



November 2016

CLIMATE CHANGE

Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications

GAO Highlights

Highlights of [GAO-17-3](#), a report to the Honorable Matthew Cartwright, House of Representatives

Why GAO Did This Study

Over the last decade, extreme weather cost the federal government more than \$320 billion for, among other things, repairs to federal infrastructure, and according to the President's 2017 budget request, these costs may rise as the climate continues to change. GAO's prior work found that using the best available climate information, including forward-looking projections, can help manage climate-related risks.

Federal, state, local, and private decision makers use design standards, building codes, and voluntary certifications in the construction of infrastructure. Standards-developing organizations, such as professional engineering societies, issue standards, model codes, and certifications.

GAO was asked to review the use of forward-looking climate information by standards-developing organizations. This report examines (1) what is known about the use of such information in standards, codes, and certifications; (2) challenges standards organizations face to using climate information; and (3) actions federal agencies have taken to address such challenges and additional actions they could take. GAO analyzed laws and policies, reviewed reports, and interviewed representatives from 17 selected organizations and officials from agencies that address climate issues.

What GAO Recommends

GAO recommends that NIST, in consultation with USGCRP and MitFLG, convene an ongoing governmentwide effort to provide forward-looking climate information to standards organizations. Commerce neither agreed nor disagreed with GAO's recommendation.

View [GAO-17-3](#). For more information, contact J. Alfredo Gomez at (202) 512-3841 or gomezj@gao.gov.

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Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications

What GAO Found

Selected standards-developing organizations generally have not used forward-looking climate information—such as projected rainfall rates—in design standards, building codes, and voluntary certifications and instead have relied on historical observations. Further, some organizations periodically update climate information in standards, codes, and certifications, but others do not. Some standards-developing organizations have taken preliminary steps that may lead to the use of forward-looking climate information. For example, in 2015, the American Society of Civil Engineers issued a paper that recommended engineers work with scientists to better understand future climate extremes.

Standards-developing organizations face institutional and technical challenges to using the best available forward-looking climate information in design standards, building codes, and voluntary certifications, according to reports, representatives of these organizations, and federal officials. Institutional challenges include a standards-developing process that must balance various interests and can be slow to change. For example, representatives of some standards-developing organizations told GAO that their members have not expressed interest in standards that use forward-looking climate information. Technical challenges include difficulties in identifying the best available forward-looking climate information and incorporating it into standards, codes, and certifications. For example, representatives from one organization said that climate models provide a wide range of possible temperatures that is difficult to use in their standards.

Agencies have initiated some actions and could take more to help standards-developing organizations address challenges, according to various reports, representatives of standards-developing organizations, and agency officials. For example, in 2015, the National Institute of Standards and Technology (NIST) convened a panel that seeks to identify gaps in standards and codes to make infrastructure more resilient to extreme weather. In addition, officials from the U.S. Global Change Research Program (USGCRP)—which coordinates research across 13 federal agencies—told GAO they have begun discussions with representatives of standards-developing organizations on their climate information needs. In 2015, the Mitigation Framework Leadership Group (MitFLG)—which coordinates hazard mitigation efforts—issued a draft strategy to encourage federal support for more resilient standards and codes. Opportunities exist for additional agency actions that may help address the challenges organizations identified to using forward-looking climate information. Specifically, agencies that address climate issues could improve interagency coordination to help standards-developing organizations address institutional challenges and could provide the best available forward-looking climate information to help them address technical challenges. Federal policy directs agency standards executives—senior-level officials who coordinate agency participation in standards organizations—to coordinate their views when they participate in the same standards activities so as to present, whenever feasible, a single, unified position. The policy also directs the Secretary of Commerce, who has delegated the responsibility to NIST, to coordinate and foster executive branch implementation of the policy governing federal participation in the development of voluntary consensus standards. A governmentwide effort could also present a benefit by reducing the federal fiscal exposure to the effects of climate change.

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Abbreviations

DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GSA	General Services Administration
HUD	Department of Housing and Urban Development
ICSP	Interagency Committee on Standards Policy
LEED	Leadership in Energy and Environmental Design
MitFLG	Mitigation Framework Leadership Group
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NTTAA	National Technology Transfer and Advancement Act of 1995, as amended
OMB	Office of Management and Budget
USGCRP	U.S. Global Change Research Program

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November 30, 2016

The Honorable Matthew Cartwright
House of Representatives

Dear Mr. Cartwright:

Over the last decade, the federal government has incurred direct costs of over \$320 billion due to extreme weather events for, among other things, repairs to federal facilities and infrastructure; and these costs are expected to rise as the impacts of climate change intensify, according to the President’s fiscal year 2017 budget request.¹ In 2014, the *Third National Climate Assessment*—which integrated findings from the 13-agency U.S. Global Change Research Program (USGCRP)—stated that damages to infrastructure from sea level rise, heavy downpours, and extreme heat are projected to increase with continued climate change.² Further, in 2013, the Department of Homeland Security’s (DHS) National Infrastructure Protection Plan stated that extreme weather—including more severe storms, extreme and prolonged drought, and severe flooding—poses a significant risk to infrastructure such as buildings, roads, and power lines.³ The plan also stated that ongoing and future changes to the climate have the potential to compound these risks and could have a major impact on infrastructure.

As a result of the significant risks posed by climate change and the nation’s fiscal condition, in February 2013, we added *Limiting the Federal*

¹U.S. Government Publishing Office, *Analytical Perspectives, Budget of the United States Government for Fiscal Year 2017* (Washington, D.C.: 2016). Specifically, \$205 billion was spent for domestic disaster response and relief; \$90 billion for crop and flood insurance; and \$28 billion for maintenance and repairs to federal facilities and federally managed lands, infrastructure, and waterways.

²Jerry M. Melillo, Terese (T.C.) Richmond, and Gary W. Yohe, Eds., USGCRP, *Climate Change Impacts in the United States: The Third National Climate Assessment* (Washington, D.C.: October 2014). The USGCRP coordinates and integrates global change research across 13 federal agencies. The Office of Science and Technology Policy within the Executive Office of the President oversees the USGCRP.

³Department of Homeland Security, *National Infrastructure Protection Plan 2013: Partnering for Critical Infrastructure Security and Resilience* (Washington, D.C.: 2013). The plan outlines the national effort—that is, the effort of government and private-sector participants—to manage risk to infrastructure whose incapacity or destruction would have a debilitating impact on national security, economic security, or public health or safety.

Government's Fiscal Exposure by Better Managing Climate Change Risks to our list of areas at high risk for fraud, waste, abuse, and mismanagement, or most in need of transformation.⁴ For example, the federal government is the owner or operator of infrastructure, such as defense facilities, and the insurer of property vulnerable to climate impacts through the National Flood Insurance Program. State, local, and private-sector decision makers can also drive federal climate-related fiscal exposure because they are responsible for planning, constructing, and maintaining certain types of vulnerable infrastructure paid for with federal funds, insured by federal programs, or eligible for federal disaster assistance. The federal government also provides data and technical assistance to federal, state, local, and private-sector decision makers responsible for managing the impacts of climate change on their activities. In November 2015, we found that using the best available climate information can be a part of a risk-management strategy for those making federal, state, local, and private-sector decisions and investments.⁵ In that report we defined climate information to encompass both historical observations of climate conditions as well as forward-looking projections of what climate change may mean for local areas, such as how increased flow for a particular river may increase flooding. We also found that to be useful, climate information must be tailored to meet the needs of each decision maker, such as an engineer responsible for building a bridge in a specific location.

Standards-developing organizations, such as professional engineering societies and trade associations within the construction industry, generally develop design standards, building codes, and voluntary certifications. Design standards and building codes are technical guidelines that promote the safety, reliability, productivity, and efficiency of infrastructure, while voluntary certifications encourage design and operation that exceed design standards and building codes. The building codes that standards-developing organizations issue are referred to as “model codes.” States and local governments may adopt model codes—

⁴GAO, *High-Risk Series: An Update*, [GAO-13-283](#) (Washington, D.C.: Feb. 14, 2013).

⁵GAO, *Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information*, [GAO-16-37](#) (Washington, D.C.: Nov. 23, 2015). We recommended that the Executive Office of the President direct a federal entity to develop a set of authoritative climate change projections and observations and create a national climate information system with defined roles for federal agencies and nonfederal entities. Relevant Executive Office of the President entities did not provide official comments and, as of October 2016, had not implemented our recommendations.

in whole or in part—into state laws and regulations and local ordinances, which makes compliance with them a requirement for builders and building owners.⁶ Some design standards, building codes, and voluntary certifications incorporate weather and climate information. For example, they may include information about average seasonal temperatures or expected precipitation rates for particular areas that may be relevant in the selection of materials or construction techniques.

You asked us to review the use of forward-looking climate information in design standards, building codes, and voluntary certifications.⁷ Our objectives were to examine (1) what is known about the use of forward-looking climate information in design standards, building codes, and voluntary certifications; (2) challenges, if any, that reports and representatives of standards-developing organizations identified to using forward-looking climate information; and (3) any actions that federal agencies have taken to help address such challenges and additional actions, if any, that reports, representatives of standards-developing organizations, and agency officials identified.

To address our objectives, we reviewed reports by selected standards-developing organizations, federal agencies, and experts in the development and use of standards and climate change. We also interviewed representatives of standards-developing organizations and agency officials. We identified standards-developing organizations through interviews with academics, subject-matter experts, representatives of professional societies, as well as through our prior work. We selected 17 organizations that develop design standards, building codes, and voluntary certifications for which climate information

⁶Most building codes enacted by state and local governments are based on model codes, although typically these governments adopt building codes that take into account factors such as resource conservation and regional construction practices, according to the American Institute of Architects. References in our report to building codes are to model codes, and not to any particular state or local government's building codes.

⁷This review was conducted in response to a 2014 request from Representative Matt Cartwright—then Ranking Member, House Subcommittee on Economic Growth, Job Creation, and Regulatory Affairs; Committee on Oversight and Government Reform—to review how standards-developing organizations account for climate change in design standards, building codes, and voluntary certifications.

is relevant.⁸ These organizations do not represent all organizations that develop standards, codes, and certifications, but they include all major standards-developing organizations that met our selection criteria.

To examine what is known about the use of forward-looking climate information in design standards, building codes, and voluntary certifications, we reviewed reports by the 17 standards-developing organizations and subject-matter experts, as well as documents that standards-developing organizations provided to us, such as examples of the use of climate information in standards, codes, and certifications. We also interviewed representatives of the 17 standards-developing organizations. To examine any challenges that reports and representatives of standards-developing organizations identified to using forward-looking climate information, we reviewed reports by standards-developing organizations, federal agencies, and subject-matter experts and interviewed representatives of standards-developing organizations. To examine any actions that federal agencies have taken to help address these challenges and any additional actions they could take, we identified and analyzed federal laws, policies, and reports. We interviewed representatives of standards-developing organizations and officials from agencies and entities with a role in coordinating, developing, and adopting standards, codes, and certifications; assessing the impacts of climate change; or helping to coordinate the federal government response to climate change. These agencies and entities were the Department of Commerce's National Institute of Standards and Technology (NIST) and National Oceanic and Atmospheric Administration (NOAA); the Department of Energy (DOE); DHS's Federal Emergency Management Agency (FEMA); the Department of Housing and Urban Development (HUD); the Department of Transportation (DOT); the Environmental Protection Agency (EPA); and the General Services Administration (GSA) and, within the Executive Office of the President, the Council on Environmental Quality, the National Security Council, the Office of

⁸The 17 organizations are the Air Conditioning Contractors of America Association; American Association of State Highway and Transportation Officials; American Society of Civil Engineers; American Society of Heating, Refrigerating, and Air-Conditioning Engineers; American Society for Testing and Materials International; American Water Works Association; Green Building Initiative; Home Innovation Research Labs; Institute of Electrical and Electronics Engineers; Institute for Sustainable Infrastructure; Insurance Institute for Business & Home Safety; International Association of Plumbing & Mechanical Officials; International Code Council; International Living Future Institute; National Electrical Manufacturers Association; National Fire Protection Association; and U.S. Green Building Council.

Management and Budget (OMB), the Office of Science and Technology Policy, and USGCRP. We compared relevant federal laws, policies, and reports with any actions that federal agencies have taken and could take that, according to reports, representatives of standards-developing organizations, and agency officials, could help standards-developing organizations address the challenges they face. A more detailed description of our objectives, scope, and methodology is presented in appendix I.

We conducted this performance audit from July 2015 to November 2016 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Design standards, building codes, and voluntary certifications provide guidelines for the construction of infrastructure. Standards-developing organizations are the primary source of the standards, codes, and certifications that federal, state, local, and private-sector infrastructure planners follow. Standards-developing organizations typically develop standards, codes, and certifications through a formal, consensus-based process, and federal law and policies govern the participation of agency officials in their development. Design standards, building codes, and voluntary certifications play a role in the federal fiscal exposure to the effects of climate change.

Design Standards, Building Codes, and Voluntary Certifications Provide Guidelines for Infrastructure Construction

Design standards, building codes, and voluntary certifications provide guidelines for the construction of infrastructure, specifically:

- **Design Standards.** OMB Circular A-119—which establishes policies on the federal government’s role in development and use of standards—defines “standards” to include the common and repeated use of rules, conditions, guidelines, or characteristics for products or related processes and production methods.⁹ For example, the

⁹Office of Management and Budget, *Circular A-119: Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities* (Washington, D.C.: Jan. 27, 2016).

American Society of Civil Engineers issued a design standard that specifies minimum structural load requirements under various types of conditions, taking into account factors such as soil type and potential for floods, snow, rain, ice, and wind.

- **Building Codes.** Building codes are minimum safeguards to ensure the public health, safety, and general welfare of the occupants of new and existing buildings and structures, according to the International Code Council, a standards-developing organization.¹⁰ For example, building codes may ensure that exterior walls and roofs are resistant to the weather, such as by including flashing and drainage. Building codes may reference one or more design standards.
- **Voluntary Certifications.** Voluntary certifications assess infrastructure across a spectrum of key criteria, including environmental performance, and recognize those that go beyond minimum code compliance. For example, the U.S. Green Building Council developed the Leadership in Energy and Environmental Design (LEED) certification, which offers four ratings levels—certified, silver, gold, and platinum—depending on how many points a project earns in various categories.¹¹

In addition to design standards, building codes, and voluntary certifications, broader considerations, such as planning ordinances and asset management, may govern the construction of infrastructure. For example, planning ordinances may specify where to site new residential or commercial buildings and place conditions on their design, such as building height. Further, asset management—a decision-making approach for providing the best level of service to customers at the lowest appropriate cost—can guide what to build. For example, builders and owners may use an asset management framework to decide whether to repair or replace a building or another physical asset. In this report, we focus on the use of climate information in standards, model codes, and certifications, although climate information may also be relevant to broader planning processes and asset management decisions.

¹⁰The International Code Council is an association that helps the building safety community and construction industry provide safe, sustainable, and affordable construction through the development of model codes and standards used in the design, construction, and compliance process.

¹¹The U.S. Green Building Council is a nonprofit organization. Among other things, it implements, through a committee structure, the LEED rating systems, which are voluntary certifications for environmentally sound buildings.

Standards-Developing Organizations Are the Primary Source of Design Standards, Building Codes, and Voluntary Certifications

In the United States, standards-developing organizations are the primary source of design standards, building codes, and voluntary certifications that federal, state, local, and private-sector infrastructure planners follow. For example, a 2015 report by the National Institute of Building Sciences' Consultative Council on the priorities of the building industry stated that standards-developing organizations develop and maintain standards and codes, while state and local governments adapt, adopt, and enforce them.¹² In April 2013, we found that federal agencies rely on professional associations in adopting design standards.¹³ In 2015, we found that federal agencies and the private sector use voluntary certifications that third-party organizations—such as standards-developing organizations—develop.¹⁴ A variety of organizations, including professional societies and trade associations such as the American Society of Civil Engineers and the International Association of Plumbing & Mechanical Officials, develop design standards, building codes, and voluntary certifications. Members of these organizations can include academics; professionals, such as architects, engineers, and planners; and federal, state, and local government officials.

Various federal laws and regulations govern the use of design standards, building codes, and voluntary certifications that standards-developing organizations issue, including the following:

- The National Technology Transfer and Advancement Act of 1995, as amended (NTTAA), codified the OMB Circular A-119 directive for federal agencies to use voluntary consensus standards in lieu of government-unique standards except where inconsistent with law or otherwise impractical.¹⁵

¹²National Institute of Building Sciences, *Moving Forward: Findings and Recommendations from the Consultative Council* (Washington, D.C.: 2015). The National Institute of Building Sciences convenes representatives of government; the professions, such as architects and engineers; and other interests to focus on issues affecting the building industry.

¹³GAO, *Climate Change: Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers*, [GAO-13-242](#) (Washington, D.C.: Apr. 12, 2013).

¹⁴GAO, *Federal Green Building: Federal Efforts and Third-Party Certification Help Agencies Implement Key Requirements, but Challenges Remain*, [GAO-15-667](#) (Washington, D.C.: July 23, 2015).

¹⁵Pub. L. No. 104-113, § 12(d)(1), 110 Stat. 775, 783 (1996) (classified as amended at 15 U.S.C. § 272 Note).

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- Federal Highway Administration (FHWA) regulations incorporate, by reference, certain design standards that the American Association of State Highway and Transportation Officials develops, thereby requiring their use for projects in the National Highway System.¹⁶
 - The Public Buildings Amendments of 1988 requires that each building constructed or altered by GSA or any other federal agency, to the maximum extent feasible, comply with one of the nationally recognized model building and other applicable codes.¹⁷
 - The Cranston-Gonzalez National Affordable Housing Act, as amended, requires the Secretaries of Agriculture and HUD to establish by regulation energy efficiency standards for certain housing (i.e., public housing and homes whose mortgages are insured by HUD's Federal Housing Administration) that meet or exceed the requirements of specified design standards and building codes and, in certain circumstances, to amend the regulation when the standards or codes are revised.¹⁸
 - The Energy Conservation and Production Act, as amended, requires the Secretary of Energy to determine whether each revision of certain model energy codes for residential and commercial buildings would improve energy efficiency.¹⁹ If the Secretary makes an affirmative determination, states have 2 years to certify that they have determined whether it was appropriate to revise their residential building energy code to meet or exceed the revised model code and updated their commercial building energy code to meet or exceed the revised model codes.
 - If a federal agency chooses to use a green building voluntary certification for a covered new building or major renovation, it must meet the certification standards in DOE's regulations.²⁰ The regulations require that the system used to certify the building be developed by an organization that provides an opportunity for developing the system through a consensus-based process and

¹⁶23 C.F.R. § 625.4(d).

¹⁷Pub. L. No. 100-678, § 6(a), 102 Stat. 4049, 4051 (1988) (codified as amended at 40 U.S.C. § 3312(b)).

¹⁸Pub. L. No. 101-625, § 109, 104 Stat. 4079, 4093 (1990) (codified as amended at 42 U.S.C. § 12709).

¹⁹42 U.S.C. § 6833(a)(5)(A), (b)(2)(A).

²⁰79 Fed. Reg. 61563 (Oct. 14, 2014) (codified at 10 C.F.R. pt. 433, 435, 436).

subject to periodic evaluation and assessment of the environmental and energy benefits that result, among other things.

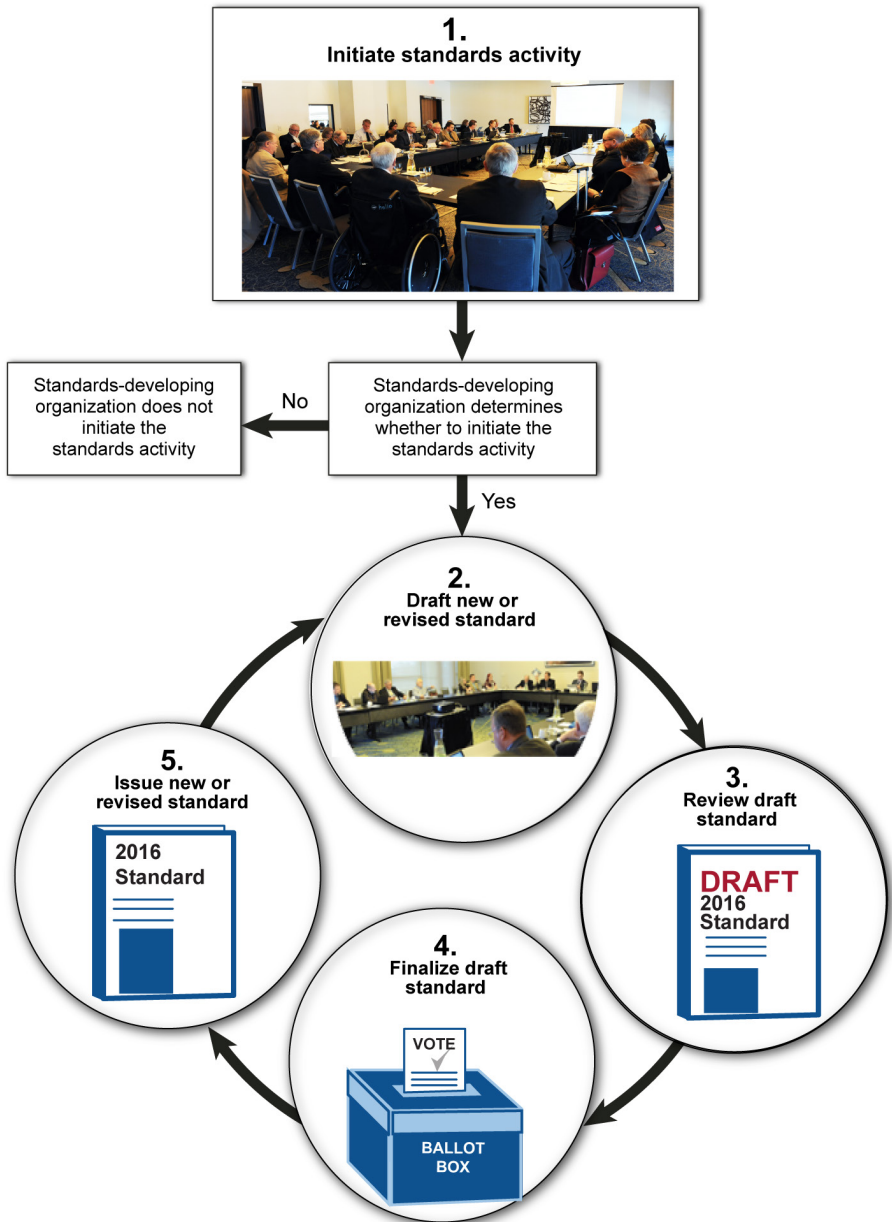
Standards-Developing Organizations Develop Certain Design Standards, Building Codes, and Voluntary Certifications through a Formal, Consensus-Based Process

Standards-developing organizations follow similar, formal, consensus-based processes in the development of American National Standards—which include design standards, building codes, and voluntary certifications. The American National Standards Institute, an organization that accredits standards-developing organizations, established requirements for due process that standards-developing organizations must follow when developing American National Standards.²¹ In 2000, NIST and the American National Standards Institute signed a memorandum of understanding to, among other things, improve communication and coordination among the private and public sector on voluntary standards issues.²² This memorandum recognizes NIST’s responsibility to coordinate standards activities with responsible federal agencies to use voluntary consensus standards to the extent practicable, participate appropriately in their development, and ensure that they meet federal agency needs. It recognizes the American National Standards Institute’s role of accrediting standards developers and approving proposed standards as American National Standards. Standards-developing organizations that plan to develop an American National Standard use a process that may differ in some of the details, such as how to determine consensus, but must follow the principles of due process, including openness; balance of interests; and consensus and the same basic steps, as seen in figure 1.

²¹*American National Standards Institute Essential Requirements: Due Process Requirements for American National Standards* (New York, NY: January 2016). Click [here](#) to access these requirements. The American National Standards Institute may approve standards that accredited standards developers issue according to its essential requirements as American National Standards, including some building codes and standards used for voluntary certification purposes.

²²*Memorandum of Understanding between the American National Standards Institute and NIST* (2000). Click [here](#) to access this memorandum. The memorandum recognized the responsibilities of individual federal agencies as well as the desirability of direct cooperation among standards-developing organizations and any federal agency and does not preempt the responsibility of any federal agency, take away any authority from any federal agency to pursue its legislated regulatory programs, or take precedence over any other memoranda of understanding between American National Standards Institute and any other federal agency.

Figure 1: Generalized Standards-Developing Process



Sources: GAO (analysis); National Institute of Building Sciences, Jocelyn Augustino, photographer © 2016 (photos). | GAO-17-3

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1. **Initiate standards-developing activity.** Members of standards-developing organizations and, in some cases, members of the public may propose to initiate standards activity. Proposals may include information about the need for and anticipated benefits to the public of the new or revised standard, as well as potential costs. The standards-developing organization determines whether to draft a new standard or revise an existing standard. If the standards-developing organization agrees to draft a new standard or revise the existing one, it directs a committee to undertake the activity. The committee may include members of the organization as well as nonmembers—i.e., representatives of companies and nonprofit organizations and government officials with subject-matter expertise who serve on a voluntary basis.
 2. **Draft new or revised standard.** The committee drafts the new or revised standard and seeks public input by notifying members of the standards-developing organization, the American National Standards Institute, and other interested parties.
 3. **Review draft standard.** The committee considers public comments and the views of all interested parties and revises the draft standard.
 4. **Finalize draft standard.** The committee uses a consensus-based process to vote on whether to approve the draft standard. For example, to approve a draft standard, some standards-developing organizations require a supermajority—at least two-thirds—of the members who cast ballots as well as resolution of any negative comments. The standards-developing organization must provide an appeals process for procedural decisions, including whether a technical issue was afforded due process.
 5. **Issue new or revised standard.** If the draft standard is approved, the standards-developing organization issues the new or revised standard and notifies the American National Standards Institute. The committee establishes a schedule for review, generally at least every 5 years.²³ At that time, the standards-developing organization may reaffirm, revise, or withdraw the standard.

²³The American National Standards Institute generally requires standards-developing organizations to revise or reaffirm American National Standards at least every 5 years. However, some standards-developing organizations opt to revise or reaffirm them more frequently. For example, the International Code Council, which publishes building safety and fire prevention codes, revises or reaffirms its codes every 3 years.

Federal Law and Policies Govern the Participation of Agency Officials in the Development of Design Standards, Building Codes, and Voluntary Certifications

Federal law requires agencies to participate in the development of standards when it is in the public interest and is compatible with agency mission, authority, priorities, and budget resources. In addition, NIST is authorized to cooperate with other departments and agencies of the federal government, state and local governments, and private organizations, among other entities, in establishing voluntary consensus standards and codes.²⁴ The Energy Policy Act of 1992 requires DOE to support the upgrading of model building energy codes for new buildings and periodically review their technical and economic basis.²⁵ OMB Circular A-119 encourages federal representatives to participate actively and on an equal basis with other members, consistent with the procedures of the standards bodies, in the standards organization, including in developing and adopting new standards by being fully involved in discussions and technical debates, registering opinions, and serving in leadership positions if selected. OMB Circular A-119 notes that agency representatives should avoid the practice or the appearance of undue influence relating to their participation in standards bodies and activities. The Secretary of Commerce, through NIST, coordinates and fosters the implementation of OMB Circular A-119.

Design Standards, Building Codes, and Voluntary Certifications Play a Role in the Federal Fiscal Exposure to the Effects of Climate Change

In our prior work, we found that decisions regarding how to account for climate change in the design of infrastructure—such as those in design standards, building codes, and voluntary certifications—could affect the federal fiscal exposure. In our February 2015 high-risk update, we noted that, among other things, governmentwide improvement is needed to reduce federal fiscal exposure, since climate change may affect the federal government in various ways, such as through its role as a provider of aid in response to disasters.²⁶ In our past work, we have found that infrastructure is typically designed to operate within past climate conditions. For example, in April 2013, we found that changes in the climate may reduce the useable lifespan of infrastructure like bridges that are expected to last as long as 50 to 100 years because historical weather patterns—in particular, those related to extreme weather—no longer provide reliable predictions for planning purposes.²⁷ Also in our

²⁴15 U.S.C. § 272(b)(10).

²⁵Pub. L. No. 102-486, § 101(a)(2), 106 Stat. 2776, 2785-86 (1992) (codified at 42 U.S.C § 6836).

²⁶GAO, *High-Risk Series: An Update*, [GAO-15-290](#) (Washington, D.C.: Feb. 11, 2015).

²⁷[GAO-13-242](#).

April 2013 report, we found that taking actions to adapt to the effects of climate change—such as raising river or coastal dikes to protect infrastructure from sea level rise, building higher bridges, or increasing the capacity of stormwater systems—may be costly, but that there is a growing recognition that the cost of inaction could be greater.

As a result of the increasing costs of natural disasters, such as Hurricane Sandy, federal agencies, state and local officials, and private-sector entities have begun to acknowledge the role of design standards, building codes, and voluntary certifications in managing the fiscal exposure to extreme weather events and the potential long-term effects of climate change, according to reports and our prior work. For example, in 2013, the Hurricane Sandy Rebuilding Strategy—which identified actions that federal agencies can take to enhance resilient rebuilding—noted that investments now will last for decades, so current construction must be completed to standards that anticipate future conditions and risks.²⁸ In July 2015, we found that some state and city officials in areas affected by Hurricane Sandy have strengthened their building codes to enhance the resilience—the ability to adapt to changing conditions and withstand and rapidly recover from disruption—of communities to future disasters.²⁹ In October 2014, we found that, according to a representative of an insurance industry group, more resilient building codes would help reduce exposure to weather-related risks, including hurricanes, floods, wildfires, hail, and wind storms, which are associated with climate change.³⁰ Further, in May 2014, we found that Department of Defense (DOD) installation planners are unlikely to go beyond current building codes, which could limit their ability to consider climate change in their facility investment decisions.³¹

²⁸Hurricane Sandy Rebuilding Task Force, *Hurricane Sandy Rebuilding Strategy* (August 2013).

²⁹GAO, *Hurricane Sandy: An Investment Strategy Could Help the Federal Government Enhance National Resilience for Future Disasters*, [GAO-15-515](#) (Washington, D.C.: July 30, 2015).

³⁰GAO, *Climate Change: Better Management of Exposure to Potential Future Losses Is Needed for Federal Flood and Crop Insurance*, [GAO-15-28](#) (Washington, D.C.: Oct. 29, 2014).

³¹GAO, *Climate Change Adaptation: DOD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*, [GAO-14-446](#) (Washington, D.C.: May 30, 2014). We found in this report that the building codes and design standards that DOD follows do not account for potential climate change impacts.

Standards-Developing Organizations Have Not Generally Used Forward-Looking Climate Information in Design Standards, Building Codes, and Voluntary Certifications

Standards-developing organizations generally have not used forward-looking climate information in design standards, building codes, and voluntary certifications and instead have relied on historical observations, according to our analysis, reports we reviewed, and representatives of standards-developing organizations we interviewed. Specifically, according to our analysis of documents that standards-developing organizations provided to us, standards, codes, and certifications do not use forward-looking climate information. Reports and representatives of standards-developing organizations stated that such standards, codes, and certifications were generally based on climate information from historical observations. For example, a 2014 report by the National Institute of Building Sciences' Consultative Council on the priorities of the building industry stated that standards and codes are based on the science and experience of the past.³² In a 2011 report, authors from the University of Michigan and the U.S. Green Building Council stated that climate-related decisions for the design of infrastructure are based on historic climate data and past trends.³³ In addition, representatives of standards-developing organizations told us they use climate information based on historical observations in standards, codes, and certifications.

Further, standards-developing organizations vary in whether they update the climate information in design standards, building codes, and voluntary certifications on a regular basis, according to our analysis. Some standards-developing organizations periodically update the climate information they use. For example, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers uses climate information—including average monthly temperatures and various measures of humidity—based on historical data that it updates periodically to balance both long-term and recent climate change trends and incorporate changes in climate as they occur.³⁴ However, other organizations do not regularly update the climate information they use. For example, the International Code Council uses climate zones based on observations of annual precipitation and average temperatures from 1961 through 1990

³²National Institute of Building Sciences, *Moving Forward: Findings and Recommendations from the Consultative Council* (Washington, D.C.: 2014).

³³University of Michigan and U.S. Green Building Council, *Green Building and Climate Resilience: Understanding Impacts and Preparing for Changing Conditions* (2011).

³⁴American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard 169-2013, *Climatic Data for Building Design Standards* (Atlanta, GA: 2013). This standard is based on historical observations, generally from 1982 to 2006.

to specify insulation levels for condensation control and has not updated these observations in 26 years.³⁵ Moreover, the International Association of Plumbing & Mechanical Officials uses rainfall rates from a 1961 federal technical paper for the sizing of stormwater drainage pipes.³⁶

Representatives from the International Code Council told us that the organization may not be updating this information because being able to do so would depend on whether federal agency officials or other participants provide more recent information during the standards-developing process.

Some standards-developing organizations have taken preliminary steps, such as issuing guidance and statements, that may lead to the use of forward-looking climate information in standards, codes, and certifications. For example, in 2015 the American Society of Civil Engineers issued a white paper about adapting engineering practices to a changing climate that recommended, among other things, that engineers work with scientists to better understand future climate extremes to improve the planning and design of infrastructure.³⁷ The American Association of State Highway and Transportation Officials provides guidance on its website to better prepare transportation design managers and engineers for changing climate trends.³⁸ Further, the American Institute of Architects and the National Institute of Building Sciences worked with 19 organizations, including standards-developing organizations, to issue a statement indicating their commitment to, among other things, improving the resilience of infrastructure.³⁹ In a progress

³⁵International Code Council, *2015 International Building Code* (May 2014). Accessed on August 31, 2015, <http://codes.iccsafe.org/app/book/toc/2015/ICodes/2015%20IBC%20HTML/index.html>.

³⁶American National Standards Institute/International Association of Plumbing & Mechanical Officials UPC 1-2015, *Uniform Plumbing Code* (Ontario, CA: Feb. 20, 2015) uses climate information from the Department of Commerce's Weather Bureau, *Technical Paper No. 40, Rainfall Frequency Atlas of the United States, for Duration from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years* (Washington, D.C.: May 1961).

³⁷American Society of Civil Engineers, *Adapting Infrastructure and Civil Engineering Practice to a Changing Climate*, ed. J. Rolf Olsen (Reston, VA: 2015).

³⁸American Association of State Highway and Transportation Officials Subcommittee on Materials, *AASHTO Extreme Weather & The Transportation System*. Click [here](#) to access the guidance, which lists the FHWA climate change adaptation website, available [here](#).

³⁹American Institute of Architects and National Institute of Building Sciences, *Industry Statement on Resilience* (May 13, 2014). Click [here](#) to access the statement. Among the 19 organizations are the American Society of Civil Engineers; the International Code Council; the National Fire Protection Association; and the U.S. Green Building Council.

report on this statement, signatories made initial commitments to develop design standards that are informed by climate data.⁴⁰ In addition, the American Association of State Highway and Transportation Officials is funding a Transportation Research Board project to develop tools that hydraulic engineers could use to account for climate change in their designs.⁴¹

Some standards-developing organizations also encourage the use of forward-looking climate information on a more limited basis. For example, the U.S. Green Building Council has offered an optional pilot credit for its voluntary certification that encouraged the use of forward-looking climate information.⁴² The U.S. Green Building Council suggested various sources for forward-looking climate information, including (1) local climate change studies, if available; (2) consultation with climate scientists; or (3) U.S. regional predictions based on information available from EPA, NOAA, FEMA, and the USGCRP. In addition, the Green Building Initiative, a different standards-developing organization, includes the EPA National Stormwater Calculator as a possible information source for its voluntary certification.⁴³ The calculator allows users to consider future climate change scenarios to demonstrate performance for the voluntary certification. Further, representatives from the Green Building Initiative told us that they may add references to forward-looking climate

⁴⁰American Institute of Architects and the National Institute of Building Sciences, *Preparing to Thrive: The Building Industry Statement on Resilience* (May 10, 2016). Accessed on May 10, 2016. <http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab108838.pdf>.

⁴¹National Research Council, Transportation Research Board, NCHRP 15-61, *Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure*. For additional information on this research project, click [here](#). The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

⁴²According to a representative from the U.S. Green Building Council, the organization is currently analyzing projects that applied for this pilot credit and may offer it again in the future. Pilot credits are a testing area for new ideas in LEED.

⁴³The calculator is a desktop application that estimates the amount of stormwater runoff from a specific site on the basis of local soil conditions, slope, land cover, and historical rainfall records.

information in their voluntary certification to address the Council on Environmental Quality's recently updated *Guiding Principles*.⁴⁴

Reports and Representatives of Standards-Developing Organizations Identified Institutional and Technical Challenges to Using Forward-Looking Climate Information

Standards-developing organizations face institutional and technical challenges to using the best available forward-looking climate information in design standards, building codes, and voluntary certifications, according to reports we reviewed and representatives of these organizations and federal officials we interviewed.

Institutional Challenges

Institutional challenges to using forward-looking climate information in design standards, building codes, and voluntary certifications include a standards-developing process that (1) must balance various interests and (2) can be decentralized and slow to change, according to reports we reviewed and representatives of standards-developing organizations we interviewed. First, with regard to the challenge of balancing various interests, as stated in GSA's 2014 climate change risk-management plan, it is unlikely that building codes will meet the needs for site-specific climate resistant design of buildings in a timely way because of the rapidly changing climate and the divergent motivations and beliefs of stakeholders that participate in the code development process.⁴⁵

⁴⁴Council on Environmental Quality, *Guiding Principles for Sustainable Federal Buildings and Associated Instructions* (Washington, D.C.: February 2016). The *Guiding Principles* direct agencies constructing new federal buildings to identify projected climate change impacts and consider these projections in the design of their projects. For certain existing buildings, the *Guiding Principles* direct agencies to assess and consider climate change risk and take action to mitigate risk considering mission criticality, potential climate change impacts, security, and cost.

⁴⁵General Services Administration, *FY 2014 Climate Change Risk Management Plan* (Washington, D.C.: June 30, 2014).

Representatives of some standards-developing organizations told us that the various interests of their members drive their process. For example, representatives of one standards-developing organization told us that their members have not expressed interest in standards that use forward-looking climate information because it would require increased upfront construction costs. Representatives of two other standards-developing organizations noted that in some cases their standards are for equipment with a relatively short life-cycle—as little as 10 to 15 years—so they would not realize appreciable benefits from increased resilience.

Second, design standards and building codes can be slow to change, as stated in a 2015 report on adapting infrastructure to climate change by the American Society of Civil Engineers.⁴⁶ Representatives of some standards-developing organizations told us that the process they follow to develop their standards is decentralized and can be slow to change. For example, they stated that they cannot use forward-looking climate information unless someone submits a proposal that includes forward-looking climate information and their members reach consensus to approve the proposal. Further, representatives of two standards-developing organizations told us they reference climate information from other standards-developing organizations in their standards, so it would be difficult for them to unilaterally begin to use forward-looking climate information. In addition, representatives of other standards-developing organizations told us that standards and codes are by their nature stable and slow to change. For example, representatives of one standards-developing organization stated that code development is a conservative process and does not accept change easily, and representatives from another standards-developing organization stated that following the consensus process takes time.

⁴⁶*Adapting Infrastructure and Civil Engineering Practice to a Changing Climate.*

Technical Challenges

Technical challenges to using forward-looking climate information include difficulty (1) identifying the best available forward-looking climate information and (2) incorporating it into design standards, building codes, and voluntary certifications, according to reports, federal officials, and representatives of standards-developing organizations. First, with respect to identifying the best available forward-looking climate information, authors from the University of Michigan and the U.S. Green Building Council noted a lack of connection between climate change research and the design of infrastructure in their 2011 report.⁴⁷ Further, participants in our July 2015 *Comptroller General's Forum on Preparing for Climate-Related Risks: Lessons from the Private Sector* stated that the absence of consistent, authoritative climate information made it hard for private-sector entities to consider climate information in planning.⁴⁸

Representatives of some standards-developing organizations told us they had difficulties identifying the best available forward-looking climate information models. For example, representatives of one standards-developing organization stated that they are not aware of updated tools—such as interactive web-based projections of flood hazards for particular locations—or forward-looking climate information from the last 4 or 5 years. In addition, representatives of some standards-developing organizations told us that they could not identify forward-looking climate information with sufficient specificity. For example, representatives of one standards-developing organization stated that they need forward-looking climate information for a site-specific project area rather than at the country or state level, which is what is available from climate models. Representatives of another standards-developing organization stated that they needed additional detailed information, such as whether any projected increased precipitation would occur evenly throughout the year or in concentrated bursts.

Second, it can be difficult to incorporate forward-looking climate information into planning decisions, such as those involved in developing design standards, building codes, and voluntary certifications, according to reports, including the *Third National Climate Assessment*, and USGCRP officials.⁴⁹ For example, in 2014, the Transportation Research

⁴⁷ *Green Building and Climate Resilience: Understanding Impacts and Preparing for Changing Conditions*.

⁴⁸ GAO, *Highlights of a Forum, Preparing for Climate-Related Risks: Lessons from the Private Sector*, [GAO-16-126SP](#) (Washington, D.C.: Nov. 19, 2015).

⁴⁹ *Climate Change Impacts in the United States: The Third National Climate Assessment*.

Board found that climate models do not generally provide climate information that is directly usable in design—they require some translation or derivation—because, for example, they do not account for seasonal or spatial variability.⁵⁰ USGCRP officials told us that it may be difficult for standards-developing organizations to move from using historical observations, such as average summer heating degree days, to model projections on the basis of a variety of assumptions.⁵¹ Representatives of one standards-developing organization told us that climate models provide a wide range of possible temperatures that is difficult to use in their standards because the technical committee does not know how to reflect this variability. In addition, representatives of some standards-developing organizations told us that it is difficult to reconcile the dynamic nature of climate change with the stable framework of infrastructure design. Moreover, representatives of some standards-developing organizations stated that they do not have such expertise in-house and would have to rely on outside experts to provide forward-looking climate information during the standards-developing process. Representatives of another organization stated that using forward-looking climate information would increase the complexity of their voluntary certification and could deter potential users.

⁵⁰Transportation Research Board, National Cooperative Highway Research Program, Report 750, *Strategic Issues Facing Transportation, Volume 2, Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report* (Washington, D.C.: 2014).

⁵¹As noted in the *Third National Climate Assessment*, while uncertainties limit scientists' ability to predict the future changes in climate, scientists can develop plausible projections of what might happen under a given set of assumptions, such as population, energy sources, technology, and atmospheric levels of carbon dioxide.

Agencies Have Initiated Some Actions and Could Take More to Help Address Challenges, According to Reports, Standards-Developing Organizations, and Agency Officials

Federal agencies have initiated some actions to help standards-developing organizations address institutional and technical challenges to using forward-looking climate information. Moreover, according to reports we reviewed, our prior work, and representatives of some standards-developing organizations and agency officials we interviewed, agencies have opportunities to take additional actions. These sources also indicated that taking further actions to address these challenges could present an additional benefit by reducing the federal fiscal exposure.

Agencies Have Initiated Some Actions that Could Help Standards-Developing Organizations Address Institutional and Technical Challenges

Federal agencies have initiated some actions that could help standards-developing organizations address institutional and technical challenges to using forward-looking climate information. Officials from USGCRP and from some federal agencies, including DOT and NOAA, told us they have initiated efforts to coordinate with other federal agencies to provide the best available forward-looking climate information to standards-developing organizations. For example, DOT and NOAA officials told us that they participate in the Mitigation Framework Leadership Group (MitFLG), which, since 2013, has coordinated federal, state, and local government efforts to mitigate the impact of hazards, including natural disasters. Further, officials from NOAA told us they provided information on their Digital Coast tools, including the Sea Level Rise Viewer, to a standards-developing organization at its request, and that they generally make these and other tools publicly available.⁵² Officials from EPA stated that they consulted with a standards-developing organization to develop a tool that provides forward-looking climate information to water utility owners and operators and helps them assess the related climate risks at their individual utilities, but that they have not directly provided this information to standards-developing organizations.⁵³

Officials from FEMA and NIST told us they have taken actions to help make design standards, building codes, and voluntary certifications more resilient to natural disasters. For example, in response to a proposal from FEMA, the 2015 International Code Council residential building code increased the minimum required building elevation above the 100-year flood plain by 1 foot. FEMA officials told us that they proposed this change because they determined it would be cost-effective under current climate conditions. Furthermore, in November 2015, MitFLG—which FEMA chairs—issued a draft implementation strategy that seeks to encourage federal support for more resilient standards and codes, but the strategy does not specifically focus on using forward-looking climate information.⁵⁴ In 2015, NIST convened the Community Resilience Panel for Buildings and Infrastructure Systems, which seeks to, among other things, identify gaps in standards and codes to make infrastructure more

⁵²NOAA's Sea Level Rise Viewer can be found [here](#). It is a web mapping tool for visualizing community-level impacts from coastal flooding or sea level rise.

⁵³Environmental Protection Agency, Office of Water, *Climate Resilience Evaluation and Awareness Tool, Version 3.0, Methodology Guide* (Washington, D.C.: May 2016).

⁵⁴MitFLG, *Draft Implementation Strategy for Increasing Disaster Resilience through Federal Support for Building Code Adoption & Enforcement* (Nov. 24, 2015).

resilient to extreme weather and other risks. The President's 2013 Climate Action Plan recognized the panel's role in helping to improve the resilience of infrastructure, although NIST officials told us that the panel does not currently focus on addressing potential climate change effects.⁵⁵

Opportunities Exist for Federal Agencies to Take Additional Actions, According to Reports, Representatives of Standards-Developing Organizations, and Agency Officials

According to reports we reviewed, our prior work, and representatives of some standards-developing organizations and federal agency officials we interviewed, opportunities exist for agencies to take additional actions that may help address the challenges standards-developing organizations face to using forward-looking climate information. Specifically, according to these sources, federal agencies with a role in coordinating, developing, and adopting standards, codes, and certifications or assessing and responding to climate-related issues could help address the challenges standards-developing organizations face by taking two types of actions. First, agencies could improve interagency coordination to address institutional challenges. Second, agencies could provide the best available forward-looking climate information to standards-developing organizations to help address their technical challenges. In addition, helping standards-developing organizations address these challenges could present opportunities to reduce federal fiscal exposure to the effects of climate change, according to federal agency officials, our prior work, and reports we reviewed.

Improving Interagency Coordination to Help Address Institutional Challenges

Federal agencies with a role in coordinating, developing, and adopting standards, codes, and certifications or assessing and responding to climate-related issues could improve interagency coordination to help address the institutional challenges standards-developing organizations face, according to reports we reviewed, our prior work, and representatives of standards-developing organizations and federal agency officials we interviewed. For example, a 2015 report from the National Institute of Building Sciences' Consultative Council on the priorities of the building industry found that efforts to improve resilience, such as incorporating anticipated climate change effects into design standards and building codes, would benefit from a coordinated effort

⁵⁵Executive Office of the President, *President's Climate Action Plan* (Washington, D.C.: June 2013).

among federal agencies that address climate-related issues.⁵⁶ Further, a 2012 National Academies report found that the roles and responsibilities for improving the resilience of buildings are not coordinated by the federal government, either through a single agency or authority, or through a unified vision.⁵⁷ This report stated that a national vision could be a more effective approach to encouraging resilience. Also, in November 2015, we found that providing climate information is an inherently interagency activity that relies on the cooperation and shared resources of many agencies, but interagency coordination is weak by design.⁵⁸ In that report we found that agency climate programs were created to meet individual agency missions and are not necessarily focused on the needs of other decision makers.

Both representatives of standards-developing organizations and federal agency officials we interviewed recognized the need for improved coordination to address institutional challenges to using climate information in design standards, building codes, and voluntary certifications. Representatives of several standards-developing organizations stated that improved coordination among federal agencies could help increase the legitimacy and visibility of efforts to use forward-looking climate information in standards, codes, and certifications. GSA's March 2016 standards for government-owned and -leased buildings noted that federal leadership is essential—especially for buildings that are vulnerable to climate change and critical to the public good—because building codes do not consider climate change.⁵⁹ Emphasizing the key role for the federal government, OMB officials stated that standards and codes are critically important to planning for climate change and that proactive federal engagement with standards-developing organizations is necessary. In addition, USGCRP officials stated that there is a need for conversations among a coordinated group of federal agencies and standards-developing organizations to help address the institutional challenges these organizations face.

⁵⁶*Moving Forward: Findings and Recommendations from the Consultative Council* (2015).

⁵⁷The National Academies, Committee on Increasing National Resilience to Hazards and Disasters; Committee on Science, Engineering, and Public Policy, *Disaster Resilience: A National Imperative* (Washington, D.C.: 2012).

⁵⁸[GAO-16-37](#).

⁵⁹General Services Administration, *PBS-100, Facilities Standards for the Public Buildings Service* (Washington, D.C.: March 2016).

Federal policy directs agency standards executives—senior-level officials who coordinate agency participation in standards organizations—to coordinate their views on matters of paramount importance when they participate in the same standards activities. The President has also established a council to, among other things, coordinate interagency efforts on priority federal government actions related to climate preparedness and resilience. First, OMB Circular A-119 directs agency standards executives to coordinate their views on matters of paramount importance when they participate in the same standards activities so as to present, whenever feasible, a single, unified position, and where not feasible, a mutual recognition of differences.⁶⁰ OMB Circular A-119 also directs the Secretary of Commerce, who has delegated this responsibility to NIST, to coordinate and foster executive branch implementation of the Circular, which addresses federal participation in the development and use of voluntary consensus standards, and to sponsor, support, and chair the Interagency Committee on Standards Policy (ICSP). According to the ICSP charter, the objective of the ICSP is to help foster cooperative participation by the federal government, among others, in standards activities. The ICSP coordinates with a view to encouraging more effective federal participation in the development of standards, among other things. Second, acknowledging that the management of climate change risks requires deliberate preparation, close cooperation, and coordinated planning by the federal government, Executive Order 13653 established the interagency Council on Climate Preparedness and Resilience.⁶¹ The Council is to, among other things, (1) coordinate interagency efforts on priority federal government actions related to climate preparedness and resilience and (2) facilitate the integration of climate science in policies and planning of government agencies and the private sector. In 2016, the Council issued a report, noting that with respect to integrating climate resilience into agencies' missions,

⁶⁰OMB Circular A-119 directs the heads of agencies that use standards for regulatory, procurement, or other mission-related activities to designate a senior-level official as the agency standards executive who will be responsible for the agency's implementation of this Circular, among other duties.

⁶¹Executive Order 13653, *Preparing the United States for the Impacts of Climate Change* (Washington, D.C.: Nov. 1, 2013). Officials from the Executive Office of the President—the Chair of the Council on Environmental Quality, the Director of the Office of Science and Technology Policy, and the Assistant to the President for Homeland Security and Counterterrorism—co-chair the interagency Council on Climate Preparedness and Resilience.

operations, and culture, strong coordination across the federal government creates the best outcomes.⁶²

Officials from the Executive Office of the President and federal agencies told us that they have not specifically coordinated efforts to help standards-developing organizations use the best available forward-looking climate information. Officials from USGCRP and the Office of Science and Technology Policy also stated that interagency coordination is unlikely to produce new climate analyses that depart from agency missions. NIST officials stated that they coordinate other governmentwide activities related to standards, codes, and certifications—for example, the ICSP serves as a forum for federal agencies to share best practices. NIST officials also told us that they coordinate the federal use of standards but they do not have the authority to coordinate federal agencies' participation in the standards-developing process.⁶³ However, as we noted above, OMB Circular A-119 directs the Secretary of Commerce to coordinate and foster executive branch implementation of the Circular, which addresses federal participation in the development of voluntary consensus standards, among other things. Moreover, NIST is authorized to cooperate with other federal agencies, among other entities, in establishing voluntary consensus standards and codes.

Providing the Best Available Forward-Looking Climate Information to Help Address Technical Challenges

Federal agencies that participate in the standards-developing process and respond to climate-related issues could help address technical challenges by providing the best available forward-looking climate information for consideration in the standards-developing process, according to reports we reviewed, our prior work, and representatives of some standards-developing organizations and federal agency officials we interviewed. For example, in November 2014, the State, Local, and Tribal

⁶²Council on Climate Preparedness and Resilience, *Opportunities to Enhance the Nation's Resilience to Climate Change* (Washington, D.C.: October 2016).

⁶³This is not consistent with the memorandum of understanding NIST entered into with the American National Standards Institute in 2000, which states that NIST's role under the NTTAA and OMB Circular A-119 is to, among other things, coordinate federal activities in voluntary standards. Moreover, the memorandum of understanding states that NIST coordinates standards activities with responsible government agencies to participate appropriately in the development of voluntary standards, among other things.

Leaders Task Force on Climate Preparedness and Resilience reported that the greatest need is often not the creation of new data or information but assistance and tools for decision makers to navigate the wide array of resources already available.⁶⁴ The Task Force also recommended that the federal government help establish standards for climate resilience in infrastructure, thus encouraging their adoption by the private sector, other levels of government, and nongovernmental organizations. Similarly, we found in November 2015 that federal technical assistance could help decision makers access, translate, and use climate information.⁶⁵ In April 2013, we found that the federal government plays a critical role in producing the information needed to facilitate a more informed response to the effects of climate change.⁶⁶ However, in this report we stated that this information exists in an uncoordinated confederation of networks and is not easily accessible. Representatives of some standards-developing organizations told us that federal agencies have the expertise and resources to identify and help incorporate the best available forward-looking climate information in standards, codes, and certifications. For example, representatives of some standards-developing organizations we interviewed stated that USGCRP agencies could work with standards-developing organizations to provide forward-looking climate information. Representatives of one standards-developing organization stated that federal agencies could provide, for example, projections of snow levels, minimum and maximum temperatures, storm surges, and coastal wind speeds. OMB officials and representatives of some standards-developing organizations stated that federal efforts would be more effective if agencies worked directly with standards-developing organizations rather than making information and tools publicly available.

Federal law requires federal agencies to participate in the standards-developing process under certain circumstances. As required by the NTTAA and consistent with OMB Circular A-119, federal agencies must consult with standards-developing organizations and participate in the

⁶⁴The State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience, *Recommendations to the President* (Washington, D.C.: November 2014). The Task Force on Climate Preparedness and Resilience was established by Executive Order 13653 and included 26 governors, mayors, county officials, and tribal leaders. It was tasked with providing recommendations to the President and an interagency council on how the federal government can support state, local, and tribal resilience to climate change, among other things.

⁶⁵[GAO-16-37](#).

⁶⁶[GAO-13-242](#).

development of technical standards when such participation is in the public interest and compatible with the agencies' missions, authorities, priorities, and budget resources. Federal policies also direct agencies to mitigate the effects of natural disasters, including by communicating and using the best available localized climate projections, and to help translate climate science for risk-management decision making. Specifically, the *National Mitigation Framework* states, among other things, that reducing long-term vulnerability can include adopting and enforcing hazard-resistant design standards and building codes.⁶⁷ It identifies as a critical task for improving community resiliency the communication and use of the best available localized climate projections so that the public and private sectors can make informed decisions. In addition, OMB Circular A-11, which provides guidance on the preparation and execution of the President's budget, directs agency proposals for construction of federal facilities to comply with relevant guidance on climate change.⁶⁸ Further, USGCRP's 2012 strategic plan calls on USGCRP to assist in the translation of science for societal benefit and related risk-management decision making.⁶⁹ It also notes that it will be critical for USGCRP to build new partnerships with engineers, architects, and planners and their supporting federal agencies because of the vulnerability of infrastructure to the effects of climate change.

Officials from some federal agencies, including FEMA, and USGCRP told us that they have provided forward-looking climate information to standards-developing organizations to a limited extent because they do not have clear direction to do so. FEMA officials told us that although MitFLG has coordinated federal, state, and local government hazard mitigation efforts, it does not have any measures that focus on providing forward-looking climate information to standards-developing organizations. Officials from USGCRP told us that they need to improve their understanding of the information needs of standards-developing organizations in order to take them into account for USGCRP research and product development. Further, officials from USGCRP told us that

⁶⁷Department of Homeland Security, *National Mitigation Framework* (Washington, D.C.: May 2013). The *National Mitigation Framework* establishes a forum for coordinating and addressing how the nation manages risk through mitigation capabilities.

⁶⁸Office of Management and Budget, Circular A-11, *Preparation, Submission, and Execution of the Budget* (Washington, D.C.: July 1, 2016).

⁶⁹U.S. Global Change Research Program, *The National Global Change Research Plan 2012-2021, A Strategic Plan for the U.S. Global Change Research Program* (Washington, D.C.: Apr. 2, 2012).

they are beginning to engage the civil engineering community, including standards-developing organizations, in this discussion. Such engagement is consistent with USGCRP's strategic plan, which notes that it will be critical for USGCRP to build new partnerships with engineers, architects, and planners because of the vulnerability of infrastructure to the effects of climate change. However, officials also noted that USGCRP assists many users and sectors and does not have the practical or financial capacity to provide detailed, tailored analyses for each sector. NIST officials told us that they have not provided forward-looking climate information to standards-developing organizations for various reasons, including because they have not conducted research on the way climate change may impact design standards. These officials stated that their research focuses on improving the resilience of communities to a variety of disruptive events but leaves it to the communities to decide for themselves what the appropriate levels of risk, mitigation, and response should be, given their local resources. However, by consulting with MitFLG and USGCRP, NIST could help coordinate a governmentwide effort to provide the best available forward-looking climate information to standards-developing organizations for consideration in the development of design standards, building codes, and voluntary certifications.

Helping Standards-Developing Organizations Address Challenges Presents a Benefit by Reducing the Federal Fiscal Exposure to the Effects of Climate Change

Helping standards-developing organizations consider forward-looking climate information in the development of voluntary consensus standards that promote the safety, reliability, productivity, and efficiency of infrastructure presents an additional benefit by reducing the federal fiscal exposure, according to federal agency officials, our prior work, and reports we reviewed. First, helping standards-developing organizations could help increase the efficiency and consistency of federal efforts to mitigate the risk that climate change poses to federal facilities. For example, GSA officials told us that the use of forward-looking climate information in developing standards and codes would help mitigate much of the climate risk to their facilities (i.e., government-owned and -leased buildings), lessening the need for the resource-intensive screenings that GSA currently conducts. Specifically, GSA officials stated that they are screening fiscal year 2017 capital building projects for climate risk in an effort to reduce or eliminate emergency response costs over the lifespan of the new buildings. GSA's climate risk screen uses forward-looking climate information from the *Third National Climate Assessment* to consider—for each new building—the importance of the project to the

mission of the agency, expected service life, historic or cultural status, and whether the building is vulnerable to projected changes in the climate.⁷⁰ Second, as previously noted, federal, state, local, and private-sector decision makers use the design standards, model building codes, and voluntary certifications that standards-developing organizations issue to plan and construct infrastructure that may be paid for with federal funds, insured by federal programs, or eligible for federal disaster assistance—key aspects of federal fiscal exposure to climate change. For example, in 2015, the National Institute of Building Sciences' Consultative Council reported that communities need standards and codes that can help them recognize the risks associated with a changing climate and prevent disruptive hazards from becoming disasters.⁷¹ Similarly, in 2014, the State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience reported that anticipating and planning for climate change impacts now—including through the standards and codes that communities adopt—can reduce harm and long-term costs.⁷²

Conclusions

Extreme weather costs the federal government billions of dollars each year and poses a significant risk to infrastructure, such as buildings, roads, and power lines that provides essential services to the American public. Ongoing and future changes to the climate have the potential to compound these risks and increase federal fiscal exposure. Design standards, building codes, and voluntary certifications play a role in ensuring the resilience of federal and nonfederal infrastructure to the effects of natural disasters and extreme weather but generally use climate information based on historical observations. We have previously found that using the best available climate information, including forward-looking projections, can be a part of a risk-management strategy for federal, state, local, and private-sector decisions and investments. However, standards-developing organizations, not federal agencies, are the primary source for standards, codes, and certifications that specify how weather and climate information is considered in infrastructure planning. These

⁷⁰GSA officials told us that they develop a climate profile for every capital project for which they require a climate screen. To do so, they use climate projections based on the Representative Concentration Pathway 8.5, which roughly corresponds to a continuation of global emissions increases. They stated that they chose these projections to better understand the extreme values of climate variables, upper limits of adaptation, and impacts that they can avoid through adaptation.

⁷¹*Moving Forward: Findings and Recommendations from the Consultative Council* (2015).

⁷²*Recommendations to the President*.

organizations face institutional and technical challenges to using forward-looking climate information, and federal agencies have initiated actions that could help them address these challenges. For example, NIST convened a panel to, among other things, identify gaps in standards and codes to make infrastructure more resilient to extreme weather and other risks. Various reports we reviewed and representatives of standards-developing organizations and agency officials we interviewed identified additional actions federal agencies could take to help standards-developing organizations use forward-looking climate information. Some agencies, such as GSA, are beginning to consider the risk climate change poses to their infrastructure, but these efforts are done on a case-by-case basis. Taking a coordinated, governmentwide approach could present an additional benefit by reducing federal fiscal exposure. Given NIST's statutory authority and role in coordinating implementation of OMB Circular A-119, it is well-positioned to convene federal agencies for such an effort.

Recommendation for Executive Action

To help reduce federal fiscal exposure by enhancing the resilience of infrastructure to extreme weather, we recommend that the Secretary of Commerce, through the Director of NIST, in consultation with MitFLG and USGCRP, convene federal agencies for an ongoing governmentwide effort to provide the best available forward-looking climate information to standards-developing organizations for their consideration in the development of design standards, building codes, and voluntary certifications.

Agency Comments and Our Evaluation

We provided the Department of Commerce, DHS, and the Office of Science and Technology Policy with a draft of this report for comment. The Department of Commerce neither agreed nor disagreed with our recommendation and provided written comments, which are summarized below and reproduced in appendix II. DHS did not provide written comments. The Office of Science and Technology Policy did not provide official written comments, but, along with OMB and USGCRP, provided technical comments, which we incorporated as appropriate.

In its response, the Department of Commerce stated that it strongly supports efforts to foster greater and more effective participation by federal agencies in the development of consensus standards for climate resilience in infrastructure and other areas. However, the Department of Commerce stated that GAO's recommendation that NIST coordinate a governmentwide effort to deliver the best available climate change information to standards-developing organizations is inconsistent with NIST's well-established role in the voluntary consensus standards-developing process. Specifically, it noted that NIST does not have the necessary expertise to play the role of arbiter of what climate information is "best." We agree that NIST should not play the role of arbiter of what climate information is "best," which is why we recommended that NIST coordinate the governmentwide effort to provide the best available forward-looking climate information to standards-developing organizations in consultation with MitFLG and USGCRP. As we found in our 2015 report on climate information, reducing the risks and realizing the opportunities of climate change require making good decisions based on reliable and appropriate information about past, present, and future climate, as well as properly integrating that information into the decision-making process.⁷³ That 2015 report also found that the federal government has a key role in providing authoritative climate information to meet the needs of federal, state, local, and private-sector decision makers. USGCRP, in particular, is well-positioned to perform this role and has the necessary expertise to identify the best available forward-looking climate information because, as we noted in our report, it coordinates global change research across 13 federal agencies.

The Department of Commerce further noted that NIST could—consistent with its mission and authority—convene stakeholders, including federal agencies, to discuss forward-looking climate information for potential use by the standards community. Our recommendation reflected that NIST is the entity responsible for coordinating executive branch implementation of OMB Circular A-119, which governs federal participation in the development and use of voluntary consensus standards. However, in response to the Department of Commerce's comments, we clarified our recommendation to better reflect its views of NIST's mission and authority. The Department of Commerce also provided technical comments, which we incorporated as appropriate.

⁷³[GAO-16-37](#).

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to appropriate congressional committees; the Secretary of Commerce; the Secretary of Homeland Security; the Director of the Office of Science and Technology Policy; and other interested parties. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or gomezj@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.

Sincerely yours,

A handwritten signature in black ink that reads "Alfredo Gomez". The signature is written in a cursive style with a large, stylized initial "A" and "G".

J. Alfredo Gomez
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

Our objectives were to examine (1) what is known about the use of forward-looking climate information in design standards, building codes, and voluntary certifications; (2) challenges, if any, that reports and representatives of standards-developing organizations identified to using forward-looking climate information; and (3) any actions that federal agencies have taken to help address these challenges and additional actions, if any, that reports, representatives of standards-developing organizations, and agency officials identified.

To address our audit objectives, we reviewed reports by selected standards-developing organizations, federal agencies, and experts in the development and use of standards and climate change that we identified through scoping interviews and prior work. We also conducted interviews with representatives of standards-developing organizations and agency officials. We focused on standards-developing organizations that develop design standards, building codes, and voluntary certifications in four infrastructure sectors: energy, government facilities, transportation systems, and water and wastewater systems. These sectors provide cities, neighborhoods, and buildings with essential services; permit movement and connection; and are components of critical infrastructure, according to the Department of Homeland Security's 2013 National Infrastructure Protection Plan. We identified standards-developing organizations through interviews with academics, subject-matter experts, and representatives of professional societies, as well as through our prior work. We selected 17 organizations that develop such standards, codes, and certifications for which climate information is relevant. For example, they incorporate or reference information about the intensity, duration, and frequency of precipitation, average daily temperatures, or flood hazards. A majority of the standards-developing organizations we selected—14 of 17—are accredited by the American National Standards Institute or similarly follow an open, consensus-based process to develop their standards, codes, or certifications. We asked each of the representatives of organizations we interviewed whether there were other organizations we should contact and adjusted our list as needed. While the standards-developing organizations we selected do not represent all organizations that develop standards, codes, and certifications in the infrastructure sectors on which we focused, they include all the major standards-developing organizations within the sectors that met our selection criteria. Table 1 lists the organizations we reviewed and the areas of focus—the scope and purpose—of their design standards, building codes, and voluntary certifications.

Table 1: Selected Standards-Developing Organizations and the Areas Their Design Standards, Building Codes, and Voluntary Certifications Focus On

Organization	Areas of focus of design standards, building codes, and voluntary certifications
1. Air Conditioning Contractors of America Association	Design, installation, operation, maintenance, and repair of heating, ventilating, air conditioning, and refrigeration systems
2. American Association of State Highway and Transportation Officials	Highway and street geometric design
3. American Society of Civil Engineers	General structural design
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers	Design, planning, and sizing of building energy systems and equipment
5. American Society for Testing and Materials International ^a	Characteristics and performance of materials, products, systems, and services
6. American Water Works Association	Reliability, life, and usage in the water profession
7. Green Building Initiative	Emissions Energy Indoor environment Project and environmental management Resources Site Water
8. Home Innovation Research Labs	Design, assembly, construction, inspection, maintenance, and performance of residential sites, dwellings, and facilities; light commercial construction; and building products, components, or systems
9. Institute of Electrical and Electronics Engineers ^a	Electrical, electronics, radio, and related engineering
10. Institute for Sustainable Infrastructure	Climate and risk Leadership Natural world Quality of life Resource allocation

Appendix I: Objectives, Scope, and Methodology

Organization	Areas of focus of design standards, building codes, and voluntary certifications
11. Insurance Institute for Business & Home Safety	Burglary Electrical surge Flood Hail Hurricane/high wind Internal fire Seismic Severe winter weather Tornado Water loss Wildfire
12. International Association of Plumbing & Mechanical Officials	Composition, dimensions, and properties of materials, fixtures, devices, and equipment used in plumbing or mechanical systems
13. International Code Council	Building construction
14. International Living Future Institute	Beauty Energy Equity Health and happiness Materials Place Water
15. National Electrical Manufacturers Association ^a	Connectors for electrical utility transmission Overhead and underground distributions and substations
16. National Fire Protection Association	Fire, electrical, and building safety
17. U.S. Green Building Council	Energy and atmosphere Indoor environmental quality Innovation Integrative process Location and transportation Materials and resources Sustainable sites Water efficiency

Source: GAO analysis of data from selected standards-developing organizations. | GAO-17-3

^aThese standards-developing organizations provided minimal responses and did not respond to follow-up requests. We included their responses as appropriate.

To address our first objective, we reviewed reports by standards-developing organizations and subject-matter experts and documents that standards-developing organizations provided to us. For example, standards-developing organizations provided us with examples of one or

more standards, codes, or certifications that referenced climate information such as average temperatures or rainfall rates to show how this information is typically used. We interviewed representatives of these organizations using semi-structured interview techniques, including a mixture of both open-ended and closed-ended questions. Some of the questions in our interviews were about the organizations' use of historical observations and forward-looking climate information and other actions they may have taken to consider how climate change may affect their standards, codes, and certifications. In this report, we defined "use forward-looking climate information" to mean that the standards-developing organization specified a particular source or sources of data and required their use in order to meet the design standard or building code or to earn the voluntary certification. Similarly, to address our second objective, we reviewed reports by standards-developing organizations, federal agencies, and subject-matter experts. Other questions in our interviews with representatives of standards-developing organizations, as seen above, were aimed at identifying any challenges they face and steps they plan, if any, to address these challenges.

To address our third objective, we identified and analyzed federal laws, policies, and reports relevant to federal use of design standards, building codes, and voluntary certifications; preparedness for natural disasters; and potential responses to the effects of climate change on infrastructure. These laws, policies, and reports included the National Technology Transfer and Advancement Act of 1995, as amended; Office of Management and Budget (OMB) Circulars A-11 and A-119; Executive Order 13653; and the *National Mitigation Framework*. We also examined our prior work on the federal response to climate change, federal green buildings, and response to natural disasters. As part of our interviews with representatives of standards-developing organizations, described above, we asked them to identify the types of federal actions that could help address any challenges they face. We also interviewed officials from agencies and entities with a role in coordinating, developing, and adopting standards, codes, and certifications; assessing the impacts of climate change; or helping to coordinate the federal government response to climate change to identify any actions they have taken and any additional actions they could take. These agencies and entities were the Department of Commerce's National Institute of Standards and Technology and National Oceanic and Atmospheric Administration; the Department of Energy; the Department of Homeland Security's Federal Emergency Management Agency; the Department of Housing and Urban Development; the Department of Transportation; the Environmental Protection Agency; and the General Services Administration and, within

the Executive Office of the President, the Council on Environmental Quality, the National Security Council, OMB, the Office of Science and Technology Policy, and the U.S. Global Change Research Program.

We analyzed standards-developing organizations' responses to our interview questions and other information to identify the actions these organizations have taken to use forward-looking climate information, any challenges they face in doing so, and any actions that federal agencies have taken, and additional actions they could take, if any, to help address these challenges. We identified categories of challenges and agency actions on the basis of scoping interviews with academics and subject-matter experts, reports, and our analysis of the interviews with representatives of standards-developing organizations and federal agency officials. These categories encompassed a majority of the challenges and actions we identified and were mutually exclusive. We categorized challenges as either institutional or technical. Categories of federal actions were improving coordination of federal efforts to help standards-developing organizations use the best available forward-looking climate information and providing such information for consideration in the standards-developing process. We did not report on challenges and actions that did not fit within the categories we developed because they were generally outside the scope of our review. For example, some challenges and federal actions were related to the adoption and enforcement of design standards and building codes. We compared relevant federal laws, policies, and reports with the actions that federal agencies have taken and could take that, according to reports we reviewed and representatives of standards-developing organizations and agency officials we interviewed, could help standards-developing organizations address the challenges they face.

We conducted this performance audit from July 2015 to November 2016 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Department of Commerce



THE DEPUTY SECRETARY OF COMMERCE
Washington, D.C. 20230

November 8, 2016

Mr. Joseph Dean Thompson
Assistant Director
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Thompson:

Thank you for the opportunity to review and comment on the Government Accountability Office's draft report titled *Climate Change: Improved Federal Coordination Could Facilitate Use of Forward-Looking Climate Information in Design Standards, Building Codes, and Certifications* (GAO-17-3). The Department of Commerce strongly supports efforts to foster greater and more effective participation by Federal agencies in the development of consensus standards for climate resilience in infrastructure and other areas.

The Government Accountability Office recommends that the National Institute of Standards and Technology (NIST) "coordinate a governmentwide effort to provide the best available forward-looking climate information to standards-developing organizations for use in the development of design standards, building codes, and voluntary certifications."

The draft recommendation that NIST coordinate a governmentwide effort to deliver the "best available" climate change information to standards-developing organizations is inconsistent with NIST's well-established role in the voluntary consensus standards development process. NIST is a scientific, non-regulatory, non-oversight agency with the principal mission to advance measurement science. NIST does not have the necessary expertise to play the role of arbiter of what climate information is the "best." Further, forcing NIST into such a role would undermine NIST's reputation as an objective third party participant in the process.

What NIST can do, however, consistent with its mission and authority, is convene stakeholders, including Federal agencies, to discuss forward-looking climate information for potential use by the standards community.

If you have any questions, please contact Kent Rochford, Associate Director for Laboratory Programs, at (301) 975-2300.

Sincerely,

A handwritten signature in black ink, appearing to read "B. Andrews", is written over a horizontal line.

Bruce H. Andrews

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

J. Alfredo Gomez, (202) 512-3841 or gomezj@gao.gov

Staff Acknowledgments

In addition to the individual named above, Joseph Dean Thompson (Assistant Director), Mark Braza, Alicia Cackley, Martin (Greg) Campbell, Christopher Currie, Swati Deo, Kathryn Godfrey, Brian Lepore, Armetha Liles, Tim Persons, Kiera Reifschneider, Oliver Richard, Michelle Sager, Amber Sinclair, Jeanette Soares, Ruth Solomon, Anne Stevens, Marie Suding, Kiki Theodoropoulos, and David Wise made key contributions to this report.

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