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Committee on Transportation and Infrastructure
Hearing on, "Examining How Federal Infrastructure Policy Could Help Mitigate and Adapt to Climate Change"

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10 a.m.

Chairman DeFazio, Ranking Member Graves and committee members, thank you for the opportunity to present The Nature Conservancy's views on enhancing resilience of our transportation infrastructure. My name is Lynn Scarlett. I am Vice President for Public Policy and Government Relations at The Nature Conservancy.

The Conservancy is a global conservation organization dedicated to conserving the lands and waters on which all life depends. Guided by science, we create innovative, on-the-ground solutions to the world's toughest challenges so that nature and people can thrive together. We are tackling climate change, conserving lands, waters and oceans at unprecedented scale, providing food and water sustainably and helping make cities more sustainable. Working in all 50 states and 72 countries, we use a collaborative approach that engages local communities, governments, the private sector and other partners, including farmers, ranchers and other landowners.

Infrastructure needs and natural infrastructure

There are tremendous needs for improving and maintaining all kinds of infrastructure throughout the United States. Review of the recent American Society of Civil Engineers' 2017 scorecard giving the state of our nation's infrastructure a D+ summarizes this need. To meet the needs for upgrading our nation's infrastructure requires investing significant resources and finding ways to cost effectively and expeditiously accomplish needed infrastructure investments while sustaining community, environmental, safety and other widely held values. One significant tool in meeting the infrastructure demands in a cost-effective manner is to consider investments in natural infrastructure.

Natural infrastructure refers to investments in restoration, conservation of nature and nature-based (bioengineered) systems to achieve infrastructure needs. Investments in natural infrastructure often occur combined with investments in more traditional "gray," or "hard," infrastructure like levees, roads and seawalls. Investments in natural infrastructure help preserve or reintroduce the basic functions of nature that deliver a suite of benefits in support human well-being; provide clean water and clean air; and sustain lands that provide food and recreation opportunities and reduce greenhouse gas emissions. Many of these solutions provide

infrastructure innovations as important for their cost-effective performance as are innovations in high-technology solutions.

Investments in natural infrastructure enhance resilience to growing impacts
Investments in natural infrastructure can help reduce the impacts of a changing climate. According to the National Oceanic and Atmospheric Administration (NOAA), the U.S. has sustained 241 weather and climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion. The total cost of these 241 events exceeds $1.6 trillion. In 2018 across the U.S., 14 weather and climate disaster events resulted in losses exceeding $1 billion each. These events included one drought, eight severe storms, two tropical cyclones, one wildfire and two winter storms. Overall, these events resulted in the deaths of 247 people and resulted in significant economic impacts.

Weather-related disasters have been escalating, and the trend is expected to continue. Over the last 50 years, Americans have seen a 20 percent increase in high-intensity downpours. In addition, research documents that the proportion of Category 4 and Category 5 hurricanes has doubled from 20 percent to 40 percent in 35 years (Holland and Bruyere, 2012). Coastal storm surge and storm impacts will intensify as sea levels continue to rise the predicted 0.6 feet and 2 feet globally in the next century (Intergovernmental Panel on Climate Change, 2007). Understanding these observed and projected effects are important to advance prudent management and infrastructure investments.

Investments in natural infrastructure are a smart investment
Incorporating nature in our infrastructure designs and investments provides opportunities to enhance the resilience of our nation's infrastructure, delivers a host of benefits and ensures that we are not repeatedly rebuilding infrastructure based on outdated standards and trends. For example, rebuilding culverts without taking into consideration trends of increased rainfall events will result in those culverts being repeatedly blown out, while also damaging roads. We see many examples of this type of repeat damage and federal funds being wasted rebuilding the same culvert or other types of infrastructure, in the same manner, only to be subsequently destroyed during the next extreme weather event. We should make smarter investments and rebuild larger culvert openings or more resilient infrastructure designs that will accommodate flood waters or withstand other extreme weather impacts. Doing so also helps avoid costly road closures. Larger culvert sizes also enhance the health of rivers, benefiting fish and other wildlife.

What is natural infrastructure?
Defining the terms natural infrastructure or nature-based solutions can help provide a common understanding of what is meant by these terms. We have received from members of Congress and congressional staff requests for more information on what is meant by these terms.

The terms have been defined in section 1184 of Water Resources Development Act (WRDA) 2016 legislation:
"The term 'natural feature' means a feature that is created through the action of physical, geological, biological and chemical processes over time."

"The term 'nature-based feature' means a feature that is created by human design, engineering and construction to provide risk reduction in coastal areas by acting in concert with natural processes."
WRDA 2018 amended the definition of nature-based feature to strike the word "coastal," resulting in the term applying to all areas.

We generally agree with this definition.

Natural infrastructure incorporates both the natural environment and engineered systems that mimic natural processes or work in concert with natural systems to provide flood, fire and drought risk reduction, clean water and clean air benefits. Natural infrastructure delivers economic, societal and environmental benefits.

At its essence, natural infrastructure can protect, restore or mimic the role that nature plays—ecological processes, including, but not limited to, water quality and quantity processes. Natural infrastructure uses vegetation, soil health, land protection, land management and other elements and practices to protect, maintain and restore the natural processes required to manage water and other natural processes, create healthier environments and protect human communities. Natural infrastructure solutions can be applied on different scales: at the city, county or regional scales. By using nature, damages and impacts can be minimized, and communities can recover more quickly from disasters and impacts.

To illustrate varied types of natural infrastructure projects, we include a compilation of natural infrastructure projects from throughout the U.S. in which the Conservancy has been involved. (See Appendix A.) The Naturally Resilient Communities website, which the Conservancy developed along with the National Association of Counties, the Association of State Floodplain Managers, as well as others, provides an overview of natural infrastructure and case studies throughout the U.S. that illustrate varied types of projects.

Benefits of natural infrastructure include the following:

- Reducing risks to people and structures
- Reducing wave heights and storm surge
- Storing and conveying water
- Improving water quality (and reducing costs of water treatment)
- Reducing drought impacts
- Reducing threats of catastrophic fires
- Reducing summer heat and improving air quality
- Reducing erosion and sedimentation
- Providing green spaces, greenways and recreational opportunities
- Providing habitat for fish and wildlife

Types of natural infrastructure include the following:

River work	Coastal work	Urban work
Reconnecting rivers to floodplains	**Conserving/restoring coastal marshes**	**Constructed wetlands**
Levee setbacks and realignments	**Conserving/restoring oyster and shellfish reefs**	**Bioretention cells**
Flood bypasses	**Conserving/restoring coral reefs**	**Planting trees**
Conserving/restoring watershed forests	**Building living shorelines**	**Conserving lands in watershed headwaters**
Conserving/restoring river corridors	**Conserving/restoring intertidal flats**	**Sustainable forest management**
Conserving/restoring wetlands	**Conserving/restoring mangroves**	
Constructing wetlands		
Establishing flood water detention areas		
Fish/flood friendly culverts/bridges		
Dam removal		
Establishing filter strips, grassed waterways on farm fields		

Investing in natural infrastructure can be economically prudent

The traditional approach to flood and water quality protection in river-floodplain systems has been to rely on dams and levees to contain flood waters; build treatment plants and lay miles of pipes to treat and transport water and wastewater; and, in coastal areas, build sea walls, bulkheads and other gray infrastructure. While built infrastructure plays an important role in helping to secure and provide essential services to communities, it requires substantial investments for both initial construction and ongoing maintenance. Moreover, extensive reliance on built infrastructure in the United States during the 19th, 20th and early 21st centuries has encouraged land development in areas particularly susceptible to flooding and storm damage and catastrophic flooding when infrastructure fails. And fail it has.

Many disasters during the past decade have involved numerous levee breaches, dam failures and seawall breaches. Failing gray infrastructure has led to extensive property and infrastructure destruction and lives lost.

If left unaddressed, as the nation's water infrastructure and flood protection infrastructure continue to age, we expect economic losses will continue to increase—including the taxpayer's large obligation under the National Flood Insurance Program—along with the risk faced by tens of millions of Americans who live and work behind levees and tens of millions more living along the coast.

Renewing the nation's traditional built flood control and water infrastructure solutions presents a daunting challenge. The American Society for Civil Engineers reports that there are 30,000 documented miles of levees in the U.S. protecting communities, critical infrastructure and valuable property. The levees in the U.S. Army Corps of Engineers' database protect an estimated $1.3 trillion in property. Yet development continues to encroach in floodplains along rivers and coastal areas, exacerbating flood risk and putting property at risk. An estimated $80 billion is needed in the next 10 years to maintain and improve the nation's system of levees. The challenge also exists for coastal infrastructure. In Massachusetts alone, there are about 140 miles of publicly owned sea walls or other structures along the coast designed to protect billions of dollars of property. Most were designed to last a half century but are older than that now. The estimated price tag to repair and fortify all of them against rising seas is more than a billion dollars.

Natural infrastructure or natural infrastructure combined with gray infrastructure is often the most cost-effective and best-performing option for reducing flood risk while delivering a host of other benefits such as improved water quality, enhanced habitat for fish and animals, improved aesthetics and overall contribution to a community's quality of life.

For example, the U.S. Forest Service estimates that 180 million people access their drinking water from national forests. More than 5 million of these people live in communities served by small- and medium-sized utilities that rely on surface water for their drinking water. At a time when climate-driven droughts and megafires are more common, these communities will need support to protect both homes and water supplies. And in urban areas, investments in natural infrastructure—such as parks and green spaces, as well as dunes and wetlands—can help increase cities' resilience to climate change, as well as improve the health, safety and quality of life of urban residents.

Growing body of evidence on effectiveness and cost effectiveness of natural infrastructure

In Coastal Areas

A growing body of knowledge and experience demonstrate the effectiveness and cost effectiveness of coastal natural infrastructure. In the U.S., coastal wetlands act as "horizontal levees" for a value of $23.2 billion per year in protection from storms (Costanza et al., 2008). Barbier et al. (2013) show that coastal marshes and vegetation have demonstrable effects on reducing storm surge levels, which provides significant value in protecting property in southeast Louisiana. They measured that a mere 1 percent increase in wetland continuity over 6 kilometers would lower residential property flood damages by $592,000 to $792,100, and a marginal increase in bottom friction over 6 kilometers would reduce flood damages by $141,000 to $258,000.

In a 2016 study, the Conservancy, in partnership with Risk Management Solutions, a global leading risk modeler for the insurance industry, Guy Carpenter & Co. and others showed that marsh wetlands saved more than $650 million in property damages during Hurricane Sandy and reduced annual property losses by nearly 20 percent in Ocean County, New Jersey (Narayan et al., 2016b).

Oyster reef development and restoration also yield significant economic benefits. A 2012 study by Conservancy economist Timm Kroeger summarized that an investment of $150 million in oyster reef restoration will achieve the following:

- Build 100 miles of oyster reefs
- Create 380 jobs per year for 10 years, or rather, 3,800 jobs during the decade-long construction phase
- Boost regional household income by $9.7 million a year during the 10-year construction period
- Increase revenues and sales of crab, fish and oyster harvests by $7.87 million yearly
- Save property owners up to $150 million on the construction of bulkheads
- Enhance yearly saltwater angler spending by $4.9 million in Alabama alone
- Increase annual sales by $7.3 million in the commercial seafood supply chain

In Freshwater Areas

There are also examples of investing in natural infrastructure in freshwater systems. The best known example is New York City's effort to protect its water supply. In the late 1990s, New York City initiated a plan to protect its source water and avoid the cost of a filtration plant by investing in its 2,000-square-mile watershed. A filtration plant would have cost the city $8 billion to $10 billion in current dollars—roughly $6 billion to build and $250 million annually to maintain. In contrast, the cost of securing natural infrastructure in the watershed was estimated at $1.5 billion. The watershed program has staved off the need to build a filtration plant and provided an annual $100 million injection to the rural economy in the upper reaches of the watershed by providing supplemental income to farmers and forestland owners, paying local contractors to install septic systems and set up stormwater protection measures and promoting ecotourism (Kenny, 2006.)

Another example is from the City of Medford, Oregon. Its wastewater facility discharges into the Rogue River but exceeds maximum temperature load requirements as allowed by its total maximum daily load (TMDL). To meet its temperature TMDL requirements, Medford evaluated three alternatives: lagoon storage for discharge later in the year, mechanical chillers and riparian restoration and shading. An economic analysis showed that riparian restoration was three times more cost effective than mechanical chillers for reducing thermal loads into the river and would provide additional benefits such as wildlife habitat and water filtration.

It is often more cost effective to invest in reduction of risks of catastrophic wildland fire than to pay for impacts of damaging fires. For example, thinning 1 acre of dense forest in the critical Rio Grande and San Juan-Chama headwaters area costs $700 on average, whereas the economic impact of 1 acre affected by damaging wildfire can be up to $2,150 per acre. Even if just one large fire burns, the upfront investment in forest health saves money: Forest thinning to boost fire resilience is estimated to cost $73 million to $174 million, with damage estimates between $104 million and $1.3 billion. This approach makes economic sense over the long term. A recent study estimated the cost of damages from wildfires from 2009 to 2012 in New Mexico was $1.5 billion. In contrast, the Rio Grande Water Fund estimates a total cost of $420 million over 20 years to accelerate the pace and scale of forest treatments and restoration. Preserving and restoring these forests will help ensure the sustainability of New Mexico's water supply and increase social and economic benefits for local communities.

Nationally, a rough estimate is that 67 percent of culverts are not designed to allow for a 1 percent flood (100-year flood) and need upsizing. Assuming a quarter of those need immediate replacement, the savings over the life of the new culverts would be $8 trillion. The savings increase with increased flood risk and grow exponentially when emergency management is required due to road or bridge washout—none of the calculations account for the dramatic costs of catastrophic failure and emergency replacement. When aggregated to a federal level, culvert upgrades could represent significant savings to public transportation budgets.

In Hancock, New York, three flood events between 1996 and 2005 damaged an undersized culvert on Big Hollow Creek. In those nine years, Delaware County spent more than $70,000 to repair damages to the culvert, as well as the road and adjacent ditches. In addition, the detour length associated with closure of the road for repairs was 18 miles. Late in 2005, with hazard mitigation funding assistance from the Federal Emergency Management Agency (FEMA), the county installed a three-sided concrete box culvert with a natural bottom, designed to convey a 100-year storm and provided at a cost of $143,000. The improved crossing has survived seven federally declared flood disasters, including Hurricane Irene, without significant damage since its replacement in 2005 (W. Reynolds, Delaware County Department of Public Works, pers. comm.).

In Urban Areas

Natural infrastructure in cities is most often called green infrastructure. Green infrastructure has a proven track record of being more cost effective, in many cases, than traditional gray infrastructure solutions in achieving surface water management goals. For instance, the American Society of Landscape Architects studied 479 green stormwater infrastructure projects, of which 44 percent were lower than and 31 percent were equivalent to the costs of gray infrastructure alternatives.

In one example at Episcopal High School in Baton Rouge, the cost of bioswales and rain gardens constructed in lieu of replacing stormwater pipes with larger-sized pipes saved the school $390,000, a cost savings of 78 percent over the original project budget of $500,000.

Green infrastructure projects, beyond level of service and environmental benefits, have compounding economic benefits. In its study of the green infrastructure alternative for the City of Lancaster, Penn., the Environmental Protection Agency demonstrated that the added-value benefits amounted to nearly $5 million per year.

Congressional actions by this committee and others have enabled increased investments in natural infrastructure

Congress has taken some important steps toward recognizing, enabling and funding investment in natural infrastructure. An important milestone occurred in the special disaster appropriations that Congress passed in response to Superstorm Sandy. Congress appropriated funding for several agencies and programs that provided important investments in natural and nature-based project work resulting in reducing future flood risk. U.S. Fish and Wildlife Service received $360 million for coastal resilience projects. This funding spurred important investments in natural infrastructure. With this funding, the Conservancy led work in New York to mitigate

flooding and improve fish passage in the Ausable watershed and invested in green infrastructure in Accomack and Northampton counties in Virginia. The Conservancy also contributed to work in Delaware restoring Delaware Bay's wetlands and beaches in Mispillion Harbor Reserve and Milford Neck Conservation area, and in Massachusetts removed 10 fish barriers in nine communities resulting in lowering flood risk and improving fish habitat and overall quality of the streams.

Other sources of funding in the Sandy bill also contributed to enhanced resilience by helping invest in natural infrastructure. NOAA was awarded a small amount of funding that it invested in funding networks of state, academic, local and nongovernmental organizations to build a learning network to spur planning and implementation of actions to enhance community resilience. This was an important capacity-building investment helping grow and disseminate and build the body of knowledge and capacity to implement future coastal resilience work. One such investment in New Jersey continues to enable ongoing coastal resilience work in that state. Natural Resource Conservation Service was awarded funds through its Emergency Watershed Protection program, which invests in easement purchases in floodplains to restore floodplain areas and allow them to function as areas to absorb and slow floodwaters.

Sandy disaster funding also included $1 billion in disaster funds for the Housing and Urban Development (HUD) National Resilience Competition. The competition encouraged communities to develop disaster recovery plans from past disasters and make investments to lower risk to future disasters while advancing broader community development goals. The competition encouraged participants to think expansively when developing projects that would enable community development goals and ensure public engagement. As part of the effort, the Rockefeller Foundation collaborated with HUD and provided workshops and expert input to applicants to help build capacity and enhance application quality. Most of the applications in response to this competition included elements of investment in natural infrastructure. The Conservancy would like to see this program replicated.

In addition to funding bills, other legislation has advanced the concept of and enabling conditions for investing in nature as a tool for reducing risk from a range of impacts such as flooding, drought and wildfires.

As noted previously, WRDA 2016 provided the most comprehensive definition of natural and nature-based infrastructure to date. The 2018 WRDA bill builds on this definition to further require the Army Corps to consider natural and nature-based infrastructure when carrying out studies of projects.

As evidence of the Army Corps' own work to support investments in natural infrastructure, the Army Corps held an event at the National Building Museum in Washington, D.C., to launch its new publication, "Engineering With Nature: An Atlas." The book is filled with global examples of natural and nature-based project work.

Further work to be done to enable natural infrastructure investments

Many other statutes have included the need to protect and restore ecosystems and watersheds to protect the myriad of important services intact and healthy natural systems provide to people. There are many more opportunities to continue to include this intent in other legislation dealing with infrastructure investments and disaster, wildfire and drought risk reduction. The Conservancy will continue to advocate for consideration of and investments in natural infrastructure as the Congress works on developing a bill to invest in infrastructure, as well as in other appropriate legislative vehicles.

Congress must also ensure that infrastructure is built to enhance resilience in the context of a changing climate and increasingly frequent extreme weather and wildfire events. Congress can improve planning, training and direct investments in nature-based and gray infrastructure by doing the following:

- Requiring resilience and flood and wildfire risk analysis in federally funded work, and upgrading flood maps and wildfire risk maps
- Bolstering interagency coordination to enhance resilience
- Incentivizing enhanced community hazard mitigation planning and investments
- Enhancing consideration of and investments in natural infrastructure alone or in combination with gray infrastructure to maximize environmental, societal and economic benefits
- Reducing wildfire risk to communities by investing in future risk reductions following disasters and updating Community Wildfire Protection Plans
- Codifying the Forest Service Legacy Roads and Trails program to prioritize corrections to deferred maintenance
- Increasing reforestation by investing in the U.S. Forest Service Reforestation Trust Fund to plant an additional 1 million trees in three years

And federal agencies can play varying roles in advancing investments in natural infrastructure, including the following:

- Army Corps can continue to invest in natural infrastructure by offering training and workshops for its staff throughout the U.S. to help them understand how best to incorporate nature in their project analysis and implementation
- NOAA can provide data, decision support tools such as online vulnerability assessment and solution analysis tools, technical assistance and training
- U.S. Geological Survey can make its science more centrally located, accessible and in easy-to-access online GIS-based tools
- FEMA can make more of its flood data available and accessible to allow better analysis and targeting of risk reduction actions
- Federal Highway Administration can invest more resources in its infrastructure vulnerability assessment work and dissemination and training around its soon-to-be-released guidance on incorporation of natural infrastructure into transportation investments

Growing support among businesses and communities

In addition to growing support in Congress to promote investments in natural infrastructure, the Conservancy has seen encouraging, growing support from businesses who see investments in nature as important business investments.

In 2015, the Conservancy joined with Caterpillar and launched the Natural Infrastructure Initiative (NII). The NII grew out of a gathering of business leaders recognizing the need to work with and invest in nature and understanding this as a business opportunity. Members of the NII in addition to the Conservancy and Caterpillar include AECOM, Great Lakes Dredge and Dock, Ducks Unlimited and Brown and Root. NII members are working collaboratively to accelerate investment in water-based natural infrastructure projects as part of a solution set for infrastructure needs, embed natural infrastructure as part of ongoing discussions about improving investment in water-based infrastructure and promote the use of natural infrastructure in general.

The Conservancy has worked with other companies and organizations to investigate natural infrastructure solutions and invest in projects. Some examples include Dow, Jacobs, Boeing, BSNF and the American Society of Civil Engineers. The Conservancy is committed to working with businesses who understand the value of making these investments.

In addition to corporate support, the Conservancy has seen growing support among elected officials and is working with organizations such as the Mississippi River Cities and Towns Initiative (MRCTI), which represents cities and towns along the main stem of the Mississippi River and advocates on issues facing the communities, such as improving water quality and reducing flood risk. The Conservancy has also worked with the National Association of County Officials (NACO), who has joined with us in support of investments in natural infrastructure. MRCTI and NACO members understand the numerous benefits provided through investments in nature.

Conservancy examples of various types of natural infrastructure work

The Conservancy is a leader in executing projects that serve as prime examples of investments in natural infrastructure. I would like to close my testimony by briefly describing a few representative examples of the Conservancy's work taking place throughout the U.S.

Hamilton City, Calif.—Hamilton City is located approximately 90 miles north of Sacramento and is adjacent to the west bank of the Sacramento River. The project is a multipurpose flood damage reduction and ecosystem restoration project consisting of construction of a 6.8-mile setback levee to provide improved flood protection to the community and agricultural areas, and reconnection of approximately 1,400 acres to the Sacramento River floodplain and restoration of that acreage into native riparian habitat. The project was authorized under WRDA 2007, amended in WRDA 2017 and is estimated to cost $91 million, of which $31.3 million is the non-federal contribution. The fact that this project addresses both flood protection and ecosystem restoration required new Army Corps policy guidelines to permit these objectives in a single project. The Conservancy is working with the Army Corps nationally to encourage expanded implementation of multi-benefit projects, which is challenging given the Army Corps' methods for evaluating the cost and benefits of projects. The project will help to lessen historic flooding that has impacted Hamilton City and result in enhanced habitat for fish and wildlife.

Pacific Northwest—Throughout the Pacific Northwest, tide gates and levees are used to control water from rivers and the ocean on low-lying properties. Tidal wetlands—which are critical to the survival of salmon—once covered most of the Coquille Valley. Today, less than 10 percent of these historic wetlands in the Coquille Basin remain. The Conservancy has been working with federal and state partners in the Coquille watershed in southwestern Oregon to design, upgrade and replace tide gates, which is already proving to provide benefits to the local community and the agricultural grazing lands while at the same time improving water quality, rearing habitat and fish passage.

The Conservancy and partners have work underway replacing old tide gates and culverts with seven new tide gates and five new bridges to dramatically improve fish passage and restore wetland function and tidal flow in the Coquille basin. By working with the Beaver Slough Drainage District, China Creek Gun Club, Coquille Indian Tribe, federal partners such as NOAA and U.S. Fish and Wildlife Service and other entities, this project is reconnecting 7.8 miles of historic channels to the Coquille River. The new infrastructure requires less maintenance, resulting in cost savings over time. Local landowners have reported their excitement about "raising cattle in the summer and salmon in the winter."

The construction projects are projected to generate at least $4.2 million and will support 18 to 25 jobs. Many local businesses will see new demand in specific industries like nurseries, heavy equipment, rock or gravel and local labor.

New Jersey—Since Superstorm Sandy, the Conservancy's New Jersey chapter has been working to demonstrate the success and benefits of projects that help its coastal salt marshes—which helped reduce damages in New Jersey during Sandy by nearly $500 million—persist in the face of sea level rise. One such project tested an innovative technique in which clean mud and sand from clogged boat channels was sprayed on top of nearby marshes to help boost the elevation of more than 60 acres of marsh. This so-called technique of beneficial reuse of dredged material is aimed at boosting the health of the wetland to help reduce future storm impacts. This project was the result of a successful partnership with the Army Corps, the State of New Jersey and others. The construction on three different marshes was completed about three years ago, and the Conservancy is helping to assess the success and impact of the project. The results have been promising. In combination with other nature-based solutions, like oyster reef breakwaters to reduce marsh erosion, the Conservancy is working to expand the consideration and implementation of a variety of natural infrastructure investments to help the Jersey Shore become more resilient to the impacts of climate change.

Washington, D.C.—To mitigate stormwater runoff, Washington, D.C., instituted a first-of-its-kind stormwater retention credit (SRC) market. The market reduces the impact of stormwater runoff—the largest-growing source of pollution to the Chesapeake Bay watershed and the fastest-growing source of urban water pollution globally. It allows land-constrained developers to meet a portion of their stormwater retention requirements by purchasing SRCs. Credits are generated by stormwater retention projects elsewhere in the city, including green infrastructure projects.

Investments in green infrastructure for stormwater retention can bring income to landowners and provide valuable co-benefits, including expanded green space, reduced localized flooding,

increased flexibility and onsite revenue options for developers and jobs to build and maintain green infrastructure sites. Offsite credit projects create opportunities for infrastructure investments in underserved communities.

The Conservancy's NatureVest is partnering with Encourage Capital to establish and capitalize District Stormwater, LLC (DS), which will finance and develop SRC-generating projects. DS will work with landowners and community groups to site credit-generating projects in parts of Washington, D.C., that would most benefit from green infrastructure while creating liquid, cost-competitive credits for sale in the SRC market. DS anticipates mitigating 500,000 gallons of runoff annually. This will protect fragile ecosystems, such as the Chesapeake Bay, that are too often overrun by polluted stormwater that can contain raw sewage; provide infrastructure services to underserved communities through increased green space and the reduction of localized flooding; and inspire new conservation-minded people as they see the benefits of green infrastructure in their communities.

Gulf of Mexico—Throughout the Gulf of Mexico and along the eastern seaboard, oysters play a vitally important role in supporting healthy estuaries. Oyster reefs provide multiple benefits, from providing habitat and food for wildlife, to filtering water, removing nitrogen and stabilizing eroding coastlines. Oysters are also a favorite cuisine for people, and states throughout the southeast once had robust oyster fisheries. A healthy adult oyster can filter up to 50 gallons of water daily, helping to cleanse estuaries and support aquatic grasses and other plants that need light to survive. These plants, in turn, yield benefits like fish production and carbon storage, completing an invaluable cycle. Healthy oyster reefs also serve as natural buffers against rising sea tides and hurricanes by forming breakwaters that help protect shorelines from erosion. Oyster reefs also create economic value, bringing upwards of $10 million (dockside valuation) into Florida alone. Oyster reefs have severely declined throughout their historical ranges all over the world. Today, oyster reefs are considered one of the planet's most imperiled marine habitats. Over the last two centuries, more than 85 percent of the world's oyster reefs have been lost. The Conservancy is working throughout the Gulf of Mexico, as well as along the eastern seaboard, to restore and build oyster reefs to maximize the services this important species provides to people and nature.

Massachusetts—In September 2016, Gov. Charlie Baker issued an executive order that launched a statewide planning process and a municipal technical assistance program. A priority is placed on investing in nature-based solutions to enhance resilience and actions to mitigate climate change.

Along with the executive order, the state launched a new website, the resilient MA Climate Clearinghouse, to provide communities access to the best science and data on expected climate change impacts, information on planning and actions communities can deploy to build resilience and avoid loss, and links to important grant programs and technical assistance. The state has also stood up the Municipal Vulnerability Preparedness program that provides communities with a planning expert to walk them through a Conservancy-developed community resilience building process. Communities must update their hazard mitigation plans after going through the process and continue to make progress to be eligible for state mitigation grant funds.

This past year, the Massachusetts legislature-enacted climate change bond provided $2.4 billion in capital funding for the next five years. The focus is on investing in nature-based solutions to lessen climate impacts and enhance resilience. In January, Baker filed a bill to increase the real estate transaction fee and use the funds for climate change adaptation and resilience (more than $1 billion over 10 years).

This program should be replicated at the federal level. An important role federal agencies can play is to provide technical and planning assistance, provide the latest science in a user-friendly manner and share best practices to effectively address the challenges of extreme weather and a changing climate that are inflicting significant costs on communities throughout our nation.

Conclusion

Thank you for the opportunity to present The Nature Conservancy's recommendations on the need for the federal government to prioritize investment in nature as an important tool for enhancing resilience to the increasing impacts of extreme weather and climate change. The Conservancy will continue to lead the way in contributing to the science and executing projects that demonstrate the important benefits and services that nature provides to people. The Conservancy will continue to work with the Congress to recommend and advance policies to support increased investments in natural infrastructure that help cost effectively address our nation's infrastructure challenges.

Appendix A:
Natural Infrastructure: What Does It Mean?

Natural infrastructure incorporates both the natural environment and engineered systems that mimic natural processes or work in concert with natural systems to provide flood, fire and drought risk reduction, clean water, and clean air benefits. Natural infrastructure delivers economic, societal and environmental benefits.

At its essence, natural infrastructure can protect, restore, or mimic the role that nature plays—the ecological processes—including, but not limited to, water quality and quantity processes. Natural infrastructure uses vegetation, soil health, land protection, land management and other elements and practices to protect, maintain and restore the natural processes required to manage water and other natural processes, create healthier environments, and protect human communities.

Natural infrastructure solutions can be applied on different scales: at the city, county or regional scale. By using nature, damages and impacts can be minimized and communities can recover more quickly from disasters and impacts.

Benefits of Natural Infrastructure

- Keep people and structures out of harm's way
- Reduce wave heights and storm surge
- Store and convey water
- Improve water quality
- Reduce drought impacts
- Reduce threat of catastrophic fires
- Reduce summer heat and improve air quality
- Reduce erosion and sedimentation
- Provide greenspaces, greenways and recreational opportunities
- Provide habitat for fish and wildlife

Types of Infrastructure Projects

River work	Coastal work	Urban work
• Reconnecting river to floodplains	• Conserving/restoring coastal marshes	• Constructed wetlands
• Levee setbacks and realignments	• Conserving/restoring oyster and shellfish reefs	• Bioretention cells
• Flood bypasses	• Conserving/restoring coral reefs	• Planting trees
• Conserving/restoring watershed forests	• Building living shorelines	• Conserving lands in watershed headwaters
• Conserving/restoring river corridors	• Conserving/restoring intertidal flats	• Sustainable forest management
• Conserving/restoring wetlands	• Conserving/restoring mangroves	
• Constructing wetlands		
• Establishing flood water detention areas		
• Fish/flood friendly culverts/bridges		
• Dam removal		
• Establishing filter strips, grassed waterways on farm fields		

Mobile Bay, Alabama

Project Type: Flood and/or Erosion Risk Reduction

Mobile Bay is the fourth largest estuary in the continental United States and plays an important role in nurturing the finfish, shrimp and oysters that are vital to Gulf communities.

Unfortunately, Mobile Bay—like the rest of the Gulf Coast—has lost many of its oyster reefs, seagrass beds and coastal marshes. Losing these reefs has meant increased shoreline erosion and related property damage.

Despite these challenges, Mobile Bay remains one of the largest potential areas for outright restoration, replacement and enhancement of these lost habitats on the Northern Gulf Coast.

The Conservancy is working with partners, including the U.S. Army Corps of Engineers, to build 100 miles of oyster reef and plant 1,000 acres of coastal marsh and seagrass here to help replenish the coastal waters and reduce shoreline flood impacts to local communities.

Hamilton City, California

Project Type: Flood and/or Erosion Risk Reduction

In partnership with the U.S. Army Corps of Engineers, the California Department of Water Resources, and Reclamation District 2140, the Conservancy is championing a $73 million project where, for the first time, the Army Corps designed a multi-benefit project to specifically reduce flood damages and restore critical floodplain habitat on the Sacramento River.

Construction began in spring 2016 building a new 6.8-mile setback levee, along with reconnecting 1,450 acres of floodplain between the new set-back levee and the river.

Approximately 1,361 acres will be restored to native riparian habitat and significantly reduce flood risk to the City of Hamilton, which has frequently evacuated due to flooding.

The Sacramento River supports important agricultural areas and critical wildlife habitat. © Jeff Fricker

Emiquon Preserve, Illinois

Project Type: Flood and/or Erosion Risk Reduction

The Nature Conservancy restored 5,900 acres of functional floodplain wetlands and five river miles along the Illinois River in Fulton County, Illinois.

Included in this restoration was, in consultation with the U.S. Army Corps of Engineers, the installation of a state-of-the-art flood control structure.

The final result of this restoration connected floodplain to the 7,000 acres of adjacent Chautauqua National Wildlife Refuge lands, resulting in 14,000 acres of contiguous conservation lands, providing flood control, environmental restoration, and public access to wildlife and waterfowl habitat.

The Nature Conservancy uses its Emiquon Preserve to demonstrate and measure the benefits of restored floodplains and wetlands. © Christina Rutter

Water control structure at Emiquon preserve.

South Cape May Meadows Preserve, New Jersey

Project Type: Flood and/or Erosion Risk Reduction

In partnership with the U.S. Army Corps of Engineers and the State of New Jersey, the Conservancy undertook a $15 million restoration project that combined natural features like dunes and wetlands with levees and other engineered structures to control water.

Completed in 2004, the restored preserve has since withstood a series of severe storms, including Irene in 2011 and Sandy in 2012.

Storm waves didn't breach the dunes, wetlands remained intact, and the preserve helped protect neighboring communities, which experienced only minor flooding unlike similar towns up and down the coast.

The Nature Conservancy has helped restore over 630 acres of coastal dunes, which can help protect communities from storms. © Harold E. Malde

Whittenton Dam, Taunton, Massachusetts

Project Type: Flood and/or Erosion Risk Reduction

In Massachusetts alone, there are close to 3,000 dams; many of them are relics of bygone uses.

The Whittenton Pond Dam was in disrepair, and heavy rains in 2005 brought the threat of a catastrophic breach and flooding of downtown Taunton, which was evacuated for a week as the dam appeared on the verge of failure.

Removing the dam was less expensive than repairing it, with rebuilding cost estimated to be $1.9 million and removal cost of $447,000.

The dam's removal in 2013 opened 30 miles of river habitat to vulnerable fish species, avoided $1.5 million in emergency response cost, increased numbers of two vulnerable species (American eel and river herring), and increased property values due to the lower flooding risk.

Whittenton Mills dam, damaged during 2005 storm. photo credit: MA Division of Ecological Restoration

Ausable River Watershed, New York

Project Type: Flood and/or Erosion Risk Reduction

Undersized stream crossings are prone to damage from high flow events and require more frequent maintenance and replacement. During major storms, undersized culverts block water, clog with debris and worsen flood impacts, requiring expensive repairs to the culverts, nearby roads, and private property. When roads shut down due to this damage, it creates lengthy detours, often affecting access to local businesses. Poorly designed and installed culverts also block fish and wildlife movement and impact habitat for economically important fisheries.

In August 2011, Tropical Storm Irene brought significant rainfall to much of New England and eastern New York, resulting in unprecedented flood damage to infrastructure.

The Conservancy secured private and government grant funding to replace and retrofit high ecological priority, flood-vulnerable culverts in New England and in upstate New York. To date, The Conservancy has worked with government and non-profit partners to complete three culvert replacements and two culvert retrofit projects in the Ausable River Watershed in the Adirondacks. These projects connect over 65 miles of previously fragmented fish habitat, mitigate future flood damage, improve safety on vital local road networks, and reduce maintenance costs for communities. The culvert upgrades prevent future road damage that occurs when undersized culverts blow out during floods.

Roaring Brook culvert prior to replacement. At lower flows this culvert outlet was perched above the water surface, creating a barrier to the movement of fish. The stream was constricted by the pipes' combined span of 12 feet, which caused debris build-up and localized flooding.

Roaring Brook culvert replacement: With a width of 35 feet, the new culvert – an open-bottom concrete box with a natural streambed – allows the stream to pass freely underneath, opening six miles of upstream habitat for fish and designed to withstand high water flows.

Upper Mississippi River

Project Type: Flood and/or Erosion Risk Reduction

In cooperation with a diverse group of Upper Mississippi River (UMR) stakeholders, The Nature Conservancy is working to garner federal appropriations for a dual-purpose program called the Navigation and Ecosystem Sustainability Program (NESP). As the name implies, this program is a measured plan to create a sustainable navigation system with strategic improvements at 7 of 37 locks and other small-scale efficiency measures. Safe and efficient movement of traffic would be renewed on the navigation system, which was constructed almost 80 years ago and is now facing continual rehabilitation to maintain. At the same time, comparable funding for ecosystem restoration on the UMR will afford the opportunity to use additional techniques for river restoration such as reconnecting 35,000 acres of river floodplain; providing native fish passage; regenerating floodplain forests; and managing water levels closer to historic conditions to replicate more natural seasonal conditions.

These new techniques, along with well-established river enhancement measures to revitalize river channels, backwaters and floodplain habitats are estimated to restore 40 percent of degraded UMR ecosystem. A higher-functioning ecosystem provides human and natural services through increased nutrient processing, flood storage capacity, ground water infiltration, cleaner water, and improved fish and wildlife habitat.

Lock extensions from 600’ to 1200’ will increase efficiency at the 7 lock improvement sites by eliminating the need double locking (as shown in picture) which is standard practice at all but two locks on the 37 lock system of the UMR. Disintegrating concrete and mechanical systems will be rehabilitated or replaced as the lock in lengthened.

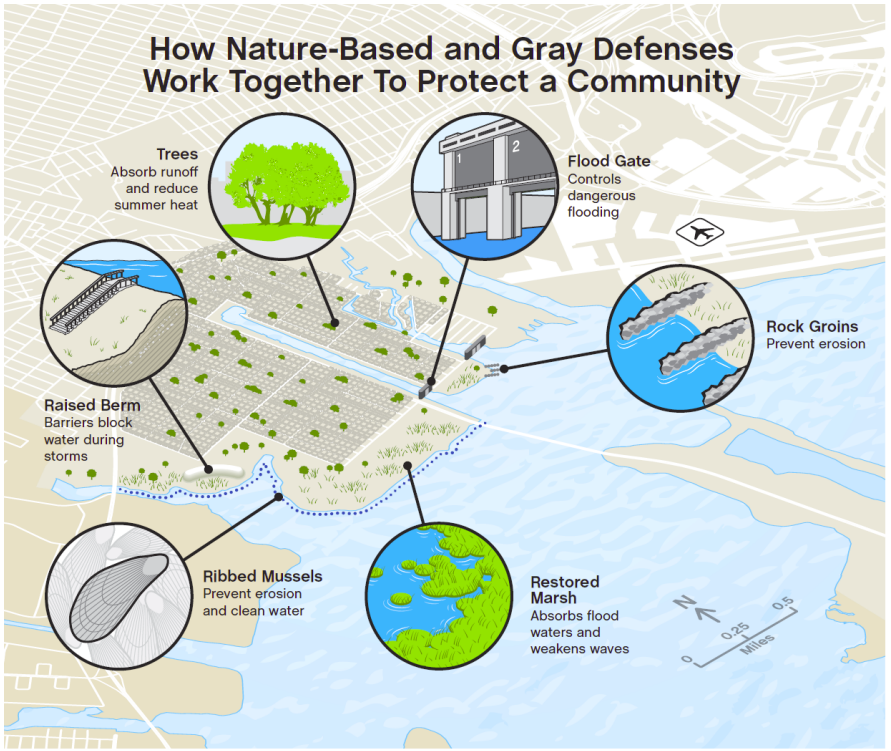
Howard Beach, Queens, New York

Project Type: Flood and/or Erosion Risk Reduction

In the wake of Hurricane Sandy, The Nature Conservancy undertook a project evaluating the role of nature and nature-based infrastructure in protecting communities from some of the impacts of climate change. The community of Howard Beach, Queens, was selected as a case study for the project because this neighborhood, hit hard during Sandy, is low-lying and densely populated. Although Howard Beach was used in the analysis, the study methodology is applicable to coastal communities across New York City and around the globe.

Experts analyzed several infrastructure alternatives, ranging from purely nature-based solutions to one consisting of only gray defenses. The study found that combining natural and gray defenses holds the most benefits. Analysis shows that a hybrid alternative could result in avoided losses in this one neighborhood of up to $244 million from the current 1-in-100-year storm event.

The best conceptual alternative and most cost-effective, according to the study, utilizes restored marsh habitat on the coast, hard toe mussel beds along the shoreline, floodgates and sea walls to protect against storm surge and rising sea levels and rock groins on the shoreline to help prevent erosion.



Infographic of design alternatives studies.

Rio Grande Water Fund, New Mexico

Project Type: Flood and/or Erosion Risk Reduction

The Rio Grande Water Fund is a ground-breaking project that is engaging private and public partners in proactively protecting vital watersheds in northern New Mexico.

Frequent, high-severity wildfires and subsequent post-fire flooding increasingly threaten the Rio Grande's water security and cause extensive soil erosion that degrade water quality for communities downstream. Restoring overgrown forests is a proven solution to make forests safer and healthier, and such efforts were already underway at a small scale before the devastating Las Conchas fire blazed in 2011. This fire demonstrated that the pace and scale of these treatments was insufficient to guarantee water security for Albuquerque and irrigated agricultural lands. The Rio Grande Water Fund works to generate sustainable funding for a 20-year, large-scale program to restore the health of the forest and watershed with treatments that include thinning overgrown forests, restoring streams and rehabilitating areas that flood after wildfires.

This approach makes good economic sense over the long-term. A recent study estimated the cost of damages from wildfires 2009 to 2012 in New Mexico was $15 billion. In contrast, the Rio Grande Water Fund estimates a total cost of $420 million over 20 years to accelerate the pace and scale of forest treatments and restoration. Preserving and restoring these forests will help ensure the sustainability of New Mexico's water supply and increase social and economic benefits for local communities.

Wetlands at Valles Caldera National Preserve. The Rio Grande Water Fund engages private and public partners in protecting vital watersheds in northern New Mexico. Photo credit: © Alan W. Eckert for The Nature Conservancy

Detroit, Michigan

Project Type: Water quality and flood risk reduction with stormwater management

Like many aging cities, Detroit faces water infrastructure challenges. The city's sewer system is combined to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipes. Heavy rain events overwhelm the system's capacity, creating raw sewage overflows that flood basements and overflow into rivers and ultimately the Great Lakes.

Under the Clean Water Act, the city is required to completely eliminate all combined sewer overflow (CSO) discharges, yet the costs of implementing traditional "gray" infrastructure are only increasing, with current estimates at $1.2 billion. To help reduce or offset these costs, The Nature Conservancy is working with the city to incorporate green infrastructure, a form of natural infrastructure used in cities. The design uses green space and natural plant material to absorb, retain, and slow stormwater runoff, reducing the amount of water entering the storage facility for treatment, reducing CSO's, and decreasing surface flooding. This, in turn, should lead to improved water quality in adjacent rivers and lakes, as well as attractive green spaces that contribute to neighborhood revitalization by offering recreational areas and beautification opportunities.

The Conservancy has also provided technical assistance to develop policies that have helped finance and encourage green infrastructure solutions within Detroit. These policies have enabled economic markets and private investment in support of public amenities in new innovative ways.

Local flooding in Detroit, the result of aging infrastructure and heavy rain.
Photo credit: Michael David-Lorne Jordan/David-Lorne Photographic

Louisville, Kentucky

Project Type: Water quality and flood risk reduction with stormwater management

The Nature Conservancy is working with partners to conduct a rigorous evaluation of the link between urban vegetation/greenspace and cardiovascular disease. The goal is to foster the development of public health policy that incentivizes using increased tree canopy and other forms of nature to achieve better health outcomes.

The desire is to quantify avoided healthcare costs as a way to identify and create a funding stream for large-scale and sustained urban tree and other vegetation plantings.

The aim is to create a replicable model for neighborhood greening that other cities and developing countries can adopt. The project hopes to provide more scientific evidence of the value of nature to people.

The Conservancy plans to manage about $8 million in greening interventions, with planting beginning in 2017 and continuing for a couple of years.

Louisville's heat island has been steadily worsening over the decades, especially in low-income neighborhoods, where temperatures can be 20 degrees higher than surrounding areas.

Washington, DC

Project Type: Water quality and flood risk reduction with stormwater management

To mitigate stormwater runoff, Washington D.C. instituted a first-of-its-kind Stormwater Retention Credit (SRC) market. The market reduces the impact of stormwater runoff—the largest growing source of pollution to the Chesapeake Bay watershed and the fastest growing source of urban water pollution globally. It allows land-constrained developers to meet a portion of their stormwater retention requirements by purchasing SRCs. Credits are generated by stormwater retention projects elsewhere in the city, including green infrastructure projects. Investments in green infrastructure for stormwater retention can bring income to landowners and provide valuable co-benefits, including expanded green space, reduced localized flooding, increased flexibility and onsite revenue options for developers, and jobs to build and maintain green infrastructure sites. Offsite credit projects create opportunities for infrastructure investments in underserved communities.

Example of a stormwater retention project

The Nature Conservancy's NatureVest is partnering with Encourage Capital to establish and capitalize District Stormwater, LLC. (DS), which will finance and develop SRC-generating projects. DS will work with landowners and community groups to site credit-generating projects in parts of the District that would most benefit from green infrastructure, while creating liquid, cost-competitive credits for sale in the SRC market. DS anticipates mitigating 500,000 gallons of runoff annually. This will protect fragile ecosystems, such as the Chesapeake Bay, that are too often overrun by polluted stormwater that can contain raw sewage; provide infrastructure services to underserved communities through increased green space and the reduction of localized flooding; and inspire new conservation-minded people as they see the benefits of green infrastructure in their communities.

Long Island, New York

Project Type: Water quality protection

In what started with the conservation of 11,000 acres of bottomlands in the Great South Bay in 2002, followed by hard clam restoration efforts in collaboration with local, state and federal resource managers and stakeholders, The Nature Conservancy has embarked on a major campaign to improve water quality on Long Island.

After shellfish restoration efforts did not perform as expected, research was conducted and a group of scientists discovered that nitrogen pollution from wastewater was contaminating Long Island's groundwater and bays at a level high enough that marine life could not thrive. Since that time the situation has worsened and fish kills and toxic algae blooms have become more frequent.

The Nature Conservancy and partners are currently working with local, state and federal agencies as well as stakeholders to upgrade municipal wastewater infrastructure and onsite wastewater systems from outdated cesspools and septic systems to technology that will remove nitrogen pollution and improve water quality. This will secure the region's fishing and tourism industries into the future, restore tidal marshes that enhance community resilience to storm impacts, and protect public health.

Photo: Kenton Rowe, TNC