site, including catchment area, and adjacent sites. Documentation may include: photographs and building department records.

6.3.3 *Interviews*—Interview owners and occupants of site to assess routine operations and maintenance of the site. Interviews may include government officials, adjacent property owners and others.

6.4 If the response to all of the questions in Table 1 is "no" then the rainwater is considered to possess baseline quality characteristics as delineated by this practice.

6.5 If any of the questions in Table 1 is "yes" then the rainwater is not considered to possess baseline quality characteristics as delineated by this practice. However, it may be tested in accordance with the monitoring requirements of Practice E2635 to assess the quality characteristics. Where such additional testing is required and utilized, document results of testing in accordance with Practice E2635. Include test results with report specified herein.

[5] Information available from National Atmospheric Deposition Program (NADP), Program Office, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820-7495, http://nadp.sws.uiuc.edu.

7. Report

7.1 A report shall be provided indicating results of rainwater assessment in accordance with this practice. The report shall clearly state whether or not baseline quality characteristics are determined to apply.

7.2 The report shall include:

7.2.1 *Date of Assessment.*

7.2.2 *Intended User*—Include the name and contact information.

7.2.3 *Assessment Entity*—Include the name and contact information. Include a description of qualifications.

7.2.4 *Site Identification*—Provide a description of the site. Include:

7.2.4.1 *Location and Legal Description.*

7.2.4.2 *Site and Vicinity General Characteristics.*

7.2.4.3 *Current Use of the Property*—Identify the zoning for the property and describe the current function of the property. Describe routine operations. Describe structures, roads, and other improvements on the site (including heating/cooling system, sewage disposal, and source of potable water).

7.2.4.4 *Current Uses of the Adjacent Site.*

7.2.5 *Summary of Review Process and Conclusions.*

7.2.6 *Documentation of Sources Checked*—The report shall document each source that was used, even if a source revealed no findings. Include information adequate for the intended user to identify and locate source(s) independently.

7.2.6.1 *Physical Observation*—Indicate the dates/times of observation(s). Include comments detailing special circumstances, if any, related to observations.

7.2.6.2 *Document Research*—Catalog the information requested and the information obtained. Identify the information requested for review; the date the request for information was filled, the date the information was provided; and the date the information was last updated by original source.

7.2.6.3 *Interviews*—Include the names, titles, and contact information for the individuals interviewed.

7.2.7 *Findings*—Provide conclusions and supporting data for each question. Include a copy of Table 1 completed based on information obtained in review of site conditions; for each question, indicate which source(s) contributed to conclusions.

7.2.8 *Appendixes*—Include copies of:

7.2.8.1 Site (vicinity) map,

7.2.8.2 Site plan showing catchment area, and

7.2.8.3 Site photograph(s)

8. Keywords

8.1 building; green building; rain; reclaimed water; sustainability; sustainable building; water conservation; water management; water reuse; water stewardship

APPENDIX

(Nonmandatory Information)

X1. FACTORS AFFECTING RAINWATER QUALITY

X1.1 Atmospheric Factors

X1.1.1 *pH*—As a raindrop falls and comes in contact with the atmosphere, it dissolves carbon dioxide to form a weak acid. The resultant pH is about 5.7 (whereas a pH of 7.0 is neutral).

NOTE X1.1—A slight buffering using 14.8 mL (1 tbs) of baking soda to 378.54 L (100 gal) of water in the tank will neutralize the acid, if desired. Also, a concrete storage tank will impart a slight alkalinity to the water.

X1.1.1.1 Smoke and fumes from burning fossil fuels rise into the atmosphere and combine with the moisture in the air to form acid rain. The main chemicals in air pollution that create acid rain are sulfur dioxide (SO_2) and nitrogen oxides (NO_x). In the United States, about 63 % of annual SO_2 emissions and 22 % of NO_x emissions are produced by burning fossil fuels for electricity generation.[6] After a few days to weeks, atmospheric SO_2 and NO_x are converted to acids and deposited on the earth's surface. The acid rain usually forms high in the clouds where SO_2 and NO_x react with water, oxygen, and oxidants. This forms a mild solution of sulfuric acid and nitric acid. Sunlight increases the rate of most of these reactions. Rainwater, snow, fog, and other forms of precipitation containing those mild solutions of sulfuric and nitric acids fall to the earth as acid rain. Acid deposition can occur hundreds of miles away from its sources.

X1.1.2 *Particulate Matter*—Particulate matter refers to smoke, dust, and soot suspended in the air. Fine particulates can be emitted by industrial and residential combustion, vehicle exhaust, agricultural controlled burns, and sandstorms. As rainwater falls through the atmosphere, it can incorporate these contaminants.

X1.1.2.1 Particulate matter derived from calcium-rich soils in Central and West Texas can add 1 mg/L to 2 mg/L (0.0000035 oz/0.26 gal to 0.000071 oz/0.26 gal) of hardness to the water. Hard water has a high mineral content, usually consisting of calcium and magnesium in the form of carbonates.

X1.1.2.2 In industrial areas, rainwater samples can have slightly higher values of suspended solids concentration and turbidity due to the greater amount of particulate matter in the air.

X1.1.3 *Chlorine*—Concentrations of chloride may be higher from regions near large bodies of salt water.

X1.1.4 *Nitrates*—In agricultural areas, rainwater could have a higher concentration of nitrates due to fertilizer residue in the atmosphere. Pesticide residues from crop dusting in agricultural areas may also be present.

X1.2 Rainwater Catchment and Harvesting System Factors

X1.2.1 *Catchment*—When rainwater comes in contact with a catchment surface, it can wash bacteria, molds, algae, fecal matter, other organic matter, or dust, or any combination thereof, into storage tanks. The longer the span of continuous number of dry days (days without rainfall), the more catchment debris is washed off the roof by a rainfall event.

X1.2.1.1 It is advisable that overhanging branches be cut away both to avoid tree litter and to deny access to the roof by rodents and lizards.

NOTE X1.2—In residential systems, the first 18.93 L (5 gal) of runoff from a gutter, roof, or other surface is likely to contain various impurities such as bird droppings and dust.

X1.2.2 *Storage*—The more filtering of rainwater prior to the storage tanks, the less sedimentation and introduction of organic matter will occur within storage tanks. Sedimentation reduces the capacity of tanks, and the breakdown of plant and animal matter may affect the color and taste of water, in addition to providing nutrients for microorganisms.

X1.3 Treatment Factors

X1.3.1 Treatment, such as filtration and ultraviolet radiation, is typically required for potable water uses.

[6] EPA, "Findings on National Air Quality," 2002.

TABLE X1.1 Air Pollution Sources, Health Effects, and Environmental Effects[A]

NOTE 1—To get emissions information at a state or local level, visit the EPA website[3] where you can find emissions totals for a state or county grouped by major source types, or select an online map resource to see nearby sources of emissions. Zoom to the area of interest, tilt the map to see emissions levels, select a site for facility information, or zoom closer for an aerial photo.

Pollutant	Sources	Health Effects	Environmental Effects
Ozone (O_2)	Secondary pollutant formed by chemical reaction of VOCs and NO_x in the presence of sunlight.	Aggravation of respiratory and cardiovascular disease, decreased lung function and increased respiratory symptoms, increased susceptibility to respiratory infection, and premature death.	Damage to vegetation such as impacts on tree growth and reduced crop yields.
Particles	Emitted or formed through chemical reactions (for example, NO_x, SO_2, or NH_2), fuel combustion (for example, burning coal, wood, or diesel), industrial processes, agriculture (plowing, field burning), and unpaved roads.	Aggravation of respiratory and cardiovascular disease, reduced lung function, increased respiratory symptoms, and premature death.	Impairment of visibility; effects on climate; and damage or discoloration, or both, of structures and property.
Lead	Smelters (metal refineries) and other metal industries; combustion of leaded gasoline in piston engine aircraft; waste incinerators; and battery manufacturing.	Damage to developing nervous system, resulting in IQ loss and impacts on learning, memory, and behavior in children. Cardiovascular and kidney effects in adults and early effects related to anemia.	Harm to environment and wildlife.
Sulfur Dioxide (SO_2)	Fuel combustion (especially high-sulfur coal), electric utilities and industrial processes, and natural sources such as volcanoes.	Aggravation of asthma and increased susceptibility to respiratory infections. Contributes to particle formation with associated health effects.	Contributes to the acidification of soil and surface water and mercury methylation in wetland areas. Contributes to particle formation with associated environmental effects.
Oxides of Nitrogen (NO_2)	Fuel combustion (for example, electric utilities, industrial boilers, and vehicles) and wood burning.	Aggravation of respiratory disease and Increased susceptibility to respiratory infections. Contributes to ozone and particle formation with associated health effects.	Contributes to the acidification and nutrient enrichment (eutrophication, nitrogen saturation) of soil and surface water. Contributes to ozone and particle formation with associated environmental effects.
Carbon Monoxide (CO)	Fuel combustion (especially vehicles).	Reduces the ability of blood to carry oxygen to body tissues including vital organs. Aggravation of cardiovascular disease.	None known.
Ammonia (NH_2)	Livestock agriculture (that is, raising/maintaining livestock for milk, meat, and egg production); fertilizer application.	Contributes to particle formation with associated health effects.	Contributes to eutrophication of surface water and nitrate contamination of ground water. Contributes to particle formation with associated environmental effects.
Volatile Organic Compounds (VOCs)	Fuel combustion and evaporation (especially vehicles), solvents, paint, and natural sources such as trees and vegetation.	Cancer (from some toxic air pollutants) and other serious health problems. Contributes to ozone formation with associated health effects.	Contributes to ozone formation with associated environmental effects.
Mercury	Fuel combustion (especially coal-fired power plants), waste disposal, industrial processes, mining, and natural sources (volcanoes and evaporation from enriched soil, wetlands, and oceans).	Liver, kidney, and brain damage; and neurological and developmental damage.	Deposition into rivers, lakes, and oceans accumulates in fish resulting in exposure to humans and wildlife.
Other Toxic Air Pollutants	Fuel combustion (including particle and gaseous emissions), vehicles, industrial processes, building materials, and solvents.	Cancer, immune system damage, neurological, reproductive, developmental, respiratory, and other health problems. Some toxic air pollutants contribute to ozone and particle pollution with associated health effects.	Harmful to wildlife and livestock. Some toxic air pollutants accumulate in the food chain. Some toxic air pollutants contribute to ozone and particle pollution with associated environmental effects.

[A] Source: EPA, http://www.epa.gov/airtrends/2008/report/AirPollution.pdf.