

**Testimony for The Pew Charitable Trusts Presented by Velma Smith
on behalf of the Flood Prepared Communities Initiative
House Committee on Transportation and Infrastructure
Subcommittee on Economic Development, Public Buildings, and Emergency Management
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Chairwoman Titus, members of the subcommittee, on behalf of The Pew Charitable Trusts (Pew), I thank you for the opportunity to testify today. My name is Velma Smith. I am a senior officer working with Pew's flood-prepared communities initiative.

Pew's flood-prepared communities initiative has been focused on the increasingly costly and common problems of floods and flooding damage. Our aim is to reduce the impact of flood-related disasters on the U.S. economy, communities, and environment. Pew is working to prioritize investments in flood-ready infrastructure, mitigate against the impact of disasters, modernize flood insurance, and promote nature-based solutions to flooding. Given that work and the fact that flooding and coastal storms have accounted for roughly 70 percent of all Presidential Disaster Declarations over the past decade¹, my comments this afternoon will focus largely on how flooding has and can impact communities and how Congress might address these problems in the context of infrastructure investment.

Costly Disasters are on the Rise.

First, the overall disaster numbers and the trendline. Flooding and other weather-related disasters are on the rise. The National Oceanic and Atmospheric Administration (NOAA) tells us that 2020 set numerous records²: 22 extreme weather and climate events caused \$1 billion or more in losses, jumping from a previous high of 16 that occurred in both 2011 and 2017. Western wildfires reached historic proportions in 2020, and the Atlantic hurricane

season produced 30 named storms, 12 of those making landfall in the contiguous U.S. Last year's record events came on the heels of the third consecutive decade in which the mounting number and costs experienced by the country reached levels never before seen. Totals have now exceeded \$1.8 trillion in aggregate since 1980.³

Costs are Felt by Communities and the American Taxpayer.

Those disasters and many others whose impacts did not hit the billion dollar mark have proven costly to U.S. families and businesses, localities and states, and to federal taxpayers who pay a significant portion toward disaster losses – over and above emergency assistance -- through programs such as the Federal Emergency Management Agency's (FEMA) Public Assistance and Individual Assistance programs, the U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) Emergency Relief Program, the Small Business Administration's disaster loan programs, the Department of Housing and Urban Development's Community Development Block Grant-Disaster Recovery (CDBG-DR) and more.

Without consistent accounting of costs across federal agencies and states⁴, it is hard to know precisely how much is being spent, but a snapshot of just one program suggests the scale of the threat. Pew looked specifically at the monies spent under FEMA's Public Assistance Program (PA) to help communities build back and repair damaged public buildings, utilities, water systems, roads, and other public assets.⁵ Overall, for disasters declared from 2000 to the present, the amount obligated for PA, excluding emergency protective management, debris removal, and state management assistance, tops \$67 billion. Expenditures on public utilities and buildings account for the lion's share: more than \$26 billion for utilities and more than \$23 billion for buildings. In looking at this number, the Committee should keep in mind that

obligations for the more recent disasters will grow. This data counts only the projects for which plans have been made and obligations approved.

Another tally comes from a study released in 2017. That analysis by the Congressional Budget Office (CBO) ⁶ looked at risk and loss associated specifically with hurricane winds and storm-related flooding across three sectors: residential, commercial, and public. It estimated expected average annual costs to the federal government – assuming the status quo in terms of public policy and excluding some federal costs as well as costs borne by state and local governments—an average cost of \$17 billion per year. One of the options to alter this outlook, CBO noted, was to “increase funding for mitigation.”

Earlier this month, the Government Accountability Office (GAO) repeated its own warnings about the risks of climate change.⁷ Since 2019, GAO's High-Risk Report has called on the government to improve its preparation for future disaster, and its accounting of disaster spending. According to GAO, the federal government must address the long-term financial exposure of disaster assistance programs and "fully implement measures that promote resilience."

It Pays to Prepare.

On the mitigation side of the disaster balance sheet, there are compelling numbers as well, because—as others on this panel have underscored—mitigation pays. Many studies of mitigation efforts have shown what can be gained.

The most widely quoted of these studies comes from the National Institute of Building Sciences (NIBS) Multi-Hazard Mitigation Council, a panel of experts in fields related to the building sciences. This group has taken a rigorous look at mitigation projects of multiple types,

including adoption and enforcement of building codes and mitigation for different types of community infrastructure. In some categories, NIBS researchers have been able to revisit their own work and refine it over multiple years. Their conclusions, over and over again, tell us that mitigation saves and that the sooner the mitigation actions are taken, the more the associated benefits will multiply. The amount of savings varies by type and by project, but overall, the numbers run in ranges from \$2 in savings per mitigation dollar invested to as high as \$11 saved per dollar invested.⁸

Numerous studies echo those findings. For example, researchers found great value in homes built in compliance with strong, wind-resistant codes; they reported damage reductions of greater than 70 percent, compared with other structures.⁹

Other work in Florida, where loss avoidance from past mitigation projects is analyzed by the State after major storm events,¹⁰ shows large benefits from activities such as buyouts of flood-prone structures, elevation of buildings, and improvements to storm drainage. The State of Florida studies conclude that “mitigating the risk of natural hazards in Florida is a sound investment” with a positive economic benefit in terms of employment and economic stabilization following a disaster.¹¹

Following the devastating 2013 floods in Colorado, analysts also determined that stronger building requirements, setbacks and restrictions on the siting of critical facilities kept storm damages from running even higher than encountered, but they also found that earlier and more widespread adoption of mitigation requirements could have reduced the costs even further. This investigation concluded that if older critical facilities, including police stations, emergency operations centers, hospital emergency rooms, fire stations, and schools, had been

removed from flood zones, damages might have been cut substantially. One of the recommendations in this FEMA report is for more widespread adoption of critical facility siting restrictions.¹²

Mitigation Lags as Costs and Threats Mount.

Despite the proven value of mitigation and disturbing predictions of more frequent severe storms and rising sea levels, we too often fail to act. Localities hesitate to restrict new building in risky areas or adopt and enforce the most recent building codes. On this point, FEMA's National Advisory Council in 2019 has warned that nearly 70 percent of the more than 23,000 cities and towns facing floods, high wind, hurricane, seismic, or tornado hazards had not adopted or enforced the latest protection codes.¹³ Without up-to-date codes and proper planning, low-lying, damaged structures are rebuilt with the same vulnerabilities; public buildings, including those that provide essential services or store important public records are too often repeatedly damaged and repaired without major improvements.

There is no publicly available database with information on those assets that have been damaged numerous times and repaired or replaced using federal funding, though a Department of Transportation rule now requires states to begin gathering and reporting this information to the Department.¹⁴ We do know, however that some assets that may be in harm's way, in fact, belong to the federal government. After reviewing just a portion of the federal property inventory, the Office of Management and Budget identified more than \$80 billion in federal assets located in designated flood zones.¹⁵

Some disaster experts, like the researchers at the Wharton School, place at least part of the blame for inaction on disaster or flood amnesia¹⁶—perhaps a very human and

understandable tendency to put aside the traumas of the big events. They also point out the very real need for better public education and hazard risk disclosure.¹⁷ Pew agrees.

Disasters Create Cascading Consequences and Long-Term Costs.

We might also suggest that, at some level, we may be allowing the large and growing numbers to deceive us. We total up the costs the best we can and as we should, but when we focus solely on the billions of dollars, perhaps we forget other important facets of disaster. The aggregate numbers can obscure the cascading impacts that follow a failure to invest in resiliency, the lasting consequences, the human-scale tragedies, and the true fragility of critical lifelines.

In looking only at the totals, we tend to forget what FEMA's Federal Advisory Council reminds us in their 2020 report¹⁸ to the Agency: "[D]isasters disproportionately affect those who are already socio-economically marginalized in a community, subjecting them to even greater depths of poverty." We may not see the true gravity of a storm that damages a small hospital in a rural community where that hospital is not only a health care lifeline but also the major employer. We may put aside that image of wheel-chair-bound seniors sitting in waist-deep flood waters in Dickinson, Texas during Hurricane Harvey.¹⁹ We may not readily consider the dangers to first responders driving on flooded roadways, the disruptions to important supply chains when interstates are closed for days or weeks, the sewage spills that threaten public health and close recreational facilities, or the water or power disruptions and their secondary impacts. Or we may miss the report that tells of more than 5,000 children separated from their families after Hurricane Katrina, some for months.²⁰

But perhaps we should give more weight to these stories and statistics that show us how disaster—and the failure to anticipate disaster—can exacerbate existing inequities and frailties in our communities and how the vulnerability of one asset can reverberate across a town or an entire region.

Today, Pew is hopeful that the experiences of past disasters as well as the mounting costs will instill in the members of this Committee a sense of urgency to close the nation's resilience gap. We believe you can do so by making certain that new investments in infrastructure incorporate new requirements for resilience.

Some might counter that requirements for new infrastructure projects to assess hazards and incorporate protections will be too costly; that unneeded delays will occur. Clearly, a balance must be struck, but we ask the Committee to consider the wasted costs that accrue when a vulnerable facility must be repaired or rebuilt repeatedly. And to keep in mind the delays and disruptions to family and civic life when a community loses water or power, shutsters a school, or finds itself isolated by destroyed bridges and impassable roads.

Resiliency Initiatives Point the Way to Progress.

As this Subcommittee considers how to support resilient infrastructure investment and what levels of assistance to offer, there is also good news. There are already successes: projects and programs that recognize risks and build in a capacity for durability and resilience. A few of these may be useful to your deliberations. They should give you assurance that resilience can grow, if you make it a priority for infrastructure spending.

Healthcare Facilities

Take a look at the University of Texas Medical Center. In 2001, one storm dumped as much as 80 percent of the rainfall that Houston and Harris County, Texas would normally experience over a full year.²¹ Tropical Storm Allison was cited as a 1,000-year event and called by some the worst urban storm in the U.S. to that point.²² At the largest aggregated medical campus in the country, water rose 22 feet and the force of flow through the sprawling operation and its underground tunnels was enough to blow doors off their hinges and cause cinderblock walls to collapse.²³

The flood took out all essential services: electrical power, heating, ventilation, air conditioning, water, fire detection and suppression, and sewage. Medical personnel managed evacuation of patients, sometimes transferring equipment and staff with patients headed to facilities that would otherwise have been unable to care for them. Researchers at the Baylor College of Medicine lost one of the world's most extensive collections of breast cancer specimens – some 60,000 specimens collected over a period of 25 years.²⁴

To avoid a repeat of the Allison disaster, the Center undertook an extensive review of vulnerabilities of the entire campus and developed a comprehensive plan to manage risks into the future. Improvements included a new, elevated combined heat and power utility plant, multiple flood doors and gates to close off areas susceptible to flooding, an elevated utility raceway that also serves as a pedestrian walkway, rooftop telecom cell towers, major improvements in drainage and stormwater management across the campus and in the larger watershed, a state-of-the-art flood warning system, various perimeter berms and barriers to protect facilities up to the 500-year flood level.²⁵ In addition, because the Houston area has experienced ground subsidence of more than three feet since 1976 and that subsidence can

alter the flood-readiness of buildings, a solar-powered system for monitoring ground subsidence was installed.²⁶

These improvements allowed the Center to continue functioning throughout Hurricane Harvey.²⁷ The storm presented challenges for receiving patients and rotating medical staff and security, and one hospital suffered a broken water pipe, but overall, the Center's preparation allowed it to function and to return to a normal schedule as the floodwaters cleared in the area. As former Congressman Ken Bentsen noted in an op-ed in the Houston Chronicle, "With the region knocked to its knees, the Medical Center stood tall on dry land."²⁸

As compelling as this story is, there are even more good examples in this arena. Many public health and medical professionals and in the engineering and architectural services that support them are taking the risks of climate change and future disasters to heart. Other facilities, like the LEED-gold-certified Spaulding Rehabilitation Hospital in Charlestown, Massachusetts, are being built with resiliency as a priority.²⁹ Sited on the waterfront, the Spaulding facility was designed around sea level rise projections out to the year 2100. The facility's first floor was placed as high as possible; critical mechanical and electrical equipment are on the roof, and patient-critical functions have been kept off the ground floor. Building designers included a combined heat and power plant for backup power; elevated all vents; incorporated operable windows; and designed the landscaping to offer reef-like barriers to mitigate against storm surge.

The Charlestown facility completed in 2013 is just one belonging to Massachusetts-based Partners HealthCare, which has since taken on the task of assessing the risks posed by climate change and weather disasters to all of its facilities and services.³⁰ For this effort, the

company is using its own expertise developed during the planning for Spaulding as well as guidance on best practices developed by the U.S. Department of Health and Human Services.³¹

Clearly, not every medical facility could accomplish the massive re-engineering that occurred in Houston, and not every feature of the Spaulding facility will transfer elsewhere, but to the extent that Congress funds the infrastructure aspects of our health care facilities, it should assure that any new resources help to make these critical facilities safer and more reliable in the face of disaster.

Transportation

The transportation sector, as well, has positive news and developments and examples of innovation in preparedness. On that front, we again thank the Committee for the groundwork it laid last year for reauthorizing highway programs. We understand that resilience in surface transportation can be complex, perhaps the ultimate example of connectedness. That is why we wholeheartedly endorse the Committee's proposals to incorporate resiliency into the long-term planning and asset management programs that are the heart of the National Highway Performance Program (NHPP).³² We also support the creation of a new pre-disaster mitigation program, efforts to use natural infrastructure for flood resilience, and, where possible, the relocation or construction of alternatives to repeatedly damaged facilities. We recommend that we incentivize action on those repeatedly flooded transportation assets with changes to the Federal Highway Administration's (FHWA) Emergency Relief (ER) program: requiring resiliency improvements and protective features for the non-emergency and permanent work undertaken with ER allocations.

In the transportation sector, we see indication that resilience advancements are both needed and feasible today: in Delaware, where oyster reefs are part of the solution to protecting a coastal highway;³³ in Arkansas, where the State Game and Fish Commission, the Nature Conservancy, the Arkansas Economic Development Commission, and other partners have set up a program to reduce flooding on rural roads and at the same time improve water quality and protect habitat;³⁴ in California, where designers address the threat of rising seas to a coastal rail line with a structural solution that is, itself, adaptable: precast piers and caps that allow insertion of additional pier segments, if needed.³⁵ In Virginia, the Hampton Roads Transportation Planning Organization (HRTPO) is working with military leadership in the region to address the impacts of sea level rise that threaten military readiness and the transportation needs of the region, collaborating to set priorities for protecting road segments, tunnels, and bridges vulnerable to future damage and destruction,³⁶ and the Department of Transportation itself is advancing resilience with trainings and outreach for highway planners and engineers based on their implementation guide “Nature-Based Solutions for Coastal Highway Resilience.”³⁷ In this sector as well, there is ample evidence that new infrastructure should and can incorporate resilience. Resiliency is what we should demand of new roads and bridges built today and going forward.

Water and wastewater utilities

Water and wastewater utilities, as well, have and will be impacted by erratic and wild weather that can bring both drought and flood, and some in this industry are leading efforts to adapt, seeking to avoid problems with service shutdowns and sewage overflows. Just over a decade ago, a report produced by the National Association of Clean Water Agencies conducted

what they called an early analysis of adaptation costs through the year 2050.³⁸ That assessment indicated that costs to utilities could range from just under \$500 billion to more than \$900 billion. Some of these utilities, have already undertaken some adaptations—including the Milwaukee Metropolitan Sewerage District which is solving flooding problems and greening the region with an ambitious nature-based stormwater management program.³⁹

Housing

Others on this panel have provided ample information about the value of and the need for more resilience in the housing sector, but we would also mention a recent initiative there, one aimed at enhancing protections for multi-family housing and keeping those units affordable. The Keep Safe Miami initiative⁴⁰ is a new outgrowth of work by Enterprise Community Partners, a non-profit with a strong record of assistance for communities recovering from disasters. The Miami work builds on previous manuals and trainings on resiliency,⁴¹ now offering owners and operators of affordable housing a set of tools that will help them assess the vulnerabilities of their properties, consider adaptation strategies for their specific portfolio of properties, set priorities, and guide them through the options for financing new resilience investments. At the same time, the program will train residents on disaster preparedness and steps they can take to save money with energy efficiency.

Congress Must Act.

These few examples—across multiple sectors—are encouraging and worth celebrating. These and more show us that there are multiple resilience strategies that can protect people and property in a changing climate. Unfortunately, they have yet to become the norm. They

must, however, for as the Department of Transportation reminds us, “many of the structures being built today will still be in use fifty or, in some cases, one hundred years in the future.”⁴²

That is why Pew urges this Committee to be clear and specific as you work on a broad infrastructure package or other legislative vehicles that will use federal dollars for investment in infrastructure.

If you stipulate that federal dollars may only be used on projects adopting appropriate safety approaches, then those investments will begin to fill the deep and growing resilience gap that researchers have identified. According to NIBS, the Nation’s disaster losses are increasing by about 6 percent per year, 10 times faster than the population and costing America an average of \$100 billion yearly, they conclude. The NIBS researchers tell us that the United States could cost-effectively spend \$520 billion to reduce its disaster liability by \$2.2 trillion.⁴³

Require Consideration of Future Risk.

Pew urges the Committee to tie infrastructure funding to requirements to look forward and consider future risks. For too long and in too many places, we have built or repaired as if the last large disaster were an isolated aberration, never to be repeated. This is particularly true in the case of flooding and coastal storms, where we foolishly assume that risk is stationary rather than dynamic. Relying solely on the 100-year floodplain as the metric of flood risk, we would suggest, is akin to driving the freeway looking only in the rearview mirror. It doesn’t work. We must plan for the harsher hazards on the horizon.

In 2018, the National Defense Authorization Act for Fiscal Year 2019 (NDAA)⁴⁴ addressed this problem when it comes to the military. It expanded the military’s authority to ensure readiness through energy and disaster resilience. On the flooding front, it called for looking at

the design life of projects, assessing the risks that might be encountered over that time period, and then incorporating protections against those risks. It accepted the reality of uncertainty and the current lack of detailed, site-specific future risk data in some instances. That is why the statute allows for incorporation of a straight-forward margin of safety on flood volumes where detailed, as necessary. Other agencies can and should follow this path.

Leverage Nature-based Solutions.

In addition, Pew urges the Committee to direct those who design a new generation of infrastructure to consider the role that nature can play—not only in enhancing protections, but also in lowering costs and providing other important benefits, such as cleaner water, protected or restored wildlife habitat, tourism, and recreational opportunities. Nature-based approaches, used in place of or alongside of more traditional “grey” defenses, will frequently be more adaptable, easier to scale up, and can become stronger and offer more resilience over time. In many instances, the nature-based solutions are also those most readily embraced by local communities.

Allow Silos to be Broken.

Whether they serve in a large city or a rural village, community leaders must always look to solve multiple problems. They want to do more than guard against hazards and can with resilient infrastructure projects that provide multiple benefits. We are hopeful that infrastructure legislation will allow for many types of resilience projects that break down silos and deliver multiple benefits: projects such as the previously mentioned Arkansas roads program, Atlanta’s green solution to storm sewer pollution in Historic Fourth Ward Park;⁴⁵ the ouR-HOME project in North Richmond, California,⁴⁶ and a major river corridor project in Iowa.⁴⁷

We urge you to allow for and encourage such multi-benefit projects and to consider targeting funds to communities that have high risks and high poverty and social vulnerabilities. Many communities need the types of projects highlighted in this testimony, but not all have the resources to achieve them. Infrastructure legislation could follow the model of the new FEMA Building Resilient Infrastructure and Communities (BRIC) program that offers technical assistance and additional help to localities with significant resource constraints. Another approach that the subcommittee may wish to consider is one being explored by disaster experts at the Reinsurance Association of America (RAA).⁴⁸ With data-driven analysis of socio-economic as well as physical vulnerabilities, RAA believes those communities most in need of adaptation assistance can be identified. Their proposal is for a new program using Community Disaster Resilience Zones bonds, which could leverage private sector funds for investments in resilience, adding to the commitments made by state and federal agencies.

Act Now.

We also urge this Subcommittee and the full committee to act swiftly on bipartisan legislation that has been introduced to specifically address future flood hazards. The Flood Resiliency and Taxpayer Savings Act, H.R. 481, would make these sorts of important protections permanent for all federal spending going forward. It is supported by a wide range of taxpayer and environmental organizations, housing advocacy groups, insurers, and engineers. We look forward to timely action on that important proposal as well.

In closing, I'd like to draw your attention to two commission reports written a decade apart. Mississippi Governor Haley Barbour, who saw his state suffer enormously from Hurricane Katrina, commissioned a post-disaster report⁴⁹ that was blunt in its assessment of

what had gone on prior to the storm: “[W]e’re facing some of the same challenges of recovery, rebuilding, and renewal in 2006 because we failed to engage them fully after 1969.” Katrina drove Mississippi to try to do better, to build back better than they had in recovering from Hurricane Camille. And after Harvey hit Texas, a state that we all know has faced a long line of hurricanes, tropical storms, and floods, Governor Greg Abbott’s Commission report,⁵⁰ “Eye of the Storm” was also clear in its urgent call to “future proof” Texas and frank about shortcomings in the State’s flood preparedness. Harvey’s lessons have prompted a serious and ambitious effort to bring enhanced flood resiliency to the Lone Star state as well.

Congress is now poised to address the pressing infrastructure needs described in the most recent report card issued by the American Society of Civil Engineers.⁵¹ As you take on this challenge, we urge you to seize the opportunity. The time for hesitation has passed. Congress must require better building practices and more durable infrastructure protected against future flooding, fire, tornados, and other hazards. Accelerate the “future-proofing” our nation so sorely needs.

Again, we appreciate the Subcommittee’s interest in this important topic and the opportunity to participate today. I look forward to your questions and working together.

¹ Federal Emergency Management Agency, OpenFEMA Data Sets, Disaster Declaration Summaries, <https://www.fema.gov/about/openfema/data-sets>

² National Centers for Environmental Information, National Oceanic and Atmospheric Administration, "Billion-Dollar Weather and Climate Disasters: Overview, <https://www.ncdc.noaa.gov/billions/overview>

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- ³ National Centers for Environmental Information, National Oceanic and Atmospheric Administration, "Billion-Dollar Weather and Climate Disasters: Summary Stats, <https://www.ncdc.noaa.gov/billions/summary-stats>
- ⁴ The Pew Charitable Trusts, "How States Pay for Natural Disasters in an Era of Rising Costs: A nationwide assessment of budgeting strategies and practices," <https://www.pewtrusts.org/-/media/assets/2020/05/how-states-pay-for-natural-disasters-in-an-era-of-rising-costs.pdf>; and Government Accountability Office, "High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas," GAO-21-119SP, March 2, 2021, <https://files.gao.gov/reports/GAO-21-119SP/index.html>
- ⁵ Federal Emergency Management Agency, OpenFEMA Dataset: Public Assistance Funded Projects Details, updated March 3, 2021, <https://www.fema.gov/openfema-data-page/public-assistance-funded-projects-details-v1>
- ⁶ Congressional Budget Office, "Expected Costs of Damage From Hurricane Winds and Storm-Related Flooding," April 2019, <https://www.cbo.gov/system/files/2019-04/55019-ExpectedCostsFromWindStorm.pdf>
- ⁷ Government Accountability Office, "High-Risk Series: Dedicated Leadership Needed to Address Limited Progress in Most High-Risk Areas," GAO-21-119SP, March 2, 2021, <https://files.gao.gov/reports/GAO-21-119SP/index.html>
- ⁸ National Institute of Building Sciences Multihazard Mitigation Council, "Natural Hazard Mitigation Saves: 2019 Report," December 2019, <https://www.nibs.org/page/mitigationsaves>; and National Institute of Building Sciences Multihazard Mitigation Council, "Natural Hazard Mitigation Saves: Utilities and Transportation Infrastructure," October 2018, <https://www.nibs.org/resource/resmgr/docs/NHMS-UtilitiesFactSheet.pdf>
- ⁹ Simmons, Kevin M., et al., "Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida," Land Economics, May 2018, <https://muse.jhu.edu/article/690441>; and Kusisto, Laura and Arian Campo-Flores, "Homes Built to Stricter Standards Fared Better in Storm," Wall Street Journal, September 16, 2017, <https://www.wsj.com/articles/one-early-lesson-from-irma-hurricane-building-codes-work-1505559600>
- ¹⁰ Florida Division of Emergency Management, "Loss Avoidance Assessment: Hurricane Matthew (DR-4283)," April 2017, https://www.floridadisaster.org/globalassets/importedpdfs/01_dr-4283-loss-avoidance-report.pdf; and "Loss Avoidance Assessment: Tropical Storm Debby: FEMA-4068-DR-FL, Flood Mitigation Projects, LA #2012-01," <https://www.floridadisaster.org/globalassets/importedpdfs/report-tsdebby-la.pdf>
- ¹¹ Koon, Bryan W., et al., "Florida Division of Emergency Management's Bureau of Mitigation Economic Impact Analysis," August 2011, <https://www.floridadisaster.org/globalassets/importedpdfs/fdem-economic-impact-analysis-final-3.14.12.pdf>
- ¹² FEMA, "Reducing Losses through Higher Regulatory Standards: 2013 Colorado Floods Case Study, FEMA-DR-4145-CO," March 2015, prepared by Dewberry Consultants LLC for FEMA, https://www.fema.gov/media-library-data/1429759760513-f96124536d2c3ccc07b3db4a4f8c35b5/FEMA_CO_RegulatoryLAS.pdf; and FEMA Region VIII, "Loss Avoidance Study: The water didn't stop." http://www.casfm.org/wp-content/uploads/2017/08/R8_Loss_Avoidance_Study.pdf
- ¹³ Federal Emergency Management Agency, "National Advisory Council Report to the FEMA Administrator, November 2019," https://www.fema.gov/sites/default/files/2020-08/fema_nac-report_11-2019.pdf
- ¹⁴ Federal Highway Administration, "Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events," Final Rule, 81 FR 73196, October 24, 2016, <https://www.govinfo.gov/app/details/FR-2016-10-24/2016-25117>
- ¹⁵ Office of Management and Budget, "Climate Change: The Fiscal Risks Facing the Federal Government, Preliminary Assessment," November 2016, https://obamawhitehouse.archives.gov/sites/default/files/omb/reports/omb_climate_change_fiscal_risk_report.pdf
- ¹⁶ Kunreuther, Howard, "Improving the National Flood Insurance Program," Behavioural Public Policy, Cambridge University Press, 2018, https://marketing.wharton.upenn.edu/wp-content/uploads/2018/08/improving_the_national_flood_insurance_program.-Behavioral-Public-Policy-2018.pdf
- ¹⁷ Kousky, Carolyn, "How Americans Fail at Communicating Flood Risk," Bloomberg CityLab, October 11, 2018, <https://www.bloomberg.com/news/articles/2018-10-11/why-flood-risk-information-doesn-t-reach-the-american-public>
- ¹⁸ Federal Emergency Management Agency, "National Advisory Council Report to the FEMA Administrator, November 2019," https://www.fema.gov/sites/default/files/documents/fema_nac-report_11-2020.pdf
- ¹⁹ Villafranca, Omar, CBS News, "Elderly are among the most vulnerable during Harvey," August 28, 2017, <https://www.cbsnews.com/news/hurricane-harvey-senior-citizens-nursing-home-dickinson-texas-elderly-vulnerable/>

-
- ²⁰ Broughton, D., et. al., "Getting 5000 Families Back Together: Reuniting Fractured Families After a Disaster: The Role of the National Center for Missing & Exploited Children," *Pediatrics*, 117, Supplement, May 2006, http://pediatrics.aappublications.org/content/117/Supplement_4/S442.short
- ²¹ Harris County Flood Control District, "Tropical Storm Allison," undated, <https://www.hcfd.org/storm-center/tropical-storm-allison-2001/>
- ²² U.S. Climate Resilience Toolkit, "After Record-Breaking Rains, a Major Medical Center's Hazard Mitigation Plan Improves Resilience," <https://toolkit.climate.gov/case-studies/after-record-breaking-rains-major-medical-centers-hazard-mitigation-plan-improves>
- ²³ Tucker, Edgar L. and Angela N. Smith, "Planning for the Worst at the World's Largest Medical Complex," presented at the Texas Emergency Management Conference, March 26, 2013, <https://www.preparingtexas.org/Resources/documents/2013%20Conference%20Presentations/Planning%20for%20the%20Worst.pdf>
- ²⁴ Bankhead, Charles, "Tropical Storm Sets Back Research in Houston," *Journal of the National Cancer Institute*, Volume 93, Issue 18, <http://jnci.oxfordjournals.org/content/93/18/1366.long>
- ²⁵ Fang, Zheng, et.al., "Case Study of Flood Mitigation and Hazard Management at the Texas Medical Center in the Wake of Tropical Storm Allison in 2001," *Natural Hazards Review*, Vol 15, Issue 3, Aug 2014, https://www.buildinggreen.com/sites/default/files/Fang14TMC_Final.pdf
- ²⁶ U.S. Climate Resilience Toolkit, "After Record-Breaking Rains, a Major Medical Center's Hazard Mitigation Plan Improves Resilience," <https://toolkit.climate.gov/case-studies/after-record-breaking-rains-major-medical-centers-hazard-mitigation-plan-improves>
- ²⁷ Galehouse, Maggie, "Despite Hurricane Harvey, TMC Institutions Are Operational and Accessible," *TMC News*, Aug 28, 2017, <http://www.tmc.edu/news/2017/08/despite-hurricane-harvey-tmc-institutions-operational-accessible/>
- ²⁸ Bentsen, Ken, "Bentsen: The Texas Medical Center defeated Harvey," *The Houston Chronicle*, Sep 4, 2017, <http://www.houstonchronicle.com/opinion/outlook/article/Bentsen-The-Texas-Medical-Center-defeated-Harvey-12172307.php>
- ²⁹ Urban Land Institute, "Developing Urban Resilience: Spaulding Rehabilitation Hospital," 2018, <https://developingresilience.uli.org/case/spaulding-rehabilitation-hospital/>
- ³⁰ Morgan, Jamie, "Partners HealthCare undergoes systemwide resiliency assessment," *Health Facilities Management*, <https://www.hfmmagazine.com/articles/3475-partners-healthcare-undergoes-systemwide-resiliency-assessment>
- ³¹ U.S. Department of Health and Human Services, "Primary Protection: Enhancing Health Care Resilience for a Changing Climate," Fall 2014, <https://toolkit.climate.gov/sites/default/files/SCRHCFI%20Best%20Practices%20Report%20final2%202014%20Web.pdf>
- ³² Letter from Thomas Wathen, The Pew Charitable Trusts to The Honorable Nancy Pelosi, The Honorable Kevin McCarthy, The Honorable Peter Defazio, The Honorable Sam Graves, June 29, 2020, <https://www.pewtrusts.org/-/media/assets/2020/06/pew-letter-on-transportation-reauthorization-bill.pdf>
- ³³ Hodges, Tina, Federal Highway Administration, "Nature-based Resilience for Coastal Highways," presentation to the International Conference on Coastal Engineering, July 29, 2018, https://ewn.el.erdc.dren.mil/workshops/2018_07-29-NNBF-short-course/ppt/1145-1205_Hodges-NNBFTransportationCaseStudy.pdf
- ³⁴ Federal Emergency Management Agency, "Better Unpaved Roads for Nature and People in Arkansas," 2021, <https://www.fema.gov/case-study/better-unpaved-roads-nature-and-people-arkansas>; Kloer, Phil, "The dirt road connection: Arkansas multi-partner project benefits residents, endangered and at-risk species," U.S. Fish & Wildlife Service, August 29, 2017, <https://www.fws.gov/southeast/articles/the-dirt-road-connection/>
- ³⁵ Wright, Richard N., "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate," presentation to the National Academies' Roundtable on Science and Technology for Sustainability, June 5, 2015, https://sites.nationalacademies.org/cs/groups/pgasite/documents/webpage/pga_165893.pdf
- ³⁶ Hampton Roads Transportation Planning Organization, "Hampton Roads Military Transportation Needs Study: Roadways Serving the Military and Sea Level Rise/Storm Surge," July 2013, <https://www.hrtpo.org/uploads/docs/Roadways%20Serving%20the%20Military%20&%20Sea%20Level%20Rise-Storm%20Surge%20Report.pdf>

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- ³⁷ Federal Highway Administration, "Implementation Guide: Nature-based Solutions for Coastal Highway Resilience," September 2019, https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/implementation_guide/fhwahep19042.pdf ; and FHWA, "Peer Exchange Report: Nature-based Solutions for Coastal Highways," August 2018, https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/coastal_highways/fhwahep18070.pdf
- ³⁸ National Association of Clean Water Agencies, "Confronting Climate Change: An Early Analysis of Water and Wastewater Adaptation Costs," October 2009, <https://www.amwa.net/publication/confronting-climate-change-early-analysis-water-and-wastewater-adaptation-costs-2009>
- ³⁹ Milwaukee Metropolitan Sewerage District, Green Infrastructure, <https://www.mmsd.com/what-we-do/green-infrastructure> ; The Pew Charitable Trusts, "Milwaukee's Sustainability Leader Advances a Back-to-Nature Strategy to Lower Risk," July 20, 2020, <https://www.pewtrusts.org/en/research-and-analysis/articles/2020/07/20/milwaukes-sustainability-leader-advances-a-back-to-nature-strategy-to-lower-flood-risk>
- ⁴⁰ Enterprise Community Partners, "Keep Safe Miami," 2021, <https://www.enterprisecommunity.org/solutions-and-innovation/emergency-management/keep-safe-miami>
- ⁴¹ Shoeman, Laurie, Enterprise Community Partners, Inc., "Ready to Respond: Strategies for Multifamily Building Resilience," 2015, <https://www.enterprisecommunity.org/resources/ready-respond-strategies-multifamily-building-resilience-13356>
- ⁴² U.S. Department of Transportation, "U.S. Department of Transportation Climate Adaptation Plan: Ensuring Transportation Infrastructure and System Resilience," undated, non-working link on dot.gov
- ⁴³ National Institute of Building Sciences, MultiHazard Mitigation Council, "A Roadmap to Resilience Incentivization," 2020, Porter, K.A. and Yuan, J.Q., eds., https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mmc_nibs_resilience_incentiv.pdf
- ⁴⁴ P.L. 115-232
- ⁴⁵ The Trust for Public Land, "City parks, clean water: Making great places using green infrastructure," 2016, <https://www.tpl.org/city-parks-clean-water>
- ⁴⁶ Bay Area Resilient by Design, ouR-HOME, undated, <http://www.resilientbayarea.org/our-home>
- ⁴⁷ U.S. Fish & Wildlife Service, "Iowa River Corridor Project: Port Louisa National Wildlife Refuge," 2013, https://www.fws.gov/midwest/planning/PlansByState/IRCP_CMP_final-July10-2013.pdf
- ⁴⁸ Conversation with Frank Nutter, President, Reinsurance Association of America, March 2021.
- ⁴⁹ Governor's Commission on Recovery, Rebuilding, and Renewal, "After Katrina: Building Back Better than Ever," December 31, 2005
- ⁵⁰ "Eye of the Storm: Report of the Governor's Commission to Rebuild Texas," November 2018, <https://www.rebuildtexas.today/wp-content/uploads/sites/52/2018/12/12-11-18-EYE-OF-THE-STORM-digital.pdf>
- ⁵¹ American Society of Civil Engineers, "2021 Report Card for America's Infrastructure," <https://infrastructurereportcard.org/>