HSOAC
HOMELAND SECURITY
OPERATIONAL ANALYSIS CENTER

Developing Recovery Options for Puerto Rico's Economic and Disaster Recovery Plan

Appendix

HSOAC PUERTO RICO RECOVERY TEAM

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Contents

Appendix B. Courses of Action Summaries

This appendix presents the courses of action (COA) developed to support the Puerto Rico recovery plan, organized by sector. The numerical assignment of these COAs is random and does not indicate a specific prioritization. The ordering in this appendix also does not reflect prioritization.

For each proposed COA's associated cost, the relevant sector team made rough order-of-magnitude cost estimates to support high-level planning and inform decisionmaking, in 2018 dollars. The estimates represent only the costs for which a specific payment is made by some source to carry out a specific action; the estimates do not include all of the costs to society that may be associated with recovery actions. Some cost estimates are more precise than others based on the quality of data available at the time, and the estimated costs may vary based on the scale of implementation or other choices made between technical, financial, or policy options.

Cost information should be regarded as preliminary because more-final cost estimates would require specificity about the implementation of recovery options and the completed damage assessments. Insufficient information is available to provide even rough order-of-magnitude estimates for all contingencies, so some actions may have incomplete cost estimates. More information about HSOAC's contribution to planning for recovery in Puerto Rico, along with links to other reports being published as part of this series, can be found at www.rand.org/hsoac/puerto-rico-recovery.

Many COAs also indicate possible implementers, although this information is preliminary because details about how the COAs would be implemented would not be known until there is additional clarity about available funding.

Communications and Information Technology Sector

COA Number	Title
CIT 1	Land Mobile Radio System
CIT 2	Puerto Rico GIS Resource and Data Platform
CIT 3	Upgrade and Enhance 911 Service
CIT 4	Rural Area Network Task Force
CIT 5	Implement Public Safety/Government Communications Backup Power
CIT 6	Modernize the Emergency Operations Center
CIT 7	Establish an Alternate Emergency Operations Center
CIT 8	Mobile EOC Vehicle
CIT 9	Auxiliary Communications—Volunteer Radio Groups and Organizations
CIT 10	Transoceanic Submarine Cable
CIT 11	Procure a Mobile Emergency Communications Capability
CIT 12	Perform Site Structural Analysis for All Government Telecom Towers (Both Public and Privately Owned)
CIT 13	Streamline the Permitting and Rights of Way Processes for Towers and the Deployment of Fiber Optic Cable
CIT 14	Consolidated Government Information Systems
CIT 15	Undersea Fiber Ring System
CIT 16	Government Digital Reform Planning and Capacity Building
CIT 17	Puerto Rico Data Center
CIT 18	Data Store and Data Exchange Standards for Critical Infrastructure
CIT 19	Municipal Hotspots
CIT 20	Continuity of Business at PRIDCO Sites
CIT 21	Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure
CIT 22	Use Federal Programs to Spur Deployment of Broadband Internet Island-Wide
CIT 23	Data Collection and Standardization for Disaster Preparedness and Emergency Response
CIT 24	Establish Puerto Rico Communications Steering Committee
CIT 25	Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico
CIT 26	Wi-fi Hotspots in Public Housing and Digital Stewards Program
CIT 27	Study Feasibility of Digital Identity
CIT 28	Innovation Economy/Human Capital Initiative
CIT 29	Health Care Connectivity to Strengthen Resilience and Disaster Preparedness
CIT 30	Resiliency Innovation Network Leading to Development of a Resiliency Industry
CIT 31	Resilience/e-Construction Learning Lab
CIT 32	Digital Citizen Services
CIT 33	Government Digital Process Reform

CIT 1
Land Mobile Radio System

Sectors Impacted

Communications and Information Technology, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster. Beyond supporting effective disaster communications, better telecommunications infrastructure is critical to improving first-responder operations more broadly.

Description

This course of action would implement a state-of-the-art, resilient public land mobile radio (LMR) system in Puerto Rico.[1] This course of action would first assess 2 potential solutions: (1) upgrading and consolidating the current public LMR systems and their supporting microwave networks and (2) making an arrangement to join the U.S. Department of Homeland Security's Puerto Rico and the U.S. Virgin Islands Interoperable Communications Network Engagement (PRINCE) system—the federal LMR system—when available. This course of action would next put together a plan that aligns Puerto Rico's build-out in parallel with the PRINCE system build-out. This plan would have several options to choose from, depending on when PRINCE is available to the commonwealth. The options may be different for the short and long terms, and they may be different for voice and nonvoice applications. Finally, this course of action would implement the plan. This course of action would also monitor and regularly assess FirstNet as a backhaul service provider, complementary service, or potential replacement for the commonwealth's first-responder system.

Potential Benefits

Aligning the commonwealth's build-out with the federal LMR system build-out would provide increased interoperability for all stakeholders within Puerto Rico and the U.S. Virgin Islands, including all federal and commonwealth users. This course of action would also potentially reduce maintenance and logistics costs and facilitate repairs, restoration, and equipment upgrades.

[1] The FEMA Communications/Information Technology Solutions-Based Team suggested this course of action. (FEMA Communications/IT Solutions-Based Team, *DHS Puerto Rico Communications/IT Solutions Based Team*, Washington, D.C.: Federal Emergency Management Agency, June 30, 2018, Not available to the general public). Several drafts of this report were provided to the HSOAC team. The latest drafts provided were from April 26, May 1, and June 30, 2018.

Potential Spillover Impacts to Other Sectors

This course of action would benefit municipalities.

Potential Costs

Potential up-front costs: $62 million in estimated up-front costs[2]
Potential recurring costs: $77 million in estimated recurring costs (11 years)
Potential total costs: $140 million in total estimated costs[3]

The up-front costs include estimated costs for upgrading and consolidating the public LMR systems ($18 million), for provisioning P25 radios to first responders ($42 million), and for workforce development ($1.5 million). The estimate for upgrading and consolidating the current public LMR systems is $14 million–$22 million, which includes antennas and associated electronic equipment.[4] The recovery plan used the average of this range for the estimated up-front cost.

Costs for the government of Puerto Rico to lease or use the federal LMR system and FirstNet are uncertain. The recurring costs are estimated based on the personnel to maintain the LMR system, at $7 million per year.

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery

Potential Implementers

Puerto Rico Department of Public Safety, Telecommunications Bureau,[5] Office of the Chief Information Officer

Potential Pitfalls

In the short term, an upgraded and consolidated system may be more expensive than upgrading individual, separate systems. That is because the preferred system (recommended by the FEMA Communications/IT Solutions-Based Team) uses P-25 radios. These radios offer technical advantages and are the ones used in the federal LMR system, but they are more

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[2] The up-front cost published in the recovery plan represented an estimated up-front cost of $65 million. That estimate is corrected here, to $62 million.

[3] The potential costs published in the recovery plan are represented with a precision of 2 significant figures. Any appearance of costs appearing to not sum properly is due to this rounding.

[4] Hurricane Maria Communications Task Force, *DR-4339-PR Consolidated Communications Restoration Plan,* October 2017.

[5] The recovery plan lists the Puerto Rico Telecommunications Regulatory Board as a potential implementer. The board's name was changed to the Telecommunications Bureau of the Public Service Regulatory Board in August 2018, after the publication of the recovery plan. Please note that Telecommunications Bureau has been named as the implementer in place of the board throughout this appendix.

expensive than standard UHF/VHF (ultra high frequency/very high frequency) radios currently used by some of the Puerto Rico LMR systems.

If Puerto Rico joins the U.S. Department of Homeland Security's PRINCE, it would have limited influence in managing the system. Moreover, in case of damage from a hurricane or other disaster, its restoration would not be eligible for FEMA disaster relief funds. However, it can be expected that the federal government would provide the resources (including personnel) to restore it to full functionality as quickly as possible.

Likely Precursors

Before alignment with the federal LMR system can take place, significant improvement and modification of existing LMR systems are required.

CIT 2
Puerto Rico GIS Resource and Data Platform

Sectors Impacted

Communications and Information Technology, Energy, Economic, Health and Social Services, Housing, Transportation, Municipalities, Education

Issue/Problem Being Solved

A centralized system for all commonwealth agencies and municipalities that comprehensively incorporates geographic information system (GIS) data for public safety, emergency response, and community planning efforts and informs decisionmaking is presently not available in Puerto Rico for seamless coordination in the event of a disaster.

Description

This course of action would adopt a centralized network that all agencies can access, and it would establish a self-governing body that would set standards for GIS products and protocols for data use. Formation of this body would be informed by inputs from technical experts in Puerto Rico to determine how GIS data can be best utilized.

The GIS personnel in this course of action would provide information technology, GIS technical support, and system and application support across all sectors. This support would include the creation, sustainment, and enhancement of the commonwealth's GIS infrastructure that would be needed to support GIS applications in, and service requests from, other sectors. This team would also manage access and storage of GIS data.

Potential Benefits

If GIS data were collected and shared in a uniform way across public safety, emergency response, and community planning agencies, that would greatly improve the government of Puerto Rico's responsiveness in the event of a crisis. It would also reduce the time needed to create actionable strategies to deal with crises, such as hurricanes and earthquakes, as well as rebuilding and restoration efforts following a crisis.

Potential Spillover Impacts to Other Sectors

The availability of GIS data across public safety, emergency response, and community planning agencies would have a positive impact on the resilience of the infrastructure of utilities, especially telecommunications infrastructure. It would also be important for determining transportation routes and strategies in the event of a crisis. Granular information about the power grid, public safety communications, telecommunications infrastructure, access roads, population, and location of medical facilities would all speed up the government of Puerto Rico's response in a crisis. GIS data could also provide the government with real-time information to advise public

safety and emergency responders. Similarly, GIS data could assist communities with rebuilding efforts following a crisis.

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs
Potential recurring costs: $41 million–$44 million in estimated recurring costs (11 years)
Potential total costs: $42 million–$45 million in total estimated costs

The recurring costs are estimated as annual costs that depend on how many GIS professionals are involved in the effort. The up-front cost estimates assume that most of the hardware costs for this course of action would be included in CIT 17 (Puerto Rico Data Center) and CIT 14 (Consolidated Government Information Systems). Moreover, costs for IT infrastructure support for this course of action would also be included in CIT 17 (Puerto Rico Data Center) and CIT 14 (Consolidated Government Information Systems). Therefore, we avoid double-counting these investments; however, we estimate that additional up-front hardware costs specific to GIS resources would be $1 million.

Potential Funding Mechanisms

FEMA, Federal Communications Commission

Potential Implementers

Office of the Chief Information Officer, Office of the Chief Innovation Officer

Potential Pitfalls

Government agency administrators might not collaborate to share GIS data unless a cross-agency core group of GIS technical experts work together to create a coherent plan to do so.

Likely Precursors

Precursor courses of action are CIT 17 (Puerto Rico Data Center), CIT 18 (Data Store and Data Exchange Standards for Critical Infrastructure), CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure), CIT 10 (Transoceanic Submarine Cable), and CIT 24 (Establish Puerto Rico Communications Steering Committee).

CIT 3
Upgrade and Enhance 911 Service

Sectors Impacted

Communications and Information Technology, Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster.

Description

This course of action would upgrade the current 911 network to an Emergency Services IP Network (ESINet), implement Next Gen 911 (NG911), consolidate dispatch at the Public Safety Answering Point (PSAP), and coordinate with government of Puerto Rico agencies in the housing sector for the adoption of E911 address conversion of rural route addresses.

Potential Benefits

Moving to NG911 brings new features, such as ALI/ANI (Automatic Location Information/Automatic Numbering Information) and the ability to share text, photo, video, and GPS location with first responders, all of which should improve the general effectiveness of 911 services. Consolidating PSAP and dispatch would also help drive down 911 response times, by removing redundant intermediaries, and improve the resiliency of the system. Converting rural route addresses to street-style addresses would ensure that emergency services can quickly and easily locate individual properties.

Potential Spillover Impacts to Other Sectors

This course of action would help improve disaster coordination at the community and municipality levels—thus, the sectors affected are Community Planning and Capacity Building and Municipalities.

Potential Costs

Potential up-front costs: $2 million–$6 million in estimated up-front costs
Potential recurring costs: $1 million in estimated recurring costs (11 years)
Potential total costs: $3 million–$7 million in total estimated costs

The estimated up-front costs to modernize the PSAP, including implementing ESINet and consolidating dispatch, range from $2 million[6] to $6 million.[7] The estimated recurring costs include maintenance and operations costs.

Potential Funding Mechanisms

U.S. Department of Commerce

Potential Implementers

Puerto Rico 911 Service Governing Board

Potential Pitfalls

Strong governance and leadership with respect to the management of telecommunications and emergency services in Puerto Rico are essential for the successful implementation of this course of action.

Likely Precursors

Precursor courses of action are CIT 5 (Implement Public Safety/Government Communications Backup Power), CIT 24 (Establish Puerto Rico Communications Steering Committee), and HOU 11 (Improve the Address System).

[6] Federal Communications Commission, Public Safety and Homeland Security Bureau, *A Next Generation 911 Cost Study: A Basis for Public Funding Essential to Bringing a Nationwide Next Generation 911 Network to America's Communications Users and First Responders*, Washington, D.C., September 2011.

[7] Hurricane Maria Communications Task Force, *DR-4339-PR Consolidated Communications Restoration Plan*, October 2017.

CIT 4
Rural Area Network Task Force

Sectors Impacted

Communications and Information Technology, Community Planning and Capacity Building, Health and Social Services, Municipalities

Issue/Problem Being Solved

Advance public safety and health care delivery to loosely connected communities (e.g., "rural areas") by providing comprehensive, real-time situational awareness on weather conditions, emergency guidance, and medical needs.

Description

This course of action would establish a task force for the development of a telecommunications network and an information system (or, networks and systems), with a focus on the public safety and health care needs of people situated in rural or disconnected areas of the commonwealth, especially those who are isolated, have limited mobility, or are elderly, as well as their caregivers. This information systems and telecommunications network would include devices within homes or at designated local stations, rely on new infrastructure (e.g., micro rings, FirstNet, Rescue 21), be practical and efficient, operate in the immediate aftermath of a disaster, and provide key information (e.g., guidance, health issues) prior to and after a disaster for residents, emergency services, and medical providers alike.

Potential Benefits

This course of action would improve survivability (avoid loss of life) and improve the medical health of people for whom there is presently a limited telecommunications infrastructure, constraining the quality or timeliness of required health or medical services.

Potential Spillover Impacts to Other Sectors

Extending the telecommunications infrastructure to poorly connected areas can improve the readiness, planning, and allocation of resources for services sourced from medical facilities and emergency responders. The government of Puerto Rico would have an improved, detailed awareness of disaster-related issues, which would better inform decisions and coordination activities at a governmental level.

Potential Costs

Potential up-front costs: $400,000–$800,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $400,000–$800,000 in total estimated costs

The up-front cost is estimated based on a range of full-time staffing of a task force of subject-matter experts for a year, with between 6 and 12 staff, with a cost of $62,300 per staff member.

Potential Funding Mechanisms

Government of Puerto Rico, private sector

Potential Implementers

Telecommunications Bureau, Puerto Rico Emergency Management Agency

Potential Pitfalls

The proposed solutions could potentially focus more on the availability of a municipality- or facility-level network infrastructure than on acute, public safety and health care information and communication needs of people situated remotely from quality medical and emergency services in the wake of a disaster. Although the availability of a network infrastructure is a major and critical component of communications, it only partly addresses the challenge of delivering public safety and health care–related services to rural regions in a way that maximizes their benefit to the population residing in those areas, especially in the wake of a disaster. In this regard, the goals of governmental acts cited for "insular and rural areas" are at risk of being undermined.

Likely Precursors

The availability of reliable power and broadband (or corresponding telecommunications backbone) throughout Puerto Rico is necessary for this course of action. Precursor courses of action are CIT 23 (Data Collection and Standardization for Disaster Preparedness and Emergency Response), CIT 24 (Establish Puerto Rico Communications Steering Committee), CIT 29 (Health Care Connectivity to Strengthen Resilience and Disaster Preparedness), CIT 6 (Modernize the Emergency Operations Center), and CPCB 9 (Coordinated Local Recovery Planning Process).

CIT 5
Implement Public Safety/Government Communications Backup Power

Sectors Impacted

Communications and Information Technology, Energy, Natural and Cultural Resources, Transportation

Issue/Problem Being Solved

Puerto Rico's telecommunications and information technology networks are dependent on the energy grid and lack resilience and redundancy. During Hurricanes Irma and Maria, the lack of sustained electrical power had a significant impact on telecommunications and information technology networks.

Description

Lack of sustained electrical power had a significant impact on telecommunications and information technology networks during Hurricanes Irma and Maria. This course of action would invest in backup power sources, using standardized equipment where possible and appropriate, to provide the public safety and government telecommunications networks with alternate power sources in the event of damage or destruction to energy infrastructure. A redundant portfolio of power sources would improve the resilience of public safety and government telecommunications networks, thus helping to ensure government operations and emergency response in the event of a catastrophic loss of power across Puerto Rico.

Potential Benefits

Using backup power sources could increase the resilience and redundancy of Puerto Rico's telecommunications networks. Renewable sources, including solar, wind, and water systems, have the potential to be self-sustaining, freeing resources for use by systems that must rely on nonrenewable sources. Use of standardized equipment where possible and appropriate could aid maintenance and repairs should Puerto Rico have access to relevant spare parts and components, according to FEMA officials.

Potential Spillover Impacts to Other Sectors

The use of backup power systems could make telecommunications and information technology less dependent on the power grid (Energy sector). Using fuel-based generators as backup power could affect transportation networks because of the need to distribute fuel. Fuel-based generators may also affect air quality or cause fuel spills that affect groundwater, flora, and fauna.

Potential Costs

Potential up-front costs: $20 million in estimated up-front costs
Potential recurring costs: $10 million in estimated recurring costs (11 years)
Potential total costs: $30 million in total estimated costs

These estimates assume an average cost of $40,000 per backup system at a site. The up-front costs are an average of a low-end estimate (452 sites) and a high-end estimate (537 sites). The low-end estimate has 30 public tower sites; 68 hospitals; 78 police, 93 fire, and 56 emergency management services stations; 78 municipal city halls; and 49 government centers identified by the Public Buildings Authority. The upper-end estimate has 30 public tower sites; 68 hospitals; 78 police, 93 fire, and 56 emergency management services stations; 78 municipal city halls; and 134 government agencies. The recurring costs account for operations and maintenance at these sites, estimated at $1,900 per site.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

Logistical and maintenance support for fuel-based generators may be more challenging in remote or mountainous areas of the island.

Likely Precursors

None

CIT 6
Modernize the Emergency Operations Center

Sectors Impacted

Communications and Information Technology, Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, and resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster.

Description

This course of action upgrades and modernizes the Emergency Operations Center—which functions as a centralized location for the coordination and management of disasters—based on FEMA guidance.[8]

Potential Benefits

An upgraded Emergency Operations Center, with improved data and telecommunications systems, would better support response operations, incident management, and decisionmaking processes, and it would enhance emergency managers' ability to manage disaster response and recovery.

Potential Spillover Impacts to Other Sectors

This course of action would help improve disaster coordination at the community and municipality levels—thus, the sectors affected are Community Planning and Capacity Building and Municipalities.

Potential Costs

Potential up-front costs: $250,000–$6.3 million in estimated up-front costs[9]
Potential recurring costs: $6.7 million in estimated recurring costs (11 years)[10]

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[8] FEMA, *Emergency Operations Center Assessment Checklist*, Washington, D.C., August 7, 2009.

[9] The high-end estimate for the up-front costs did not capture the cost of the hardware and software for the new facility as represented in the recovery plan. The high-end estimate is corrected here.

[10] The recovery plan represented the potential recurring costs as $10 million over an 11-year period. The recurring cost estimate is updated here (1) using a labor cost consistent with other courses of action and (2) assuming a smaller-size Emergency Operations Center with reduced square footage as the basis for the operations and maintenances costs. The size of the facility was revisited after the publication of the recovery plan, resulting in this update.

Potential total costs: $7 million–$13 million in total estimated costs[11]

The range of potential up-front costs assumes a low-end up-front cost of $250,000, which includes only hardware and software costs, and a high-end up-front cost of $6.3 million, which includes both the cost of a new facility and the hardware and software costs for the facility. The potential recurring costs include facility operations and maintenance and additional labor. Operations and maintenance costs for the facility are estimated at $360,000 per year, and labor costs for two additional personnel at the existing Emergency Operations Center are estimated at $250,000 per year.[12]

Potential Funding Mechanisms

FEMA Emergency Management Performance Grant, government of Puerto Rico

Potential Implementers

Puerto Rico Emergency Management Agency, Telecommunications Bureau

Potential Pitfalls

None

Likely Precursors

CIT 5 (Implement Public Safety/Government Communications Backup Power).

[11] The recovery plan represented the total costs as a range of $11 million to $16 million. The total estimated costs are updated here to reflect the reduced recurring cost estimate.

[12] In the cost estimate published in the recovery plan, a lower personnel cost was used as the basis of estimate, only $100,000 per staff member, compared with $124,600 per staff member used in the current estimate.

CIT 7
Establish an Alternate Emergency Operations Center

Sectors Impacted

Communications and Information Technology, Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, and resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster.

Description

This course of action establishes an alternate Emergency Operations Center (EOC) outside the San Juan area, and it establishes a Public Safety Answering Point (PSAP) in the alternate EOC to serve as a backup to the primary PSAPs in San Juan. The alternate EOC would be designed to serve as a continuation of government and continuity of operations site for non-EOC activities. The alternate EOC would not be located in vulnerable areas, such as floodplains or tsunami zones.

Potential Benefits

An alternate EOC would serve as a backup location for emergency management activities should the primary EOC in San Juan become inoperable.

Potential Spillover Impacts to Other Sectors

This course of action would help improve disaster coordination at the community and municipality levels—thus, the sectors affected are Community Planning and Capacity Building and Municipalities.

Potential Costs

Potential up-front costs: $6.3 million in estimated up-front costs
Potential recurring costs: $6.7 million in estimated recurring costs (11 years)[13]
Potential total costs: $13 million in total estimated costs[14]

[13] The recovery plan represented the potential recurring costs as $10 million over an 11-year period. The recurring cost estimate is updated here (1) using a labor cost consistent with other courses of action and (2) assuming a smaller-size EOC with reduced square footage as the basis for the operations and maintenances costs. The size of the facility was revisited after the publication of the recovery plan, resulting in this update.

[14] The recovery plan represented the total costs as $17 million. The total estimated costs are updated here to reflect the reduced recurring cost estimate.

The up-front cost estimate includes capital costs of $6 million for an EOC facility[15] and hardware, plus software costs of $250,000, for equipment to be installed at the facility. The potential recurring costs consist of facility operations and maintenance and additional labor. Operations and maintenance costs are estimated at $360,000 per year. Labor costs for two additional personnel to staff the alternate EOC are estimated at $250,000 per year.[16]

Potential Funding Mechanisms

FEMA Emergency Management Performance Grant, government of Puerto Rico

Potential Implementers

Puerto Rico Emergency Management Agency, Telecommunications Bureau

Potential Pitfalls

None

Likely Precursors

Precursor courses of action are CIT 3 (Upgrade and Enhance 911 Service), CIT 5 (Implement Public Safety/Government Communications Backup Power), and CIT 6 (Modernize the Emergency Operations Center).

[15] This is the same cost as the upper limit for upgrading the existing EOC in CIT 6, Modernize the Emergency Operations Center.

[16] In the cost estimate published in the recovery plan, a lower personnel cost was used as the basis of estimate, only $100,000 per staff member, compared with $124,600 per staff member used in the current estimate.

CIT 8
Mobile EOC Vehicle

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, and resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster.

Description

This course of action calls for a mobile Emergency Operations Center (EOC), which is a deployable asset that functions as a centralized location for the coordination of disaster recovery and first-responder activities when other infrastructure is disabled. The mobile EOC would be able to operate independently from remote and austere locations.

Potential Benefits

A mobile EOC is a useful tool when coordinating an on-site response to a local emergency or disaster. It provides independent communications over civilian and military frequencies, cellular or satellite. It can generate its own power. It may also contain computers to run incident management software and video teleconferencing equipment. In addition to being used for emergency purposes, a mobile EOC can function as a command center to monitor special events.

Potential Spillover Impacts to Other Sectors

This course of action would help improve disaster coordination at the community and municipality levels—thus, the sectors affected are Community Planning and Capacity Building and Municipalities.

Potential Costs

Potential up-front costs: $1.1 million in estimated up-front costs
Potential recurring costs: $1.4 million in estimated recurring costs (11 years)
Potential total costs: $2.5 million in total estimated costs

The up-front costs are estimated for a mobile EOC, based on a search of similar vehicles used in cities in the United States. The recurring cost is estimated as $124,600 annually, for 2 staff employed at half-time.

Potential Funding Mechanisms

FEMA Emergency Management Performance Grant, government of Puerto Rico

Potential Implementers

Puerto Rico Department of Public Safety

Potential Pitfalls

None

Likely Precursors

None

CIT 9
Auxiliary Communications—Volunteer Radio Groups and Organizations

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Health and Social Services, Municipalities

Issue/Problem Being Solved

A workforce of available communications volunteers may be accessible to Puerto Rico, but it is not formally engaged for disaster services.

Description

This course of action would enhance the capacity of disaster response services through a coordinated, structured engagement between Puerto Rico and uniformly trained, highly skilled, and certified communications volunteers or volunteer groups. This course of action would cultivate a highly skilled, uniformly trained volunteer workforce to leverage auxiliary community communications (AUXCOMM) during disasters by engaging with volunteer radio groups and organizations. This course of action would support, incentivize, and encourage volunteer radio operations (e.g., the government of Puerto Rico sets up backup stations, distributes radios, or has representatives attend AUXCOMM working group meetings), following on, or improving on, models implemented in disaster-prone regions.

Potential Benefits

This course of action extends emergency operations, at minimal cost, by utilizing an experienced, intrinsically motivated group of volunteers.

Potential Spillover Impacts to Other Sectors

Highly dispersed AUXCOMM could benefit multiple sectors by informing the Housing, Transportation, Health and Social Services, Water, and Energy sectors on detailed issues arising from a disaster-related event. Guidance might also be relayed from informed, authoritative sources via recognized volunteers to individuals residing in affected regions.

Potential Costs

Potential up-front costs: $100,000 in estimated up-front costs
Potential recurring costs: $1 million in estimated recurring costs (11 years)

Potential total costs: $1.1 million in total estimated costs[17]

Costs were estimated using examples from state-based initiatives. Example program expenses or costs may include credentialing services (e.g., background checks), training services and exercises, travel and other approved expenses incurred for the performance of duties, increased demand for supplies and repairs, incentives for participation (e.g., tax incentives), capacity-related enhancements to infrastructure to support increased communications needs, and those expenses or costs required by statute, local law, or ordinance.

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementers

Puerto Rico Emergency Management Agency, Telecommunications Bureau, volunteer groups

Potential Pitfalls

If volunteer groups become too large or experience high turnover, volunteers might not receive adequate training and preparation for disaster scenarios. The postdisaster availability and condition of an emergency telecommunications infrastructure poses an operational uncertainty for AUXCOMM activities, which potentially undermines the program's utility. However, this uncertainty is shared across emergency services and not unique to AUXCOMM or availability of a prepared workforce.

Likely Precursors

An emergency operations center with point(s) of contact for auxiliary or volunteer communications is necessary. Precursor courses of action are CIT 6 (Modernize the Emergency Operations Center) and CPCB 9 (Coordinated Local Recovery Planning Process).

[17] The total cost for this course of action is $1.1 million. The recovery plan represents the estimated cost using a precision of one significant figure for the course of action and, therefore, the estimate total cost appears to be rounded.

CIT 10
Transoceanic Submarine Cable

Sectors Impacted

Communications and Information Technology, Economic, Municipalities, Energy

Issue/Problem Being Solved

Expanding the capacity and availability of commonwealth-wide communications that depend on submarine infrastructure would help meet Puerto Rico's goals for communications redundancy.

Description

This course of action would introduce new, very high bandwidth undersea cable(s) to Puerto Rico, situated away from San Juan: one landing point for the midterm, followed by additional ones in the long term to increase capacity and route options. This course of action would also mitigate the known threats to existing landing stations and related infrastructure from disaster events.

Potential Benefits

Improvements to the undersea telecommunications network topology would help create a highly resilient, commonwealth-level telecommunications network with a reduced recovery time for failures that may arise from disasters. Redundant, high-capacity network channels to Puerto Rico would also improve the overall telecommunications capacity and quality of available services should a single route become impaired. This course of action also helps to boost the value of Puerto Rican network infrastructure for the Puerto Rican economy, and it enhances the overall utility of Puerto Rican submarine cable systems for U.S.-to-global telecommunications.

Potential Spillover Impacts to Other Sectors

New infrastructure and increased operational costs would place additional demands on the utilities, the government, and people of Puerto Rico for power needs, funding, and the workforce. However, a robust telecommunications infrastructure would mitigate the extent of challenges faced by response and recovery operations. A submarine cabling infrastructure would link Puerto Rico to external networks and embody the primary mechanism to connect and network Puerto Rico to the rest of the United States for all activities. Consequently, this course of action could have a positive cascading effect across many sectors, such as Health and Social Services, Water, and Energy.

Potential Costs

Potential up-front costs: $25 million–$130 million in estimated up-front costs (2 years)

Potential recurring costs: $42 million–$105 million in estimated recurring costs (11 years)
Potential total costs: $67 million–$235 million in total estimated costs[18]

The capital expenditure is captured as potential up-front cost. Potential recurring costs include operational expenditures, estimated on an annual basis. Upgrades and loan payments with interest are excluded from the estimate. Depending on assumptions, costs other the operational expenditures may constitute the bulk of the annual cost.

Potential Funding Mechanisms

Government of Puerto Rico, private sector, sale of capacity via indefeasible right of use or by lease

Potential Implementers

Telecommunications Bureau, government of Puerto Rico agencies, private industry

Potential Pitfalls

Poor coordination among stakeholders during discovery, implementation, or funding could lead to higher-than-anticipated costs. Other potential pitfalls are irreparable loss to economically sensitive natural resources, unanticipated repairs to undersea cables, and single-vendor lock-in that does not allow Puerto Rico to exercise influence over key decisions. A development plan also requires a strategy for spanning multiple hurricane seasons.

Likely Precursors

Clear governance or policy for ownership rights

[18] Costs were estimated based on input from Puerto Rico government representatives and FEMA solutions-based teams. We also referenced Elaine Stafford, "Planning, Contracting, Constructing, Owning and Operating a Submarine Cable Network," in *The Suboptic Guide*, Morristown, N.J.: David Ross Group, 2013.

CIT 11
Procure a Mobile Emergency Communications Capability

Sector Impacted

Communications and Information Technology, Municipalities

Issue/Problem Being Solved

Puerto Rico needs a state-of-the-art, survivable, and resilient telecommunications infrastructure to ensure the continuity of essential government functions and the provision of public safety services after a disaster.

Description

This course of action would develop the capability to quickly reestablish communications for emergency and government operations in the aftermath of a man-made or natural disaster that causes widespread, catastrophic damage to the telecommunications infrastructure. This system, consisting of deployable telecommunications equipment, is envisioned as a quick and temporary fix for the loss of primary telecommunications capability.

Potential Benefits

Reliable and interoperable telecommunications are essential to providing effective and responsive disaster recovery, emergency services, and government operations.

Potential Spillover Impacts to Other Sectors

Because this course of action envisions providing capability to support government operations, there must be coordination with the municipalities to ensure that their needs are understood and that the municipalities understand the limitations of the capability being provided.

Potential Costs

Potential up-front costs: $83 million–$165 million in estimated up-front costs
Potential recurring costs: $38.5 million–$58.3 million in estimated recurring costs (11 years)
Potential total costs: $122 million–$223 million in total estimated costs

These estimates are based on a similar deployable network already implemented in several New Jersey counties (JerseyNet). The lower-bound estimates assume that, after a future disaster, about 50% of Puerto Rico's telecommunications infrastructure would be operational, and thus only 50% of the deployable network would be needed. This deployable network is assumed to be interoperable with the telecommunications infrastructure that remains operational after the disaster. The upper-bound estimates assume that the full deployable network would be needed.

Potential Funding Mechanisms

FEMA Emergency Management Performance Grant, government of Puerto Rico

Potential Implementers

Puerto Rico Emergency Management Agency, Office of the Chief Information Officer, Puerto Rico Department of Public Safety

Potential Pitfalls

The FEMA Communications/IT Solutions-Based Team has stated that most of the mobile communications capabilities outlined in this course of action are redundant to other capabilities already being pursued by private, commonwealth, and federal efforts. However, the government of Puerto Rico believes that such capabilities would not be available for some time and that the commonwealth needs a solution that can be implemented in the near term. Uncertainty in the delivery of long-term communications capabilities being pursued could lead to additional costs for Puerto Rico to maintain the near-term solution beyond the anticipated need.

Likely Precursors

None

CIT 12
Perform Site Structural Analysis for All Government Telecom Towers (Both Public and Privately Owned)

Sectors Impacted

Communications and Information Technology, Health and Social Services, Housing, Transportation, Municipalities

Issue/Problem Being Solved

Increase the resilience of telecommunications infrastructure and emergency communications.

Description

This course of action would survey all telecommunications towers and sites that have been identified by the FEMA Communications/IT Solutions-Based Team and the U.S. Army Corps of Engineers as critical infrastructure for the provision of government emergency and other services. This course of action would determine whether all towers used for emergency communications meet the Puerto Rico tower code for structural loading. The first step would be to review the structural requirements of the tower code and the enforcement powers of the Puerto Rico Planning Board (PRPB). Note: The Telecommunications Bureau advised that there is a new proceeding at the PRPB (which controls the permitting of towers) that would address the structural overloading of towers. It is possible that the new proceeding at the PRPB may make this course of action unnecessary. However, it is likely that the PRPB would require tower owners to pay for these structural inspections, which may not occur on a timely basis.

Potential Benefits

This course of action would contribute to maintaining a resilient telecommunications infrastructure and emergency communications. A resilient telecommunications infrastructure is necessary to provide continuity of education, health care, social services, tourism supports, and the emergency services sector.

Potential Spillover Impacts to Other Sectors

Failure to take this course of action could result in loss of communications during a disaster, which would negatively affect all other sectors.

Potential Costs

Potential up-front costs: $1.5 million–$3 million in estimated up-front costs[19]

[19] In the recovery plan, the total estimated cost is represented as $4 million. The estimated cost is being revised here, reducing the number of towers surveyed.

Potential recurring costs: —
Potential costs: $1.5 million–$3 million in total estimated costs[20]

A FEMA subject-matter expert estimated that this work would require approximately $50,000 per tower.[21] An official of the government of Puerto Rico estimated the number of sites requiring this analysis at 30 to 60 towers.

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery

Potential Implementers

Puerto Rico Department of Public Safety, Telecommunications Bureau, PRPB[22]

Potential Pitfalls

There could be a conflict between this course of action and an administrative proceeding that is underway at the PRPB. It is unclear what the PRPB might order tower owners to do concerning tower inspections and structural analyses. Even if tower owners were ordered by PRPB to conduct tower inspections and structural analyses, it is unknown what the timeline would be for compliance and what PRPB's enforcement authority would be. However, it would be advisable to act in concert with the administrative proceeding at the PRPB.

Likely Precursors

The administrative proceeding that includes towers at the PRPB should be the first step in implementing this course of action. The PRPB should address requirements for tower owners to conduct tower inspections and structural analyses in the context of the Puerto Rico tower code.

[20] In the recovery plan, the total estimated cost is represented as $4 million. The estimated cost is being revised here, based on the change to the estimated up-front costs.

[21] The work would consist of the following: visual inspection by a team of structural engineers and other subject-matter experts (this team would look for rusting, cracking or welds, bent members, etc.); tower mechanical structural analysis or modeling using mathematical engineering formulas for stress, along with the known behavior of different materials under stress; and analysis of the soil and the ground of the sites where the towers are installed. The last item may be particularly important for locations in Puerto Rico that are susceptible to mudslides.

[22] PRPB was inadvertently not included in the recovery plan.

CIT 13
Streamline the Permitting and Rights of Way Processes for Towers and the Deployment of Fiber Optic Cable

Sectors Impacted

Communications and Information Technology, Energy, Economic, Health and Social Services, Housing, Transportation, Municipalities

Issue/Problem Being Solved

This course of action would address the current long administrative lead times and expense of obtaining rights of way (ROWs) and other approvals needed to construct cellular towers and to trench and bury fiber optic cable for telecommunications and broadband internet services. The expense in time and money of obtaining these approvals has limited the deployment of resilient telecommunications and broadband internet services throughout Puerto Rico. This course of action is necessary to accomplish the governor's objectives for digital transformation and a digital economy.

Description

In collaboration with the new Puerto Rico Public Service Regulatory Board and the Telecommunications Bureau, this course of action would establish and staff a central ROW and permitting approval authority, using uniform, streamlined approval processes. This authority may be part of the Public Service Regulatory Board or the Telecommunications Bureau. The central authority would supersede the powers of municipalities and other Puerto Rico agencies and departments to govern the ROWs and permitting approval processes for the deployment of fiber optic cable and cellular towers. This course of action was endorsed by all Puerto Rico telecommunications providers, as well as regulators, in a May 11, 2018, meeting held at the Puerto Rico Telecommunications Regulatory Board, the predecessor to the Telecommunications Bureau.

Potential Benefits

This course of action is a crucial first step for the swift deployment of telecommunications services and broadband internet to the education, health and social services, economics, visitor economy, and emergency services sectors.

Potential Spillover Impacts to Other Sectors

The lengthy permitting process in Puerto Rico has been identified as one of the primary reasons that it is difficult to do business in Puerto Rico. This issue also affects other sectors, especially Transportation, Energy, and Water.

Potential Costs

Potential up-front costs: $600,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $600,000 in total estimated costs

This estimated up-front cost was calculated based on the cost of 5 professionals for a year, each with an annual salary of $124,600.

Potential Funding Mechanisms

Federal Communications Commission

Potential Implementers

Telecommunications Bureau, Puerto Rico Department of Transportation and Public Works (Puerto Rico Highway and Transportation Authority), other government of Puerto Rico agencies, municipalities

Potential Pitfalls

Some municipal mayors may resist a centralized commonwealth agency for permitting and ROWs if they think that it removes either their control over disruption to streets or their power to approve and exact revenues from telecommunications providers. As an alternative, a uniform fee established by the new central ROW and permitting authority could be paid by telecommunications and broadband internet providers to municipalities.

Likely Precursors

None

CIT 14
Consolidated Government Information Systems

Sectors Impacted

Communications and Information Technology, Economic, Municipalities

Issue/Problem Being Solved

Currently, in Puerto Rico, the delivery of government services is inconsistent; the availability of timely, accurate, and coherent system of records management is lacking; and there is a reliance on legacy computing systems for infrastructure and information management.

Description

This course of action would establish and implement an open, modular, standards-based platform for information systems, and it would consolidate governmental systems across the commonwealth (all 78 municipalities and the government of Puerto Rico). Through software and associated information systems, the platform would natively enable interoperability, consistent standards and policies for information and data management, and the scaling of the system overtime, naturally, at reduced expense and effort.

Potential Benefits

Presently, the landscape for governmental information systems is populated by a heterogeneous mixture of legacy systems that are seen as not having an adequate capacity to scale, evolve, or interoperate for governmental needs. A fully integrated approach that uses a common, standards-based platform for information systems across the commonwealth could reduce operating costs for all municipalities and simultaneously enable highly reliable governmental functions, including coordination of response and recovery activities within Puerto Rico and externally (e.g., supply chain logistics).

Potential Spillover Impacts to Other Sectors

An open, modular, and standards-based common platform for information systems improves the government's ability to deliver timely services to citizens and the private sector alike. The efficiencies and experience gained and shared through these efforts with the private sector might incentivize economic activity in the private sector. The same systems may leverage the product of workforce development initiatives to preserve essential trade skills developed in Puerto Rico. Success with this initiative could inform publicly supported initiatives in Health and Social Services, Housing, and Transportation, as well.

Potential Costs

Potential up-front costs: $152 million in estimated up-front costs

Potential recurring costs: $330 million in estimated recurring costs (11 years)
Potential total costs: $482 million in total estimated costs

For 134 agencies, the high-level costs presently estimated by the government of Puerto Rico include platform-related costs and implementation estimates for the consolidation effort.

The up-front costs are estimated for 134 agencies, based on size. The up-front costs include platform costs and implementation costs for the consolidation. Platform costs include on-premise and cloud-based infrastructure and information systems, such as on-premise systems and services, licensing fees, disaster recovery and business continuity, and colocation. Implementation costs include data and application management, re-engineering applications, planning and managing replatforming, and integration.

Potential recurring costs are estimated as 40% of the initial platform costs per year, $30 million annually.

Estimated Costs by Agency Size

Estimated Up-Front Costs	Large Agency	Medium Agency	Small Agency
Platform costs per agency	$1.38 million	$0.83 million	$0.41 million
Implementation cost per agency	$1.39 million	$0.83 million	$0.42 million
Number of agencies (134 total)	6	35	93
Total costs	$16.6 million	$58.2 million	$77.2 million

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Office of the Chief Information Officer, government of Puerto Rico agencies

Potential Pitfalls

Development of a common-standards with cross-municipality collaboration may be challenging without adequate stakeholder engagement. Goals, requirements, and capabilities of the underlying system would need to match today's needs with future ones and be prepared in a way that clearly defines usage and tools of the system while enabling enough flexibility for specific configurations to meet needs at the level of a municipality or agency.

Transition from existing systems to new ones may encounter opposition or fundamental changes to business process and organizational roles. Such issues would need to be addressed in a way to facilitate progress while addressing stakeholder concerns. Access to data would require the buy-in of many government of Puerto Rico agencies. An additional important issue would be properly addressing data security.

A sizable, experienced, and dedicated workforce would be required for implementation. Lack of availability of skilled, experienced individuals may undermine the activity in a variety of

ways. The availability and participation of informed, authoritative decisionmakers would also be critical for the success of the effort.

Likely Precursors

Robust availability of on-island broadband to all municipalities is necessary. Precursors courses of action are CIT 17 (Puerto Rico Data Center) and CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure).

CIT 15
Undersea Fiber Ring System

Sectors Impacted

Communications and Information Technology, Economic, Energy, Municipalities

Issue/Problem Being Solved

Increase the availability of Puerto Rico's submarine telecommunications network through infrastructure expansion using a ring network, pursuant to Puerto Rico's goals for telecommunications resiliency.

Description

This course of action would evolve the undersea network infrastructure to incorporate a telecommunications ring system encircling Puerto Rico. This ring network would connect landing points (present and future) around Puerto Rico and would improve the availability of routes to or from Puerto Rico in the event of natural disasters in the long term.

Potential Benefits

This course of action would support a highly resilient, island-level network with a greatly reduced recovery time arising from subsea network failures. It would also boost both the value of the Puerto Rican network infrastructure for the Puerto Rican economy overall and the utility of Puerto Rican submarine cable systems for U.S.-to-global communications.

Potential Spillover Impacts to Other Sectors

New infrastructure and increased operational costs would place additional demands on Puerto Rico for power needs, funding, and the workforce. However, a robust telecommunications infrastructure would mitigate the extent of challenges faced by response and recovery operations. A submarine cabling infrastructure would link Puerto Rico to external networks and embody the primary mechanism for communication with the United States for all activities. Consequently, this course of action could have a positive cascading effect across many sectors, such as Health and Social Services, Water, and Energy.

Potential Costs

Potential up-front costs: $25 million–$130 million in estimated up-front costs (2 years)
Potential recurring costs: $42 million–$110 million in estimated recurring costs (11 years)
Potential total costs: $67 million–$240 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, government of Puerto Rico, private sector, sale of capacity via indefeasible right of use or by lease

Potential Implementers

Telecommunications Bureau, private industry

Potential Pitfalls

Poor coordination among stakeholders during discovery, implementation, or funding could lead to higher-than-anticipated costs. Other potential pitfalls are irreparable loss to economically sensitive natural resources, unanticipated repairs to undersea cables, and single-vendor lock-in that does not allow Puerto Rico to exercise influence over key decisions. A development plan also requires a strategy for spanning multiple hurricane seasons.

Likely Precursors

Clear governance or policy for ownership rights

CIT 16
Government Digital Reform Planning and Capacity Building

Sector Impacted

Communications and Information Technology

Issue/Problem Being Solved

The main issue to be addressed by this course of action is to establish a road map for the digital transformation of Puerto Rico. This would require (1) setting achievable goals and metrics for success; (2) a rigorous assessment of needs, costs, feasibility, and cultural and legal issues to be addressed; and (3) the establishment of a clear strategy that can be communicated and championed both inside the government and with the public.

Description

This course of action would create a road map to establish priorities, and assess needs, costs, and feasibility for a government-wide digital transformation strategy. This course of action would build stakeholder buy-in; surface ideas, needs, and issues from a broad set of participants, including the private industry; and provide a comprehensive strategy with associated metrics to improve chances of success.

Potential Benefits

This course of action provides a framework for Puerto Rico to benefit from best practices and avoid the pitfalls that have beset digital transformation efforts in other jurisdictions.

Potential Spillover Impacts to Other Sectors

This course of action would result in better data and improved processes throughout the government of Puerto Rico, positively affecting all sectors.

Potential Costs

Potential up-front costs: $6.2 million in estimated up-front costs[23]
Potential recurring costs: $2.0 million in estimated recurring costs (11 years)[24]
Potential total costs: $8.2 million in total estimated costs[25]

[23] The recovery plan represented the up-front costs as $14 million. The estimated up-front cost here is updated to reflect including training costs as recurring costs and to use labor costs, consistent with the other COAs.

[24] The recovery plan inadvertently included training costs as up-front costs and represented no recurring costs. The estimated recurring costs are updated here.

[25] The recovery plan represented the total estimated cost as $14 million. The total is updated here to reflect reduced estimated up-front costs.

The up-front cost estimate includes costs for staff to create the road map, to undertake stakeholder outreach and planning process, for work with small and medium enterprises and consultants on forming plans and metrics, and for change management training within commonwealth agencies. A multiyear task force would provide additional capacity to conduct needs assessments, convene with agencies, and prioritize projects and establish key performance indicator and reporting mechanisms.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Office of the Chief Innovation Officer, Office of the Chief Information Officer

Potential Pitfalls

This course of action seeks to mitigate pitfalls for and to other courses of action. Accommodating other sectors would require costs to the sector that engages in this effort. Lack of support by government agencies would be a challenge to this course of action.

Likely Precursors

None—this course of action is a starting point for several other courses of action related to the digital transformation of Puerto Rico, including CIT 23 (Data Collection and Standardization for Disaster Preparedness and Emergency Response), CIT 26 (Establish Secure Digital Identity), CIT 32 (Digital Citizen Services), and CIT 33 (Government Digital Process Reform).

CIT 17
Puerto Rico Data Center

Sectors Impacted

Communications and Information Technology, Economic, Energy, Health and Social Services, Housing, Transportation, Water

Issue/Problem Being Solved

Expand the government of Puerto Rico's capacity and independent ability to perform essential governmental functions and deliver essential governmental services throughout Puerto Rico.

Description

This course of action would establish a robust, disaster-proof (Tier III or Tier IV), and cloud-enabled data center in Puerto Rico for government of Puerto Rico information systems, initially targeting a medium-sized capacity. This course of action would expand the government of Puerto Rico's capacity and ability to perform essential governmental functions and deliver essential governmental services efficiently by using a commonwealth-owned, highly available, scalable, and evolvable infrastructure for its information systems.

Potential Benefits

An independent, commonwealth-owned, and disaster-resilient data center can enable highly reliable governmental information technology services for tracking, supporting, and coordinating response and recovery needs both within Puerto Rico and externally while preserving the integrity of all essential information systems. At present, there is no disaster-resilient or hardened facility that reliably and comprehensively preserves important governmental data or ensures the availability of corresponding information systems. This complicates disaster response efforts (coordination, situational awareness, etc.) and undermines the governmental capacity to assess and responsively address disaster-related needs through informed decisionmaking. There is potential to dramatically improve the planning efforts, through the evolution of existing commonwealth information systems in a cloud-based environment, for disaster response and recovery efforts.

Potential Spillover Impacts to Other Sectors

This data center is potentially a key infrastructure component that would enable Puerto Rico to pursue digitally driven economic goals and support digital initiatives, leveraging the communications capacity of a broadband infrastructure for workforce development, health and medicine, and so on, in addition to supporting continuity of government and related information needs or services. The course of action also seeks to address needs for a computing infrastructure

in a way that could support other initiatives—e.g., by providing a common, resilient computing infrastructure and capabilities for related services.

Potential Costs

Potential up-front costs: $7 million–$20 million in estimated up-front costs
Potential recurring costs: $61 million–$170 million in estimated recurring costs (11 years)
Potential total costs: $68 million–$190 million in total estimated costs

The range of up-front estimated costs is based on redundant power needs and workforce. Both up-front and annual costs vary depending on the engineering design for the required capacity (cooling and power requirements—e.g., maximum available power versus consumed power), number of cabinets (a measure of computing units or servers), and staffing requirements. These values assume 150 cabinets for a Tier IV data center, with average power consumed at 60% of what is available. Potential additional costs exist for failover to secondary cloud providers, depending on the approach taken for continuity of operations.

Potential Funding Mechanisms

Government of Puerto Rico, leasing of excess capacity, nongovernment sources

Potential Implementers

Office of the Chief Information Officer, government of Puerto Rico agencies

Potential Pitfalls

Determining a suitable location for the data center's facility and acquiring use rights, the availability of workforce or excessive dependence on nonresident workers, and improperly assessed power needs could have a dramatic effect on up-front costs, underutilization of resources, or excessive annual expenses.

Likely Precursors

Robust power generation and supply systems, availability of on-island broadband, and reliable submarine cable infrastructure are necessary. Precursor courses of action are CIT 10 (Transoceanic Submarine Cable), CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure), and CIT 23 (Data Collection and Standardization for Disaster Preparedness and Emergency Response).

CIT 18
Data Store and Data Exchange Standards for Critical Infrastructure

Sectors Impacted

Communications and Information Technology, Water, Energy, Economic, Health and Social Services, Transportation, Housing

Issue/Problem Being Solved

Improve Puerto Rico's ability to plan for and comprehensively support critical infrastructure needs.

Description

This course of action would create an online data store and data exchange standards for up-to-date, cross-sector data about critical infrastructure (government and private sector) using an open, modular, and standards-based approach for information exchange, interoperability, and storage. This course of action would formally evaluate and develop a standardized interface definition (or multiple definitions) for data exchanges and persisting data in a standard form. This course of action would also consider opportunities to leverage existing data standards and systems, such as ones offered by the National Information Exchange Model and the U.S. Department of Homeland Security Infrastructure Protection Gateway, either directly or as a basis for a commonwealth-developed service designed for and capable of satisfying Puerto Rico's near- and long-term needs.

Potential Benefits

The improved visibility into the critical infrastructure assets in Puerto Rico would support a comprehensive, quantitative picture of their availability. For example, a quantitative analysis may support burying aerial fiber, which would increase resilience to severe weather. Accurate, situational awareness of infrastructure issues may also inform emergency response activities prior to or after a disaster. Private companies can also know when and where Puerto Rico Electric Power Authority and Puerto Rico Aqueduct and Sewer Authority road repair will be trenching. Governmental and private-sector entities providing support for, or involved with, critical infrastructure assets would also benefit.

Potential Spillover Impacts to Other Sectors

Coordinated reconstruction activities can be informed by critical infrastructure data to streamline planning, budgeting, and supply chain logistics, as well as to optimize recovery-related activities. These improvements would naturally benefit multiple sectors, such as Water, Energy, Health and Social Services, Transportation, and Housing.

Potential Costs

Potential up-front costs: $1.8 million–$2.5 million in estimated up-front costs (2 years)
Potential recurring costs: $6.3 million–$13 million in estimated recurring costs (11 years)
Potential total costs: $8.1 million–$15 million in total estimated costs

Costs will depend on the detailed approach, scope of the data being maintained, long-term plan for using critical infrastructure data, and staffing needs. For a cloud-based service, total volume of persisted data and transactional frequency are potential drivers. Assuming that physical information technology infrastructure is sourced from the Puerto Rico Data Center (costed under CIT 17), a development effort involving 15–20 team members that includes informed and authoritative decisionmakers and key stakeholders, a new open and modular information system for critical infrastructure data will incur up-front costs for design and implementation, in addition to operational costs. Once operational, a smaller team can maintain the information system and support participating entities for integration efforts (e.g., 8 members).

Potential Funding Mechanisms

Private sector, government of Puerto Rico

Potential Implementers

Office of the Chief Information Officer, government of Puerto Rico agencies

Potential Pitfalls

Because of the broad range of private- and public-sector entities that are potential sources for critical infrastructure data, there is an inherent challenge regarding engagement through implementation and ongoing sustainment. Lack of inclusion or availability of key stakeholders able to make authoritative decisions regarding standard interfaces, interoperability requirements, and data needs, or to reconcile and prioritize functionality, may undermine the quality of data incorporated and the final performance (measured against governmental "business" needs) of the system.

Likely Precursors

Availability of a secure data center for governmental information systems and formalized governance for informed, authoritative decisions is necessary. Precursor courses of action are CIT 17 (Puerto Rico Data Center) and CIT 24 (Establish Puerto Rico Communications Steering Committee).

CIT 19
Municipal Hotspots

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic, Health and Social Services, Municipalities

Issue/Problem Being Solved

Many residents and visitors to Puerto Rico lack options for reliable, affordable internet access. Providing government-sponsored wi-fi in town centers and public buildings addresses digital disparity and provides a priority connection point for reaching a large number of residents in one place after a disaster.

Description

This course of action would maximize public access to government-sponsored wi-fi in the main centers of public life, including municipal buildings, parks, libraries, and town squares across Puerto Rico. This course of action would expand the existing 58 municipal hotspots sponsored by the Telecommunications Bureau (formerly, the Puerto Rico Telecommunications Regulatory Board) as feasible and appropriate. Currently, the Telecommunications Bureau sponsors installation of equipment, and municipalities provide for recurring costs for service to a telecommunications provider. The Telecommunications Bureau program has been working well for many years and is accepted by telecommunications providers. For that reason, the scope of this course of action reflects the current Telecommunications Bureau program, which would also provide municipal hotspots for government outreach in the event of an emergency.

Potential Benefits

Government-sponsored public wi-fi would provide a priority postdisaster connection point for reaching a large number of residents in one place. Commonwealth or municipal governments would be able to provide information to citizens through a main internet page, such as status.pr.gov. Citizens would benefit from increased access to the internet, which may help encourage a more digitally capable society.

Potential Spillover Impacts to Other Sectors

With reliable, affordable access to wi-fi, residents of Puerto Rico would have more ways to participate in every sector of society, including Community Planning and Capacity Building (wi-fi would enable citizens to participate in planning activities, share needs and views on proposed actions, and feel more included), Economic (wi-fi would give citizens access to job opportunities), and Health and Social Services (wi-fi would allow residents to book appointments, research health care information, submit forms, or report for social services).

Potential Costs

Potential up-front costs: $0.8 million in estimated up-front costs[26]
Potential recurring costs: $8.8 million in estimated recurring costs (11 years)[27]
Potential total costs: $9.6 million in total estimated costs[28]

The estimate for up-front costs for municipal hotspots is based on comparable projects in the United States.[29]

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, Federal Communications Commission

Potential Implementers

Office of the Chief Innovation Officer, Telecommunications Bureau, government of Puerto Rico agencies, municipal governments

Potential Pitfalls

Although Telecommunications Bureau officials said that they have managed government-sponsored hot spots since 1999, the Telecommunications Bureau could face resistance expanding the program into areas covered solely by the private telecommunications market, a situation encountered by some municipalities in the continental United States. However, a senior Telecommunications Bureau official explained that, although that office pays for the initial installation of wi-fi equipment and internet service in the municipalities involved in the program, the municipalities pay the internet service provider directly after approximately two years. Thus, private telecommunications providers are paid for their services in rural or disadvantaged areas to which they might not otherwise have provided service. Also, in the future, the Telecommunications Bureau would need to make citizens aware of the lack of security associated with public wi-fi and establish content policies for use. In order to realize the full potential of affordable wi-fi access, individuals must also have access to digital devices and the digital skills to make use of the technology that connectivity makes possible.

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[26] The recovery plan represented the potential up-front cost at $1.6 million in estimated costs. That estimate is being corrected here. The setup cost for each hotspot was doubled counted previously and is updated here, reducing the estimated cost.

[27] The recovery plan represented the potential recurring cost as $16 million in estimated costs. That recurring cost is being corrected here. The annual cost was inadvertently represented at twice the value estimated.

[28] The recovery plan total potential cost was represented as $18 million. The cost to acquire and maintain each hotspot has been corrected, resulting in the cost decreasing by half the estimate in the recovery plan.

[29] The comparable projects are Tribal Digital Village from the Southern California Tribal Chairmen's Association and Red Hook WiFi (in New York).

Likely Precursors

The Telecommunications Bureau would need to make citizens aware of the lack of security associated with public wi-fi and would need to establish content policies for use. Precursor courses of action are CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure) and CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

CIT 20
Continuity of Business at PRIDCO Sites

Sectors Impacted

Communications and Information Technology, Economic, Municipalities

Issue/Problem Being Solved

Improve the resiliency of essential business activities delivered by the Puerto Rico Industrial Development Company (PRIDCO) in the aftermath of a disaster.

Description

This course of action would maintain key business activities at PRIDCO sites when primary telecommunications methods are degraded or unavailable to provide continuity of services related to disaster recovery. This course of action would establish multiple alternative business processes to leverage several platforms for telecommunications and information systems, including, but not limited to, the use of fiber, satellite, microwave systems, and cloud-based or hosted services and information systems.

Potential Benefits

PRIDCO facilitates economic development in several key ways across a wide range of sectors, including investment incentives, design of business proposals, assistance with the regulatory and permitting process, project management, and facility selection. Continuity of business at PRIDCO sites would directly benefit recovery options.

Potential Spillover Impacts to Other Sectors

Recovery efforts across sectors—including Health and Social Services, Housing, Transportation, Energy, and Communications and Information Technology—could be accelerated by leveraging PRIDCO services if they are available during a disaster or outage.

Potential Costs

Potential up-front costs: $24 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $24 million in total estimated costs

Estimates for preparing microgrids at 5 PRIDCO sites range from $11 million to $37.5 million. Estimates for a microwave-based site-to-site telecommunications network range from $75,000 to $125,000, or $15,000 to $25,000 per site for equipment.

The costs would vary strongly by approach for selected sites and the requirements for telecommunications needs and backup power. As a rough estimate, drawn from Microgrids at

Berkeley Labs case studies,[30] a 5 MW natural gas system has a construction cost of $7.5 million (completed in 1 year).

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Community Development Block Grant–Disaster Recovery, government of Puerto Rico, private insurance

Potential Implementers

Puerto Rico Industrial Development Company

Potential Pitfalls

None

Likely Precursors

This course of action would need reliable power systems and may require infrastructural upgrades to accommodate modernized telecommunications systems. Precursor courses of action are CIT 5 (Implement Public Safety/Government Communications Backup Power), CIT 17 (Puerto Rico Data Center), and CIT 23 (Data Collection and Standardization for Disaster Preparedness and Emergency Response).

[30] Microgrids at Berkeley Labs, "Case Studies," webpage, undated (as of February 20, 2019: https://building-microgrid.lbl.gov/projects/der-cam/case-studies).

CIT 21
Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure

Sectors Impacted

Communications and Information Technology, Economic, Education, Energy, Health and Social Services, Housing, Municipalities, Transportation

Issue/Problem Being Solved

Increase the resilience of telecommunications services while reducing costs to telecommunications providers for burying cable. Facilitate the burial of aerial fiber optic cable and the provision of broadband infrastructure throughout Puerto Rico.

Description

This course of action would provide trenching and conduit adequate for accommodating other utilities. This course of action would also expedite permitting and rights of way processes, which are time-consuming and expensive, and it would offer telecommunications providers the opportunity to pull fiber through government-owned conduit.

The design for the deployment of conduit for fiber optic cable would be developed by the government of Puerto Rico in consultation with Puerto Rican telecommunications providers. The government of Puerto Rico would trench and lay empty conduit according to the design. The government of Puerto Rico would own the conduit, but telecommunications providers would install and own their own fiber optic cable.

Potential Benefits

If the government of Puerto Rico provides the trenching and conduit for fiber optic cable, it would greatly reduce the cost in time and money for telecommunications providers to deploy buried instead of aerial fiber optic cable. Buried fiber optic cable is far more resilient to disasters. This course of action would minimize the need for multiple roadway disturbances to lay cable for separate firms.

Potential Spillover Impacts to Other Sectors

This course of action would require coordination with the Puerto Rico Department of Transportation and with municipalities, if conduit for fiber is built along the highways. Municipalities would obtain access to broadband internet services and potentially also to health care services and education.

Potential Costs

Potential up-front costs: $1.3 billion in estimated up-front costs

Potential recurring costs: —
Potential total costs: $1.3 billion in total estimated costs

The up-front cost estimate is based on all federal aid for nonmunicipal roads. The cost of this course of action would depend on whether federal grants are obtained to design the plan for the conduit and the trenching to bury the conduit throughout Puerto Rico.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, public-private partnership, Federal Communications Commission

Potential Implementers

Telecommunications Bureau, Puerto Rico Department of Transportation and Public Works (Puerto Rico Highway and Transportation Authority), Federal Communications Commission, private telecommunications companies

Potential Pitfalls

Maintenance of the conduit network by the government of Puerto Rico would be important to its resilience and to its use by telecommunications providers. If telecommunications providers pay a reasonable fee for using the conduit network, those funds could be escrowed for maintenance of the conduit network by the government of Puerto Rico.

Likely Precursors

This course of action could be implemented along with CIT 13 (Streamline the Permitting and Rights of Way Processes for Towers and the Deployment of Fiber Optic Cable). The precursor course of action is CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

CIT 22
Use Federal Programs to Spur Deployment of Broadband Internet Island-Wide

Sectors Impacted

Communications and Information Technology, Education, Municipalities

Issue/Problem Being Solved

Providing broadband internet services to students throughout Puerto Rico, allowing them to participate in digital learning, would help meet the governor's objectives for digital transformation and a digital economy.

Description

This course of action would develop a program to obtain broadband internet services for schools and libraries in 78 municipalities using the Federal Communications Commission's E-Rate program and other federal programs. This course of action would build on the new pilot project established by Puerto Rico legislation for the use of E-Rate funding in approximately 20 schools in central Puerto Rico, as well as the Puerto Rico Bridge Initiative funded by National Telecommunications and Information Administration.[31] The Puerto Rico Department of Education, assisted by the Telecommunications Bureau, has been designated by the new Puerto Rico legislation to administer the pilot project.

Potential Benefits

This course of action would allow Puerto Rico schools to participate fully in the E-Rate program, by obtaining funding from additional federal sources to address such issues as upgrading the electricity grid at schools and providing PCs and laptops for students, security for equipment, and air conditioning for equipment. The lack of some of these precursors would prevent a school from participating in the E-Rate program. In addition, supplemental funding for many schools would be required, even if schools qualify for funding at the 90% level. The Federal Communications Commission's website states, "eligible schools and libraries may receive discounts on telecommunications, telecommunications services and Internet access, as well as internal connections, managed internal broadband services and basic maintenance of

[31] The recent legislation is Joint Resolution 40-2018 (Resolucion Conjunta 40-2018). Puerto Rico Legislative Action, March 20, 2018.

internal connections. Discounts range from 20 to 90 percent, with higher discounts for higher poverty and rural schools and libraries. Recipients must pay some portion of the service costs."[32]

Potential Spillover Impacts to Other Sectors

The availability of reliable, high-speed broadband internet to schools and libraries across Puerto Rico will have major impacts on other sectors, such as Education and Municipalities.

Telecommunications and broadband internet services being made available to schools and libraries in a remote or disadvantaged area may incentivize telecommunications and broadband internet providers to offer services to residential and retail customers in those areas.

Potential Costs

Potential up-front costs: $1.25 million in estimated up-front costs (2 years)
Potential recurring costs: $37.8 million–$66.4 million in estimated recurring costs (11 years)
Potential total costs: $39.0 million–$67.6 million in total estimated costs

Estimate for up-front costs is $1.25 million for a contractor (team of 5) to assist with implementation over a 2-year period. The best estimate for annual costs range from $3.6 million–$6.3 million per year.

Potential Funding Mechanisms

Federal Communications Commission, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development, U.S. Department of Commerce Economic Development Administration, National Telecommunications and Information Administration

Potential Implementers

Telecommunications Bureau, Federal Communications Commission, Puerto Rico Department of Education

Potential Pitfalls

It is possible that a school that obtains funding from the E-Rate program could subsequently be closed by Puerto Rico Department of Education.

Likely Precursors

The precursor course of action is CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

[32] Federal Communications Commission, "E-Rate: Universal Service Program for Schools and Libraries," webpage, February 9, 2018 (as of June 18, 2018: https://www.fcc.gov/consumers/guides/universal-service-program-schools-and-libraries-e-rate).

CIT 23
Data Collection and Standardization for Disaster Preparedness and Emergency Response

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Energy, Water, Economic, Health and Social Services, Municipalities

Issue/Problem Being Solved

Puerto Rico lacks quality data to inform the public and the policymaking process. Updated data on day-to-day information is helpful under normal circumstances—and critical after a disaster.

Description

This course of action would support expansion and ongoing development of the status.pr webpage with data-sharing protocol, including partnerships with private businesses, to enable ongoing situational awareness.

Potential Benefits

Creating a platform for publicly sharing data in a standardized, user-friendly format would provide valuable information for policymakers, the media, and emergency responders. The platform would provide access to standardized, machine-readable information that can be utilized for the development of new applications based on the collected data.

Potential Spillover Impacts to Other Sectors

This course of action would provide better information and situational awareness that would aid the Community Planning and Capacity Building, Economic, Municipalities, Health and Social Services, Energy, and Water sectors.

Potential Costs

Potential up-front costs: $0.8 million in estimated up-front costs[33]
Potential recurring costs: $2.7 million in estimated recurring costs[34]

[33] The recovery plan represented the potential up-front cost as $100,000. That estimated up-front cost is corrected here to include equipment and labor. The potential cost is the average of the low and high up-front estimated costs ($130,000 and $1.4 million), and rounded off.

[34] The recovery plan presented no recurring cost for this course of action. The potential recurring costs are corrected here to include the annual cost of two staff members.

Potential total costs: $3.5 million in total estimated costs[35]

Costs range depending on the level of technical build-out for the data-sharing platform, which can be managed either by an internal team (as described in CIT 16, Government Digital Reform Planning and Capacity Building) or contracted out.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery

Potential Implementers

Office of the Chief Innovation Officer, Puerto Rico Emergency Management Agency, government of Puerto Rico agencies

Potential Pitfalls

Open data, including crowd-sourced data, always carry perceived political risk because they provide a view on actual service delivery, which can reveal unsuccessful efforts and thus provoke backlash or public critique.

Likely Precursors

Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building) and CIT 18 (Data Store and Data Exchange Standards for Critical Infrastructure).

[35] The recovery plan represented the potential to cost as $100,000. That estimated total cost is corrected here to account for equipment and labor inadvertently not included in the potential cost in the recovery plan.

CIT 24
Establish Puerto Rico Communications Steering Committee

Sectors Impacted

Communications and Information Technology, Municipalities

Issue/Problem Being Solved

Facilitate governance, coordination, and information sharing between relevant communications stakeholders.

Description

This course of action proposes the establishment of a new Puerto Rico Communications Steering Committee to develop clear governance in the Communications and Information Technology sector, allowing key public safety and commercial communications stakeholders to better organize planning efforts, prioritize requirements, and coordinate among themselves. The Communications Steering Committee would be led by a rotating chairperson.

Potential Benefits

The Communications Steering Committee proposed by this course of action could allow for proper planning, governance, and collaboration for effective and efficient maintenance and recovery of the telecommunications infrastructure in the event of a future disaster. It could also mitigate the potential for interoperability and duplication of effort issues in the event of a future disaster.

Potential Spillover Impacts to Other Sectors

Given the important role that municipalities play in disaster response, participation by municipalities in the Communications Steering Committee would be a critical factor to its success. Conversely, municipalities can benefit from improved disaster preparation and response by helping shape governance and other efforts led by the Communications Steering Committee. Participation would require that municipalities invest time and effort, which may create challenges because of competing priorities and demands.

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs
Potential recurring costs: $6 million in estimated recurring costs (11 years)
Potential total costs: $7 million in total estimated costs

The up-front costs capture the cost to stand up the committee, including office space and permanent staff.[36]

Potential Funding Mechanisms

Government of Puerto Rico

Potential Implementers

Office of the Governor, Puerto Rico Emergency Management Agency, Telecommunications Bureau, Puerto Rico Department of Public Safety, Office of the Chief Information Officer, Office of the Chief Innovation Officer, municipalities

Potential Pitfalls

The Communications Steering Committee would need discrete responsibilities, measurable goals and objectives, authorization to make decisions, and effective leadership. The rotating chairperson would need authority to set direction and facilitate decisions. A prior emergency communications committee did not meet for 2 years.

Likely Precursors

None

[36] This rough-order-of-magnitude cost is based on Congressional Budget Office estimates to establish congressionally mandated commissions. Such commissions may have similar startup and maintenance costs to the proposed committee. See Jacob R. Straus, *Congressional Commissions: Overview, Structure, and Legislative Considerations*, Washington, D.C.: Congressional Research Service, November 17, 2017. However, additional work must be performed to determine whether these similarities are relevant to Puerto Rico.

CIT 25
Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico

Sectors Impacted

Communications and Information Technology, Economic, Energy, Health and Social Services, Housing, Public Buildings, Municipalities, Transportation

Problem Being Solved

Speed deployment of broadband internet services across Puerto Rico to accomplish the governor's objectives for a digital economy.

Description

This course of action would create a comprehensive plan for deployment of broadband internet in Puerto Rico. A high-profile panel of nationally recognized subject-matter experts, industry leaders, senior government officials, and civil society representatives, including disability community advocates, would seek to obtain political and industry support for a broadband deployment plan within Puerto Rico.

Potential Benefits

This course of action is a crucial first step for swift deployment of broadband internet to the Education, Health and Social Services, and Economic sectors. Strategic initiatives, such as the visitor economy, are supported by the expansion of the availability of broadband internet. Notably, emergency services may also be improved.

Potential Spillover Impacts to Other Sectors

The availability of reliable, high-speed broadband internet across Puerto Rico would have major impacts on multiport and transportation services, energy, telecommunications, emergency services, local integrated services, entrepreneurship, housing, health and social services, education, human capital, the visitor economy, investments, and the ocean economy.

Potential Costs

Potential up-front costs: $900,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $900,000 in total estimated costs

The estimate for the up-front costs includes a Puerto Rico–wide comprehensive plan for broadband internet deployment. The cost of this course of action would depend on the size of the integration team.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Federal Communications Commission

Potential Implementers

Telecommunications Bureau, Federal Communications Commission, private telecommunications companies

Potential Pitfalls

A comprehensive plan for broadband deployment could be derailed by disagreements among government officials or telecommunications providers, or municipalities that do not wish to lose revenue from rights of way and permitting approvals. For this reason, a highly respected team of experts that has political and industry support is needed to devise the plan.

Likely Precursors

No precursors. This course of action would serve as a precursor for CIT 19 (Municipal Hotspots), CIT 22 (Use Federal Programs to Spur Deployment of Broadband Internet Island-Wide), CIT 26 (Wi-fi Hotspots in Public Housing and Digital Stewards Program), and CIT 29 (Health Care Connectivity to Strengthen Resilience and Disaster Preparedness).

CIT 26
Wi-fi Hotspots in Public Housing and Digital Stewards Program

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic, Health and Social Services, Public Buildings

Issue/Problem Being Solved

Many public housing residents lack options for internet access without expensive data plans. Government-sponsored wi-fi in public housing will enable reliable delivery of internet services for the residents and allow for postdisaster priority connection points.

Description

This course of action would establish the Digital Stewards program in Puerto Rico. Digital Stewards are public housing residents who are trained on how to use the internet from a technical perspective, how to use the internet for education and entrepreneurial purposes in the community, and about cybersecurity and privacy best practices. The Digital Stewards also learn how to install and service wi-fi hotspots in public housing (and other public projects).[37] Digital Stewards programs have been successfully implemented in Michigan and New York.[38]

Potential Benefits

Government-sponsored wi-fi access (and the ability to access computers, tablets, and smartphones) can help decrease the "digital divide," expand opportunities for public housing residents, and provide a priority point of connection and coordination after disasters.

Potential Spillover Impacts to Other Sectors

With reliable, affordable access to wi-fi, public housing residents would have more ways to participate in other sectors of society, including Community Planning and Capacity Building (wi-fi would enable residents to participate in planning activities and share needs and views on proposed actions), Economic (wi-fi would give residents access to job opportunities); Health and Social Services (wi-fi would allow residents to apply for social services and update their information), and Public Buildings (wi-fi would expand digital security systems, send updates to residents, and increase the ability to monitor building condition, maintenance needs, and energy use).

[37] This would also happen in CIT 16 (Government Digital Reform Planning and Capacity Building).
[38] See Red Hook Initiative, "Digital Stewards," webpage, undated (as of February 20, 2019: http://rhicenter.org/programs-2/youth-development/digital-stewards/); Allied Media Projects, Detroit Community Technology Project: Digital Stewards Training, webpage, undated (as of February 20, 2019: https://www.alliedmedia.org/dctp/digitalstewards).

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs
Potential recurring costs: $39 million in estimated recurring costs (11 years)[39]
Potential total costs: $40 million in total estimated costs[40]

The estimate for up-front costs includes hot spot equipment, computers, and mobile devices for Digital Stewards program.[41] These estimates assume 200 installations and 20 Digital Stewards. The recurring costs include the annual costs for internet access, Digital Stewards program management, periodic internet training in the local community, and a salary for each Digital Steward.[42]

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Puerto Rico Department of Housing

Potential Implementers

Office of the Chief Innovation Officer, U.S. Department of Housing and Urban Development, Puerto Rico Department of Housing

Potential Pitfalls

It would be important to ensure awareness of online safety, security, and privacy and establish content policies for use. Existing commercial internet providers cannot be displaced. Equipment could be stolen or vandalized.

Likely Precursors

This course of action could be implemented together with CIT 19 (Municipal Hotspots). Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building), CIT 22 (Use Federal Programs to Spur Deployment of Broadband Internet Island-Wide), CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure), and CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

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[39] The recovery plan published a potential recurring cost of $20 million. The recovery plan cost did not include the labor of the Digital Stewards at a cost consistent with other courses of action. The cost estimate is updated here to reflect an estimate for the anticipated labor for this action.

[40] The recovery plan published a potential total cost of $20 million. That estimate is updated here to reflect the updated recurring cost estimated.

[41] Estimates are based on comparable projects, such as Southern California Digital Village and Red Hook WiFi.

[42] The annual recurring costs include $2.5 million for the 20 Digital Stewards and $1 million for other costs, for a total of $3.5 million in annual recurring costs.

CIT 27
Study Feasibility of Digital Identity

Sector Impacted

Communications and Information Technology, Economic, Health and Social Services

Issue/Problem Being Solved

The creation of a secure digital identity enables digital transactions and reduces transaction costs while decreasing the potential for fraud and identity theft. The Puerto Rico chief innovation officer has described digital identity as "the key" to successful digital services implementation and has identified this as a top priority for her office.[43]

Description

This course of action would undertake a study of existing approaches—and would assess potential acceptance by the people of Puerto Rico and the business community—of a secure, strong digital identity, based on a resilient power and telecommunications infrastructure, to facilitate government and private-sector transactions. The scope would include surveying existing approaches for digital identity and undertaking field work within Puerto Rico to test cultural perceptions, public concerns, and identify obstacles to adoption.

Potential Benefits

A secure digital identity is a key component to digital transformation, facilitating financial transactions, contracts, and government services. A secure digital identity can increase accuracy and reduce costs associated with validation and access to government services, especially in disaster recovery, when paper records can be inaccessible.[44]

Potential Spillover Impacts to Other Sectors

A secure digital identity would allow for a secure login for government services, would prevent duplication, and would allow for an "ask/update once" so that information is accurate and updated across government services (Health and Social Services). A secure digital identity would also allow for more-efficient business formation processes and transactions, eliminating the need for in-person authentication (Economic).

Potential Costs

Potential up-front costs: $2 million in estimated up-front costs

[43] Conversation with the chief innovation officer, May 31, 2018.

[44] This assumes that the telecommunications and information technology infrastructure that supports digital identity is still operational after the disaster.

Potential recurring costs: —
Potential total costs: $2 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, public-private partnerships

Potential Implementers

Office of the Chief Innovation Officer, government of Puerto Rico agencies

Potential Pitfalls

At the completion of this course of action, the government of Puerto Rico should be ready to undertake the larger effort of adopting digital identity throughout its agencies. For that larger effort, Puerto Rico would need to implement cybersecurity best practices. The costs to meet cybersecurity requirements—including systems, personnel, insurance overhead—can be significant.

Likely Precursors

Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building), CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure), and CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

CIT 28
Innovation Economy/Human Capital Initiative

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic, Education

Issue/Problem Being Solved

Provide people in Puerto Rico with the skills to work and participate in an increasingly digital society through skills training in schools, access to technology, and cultivating a culture of entrepreneurship.

Description

This course of action would create a public-private initiative to provide digital skills training, entrepreneurship programs, and access to new technologies for people throughout Puerto Rico through a network of innovation hubs and entrepreneur centers, training partnerships with schools, and outreach via mobile labs to rural and underserved areas.

Potential Benefits

A broad, coordinated push to provide technology access and digital and coding skills training would help develop a digitally literate employment pool for recruiting or expanding tech-reliant industries, consistent with the governor's idea of the "human cloud"—a skilled digital workforce that can work from Puerto Rico with companies around the world. This initiative would reinforce the governor's message that Puerto Rico is "open for business" and intends to welcome new technologies and a digital workforce.

Potential Spillover Impacts to Other Sectors

Providing access and the skills for residents of Puerto Rico to use emerging technologies would create a positive impact in several sectors, including Community Planning and Capacity Building, Education, and Economic—for example, increased educational attainment for people who take online courses using the Network of Innovation Hubs, economic benefits from products created with new digital tools, and new businesses launched through the entrepreneurship resources provided at innovation hubs.

Potential Costs

Potential up-front costs: $1 million–$4 million in estimated up-front costs
Potential recurring costs: $30 million–$70 million in estimated recurring costs (11 years)
Potential total costs: $30 million–$70 million in total estimated costs

The estimate for up-front costs scale with the number of hubs or mobile labs. The estimate for annual costs also scale depending on the number of hubs, labs, schools, and teachers participating.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, National Science Foundation, U.S. Department of Education, nongovernment sources

Potential Implementers

Office of the Chief Innovation Officer, government of Puerto Rico agencies, universities, municipal governments

Potential Pitfalls

Physical equipment would need to be protected from theft and extreme weather. This course of action would require dynamic leadership and relationships with stakeholders in Puerto Rico and in the tech community worldwide.

Likely Precursors

Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building), CIT 22 (Use Federal Programs to Spur Deployment of Broadband Internet Island-Wide), CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure), and CIT 25 (Evaluate and Implement Alternative Methods to Deploy Broadband Internet Service Throughout Puerto Rico).

CIT 29
Health Care Connectivity to Strengthen Resilience and Disaster Preparedness

Sectors Impacted

Communications and Information Technology, Community Planning and Capacity Building, Health and Social Services, Municipalities

Issue/Problem Being Solved

Data connectivity is critical to clinical care, access to patient data commonwealth-wide and outside a clinical facility is a necessity, and additional bandwidth enhances the delivery of health and social services.

Description

This course of action has two complementary objectives. First, it aims to provide robust, resilient, multimodal "mesh" communications connectivity to the 86 community clinics across Puerto Rico, using satellite and low-power radio and line-of-site technologies, to complement connectivity that is available through the telecommunications infrastructure or to provide redundancy when such infrastructure is damaged. Second, this course of action aims at using the increased connectivity and information technology to ensure real-time access to clinical data—including mobile and telehealth—from many access points to improve clinical care delivery and to better adapt to disaster impacts.

Potential Benefits

This course of action would leverage the network of health clinics spanning Puerto Rico and would improve care and emergency response capabilities. It would also enable medical innovation and would provide real-time clinical electronic health record access and telehealth. The mesh network would bolster access to local services and situational awareness during a disaster.

Potential Spillover Impacts to Other Sectors

Mesh network capacity could enhance access to local government services (Municipalities). This course of action could also leverage clinic connectivity for resilience, education, and emergency response (Community Planning and Capacity Building). This course of action affects other courses of action, as Health and Social Services is the primary resource for the health and wellness of the entire commonwealth, including the workforce involved in response, recovery, and restoration efforts.

Potential Costs

Potential upfront costs: $7.6 million–$16 million in estimated upfront costs[45]
Potential recurring costs: $140 million–$260 million in estimated recurring costs (11 years)
Potential total costs: $150 million–$280 million in total estimated costs[46]

The up-front cost estimate is based on implementation of a multimodal mesh network for 86 Federally Qualified Health Centers in Puerto Rico, with 2 short-cycle assessment and evaluation phases. The estimate for recurring costs includes the yearly cost for ongoing connectivity, usage, maintenance, and operations.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Office of the Assistant Secretary for Preparedness and Response, Federal Communications Commission, U.S. Department of Health and Human Services, U.S. Department of Veterans Affairs, U.S. Department of Defense, government of Puerto Rico

Potential Implementers

Office of the Chief Innovation Officer, Puerto Rico Emergency Management Agency, Telecommunications Bureau, Puerto Rico Department of Health

Potential Pitfalls

This course of action would require coordination with external medical expertise, including remote, continental U.S.–based health care and social and behavioral services, and it must leverage the resilience of clinics' connectivity to mitigate risk.

Likely Precursors

Precursor course of action is CIT 21 (Government-Owned Fiber Optic Conduits to Reduce Aerial Fiber Optic Cable and Incentivize Expansion of Broadband Infrastructure).

[45] The recovery plan represents the potential up-front costs as $5.6 million to $12 million. That number inadvertently did not include assessments costs intended to be captured in the estimated costs. This is being corrected here.

[46] The recovery plan represents the potential total costs as $140 million to $280 million. This is being corrected here to account for the increase to the potential up-front costs.

CIT 30
Resiliency Innovation Network Leading to Development of a Resiliency Industry

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

Puerto Rico is vulnerable to natural disasters and needs innovative capacity development approaches to enhance resiliency and overcome human capital and investment constraints.

Description

This course of action would create the Resiliency Innovation Network (RIN) across Puerto Rico to build on the existing Puerto Rico Science, Technology, and Research Trust (PRSTRT) and university facilities to teach, test, and refine existing resiliency products and services and to develop new ones to enhance capability and stimulate new commercial ventures.

Potential Benefits

This course of action will help generate local companies and jobs to increase Puerto Rico's long-term resilience to natural disasters through an innovation initiative and will lower the impacts and costs of such events. One expected long-term outcome is the establishment of a resiliency innovation cluster in Puerto Rico.[47]

Potential Spillover Impacts to Other Sectors

The RIN would teach innovation and entrepreneurship to expand business and community capacity and promote Puerto Rican educational institutions (Community Planning and Capacity Building). This would attract investment, while the RIN's distributed network would open rural and municipal areas to investors (Municipalities, Economic).

Potential Costs

Potential up-front costs: $2.2 million in estimated up-front costs
Potential recurring costs: $26 million in estimated recurring costs (11 years)
Potential total costs: $29 million in total estimated costs

[47] A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration; National Science Foundation; Puerto Rico Science, Technology, and Research Trust; Puerto Rico Industrial Development Company; private sector

Potential Implementers

Central Office of Recovery, Reconstruction, and Resiliency; Office of the Chief Innovation Officer; universities; Puerto Rico Science, Technology, and Research Trust; Resilient Puerto Rico Advisory Commission; Puerto Rico Department of Economic Development and Commerce; Puerto Rico Industrial Development Company

Potential Pitfalls

Investment could be limited by Puerto Rico's austere fiscal situation, the participant pool could be limited by the ongoing "brain drain," and new businesses could be dissuaded by barriers.

Likely Precursors

The Resiliency Innovation Network can benefit from other CITs but does not depend on them—e.g., hotspots support entrepreneurship and innovation (CIT 19, Municipal Hotspots, and CIT 26, Wi-fi Hotspots in Public Housing and Digital Stewards Program). The network can use digital workforce skills and rural mesh networks (CIT 28, Innovation Economy/Human Capital Initiative, and CIT 29, Health Care Connectivity to Strengthen Resilience and Disaster Preparedness). It also can draw on past and present Puerto Rico Science, Technology, and Research Trust and University of Puerto Rico research projects and existing resiliency labs.

CIT 31
Resilience/e-Construction Learning Lab

Sector Impacted

Communications and Information Technology, Housing, Municipalities, Transportation

Issue/Problem Being Solved

Leverage state-of-the-art resilient e-construction approaches to accelerate socioeconomic development.

Description

This course of action would start by establishing a Resilience/e-Construction Learning Lab for a 1-year pilot project to digitize assessment, permitting, and reporting processes in 1 Puerto Rican municipality. At the end of this pilot projects, findings would be presented to inform the feasibility and cost-benefit analysis for a commonwealth-wide e-permitting and e-construction ecosystem.

Potential Benefits

A streamlined paperless construction administration delivery process facilitates all legacy and new construction documentation and digital management in a secure environment. It also saves money by decreasing paper use, printing, and document storage costs, and it saves time by decreasing communication delays and transmittal time, all while increasing transparency and tax collection.

Potential Spillover Impacts to Other Sectors

This course of action would accelerate the development of efficient ways to build affordable and resilient homes and structures (Housing). It would facilitate the development of roads and bridges, ensuring public safety and the continuity of essential government functions (Transportation). And it would streamline paperless construction administration and increase transparency and tax collection (Municipalities).

Potential Costs

Potential upfront costs: $1.5 million–$6.0 million in estimated upfront costs[48]

[48] The recovery plan represented potential up-front costs as $500,000–$10 million. The up-front costs' lower bound is updated here to include software tools.

Potential recurring costs: $9.6 million–$38 million in estimated recurring (11 years)[49]
Potential total costs: $11 million–$44 million in total estimated costs[50]

Once a successful pilot is completed, costs for expansion, barriers and facilitators can be further refined. The costs of software tools and services can vary significantly depending on desired capabilities, to be defined and evaluated during the pilot project.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Department of Transportation

Potential Implementers

Central Office of Recovery, Reconstruction, and Resiliency, Office of the Chief Innovation Officer, Puerto Rico Department of Housing

Potential Pitfalls

This process requires coordination to organize a multidisciplinary team. The risks are minimized by conducting an initial pilot project to present findings and cost-benefit analysis before expansion.

Likely Precursors

Precursor courses of action are CIT 30 (Resiliency Innovation Network Leading to Development of a Resiliency Industry) and CIT 16 (Government Digital Reform Planning and Capacity Building). It would be important to empower the Puerto Rico Department of Housing with the resilient e-construction mission before establishing collaboration with the U.S. Department of Transportation, academia, and a municipality for the staffing of the e-Construction Learning Lab.

[49] The recovery plan represented potential recurring costs as $20 million–$60 million. That estimate is updated here to reflect labor costs, consistent with the other courses of action.

[50] The recovery plan represented potential total costs $20 million–$70 million. That estimate is updated here to reflect labor costs, consistent with the other courses of action.

CIT 32
Digital Citizen Services

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic, Health and Social Services

Issue/Problem Being Solved

Citizens increasingly expect their experience with government services to be as easy, quick, and simple to understand as the user interfaces for consumer services. This requires building on successful efforts for the provision of digital services at the federal and state levels, as well as learning what has and has not worked when updating public-facing digital services.

Description

This course of action would expand the scope of the Puerto Rico Innovation and Technology Service (PRITS) to include a focus on citizen-centered services and prioritize a "one-stop shop" experience for accessing government services and information in an easy-to-use fashion. This course of action would implement best practices for ensuring digital inclusion and accessibility, such as the ability to access government services from mobile devices.

Potential Benefits

This course of action could increase public trust, transparency, and accountability; increase use and adoption of digital services tailored to citizens' needs and experiences; streamline internal government processes; and reduce the number of people and resources required for rote government services, thus allowing for more attention to human interaction and other challenges to improve the public experience overall.

Potential Spillover Impacts to Other Sectors

Digitized government services would affect all sectors through (1) better data for planning and evaluation, (2) transparency and accountability, (3) more efficient citizen interaction for services, and (4) possible cost savings, streamlining reporting, and reducing time to decision.

Potential Costs

Potential up-front costs: $240,000 in estimated up-front costs[51]

[51] The recovery plan published a potential up-front cost of $400,000. That cost overestimated the cost of equipment for setup. The estimated cost is corrected here, lowering the estimated cost.

Potential recurring costs: $25 million in estimated recurring costs (11 years)[52]
Potential total costs: $25 million in total estimated costs[53]

The potential total cost scales with the number of teams employed. The recovery plan estimated the cost for 2 teams.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, government of Puerto Rico

Potential Implementers

Office of the Chief Innovation Officer, government of Puerto Rico agencies

Potential Pitfalls

This course of action may lead to internal friction, "change fatigue," workforce reduction, and perceived loss of control from existing agencies. It would be crucial to ensure protection of citizen privacy and strong cybersecurity.

Likely Precursors

Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building) and CIT 27 (Study Feasibility of Digital Identity).

[52] The recovery plan published potential recurring costs of $33 million. The recurring costs have been corrected to have labor costs consistent with other courses of action, reducing the estimated recurring costs. This update lowers the estimated recurring cost to $25 million.

[53] The recovery plan published a potential total cost of $33 million. The total potential costs are updated here to reflect labor costs, consistent with other courses of action, reducing the total estimated cost. This update lowers the estimated recurring costs to $25 million, using two significant figures.

CIT 33
Government Digital Process Reform

Sector Impacted

Communications and Information Technology, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

Puerto Rico is undergoing a government transition to consolidate and reorganize its government departments and agencies. This presents an opportunity to bridge traditional silos and introduce service *cultures* (plural, as each agency has different missions) of coordination by design to include data-driven, outcomes-based, whole-systems governing to continuously improve service, be more effective with the money spent, improve service delivery, better serve the public, and make better policy. Such a venture is inward-facing and should work hand-in-glove with the digital services efforts of the Puerto Rico Innovation & Technology Service (PRITS).

Description

This course of action would (1) adopt a systems approach to government technology, with an emphasis on human-centered digital process design and data standardization to drive policy decisions; (2) establish people-centered, digital design and data science teams within the government of Puerto Rico to tackle cross-cutting policy and operational issues, coordinating different projects with agencies (especially during the agency-consolidation process to ensure clear accountability); and (3) open up government services internally and externally through the use of APIs (application program interfaces), where appropriate, and for feedback to drive continuous improvement.

Potential Benefits

Agency consolidation and reorganization is an opportunity to establish a "whole-of-government," people-centered, digital design, and data–driven approach that would improve service and service delivery, be more cost-effective, better serve the public good, and make better policy.

Potential Spillover Impacts to Other Sectors

All sectors would benefit from a coordinated, effective, integrated, feedback-driven, and more holistic data-driven governing approach. Sectors that will benefit from this course of action are Community Planning and Capacity Building and Economic.

Potential Costs

Potential up-front costs: $300,000 in estimated up-front costs
Potential recurring costs: $70 million in estimated recurring costs (11 years)
Potential total costs: $70 million in total estimated costs

The estimated recurring cost for each digital design and data team is $2 million annually.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, government of Puerto Rico

Potential Implementers

Office of the Chief Innovation Officer, government of Puerto Rico agencies

Potential Pitfalls

As with CIT 32 (Digital Citizen Services), this course of action could potentially lead to internal friction, "change fatigue," workforce reduction, a shift or reduction in influence and authority by existing leadership, and perceived loss of control from existing agencies. It would be crucial to ensure access and safety for the most vulnerable and underserved, as well as protection of citizen privacy and strong cybersecurity.

Likely Precursors

Precursor courses of action are CIT 16 (Government Digital Reform Planning and Capacity Building), CIT 27 (Study Feasibility of Digital Identity), and CIT 32 (Digital Citizen Services).

Community Planning and Capacity Building Sector

COA Number	Title
CPCB 1	Disaster Preparedness Data Analysis and Decision Support Capability
CPCB 2	Capacity Building for Community-Level Preparedness and Response
CPCB 3	Capacity Building to Incorporate Hazard Risk Reduction into Planning and Design
CPCB 4	Resilience Building in Collaboration with High-Risk Communities
CPCB 5	Establishing a University-Based Center of Excellence for Disaster Preparedness and Recovery
CPCB 6	Public Information and Communication Capability for Coordinated Recovery
CPCB 7	Capacity Building for Emergency Shelter Planning
CPCB 8	Strengthening Emergency Management Capacity at Municipalities
CPCB 9	Coordinated Local Recovery Planning Process
CPCB 10	Incentivize Resilient, Creative Design Solutions for Addressing Hazards
CPCB 11	Cross-Sector Coordination in Infrastructure and Implementation
CPCB 12	Capacity Building for Financial Management
CPCB 13	Training Workshop on Best Practices in Post-Disaster Procurement
CPCB 14	Building Grant Writing Capacity
CPCB 15	Strengthen Local Nonprofit and NGO Involvement in Disaster Recovery

CPCB 1
Disaster Preparedness Data Analysis and Decision Support Capability

Sectors Impacted

Community Planning and Capacity Building, Municipalities, Natural and Cultural Resources, Housing, Health and Social Services, Water

Issue/Problem Being Solved

Improve disaster planning and decisionmaking with better information. To efficiently and effectively spend disaster preparedness resources, which are typically limited, Puerto Rico would benefit from an improved ability to make informed choices about priority preparedness activities.

Description

This course of action would build a disaster-related data analysis and decision support capability at the Puerto Rico Emergency Management Agency (PREMA) and in partnership with the Puerto Rico Planning Board that would support disaster preparedness and hazard mitigation activities. It would establish a commonwealth-level team of 10 people to oversee the continued collection and analysis of data on hazards, environmental risks, housing, infrastructure, economic barriers, preparedness, and so on by geography (municipality or smaller). This information would then be disseminated to planners in PREMA, other commonwealth-level agencies, and municipalities. In addition, this course of action would establish outreach teams within each of Puerto Rico's 78 municipalities to work directly with communities to collect data on hazard vulnerabilities and preparedness capabilities. These types of high-quality data would support the development of decision support tools, such as GIS tools, to help prioritize areas for improving disaster preparedness or hazard mitigation activities.

Potential Benefits

Given limited resources for dealing with disasters and the regularity of disaster threats (e.g., hurricane season, landslides), systematically collecting better data to help support decisionmaking for improving preparedness can help Puerto Rico efficiently and effectively spend the funds it has.

Potential Spillover Impacts to Other Sectors

Many decisions for improving disaster preparedness happen at the municipal level, but the ability of municipalities to collect data varies. This course of action creates a robust data-gathering and data-analysis capability at PREMA that can support the work of municipalities, as well as other commonwealth agencies. The key sectors in which disaster preparedness analysis could have an impact are Natural and Cultural Resources (because of mitigation activities related to the environment), Housing (because of activities related to residents of informal housing and

activities to make homes safer and more resilient to hurricanes), and Health and Social Services (because medical facilities, social service providers, and community-based organizations are likely to be key players in disaster response).

Potential Costs

Potential up-front costs: —
Potential recurring costs: $21 million in estimated recurring costs (11 years)
Potential total costs: $21 million in total estimated costs

Recurring costs are estimated based on personnel cost. The basis of the cost assumes a 10 full-time-equivalent (FTE) analytic team at the commonwealth level and an average 0.25 FTEs outreach per municipality (approximately 20 in total). The estimate assumes 30 FTEs annually, at a cost of $1.9 million.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, Puerto Rico Emergency Management Agency

Implementation

Government of Puerto Rico, municipal governments, Puerto Rico Planning Board

Potential Pitfalls

Spending money on disaster preparedness is a challenge for a cash-strapped government that may need to divert resources to other priorities. Furthermore, the collection of quality data at the level of communities is hard to establish and maintain. Coordination between the commonwealth and municipalities is critical.

Likely Precursors

A thorough review of available data at the commonwealth and municipal levels to identify gaps

CPCB 2
Capacity Building for Community-Level Preparedness and Response

Sectors Impacted

Community Planning and Capacity Building, Health and Social Services

Issue/Problem Being Solved

Lack of disaster preparation: Puerto Rico was not adequately prepared during the last hurricane season. In addition to a financial crisis and aging infrastructure, essential preparation and disaster response and recovery capabilities were not in place, especially for the most isolated and vulnerable communities.

Description

This course of action would focus on capacity building for preparedness and response. Efforts are currently under way to update preparedness and response plans for the commonwealth, 30 commonwealth-level agencies, and all 78 municipalities. However, community-level response and recovery preparedness activities should be developed and implemented for 50–100 priority communities (i.e., at levels smaller than the municipality level) that are particularly vulnerable to disaster impacts. The communities would be identified by Puerto Rico Emergency Management Agency (PREMA), in consultation with the Office for the Socioeconomic and Community Development (Oficina para el Desarrollo Socioeconómico y Comunitario [ODSEC]) and municipality governments. The number of communities needing more-specific disaster preparedness plans and training would be increased as needed. The commonwealth would also actively recruit, train, and equip Community Emergency Response Teams (CERTs) in these vulnerable communities. Communities would work with community leaders and community-based organizations that are most knowledgeable about the special needs of local communities and would establish with them an approach for checking on people with access and functional needs. This would allow communities to better sustain themselves during response periods, when the availability of emergency responders and access to communities is often limited. Finally, poor road conditions and hard-to-reach locations of some communities warrant building caches of emergency supplies, such as water filters and generators.

Potential Benefits

This course of action would put into place fundamental preparedness and response capabilities at the commonwealth and municipal levels.

Potential Spillover Impacts to Other Sectors

This course of action is not likely to have spillover to many other sectors, but there may be some collaboration with Health and Social Services, based on the training of CERT teams and

their potential interaction with health and social services entities (e.g., hospitals, disaster nongovernmental organizations) during and after a disaster.

Potential Costs

Potential up-front costs: $3 million in estimated up-front costs
Potential recurring costs: $34 million in estimated recurring costs
Potential total costs: $37 million in total estimated costs

The up-front costs are estimated as material consisting of $30,000 per community cache, multiplied by 100 communities. The recurring costs are estimated base on a 10 full-time-equivalent (FTE) planning team at the commonwealth level and 0.5 FTE (on average) CERT coordinators per municipality (approximately 40), for a total of 50 FTEs annually.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Puerto Rico Emergency Management Agency

Implementation

FEMA, Puerto Rico Emergency Management Agency, municipal governments

Potential Pitfalls

This course of action could be affected by challenges in funding and coordination between the commonwealth and municipalities. PREMA would be responsible for identifying the communities but would have to do so in consultation with ODSEC and the municipalities. The development of plans and placement of supply caches would also need to be done in cooperation with each of the municipalities, which would necessitate establishing accountability mechanisms between the commonwealth and municipalities.

Likely Precursors

To select the 50–100 high-risk communities for focused development of preparedness plans and other related activities, it would be necessary to complete CPCB 1 (Disaster Preparedness Data Analysis and Decision Support Capability), which focuses on collecting better data for preparedness decision support.

CPCB 3
Capacity Building to Incorporate Hazard Risk Reduction into Planning and Design

Sectors Impacted

Community Planning and Capacity Building, Natural and Cultural Resources, Water, Energy, Public Buildings

Issue/Problem Being Solved

As Puerto Rico rebuilds, all planning and design decisions should incorporate risk reduction as a principle. To enable this, a sustained, systematic, and standardized approach to identifying risks across the commonwealth is required.

Description

This course of action would enhance the commonwealth-wide hazard mitigation assessment, monitoring, and evaluation enterprise within the Puerto Rico Planning Board (PRPB), so that the board can better inform and promote the incorporation of risk reduction as a principle in all planning and design decisions. For this course of action, analysts capable of using GIS (geographic information system) would generate hazard maps for each municipality to inform zoning decisions and improve municipal hazard mitigation planning capacity. Additionally, hiring a risk officer for each of the 27 commonwealth-level agencies would infuse risk reduction into decisions across those agencies.

Potential Benefits

This course of action brings needed analytic capability to enable a standardized and systematic approach to hazard mitigation by specifying the need to routinely assess, monitor, and evaluate hazards. This course of action would also encourage a more data-driven implementation of Puerto Rico's hazard mitigation plan.

Potential Spillover Impacts to Other Sectors

Although many key activities are categorized as response or preparedness actions, hazard mitigation can also include regulation revision, infrastructure projects, natural systems protection, and education programs for the public. A monitoring and evaluation system may need to coordinate with sectors leading these activities—e.g., Water, Energy, Buildings, and Natural and Cultural Resources—to ensure that goals are being met.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $84 million in estimated recurring costs (11 years)

Potential total costs: $84 million in total estimated costs

The recurring costs are based on the annual staffing cost of personnel, include 20 full-time-equivalent analysts at the PRPB ($124,600 per analyst annually) and 1 risk officer in each of the 27 commonwealth-level agencies ($187,000 per risk officer annually). The totally annual cost for personnel is estimated as $7.6 million.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery

Potential Implementers

PRPB, infrastructure sectors

Potential Pitfalls

The successful incorporation of risk-reduction principles in building decisions depends on many other sectors, such as Public Buildings, Water, Energy, and Natural and Cultural Resources. Although the PRPB may have some influence over decisions by other sectors, its formal power may have limitations. Consequently, these other sectors would have to agree to having their activities monitored at the commonwealth level by the PRPB.

Likely Precursors

A comprehensive review and alignment of hazard mitigation plans at the commonwealth and municipal levels

CPCB 4
Resilience Building in Collaboration with High-Risk Communities

Sectors Impacted

Community Planning and Capacity Building, Health and Social Services

Issue/Problem Being Solved

Communities that could not be reached quickly in the aftermath of Hurricanes Maria and Irma had to find ways to survive without outside help. The challenge of withstanding and recovering from the ensuing adversity was compounded by the lack of disaster preparedness and response systems to reduce negative impacts. Given the continued fragility of infrastructure systems—and the arrival of a new hurricane season—the possibility of communities facing long periods without essential services in the aftermath of a disaster remains a potential future scenario.

Description

This course of action would hire planners, on average 1.5 full-time equivalents (FTEs) per municipality, to develop and implement disaster resilience plans in collaboration with 50–100 selected communities. These plans would include investments into programs that address long-term stressors, such as workforce development, microfinance loans, and education, as well as the improvement of essential services. Such plans promote the capacity to cope and acclimate to chronic and acute stressors. This course of action would also conduct a gap analysis to understand which essential services are missing in communities that nonprofits could then be incentivized to provide. In partnership with local nongovernmental organizations, the commonwealth would set up resilience-building events, including making connections among governmental agencies, community groups, and nongovernmental organizations, and would provide settings and resources to enable selected communities to take charge of becoming more resilient to future disasters. The resilience of a community depends on the diversity of economic opportunities, robust public services, a tight-knit social support network, effective emergency management, and cross-sector collaborations.

Potential Benefits

Building community and individual resilience is critical for both response and long-term recovery. Puerto Rico has already experienced inadequate response and suboptimal recovery phases, so it makes sense to focus on building resilience for the future.

Potential Spillover Impacts to Other Sectors

One critical aspect of community resilience planning is improving critical community resources and assets over the long term, such as health care facilities, schools, and social services. Therefore, Health and Social Services could experience spillover impacts.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $83 million in estimated recurring costs (11 years)
Potential total costs: $83 million in total estimated costs

The recurring cost is based on the personnel for an average of 1.5 FTEs per municipality (approximately 120 FTEs in total). The annual recurring cost is estimated to be $7.5 million.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Hazard Mitigation Grant Program, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Government of Puerto Rico, municipal governments, local nongovernmental organizations

Potential Pitfalls

The most difficult aspect of resilience building is the need to improve critical community resources and assets, such as hospitals, education, and mental health services. Having to depend on other sectors being able to improve their own capacities may affect a community's ability to build resilience. The second most difficult part of resilience building is getting those community assets—governmental and nongovernmental—to work with each other.

Likely Precursors

Identifying key local partners: community-based organizations, hospitals, schools, etc.

CPCB 5
Establishing a University-Based Center of Excellence for Disaster Preparedness and Recovery

Sectors Impacted

All

Issue/Problem Being Solved

Build capacity among colleges and universities to maximize recovery and disaster preparedness through research and curriculum development.

Description

This course of action would establish the Center of Excellence (COE) for Disaster Preparedness and Recovery at a university in Puerto Rico. The mission of the COE would be threefold: First, it would foster local, multidisciplinary research on disaster preparedness, response, and recovery. Second, it would develop innovative solutions to preparedness, resilience, hazard mitigation, and recovery problems, with a focus on environments particularly vulnerable to climate change, such as Puerto Rico. Third, it would build preparedness, response, and recovery capacity in Puerto Rico through curriculum development and training that would be provided to government agencies, nonprofit organizations, and individuals.

Potential Benefits

As a research entity, the COE would contribute to the body of knowledge. As a design center, the COE would translate that knowledge to innovative and usable solutions. As a training center, the COE would increase the preparedness of agencies, entities, and residents of Puerto Rico and beyond. The COE would provide benefits to the university through increased resources for research and teaching and the fostering of multidisciplinary and multiagency collaboration. This would contribute to the attraction and retention of students and faculty.

Potential Spillover Impacts to Other Sectors

The knowledge and solutions created by the COE would have an impact on all sectors involved in the building of resilient infrastructure and the mitigation of hazards. Improving preparedness and response would have an impact on government and nongovernment entities involved in the well-being of people. Strengthening the university would have an impact on education and economics by providing an attractor of students and faculty.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $22 million–$55 million in estimated recurring costs (11 years)

Potential total costs: $22 million–$55 million in total estimated costs

The recurring costs are based on funding levels of other U.S. Department of Homeland Security COEs. The cost of establishing a COE in Puerto Rico could be as high as $5 million. However, even a smaller funding level would be useful. Consequently, the estimated costs for a COE for disaster preparedness and recovery range from $2 million to $5 million annually. This funding would be used to fund research projects and design projects, develop curriculum, disseminate training, and administer the new center.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Homeland Security Science and Technology Directorate, private sector, nongovernment sources

Potential Implementers

Universities, U.S. Department of Homeland Security Science and Technology Directorate

Potential Pitfalls

Initial establishment of the COE would require some development of university infrastructure to sustain a center of this magnitude. Initial hiring and curriculum and infrastructure planning would be needed. A longer-term funding source beyond Community Development Block Grant–Disaster Recovery would have to be identified to sustain the COE; this would require a decision by the U.S. Department of Homeland Security Science and Technology Directorate and a request to Congress.

Likely Precursors

Identify an appropriate university with the infrastructure needed and willingness to maintain and develop a COE at the university.

CPCB 6
Public Information and Communication Capability for Coordinated Recovery

Sectors Impacted

Community Planning and Capacity Building and any sector communicating with the public about recovery

Issue/Problem Being Solved

It is challenging for government agencies in both Puerto Rico and the United States to communicate consistently with the public about their respective recovery efforts.

Description

This course of action would build a public information and communication (PIC) capability that would facilitate the continued engagement of Puerto Rican communities in the recovery process. This course of action would not only support one-way informational dissemination from the government to residents—in the form of press releases, policy briefs, newsletters, and websites—but would also establish and maintain methods of two-way communication focused on listening to, responding to, and involving residents during the entire life cycle of the recovery process. The commonwealth government PIC capability would support the community engagement component of local recovery planning processes. Specific communication activities include community meetings, listening sessions, and sharing information relevant to communities broadly via interpersonal and mediated channels (e.g., radio, print, online). Effective communication can have a significant impact on residents' participation in community development; this participation, in turn, can improve the likelihood that residents would support and believe in the changes in their communities. Including communities of Puerto Ricans who have moved to the continental United States is also important because it would help the government of Puerto Rico understand—and plan accordingly for—both the informational needs of these communities and also how or when residents might decide to return to Puerto Rico.

Potential Benefits

Developing and implementing a communications strategy, particularly one that is supported by well-established approaches such as message testing, would help the government of Puerto Rico communicate more clearly with the public, increase transparency, and improve public trust. These positive effects may also help stakeholders involved in the recovery process work together to accomplish their mutual goals.

Potential Spillover Impacts to Other Sectors

Implementation of PIC capability could be beneficial to all sectors involved in recovery. For example, there is a great deal of public interest in the progress of efforts to fix the power grid at the commonwealth and local levels. Engaging in two-way communication channels would help infrastructure sectors not only deliver information but also receive information to inform their work.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $8.8 million in estimated recurring costs (11 years)
Potential total costs: $8.8 million in total estimated costs

Estimates range from $250,000 to $500,000 annually for engaging a communications firm. Recurring costs include $320,000 annually, for an estimated 5 full-time equivalents, to ensure that feedback from the community is disseminated back to planners. Total recurring costs are estimated as $800,000 per year.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, Puerto Rico Emergency Management Agency

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

This course of action depends on a strong coordinating mechanism across the government of Puerto Rico, other sectors, and many stakeholders. Additionally, a communications strategy cannot control the flow of information from other potentially conflicting data sources outside its scope.

Likely Precursors

Conduct outreach to other government or partner entities that are working in communications on recovery.

CPCB 7
Capacity Building for Emergency Shelter Planning

Sectors Impacted

Community Planning and Capacity Building, Health and Social Services, Municipalities, Public Buildings

Issue/Problem Being Solved

Many of the shelters in which residents sought refuge after Hurricanes Maria and Irma lacked basic accommodations, such as kitchens or showers, for use by residents in the longer term, or an appropriate level of supplies. A comprehensive assessment of the capacity and capability of shelter facilities is required.

Description

This course of action would conduct an assessment and develop a shelter plan that has a comprehensive and strategic approach to sheltering across Puerto Rico. Actions include hiring planners in each municipality and at the commonwealth level to support the development of a more robust emergency shelter system and borrowing from best practices in sheltering, such as involvement of the community and tying sheltering considerations to long-term housing development and survivor services. Planners would develop parameters, standards, and general design guidelines for shelters that would better support residents in the longer term. The planners at the commonwealth level would provide appropriate support to planners in municipalities so that they can develop and implement their own emergency shelter plans. This would involve the selection of appropriate facilities; ensuring optimal numbers and locations of shelters; and developing and implementing shelter maintenance, power, water, and security plans. Planners would also establish a protocol with the National Guard for effective management of response commodities for shelters and with Departamento de la Vivienda for the staffing and management of the shelters themselves.

Potential Benefits

This course of action would improve access to safe and appropriately resourced shelters, within a reasonable distance, that can accommodate community needs, such as disabilities and medical conditions.

Potential Spillover Impacts to Other Sectors

Intensive collaboration on the development and implementation of emergency shelter plans could empower the Municipalities sector—which already has local knowledge of facilities and a faster ability to respond during a disaster—to make key emergency shelter plan decisions. Furthermore, collaboration with Health and Social Services to improve medical care for the ill or

injured at emergency shelters could mean less stress on hospitals during a disaster. Public Buildings may be asked to work closely with emergency planners around the repair and upgrade of existing facilities, which could result in safer buildings outside of disasters.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $57 million in estimated recurring costs (11 years)
Potential total costs: $57 million in total estimated costs

The recurring costs are personnel costs, including 3 full-time-equivalent (FTE) planning staff at the commonwealth level and approximately 1 FTE on an average planning staff in each municipality (approximately 80 in total). The recurring costs are estimated as $5.2 million per year.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico, municipal governments

Potential Implementers

FEMA, Puerto Rico Emergency Management Agency, Public Buildings

Potential Pitfalls

Because the establishment of a robust emergency shelter system depends very heavily on collaboration with other sectors, it is critical to bring many stakeholders to the table from Health and Social Services, Public Buildings, Municipalities, and potentially other sectors during the planning stages.

Likely Precursors

The precursors are a review of current guidelines for selecting and establishing emergency shelters and commonwealth partnerships with municipalities to designate roles in emergency shelter planning and implementation.

CPCB 8
Strengthening Emergency Management Capacity at Municipalities

Sectors Impacted

Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Many municipal governments lack sufficient trained personnel for emergency management and response. Since municipal governments are more likely to be the first to respond to their local needs than the commonwealth government, it is critical to ensure that municipalities have enough adequately trained staff to plan for emergencies and coordinate the response of various agencies.

Description

This course of action would establish a Municipal Emergency Management Office in municipalities where one does not already exist. FEMA would work with Puerto Rico Emergency Management Agency (PREMA) zone managers and local emergency managers to identify gaps in emergency management capability, including personnel needs, training gaps, and equipment. This course of action would develop a strategy for addressing capability gaps; develop a training curriculum that more directly establishes a clear understanding of the diverse roles of different entities during a disaster and how they connect; provide training that involves all the entities with a role in disaster management (emergency managers, public works officials, finance officers, mayors and vice mayors, local city planners, health officials, community leaders, etc.); ensure that state and local stakeholders understand their roles and responsibilities and have access to checklists, protocols, and staff rosters and communications plans that enable them to perform their duties; train emergency managers to collect better information about people requiring evacuation (e.g., disabled, elderly) and to prepare to be able to serve people with access and functional needs during a disaster; and develop forms, templates, and relationships (mutual aid compacts, procurement guidelines, permitting reserve capability, etc.) that would enable municipalities to meet response and recovery needs effectively after a disaster.

Potential Benefits

Given that municipalities are fundamentally responsible for responding first to their residents during a disaster, it is critical that municipalities have appropriate emergency management and response capacity. To this end, this course of action would benefit residents of Puerto Rico by providing them better emergency response and addressing severe disaster impacts with more efficiency.

Potential Spillover Impacts to Other Sectors

Improved emergency planning and response could lead to economic benefits from perceived reductions in risk.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $165 million in estimated recurring costs (11 years)
Potential total costs: $165 million in total estimated costs

Recurring costs are estimated based up on personnel costs, including 3 full-time-equivalents (FTEs), on average, for each Municipal Emergency Management Office, or about 240 FTEs total. At a cost of $62,300 per FTE, the total recurring cost is estimated as $15 million per year.

Potential Funding Mechanisms

FEMA Emergency Management Performance Grant, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, Puerto Rico Emergency Management Agency

Potential Implementers

FEMA, PREMA, Municipal Emergency Management Offices, U.S. Department of Health and Human Services

Potential Pitfalls

Emergency management responsibilities of PREMA could overlap with those of the Municipal Emergency Management Offices. A clear division of responsibilities would be required to avoid conflict or unnecessary duplication. Strengthened Municipal Emergency Management Offices, which take on more responsibility, could also mean that municipalities would have to coordinate with each other.

Likely Precursors

Identify which municipalities *do or do not* have a Municipal Emergency Management Office. Begin connecting municipalities lacking such offices with key agencies (e.g., PREMA, FEMA) to establish an office.

In addition, many of the other proposed Community Planning and Capacity Building courses of action involve adding staff to work at the local level on specific tasks. Those courses of action did not specify whether their field staff would be employed by PREMA or the Municipal Emergency Management Offices. That staff would be in addition to the staff counted in this course of action. If Municipal Emergency Management Offices were strengthened, as called for in this course of action, it is possible that the staff in the other courses of action aligned with the

Community Planning and Capability Building sector could be employed by the Municipal Emergency Management Offices rather than by PREMA.

CPCB 9
Coordinated Local Recovery Planning Process

Sectors Impacted

All

Issue/Problem Being Solved

A fundamental challenge to maximizing the opportunities present in recovery is the fragmented delivery of federal resources, both over time and among numerous programs. Absent a coordinated recovery planning process, this leads to ad hoc decisionmaking and a piecemeal recovery. The effectiveness of the recovery plan is likely to be substantially reduced without a coordinated framework for translating the larger strategic objectives and courses of action into recovery projects and programs on the ground at the local level.

Description

This course of action would establish a process by which all the municipalities that were severely affected by the hurricanes develop their respective recovery and reconstruction plans in a common, coordinated way. An additional component of this course of action would be to provide support to municipal governments needing to coordinate the implementation of a large number of recovery projects in the form of a dedicated local disaster recovery manager.

Potential Benefits

The substantial investment in disaster recovery and reconstruction following Hurricanes Irma and Maria provides an opportunity to address long-standing problems. The benefit of investing tens of billions of dollars in a planned and coordinated way is that capitalizing on these opportunities would be maximized, resulting in transformational change. Coordinated planning of recovery investments also enables hazard risk to be examined and addressed at a neighborhood, municipal, or multijurisdictional scale, increasing return on investment and reducing future losses. Through a structured planning process, innovative solutions can be developed to produce benefits across sectors, from jobs to housing to social services to infrastructure.

Potential Spillover Impacts to Other Sectors

A coordinated local recovery planning process would have a method of integrating sector-level recovery planning activities and initiatives (such as for FEMA Section 428 Public Assistance and Hazard Mitigation Grant Program funds) with the development of local recovery plans to coordinate commonwealth-level projects with local projects.

Potential Costs

Potential up-front costs: $51 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $51 million in total estimated costs

The up-front cost is estimated as $35 million–$40 million for the planning process, plus approximately $11.2 million for local disaster recovery managers (on average 0.5 full-time-equivalents [FTEs] per municipality) for about 40 FTEs. The local disaster recovery managers are estimated to cost $93,500 per FTE.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, nongovernment sources

Potential Implementers

Puerto Rico Planning Board, municipal governments

Potential Pitfalls

Coordinating any planning efforts occurring at a sector-wide scale with local planning efforts is inherently challenging. To be effective, it would be imperative that senior leadership at FEMA and at the commonwealth level make this a priority and communicate to program and field staff accordingly.

Each local recovery planning process should be guided by a community recovery committee consisting of a cross-section of key stakeholders. Although the mayor is ultimately responsible for the implementation of each plan, broad community participation and support are needed to help drive successful implementation and ensure accountability.

Consultant resources in Puerto Rico may be limited both in number and in experience. As a result, increased costs necessary for importing specialized labor should be considered.

Likely Precursors

The activity needs to be included in the Community Development Block Grant–Disaster Recovery action plan if Community Development Block Grant–Disaster Recovery funds are to be used. Submission of an Hazard Mitigation Grant Program project application is needed if Hazard Mitigation Grant Program funds are to be used. Collaboration, not just coordination, is needed between the Puerto Rico Planning Board and the Central Office of Recovery, Reconstruction, and Resiliency regarding Section 428 Public Assistance projects and other projects in development.

CPCB 10
Incentivize Resilient, Creative Design Solutions for Addressing Hazards

Sectors Impacted

Community Planning and Capacity Building, Natural and Cultural Resources

Issue/Problem Being Solved

Disaster preparedness projects are often narrow in scope and targeted to address a specific risk. However, they have the potential for a greater return on investment. It would be more efficient to spend funds to develop solutions that not only reduce risk but also have added social, economic, or environmental benefits.

Description

This course of action would fund a design competition that fosters innovative solutions for risk reduction. The design would be required to aim to mitigate hazards, including, but not limited to, hurricanes and flooding while having added social or economic benefits to the community. The design determined to be the most beneficial and favorable to the respective community would be commissioned using hurricane recovery funds.

Potential Benefits

The design competition would elicit original ideas to mitigate disaster risks. Because the ideas are crowd-sourced from the broad public, expertise and deliberation unconventional to traditional risk-mitigation strategies may yield outside-the-box solutions and transdisciplinary approaches. Implementing such projects is an efficient use of funds, because the projects concurrently address multiple issues. Also, people would base ideas on what they perceive to be actual problems or areas of improvement in their own communities, providing a valuable perspective from the ground level. If the funds are unavailable to realize the entirety of the project, a substantial funding of the project and publicity of its positive impact could prompt more funds from other investors.

Potential Spillover Impacts to Other Sectors

The designs may target a variety of issues, in turn affecting other sectors.

Potential Costs

Potential up-front costs: $6 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $6 million in total estimated costs

The up-front cost is estimated as $6 million for the design competition (not including the cost of building the winning design).

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, Puerto Rico Emergency Management Agency

Potential Implementers

Puerto Rico Planning Board; Central Office of Recovery, Reconstruction, and Resiliency; FEMA; Puerto Rico Emergency Management Agency; general public of Puerto Rico

Potential Pitfalls

Design submitters may have concern over releasing ideas because of rights over intellectual property. There may be legal measures to apply to encourage the sharing of concepts.

Likely Precursors

This course of action includes the cost of operating a design competition to solicit creative ideas, but it does not include the cost of building the selected project. Building costs are assumed to be included in the various sector courses of action calling for respective rebuilding efforts. This course of action is therefore dependent on rebuilding efforts being funded.

CPCB 11
Cross-Sector Coordination in Infrastructure and Implementation

Sectors Impacted

All

Issue/Problem Being Solved

Build government capacity to develop coordinated sector-based plans for infrastructure systems and ensure that capital improvement projects are implemented in a coordinated manner.

Description

This course of action would ensure coordination and development across sectors and would guarantee that major infrastructure projects are implemented in a thoughtful manner, while taking into account participation from other sectors during development and implementation phases. Five experienced planners—cross-sector infrastructure and implementation leaders (CIILs)—would be hired into dedicated positions within the Central Office of Recovery, Reconstruction, and Resilience (COR3). CIILs would be devoted to ensuring collaboration and coordination between sectors when major infrastructure projects are proposed or are in the process of being developed. CIIL activities include coordinating cross-sector meetings with relevant sector members and stakeholders, reviewing infrastructure plans, coordinating participation in cross-sector meetings during infrastructure planning and development, and ensuring thoughtful development and coordination during the infrastructure planning process.

Potential Benefits

This course of action would help to increase transparency of infrastructure planning and integrate sector needs during development and implementation. In addition, because of the interdependency of systems, especially evident postdisaster, it is critical that there is integration of planning from the start to ensure that systems are built stronger and smarter. The CIILs would work to ensure that there is investment in collaboration and would coordinate input from all sectors to achieve infrastructure system development goals.

Potential Spillover Impacts to Other Sectors

CIILs would help all sectors involved with any aspect of infrastructure system planning.

Potential Costs

Potential up-front costs: —

Potential recurring costs: $6.9 million in estimated recurring costs (11 years)[54]
Potential total costs: $6.9 million in total estimated costs[55]

The recurring costs are estimated as personnel costs, including 5 full-time-equivalent (FTE) dedicated CIILs at COR3 costed at $124,600 per FTE. The recurring costs are estimated as $623,000 annually.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

Because successful implementation and planning of infrastructure systems relies on cross-sector collaboration, it is critical to ensure transparency within the development of these systems. However, this relies on the willingness of sectors to invest time and energy into collaborative engagements to ensure that the collaboration is a success.

Likely Precursors

The CIIL role and responsibilities would need to be developed within COR3. The role and its responsibilities would also need to be introduced to all sectors, who would need to have a clear understanding of its purpose.

[54] This estimated recurring cost was represented as $6.8 million in the recovery plan. It is corrected to $6.9 million here.

[55] This estimated total cost was represented as $6.8 million in the recovery plan. It is corrected to $6.9 million here.

CPCB 12
Capacity Building for Financial Management

Sectors Impacted

Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

The number and size of grants that will be received by Puerto Rico as part of rebuilding efforts are likely to be much larger than the historical levels the commonwealth has been used to receiving. Effectively and efficiently managing those funds will be vital to ensuring they are spent in accordance with regulations and accounting practices.

Description

This course of action would conduct a study to reevaluate the current state of the commonwealth's grant management processes and workforce in light of the increased volume and pace of work that will follow from hurricane rebuilding efforts. In anticipation that the study will call for the hiring of additional financial management personnel, this course of action includes hiring 10 additional full-time equivalents (FTEs).

Potential Benefits

According to the U.S. Census Bureau's *Consolidated Federal Funds for Fiscal Year 2010*,[56] the last year for which the report is available, Puerto Rico received $6.3 billion in federal grants. Grants to assist with the rebuilding of Puerto Rico following Hurricanes Irma and Maria may be many times larger than this. An evaluation of, and likely an increase in, the financial management workforce would help address this additional workload and prevent the poor management of funds.

Potential Spillover Impacts to Other Sectors

Improving the financial management of recovery funds would have a positive impact across all sectors engaged in rebuilding and recovery.

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs
Potential recurring costs: $14 million in estimated recurring costs (11 years)
Potential total costs: $15 million in total estimated costs

[56] U.S. Census Bureau, *Consolidated Federal Funds for Fiscal Year 2010: State and County Areas*, Washington, D.C., 2011.

The up-front costs are estimated as $1 million for contracting an outside firm to assist with a study. The recurring costs are estimated from 10 FTEs annually, at a rate of $124,600 per year (representing double the cost of an average government employee), for a total cost of $1.25 million annually.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery

Potential Implementers

Puerto Rico Federal Funds Management Office

Potential Pitfalls

Qualified financial management personnel would have to be identified and hired. If there are not sufficient numbers of trained personnel in Puerto Rico, incentives may be needed to draw individuals willing to relocate. Additional personnel may have to be hired beyond those budgeted in this course of action.

Likely Precursors

Sizing the workforce required would depend on an estimate of the likely amount of funds to be managed, but that total amount is not yet known.

CPCB 13
Training Workshop on Best Practices in Post-Disaster Procurement

Sectors Impacted

Community Planning and Capacity Building, Municipalities, Housing, Health and Social Services, Water

Issue/Problem Being Solved

With Puerto Rico receiving 3 times the postdisaster recovery funds given to states affected by Hurricane Sandy, it is imperative for local governments to possess the capacity to use these funds to procure resources and aid in an effective and efficient way. Governments must be able to process the quantity of procurement contracts and amendments in a timely and compliant manner in the face of a disaster. Because inadequacies in procurement can cause bottlenecks and challenges for postdisaster rebuilding, there is a need to identify areas of improvement and to streamline processes. Puerto Rico has much to learn from past recovery experiences in the continental United States (e.g., Hurricane Katrina, Hurricane Sandy), where similar problems in procurement have arisen.

Description

This course of action would organize a 3-day conference in Puerto Rico that convenes chief acquisition officers, contract officers, and other procurement experts from the continental United States (particularly Louisiana, New Jersey, and New York) involved in rebuilding after Hurricanes Katrina, Harvey, and Sandy, along with officers and experts in Puerto Rico. Workshops on various topics in recovery would be offered. Two deliverables would be produced after the event: a document on conference proceedings and a guide to postdisaster procurement for innovation and resilience.

Potential Benefits

The conference would provide a forum for individuals with postdisaster experience to train procurement officers in Puerto Rico, share best practices, give advice on possible shortcomings, and provide recommendations. Current officials can build on past knowledge and avoid oversight that has already occurred. The conference would also provide a networking opportunity among professionals in disaster management for continued guidance and advising. The conference proceedings would memorialize conversations held and document best practices. The guide to postdisaster procurement for innovation and resilience would act as a working tool that could be disseminated to procurement officers across Puerto Rico, with useful applications from the best practices and lessons learned.

Potential Spillover Impacts to Other Sectors

This course of action could have a positive impact across almost all sectors, since procurement contracts affect all aspects of recovery.

Potential Costs

Potential up-front costs: $400,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $400,000 in total estimated costs

The up-front costs are estimated as a combination of personnel, travel, and venue costs. The personnel cost is estimated as 5 full-time equivalents (FTEs) for a 6-month period, at $124,600 per year per FTE, for a total of $311,500. Travel expenses are estimated as $57,500 for 25 people from the continental United States and an additional $32,500 to house 25 participants from Puerto Rico. The venue cost is estimated to be $30,000. The total up-front costs are estimated as $431,500, represented as $400,000 in the recovery plan.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, FEMA

Potential Implementers

Puerto Rico Federal Funds Management Office, chief acquisition officers, contract officers, procurement experts

Potential Pitfalls

Not all ideas and practices shared would necessarily be effective or relatable solutions. Puerto Rico faces unique challenges because it is an island, has a different baseline infrastructure being dealt with, and has a different set of resources available, as well as numerous other factors. Therefore, lessons learned from the conference should be taken with caution and consideration.

Likely Precursors

Identify individuals in acquisition, procurement, and disaster management positions in Louisiana, New Jersey, and New York who were involved in rebuilding after hurricane destruction. Identify logistical and administrative processes to organize a well-run conference.

CPCB 14
Building Grant Writing Capacity

Sectors Impacted

Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Many municipalities do not have the capacity to apply for grants or the expertise to write quality proposals. This gap leads to a lack of federal grant participation and potential unused funds that could benefit Puerto Rico.

Description

This course of action would establish a set of 100 scholarships each year, for 5 years, for municipal government office workers and local nongovernmental organizations staff to receive ongoing training over a 1-year period in grant writing from university-based certification programs (many of which are established in the continental United States, as well as one located at the University of Puerto Rico). This builds on existing policy set by the governor's executive order that every agency from the executive branch must contract with the University of Puerto Rico for capacity building. These programs prepare participants to research funding prospects, write effective proposals, and budget and implement grants. In addition to spending time on site at academic institutions in the continental United States, awarded scholars would have continuing remote support as they write grants. The scholarship would provide funds for tuition, travel, and room and board for the duration of the 1-year program. To manage the scholarship, a 3-person committee would be needed to organize the program and coordinate with grant sources and training programs. Because municipalities may lack personnel to write grants, this course of action also includes funding to hire an average of 0.25 full-time equivalents (FTEs) per municipality to seek grants and ultimately run projects.

Potential Benefits

This course of action further encourages municipal government office workers to prepare competitive and compelling grant proposals to acquire funds for commonwealth-financed projects, including those in disaster recovery. This course of action would also provide professional development for the governmental workforce and empower members of the municipalities to seek solutions for their own community. In contrast, outsourcing grant writing skills would cost more long term and might entail conflicts of interest. Also, there is general increased capacity for raising awareness of issues, proposing courses of action, and costing activities.

Potential Spillover Impacts to Other Sectors

Writing effective and successful grant proposals would increase the likelihood of municipalities acquiring funds and, in turn, resources to address their most-pressing issues. Grants can also provide funding for projects that would improve issues spanning various sectors (e.g., increasing access to water, making transportation more efficient, identifying renewable sources of energy).

Potential Costs

Potential up-front costs: $3.2 million in estimated up-front costs (5 years)
Potential recurring costs: $14 million in estimated recurring costs (11 years)
Potential total costs: $17 million in total estimated costs

The up-front costs are based on the costs of the students and the personnel to manage the program. The student costs are $1,500 for certification program tuition, $1,000 for airfare, $1,500 for 1 week's lodging, and $500 for 1 week's meals and incidentals, per student, for a total of $4,500. For 100 students per year over a 5-year period, the total cost is $2.25 million total up-front cost. The personnel to manage the program are estimated as 3 FTEs, at a cost of $62,300 per FTE per year, for a total of $187,000 annually, or an estimated $900,000 over 5 years.

The recurring costs are estimated based on 0.25 FTEs per municipality on average, or approximately 20 FTEs, at cost of $62,300 per staff, totaling $1.25 million annually.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, nongovernment sources

Potential Implementers

Government of Puerto Rico, municipal governments

Potential Pitfalls

Grants have different application requirements because agencies providing grants have different priorities and cover different subject matters. The grant writing curricula in the programs would provide general skills, but the participants would still need to hone their writing skills for specific subject matters and agencies.

Likely Precursors

Identifying the most-suitable grant writing programs

CPCB 15
Strengthen Local Nonprofit and NGO Involvement in Disaster Recovery

Sectors Impacted

All

Issue/Problem Being Solved

The engagement of local nonprofits and nongovernmental organizations with governmental agencies needs to be increased to maximize their coordination and contributions as partners in delivering recovery programs and resources, while also building capacity to develop community resilience.

Description

This course of action would strengthen local nonprofit and nongovernmental organization (NGO) involvement in disaster recovery. It would establish a unit within the Office for the Socioeconomic and Community Development (Oficina para el Desarrollo Socioeconómico y Comunitario [ODSEC]) that would work to strengthen the engagement of local nonprofits and nongovernmental organizations with government agencies to maximize their contributions as partners in the recovery process, while also helping to build their capacity. This course of action would also develop symposia, involving both new and long-term nonprofits from places that have experienced large-scale disasters, to network and share experiences working in the postdisaster time frame.

Potential Benefits

A clear plan is needed to delineate the roles and responsibilities of nongovernmental organizations during disaster response and recovery. Working together alongside nongovernmental organizations to create a plan is a necessary step to outline these responsibilities should a similar disaster occur. Improving cooperation and coordination would strengthen partnerships and drive more-successful cross-sector collaboration. Creating a centralized system to track nongovernmental organizations and their capabilities would improve coordination and communication among government agencies and nongovernmental organizations and would enhance resource allocation. Strengthening local nongovernmental organizations and nonprofit support is critical to building community resilience. Improving credentialing for these organizations and offering opportunities for additional funding would improve their capacity while helping them to begin developing more long-term sustainable funding.

Potential Spillover Impacts to Other Sectors

Improving local capacity support enables communities to rebuild and strengthens community resilience in the face of disaster. This course of action has the potential to spill over to all other sectors, and specifically to Housing, Municipalities, Water, Health and Social Services, Transportation, and Communications and Information Technology.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $9 million in estimated recurring costs (11 years)
Potential total costs: $9 million in total estimated costs

The recurring costs are estimated as personnel cost. The personnel costs include 2 full-time equivalents (FTEs) to manage outreach, coordinate the working group, and supervise development of commonwealth-wide plan; 1 FTE to assist with maintenance and creation of the database; and 3 FTEs to help coordinate technical assistance programs, oversee certification, and manage grant-match funding. These 6 FTEs, at $124,600 per year, are estimated to cost $747,600 annually.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, nongovernment sources

Potential Implementers

Office for Socioeconomic and Community Development, nongovernmental organizations, local nonprofits

Potential Pitfalls

It could be challenging to engage already overburdened local nonprofits and nongovernmental organizations in additional disaster recovery initiatives.

Likely Precursors

Identify local nonprofits and nongovernmental organizations who were involved in disaster recovery after the hurricanes. Include any newly formed (e.g., after the hurricanes) local nonprofits and nongovernmental organizations that could be effective partners in future disaster recovery efforts.

Economic Sector

COA Number	Title
ECN 1	Increase Ease of Doing Business
ECN 2	Implement Workforce Development Programs
ECN 3	Assist Sport Fishing Industry
ECN 4	Enact Sound Fiscal Policies
ECN 5	Improve Retention of Educated Workforce Through Policy Change
ECN 6	Improve Data Collection, Analysis, and Presentation
ECN 7	Create Research Centers and Partnerships
ECN 8	Define and Develop Economic Development Zones
ECN 9	Invest in Agricultural Recovery Assistance
ECN 10	BLUEtide Initiative
ECN 11	Medical Tourism Initiative
ECN 12	Provide Innovation and Entrepreneurial Training
ECN 13	Develop PRIDCO's Abandoned Buildings for Business Incubators
ECN 14	Direct Small Business Investment
ECN 15	Redevelop Former Roosevelt Roads Naval Station
ECN 16	Revitalize the Santurce Neighborhood of San Juan Through Business Development Activities
ECN 17	Construct the Puerto Rico Science, Technology & Research Trust's Research and Development Center at Science City
ECN 18	Compensate Farmers for Crop Losses
ECN 19	Recover and Restore Fishing Facilities and Equipment
ECN 20	Rehabilitate Plaza Dársenas
ECN 21	Study Hurricane Impacts on the Local Economy
ECN 22	Rehabilitate Paseo de la Princesa and Princesa Building
ECN 23	Implement Job Creation Initiative
ECN 24	Revitalize the PR-127 Petrochemical Corridor in Guayanilla-Peñuelas
ECN 25	Assist Dislocated Workers Through the Use of Existing Grants
ECN 26	Conduct Studies for Workforce Development and Rapid Response
ECN 27	Rehabilitate Esperanza Boardwalk and Waterfront
ECN 28	Implement Initiative to Promote Entrepreneurship
ECN 29	Design Puerto Rico "Open for Business" Campaign
ECN 30	Help Revitalize Eco and Beach Adventure and Fleet Boat Assistance
ECN 31	Change Social Welfare and Benefits Policy
ECN 32	Create Business Resiliency Hubs
ECN 33	Establish Business and Industrial Development Corporations (BIDCOs)
ECN 34	Establish Matching Fund Set-Aside
ECN 35	Center of Excellence for Agricultural Technologies Training
ECN 36	Agricultural Financial Support for Access to Capital
ECN 37	PRIDCO Agricultural Parks

ECN 38	Agricultural Industry Support
ECN 39	Exemption of Puerto Rico from the Jones Act After Consideration of Costs and Benefits
ECN 40	Enable Puerto Rico to Become an International Air Cargo and Passenger Hub

ECN 1
Increase Ease of Doing Business

Sectors Impacted

All

Issue/Problem Being Solved

Economic conditions that hinder economic growth and result in outmigration. Policies that make it difficult to conduct business are considered to be a primary factor.

Description

This course of action is a collection of policies that would affect the overall ease of doing business across Puerto Rico, as measured by the World Bank's *Ease of Doing Business* annual report. The policies include lowering labor costs, energy and other input costs, tax costs, and transaction costs in dealing with the government.[57] Most of these policies are locally controlled by the government of Puerto Rico, although some may require action by the U.S. government. Actions taken to decrease costs of doing business are consistent with both the governor's proposed new fiscal plan and the certified fiscal plan (certified by the Financial Oversight and Management Board).[58] Benefits would accrue in the short, medium, and long terms.

Potential Benefits

Increasing the ease of doing business should stimulate investment and economic growth across most sectors by reducing policy-induced barriers to business activities. For example, decreasing the overall tax burden could reduce distortions in the real economy and increase economic and revenue resiliency in the face of negative natural and economic shocks. Increasing the efficiency of government permitting (e.g., obtaining construction permits) and other processes should reduce nonfinancial costs of doing business and help incentivize movement into the formal sector. Policy changes that affect specific inputs (e.g., labor) could also lower costs while creating an incentive to shift the input mix toward those goods and services.

Potential Spillover Impacts to Other Sectors

Simplifying the conduct of business would improve most private-sector economic activity, but decreases in regulation could result in decreases in public-sector employment.

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[57] Input costs, such as energy, water, and transportation, that are directly associated with a sector are generally not included here, although lowering them would result in similar benefits.

[58] Government of Puerto Rico, *New Fiscal Plan for Puerto Rico*, San Juan, April 5, 2018; Government of Puerto Rico, *New Fiscal Plan for Puerto Rico: Restoring Growth and Prosperity*, certified by the Financial Oversight and Management Board for Puerto Rico, San Juan, 2018.

Potential Costs

Most of these policies have no direct financial costs. Policies that lower labor costs may affect workers through lower wages or benefits in the short run, but these effects may be offset by increased demand in the longer term.

Potential Funding Mechanisms

Not applicable

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

Polices targeted to specific inputs could create distortions and distributional issues that result in unintended consequences. The efficacy of any of these policies would likely depend on the external economic environment.

Likely Precursors

None

ECN 2
Implement Workforce Development Programs

Sectors Impacted

All, with the Economic sector being most relevant

Issue/Problem Being Solved

Puerto Rico has a low labor force participation rate, lack of economic growth, and lack of career and technical education system, and the workforce lacks the ability to keep pace with the evolving need for skills in the labor market.

Description

This course of action is a collection of activities and policy levers that would support the education and training of the workforce (the unemployed, underemployed, and talent in the pipeline toward employment), especially the most vulnerable populations (e.g., youth, women, veterans, and workers who recently lost employment) in high-need occupations across multiple sectors. These activities and policies include standing up workforce training centers in strategic geographic areas across Puerto Rico, instituting policies to encourage industry and education sector collaboration, and developing a pipeline of talent by supporting K–14 career and technical education and on-the-job experiences for youth and others seeking employment.

Potential Benefits

Implementing workforce development programs should (1) improve the labor force participation rate (engage heretofore dislocated and disengaged workers who otherwise would not be gainfully employed) and (2) increase individuals' education levels and skill sets. These effects would have numerous benefits to individuals and to Puerto Rico's economy.

Potential Spillover Impacts to Other Sectors

Developing the workforce would allow industry leaders and businesses across multiple sectors (e.g., Energy, Education, Health and Human Services) and strategic initiatives, such as agriculture modernization and processing and the visitor economy, to draw from a strong pool of talent in Puerto Rico (thereby attracting more businesses to Puerto Rico), support retention of talent, and enhance the education system so that it keeps pace with evolving industry needs for skills. These improvements would in turn affect labor availability, job creation, and potentially wages and would improve efficiencies in the delivery of education and training.

Potential Costs

Potential up-front costs: $68 million in estimated up-front costs
Potential recurring costs: —

Potential total costs: $68 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Labor, Education and Training Administration; FEMA Dislocated Workers Program; Community Development Block Grant–Disaster Recovery; U.S. Department of Education; U.S. Department of Commerce Economic Development Administration; consortia of private businesses and philanthropic foundations.

Potential Implementers

Puerto Rico Department of Labor and Human Resources, Puerto Rico Department of Economic Development and Commerce

Potential Pitfalls

Outmigration; porous formal-informal labor market boundaries; time to (up)skill a local workforce; lack of local interest in middle-skill jobs; lack of quality social services for other family members (e.g., K–12 education); current disincentives for formal, built-to-code residential construction; and titling and registration of land and buildings

Likely Precursors

Policy framework to support training programs to meet various sectors' needs, skills gap analysis, finding instructional staff, standing up brick and mortar facilities alongside online programs, instituting on-the-job experiences, education and industry collaborations to develop curriculum and find materials

ECN 3
Assist Sport Fishing Industry

Sectors Impacted

Economic

Issue/Problem Being Solved

There is hurricane damage to sport fishery resources across Puerto Rico that made them unsafe for public use.

Description

This course of action, which was included in the *Build Back Better* plan,[59] restores and enhances Puerto Rico's sport fishery resources that were affected by the hurricanes.

Potential Benefits

Enhancing the sport fish population and improving facilities for public use would help spur economic growth in the surrounding areas and encourage the development of tourism and other industries. This course of action could be subsumed under the BLUEtide Initiative (ECN 10).

Potential Spillover Impacts to Other Sectors

Other Economic (retail, services, food and beverage), Transportation

Potential Costs

Potential up-front costs: $4 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $4 million in estimated total costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, private insurance

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, Puerto Rico Department of Natural and Environmental Resources

[59] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery:*, San Juan: Government of Puerto Rico, November 2017.

Potential Pitfalls

The steps needed and how best to implement them to enhance these resources are unclear, leading to the potential for waste or low returns to the program.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. The matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 4
Enact Sound Fiscal Policies

Sectors Impacted

Economic, all that receive public funding

Issue/Problem Being Solved

Sustained public deficits resulted from high public expenditures relative to revenues.

Description

This course of action is a collection of policy levers that would affect the level of public spending relative to revenues or enhance the revenue base of the government of Puerto Rico.

Potential Benefits

Sustained public deficits are no longer an option for Puerto Rico. The proposed policies are designed to restrict public expenditures, keep spending commensurate with collected revenues, or enforce tax compliance to increase revenues. The benefits of fiscal responsibility include access to credit markets and reduced uncertainty in the public and private sectors. Improved fiscal responsibility for Puerto Rico could also increase confidence in attracting private investment, thus affecting the private market.

Potential Spillover Impacts to Other Sectors

Depending on subsequent choices of expenditure allocation, these policies could affect most sectors that receive government funding.

Potential Costs

No direct financial costs—the policies potentially affect the revenue and expenditure streams of the government of Puerto Rico.

Potential Funding Mechanisms

Not applicable

Potential Implementers

The executive branch of the government of Puerto Rico

Potential Pitfalls

Restricting public expenditures would require spending cuts to certain programs. The programs affected depend on the specifics of the spending cuts. Augmentation of revenues could

increase inefficient public spending, depending on the choices made, and could result in inefficient taxation that could negatively impact businesses.

Likely Precursors

Not applicable

ECN 5
Improve Retention of Educated Workforce Through Policy Change

Sectors Impacted

Most sectors that use labor

Issue/Problem Being Solved

Reduce outmigration by creating incentives to remain.

Description

This plan is a collection of policy levers that would reduce outmigration by creating noneconomic incentives to stay in Puerto Rico. At present, the plan has one specific course of action—namely, instituting an in-commonwealth service requirement for students attending Puerto Rican universities who receive public funds for higher-education expenses.

Potential Benefits

The in-commonwealth service requirement would provide an incentive for college-educated workers to stay in Puerto Rico in return for the use of public funds for their higher education. This policy would result in increased retention of those who would otherwise migrate after completing their studies, as well as the provision of goods and services produced as part of the in-commonwealth service.

Potential Spillover Impacts to Other Sectors

Most sectors could be affected by this policy.

Potential Costs

There are no direct financial costs for these policies, but some individuals might resist on personal-liberty grounds.

Potential Funding Mechanisms

Not applicable

Potential Implementers

Puerto Rico Executive Branch, Puerto Rico Legislative Assembly

Potential Pitfalls

In addition to potential resistance on personal-liberty grounds, a mechanism for enforcement is uncertain. Local stakeholders also fear that an increase in the numbers of young people leaving Puerto Rico for higher education could increase outmigration of the youngest, best, and brightest.

Likely Precursors

Not applicable

ECN 6
Improve Data Collection, Analysis, and Presentation

Sectors Impacted

All

Issue/Problem Being Solved

A lack of high-quality, reliable economic and tax roll data creates uncertainty among potential investors and the public, hindering decisionmaking about resource allocation.

Description

This course of action is a collection of policy levers that would improve the collection, analysis, and presentation of publicly available data. Impacts would include updating tax rolls and land registries; presenting timely, audited financial reports; improving the process of collecting and storing basic economic information, such as gross domestic product and gross national product and tourism satellite accounts; and providing information about public-sector policies and programs to interested parties. In addition, to promote innovation, this course of action would institute the understanding and cataloging of current intellectual property and patents held by individuals and corporations in Puerto Rico.

Potential Benefits

High-quality data and information can serve to increase the confidence for investors and the public at large and help both the public and private sectors make better resource allocation decisions.

Potential Spillover Impacts to Other Sectors

Most sectors would benefit, although Economic and Housing are likely to benefit most.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $55 million in estimated recurring costs (11 years)
Potential total costs: $55 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, U.S. Department of Agriculture, Community Development Block Grant–Disaster Recovery

Potential Implementers

Puerto Rico Planning Board, Puerto Rico Tourism Company, Institute of Statistics, other government of Puerto Rico agencies, federal agencies

Potential Pitfalls

Initiating information solutions without adequate resources can lead to suboptimal results. The risks include collecting data that are not useful for decisionmaking, collecting data via means that are nonrepresentative or misleading, and providing ineffective dissemination of and access to the data.

Likely Precursors

Restoration of high-quality electricity service would be necessary to provide digitized data over the internet.

ECN 7
Create Research Centers and Partnerships

Sectors Impacted

Economic, sectors that could use primary or applied research outputs

Issue/Problem Being Solved

Economic decline and innovation

Description

This course of action is a collection of proposals to create various research centers and partnerships across a wide variety of areas, including general and specific (agricultural) partnerships with universities; specialized research centers in technology, biotechnology, and the ocean economy; and development and use of blockchain technology. Therefore, the focus is on the knowledge economy.

Potential Benefits

These proposals leverage the intellectual capital of Puerto Rico by encouraging or establishing partnerships to foster technological development aimed at increasing the overall technical efficiency of production across diverse sectors of the economy.

Potential Spillover Impacts to Other Sectors

Research partnerships have the potential to bring together thought leaders and industry to help shape solutions to a variety of problems; therefore, the potential spillover impacts can extend across most sectors.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $110 million in estimated recurring costs (11 years)
Potential total costs: $110 million in estimated total costs

Potential Funding Mechanisms

Federal agencies

Potential Implementers

Universities, private industry

Potential Pitfalls

The primary risk associated with this course of action is the uncertainty of results from the research efforts.

Likely Precursors

Not applicable

ECN 8
Define and Develop Economic Development Zones

Sectors Impacted

Economic, Transportation

Issue/Problem Being Solved

Economic contraction

Description

This course of action is a collection of policy levers that would define particular geographic economic zones or districts with varying levels of benefits, including tax advantages and waivers of certain regulations (e.g., a waiver of the Jones Act for the Port of Ponce). This course of action also includes the establishment of Business and Industrial Development Companies (BIDCOs), which are regulated but nondepository lenders designed to increase access to capital.

Potential Benefits

The economic development zones are designed to incentivize particular types of economic activity in specific geographic regions of Puerto Rico to promote increased levels of employment. BIDCOs provide financial capital backed by Small Business Administration loans.

Potential Spillover Impacts to Other Sectors

Most sectors would benefit, although Economic and Transportation are likely to be most affected.

Potential Costs

Potential up-front costs: $50 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $50 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration

Potential Implementers

Executive branch of the government of Puerto Rico, Legislative Assembly of Puerto Rico

Potential Pitfalls

The proposed policies would not guarantee successful, sustainable economic development in the zones; success depends largely on both the internal and external business environments.

Likely Precursors

Lower the costs of doing business (ECN 1, Increase Ease of Doing Business), which helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs. An exemption from the Jones Act would be important for the Ponce Economic Development Zone (ECN 39, Exemption of Puerto Rico from the Jones Act After Consideration of Costs and Benefits).

ECN 9
Invest in Agricultural Recovery Assistance

Sectors Impacted

Economic, Natural and Cultural Resources

Issue/Problem Being Solved

Damage to the agricultural sector's man-made and natural capital from the hurricanes

Description

This course of action is taken directly from the *Build Back Better* plan.[60] It proposes $1.827 billion in direct recovery assistance to agricultural industries: poultry, dairy milking, livestock breeding, orchards, specialty animals, vegetables and tubers, grain production, horticulture, fruit and nut trees, melons, and coffee.

Potential Benefits

This assistance would allow farmers and others in the agriculture sector to reestablish operations. It can also be strategically deployed to stimulate innovative farming practices and spur investment in the sector to encourage farmers to begin using next-generation agricultural technology. In this way, the course of action would expand the profitability of the agriculture industry and allow it to export Puerto Rican products by using more-efficient and more-modern agriculture practices.

Potential Spillover Impacts to Other Sectors

Suppliers of the agricultural industry would be affected, as would natural resources.

Potential Costs

Potential up-front costs: $1.8 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.8 billion in estimated total costs

Potential Funding Mechanisms

U.S. Department of Agriculture, Community Development Block Grant–Disaster Recovery, private insurance

[60] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementer

Puerto Rico Department of Agriculture

Potential Pitfalls

No guarantee can be made that investments would lead to improved agricultural productivity or be used for agricultural recovery. This course of action may be at odds with a Puerto Rico Department of Economic Development and Commerce initiative to phase out several outstanding incentives, including agricultural ones.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 10
BLUEtide Initiative

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education, Public Buildings

Issue/Problem Being Solved

Develop coastal resources with the objectives of increasing tourism twofold, increasing economic growth, increasing food security, and mitigating against future hurricane damage.

Description

The BLUEtide initiative proposes a whole-of-Puerto-Rico approach to disaster mitigation and resilience, workforce development, advanced manufacturing, and tourism by developing coastal resources. The strategy would maximize Puerto Rico's ocean assets and leverage building ocean structures that promote biocompound extraction, research and development technology transfer, tourism, and fishing, while at the same time establishing an ecoresponsible development policy. Workforce development efforts are anticipated.

Potential Benefits

This initiative would incentivize jobs in advanced manufacturing, fishing, knowledge economy, and tourism industries, increasing the value of ocean-dependent assets and human capital development, international competitiveness, natural disaster mitigation and resilience, and food security. The effort would also incentivize activities related to value-added agriculture, aquaculture, and biopharmaceutical applications.

Potential Spillovers to Other Sectors

The proposed strategy may affect Health and Social Services through job creation, and it has an educational component and utilizes public buildings as assets. Attention must be paid to the health of coastal ecosystems, a source of renewable natural capital for economic development.

Potential Costs

Potential up-front costs: $200 million–$300 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $200 million–$300 million in estimated total costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, FEMA, U.S. Department of Commerce Economic Development Administration, National Oceanic and Atmospheric

Administration, U.S. Department of the Interior, U.S. Environmental Protection Agency, U.S. Department of Agriculture, nongovernment sources

Potential Implementers

FEMA; U.S. Department of Commerce Economic Development Administration; National Oceanic and Atmospheric Administration; U.S. Department of the Interior; U.S. Environmental Protection Agency; U.S. Department of Agriculture; U.S. Department of Housing and Urban Development; Puerto Rico Department of Economic Development and Commerce; Puerto Rico Department of Natural and Environmental Resources; Puerto Rico Science, Technology, and Research Trust; municipal governments; nongovernmental organizations

Potential Pitfalls

This course of action would rely on external economic conditions (tourism demand) and favorable business environment. Some climate risk would be incurred because future hurricanes might lead to investment losses.

Likely Precursors

Establishing the Marine Business Innovation and Research Center and identifying closed schools would be helpful. Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34 Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 11
Medical Tourism Initiative

Sectors Impacted

Economic, Health and Social Services, Education

Issue/Problem Being Solved

This course of action addresses the flight of medical personnel from Puerto Rico due to the hurricanes and other factors and the decrease in the number of visitors posthurricane.

Description

Through the Puerto Rico Tourism Company, the Puerto Rico Department of Economic Development and Commerce would establish and fund the not-for-profit Medical Tourism Corporation (MTC) with a board of directors until such an organization generated sustainable funding. The recently formed Destination Management Organization would manage day-to-day operations of the corporation. The course of action may also include an initiative to retain health care workers in Puerto Rico.

Potential Benefits

Medical tourism brings individuals to Puerto Rico. These so-called medical tourists stay in hotels and eat at local restaurants before and after procedures. Additionally, by increasing demand for the services of medical professionals, a growth in medical tourism in Puerto Rico might slow their ongoing outmigration.

Potential Spillover Impacts to Other Sectors

As a tourism initiative, visitor spending would spill over to most economic sectors.

Potential Costs

Potential up-front costs: $8 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $8 million in estimated total costs

A similar proposal from Advantage Business Consulting prepared for the Puerto Rico Department of Economic Development and Commerce in 2014 suggested the need for $8 million in government investment during the first 3 years of operation.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, private sector, nongovernment sources

Potential Implementers

Puerto Rico Tourism Company, Puerto Rico Department of Economic Development and Commerce

Potential Pitfalls

The success of this course of action largely depends on demand-side considerations—namely, the volume of patient visits that could be generated and the resulting retention of medical personnel, as well as the advantage of Puerto Rico as a medical tourism destination compared with other Caribbean destinations and Mexico. The number of medical professionals in Puerto Rico is currently insufficient to serve the population, so the supply of health care workers would also need to be increased.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 12
Provide Innovation and Entrepreneurial Training

Sectors Impacted

Economic, Education

Issue/Problem Being Solved

Innovation and research stalled after the hurricanes, and there was a lack of access to business capital. Future job creation may improve low labor force participation rates and contribute to economic growth.

Description

A model has been proposed for developing initiatives designed to support the start-up and research ecosystems in Puerto Rico. The model contains 3 critical strategies: (1) focus resources on ecosystems to feed more talent and innovation into the start-up and research teams, (2) direct teams through a customer discovery process to screen and find those with high potential, and (3) use all the resources of the ecosystem to propel high-potential start-up teams toward scale.

Potential Benefits

These initiatives would generate young, trained entrepreneurs who could start businesses in Puerto Rico, where they would create new products and services for export. The initiatives would also promote public-private partnerships. Ultimately, if successful, the new businesses would generate local job opportunities.

Potential Spillover Impacts to Other Sectors

If successful, new businesses could potentially be created in any number of sectors with associated supply-chain and demand-side linkages.

Potential Costs

Potential up-front costs: $26 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $26 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, National Science Foundation, U.S. Department of Labor, U.S. Department of Agriculture

Potential Implementers

Puerto Rican and other universities; Puerto Rico Department of Education; Puerto Rico Science, Technology, and Research Trust; Grupo Guayacán; Puerto Rico Department of Economic Development and Commerce; Puerto Rico Manufacturing Extension; Small Business Technology Development Center; Echar Pa'lante; Puerto Rico Innovation and Technology Service

Potential Pitfalls

Because initiatives do not guarantee successful business spinoff or retention of newly trained personnel, job creation might not occur. The proposals assume that funding beyond 2 to 4 years would continue from "university budgets," which may be overly optimistic.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs. A digital system for instant-use permits, a single permit office (Plan para Puerto Rico), and streamlined permitting processes are necessary.

ECN 13
Develop PRIDCO's Abandoned Buildings for Business Incubators

Sectors Impacted

Economic, Housing, Municipalities, Communications and Information Technology, Education, Water, Energy, Public Buildings, Health and Social Services, Community Planning and Capacity Building, Transportation, Natural and Cultural Resources

Issue/Problem Being Solved

There are a lack of tenants for Puerto Rico Industrial Development Company (PRIDCO) facilities and a lack of available facilities for the incubators called for in the governor's Plan para Puerto Rico[61] and other economic development plans. Additional challenges include difficulty in doing business and in starting and growing new businesses, as well as difficulty in training and developing entrepreneurs.

Description

This strategy proposes to find tenants for unused PRIDCO-owned buildings, increasing the efficiency of public assets and contributing to economic development. It also provides ideal conditions for business incubation by reducing operating costs and, in some cases, sharing those costs among several different enterprises. Finally, it allows for a multiplier effect for capacity-building activities because start-ups in cohorts working in close proximity foster network effects and increase learning. The time frame would cover the next 5 years, with benefits anticipated immediately. PRIDCO is expected to implement this course of action in locations across Puerto Rico. As part of Plan para Puerto Rico, this effort would have to be teamed with ECN 37, PRIDCO Agricultural Parks, to be effective.

Potential Benefits

The potential benefits of this course of action include improving the "ease of doing business," avoiding blight, securing opportunities for various communities, enhancing the development of Puerto Rico's start-up culture, and providing community anchor points for business development. Incubators would incentivize the rapid recovery of the small-business sector. This course of action would also provide opportunities for maturing small businesses to bring innovation to key sectors of the Puerto Rican economy.

Potential Spillover Impacts to Other Sectors

Municipalities would receive additional tax revenue, PRIDCO would avoid a decaying portfolio of assets, the Puerto Rico Department of Economic Development and Commerce would

[61] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

have a network of incubators to focus its efforts, and start-ups would have lower costs of entry and operation. The approach could also contribute to stabilizing Energy, Water, Transportation, Municipalities, Public Buildings, Education, and Housing initiatives related to employment. A successful incubator program would lead to strong economic growth, innovation, and maturation of the business models providing goods and services to Puerto Rico.

Potential Costs

Potential up-front costs: Not applicable
Potential recurring costs: Not applicable
Potential total costs: Not applicable

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, Puerto Rico Industrial Development Company

Potential Implementers

Puerto Rico Industrial Development Company, Small Business Administration

Potential Pitfalls

These start-ups would rely heavily on infrastructure and are extremely sensitive to changes in operating costs. Growing companies would need a plan for expansion so they do not take over the space. Success for individual cohorts would likely be highly variable. This course of action needs to be teamed up with a program designed to fund and provide technical expertise to the incubator programs, as the course of action covers only the building stock. Additional concerns are unsustainable funding and lack of entrepreneurs for a given area: Long-term planning and entrepreneurial development in conjunction with business and education entities are critical. Success is not guaranteed. Additionally, placing an incubator in each municipality could result in lower utilization rates than would having fewer incubators, which could yield greater benefits. Many of the unoccupied buildings are large—12,000 square feet or greater—and might not be suitable for small businesses without significant modifications.

Likely Precursors

For this course of action to be successful, ease of doing business must be improved, including creating a digital system for instant-use permits and a single permit office (as in the Plan para Puerto Rico). Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

Obtaining an accurate picture of the availability of PRIDCO buildings and reliable energy and telecommunications infrastructure is also needed.

ECN 14
Direct Small Business Investment

Sectors Impacted

Economic, Public Buildings, Municipalities, Health and Social Services, Communications and Information Technology, Energy, Education

Issue/Problem Being Solved

Multiple small businesses, start-ups, and entrepreneurs have described "access to capital" as a critical issue that threatens their viability and business health.

Description

This course of action is taken from the *Build Back Better* plan.[62] It provides access to capital for small businesses, start-ups, and entrepreneurs to ensure that small businesses can continue to grow without allowing access to small sums to become an obstacle. Programs would be created to assist thousands of storm-affected small businesses by providing grants for working capital assistance, inventory losses, equipment and fixture replacement costs, repairs of hurricane damage, and mitigation projects.

Potential Benefits

This program would allow businesses to reestablish operations, rebuild, recover, and grow. Improving access to capital would allow the small business community to become more resilient, less likely to close operations in the event of a disaster, and able to plan for continued growth with more confidence. The employment market, economic growth, and the tax base would experience immediate benefits.

Potential Spillover Impacts to Other Sectors

Reestablishment of operations and supply and demand chains can spill over to most sectors of the economy and in nearly every municipality.

Potential Costs

Potential up-front costs: $2.7 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2.7 billion in estimated total costs

Small-business grants were budgeted at $2.651 billion in the *Build Back Better* plan.

[62] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Department of Labor, Small Business Administration, private insurance

Potential Implementers

Individual applicants

Potential Pitfalls

Some grants may be allocated to nonviable businesses or to those with access to alternative sources of financial capital, resulting in inefficiencies. Scarcity of funds and management difficulties may occur. Successful companies may leave the area and not provide long-term benefits to the communities.

Likely Precursors

Potential grantees would need to be evaluated, and control mechanisms and grant management structures would need to be in place. Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 15
Redevelop Former Roosevelt Roads Naval Station

Sectors Impacted

Economic, Housing, Municipalities, Communications and Information Technology, Education, Water, Energy, Public Buildings, Health and Social Services, Community Planning and Capacity Building, Transportation, and Natural and Cultural Resources

Issue/Problem Being Solved

Low economic productivity in Ceiba and lack of diversity in port options

Description

The commonwealth would redevelop Roosevelt Roads, a former naval base, to encourage new investment. This development is intended to include infrastructure requirements with the aim of encouraging new economic opportunities. This development is intended to include housing, retail, industrial parks, maritime and air transportation, and the complete spectrum of infrastructure requirements. The development of the Roosevelt Roads sites would require a spectrum of investment partners to help develop infrastructure investments, such as housing, industrial sites, and mixed-use retail.

Potential Benefits

Mixed development of Roosevelt Roads would result in economic growth, stabilization, and growth in the surrounding communities.

Potential Spillover Impacts to Other Sectors

Successful development of Roosevelt Roads would result in enhanced opportunities for most sectors.

Potential Costs

Potential up-front costs: $500 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $500 million

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, Puerto Rico Industrial Development Company

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, private developers

Potential Pitfalls

The development of this site could fail for a variety of reasons, most likely among them a lack of partners to invest or a failure of incentives for communities and businesses to locate there.

Likely Precursors

Environmental remediation of remaining brownfields must occur. The move of the ferry port from Fajardo to Roosevelt Roads must be completed. Ease of doing business must be improved for this course of action to be successful. A digital system for instant-use permits and a single permit office are needed (Plan para Puerto Rico[63]). Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

[63] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 16
Revitalize the Santurce Neighborhood of San Juan Through Business Development Activities

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education

Issue/Problem Being Solved

Urban blight associated with vacant buildings and issues associated with unemployment

Description

The Nuestro Barrio Creative Industries Acceleration and Commercialization Program at the Universidad del Sagrado Corazón would attract urban investment and revitalize the Santurce neighborhood of San Juan. The initiative would establish Santurce as an epicenter of innovation and would serve as a replicable model of an urban cluster. The project is envisioned to increase the retention and expansion of business activity in a neighborhood that is currently undergoing an economic transformation.

Potential Benefits

The developer's vision for the project includes retaining, diversifying, and commercializing creative industries and potentially creating an affordable housing component. The project would create a bridge between the university and the neighborhood.

Potential Spillover Impacts to Other Sectors

Workforce and entrepreneurship development would affect the Education, Housing, and Natural and Cultural Resources sectors.

Potential Costs

Potential up-front costs: $3 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $3 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration

Potential Implementers

Private developer, agencies of the government of Puerto Rico

Potential Pitfalls

Potential pitfalls could include permitting struggles, construction issues, and cost overruns. Limited availability of skilled construction workers could result in increased costs. The proposed course of action might not be the most efficient use of funds.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses' activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs. The course of action includes a digital system for instant-use permits and a single permit office (Plan para Puerto Rico[64]).

[64] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 17
Construct the Puerto Rico Science, Technology & Research Trust's Research and Development Center at Science City

Sectors Impacted

Economic, Health and Social Services

Issue/Problem Being Solved

Lack of opportunities for scientific research and product development

Description

The proposed Puerto Rico Science, Technology & Research Trust project entails the construction of a Forward Center—a 30,000-square-foot state-of-the-art and resilient facility for research, development, and prototyping—to be built at Science City, a 68-acre plot owned by the trust to develop a science park. The development of Science City is one of Puerto Rico's Comprehensive Economic Development Strategy approaches to move Puerto Rico to the forefront of the science, technology, and research and development sector. The time frame for completion is 20 months.

Potential Benefits

The initiative would provide space for companies like Boston Scientific in Puerto Rico to conduct research and development and prototyping activity. Additionally, a new co-working space would be created for up to 50 high-technology ventures arising from Parallel18 ventures.

Potential Spillover Impacts to Other Sectors

Workforce development, education, and critical infrastructure

Potential Costs

Potential up-front costs: $6 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $6 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Opportunity Zone Funds, New Markets Tax Credit Program

Potential Implementers

Puerto Rico Department of Economic Development and Commerce

Potential Pitfalls

No contract with Boston Scientific currently exists, and its participation is not confirmed. The strategy is multitenant and multiuse, so additional participants would be needed. Not all spaces have declared tenants.

Likely Precursors

A contract would need to be in place with Boston Scientific for a certain period (e.g., 5–10 years) to occupy a portion of the building. A digital system for instant-use permits and a single permit office would be needed (Plan para Puerto Rico[65]). Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

[65] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 18
Compensate Farmers for Crop Losses

Sectors Impacted

Economic, Natural and Cultural Resources

Issue/Problem Being Solved

Crop losses that resulted in lost income in the agricultural sector

Description

This course of action is taken directly from the *Build Back Better* plan.[66] It proposes $250 million in direct compensation for crop losses in Puerto Rico.

Potential Benefits

This assistance directly replaces income lost from the loss of crops.

Potential Spillover Impacts to Other Sectors

Replaced income would be spent across all sectors of the economy.

Potential Costs

Potential up-front costs: $250 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $250 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Agriculture, private insurance

Potential Implementers

U.S. Department of Agriculture, Puerto Rico Department of Agriculture

Potential Pitfalls

Farmworkers who do not own land would not receive any compensation.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching

[66] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 19
Recover and Restore Fishing Facilities and Equipment

Sectors Impacted

Economic, Health and Social Services

Issue/Problem Being Solved

Docks, buoys, boats, and fishing equipment were damaged in the hurricanes.

Description

This course of action covers construction and restoration of wharfs, docks, fishing centers, and equipment supply damaged in the hurricanes.

Potential Benefits

This course of action provides restoration to the items essential to the fishing industry to support the industry across Puerto Rico.

Potential Spillover Impacts to Other Sectors

Increased fish production would increase the availability of fresh fish on the island, with possible positive effects on residents' diet. Excess production could be exported, pending the creation of more fish processing centers. This would likely be part of the BLUEtide initiative (ECN 10).

Potential Costs

Potential up-front costs: $60 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $60 million in estimated total costs

The up-front costs are estimated from the *Build Back Better* plan.[67]

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration private insurance

[67] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, National Oceanic and Atmospheric Administration

Potential Pitfalls

Possible harm to the environment and overfishing without regulation

Likely Precursors

The success of this course of action depends on improvement in ease of doing business. A digital system is needed for instant-use permits and a single permit office (Plan para Puerto Rico[68]). Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs. This course of action also can be part of the BLUEtide Initiative (ECN 10).

[68] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 20
Rehabilitate Plaza Dársenas

Sectors Impacted

Economic

Issue/Problem Being Solved

Damage from Hurricane Maria resulted in losses at Plaza Dársenas, mainly to trees and lighting. This plaza is a landmark in Old San Juan that attracts many cruise-ship tourists and provides a venue for local artisans to show off their work.

Description

The project would include planting new trees, fixing concrete walkways, relocating benches, and installing new lighting. This course of action is directly from the *Build Back Better* plan.[69] Linking this project with ECN 22 (Rehabilitate Paseo de la Princesa and Princesa Building) would provide a broader impact.

Potential Benefits

Having a strong tourist front for the Old San Juan main gate for cruise-ship passengers and other tourists would help improve Puerto Rico's destination image and attract more tourists to Puerto Rico.

Potential Spillover Impacts to Other Sectors

This course of action helps local businesses, such as gift shops, restaurants, and cafes, as well as tour operators.

Potential Costs

Potential up-front costs: $10 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $10 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, private insurance

[69] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, Puerto Rico Tourism Company

Potential Pitfalls

Construction costs could be high, and labor to do the project might be scarce or expensive because of high industry demand. Because of the recent (2013) construction of a similar area, Bahía Urbana, the proposed project might not add much additional value.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 21
Study Hurricane Impacts on the Local Economy

Sectors Impacted

Economic, potentially all other sectors

Issue/Problem Being Solved

The hurricanes severely disrupted the Puerto Rican economy and exacerbated outmigration caused by the long-term economic decline. How these trends will affect local businesses is unclear, but the already existing worker shortages and subsequent drop in consumer demand may significantly affect the economy, only partially offset by recovery spending.

Description

This course of action would fund an economic report highlighting the main effects of Hurricane Maria on the local economy, as described in the *Build Back Better* plan.[70] The report would evaluate and prepare macroeconomic estimates of economic damages by sector. The study would also track recent demographic changes in the local economy, particularly the effects of migration and other movements since the hurricanes.

Potential Benefits

Understanding Hurricane Maria's impact on the economy and future demographic trends can help local businesses plan better for the future and invest strategically and efficiently. The project's cost could be offset by the aggregate benefits of providing the most-effective interventions in each economics-related industry to stimulate growth. The results could serve as the basis for the government's estimate on fiscal revenues and other fiscal planning issues and could also support mid- and long-term planning of government services. Estimates would also provide guidance on infrastructure planning.

Potential Spillover Impacts to Other Sectors

Even sectors not highlighted in the report could benefit from access to better information about the economy and demographic changes.

Potential Costs

Potential up-front costs: $300,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $300,000 in estimated total costs

[70] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Community Development Block Grant–Disaster Recovery

Potential Implementers

Private-sector firm or university

Potential Pitfalls

Study could replicate information available elsewhere or could be completed too late to be useful.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 22
Rehabilitate Paseo de la Princesa and Princesa Building

Sectors Impacted

Economic

Issue/Problem Being Solved

Hurricane Irma caused significant losses to the Paseo de la Princesa and the Princesa Building. These losses were mainly to trees and lighting but also involved flooding in the main building. The damage was exacerbated by Hurricane Maria, which destroyed trees, lighting posts, and benches and caused additional main-building flooding.

Description

This course of action was taken from the *Build Back Better* plan.[71] This project would involve the revitalization of the Paseo de la Princesa (walkway) and Princesa Building, a historical site visited by thousands of tourists every year. The Paseo attracts many cruise-ship tourists and allows local artisans to showcase their work. Linking this project with ECN 20 (Rehabilitate Plaza Dársenas) might provide a broader impact.

Potential Benefits

Having a strong tourist front close to where cruise-ship passengers depart would help improve Puerto Rico's destination image and help lure more tourists to Puerto Rico.

Potential Spillover Impacts to Other Sectors

This course of action helps local businesses, such as gift shops, restaurants, and cafes, as well as tour operators.

Potential Costs

Potential up-front costs: $4.5 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $4.5 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Opportunity Zone Funds, New Markets Tax Credit Program

[71] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Industrial Development Company, Puerto Rico Department of Economic Development and Commerce, Puerto Rico Tourism Company

Potential Pitfalls

Construction costs could be high and labor could be scarce or expensive because of high demand in the construction industry during the recovery period.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 23
Implement Job Creation Initiative

Sector Impacted

Economic

Issue/Problem Being Solved

Damage from Hurricanes Irma and Maria caused extensive loss of homes, personal property, and jobs and forced many residents of Puerto Rico to move into shelters. This upheaval exacerbated issues caused by high unemployment and low labor force participation prior to the hurricanes. As a result, many people are now struggling to support their families.

Description

This course of action would create jobs within communities, especially jobs targeting women and young adults. Individuals would work in or near their communities in physical and social reconstruction projects. A skeletal version of this course of action was presented in the *Build Back Better* plan.[72] Additional workforce development options are presented in workforce development (ECN 2, Implement Workforce Development Programs), similar in spirit to ECN 25 (Assist Dislocated Workers Through the Use of Existing Grants) but focusing on women and young adults.

Potential Benefits

This course of action would help to rebuild local communities destroyed by the hurricanes and help put people back to work. It would also help families become more self-sufficient and resilient in the future.

Potential Spillover Impacts to Other Sectors

Local efforts to repair and improve communities would help larger businesses in the area as well.

Potential Costs

Potential up-front costs: $80 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $80 million in estimated total costs

[72] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Community Development Block Grant–Disaster Recovery, U.S. Department of Labor, U.S. Department of Agriculture

Potential Implementers

Local public agency and individual program applicants

Potential Pitfalls

Construction costs could be high, and individuals might not have the necessary skills to complete complex projects. Temporary employment programs might not help individuals once the specific program ends unless participants acquire skills.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 24
Revitalize the PR-127 Petrochemical Corridor in Guayanilla-Peñuelas

Sectors Impacted

Economic, Energy

Issue/Problem Being Solved

The petrochemical corridor in Guayanilla and Peñuelas is dilapidated and needs resources to create value for the economy in the future.

Description

This course of action, which was presented in the *Build Back Better* plan,[73] would consist of the brownfield cleanup and revitalization of the former petrochemical zone in Guayanilla and Peñuelas. It took on new significance in the aftermath of Hurricanes Irma and Maria because of the importance of facilities in the corridor as a source of energy to drive commerce and industrialization by providing incentives for renewable energy production, pharmaceuticals, and recycling industries. The aim is to revitalize this area to enable next-generation manufacturing and not to rebuild the former petrochemical firms.

Potential Benefits

A new generation of industries would be created, focused on the production of renewable energy and renewable energy resources and products; microalgae-based pharmaceuticals; and the creation of new, responsible recycling industries.

Potential Spillover Impacts to Other Sectors

Other sectors may also benefit from access to this space or to the businesses that establish here, particularly energy-producing firms that show success.

Potential Costs

Potential up-front costs: $30 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $30 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Community Development Block Grant–Disaster Recovery

[73] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Department of Economic Development and Commerce

Potential Pitfalls

Construction costs could be high, and high demand could affect access to labor. There is no guarantee that the desired industries—or any industries—would locate in this area or that any industries would locate in this area. It is also unknown whether the abandoned or idle facilities are technically usable for these purposes and whether their use would be economically feasible.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 25
Assist Dislocated Workers Through the Use of Existing Grants

Sectors Impacted

Economic, although all likely affected

Issue/Problem Being Solved

Widespread job loss due to the permanent or temporary shutdown of places of employment following Hurricane Maria

Description

When an area affected by disaster is declared eligible for public assistance by FEMA or other federal agencies, Disaster Dislocated Worker Grants, which were included in the *Build Back Better* plan,[74] provide funding to create temporary employment opportunities to assist with clean-up and recovery efforts (similar to ECN 23, Implement Job Creation Initiative).

Potential Benefits

Temporary jobs would support workers who lost their source of income because of the hurricane and would promote economic activity.

Potential Spillover Impacts to Other Sectors

Retail, food services, other services, and many other sectors would benefit if individuals were working again and earning money to support themselves and their families. Tourism could also benefit if tourist areas were cleaned up.

Potential Costs

Potential up-front costs: $50 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $50 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Labor

Potential Implementers

Local public agency and individual program applicants

[74] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Pitfalls

Temporary employment could compete with more-stable long-term employers for workers or could lead to dependency for workers receiving the assistance. The program might not be as efficient as the private sector.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 26
Conduct Studies for Workforce Development and Rapid Response

Sector Impacted

Economic

Issue/Problem Being Solved

Changes in the operating environment for local businesses that resulted from the hurricanes have created an information gap.

Description

Workforce development and rapid-response studies, which were included in the *Build Back Better* plan,[75] would help local businesses better understand the available labor supply to meet demands and help the government modify its plan to optimize worker training for the needs of local employers. The government of Puerto Rico could use the information to implement new strategies that would better align labor supply with labor demand. See also ECN 2, Implement Workforce Development Programs.

Potential Benefits

Appropriate evidence and information would provide decisionmakers with the tools to implement new workforce development strategies that support the changing labor market.

Potential Spillover Impacts to Other Sectors

All sectors could benefit by better understanding the labor needs of local businesses. This knowledge could especially benefit the Education sector and workforce development programs.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $5 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Labor, Community Development Block Grant–Disaster Recovery

Potential Implementers

Private-sector firm or university

[75] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Pitfalls

The time required to conduct studies properly might minimize their potential impact. Since labor market conditions are constantly evolving, the findings might quickly be out of date. New studies might duplicate ongoing efforts to expand workforce development.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 27
Rehabilitate Esperanza Boardwalk and Waterfront

Sector Impacted

Economic

Issue/Problem Being Solved

Significant damage was caused by Hurricanes Irma and Maria to the famous waterfront (the Malecón) in Esperanza on the island of Vieques. This popular Vieques tourist destination is currently closed to visitors. Most restaurants and businesses were also damaged.

Description

This course of action, which was included in the *Build Back Better* plan,[76] involves revitalizing the Esperanza Boardwalk, providing assistance to the neighboring businesses to reopen, and building to enhance resilience and better protect against future hurricanes.

Potential Benefits

The Esperanza Boardwalk is an area that is enjoyed by both locals and visitors. The area would be able to reopen and be better protected against future hurricane. Businesses would be built back better and would benefit from the visitors to the popular waterfront.

Potential Spillover Impacts to Other Sectors

Services, food services, cleaning, and maintenance

Potential Costs

Potential up-front costs: $10 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $10 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, private insurance

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, private companies

[76] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Pitfalls

High industry demand could raise construction costs and reduce the labor supply. There is no guarantee that businesses would rebuild and return.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 28
Implement Initiative to Promote Entrepreneurship

Sectors Impacted

All

Issue/Problem Being Solved

Statistics, information, and data needed to establish plans, strategies, and actions based on market studies, financing options, and economic projections are lacking.

Description

The government of Puerto Rico would establish the Business and Entrepreneurial Intelligence System, which would be managed by an organization outside the government, to provide statistics, information, and data to simplify the preparation of business plans, strategies, and market studies. Other entrepreneurship initiatives for seniors and individuals with disabilities are also being considered. In contrast to ECN 7, Create Research Centers and Partnerships, the focus of this course of action is on general entrepreneurship.

Potential Benefits

Providing a clearer picture of the investment and business climate in Puerto Rico would increase business owners' confidence in establishing markets in Puerto Rico.

Potential Spillover Impacts to Other Sectors

This reform in data gathering should spur improved data gathering in other industries.

Potential Costs

Potential up-front costs: $50 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $50 million in estimated total costs

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Community Development Block Grant–Disaster Recovery, U.S. Department of Labor

Potential Implementers

Puerto Rico Department of Economic Development and Commerce

Potential Pitfalls

Entrepreneurial success is not guaranteed, nor is it clear that that the data collected would be useful (and presented in a format that is useful) to firms and entrepreneurs.

Likely Precursors

The success of this course of action would depend on improvements in the ease of doing business. A digital system for instant-use permits and a single permit office (Plan para Puerto Rico[77]) are needed. Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

[77] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 29
Design Puerto Rico "Open for Business" Campaign

Sector Impacted

Economic

Issue/Problem Being Solved

There is a lack of awareness that Puerto Rico is ready to receive visitors and a lack of information about its status as a tourist destination.

Description

This course of action, which is included in the *Build Back Better* plan,[78] would develop a marketing strategy to invite tourists to Puerto Rico and to promote the news that Puerto Rico is ready to receive tourists, that the natural resources continue to be as beautiful as they were before the hurricanes, and that the industry is ready to serve tourists. This course of action complements the BLUEtide initiative (ECN 10).

Potential Benefits

The marketing campaign would fill information gaps and promote tourism to Puerto Rico, leading to enhanced exports and economic development. The initiative would be a complement to private initiatives that promote business development and motivate locals to stay in Puerto Rico, such as the Banco Popular Echar Pa'lante initiative.

Potential Spillover Impacts to Other Sectors

Spillovers from additional tourism spending would affect most sectors of Puerto Rico.

Potential Costs

Potential up-front costs: $67 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $67 million in estimated total costs

The up-front costs are updated from the *Build Back Better* plan.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration

[78] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Tourism Company, Puerto Rico Department of Economic Development and Commerce, Institute of Puerto Rican Culture

Potential Pitfalls

To be most effective, messaging should be coordinated with other tourism initiatives. The impact would depend on external demand (tourism) and competition with other Caribbean destinations.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 30
Help Revitalize Eco and Beach Adventure and Fleet Boat Assistance

Sector Impacted

Economic

Issue/Problem Being Solved

Income opportunities on the island of Culebra are hampered by damage to businesses and boats.

Description

This course of action, which was included in the *Build Back Better* plan,[79] would identify key businesses damaged by the hurricanes and other possible services and products that can be offered on Culebra. The project would provide economic assistance to existing businesses and resources to repair the beach and create new opportunities. This effort could be subsumed within the BLUEtide Initiative (ECN 10).

Potential Benefits

By creating or stimulating sustainable tourism, the local sector would benefit from job creation and increased economic activity, as well as providing a better range of services and experiences to visitors.

Potential Spillover Impacts to Other Sectors

Retail, services, food services, cleaning, and maintenance would be affected in the Economic sector.

Potential Costs

Potential up-front costs: $2.5 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2.5 million in estimated total costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, private insurance

Potential Implementers

Puerto Rico Department of Economic Development and Commerce, private companies

[79] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Pitfalls

High demand for construction could result in high repair costs and a shortage of labor to do the project. Further studies are needed to assess what types of adventure tourism would be successful in the area. Success would depend on external demand.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 31
Change Social Welfare and Benefits Policy

Sectors Impacted

All, with the Economic sector being most relevant

Issue/Problem Being Solved

Low labor force participation rate, lack of economic growth and equity

Description

This course of action is a collection of policy levers that would affect the distribution of social welfare benefits and income in Puerto Rico, including Medicaid and the Programa de Asistencia Nutricional (PAN; food stamps) and individual income tax rates and structure.

Potential Benefits

The current structure of social welfare benefits and individual income tax policy creates disincentives for work. Altering this structure would remove these disincentives. Reducing the overall level of benefits or changing the eligibility structure of certain benefits (e.g., establishing work requirements using income tax credits to change hard thresholds for benefits eligibility and thus the incentive to work) would incentivize beneficiaries to enter the labor force. Lowering individual tax rates would stimulate consumption spending or saving. Depending on the policy shift (e.g., reducing financial benefits), fiscal benefits might also accrue on the expenditure side. Over time, additional economic activity—and associated tax collections—may partially or fully offset reduced marginal tax rates, and participation in the formal financial system might also increase.

Potential Spillover Impacts to Other Sectors

Changes in social welfare and benefits policy that lower overall benefit amounts or allow workers to keep more of their income should create an incentive to work. This change would increase labor availability—and potentially wages—across most of the Economic sector.

Potential Costs

No direct financial costs in terms of public investment for most of these policies

Potential Funding Mechanisms

Not applicable

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

Policies that reduce marginal individual income tax rates may lower public revenues in the short run. Without appropriate safeguards, reducing or restructuring social welfare benefits may negatively affect more-vulnerable populations and may increase outmigration.

Likely Precursors

Not applicable

ECN 32
Create Business Resiliency Hubs

Sectors Impacted

Economic, Community Planning and Capacity Building, Municipalities

Issue/Problem Being Solved

Businesses, especially small- and medium-sized businesses, lacked adequate preparation for the hurricanes and the resulting extended outage of basic utilities. According to a national survey by Nationwide Insurance Company,[80] fewer than 20% of small businesses have an active continuity plan. Large, multinational entities were also unprepared with respect to the unavailability of telecommunications and information services.

Description

A business resiliency hub would provide space for business operations after a disaster, supplying a workspace, electricity, and communications. A business resiliency hub would be a community facility that is built to code, outside a flood plain (or properly elevated if within a flood plain), with sufficient backup generating capacity and fuel supply for the response phase of a disaster. Closed schools might be used as business resiliency hubs. If feasible, satellite communications (phone and internet) may be obtained to enhance the resiliency of the telecommunications systems.

Potential Benefits

This course of action would help businesses survive and recover from disasters by assisting with the continuity of (administrative) operations and enabling businesses to communicate with employees, customers, and vendors.

Potential Spillover Impacts to Other Sectors

Enhanced business and community resiliency should enhance the overall stability of Puerto Rico and positively affect every sector.

Potential Costs

Potential up-front costs: $4 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $4 million in estimated total costs

[80] Nationwide, "Most Small Business Owners at Risk for a Disaster," August 31, 2015 (as of April 10, 2019: https://www.nationwide.com/personal/about-us/newsroom/press-release?title=083115-small-biz-survey).

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration

Potential Implementers

Local public agency and individual program applicants

Potential Pitfalls

If small- and medium-sized businesses do not invest in private resilience measures because business resiliency hubs are available for use in the event of a disaster, significantly less resilience investment would be achieved than in the absence of business resiliency hubs. This situation would create a potential moral hazard problem.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 33
Establish Business and Industrial Development Corporations (BIDCOs)

Sector Impacted

Economic

Issue/Problem Being Solved

Puerto Rican businesses lack access to capital.

Description

This course of action would establish Business and Industrial Development Corporations (BIDCOs) in Puerto Rico. BIDCOs are state-chartered private lending institutions designed to help businesses that conventional lenders consider too risky but that do not have the high growth potential required by venture capitalists.

Potential Benefits

BIDCOs attract institutional investment capital by selling the guaranteed portions of their government-guaranteed loans and subsequently re-lending these funds to other businesses. According to the Detroit Regional Chamber of Commerce, BIDCOs in Michigan created or saved 3,684 jobs during the first 5 years after passing the BIDCO Act of 1986 (Act 89). Assuming a 75% guaranteed portion, a BIDCO with $5 million in capital could provide $20 million of financing to businesses in the communities it serves via selling the guaranteed portion in the secondary markets.

Potential Spillover Impacts to Other Sectors

As a gap financing solution for businesses in general, a BIDCO could affect most sectors.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: $3 million in estimated recurring costs
Potential total costs: $8 million in estimated total costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, private sector

Potential Implementers

Government of Puerto Rico, private sector

Potential Pitfalls

High administrative burden in ensuring efficient allocation of resources and misallocation of capital is possible, as these investments cannot acquire funding through market mechanisms.

Likely Precursors

Ease of doing business must be improved for this course of action to succeed. Also needed are a digital system for instant-use permits and a single permit office (Plan para Puerto Rico[81]). Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) would help all business activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs. Puerto Rico would need to enact BIDCO legislation and create a system of regulation, most likely within its bank licensing and regulation code.

[81] Plan para Puerto Rico, "Modelo de transformación socioeconómico," undated.

ECN 34
Establish Matching Fund Set-Aside

Sectors Impacted

All

Issue/Problem Being Solved

There is a lack of government of Puerto Rico funding to provide matching funds to unlock additional federal funding to rebuild Puerto Rico.

Description

The federal government—through FEMA (Sections 404, 406, and 421 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act [Pub. L. 100-707]), U.S. Department of Agriculture, U.S. Environmental Protection Agency, Economic Development Administration, and other federal agencies—can spend approximately $50 billion–$100 billion dollars to help rebuild Puerto Rico. However, to access these funds, the government of Puerto Rico must provide matching funds of between 0% and 20%, depending on the specific sources of money (typically, FEMA, 10%; U.S. Department of Agriculture, 10%–20%; U.S. Environmental Protection Agency, 10%–20%; Economic Development Administration, 0%–20%; other federal, 10%–20%). Given that the government of Puerto Rico does not have money to provide matching funds, it should set aside at least $10 billion over the time frame of the plan from the unrestricted Community Development Block Grant–Disaster Recovery (CDBG-DR) funding to fund matching grants and unlock the additional billions in federal funding. CDBG-DR funding becomes local funding from a federal government perspective; no other federal funding has this ability.

Potential Benefits

The commonwealth could access billions of dollars in additional funding to repair roads, public buildings, and other infrastructure. If CDBG-DR funds are not set aside for matching, the additional money needed for a local cost share would not be available.

Potential Spillover Impacts to Other Sectors

All sectors of the economy would benefit by the projects that can be financed by the additional government funding.

Potential Costs

Potential up-front costs: Not applicable
Potential recurring costs: Not applicable

Potential total costs: Not applicable ($10 billion in total estimated costs as cost-share requirement)

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery

Potential Implementers

Executive branch of the government of Puerto Rico

Potential Pitfalls

Potential misallocation of resources would depend on how federal funds are spent. The opportunity cost of short-term projects must be weighed against unlocking longer-run funding for a larger pool of projects.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico and would be important for the success of projects funded through federal sources with matching funds.

ECN 35
Center of Excellence for Agricultural Technologies Training

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education, Public Buildings

Issue/Problem Being Solved

Industry problems stemming from outdated farming practices, land- and capital-constrained operations, an older workforce, and labor shortages.

Description

This course of action would establish a fully operational agricultural training center to catalyze applied-technology-driven agro-innovation to integrate veterans, youth, and marginalized populations into agricultural business opportunities. Because of the limited access to capital, the center would serve as an incubator for agricultural businesses in controlled-environment agriculture, which can then use the Economic Development Bank program to expand operations outside the center, creating the first step in a pipeline for agricultural scale-up to increase productive capacity.

Potential Benefits

This initiative could increase the number of farmers in Puerto Rico while contributing to human capital development, hurricane damage mitigation, and food security.

Potential Spillover Impacts to Other Sectors

This strategy leverages Natural and Cultural Resources efforts. It may affect Health and Social Services through increased food security and food safety if new crops result in more-nutritious varieties with better yields, thus enabling them to be offered at more-affordable prices. The course of action also creates jobs, has an education component, and could use public buildings as assets.

Potential Costs

Potential up-front costs: $6 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $6 million in estimated total costs

The up-front costs include a training center.

Potential Funding Mechanisms

National Oceanic and Atmospheric Administration, U.S. Department of the Interior, U.S. Environmental Protection Agency, U.S. Department of Labor, Employment and Training Administration, National Farmworker Jobs Program, U.S. Department of Agriculture Rural Development, and U.S. Department of Housing and Urban Development

Potential Implementers

Government of Puerto Rico, Puerto Rico Department of Agriculture

Potential Pitfalls

Reliance on external economic conditions, a favorable business environment for agriculture, and job opportunities in other sectors may lead to less desire to work in agriculture. Changes in climate could potentially increase risks of damage or loss for crops grown under traditional (outdoor) conditions.

Likely Precursors

Identification of closed schools to incorporate into this initiative, ECN 1 (Increase Ease of Doing Business), ECN 34 (Establish Matching Fund Set-Aside), ECN 36 (Agricultural Financial Support for Access to Capital) are all needed.

ECN 36
Agricultural Financial Support for Access to Capital

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education, Public Buildings

Issue/Problem Being Solved

Lack of access to capital and outdated agricultural operations

Description

This course of action would expand agricultural capital access through a dedicated revolving loan fund that would be used to establish the Agricultural Enterprise Program in the Economic Development Bank for Puerto Rico. The Economic Development Bank would be able to combine Small Business Administration loan guarantees for agricultural activities within the Small Business Administration's standard operating procedures. The revolving loan fund could then be used to pursue innovative projects that incur a higher level of financial risk. Given the bank's lack of knowledge in this field and Puerto Rico's lack of experience with this type of enterprise, this new program would require a committee comprising private-sector industry experts, particularly in controlled-environment agriculture, to support the decisionmaking process of the Economic Development Bank.

Potential Benefits

This initiative could increase the number and productivity of farmers in Puerto Rico while contributing to hurricane mitigation and food security by encouraging innovation.

Potential Spillover Impacts to Other Sectors

This strategy would leverage natural resources, could affect Health and Social Services through job creation, and has an education component. The course of action could also increase agricultural outputs and contribution to the gross domestic product.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $5 million in estimated total costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture Rural Development, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Puerto Rico Economic Development Bank

Potential Pitfalls

This course of action would rely on external economic conditions and favorable business environment. This course of action would carry some climate risk and a risk that lack of experienced local small and medium enterprises in this field could lead to poor agricultural investment choices.

Likely Precursors

Lowering the costs of doing business (ECN 1, Increase Ease of Doing Business) helps all businesses activities across Puerto Rico. A matching fund set-aside (ECN 34, Establish Matching Fund Set-Aside) anticipates the use of Community Development Block Grant–Disaster Recovery funds as a match for other federal funds and programs.

ECN 37
PRIDCO Agricultural Parks

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education, Public Buildings

Issue/Problem Being Solved

Puerto Rico has insufficient land for agricultural use. The land currently dedicated to agricultural use is insufficient to support Puerto Rico's food needs. At the same time, Puerto Rico Industrial Development Company (PRIDCO) parks are underutilized.

Description

The Economic Incentives for the Development of Puerto Rico Act (Act No. 73 of 2008) includes development of hydroponics and aquaculture to address the economic emergency. This course of action would allow undeveloped PRIDCO parks to be converted to state-of-the-art controlled-environment agriculture structures available for private lease using the current landlord model.

Potential Benefits

Developing modern agricultural facilities and eliminating the need for up-front investment by operators would attract young entrepreneurs to the agriculture industry, which would contribute to improving agricultural output. This effort would be helped by the technical expertise of the Center of Excellence and operational capital provided by Economic Development Board. Controlled-environment agriculture can reduce climate vulnerability, overcome land constraints, and increase food security and exports. This course of action would give Puerto Rico the opportunity to increase production for both domestic consumption and export.

Potential Spillover Impacts to Other Sectors

This strategy would leverage Natural and Cultural Resources. It also may affect Health and Social Services through job creation, has an education component, and utilizes public buildings as assets.

Potential Costs

Potential up-front costs: $100 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $100 million in estimated total costs

The up-front cost estimate includes the cost for a 40-acre turn-key complex.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture Rural Development, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Puerto Rico Industrial Development Company

Potential Pitfalls

Success would depend on external economic conditions, favorable business environment, and some climate stability. Other potential challenges would be lack of perceived value of the agricultural potential and historical mismanagement of agricultural projects.

Likely Precursors

ECN 1 (Increase Ease of Doing Business), ECN 34 (Establish Matching Fund Set Aside), and ECN 35 (Center of Excellence for Agricultural Technologies Training)

ECN 38
Agricultural Industry Support

Sectors Impacted

Economic, Natural and Cultural Resources, Health and Social Services, Education, Public Buildings

Issue/Problem Being Solved

The Puerto Rico Department of Agriculture Agrological Laboratory is limited by resource and knowledge constraints regarding its ability to help Puerto Rico's farmers in a timely manner.

Description

Changing the Puerto Rico Department of Agriculture's current Agrological Laboratory's model to a public-private partnership with greater resources could enable it to communicate effectively and in a timely manner with farmers to better serve its intended function as a resource to support optimal farm-level decisionmaking.

Potential Benefits

This initiative would contribute to human capital development, hurricane mitigation, agricultural productivity, and, therefore, food security by promoting better agricultural practices.

Potential Spillover Impacts to Other Sectors

The strategy leverages Natural and Cultural Resources and has an education component.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: $22 million in estimated recurring costs
Potential total costs: $27 million in estimated total costs

Reconditioning existing assets for public-private partnerships management and contract operation for 10 years are estimated to cost $25 million ($5 million for reconditioning laboratories and $2 million for operations and maintenance cost).

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture Rural Development, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Puerto Rico Department of Agriculture, private sector

Potential Pitfalls

This strategy depends on external economic conditions, favorable business environment, and some climate stability.

Likely Precursors

ECN 1 (Increase Ease of Doing Business), ECN 34 (Establish Matching Fund Set-Aside), and ECN 35 (Center of Excellence for Agricultural Technologies Training) are prerequisites.

ECN 39
Exemption of Puerto Rico from the Jones Act After Consideration of Costs and Benefits

Sectors Impacted

All

Issue/Problem Being Solved

The transportation and warehousing industry is lacking in Puerto Rico. Additionally, substantial investments have been made in the Port of Ponce/Port of the Americas to develop this port as a transshipment hub in the post-Panamax era; however, this development has failed to materialize. Evidence suggests the Jones Act (specifically, Section 27 of the Merchant Marine Act [Pub. L. 66-261]) is responsible for this failure, as well as for Puerto Rico's poor economy.

Description

This course of action would support efforts to work with the U.S. government to provide a permanent exemption to the Jones Act for Puerto Rico, similar to the exemption enjoyed by the U.S. Virgin Islands.

Potential Benefits

Exempting Puerto Rico from the Jones Act would result in less expensive costs of shipping, on average, which is expected to (1) lower the price of some imported items used by business, consumer, government, and agricultural concerns in Puerto Rico and (2) lower the cost of exporting some items from Puerto Rico. Lifting the Jones Act restrictions would also likely result in less expensive energy and would lift an impediment to Puerto Rico evolving as an international transshipment hub in the post-Panamax era.

Potential Spillover Impacts to Other Sectors

Energy may be the sector most affected by the Jones Act or its waiver, as less expensive energy may be imported from the continental United States.

Potential Costs

Potential up-front costs: Not applicable
Potential recurring costs: Not applicable
Potential total costs: Not applicable

Potential Funding Mechanisms

Not applicable

Potential Implementers

Government of Puerto Rico congressional delegation

Potential Pitfalls

Opposition to repealing the Jones Act has been intense in the past, and industry groups may work hard to block any exemption for Puerto Rico. Relatedly, there may be national security implications to this course of action for the United States, although the extent is unknown and a matter of some dispute.

Likely Precursors

ECN 1 (Increase Ease of Doing Business) is a prerequisite. A permanent repeal of the Jones Act is not a "fix-all" solution. Many laws and regulations at the commonwealth and municipal levels would also have to be revised. Key among them are local tariffs and taxes on inventories.

ECN 40
Enable Puerto Rico to Become an International Air Cargo and Passenger Hub

Sectors Impacted

Most sectors would be affected.

Issue/Problem Being Solved

Puerto Rico lacks economic growth and outmigration because of economic conditions. Puerto Rican air cargo routes are currently disadvantaged compared with Colombia's, Panama's, and the Dominican Republic's routes.

Description

This course of action is designed to increase air cargo transported through airports located in Puerto Rico. Title 49, Section 41703(e) ("Cargo in Alaska"), of the U.S. Code allows foreign cargo aircraft that stop in Alaskan airports to proceed to other cargo airports within the United States. This exception is not allowed for any other airports within the United States. Since the passage of this, known as the Stevens Amendment, Alaska is now a major international air cargo hub serving flights in the Asia–North America routes. Adding Puerto Rico to the law would boost air cargo activity and create additional economic opportunities for the air industry in Puerto Rico. The inclusion of Puerto Rico in this exception should be paired with authorizations from the U.S. Department of Transportation to allow for cargo transfers; Alaska, the Mariana Islands, and Guam currently enjoy these benefits. This initiative should also work to reestablish the "transit without visa" program in Puerto Rico, with all the necessary security requirements and safeguards. This policy change would make it easier for people to visit Puerto Rico and would stimulate the air passenger and cargo industry.

Potential Benefits

Implementing the Stevens Amendment for Puerto Rico should attract additional air carriers by allowing them to transfer and consolidate cargos. This action could create a major air cargo hub to serve air trade routes between North America and South America, Europe and South America, and the Middle East and South America. A "transit without visa" program would bring additional tourists to Puerto Rico.

Potential Spillover Impacts to Other Sectors

Because of Puerto Rico's geographical location, which is equidistant from the trade corridors of North and South America and Europe, it has the capacity to become a major hub for air cargo, which can greatly stimulate the economy. Additional tourists would benefit retail, restaurants, hotels, and other industries.

Potential Costs

Potential up-front costs: Not applicable
Potential recurring costs: Not applicable
Potential total costs: Not applicable

Potential Funding Mechanisms

Not applicable

Potential Implementers

Government of Puerto Rico congressional delegation

Potential Pitfalls

Some stakeholders may object to additional air traffic or a “transit without visa” program.

Likely Precursors

Eliminating local laws that place taxes on inventory, as well as local tariffs, would be desirable prerequisites.

Education Sector

COA Number	Title
EDU 1	Create New—and Enhance Existing—After-School and Summer Learning Opportunities
EDU 2	Improve Longitudinal Data System to Support Evidence-Based Policy
EDU 3	Landscape Analysis of Early Childhood Interventions and Care Opportunities
EDU 4	Multisector Analysis to Support Resource Allocation Decisions Related to Schools
EDU 5	Implement a Student-Based Budget System
EDU 6	Expanding and Updating K–12 Vocational Programs
EDU 7	Augment Tele-Education/Online Education
EDU 8	Strengthen School Leadership Pipeline
EDU 9	Develop and Implement Teacher Pipeline Program
EDU 10	Develop and Implement a Parent Education Program on School Choice
EDU 11	Rebuilding of Public (PRDE & Municipal) PreK–12 School Infrastructure
EDU 12	Consolidate and Rebuild University of Puerto Rico Infrastructure
EDU 13	Landscape Analysis and Rebuilding of Private Non-Profit (PNP) PreK–12 School Infrastructure

EDU 1
Create New—and Enhance Existing—After-School and Summer Learning Opportunities

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

Posthurricane school closures lasted between 30 to 70 days, and even after reopening, many schools were not able to operate on a normal schedule because of such problems as a lack of electricity and potable water. Prolonged closures can cause a significant amount of learning loss for students. Additionally, students' mental and physical health have been negatively affected by the hurricanes. Ongoing changes in the school system can cause further confusion and distress among students.

Description

This course of action would expand existing and implement new after-school and summer learning programs to address posthurricane learning loss, ensure access to the full range of educational opportunities, and provide consistency to snack or meal programs that are offered as part of after-school and summer programs. These programs would incorporate academic, health, nutrition, and mental health services to alleviate the impact of the hurricanes, as well as ongoing changes in the school system, on both student learning and students' mental and physical health. Where appropriate, this course of action would also help integrate students into K–12 vocational and entrepreneurship programs described in EDU 6 (Expanding and Updating K–12 Vocational Programs).

Potential Benefits

This course of action could lead to a faster recovery in student achievement from posthurricane learning loss; a stronger sense of stability; a better understanding of students' educational, health, and mental health; and a source of employment for young people in Puerto Rico as after-school and summer instructors.

Potential Spillover Impacts to Other Sectors

Expanding existing and implementing new after-school and summer learning programs would provide a point of access for health and mental health care for students, as well as for vocational and technical enrichment programs.

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs

Potential recurring costs: $3.9 billion in estimated recurring costs (11 years)
Potential total costs: $3.9 billion in total estimated costs

Total cost per student for summer learning programs ranges from $1,000 to $1,700. This is based on staff salary (instructor, administrative, health care: approximately 60% of the total cost of professionals), transportation (approximately 7% of the total cost), development of new and strengthening of existing summer curricula (approximately 4% of the total cost), professional development (approximately 4% of the total cost), and lunch (approximately 4% of the total cost). The remainder of the potential costs includes the program facility and incentives for teacher and parent participation.

The total cost for summer learning programs, assuming the participation of 69,000 students (or about 20% of student population) and a $1,350 cost per student, is estimated to be $93 million annually.

The total daily cost per student for after-school programs ranges from $14 to $31.[82] Assuming that the school year is approximately 180 days, and assuming a program participation of 20% of students and the midpoint cost of $21 per student per day, the recurring cost is estimated as $261 million annually.[83]

The grand total cost for after-school and summer learning programs is estimated as $354 million annually.

Potential Funding Mechanisms

U.S. Department of Education, U.S. Department of Agriculture, nongovernment sources

Potential Implementers

Puerto Rico Department of Education, U.S. Department of Education, U.S. Department of Agriculture Summer Food Program, Echar Pa'lante alliance

Potential Pitfalls

Pitfalls include overburdening schools that are already overburdened with changes related to school consolidations and recovery efforts and getting buy-in from parents and students.

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[82] Jean Baldwin Grossman, Christianne Lind, Cheryl Hayes, Jennifer McMaken, and Andrew Gersick, *The Cost of Quality Out-of-School-Time Programs*, New York: The Wallace Foundation, 2009; Afterschool Alliance, *America After 3PM: Afterschool Programs in Demand*, Washington, D.C., 2014.

[83] T. Webber, "Why It's So Hard to Turn the Lights Back on in Puerto Rico," National Public Radio, October 20, 2017; A. Campo-Flores, "Struggling to Fill Jobs, U.S. Employers Look to Storm Battered Puerto Rico," *Washington Post*, January 26, 2018.

Likely Precursors

Precursors include functioning facilities to host summer programs, partners that can provide staff and programs for students in the areas of academic enrichment and mental and physical health, and school district buy-in.

EDU 2
Improve Longitudinal Data System to Support Evidence-Based Policy

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

Puerto Rico is experiencing large changes in student populations from mobility, and particularly from people leaving Puerto Rico in the wake of Hurricanes Irma and Maria. A robust data system would help educators and administrators respond to these changes. Puerto Rico is in a multiyear process of developing such a system. Continuing to build a linked education data system and providing training and protocols for how to use it are valuable courses of action for Puerto Rico's recovery. A data system would also support the Puerto Rico Department of Education in making timely data-driven decisions about school closures, the reallocation of teachers and students to consolidated schools, resource allocation, targeted professional development, and other operational decisions and education policymaking.

Description

This course of action would (1) complete previous efforts to develop a longitudinal data system, (2) enhance the system to make it more user-friendly, (3) provide training on how to integrate data into operations and decisionmaking, and (4) link K–12 data to postsecondary outcomes and workforce data to better manage school-to-work transitions.

Potential Benefits

A longitudinal data system would support decisions by teachers and administrators in everyday practice, as well as help inform students and their parents. In addition, it would provide information that may be useful around school consolidations, district decentralization, resource allocations, and investments that improve student achievement by identifying and assigning high-quality teachers, targeting development and improvement of teachers, more easily meeting federal reporting standards, and supporting other operational decisions and evidence-based education policymaking. Having access to student data following a natural disaster would also help track the continued displacement of residents, inform proposals for the allocation of disaster relief funds, and allow for sharing data with school systems in the continental United States that receive students from Puerto Rico.

Potential Spillover Impacts to Other Sectors

Postsecondary education and the workforce may benefit from improvements to K–12 education. Teacher labor markets may also be affected. Linking these data with physical health and mental health data could allow for better service provision for students.

Potential Costs

Potential up-front costs: $2.2 million in estimated up-front costs
Potential recurring costs: $5.5 million in estimated recurring costs (11 years)
Potential total costs: $7.7 million in total estimated costs

The estimated costs are based on the cost of personnel to develop, maintain, and continually improve electronic and online data systems. A rough estimate is based on experience with similar projects in other districts, including $2.2 million in up-front costs and $500,000 in ongoing annual costs.

Potential Funding Mechanisms

U.S. Department of Education, nongovernment sources

Potential Implementers

Puerto Rico Department of Education

Potential Pitfalls

Puerto Rico has already overcome the challenges of computerizing and linking student records. A lack of funding and resources are potential obstacles to completing the process. There is also potential disagreement on how these measures should be used to make policy decisions.

Likely Precursors

This effort is ongoing, building on the Sistema de Información Estudiantil and the 2012 Statewide Longitudinal Data System grant. Some uses for these data are set forth in the Puerto Rico Department of Education strategic plan, and some dashboards have been designed for use. However, technical personnel for governance and implementation, as well as technical infrastructure, would be required.

EDU 3
Landscape Analysis of Early Childhood Interventions and Care Opportunities

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

Early childhood interventions (e.g., parenting programs for families and early childhood care settings in the first 5 years before formal schooling) provide an important foundation that improves children's later academic, social, and health development. High-quality programs can improve outcomes for parents and generate positive economic returns. Yet, given limited resources, it is important to target resources where they can do the most good. By understanding what interventions are available, the current supply of early childhood care settings, variation in intervention and care usage by demographics, how much rates of intervention or care usage may increase (i.e., how many children would enroll in early childhood interventions or care opportunities), and the cost of expanding high-quality programs, Puerto Rico can better determine how to provide additional intervention and care opportunities to children.

Description

This course of action would undertake a landscape analysis of (1) the demographics of children 0–5 years old (and their families), (2) the current supply of interventions and care settings in Puerto Rico, and (3) opportunities to address unmet needs or achieve better outcomes through evidence-based interventions and high-quality care. The analysis would also consider costs, demographics of children 0–5 years old (and their families), and possible funding streams.

Potential Benefits

Research continually shows that high-quality early learning experiences promote children's school readiness and have the potential to have long-term effects on development, such as health and well-being, and life outcomes, including college attendance and workforce participation.

Potential Spillover Impacts to Other Sectors

Expanding high-quality early childhood interventions and care settings would allow families to return to or enter the workforce, which could affect family economic well-being and potentially the larger economy. Spillover effects may also occur in other sectors as a result of reduced crime and better health later in life.

Potential Costs

Potential up-front costs: $1 million in estimated up-front costs (2 years)

Potential recurring costs: —
Potential total costs: $1 million in total estimated costs

The up-front costs support local teams, planning coaches, and national experts. The costs are estimated based on 0.75 full-time equivalents required annually for each of the 8 regions. Assuming a labor rate of double the government of Puerto Rico rate, this is $124,600 × 0.75) for 8 regions, for a total of $747,600 in annual labor costs. We also assume $10,000 per region per year in costs for local travel, materials, and meeting costs (total annual nonlabor costs = $80,000) and $100,000 to consult with national experts. Thus, total annual costs are approximately $1 million (rounded up) for a duration of 2 years. This estimate assumes that the project can employ Puerto Rico–based consultants and that off-the-shelf assessment frameworks can be used.

Potential Funding Mechanisms

U.S. Department of Health and Human Services, government of Puerto Rico, municipal governments, nongovernment sources

Potential Implementers

Puerto Rico's Administration for the Care and Integral Development of Children, Puerto Rico Department of Education

Potential Pitfalls

After the study is complete, and potential need is established, providing high-quality care and interventions would require many important elements (e.g., a strong early childhood support system, preservice and ongoing staff professional development, coaching, and evidence-based curricula), which are expensive and difficult to maintain across multiple programs.

Likely Precursors

This course of action would be dependent on buy-in from funders and local stakeholders about the importance of understanding needs, costs, and funding streams for high-quality care and interventions. Additionally, the willingness of local agencies to provide contact information of established programs and interventions serving children 0–5 years old (and their families) would be important for conducting the study.

EDU 4
Multisector Analysis to Support Resource Allocation Decisions Related to Schools

Sectors Impacted

Education, Health and Social Services, Public Buildings, Economic, Transportation, Energy, Water, Natural and Cultural Resources

Issue/Problem Being Solved

The need to close approximately 265 schools means that decisionmakers in the Puerto Rico Department of Education have a rare opportunity to reexamine how education-related resources (e.g., funds to repair and upgrade facilities, location of teachers, targeting of professional development, and school-to-work programming) should be distributed across Puerto Rico for maximum social and economic impact.

Description

This course of action would engage a multidisciplinary group of analysts and key stakeholders to (1) review the manner in which economic, infrastructure, educational, and teacher workforce resources are currently colocated across communities and (2) identify strategies, ongoing analysis, decision rules, and other approaches that can help the Puerto Rico Department of Education and related departments and stakeholders make decisions about where to invest in school infrastructure updates, where to reassign teachers, where to invest in school-to-work programs, and other related decisions.

Potential Benefits

The ability to allocate scarce resources in a way that recognizes the interdependencies between investments in schools and nonschool resources may lead to improved educational outcomes and community impacts and to better value for the money.

Potential Spillover Impacts to Other Sectors

Allocations of resources to schools could have more impact if decisions were made in a way that jointly recognized interdependencies with other sectors—namely, Energy, Water, Transportation, and Public Buildings.

Potential Costs

Potential up-front costs: $2.2 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2.2 million in total estimated costs

The up-front costs are estimated as based on 5 full-time-equivalent (FTE) subject-matter-expert time for Puerto Rico universities × $124,600 salary, totaling $623,000, plus 4 FTE top-level consulting time at a rate of $520,000 annually, totaling $1.6 million.

Potential Funding Mechanisms

Nongovernment sources

Potential Implementers

Puerto Rico Department of Education

Potential Pitfalls

Integrating the perspectives of multiple disciplines and stakeholder groups while basing the course of action on rigorous analysis is a complex undertaking.

Likely Precursors

This effort assumes that Puerto Rico–based universities would be willing to contribute resources.

EDU 5
Implement a Student-Based Budget System

Sector Impacted

Education

Issue/Problem Being Solved

Puerto Rico's recently approved education reform bill aims to guarantee equitable funding for all its students. The distribution of money to schools, no matter the overall amount, is a key lever in ensuring equity in any system, especially one undergoing large-scale change. With the influx of additional dollars from federal relief funds and philanthropic investments, Puerto Rico has an opportunity to review existing budgeting practices, assess whether there are specific regional or municipal funding needs and priorities, and ensure that new funding sources, as well as existing dollars, are distributed equitably, effectively, and in a transparent manner.

Description

This course of action would review current budget practices to assess how funds are allocated to schools and identify unmet funding needs and inequities based on geographic location or school characteristics (e.g., percentage of economically disadvantaged students at a school, special-needs population, proportion of Spanish learners, homeless population, grade levels served, rural versus urban). Based on this review, this course of action would determine whether and how a new student-based budget formula would allow funding to be distributed more equitably, effectively, and transparently across both public and new charter schools.

Potential Benefits

Moving to a student-based funding policy could increase equity, driving more dollars to higher-need schools. As efforts to decentralize aspects of the system occur, a student-based funding policy would ensure consistency across all regions in terms of who has access to resources. Further, as this funding policy attaches dollars to students, and as students move throughout a system with more choice in enrollment because of charter schools and school vouchers, these dollars would follow them.

Potential Spillover Impacts to Other Sectors

No direct spillovers

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: $1.1 million in estimated recurring costs (11 years)
Potential total costs: $1.6 million in total estimated costs

A rough initial cost estimate for hiring external consultants to develop a student-based budget formula and provide training on its use to district leadership is $500,000. Estimate for this annual costs is of $100,000.

Potential Funding Mechanisms

U.S. Department of Education, nongovernment sources

Potential Implementers

Puerto Rico Department of Education

Potential Pitfalls

The formula by its very nature would redistribute funding, providing more money to certain schools but less money to other schools that have lesser need. While this is not a pitfall, per se, it creates a challenge in getting buy-in from all schools.

Likely Precursors

Providing adequate training to school leaders on how to use money allocated to their schools is an important precursor; this issue is addressed in EDU 8 (Strengthen School Leadership Pipeline). Also, a student-based budgeting formula would need to appropriately account for additional funding for schools that need to invest in infrastructure repair and building updates.

EDU 6
Expanding and Updating K–12 Vocational Programs

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

A key strategy for addressing Puerto Rico's economic problems may lie in its education system, particularly in creating a skilled vocational workforce. This is especially true as Puerto Rico faces critical labor shortages and as it looks to new and growing industries.[84]

Description

This course of action would implement a 1-year pilot program and subsequent full-scale program to expand and update K–12 vocational programs. Proposed courses would emphasize growth sectors, including manufacturing (particularly biopharma), finance, renewable energy, construction, hospitality, health care, and emerging industries. Other topics may include (but are not limited to) entrepreneurship, economics, financial education, and creative problem-solving and design thinking. Instruction may also come through the creation of school-based clubs, expos and competitions, start-up experiences, idea labs, and so on and, where possible, can build on existing efforts (e.g., by Echar Pa'lante). A 1-year pilot of 14 proposed courses includes 6 months (2 summers) of teacher professional development, serving 280–560 students. The pilot can be replicated at multiple sites. Scaling the pilot up over a 10-year period would allow it to serve as many 22,000 students (approximately 20% of the secondary student body).

Potential Benefits

This course of action would help build a skilled labor force for sectors key to Puerto Rico's recovery, help address the needs of (vulnerable) populations, help create or strengthen public-private partner consortiums to support long-term recovery, and help create closer relationships between K–12 schools and universities.

Potential Spillover Impacts to Other Sectors

This course of action would enhance the STEM pre-K–16 pipeline, given extant strengths in STEM fields in the University of Puerto Rico system; enhance eldercare services for a rapidly aging population; potentially help reverse negative net migration and population decline in Puerto Rico; and address labor shortages by strengthening alignment between schools,

[84] T. Webber, "Why It's So Hard to Turn the Lights Back on in Puerto Rico," National Public Radio, October 20, 2017; A. Campo-Flores, "Struggling to Fill Jobs, U.S. Employers Look to Storm Battered Puerto Rico," *Washington Post*, January 26, 2018.

universities, and industry.[85] The benefits of this course of action could also spill over to (or synergize with) CIT 28 (Innovation Economy/Human Capital Initiative) and ECN 2 (Implement Workforce Development Programs).

Potential Costs

Potential up-front costs: $4 million in estimated up-front costs
Potential recurring costs: $3 billion in estimated recurring costs (10 years)
Potential total costs: $3 billion in total estimated costs

Up-front costs are based on a range of $4.11 million for 280 students to $5.77 million for 560 students (including initial instruction, administration, facilities, publicity, and materials costs with linear and monotonic per-student cost increases for student internship and apprenticeship support).

Annual costs are based on average annual per student costs over the proposed 10-year pilot, and scale-up is approximately $11,870. To scale this program to include 20% of Puerto Rico's secondary student body, or some 22,625 students (40 to 60 teachers) by the end of the 10-year period, the estimated total cost is $268.6 million.[86]

Estimated number of students at full scale = 22,625
Estimated number of teachers at full scale = 40 to 60
Average annual cost per student at full scale = $11,870
Total program annual cost at full scale = $268.6 million

These estimates assume no efficiencies across existing K–12 vocational education and the proposed program, including extant instructional staff and equipment. The provided estimates

[85] The total fertility rate in Puerto Rico in 2015 was 1.43 children born per woman, compared with an average of 1.84 in the United States overall. Replacement fertility in developed countries is generally about 2.1. The combination of Puerto Rico's fertility and migration patterns aggravates population aging in Puerto Rico overall. As a result, the graying or aging of Puerto Rico's population is accelerated relative to continental United States. See M. Mather, L. A. Jacobsen, and K. M. Pollard, "Aging in the United States," *Population Bulletin*, Vol. 70, No. 2, 2015; J. R. Abel and R. Dietz, "The Causes and Consequences of Puerto Rico's Declining Population," *Current Issues in Economics and Finance: Second District Highlights*, Vol. 20, No. 4, 2014; J. M. Krogstad, "Historic Population Losses Continue Across Puerto Rico," Pew Research Center, 2016; E. Melendez and J. Hinojosa, "Estimates of Post-Hurricane Maria Exodus from Puerto Rico," Center for Puerto Rican Studies, City University of New York, Hunter College, 2017.

[86] Since data for the number of secondary students in Puerto Rico were not readily available, we used the national percentage of secondary students to estimate the total number of secondary students in Puerto Rico (approximately 113,122). If the program includes 20% of the secondary student body at full scale, the total number of students in a vocational technical education program would be approximately 22,625. We estimated that one teacher can instruct up to 40 students in a given school day. With 14 proposed courses, we estimated 14 teachers per 560 students. A full-scale program including some 22,625 students would require a minimum of 40 teachers. Given the variable geographic dispersion of students that might necessitate additional teachers, we therefore estimated 40 to 60 teachers for a full-scale program.

therefore likely serve as an upper bound on program costs. Online or virtual programs could further reduce some program costs and facilitate scale-up.

Potential Funding Mechanisms

U.S. Department of Education, National Science Foundation, U.S. Department of Defense, National Institutes of Health, U.S. Department of Labor, public-private partnerships, Puerto Rico Department of Economic Development and Commerce, Puerto Rico Department of Labor and Human Resources, nongovernment sources

Potential Implementers

Puerto Rico Department of Education, Puerto Rico Innovation and Technology Service, Echar Pa'lante alliance, schools, private industry

Potential Pitfalls

Private companies would be central to this initiative, but they could be reticent to commit to a vocational program given economic uncertainty in Puerto Rico. Similarly, students may hesitate to train in some vocational fields given a decade-long downturn in these fields (e.g., construction). Vocational training may actually increase the probability of people moving to the continental United States.

Likely Precursors

None envisioned: This course of action could align with Economic sector courses of action: ECN 2 (Implement Workforce Development Programs) and ECN 28 (Implement Initiative to Promote Entrepreneurship).

EDU 7
Augment Tele-Education/Online Education

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

Posthurricane school closures have lasted between 30 to 70 days, representing a loss of approximately 20–40% of a school year (based on a 180-day school year). In addition, many schools were not operating on a normal schedule even after reopening, causing further learning loss for students in Puerto Rico.

Description

This course of action would address loss of instructional time in schools through continued online learning programs aligned with the scope and sequence of the curriculum during temporary school closures. This course of action would help schools and teachers provide "emergency instruction" in the event of a period of significant school closure (e.g., more than 2 weeks) so that students do not experience a significant disruption in their education. This course of action would build an online repository of free open educational resources available in Spanish and appropriate for various subject areas, grade levels (K–12), and technology platforms (e.g., desktop, laptops and tablets, mobile and smartphones). Echar Pa'lante is currently involved in tele-education activities in the commonwealth and is a possible implementer or collaborator.

Potential Benefits

This course of action would compensate for loss of instructional time because of school closures; provide a supplemental remedial instructional resource; provide access to instruction in advanced STEM areas; strengthen or build on the Puerto Rico Department of Education's own initiative to integrate technology into the classroom, build virtual libraries, and increase access to different technology platforms; and expand the repository of resources related to adult education, vocational and technical training, and technology that supports personalized learning.

Potential Spillover Impacts to Other Sectors

Postsecondary, adult continuing education, and vocational training sectors could make use of the repository and infrastructure to supplement their instructional offerings.

Potential Costs

Potential up-front costs: $3.7 million in estimated up-front costs (2 years)
Potential recurring costs: $18 million in estimated recurring costs (11 years)
Potential total costs: $22 million in total estimated costs

Major cost drivers of this course of action include up-front costs of 15 full-time equivalents (FTEs) per year for 2 years and 14 FTEs in subsequent years: development of repository and regional emergency education plans (5 FTEs), a survey of internet and computer availability in schools (2 FTEs), staff training (5 FTEs), coordination with community-based organizations and postsecondary institutions (1 FTE), updating of the repository (4 FTEs), and ongoing training to school teachers and administrators (10 FTEs).

To compute costs for the technical staff required to implement this course of action, a standard annual labor cost of $124,600 for an engineer or subject-matter expert in Puerto Rico was used. The estimate for up-front costs also assumes that the digital learning content archived in the repository are publicly available, free open educational resources. This estimate also assumes that the cost of the build-out of a reliable internet and power infrastructure is covered under other courses of action and that sufficient number of devices are available in schools under the implementation of the online learning plan as described in the Puerto Rico Department of Education's *Consolidated State Plan* under the Every Student Succeeds Act (Pub. L. 114-95).[87]

Potential Funding Mechanisms

U.S. Department of Education, nongovernment sources, private sector

Potential Implementers

Puerto Rico Department of Education, Echar Pa'lante alliance, professional development partners

Potential Pitfalls

In addition to costs, potential challenges to this course of action are access (for students) to compatible devices and operating systems, the need for robust internet and power infrastructure, gaps in available high-quality content coverage, the need for leadership commitment to implementing the plan, and the need for teachers and students who can adapt to teaching and learning online.

Likely Precursors

This course of action would assume reliable power and broadband access to schools, and it would benefit from CIT 19 (Municipal Hotspots) and CIT 4 (Rural Area Network Task Force).

[87] Puerto Rico Department of Education, *Consolidated State Plan*, San Juan, 2018.

EDU 8
Strengthen School Leadership Pipeline

Sectors Impacted

Education, Health and Social Services

Issue/Problem Being Solved

Puerto Rico's recently approved education reform bill gives increased responsibility to regional offices and their regional superintendents in managing and supporting schools.[88] Additionally, ongoing school consolidations and the new school-choice environment are likely to present new challenges for school directors and regional superintendents as they think about how to reallocate teachers across schools, how to provide transition support to families assigned to new schools, and how to promote staff integration in consolidated schools. These new responsibilities and system changes will require a change in the skills necessary for school and district leaders.

Description

This course of action would build on the Puerto Rico Department of Education's existing leadership development strategy, with the goal of increasing the availability and quality of school directors and regional superintendents by strengthening the school director and district leader pipeline through the improvement and alignment of recruitment, embedded training, support (e.g., mentoring, coaching, program and change management supporting entrepreneurship among students), retention practices, and efforts to understand future skill demands on education leaders.

Potential Benefits

This course of action would contribute to student learning, reduce teacher and leadership turnover, improve understanding of local education needs, improve communication between schools and regional administrators, and increase buy-in for education reform.

Potential Spillover Impacts to Other Sectors

None

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: $290 million in estimated recurring costs (11 years)
Potential total costs: $290 million in total estimated costs

[88] Act 85 of 2018, Act to Adopt the Puerto Rico Education Reform Act, March 29, 2018.

Up-front costs are district personnel supporting leadership pipeline efforts, technology supporting pipeline, and compensation for school directors who would take part in such pipeline activities as professional development. Total annual estimated costs of implementing a principal pipeline based on per-principal cost estimates) are $31,000 × 800 principals).[89]

Total estimated annual cost for training 7 regional superintendents: $142,702
Annual cost: $26 million

The following are the average annual cost estimates per principal of implementing specific principal pipeline activities: Develop leader standards, $292; preservice preparation, $9,386; selective hiring and placement, $2,894; and on-the-job support and evaluation, $11,000.

Although researchers estimated the costs of leadership standards and selective hiring and placement systems at, respectively, $292 per principal and $2,894 per principal,[90] it is possible that the costs of these activities in Puerto Rico would be lower, given that some costs of these activities were fixed and not found to be driven by the number of principals. Since Puerto Rico includes more principals than the principal pipeline districts in Kaufman et al.'s study, it is likely that there would be cost efficiencies for leadership standards and selective hiring and placement activities.

Potential Funding Mechanisms

U.S. Department of Education, nongovernment sources

Potential Implementers

Puerto Rico Department of Education, professional development partners

Potential Pitfalls

The high cost of training principals and the time commitment required to participate in trainings are potential challenges to this course of action.

Likely Precursors

Implementation of this course of action is dependent on the Puerto Rico Department of Education's buy-in and its own processes and plans for decentralizing the school district into regional offices.

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[89] Julia H. Kaufman, Susan M. Gates, Melody Harvey, Yanlin Wang, and Mark Barrett, *What It Takes to Operate and Maintain Principal Pipelines: Costs and Other Resources*, Santa Monica, Calif.: RAND Corporation, RR-2078-WF, 2017 (as of May 15, 2019: https://www.rand.org/pubs/research_reports/RR2078.html).

[90] Kaufman et al., 2017.

EDU 9
Develop and Implement Teacher Pipeline Program

Sector Impacted

Education

Issue/Problem Being Solved

All school systems face the continuing challenge of developing and sustaining a pipeline of high-quality teachers who can both engage in high-quality instruction and support others in improving their practice.

Description

This course of action would pursue a multipronged strategy to align and strengthen teacher preparation programs, improve instructional practice through professional development, and retain high-quality teachers. Teacher pipeline activities would include creating a residency model for teacher training, reviewing teacher certification requirements and developing options for alternative certification, aligning personnel decisionmaking processes with assessment of teacher quality, improving teacher supports through coaching and professional development, strengthening teachers' career pathways, and considering the creation of an incentive system that rewards high-quality teachers working in especially demanding environments.

Potential Benefits

Research has shown that an effective teacher is the single most influential school-level determinant for students' educational success. Implementation of any other reforms in the system relies almost solely on the people implementing the work. This course of action would help ensure a good match between teacher skills and student needs, and it could also lead to a reduction in teacher turnover and a closer relationship among pre-K–12 schools, the University of Puerto Rico, and other universities that train teachers. These universities would also benefit from the improvement of their teacher preparation programs and better placements for their graduates.

Potential Spillover Impacts to Other Sectors

Programs that tap into building a stronger education system could have significant benefits in stabilizing population and emigration patterns in Puerto Rico.

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: $350 million in estimated recurring costs (11 years)
Potential total costs: $350 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Education

Potential Implementers

Puerto Rico Department of Education, University of Puerto Rico, professional development partners, schools

Potential Pitfalls

This course of action would depend on school district buy-in and teacher buy-in. This course of action could face opposition from teachers' unions, as well as legal challenges in changing teacher contracts.

Likely Precursors

If the regional and school leadership making implementation decisions is not capable, much of what is proposed in teacher talent development would likely not result in an improvement of teacher quality.

EDU 10
Develop and Implement a Parent Education Program on School Choice

Sector Impacted

Education

Issue/Problem Being Solved

Choice-based education reforms, such as charter schools and vouchers, require both a robust supply of school options and parents/families who can make good choices on behalf of their children and hold schools accountable.

Description

This course of action would develop outreach and public education programs, with special emphasis on disadvantaged families, to ensure that all parents and guardians have the knowledge and tools they need to be effective consumers in a school-choice environment.

Potential Benefits

School choice has the potential to improve the school system and individual student performance while also making parents and families happier and more invested in their chosen schools. This is more likely to be achieved if parents are educated about the choices they are making.

Potential Spillover Impacts to Other Sectors

Access to schooling information may increase demand for information about quality in other sectors, such as health and government services. Teacher and administrator recruitment may also be affected.

Potential Costs

Potential up-front costs: $200,000 in estimated up-front costs
Potential recurring costs: $5.5 million in estimated recurring costs
Potential total costs: $5.7 million in total estimated costs

Annual costs consist of 2 full-time equivalents (FTEs) for the development and implementation of the public-education campaign ($124,600 per year), the mass-media campaign ($250,000–$500,000/year[91]), and one-time 0.25 FTEs to develop parent-staff training ($31,150 per year). Staff costs could be lower if some of this work were undertaken by existing staff in the

[91] The midpoint ($375,000) was used in producing the total annual cost estimate noted above.

Family Engagement Office of Puerto Rico's Department of Education. Additional funding for a randomized controlled trial could test the effectiveness of the program and help iterate to the ideal implementation of the program, but that is not included in this estimate.

Potential Funding Mechanisms

U.S. Department of Education, Puerto Rico Department of Education, nongovernment sources

Potential Implementers

Puerto Rico Department of Education (Family Engagement Office)

Potential Pitfalls

Lack of information could make the program ineffective. Parents could also make choices based on things besides quality.

Likely Precursors

Schools need a valid, reliable, and transparent system of measuring and collecting information on school performance, as well as a mechanism for making that information accessible and understandable to families.

EDU 11
Rebuilding of Public (PRDE & Municipal) PreK–12 School Infrastructure

Sectors Impacted

Education, Municipalities

Issue/Problem Being Solved

Many public schools suffered significant hurricane-related damage.

Description

This course of action would repair hurricane damages to pre-K–12 public schools that are managed by the Puerto Rico Department of Education and municipalities. It would ensure that repairs meet current building safety codes, support whole community standards and all access needs (e.g., compliant with the Americans with Disabilities Act), and adhere to an "education is resilient" approach. It would also increase the extent to which school facilities promote student-directed learning and provide collaborative workspaces in which students and teachers share creative, innovative, and developmentally appropriate teaching and learning experiences.

Potential Benefits

This course of action would result in rebuilt school infrastructure, increased school safety, and enhanced support of community resilience. Schools would be more conducive to 21st-century learning approaches.

Potential Spillover Impacts to Other Sectors

Rebuilding resilient and safe schools that foster 21st-century learning would increase the skill level of the future workforce. This course of action could also lead to construction-sector job creation.

Potential Costs

Potential up-front costs: $3.5 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $3.5 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, private sector, nongovernment sources

Potential Implementers

Puerto Rico Department of Education

Potential Pitfalls

If building codes are not enforced, schools may still be susceptible to significant damage during future storm events. Students would be negatively affected if this course of action is implemented and EDU 13 (Landscape Analysis and Rebuilding of Private Non-Profit (PNP) pre-K–12 School Infrastructure) is not.

Likely Precursors

Completion of EDU 4 (Multisector Analysis to Support Resource Allocation Decisions Related to Schools) would ensure that the school infrastructure fits the needs of the student population.

EDU 12
Consolidate and Rebuild University of Puerto Rico Infrastructure

Sector Impacted

Education

Issue/Problem Being Solved

University of Puerto Rico (UPR) facilities suffered significant hurricane-related damage. Given the gradual decline in UPR's student population prior to Hurricanes Irma and Maria, it would be important to consider a system reconfiguration in the rebuilding process.

Description

This course of action would repair hurricane damage to UPR facilities, ensuring that repairs meet current building safety codes and using green infrastructure features that reduce heat and stormwater impacts. To guide the rebuilding, this course of action would begin with an analysis of the UPR system to determine how campus consolidation during the rebuilding process could best meet the educational goals of the university system and ensure the system's financial stability.

Potential Benefits

This course of action would result in a rebuilt and more resilient UPR infrastructure and a university system that facilitates Puerto Rico's higher education and professional workforce development goals.

Potential Spillover Impacts to Other Sectors

Improvements to and rescaling of UPR infrastructure would help foster a well-prepared workforce. Rebuilding efforts would create construction sector jobs, at least temporarily.

Potential Costs

Potential up-front costs: $2.5 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2.5 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance

Potential Implementers

University of Puerto Rico

Potential Pitfalls

Closing or limiting degree programs may cause potential students to consider leaving Puerto Rico to study elsewhere. If building codes are not enforced, facilities may still be susceptible to significant damage during future hurricanes.

Likely Precursors

None anticipated

EDU 13
Landscape Analysis and Rebuilding of Private Non-Profit (PNP) PreK–12 School Infrastructure

Sector Impacted

Education

Issue/Problem Being Solved

Many private nonprofit (PNP) pre-K–12 schools suffered significant hurricane-related damage. Many of these schools are unaware of their FEMA Public Assistance eligibility. The complete landscape and scope of PNP schools requiring assistance is being finalized.

Description

This course of action would repair hurricane damages to PNP pre-K–12 schools. It would ensure that repairs meet current building safety codes, support whole community standards and all access needs (e.g., compliant with the Americans with Disabilities Act), and adhere to an "education is resilient" approach. It would increase the extent to which school facilities promote student-directed learning and provide collaborative workspaces in which students and teachers share creative, innovative, and developmentally appropriate teaching and learning experiences. To guide the rebuilding, this course of action also would begin with a landscape analysis of the PNP school infrastructure and conduct outreach to those schools on eligibility for assistance.

Potential Benefits

This course of action would result in rebuilt school infrastructure, increased school safety, enhanced support of community resilience, and comprehensive knowledge of PNP school infrastructure. Schools would be more conducive to 21st-century learning approaches.

Potential Spillover Impacts to Other Sectors

Rebuilding resilient and safe schools that foster 21st-century learning would increase the skill level of the future workforce. This course of action could also lead to construction-sector job creation.

Potential Costs

Potential up-front costs: $1.7 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.7 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, private sector, nongovernment sources

Potential Implementers

Puerto Rico Department of Education, private nonprofit schools

Potential Pitfalls

If building codes are not enforced, schools may still be susceptible to significant damage during future hurricanes. Students would be negatively affected if this course of action is implemented and EDU 11 (Rebuilding of Public [PRDE & Municipal] PreK–12 School Infrastructure) is not.

Likely Precursors

Completion of EDU 4 (Multisector Analysis to Support Resource Allocation Decisions Related to Schools) would ensure that the school infrastructure fits the needs of the student population.

Energy Sector

COA Number	Title
ENR 1	Establish and Enforce Best Practices for the Electrical Grid
ENR 2	Design, Build, and Maintain “Islandable” Portions of the Electrical Grid
ENR 3	Harden Supporting Infrastructure for the Electricity System, Including Communications
ENR 4	Perform Routine Operations and Maintenance Informed by Periodic Risk Assessment
ENR 5	Harden Grid Assets to Support Critical Infrastructure
ENR 6	Improve Grid Assets' Resilience to Flooding
ENR 7	Improve Grid Assets' Resilience to High Windspeeds
ENR 8	Maintain Disaster-Resilient Generation Assets
ENR 9	Design and Build Fuel Supply Chain to Provide Reliable Energy Source
ENR 10	Improve the Availability of Ancillary Services for the Grid
ENR 11	Design and Deploy Technologies to Improve Real-Time Information and Grid Control
ENR 12	Coordinate Federal and State Emergency Response with Private Sector
ENR 13	Pre-Position Materials and Prepare Workforce for Rapid Response
ENR 14	Design and Build Grid Assets to Meet Current and Future Demand
ENR 15	Enable Private Standby Generation to Provide Emergency Power
ENR 16	Provide Backup Generation to Priority Loads
ENR 17	Provide Energy and Water to Critical Facilities That Serve as Congregate Shelters
ENR 18	Right-Size and Train the Future Energy Workforce
ENR 19	Design and Deploy Data Systems to Inform Response Decisions and Improve Operations and Maintenance
ENR 20	Design and Build Capital Assets to Reduce Restoration Time and Cost
ENR 21	Establish Energy Response and Preparedness Plan
ENR 22	Enable and Promote Distributed Generation
ENR 23	Design Best Strategies for Renewable Energy Resources
ENR 24	Design Best Strategies for Affordable and Stable Energy Prices
ENR 25	Build Capacity for Municipality Decisionmaking of Energy Systems
ENR 26	Establish Energy Sector Governance Responsibilities for State-Level Agencies
ENR 27	Establish Regulations to Transform the Energy Sector

Introduction to Energy Sector Courses of Action

The Energy courses of action are presented here with costs, potential funders, and potential implementers described for the entire set of 27 courses of action. Similarly, spillovers, pitfalls, and precursors are discussed in the context of cross-course of action issues. This alternative presentation is a result of the nascent state of decisionmaking in the energy sector and the fluctuating nature of the restructuring of the Puerto Rico Electric Power Authority (PREPA).[92] Costs associated with future scenarios for the transformed energy sector are presented below, but precise costing depends on additional decisions concerning trade-offs in the sector, modeling and analysis results, and stakeholder engagement that was ongoing at the time of development of the courses of action and at the time of the preparation of this methods report.

The potential costs associated with transformation of the energy sector in Puerto Rico would vary greatly depending on choices made between many technical, financial, and policy options and trade-offs. Strategic-level trade-offs would need to be made, including the level of decentralization of the system (i.e., inclusion of "islanded" portions and microgrids), the level of renewable energy production, the extent of distributed energy resource growth, and prioritization of assets for hardening measures. The courses of action described here enumerate the many actions that could be taken, but the specific approach, level, and timing of the activities within these courses of action could vary depending on the strategic goals and constraints.

Because the cost of transforming the energy sector depends on decisions still to be made, the total amount that must be spent is uncertain and could differ by many millions—or up to many billions—of dollars, depending on these choices. Thus, a point estimate or total cost for the Energy sector is not possible and cannot be calculated by adding the sum of the costs associated with individual courses of action.

The total cost of deploying a grid that loosely aligns with the vision articulated in *Build Back Better Puerto Rico* and the Puerto Rico Energy Working Group's *Build Back Better: Reimagining and Strengthening the Power Grid of Puerto Rico* plans is approximately $30 billion.[93] In both of these earlier reports, the total cost to "build back better" was estimated to be about $18 billion, and the analogous scenario here additionally includes policy initiatives, ongoing operations and maintenance, and a few more extensive measures required for resilience, among other differences. More specifically, executing this vision would likely involve extensive construction of new generation capacity in existing locations, rebuilding and upgrading transmission and distribution lines (including some undergrounding of distribution lines that

[92] Additionally, the government of Puerto Rico selected the portfolio that included all of the Energy courses of action "at full strength," and so all courses of action were included in cost estimates in the recovery plan.

[93] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017; Puerto Rico Energy Working Group, *Build Back Better: Reimagining and Strengthening the Power Grid of Puerto*, December 2017.

likely exceeds what was included in the earlier plans), adding smart-grid capabilities (e.g., metering), and deploying a modern operational technology system.

The estimated costs for this moderate-cost pathway over 11 years are as follows:

Potential up-front costs: $20 billion in estimated up-front costs

Potential recurring costs: $10 billion

Potential total costs: $30 billion

However, this is not the only possible path forward, and even more—or substantially less—could be invested in this sector. For example, investing only an additional $2 billion to $4 billion would likely just enable incremental improvements in the electricity system beyond the repairs to date and would not provide a sufficiently robust and resilient grid, especially in the face of future storms. This low-cost scenario would fully fund permanent repairs to generation, transmission, and distribution assets (i.e., redo all temporary posthurricane repairs) but would not substantially improve or modernize the existing grid architecture. At the other extreme, deploying enough new renewable energy to generate 40% to 50% of Puerto Rico's electricity (including sufficient battery storage to ensure system reliability) is estimated to exceed $30 billion, and perhaps as much as $90 billion, assuming traditional approaches to handling intermittency of renewable resources, such as solar. This scenario also assumes widespread system modernization (e.g., deployment of smart-grid technologies) and improved system resilience.

Neither of these extreme scenarios may be the best long-term solution for Puerto Rico, and the right balance of choices and investments is likely some combination of the attributes and choices of these illustrative scenarios. Additionally, substantial cost savings may be possible by modifying the utility's approach to grid operation, including new approaches, such as the Massachusetts Institute of Technology Lincoln Laboratory's innovative concept of "corrective dispatch,"[94] which involves adjusting power generation, delivery, and consumption to find feasible services during extreme conditions when a power flow solution does not exist. An illustrative set of potential infrastructure investment scenarios and associated costs, and the underlying assumptions and trade-offs within and between the scenarios, will be presented in the Energy sector's separate report so that some of these investment trade-offs can be better understood.[95]

Potential funders across these scenarios and the associated Energy courses of action include FEMA (including the Hazard Mitigation Grant Program), the government of Puerto Rico, the National Oceanic and Atmospheric Administration, the National Science Foundation, the Puerto Rico Electric Power Authority, the U.S. Department of Agriculture, the U.S. Department of Education, the U.S. Department of Energy, the U.S. Environmental Protection Agency, the U.S. Department of Housing and Urban Development (including the Community Development Block

[94] See www.rand.org/hsoac/puerto-rico-recovery for additional information.

[95] The sector-specific reports will be posted at www.rand.org/hsoac/puerto-rico-recovery.

Grant–Disaster Recovery), the U.S. Department of Labor, nongovernment sources, and the private sector.

Potential implementers across Energy courses of action include FEMA, the government of Puerto Rico, the Central Office of Recovery, Reconstruction, and Resilience, the Puerto Rico Aqueduct and Sewer Authority, the Puerto Rico Emergency Management Agency, the Puerto Rico Electric Power Authority, the Puerto Rico Energy Commission, the Puerto Rico Industrial Development Company, the Puerto Rico Department of Labor and Human Resources, the U.S. Army Corps of Engineers, the U.S. Department of Agriculture Rural Development Rural Utilities Service, the U.S. Department of Energy, Puerto Rico municipal governments, new private owners and operators, and professional societies.

The potential funders and the potential implementers listed are notional and cannot be definitively identified until long-term planning has been finalized. Note that organizations that could fund or implement planning efforts (including modeling and analyses) related to infrastructure investment are included in these categories. Where listed, federal agencies may potentially require clarification of legislative authorities, in addition to appropriations, to successfully participate in a given course of action. Thus, the potential funders and potential implementation partners are presented here as illustrative and not prescriptive.

Potential spillover impacts to other sectors would be incurred by the other infrastructure sectors (e.g., Water, Communications and Information Technology, Transportation, Public Buildings) across the full set of courses of action. Additionally, because energy is a component of the critical lifeline infrastructure, all other sectors depend on successful execution of these courses of action and would be affected in both direct and indirect ways. For example, if sections of the grid require major infrastructure upgrades or replacements, with associated planned outages, there could be short-term disruptions to the power supply that affect how well other sectors function. On the flip side, more reliable electricity and more predictable electricity prices would have positive spillover effects to most other sectors.

Potential pitfalls across many of these courses of action relate to the large investments that would be required to create a resilient grid and the potential lack of sufficient funding to execute all the courses of action at the highest desirable level. Additionally, reliance on resolution of governance uncertainties and the interdependency of the courses of action are both potential pitfalls shared across many of the courses of action.

Likely precursors across most of the courses of action include concurrent recovery of and coordination with other critical lifeline infrastructures, establishment of clearer structures and guidance for governance, access to adequate numbers of appropriately skilled workforce, and technical assessments and studies and analysis of technical options and trade-offs in performance (e.g., expected reliability and resilience outcomes).

ENR 1
Establish and Enforce Best Practices for the Electrical Grid

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

To improve the quality and reliability—and speed recovery efforts—of electricity in Puerto Rico, the grid would need to be rebuilt and maintained in accordance with industry best practices, and tailored to the unique conditions in Puerto Rico, and regulators would need to ensure timely and continual compliance and enforcement with established standards. Toward this goal, the Puerto Rico Electric Power Authority (PREPA) announced that grid reconstruction would use U.S. Department of Agriculture Rural Utilities Service standards.[96]

Description

This course of action would align grid standards with industry best practices; for example, the recently announced implementation of Rural Utilities Service standards should potentially be followed by use of additional standards in some situations or locations (e.g., North America Electric Reliability Corporation standards). This course of action would likely necessitate replacing some components of existing generation, transmission, and distribution assets, as described in other courses of action.

Potential Benefits

By incorporating industry best practices (for both management and technical considerations), this course of action would provide a foundation for all investments to the electricity grid. Other benefits may include enhanced knowledge of the system components, increased access to replacement parts, faster repairs, lower maintenance costs, and possible expansion of range of material and supplies that can be used.

[96] "Puerto Rico Grid Reconstruction to Follow USDA Rural Utilities Service Standard," *Caribbean Business*, May 8, 2018.

ENR 2
Design, Build, and Maintain "Islandable" Portions of the Electrical Grid

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

The rebuild of the electrical grid in Puerto Rico offers an opportunity to incorporate technology and design to limit the extent of grid failures during future events. These solutions could range in scale from community and local (microgrids) to regional (electricity islands). Microgrids and electricity islands can balance generation and load to continue delivering locally generated electricity if sections of the transmission grid fail. Several groups (e.g., U.S. Department of Energy National Laboratories) are performing modeling and analysis to determine the optimal design of a system architecture that incorporates technically feasible, resilient, and financially viable solutions. In the meantime, the Puerto Rico Energy Commission established final microgrid rules in May 2018 to be supplemented by interconnection standards by Puerto Rico Electric Power Authority (PREPA) in the coming months. The PREPA Integrated Resource Plan will include recommendations for incorporating islandable portions into the grid.[97] At a smaller scale, the Puerto Rico Industrial Development Company (PRIDCO) released requests for proposals for microgrid pilot projects at industrial sites across Puerto Rico in July 2018.[98] Other ongoing efforts include consideration of Operational Energy Plans and Programs energy regions and legislation considering a 30-year vision and plan that was due in December 2018. How these microgrids and electricity islands are optimally integrated in the future system requires collaboration and further conversation with many decisionmaking bodies in Puerto Rico.

[97] The Puerto Rico Energy Commission required PREPA to submit an updated Integrated Resource Plan by October 1, 2018. Based on extensive analysis and stakeholder engagement, the Integrated Resource Plan would articulate the utility's blueprint for meeting forecasted demand using a combination of traditional and nontraditional generation resources, transmission and distribution enhancements, and demand management.

[98] PRIDCO, "Request for Proposals Pilot Project: Aguadilla Industrial Site Microgrid Solutions in Puerto Rico," July 8, 2018.

Description

This course of action would design and create an islandable, or sectionalized, grid that could balance generation and load to continue delivering locally generated electricity in the event that sections of the transmission grid fail. This course of action would include modeling and analysis to determine optimal design of system architecture, as well as strategic installation, testing, and maintenance of microgrids with an adequate inventory of replacement assets. Modeling and analysis could include developing complementary specialized technical studies to analyze and compare storage technologies that could be deployed in the minigrids in the context of system characteristics, inertial response, and high cycling environment; developing specialized technical studies to analyze and compare communications- and control-system strategies and technologies that could be implemented and installed to allow the operation of minigrids in islanded or grid-integrated mode, depending on system conditions (e.g., disturbances, cascaded outages, dynamic events, security margins, instability predisposition); developing test protocols and maintenance programs to continuously maintain the microgrid's optimum performance and functionality; and developing research on microgrid standards for both emergency and ongoing operational modes while considering resiliency, black start capability, reliability, energy efficiency, cost of environmental impact, maintainability, and criticality.

Potential Benefits

This course of action could allow for more-resilient electricity and potentially improved environmental performance. It may save money, depending on relative electricity rates, and it would likely promote economic growth through reduced price volatility and potentially improved access to electricity.

ENR 3
Harden Supporting Infrastructure for the Electricity System, Including Communications

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sectors Impacted

Energy, Communications and Information Technology

Issue/Problem Being Solved

Infrastructure that supports the electrical grid, such as control centers, telecommunications systems, and collection systems, need to be hardened to withstand future disasters. For example, the Puerto Rico Electric Power Authority's (PREPA's) telecommunications backbone suffered considerable damage from high winds, flooding, and other threats, thus preventing normal system operations and billing and requiring expensive temporary solutions. An assessment of existing telecommunications infrastructure that supports grid monitoring and control functionality is required.

Description

This course of action would strengthen the electricity system through hardening supporting infrastructure, such as control centers, communications systems, and collection systems.[99] This course of action would assess existing telecommunications infrastructure that supports grid monitoring and control functionality. Note: This course of action does not include decisionmaking in real time (ENR 11, Design and Deploy Technologies to Improve Real-Time Information and Grid Control) or the data system and inventory of assets (ENR 19, Design and Deploy Data Systems to Inform Response and Improve Operations and Maintenance).

Potential Benefits

This course of action would improve telecommunications and systems for a more reliable and resilient energy supply.

[99] This course of action refers specifically to PREPA's own communications architecture. The broader telecommunications and information technology network is addressed by that sector's courses of action.

ENR 4
Perform Routine Operations and Maintenance Informed by Periodic Risk Assessment

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

To improve the quality and reliability—and speed recovery efforts—of electricity in Puerto Rico, the grid would need to be rebuilt and maintained in accordance with industry best practices and tailored to the unique conditions in Puerto Rico. Operations and maintenance would need to be performed routinely and based on periodic risk assessments, and the industry best practices could help inform and implement a predictive maintenance effort.

Description

This course of action would improve operations and maintenance with ongoing risk assessments and predictive maintenance, including periodic risk assessments that would inform maintenance efforts of the electrical system. As appropriate, this course of action would include an independent verification and validation of work performed, continual review of improvement recommendations, industry technological and operational improvements, and use of automation.

Potential Benefits

By establishing operations and maintenance best practices, this course of action would provide a foundation for all investments to the electricity grid.

ENR 5
Harden Grid Assets to Support Critical Infrastructure

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Given the widespread failure of the electrical grid, and the virtual certainty of future hurricanes, the electrical grid should be hardened to withstand future natural disasters. The hardening of transmission and distribution system assets to provide reliability and resiliency to critical loads is an essential part of the Puerto Rico Electric Power Authority's Integrated Resource Plan. To this end, electrical grid assets would need to be hardened to support critical infrastructure and public services. These improvements would ensure that hospitals could care for the injured, first responders could dispatch 911 calls, and water pumps could continue to work.

Description

This course of action would prioritize the hardening of electricity and distribution assets—and design assets that enable rapid response time—to support other critical infrastructure. This course of action would include the design and construction of transmission and distribution underground infrastructure that would provide interconnection to critical loads (e.g., medical centers, hospitals, water pump systems, water treatment centers, telecommunications centers and transmitters, food distribution centers, ports, airports, pharmaceutical and biotechnology industries); the extension of existing transmission system underground infrastructure, such as the 115 kV metro underground loop, to integrate critical transmission centers and substations to the local generation facilities; the design and construction of gas-insulated switchgear transmission centers and distribution substations (including new switchyards to replace air insulated existing facilities, as well as extensions to existing gas-insulated switchgear facilities) that would provide interconnection to critical loads (e.g., medical centers, hospitals, water pump systems, water treatment centers, telecommunications centers and transmitters, food distribution centers, ports, airports, pharmaceutical/biotechnology industries); and the development of a plan ensuring operations and maintenance of critical assets that considers N-2 emergency conditions, including

whether and how to prioritize generation, transmission, and distribution feeders.[100] This course of action would also include a number of analyses, such as an analysis to identify interdependencies and to help coordinate large-scale, regional infrastructure projects. Note: The critical infrastructure listed here are a different focus than the priority loads in ENR 16 (Provide Backup Generation to Priority Loads) and the critical facilities in ENR 17 (Provide Energy and Water to Critical Facilities That Serve as Congregate Shelters).

Potential Benefits

A benefit of this course of action is a reliable electricity supply that is less affected by threats and hazards.

[100] Planning for N-2 emergency conditions refers to planning for operations with multiple failures events. For further characterization, see North American Electric Reliability Corporation, *Reliability Concepts*, Atlanta, Ga., Version 1.0.2, December 19, 2007, p. 20.

ENR 6
Improve Grid Assets' Resilience to Flooding

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Many of Puerto Rico's existing generation, transmission, and distribution assets are vulnerable to flooding. Specific asset improvements would need to be made to reduce vulnerability to both flooding and high wind speeds. In some cases, these improvements could be complementary; in others, trade-offs would need to be made based on the modeling and analyses currently being conducted on system design and asset improvements.

Description

This course of action would prioritize hardening the grid to flooding, including altering siting requirements in floodplains; altering asset types to reduce vulnerability; reducing exposure by moving, raising, or waterproofing assets; strengthening assets against hydrostatic and hydrodynamic pressures; decommissioning assets where flood risks are too costly to mitigate; and expediting repairs to reduce mold and rot damage. This course of action may also include the retirement or replacement of existing substation equipment with the latest technology (sulfur hexafluoride, etc.) or the elimination of old oil-filled circuit breakers to minimize the effects of oil spills and contamination.

Potential Benefits

This course of action would create a more reliable and resilient electricity supply and would reduce maintenance costs.

ENR 7
Improve Grid Assets' Resilience to High Windspeeds

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Many of Puerto Rico's existing generation, transmission, and distribution assets are vulnerable to wind damage. Specific asset improvements would need to be made to reduce vulnerability to high wind speeds and flooding. In some cases, these improvements could be complementary; in others, trade-offs would need to be made based on the modeling and analyses currently being conducted on system design and asset improvements.

Description

This course of action would prioritize hardening the grid to high wind speeds. This course of action would consist of (1) strategic undergrounding of high-risk lines for critical loads, (2) designing and installing poles and towers to withstand a minimum of 150-mph winds per U.S. standards, (3) scientific implementation of vegetation management programs with metrics and prioritization levels, (4) reducing transmission and distribution distances by moving generation closer to load centers, (5) structural analysis of the transmission system structures and distribution system poles, and (6) establishing dual-use programs to better manage third-party use of assets. Studies and analyses could include structural analysis of the performance of the transmission system structures and distribution system poles or classification of the structural failures, guyed wire system failures, insulation failures, hardware failures, overhead ground wire system failures and phase conductor failures; analytical correlation and statistical comparative analysis of structural failures with structure types and designs; analytical correlation of structural failures with wind speed exposure and topographical conditions; and statistical analysis of failure or outage modes of transmission and distribution system structural components. These and other analyses may lead to strategic changes, such as the undergrounding of already-identified transmission and distribution infrastructure.

Potential Benefits

This course of action would create a more reliable and resilient electricity supply and would reduce maintenance costs.

ENR 8
Maintain Disaster-Resilient Generation Assets

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Because of the extended impacts and unprecedented damage incurred by Hurricanes Irma and Maria, the power system would need to be designed and built to meet current and future projections for demand and growth, including right-sizing and relocating assets as required. However, most generation assets did survive the storm, and other assets were newly installed during the power restoration efforts. Many of these assets should be maintained to ensure resilience to future disasters.

Description

This course of action would maintain generation assets that were resilient to storm damage or that were newly installed during the power restoration efforts. This course of action would include assessing the current state of generation assets, establishing a generation asset maintenance budget, and conducting routine maintenance efforts.

Potential Benefits

This course of action would prepare the generation system for storm impacts, and it would provide a steady, reliable energy supply.

ENR 9
Design and Build Fuel Supply Chain to Provide Reliable Energy Source

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

In the initial emergency response to Hurricane Maria, many issues prevented the efficient transfer of fuel from port to end use. If these issues are left unaddressed, initial responses to future emergencies will similarly be challenged by limited coordination of the fuel supply and lack of sufficient planning for infrastructure, personnel, and stockpiled resources.

Description

This course of action would establish a fuel supply chain that is prepared for future disasters, including (1) stockpiling fuel (diesel and propane) in strategic locations near critical facilities to ensure continual power for a predetermined period, (2) establishing "blanket purchase order" contracts with a fuel provider in case of storm emergencies, and (3) coordinating among agencies to determine optimal resource planning (e.g., the number of delivery trucks and trained personnel).

Potential Benefits

Improvements to the fuel supply chain from port to end use would enable the rapid distribution of emergency fuel, particularly to geographically dispersed areas.

ENR 10
Improve the Availability of Ancillary Services for the Grid

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Puerto Rico's existing electrical grid design does not include sufficient readily available ancillary services. Electricity has been restored to most of Puerto Rico, but the repaired grid remains vulnerable to sudden outages.

Description

This course of action would improve the availability of ancillary services by (1) upgrading generation black start capacity based on detailed evaluation and analysis of black start assets, (2) repairing or replacing damaged or high-risk supervisory control and data acquisition (SCADA) systems, (3) selectively installing redundant battery systems for storage and backup generators for charging, and (4) expanding the use of renewable and distributed energy resources.

Potential Benefits

This course of action would create a more stable, resilient electricity supply and synergies with other endeavors, such as the installation of renewable and distributed energy resources. Stable, resilient electricity supply would potentially change the cost structure for the electricity utility.

ENR 11
Design and Deploy Technologies to Improve Real-Time Information and Grid Control

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Improvements in the electrical grid's supporting infrastructure (such as control centers, communications systems, and collection systems) would allow for implementing technologies to the modern grid that provide real-time information and grid control to keep the power system operating or speed its recovery. This may improve the monitoring and analytic capabilities of the supervisory control and data acquisition (SCADA) system to identify, provide warnings to system operators, and quantify system predisposition to instability problems in real time.

Description

This course of action would deploy technologies to improve real-time information and control. To this end, this course of action would install a distributed energy resource management system and advanced metering infrastructure, improve grid control and telecommunications systems to stay online during major disturbances and support rapid recovery, improve the monitoring and analytic capabilities of the energy management system and the SCADA system for real-time operations and security assessments, and develop control system strategies to maintain adequate operational security margins and system stability under major events and significant system perturbations. Note: This course of action would not include hardening this infrastructure, as in ENR 3 (Harden Supporting Infrastructure for the Electricity System, Including Communications), or the data system and inventory of assets in ENR 19 (Design and Deploy Data Systems to Inform Response Decisions and Improve Operations and Maintenance).

Potential Benefits

Improved real-time information and grid control would enhance reliability and resilience.

ENR 12
Coordinate Federal and State Emergency Response with Private Sector

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

The recovery and response activities after Hurricanes Irma and Maria revealed areas of needed improvement in federal, state, and private-sector coordination. The federal and state emergency response should be coordinated with the private sector to improve the response to outages, access to information, and the use of available resources.

Description

This course of action would coordinate the federal and state emergency response with the private sector. This would include incident response improvements, increased access to information, and efficient resource realignments. Additionally, energy sector partners could evaluate the response efforts and design new incident response plans that efficiently align resources, lines of authority, and areas of need for the energy sector.

Potential Benefits

This course of action could increase speed of response, and it could lead to more-efficient use of resources, increased support from local populations, and increased access to resources.

ENR 13
Pre-Position Materials and Prepare Workforce for Rapid Response

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sectors Impacted

Energy, Economic

Issue/Problem Being Solved

An energy response and preparedness plan needs to be created right away. Through the State Office of Public Energy Policy (Oficina Estatal de Política Pública Energética), the commonwealth is currently updating its energy assurance plan for this purpose. Pre-positioning efforts are expected to include assessing the optimal level of material and workers needed for each portion of the grid. For example, the updated Energy Assurance Plan for Puerto Rico is expected to include fuel coordination between local fuel distributors and commonwealth agencies to monitor the fuel-storage level.

Description

This course of action would strategically locate material (poles, lines, other essential hardware) and prepare the workforce to facilitate a rapid restoration of electricity service. This would include assessing the optimal level of material and workforce resources necessary for recovery for each portion of the grid and installing the materials and training the workforce (likely both personnel in Puerto Rico and mutual-aid partners).

Potential Benefits

This course of action would create an electricity supply that is more resilient and more easily recovered following natural disasters, as well as greater access and reliability.

ENR 14
Design and Build Grid Assets to Meet Current and Future Demand

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Although the current generating capacity of the Puerto Rico Electric Power Authority (PREPA) fleet exceeds peak demand, the need to rebuild following the damages incurred during Hurricanes Irma and Maria offers an opportunity to modify the size, location, and technology of generation, transmission, and distribution assets to align with current and future demand. Given Puerto Rico's evolving migration patterns, aligning with future demand would require tools that facilitate dynamic response to changes in demand.

Description

This course of action would design and build generation, transmission, and distribution assets to meet current and future projections for demand and growth, including right-sizing and relocating assets as required. Current efforts by PREPA include updating and strengthening system planning analytical tools, including transmission- and distribution-monitoring equipment, especially for dynamic system monitoring.

Potential Benefits

The use of updated technology could increase efficiency. This course of action also could improve the efficiency and effectiveness of response efforts, and it could improve access during all types of operations.

ENR 15
Enable Private Standby Generation to Provide Emergency Power

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

The electrical grid should have sufficient private standby generation capacity to meet demand for emergency power not only during events when the grid is operating normally (blue sky event) but also when it has suffered a long and geographically widespread outage (black sky event).

Description

This course of action would enable regulation of private standby generation. This course of action would create and enforce policies requiring certain private facilities, such as hospitals and communications towers, to maintain backup generation; establish enforceable inspection and maintenance measures for compliance with requirements; and remove barriers to consumer investment in distributed energy resources that could provide emergency energy services.

Potential Benefits

This course of action could create an electricity supply that is better able to provide energy during—and more easily recover from—emergency situations. It could also limit vulnerability to the cascading effects of grid failures and create synergies with other endeavors, such as microgrid installation.

ENR 16
Provide Backup Generation to Priority Loads

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Grid assets would need to be hardened to support critical infrastructure and public services. Backup generation should be provided to priority loads to ensure the sustained delivery of public services in the absence of the bulk power system.

Description

This course of action would maintain electricity delivery to priority loads—water, communications, manufacturing, health services, schools, airports, and seaports—to ensure the sustained delivery of public services in the absence of the bulk power system. This course of action would target energy solutions for high-needs and high-benefit cases, such as households with electricity-dependent medical needs, and it would prioritize backup generation for facilities that provide greatest public benefit. This could include working with the Puerto Rico Department of Health to collaborate on solar photovoltaic projects (20 kW) with batteries and emergency generators for public housings. Note: The priority loads listed here have a different focus from the critical infrastructure targeted in ENR 5 (Harden Grid Assets to Support Critical Infrastructure) and the critical facilities in ENR 17 (Provide Energy and Water to Critical Facilities That Serve as Congregate Shelters).

Potential Benefits

This course of action could improve efficiency and effectiveness of response efforts, as well as access to life-sustaining resources after a disaster.

ENR 17
Provide Energy and Water to Critical Facilities That Serve as Congregate Shelters

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Compounded damage caused by Hurricanes Irma and Maria resulted in 100% of Puerto Rico experiencing power loss—including critical facilities and vulnerable populations. During natural disasters and their resulting response phases, power must be restored rapidly to critical facilities that serve as congregate shelters and resilient community service hubs, such as public school buildings.

Description

This course of action would ensure that critical facilities that serve as congregate shelters and resilient community services hubs, like public school buildings, have the appropriate energy and water infrastructure. This would include designating facilities as congregate shelters and installing technologies that ensure that these facilities provide continuity of public services. Note: The critical facilities listed here have a different focus from the critical infrastructure targeted in ENR 5 (Harden Grid Assets to Support Critical Infrastructure) and the priority loads in ENR 16 (Provide Backup Generation to Priority Loads).

Potential Benefits

A reliable energy source in the immediate aftermath of a catastrophe would improve both the efficiency and the effectiveness of emergency response efforts.

ENR 18
Right-Size and Train the Future Energy Workforce

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sectors Impacted

Energy, Economic

Issue/Problem Being Solved

Achieving the vision for Puerto Rico's Energy sector calls for a workforce with the ability to install, operate, and maintain an energy system for the future (including asset management, system planning, and data management) and also the ability to quickly respond to and repair damages to the electric system. Federal and commonwealth agencies have begun to conduct exercises in Puerto Rico in support of this goal. The workforce would need to be right-sized, new workers would need to be trained, and existing personnel would need to be retrained.

Description

This course of action would train a workforce capable of installing, operating, and maintaining Puerto Rico's future energy system—especially in asset management, system planning, and data management—and also capable of quickly responding to and repairing damages to the electricity system. This would include developing and implementing plans to provide workforce training and capacity building, right-sizing the workforce, adequately supporting the integrated resource plan process, and establishing centers of excellence to attract skilled research and engineering talent.

Potential Benefits

A skilled workforce could drive energy system transformation and speed recovery from power loss events; a steady, reliable energy supply could, in turn, spur economic growth.

ENR 19
Design and Deploy Data Systems to Inform Response Decisions and Improve Operations and Maintenance

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Robust data systems are important for identifying threats, outages, and anomalies, and also for informing response decisions and improving ongoing operations and maintenance. Deploying these systems includes creating a robust data inventory of assets—which could potentially be coordinated and integrated across other critical infrastructure systems—and acquiring information technology systems to support inventory and asset management.

Description

This course of action would establish data systems to inform decisions during response efforts and to improve ongoing operations and maintenance. It would create a robust data inventory of assets, which could potentially be coordinated and integrated across other critical infrastructure systems, and it would acquire information technology systems to support inventory and asset management. Note: This course of action does not include hardening this infrastructure (ENR 3, Harden Supporting Infrastructure for the Electricity System, Including Communications) or making decisions in real time (ENR 11, Design and Deploy Technologies to Improve Real-Time Information and Grid Control).

Potential Benefits

This course of action could lead to improved asset management, enhanced operations and maintenance practices, and expedited system restoration.

ENR 20
Design and Build Capital Assets to Reduce Restoration Time and Cost

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

To reduce the time and cost of energy restoration after an emergency, new investments could be made in maintenance and operations, standardization of components, relocation of transmission and distribution assets to improve access, stockpiling of rapidly deployable grid restoration assets, installation of additional assets to reduce failures, and redesign of some existing generation and substation units. These investments would be best informed by whole-system modeling efforts.

Description

This course of action would invest in capital assets that reduce restoration time and cost. This includes investments to enhance maintenance and operations, standardization of components, relocation of transmission and distribution assets to improve access, stockpiling of rapidly deployable grid restoration assets, installation of additional assets to reduce failures, and the redesign of some existing generation and substation units.

Potential Benefits

This course of action would create an electricity system that could be restored more quickly after a major power loss and that would be more resistant to damage in the first place.

ENR 21
Establish Energy Response and Preparedness Plan

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

An energy response and preparedness plan needs to be created right away. Through the State Office of Public Energy Policy (Oficina Estatal de Política Pública Energética), the commonwealth is currently updating its energy assurance plan for this purpose. This effort is expected to create an initial plan that is reevaluated and updated on a regular schedule, and it could include implementing preparedness best practices, such as updating mutual aid agreements; pre-positioning equipment, materials, and personnel; and streamlining the incident command system.

Description

This course of action would create and maintain an energy-specific emergency response and preparedness plan. This would include the reevaluation and updating of plans on a regular schedule, the establishment and updating of mutual aid agreements, and the streamlining of an incident command system.

Potential Benefits

An energy response and preparedness plan would mean that the electricity supply could be restored more quickly in the event of future major power-loss events.

ENR 22
Enable and Promote Distributed Generation

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Puerto Rico's electricity-generation assets are clustered in the southeast of the main island, while demand is greatest in the central north. As a result, the existing transmission and distribution system crosses a wide variety of terrain and makes the grid vulnerable to long-term outages following storms. The power system would need to be designed and built to meet current and future projections for demand and growth, including right-sizing and relocating assets as required.

Description

This course of action would enable the proliferation of distributed generation, particularly at critical loads. This right-sizing may include implementing cost-effective energy efficiency and locating generation closer to demand or critical loads. Distributing generation assets in different ways would help align generation facilities with the highest demands, thereby decreasing the transmission distances and strengthening the system. Solutions could include integrating distributed energy resources and maintaining service continuity to critical customers and loads. These efforts may be complemented by studies to analyze and compare storage technologies, such as Argonne National Lab's research efforts on identifying critical loads.

Potential Benefits

This course of action could offer diversification and resiliency benefits. It could help prevent cascading failures, provide emergency power to critical needs, provide reliable power options to consumers, and advance clean energy and energy cost goals.

ENR 23
Design Best Strategies for Renewable Energy Resources

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Energy generation on islands is often challenging and costly because of such factors as high-cost imported fuels and the inability to leverage the resilience and efficiency benefits of being connected to a larger grid. Puerto Rico's Energy sector goals are to diversify energy sources to be less dependent on costly imports and to establish energy policies and public-private partnerships that leverage resources and energize economic growth.

Description

To determine the best path forward, the course of action would require assessing the potential for all types of renewable energy (wind, solar, biomass, hydro, tidal, etc.); evaluating the possibility of revitalizing hydropower facilities across Puerto Rico, especially facilities with black start or islanding capabilities; and prioritizing the development of ideal renewable energy sites. Ongoing analysis would inform the trade-offs between these and other choices for the grid.

Potential Benefits

This course of action could improve resilience and enable faster recovery of the energy grid, and it could increase access to and reliability of energy.

ENR 24
Design Best Strategies for Affordable and Stable Energy Prices

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sectors Impacted

Energy, Economic

Issue/Problem Being Solved

To support economic growth, energy needs to become more affordable and prices more predictable. Toward this end, goals for the quantity and type of energy sources to be generated need to be established, the costs and benefits of alternative generation resources and grid architectures evaluated, and incentives for private investment assessed.

Description

This course of action would prioritize strategies to reduce prices and volatility faced by consumers. This course of action would establish goals for the quantity and type of energy sources, including generation and energy efficiency; evaluate the costs and benefits of alternative generation resources; and evaluate options and establish policies that incentivize private investment.

Potential Benefits

This course of action would establish a system that provides affordable, reliable, and high-quality electric power to small businesses, commercial and industrial users, and the broader economy of Puerto Rico.

ENR 25
Build Capacity for Municipality Decisionmaking of Energy Systems

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Increasing the capacity of municipalities to make decisions concerning energy systems, and helping them manage the decisionmaking and the implementation processes, can help advance efforts to meet Puerto Rico's broader resilience and renewable energy goals and create consumer participation.

Description

This course of action would build capacity for municipalities to make decisions concerning energy systems. This would include planning, financing, and developing energy systems (e.g., energy efficiency, renewable energy resources, and distributed energy resources) for municipal buildings. This course of action would use education initiatives to strengthen public decisionmaking and engagement.

Potential Benefits

This course of action could improve capacity across Puerto Rico to decide and implement local energy decisions.

ENR 26
Establish Energy Sector Governance Responsibilities for State-Level Agencies

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

Because of the ongoing restructuring of the Puerto Rico Electric Power Authority, and because of potential regulatory changes, the roles and responsibilities of Puerto Rico's government agencies in the Energy sector need to be clarified.

Description

This course of action would require the commonwealth to clarify the goals, and the roles and responsibilities, of Puerto Rico's government agencies in the Energy sector. It would also require clear and strong authority for regulatory organizations, whether this be a single public utilities commission or several regulatory agencies. Increased transparency, accountability, and coordination of authority among regulators, energy system operators, legislators, and executive officers would also be needed.

Potential Benefits

This course of action would ensure more-efficient use of resources and improved government services. It would also increase transparency and accountability among regulators, energy system operators, legislators, and executive officers.

ENR 27
Establish Regulations to Transform the Energy Sector

Note: The costs of the Energy sector courses of action were estimated as a set, not on the basis of individual courses of action. All courses of action are included in a range of potential scenarios, in differing levels, under the assumptions described in the introduction to this section. The funding mechanisms and potential implementers, as well as potential spillover effects, potential pitfalls, and precursors, are also described in the introduction in the context of issues across courses of action.

Sector Impacted

Energy

Issue/Problem Being Solved

The overarching goal of the Energy sector should be to provide a modern energy system that is affordable, reliable, renewable, scalable, and redundant, with the appropriate regulatory policies in place, and that responds to the needs of customers. A suite of Energy sector regulations would be required to align the needs, resources, monitoring, incentives, and feedback to deliver on this vision, contribute to economic growth, and facilitate the efficient achievement of the energy-related strategic objectives in this plan.

Description

This course of action would establish regulatory policies to align needs, resources, monitoring, incentives, and feedback; contribute to economic growth; and facilitate the efficient achievement of the energy-related strategic objectives in this plan. The Puerto Rico Department of Justice's establishment of the microgrid rule, for example, supports this course of action, and other technical requirements in support of other courses of action could be implemented (such as establishing guidelines or requirements to reduce vulnerability to flooding or high wind speeds). Policies should be established in the context of sound analysis. For example, many of the U.S. Department of Energy National Laboratories are looking at the impacts of regulations on the system, including the microgrid rule (e.g., Sandia is looking at the impact of the microgrid rule on the industrial projects by the Puerto Rico Industrial Development Company).

Potential Benefits

This course of action could help modernize the energy system to ensure that it is affordable, renewable, scalable, and redundant.

Health and Social Services Sector

COA Number	Title
HSS 1	Increase Use of Solar-Powered Generators and Solar Backup Power Sources
HSS 2	Prevent Disease Through a Capacity-Building Healthy Housing Initiative: Targeting Mold, Lead, and Other Stressors
HSS 3	Implement Integrated Waste Management Program and Expand Programs to Increase Recycling Rates
HSS 4	Improve Surveillance of Waterborne Disease
HSS 5	Develop and Implement an Integrated Electronic Reporting System for Vital Records
HSS 6	Reduce Opportunities for Vector-Borne Diseases
HSS 7	Reduce Gap in Medicaid/Medicare Reimbursement Rate
HSS 8	Increase Public Health Laboratory Capacity
HSS 9	Increase Access to Telehealth Options as Telecommunication Supports Become More Robust
HSS 10	Expand Care for Trauma and Chronic Stress
HSS 11	Add Incentives and Other Supports to Increase and Retain Supply of Health Care Providers and Public Health Practitioners
HSS 12	Augment Community Health Centers and Elements for Primary Care and Chronic Disease Prevention and Management
HSS 13	Expand Practice Laws for Health Care Providers
HSS 14	Develop a More Robust and Resilient Data System of Health Costs and Links to Health Outcomes
HSS 15	Advance Uptake of Evidence-Based Practices/Quality of Care for Mental Health
HSS 16	Address Food Insecurity by Ensuring Flexible Nutrition Assistance Programs
HSS 17	Ensure That There Are Nutrition Supports for Populations Disproportionally Affected by the Disaster
HSS 18	Improve Programs to Prevent and Address Abuse of Children and Seniors After a Disaster
HSS 19	Create Flex-Funding for Social Service Centers
HSS 20	Improve Supports for Seniors, Particularly Those Living Alone
HSS 21	Improve Public Awareness of Proper Storage of Insulin Post-Disaster
HSS 22	Move to a More Regionally-Integrated Approach to Emergency Planning, Exercising, Response, and Recovery
HSS 23	Review and Improve Systems and Processes for Managing Volunteers and Donated Supplies
HSS 24	Increase the Child Welfare Investigative Workforce
HSS 25	Establish a Collaborative Agreement Between PRDF and WIC for Infant Formula Storage and Distribution
HSS 26	Review and Improve Systems for Stockpiling and Distributing Supplies and Pharmaceuticals Post-Disaster
HSS 27	Improve Current Epidemiological Surveillance to Better Respond to Natural and Man-Made Disasters
HSS 28	Support the Development of a Suicide Prevention Campaign
HSS 29	Revise Regulations on Food Stockpiling at Child- and Elder-Care Facilities
HSS 30	Review and Improve Plans, Systems, and Processes for Tracking and Responding to Physical and Mental Health Needs of First Responders
HSS 31	Review and Improve Systems for Administration and Finance of Response-Related Activities

HSS 1
Increase Use of Solar-Powered Generators and Solar Backup Power Sources

Sectors Impacted

Health and Social Services, Natural and Cultural Resources, Energy

Issue/Problem Being Solved

Fossil fuel generators create air and noise pollution, require fuel that may be difficult to acquire following a disaster, can result in injury, and often last only one season or a single disaster event.

Description

This course of action would create a program to promote solar-powered generators for residential properties to reduce air and noise pollution. Commonwealth-wide implementation would be done via subsidies for equipment purchases, as well as public-education campaigns. To supplement portable solar generators, this course of action also recommends that a portion of households have a backup system involving both a permanently installed solar panel array and a backup battery system.

Potential Benefits

Solar-powered generators would reduce noise and air pollution and subsequently reduce the risk for respiratory and hearing-related illnesses. Widespread use of energy-efficient generators and battery backup systems could reduce the number of residents who need to be evacuated because of lack of power, reduce morbidity among residents with technological dependence related to health issues, and reduce mortality and risk associated with fossil-fuel generators. Moreover, most solar panels are tested by manufacturers to ensure that they can survive high winds (e.g., 140 mph) and hail of up to 25 mm (1 inch) falling at 23 meters per second (approximately 50 mph) without being dislodged, shattered, or damaged by heavy rain.

Potential Spillover Impacts to Other Sectors

This course of action would affect the Energy and Natural and Cultural Resources sectors by decreasing reliance on municipal power sources and burning of fossil fuels.

Potential Costs

Potential up-front costs: $4.2 billion–$6.2 billion in estimated up-front costs
Potential recurring costs: $1.4 million in estimated recurring costs (11 years)
Potential total costs: $4.2 billion–$6.2 billion in total estimated costs

The estimate for operating costs is $125,000 per year. These estimates for up-front costs are based on the following assumptions: portable solar generators ($85–$2,100 per unit) or installed solar panels with backup batteries ($19,000 per household), with 50% of households (618,590) likely opting for portable solar generators and 15% of households (185,577) likely opting for installed panels; public-education campaign ($125,000 per year); and labor for subsidy program management ($155,750).

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, Environmental Quality Board, private sector

Potential Implementers

Environmental Quality Board, U.S. Environmental Protection Agency's Caribbean Division

Potential Pitfalls

Gas-powered generators would need to be phased out and disposed of, and it is unclear whether appropriate disposal sites exist in Puerto Rico. Individual households might not want permanent solar panels installed on their rooftops for the backup battery option. Although solar generators can continuously store energy before a storm hits, cloudy days can reduce the efficiency of solar panels. Also, while solar panels are tested to withstand heavy rainfall, hail, and wind speeds, the longevity of the panels depends on the quality of the rooftop on which they are installed.

Likely Precursors

None envisioned at this time.

HSS 2
Prevent Disease Through a Capacity-Building Healthy Housing Initiative: Targeting Mold, Lead, and Other Stressors

Sectors Impacted

Health and Social Services, Public Buildings, Education

Issue/Problem Being Solved

The prevalence of asthma in Puerto Rico is very high, and exposure to asthma triggers—including mold and mildew—can exacerbate asthma and other respiratory-related symptoms. Although complete data are not available at this time, there have been several reports of steep increases in the number and severity of asthma cases since Hurricanes Irma and Maria.[101]

Description

To prevent respiratory-related and other health exacerbations, this course of action would build capacity for the identification and management of mold and other environmental stressors through an integrated healthy homes/housing and buildings initiative. This course of action would focus on training (including certification) of different targeted actors for implementation, capacity-building mechanisms within agencies for enforcement across Puerto Rico, and promotion of National Heart, Lung, and Blood Institute Expert Panel Report 3 guidelines for asthma management.[102]

Potential Benefits

Measures to decrease exposure to environmental triggers could decrease the public health burden of asthma and other respiratory-related diseases and could thus lead to decreased health care costs.

Potential Spillover Impacts to Other Sectors

Public Buildings and Education would be affected by coordinated implementation measures.

Potential Costs

Potential up-front costs: $1.2 million–$5.3 million in estimated up-front costs
Potential recurring costs: $14 million–$18 million in estimated recurring costs (11 years)
Potential total costs: $16 million–$23 million in total estimated costs

[101] Danica Coto, "Puerto Rico Struggles with Jump in Asthma Cases Post-Maria," Associated Press, June 18, 2018.

[102] National Heart, Lung, and Blood Institute, *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma*, Bethesda, Md., August 2007.

Estimates for annual costs range from $1.3 million to $1.6 million per year. These estimates are based on the following assumptions: for labor, 14–19 full-time equivalents (FTEs) at $62,300 per FTE up-front for implementing guidelines and programs and 21–26 FTE professionals who have skills in environmental monitoring and mitigation strategies for ongoing management, education, and enforcement, and for mold remediation, $3.40–$4.10 per square foot = $340,000–$4.1 million.

Potential Funding Mechanisms

U.S. Department of Health and Human Services Health Resources and Services Administration

Potential Implementers

U.S. Environmental Protection Agency, Centers for Disease Control and Prevention, other federal agencies, Puerto Rico Department of Housing, Puerto Rico Department of Health, other government of Puerto Rico agencies

Potential Pitfalls

There is a lack of sustained coordination and accountability between key government agencies, health care organizations, universities, and nonprofits. The increased likelihood of extreme precipitation events because of climate change is expected to increase the presence of fungal spores and may exacerbate associated public health problems.

Likely Precursors

This course of action does not include the costs of remediation for individual private homes, which would need to be financed through separate efforts.

HSS 3
Implement Integrated Waste Management Program and Expand Programs to Increase Recycling Rates

Sectors Impacted

Health and Social Services, Natural and Cultural Resources, Municipalities, Energy

Issue/Problem Being Solved

The majority of landfills in Puerto Rico are at or beyond capacity, and the accumulation of hazardous and solid waste can create environmental health problems via vectors, contaminant exposure, and leeching.

Description

This course of action would create an integrated material recovery and solid waste management program and would increase recycling practices, and thus increase the proportion of waste that is diverted from landfills. This course of action would produce a comprehensive cost analysis and create enforceable recycling and composting mandates and include public education.

Potential Benefits

A Puerto Rico–wide waste management program would decrease negative health impacts.

Potential Spillover Impacts to Other Sectors

Improved waste management practices would decrease ecological hazards. A reduction in waste produced could result in a cost savings that could be applied to other municipal priorities.

Potential Costs

Potential up-front costs: $220,000 in estimated up-front costs
Potential recurring costs: $6.2 million in estimated recurring costs (11 years)
Potential total costs: $6.4 million in total estimated costs

The up-front cost is estimated as 2 staff members for development and implementation of public-education campaign. The annual cost estimate is based on the following assumptions: 1–2 full-time equivalents (FTEs) to conduct cost analysis ($124,600) in the first year only, 1 FTE (annually) to manage consumer electronic takeback program ($62,300 per year), and 8 FTEs (annually) for regulatory implementation and enforcement ($499,000 per year).

Potential Funding Mechanisms

U.S. Environmental Protection Agency, nongovernment sources

Potential Implementers

U.S. Environmental Protection Agency, Puerto Rico Department of Natural and Environmental Resources (Environmental Quality Board), Puerto Rico Recycling Partnership, universities

Potential Pitfalls

Waste management fees assessed at the household level could lead to improper waste disposal if households cannot pay them.

Likely Precursors

Implementation of expanded recycling would depend on what existing equipment is functioning and available or on additional capital investments.

HSS 4
Improve Surveillance of Waterborne Disease

Sectors Impacted

Health and Social Services, Water

Issue/Problem Being Solved

In 2015, 99.5% of the population of Puerto Rico was served by community water systems in violation of the Safe Drinking Water Act.[103] Power outages due to hurricanes can lead to disruptions in water treatment, drinking water contamination, and disruptions in water service, all of which can have large impacts on public health. An outbreak of leptospirosis was reported to have occurred in Puerto Rico in October 2017. Reports of gastrointestinal illness, conjunctivitis, and respiratory problems suggest public health outbreaks from poor water quality occurred as a result of Hurricanes Irma and Maria.

Description

This course of action would strengthen the robustness of the surveillance system for waterborne disease by ensuring equipment is operational by conducting quality assurance and quality control, developing communication tools, and establishing interagency partnerships.

Potential Benefits

A surveillance system that provides rapid detection, identification of the cause, and response to illness reports can reduce the transmission of infectious pathogens and harmful chemicals and toxins in the water system. The potential adoption of a syndromic surveillance system has many ancillary benefits, including that it can be used to track multiple other disease outbreaks (e.g., influenza, vector-borne disease).

Potential Spillover Impacts to Other Sectors

This course of action would increase interagency collaboration with the Water sector and would decrease the burden on the health care system.

Potential Costs

Potential up-front costs: $90,000 in estimated up-front costs
Potential recurring costs: $2.8 million in estimated recurring costs (11 years)
Potential total costs: $2.9 million in total estimated costs

[103] Natural Resources Defense Council, *Threats on Tap: Drinking Water Violations in Puerto Rico*, New York, May 10, 2017.

The estimated annual cost is $250,000. The cost estimates are based on the following assumptions: 4 full-time new staff from the Puerto Rico Department of Health, 2 full-time staff from the Puerto Rico Aqueduct and Sewer Authority (PRASA) (ongoing), and 1–2 full-time staff to perform quality assurance and quality control of equipment and investigate syndromic surveillance.

Potential Funding Mechanisms

U.S. Environmental Protection Agency Water Finance Clearinghouse

Potential Implementers

Puerto Rico Department of Health, Puerto Rico Aqueduct and Sewer Authority, Centers for Disease Control and Prevention

Potential Pitfalls

Laboratory operations are dependent on sustained power supply.

Likely Precursors

Fully functioning public-health laboratories would depend on building and equipment repairs (Public Buildings) and a reliable source of electricity (Energy). It is also important to be clear about jurisdiction of various agencies, including the Puerto Rico Department of Health.

HSS 5
Develop and Implement an Integrated Electronic Reporting System for Vital Records

Sectors Impacted

Health and Social Services

Issue/Problem Being Solved

The Puerto Rico Demographic Registry (PRDR) currently uses a paper-based reporting system, which does not allow real-time sharing of vital event information after a disaster or the surveillance of disaster-related deaths. Lack of access to timely and accurate data delays response after any emergency, and the lack of transparency in sharing death-related data is detrimental to planning for future natural disasters.

Description

This course of action would develop and implement an electronic reporting system for vital events at the PRDR. An assessment of current infrastructure and reporting process would inform the development and implementation. Training would be provided to staff across relevant agencies and facilities, including training on proper reporting of disaster-related deaths to assist with future surveillance efforts. The PRDR Quality Office would establish and conduct a quality assurance program to strengthen methods and procedures and monitor the system for appropriate use across Puerto Rico.

Potential Benefits

Timely data entry and increased accuracy and completeness of vital records would result in more-accurate reports, which would support public health surveillance systems. This system would increase efficiency in the death-reporting process after a disaster and would allow the ability to monitor mortality data.

Potential Costs

Potential up-front costs: $1.5 million in estimated up-front costs
Potential recurring costs: $13 million in estimated recurring costs (11 years)
Potential total costs: $14 million in total estimated costs

The up-front costs are for equipment, infrastructure assessment, training and media campaign, and pilot testing. The estimated annual cost is $1.16 million.

Potential Funding Mechanisms

Centers for Disease Control and Prevention's National Center for Health Statistics, National Association for Public Health Statistics and Information System, Pan American Health Organization, private donors

Potential Implementers

Puerto Rico Department of Health, Office of Informatics and Technological Affairs, Planning and Development Office

Potential Pitfalls

Unavailability of power supply, lack of internet access in funeral homes; providers not willing to use the electronic system, untrained personnel, and infrastructure deficiencies at PRDR central and local offices

Likely Precursors

Reliable telecommunications infrastructure and commonwealth-wide broadband access

HSS 6
Reduce Opportunities for Vector-Borne Diseases

Sectors Impacted

Health and Social Services

Issue/Problem Being Solved

Vector-borne diseases, including zika, chikungunya, and dengue, are a public health burden in Puerto Rico.

Description

This course of action would support ongoing monitoring and engagement for mosquito control. It would establish additional innovative practices for mosquito control—for example, a pilot program using drones to detect breeding grounds and apply larvicide at abandoned properties. This could be conducted in 1 municipality (although evaluation should be done to determine whether aerial larvicide is effective before broader implementation) to determine whether it could be implemented on a commonwealth-wide scale.

Potential Benefits

Efforts to bolster ongoing vector management programs could reduce the transmission of disease in Puerto Rico. Drone technology has the potential to dramatically improve mosquito control in areas that have been difficult to reach. Proof-of-concept studies have demonstrated that low-cost drones can be used effectively to map mosquito aquatic habitats for larval source management.

Potential Spillover Impacts to Other Sectors

This proposal could affect the Natural and Cultural Resources sector because eradication could occur on public lands.

Potential Costs

Potential up-front costs: $370,000–$3.4 million in estimated up-front costs
Potential recurring costs: $170,000–$350,000 in estimated recurring costs
Potential total costs: $530,000–$3.8 million in total estimated costs

Estimates for ongoing costs range from $15,000 to $32,000 annually.

These estimates are based on the following assumptions: legal consultation (likely higher than the $62,000 full-time-equivalent [FTE] assumption); 2 FTEs to expand monitoring and engagement program ($124,600); 1 Puerto Rico Vector Control Unit FTE to oversee the pilot ($62,300), start-up, and implementation; and drones ($1,000–$8,000 per drone).

Potential Funding Mechanisms

U.S. Department of Health and Human Services

Potential Implementers

Puerto Rico Vector Control Unit, Puerto Rico Department of Health, municipal governments

Potential Pitfalls

Larvicide application must be highly targeted and avoid contaminating areas that are potential drinking-water sources. In addition, privacy concerns must be considered to avoid ancillary uses and "overreach" of drone technology.

Likely Precursors

None envisioned at this time

HSS 7
Reduce Gap in Medicaid/Medicare Reimbursement Rate

Sectors Impacted

Health and Social Services

Issue/Problem Being Solved

Although there have been temporary solutions to improve access to health care, temporary fixes to offset the Medicaid shortfall—and thus the future robustness of the system—with an influx of funds remain in question.

Description

This course of action would analyze the extent to which reimbursement rates could be raised within the existing authorities and the capabilities of the law to help address the financial viability of the health care system. This analysis would research methods currently used in the continental United States for improving patient outcomes, reducing Medicaid costs, and increasing payments to providers. This analysis would specifically examine opportunities in the context of disaster recovery needs over the long term and future system robustness. Financial loss and provider retention issues are affected by reimbursement rates that are unable to keep up with cost of living and related economic conditions. This course of action would review the impact of varying reimbursement rates on service provision, access to care, and provider retention.

Potential Benefits

Analysis of the impacts of reimbursement rates on access to care and provider retention would help determine the extent of health care system fragility. Robust analysis would help capture where positive health care outcomes could be achieved by changes in payment structure.

Potential Spillover Impacts to Other Sectors

Health care access is key to resident livelihood and good health. Reimbursement rate change could have an impact on provider retention.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

Reducing the gap in reimbursement rates represents a policy change and thus has no cost. If the rate analysis requires additional study, the cost would range from $250,000 to $500,000 (over 1 year, up-front).

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources, U.S. Department of Health and Human Services

Potential Implementers

Independent research organizations, U.S. Congress

Potential Pitfalls

The most critical element of this course of action is a willingness to review current rate schedules, but they should be reviewed in the broader context of payment reform and demographic conditions in Puerto Rico today.

Likely Precursors

Reviewing rate history and impact on access to care, provider retention, and other health outcomes

HSS 8
Increase Public Health Laboratory Capacity

Sectors Impacted

Health and Social Services, Water, Energy, Communications and Information Technology, Public Buildings

Issue/Problem Being Solved

Already-fragile Puerto Rico Department of Health laboratory infrastructure was severely damaged by Hurricanes Irma and Maria, thereby endangering the public's health and diminishing diagnostic and surveillance response capacity.

Description

This course of action would help boost Puerto Rico Department of Health laboratory infrastructure with the latest diagnostic technologies and electronic data reporting capacity. It would also build and maintain a competent workforce for rapid response to emerging and public health threats, as well as for monitoring disease conditions affecting the health of all people in Puerto Rico. This course of action also would provide a laboratory network infrastructure (a laboratory and patient information management system) whereby data could be communicated and shared between health care facilities to access data in a timely manner for rapid response.

Potential Benefits

The implementation of early-detection methodologies would facilitate timely implementation of needed control measures to minimize disease transmission and additional health-related costs.

Potential Spillover Impacts to Other Sectors

This course of action would require the full and immediate support of the Public Buildings Authority for the evaluation of facilities.

Potential Costs

Potential up-front costs: $9 million in estimated up-front costs
Potential recurring costs: $62 million in estimated recurring costs (11 years)
Potential total costs: $71 million in total estimated costs

Up-front costs are estimated for laboratory building repairs. Recurring costs are estimated as annual costs for 37 full-time equivalents at a rate of $150,000 per full-time equivalent.

Potential Funding Mechanisms

Government of Puerto Rico, Centers for Disease Control and Prevention, Association of Public Health Laboratories, U.S. Department of Labor, nongovernmental organizations

Potential Implementers

Puerto Rico Department of Health, U.S. Department of Health and Human Services (Centers for Disease Control and Prevention, Health Resources and Services Administration, Association of Public Health Laboratories)

Potential Pitfalls

Laboratory operations depend on sustained power and water supply.

Likely Precursors

Fully functioning public health laboratories would depend on building and equipment repairs (Public Buildings) and a reliable source of electricity (Energy).

HSS 9
Increase Access to Telehealth Options as Telecommunication Supports Become More Robust

Sectors Impacted

Health and Social Services, Communications and Information Technology, Community Planning and Capacity Building

Issue/Problem Being Solved

Health professional shortages, including in the mental health and specialist workforces, limit access to care in Puerto Rico.

Description

This course of action would expand the use of telehealth across Puerto Rico and would train the health care workforce in the use of telehealth technologies. This would include using social media to screen and enroll more geographically isolated populations in mental health care services and using phone and online applications to target those with trauma-related mental illness.

Potential Benefits

This course of action would provide greater access to specialty care for nonurban populations. It could also foster quicker networking and best-practice sharing among health care professionals in an emergency (depending on the nature of the emergency and the state of the power and telecommunications systems).

Potential Spillover Impacts to Other Sectors

The hub-and-spoke model (hubs in urban centers linked to spokes in rural areas) could create jobs for nonphysician practitioners (nurse practitioners, physician assistants, etc.) in nonurban areas to serve as the spokes. The telecommunications sector broadband service efforts could be leveraged for health services.

Potential Costs

Potential up-front costs: $1.8 million in estimated up-front costs
Potential recurring costs: $19 million in estimated recurring costs (11 years)
Potential total costs: $21 million in total estimated costs

The estimate for implementation is $1.75 million annually, or $250,000 per year, per program for each of the 7 health districts in Puerto Rico.

Potential Funding Mechanisms

U.S. Department of Health and Human Services

Potential Implementers

Health care providers, mental health care providers, private industry

Potential Pitfalls

Lack of sustained funding would be a challenge, and potential legal barriers would need to be reviewed and addressed.

Likely Precursors

Significant improvements in infrastructure, particularly stable and reliable telecommunications

HSS 10
Expand Care for Trauma and Chronic Stress

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Puerto Rico needs to expand appropriate care for trauma and chronic stress, including services provided by nontraditional mental health providers.

Description

This course of action would expand the networks available to provide relief for trauma, stress, and anxiety-related behavioral health issues. Building on the mental health (clinical) care network, this course of action would empower faith-based organizations, schools, and nongovernmental organizations to better understand and support their constituents in managing postdisaster stressors in a culturally compatible way. These nontraditional providers would work with professionals for both training and guidance and would be located in nontraditional medical settings.

Potential Benefits

Improving trauma-based services would improve quality-of-care outcomes for traumatic stress, and expanding services would address the shortage of mental health providers and distribution issues, as well as build on trust-based relationships. Engaging nontraditional providers may also address issues around mental health stigma.

Potential Spillover Impacts to Other Sectors

Trauma affects the ability to work and can have lasting psychological and cognitive consequences, so improving and expanding trauma services would have benefits for social, economic, and other health recovery.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $3 million in estimated recurring costs (5 years)
Potential total costs: $3 million in total estimated costs

The cost estimate is $600,000 per year, over 5 years, to implement an intervention such as Psychological First Aid in Puerto Rico with one-quarter of the teachers, clergy, and first responders.

Potential Funding Mechanisms

U.S. Department of Health and Human Services Substance Abuse and Mental Health Services Administration grants, nongovernment sources

Potential Implementers

Mental health providers, faith-based schools, nongovernmental organizations

Potential Pitfalls

Blending professional cultures can be challenging. Full implementation across provider types would be a lengthy process. To be effective, training materials would need to be culturally and linguistically appropriate.

Likely Precursors

Feasibility research may be required to identify the type of community members and organizations best suited to implement, as well as willing providers and appropriate interventions.

HSS 11

Add Incentives and Other Supports to Increase and Retain Supply of Health Care Providers and Public Health Practitioners

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Continued provider outmigration and areas with health provider shortages limit access to care.

Description

This course of action would ensure that Puerto Rico has a robust and stable health care provider and public health practitioner workforce, not only to attend to disaster-related health issues but also over the long term. Given prior efforts to use incentive and other programs, continuous analysis of what works structurally and culturally would need to be considered.

Potential Benefits

Reducing the number of providers who leave Puerto Rico could lead to better distribution of providers, and ultimately improvements in access to health care services, including mental health. Having a sufficient and capable public health workforce would improve the health of the population, and consequently reduce overall costs related to health.

Potential Spillover Impacts to Other Sectors

Improving health care access and health promotion is key to social and economic stability in Puerto Rico.

Potential Costs

Potential up-front costs: $39 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $39 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Health and Human Services Health Resources and Services Administration, government of Puerto Rico, nongovernment sources

Potential Implementers

Universities in Puerto Rico, associated hospitals and health care facilities

Potential Pitfalls

It would be important to calibrate expectations about incentives to stay in Puerto Rico, put time minimums or dollar limits on forgiveness eligibility, and work on other aspects of quality of provider life to ensure that providers and practitioners stay in Puerto Rico for the long term.

Likely Precursors

Determine provider-shortage trends by specialty and geographic area and the public health practitioner capacity needed to implement the public-health agenda.

HSS 12
Augment Community Health Centers and Elements for Primary Care and Chronic Disease Prevention and Management

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Ensure that timely, accessible care can be provided during disaster response and over the long term, particularly with respect to chronic disease prevention and management.

Description

This course of action would strengthen Puerto Rico's network of community health centers, such as centers for diagnostics and treatment and Centros 330, and would augment supporting elements, such as all-terrain vehicles and community health care mobile care clinics, particularly in places with sustained damage or in isolated areas. This course of action would also explore how these centers could be supported to better advance chronic disease prevention and management.

Potential Benefits

This course of action would provide relatively efficient alternatives to standing up new hospitals or larger health care facilities. For example, community health centers could repurpose trailers as mobile care clinics. Also, this course of action would improve access to services, particularly in places where there are currently health provider shortages or significant hurricane-related damage. In addition, this course of action would improve patient outcomes and patient care with more-efficient and more-proactive management of chronic diseases, as well as reduce the strain on an already-strained health care system by preventing further complications of chronic disease.

Potential Spillover Impacts to Other Sectors

Improved access to care would help ensure that Puerto Ricans are healthier, have the services they need for primary care and chronic care management, and thus can work and take care of their families.

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: $250 million in estimated recurring costs (11 years)
Potential total costs: $250 million in total estimated costs

The estimated annual cost is $22.7 million. These estimates are based on the following assumptions: operating a mobile clinic, including vehicle and labor, at $400,000–$500,000 per year each, for 35 mobile clinics (assuming 5 community health centers operate at least 1 mobile clinic per region) = $17.5 million annually. Augmenting community health clinics via grant supports of up to $200,000 per year (assuming 25 clinics across Puerto Rico) = $5 million annually. Tools to support chronic disease management might total $500,000 up-front and require $200,000 annually to maintain.

Potential Funding Mechanisms

U.S. Department of Health and Human Services Health Resources and Services Administration, government of Puerto Rico, Puerto Rico Department of Health, nongovernment sources

Potential Implementers

Community health centers, Puerto Rico Department of Health

Potential Pitfalls

It would be important to ensure that these mobile clinics were networked into emergency plans and hospitals (information exchange, ability to move patients, access to roads to geographically vulnerable areas, etc.).

Likely Precursors

Determine the optimal location of new mobile care clinics to maximize their benefit. Outline what elements of clinic augmentation would best support patient needs locally.

HSS 13
Expand Practice Laws for Health Care Providers

Sectors Impacted

Health and Social Services, Economic, Education

Issue/Problem Being Solved

Primary-care workforce shortages in Puerto Rico were exacerbated by hurricane stress and providers leaving Puerto Rico.

Description

This course of action would increase the supply of licensed health care providers in Puerto Rico by (1) allowing nurse practitioners and physician assistants from elsewhere in the United States, including territories, to provide care in Puerto Rico, which would increase the supply in the short term; (2) providing incentives to attract licensed nurse practitioners and physician assistants from elsewhere in the United States, including territories, which would bolster the supply in the medium term; and (3) establishing and expanding nurse practitioner and physician assistant degree programs in Puerto Rico, which would help develop the workforce for the long term. This effort should include sexual assault nurse examiners who could mobilize to the community using the mobile care clinics (HSS 12, Augment Community Health Centers and Elements for Primary Care and Chronic Disease Prevention and Management). This staff would re-collect forensic evidence and offer a trauma-centered intervention to victims.

Potential Benefits

Allowing nurse practitioners and physician assistants to practice at the top of their licenses would increase access to quality care across Puerto Rico.

Potential Spillover Impacts to Other Sectors

Having more nurse practitioners and physician assistants on hand could positively affect emergency preparedness by increasing the number of people available to act as frontline providers in a future disaster event.

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: $8 million in estimated recurring costs (5 years)
Potential total costs: $8 million in total estimated costs

These estimates are based on the following assumptions: marketing to new graduates of nurse practitioner and physician assistant programs within and outside Puerto Rico ($250,000–

$500,000 up-front, with lesser annual costs as the policy shift becomes common knowledge); incentives such as loan repayment to the order of $100,000 per student (for up to 50 providers, or $5 million annually); supports to nurse practitioner and physician assistant programs in Puerto Rico to ensure new practice guidelines are part of training ($500,000 per year for 5 programs = $2.5 million); and costs to expand the laws would be limited (e.g., creating licensure language), since this would be based on successful laws used in other parts of the United States.

Potential Funding Mechanisms

Medicaid/Mi Salud reimbursement

Potential Implementers

Local universities, government of Puerto Rico, Board of Nursing, independent health care licensure body, Puerto Rico Department of Health

Potential Pitfalls

If reimbursement rates remain low for nurse practitioners and physician assistants, this course of action could end up bolstering a system that trains providers who then migrate to the continental United States. Physician assistants do not have a history of providing care in Puerto Rico, so there may be less existing trust in their abilities.

Likely Precursors

Discussions of the role and value of advanced clinical practice providers, including complementary responsibilities to physicians and review of expanded law-implementation practices that are best matched to Puerto Rico's demographics and provider composition

HSS 14
Develop a More Robust and Resilient Data System of Health Costs and Links to Health Outcomes

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Limited systematic and digitized data on costs of health care across health facilities and impacts on improvements in health outcomes can influence resource allocation decisions after a disaster and over the long term, particularly when data are affected or lost due because of a disaster.

Description

This course of action would create supports for measuring health costs systematically, including merging claims data, hospital and other health center discharge data, and disease and health outcome information. This course of action would solidify the robustness of data systems for health outcomes information, be inclusive of related social and human service data, and ensure greater data digitization to facilitate analysis.

Potential Benefits

Clear and robust data would facilitate decisionmaking about provider retention supports and location and supports for a range of health care facilities. It would also help assess progress on health outcomes, accounting for cost and service outcomes together.

Potential Spillover Impacts to Other Sectors

Better consideration of health resources should support greater efficiency in key areas that would benefit overall fiscal decisions across sectors.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $3.3 million in estimated recurring costs (11 years)
Potential total costs: $3.3 million in total estimated costs

Estimate for annual recurring costs assumed 4 full-time equivalents per year, at a cost of $75,000 each per year. This assumes a higher salary for health data systems specialists. There may be a cost for training and monitoring, which could add up-front cost.

Potential Funding Mechanisms

U.S. Department of Health and Human Services, government of Puerto Rico

Potential Implementers

Institute for Statistics, health care payers, health care providers, Puerto Rico Department of Health

Potential Pitfalls

To provide an accurate and consistent picture of costs and outcomes over time, this course of action would require systematic data delivery by all health providers, as well as the Puerto Rico Department of Health.

Likely Precursors

Developing the data framework and ensuring buy-in from all providers and payers

HSS 15
Advance Uptake of Evidence-Based Practices/Quality of Care for Mental Health

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

There is a lack of access to appropriate and evidence-based mental health care in Puerto Rico, especially given higher rates of stress postdisaster.

Description

This course of action would ensure greater uptake of evidence-based mental health practice (EBP) in health care settings by (1) identifying gaps in EBP in Puerto Rico, (2) training providers in the use of relevant EBPs, and (3) monitoring how those practices are being applied.

Potential Benefits

This course of action would increase the standards of care and access to quality care for those with mental and behavioral problems, and it would help identify individuals in need of mental health care who are not receiving it.

Potential Spillover Impacts to Other Sectors

Poor mental health is associated with poor educational and work outcomes and poorer quality of life. Improving mental health is key to Puerto Rico's economic future.

Potential Costs

Potential up-front costs: $2.5 million–$5.5 million in estimated up-front costs (5 years)
Potential recurring costs: —
Potential total costs: $2.5 million–$5.5 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Health and Human Services Substance Abuse and Mental Health Services Administration grants, Medicaid, nongovernment sources

Potential Implementers

Mental health care providers

Potential Pitfalls

Ensuring the deployment and full implementation of EBP could take time. This would require having training materials that are culturally and linguistically appropriate for Puerto Rico.

Likely Precursors

Identifying providers willing to train others in EBP and the 2–3 EBPs that are priorities for Puerto Rico

HSS 16
Address Food Insecurity by Ensuring Flexible Nutrition Assistance Programs

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

A large portion of people in Puerto Rico experienced food insecurity before and after Hurricanes Irma and Maria, and many residents depend on the Nutrition Assistance Program for income and food. The Nutrition Assistance Program is funded by a capped block grant, so it cannot expand to accommodate a sudden change in need.

Description

This course of action would transition Puerto Rico back to the Supplemental Nutrition Assistance Program (SNAP) to allow greater flexibility postdisaster and to provide greater benefit to participants.

Potential Benefits

Switching back to SNAP would allow for a more efficient disaster response. Making food assistance more readily available would help prevent hunger. In addition, the dangerous effects of hunger on people with chronic diseases, such as diabetes, Crohn's disease, and hypertension, would be minimized.

Potential Spillover Impacts to Other Sectors

Higher benefit levels during nondisaster circumstances could lead to a healthier population and workforce.

Potential Costs

Potential up-front costs: $3 million in estimated up-front costs (3 years)
Potential recurring costs: $200 million in estimated recurring costs (11 years)
Potential total costs: $200 million in total estimated costs

The estimated annual cost is $18.28 million. The cost to the federal SNAP program is not included for the purpose of estimating costs of this course of action.

Potential Funding Mechanisms

U.S. Department of Agriculture, Puerto Rico Department of the Family

Potential Implementers

U.S. Congress

Potential Pitfalls

Transitioning back to SNAP could be a politically sensitive issue, and negotiations with the Financial Oversight and Management Board for Puerto Rico would affect the availability of funds.

Likely Precursors

Agreement among U.S. Congress, U.S. Department of Agriculture Food and Nutrition Service, and the government of Puerto Rico

HSS 17
Ensure That There Are Nutrition Supports for Populations Disproportionally Affected by the Disaster

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Nutrition Assistance Program regulations that stipulate how benefits can be used limit how and where recipients can purchase food, which could exacerbate already limited access to food following a disaster.

Description

This course of action would create long-term (3 months or longer) waivers to Nutrition Assistance Program regulations that would be implemented by the U.S. Department of Agriculture Food and Nutrition Service to enable greater flexibility in how program participants access food during a disaster. Waivers would be triggered on the declaration of a disaster.

Potential Benefits

Rapidly activating waivers to nutrition assistance programs would avoid unnecessary gaps in benefits and avert negative health outcomes that could result from inadequate nutrition.

Potential Spillover Impacts to Other Sectors

Increasing consistent access to nutrition assistance could reduce acute health issues or complications, thereby reducing demand for health care services or burden on family and friends.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

Waivers are implemented by U.S. Department of Agriculture Food and Nutrition Service to existing programs and would not incur a cost to Puerto Rico.

Potential Funding Mechanisms

U.S. Department of Agriculture

Potential Implementers

U.S. Department of Agriculture Food and Nutrition Service

Potential Pitfalls

Rapidly transitioning the Nutrition Assistance Program cases of people who migrate from Puerto Rico to elsewhere in the United States and enroll in Supplemental Nutrition Assistance Program (SNAP) could result in duplication of benefits and possibly fraud. People moving elsewhere in the United States following a disaster would affect how costs are shared by the commonwealth and recipient states. The nutritional value of foods could be negatively affected by the waivers. Allowing flexibility in the meal pattern and menu planning requirements (e.g., nutrition standards) could result in lower-quality food being served through school or other meal programs. Similarly, allowing Nutrition Assistance Program benefits to be used to purchase prepared or ready-to-consume foods could result in increased purchase of foods with lower nutritional value.

Likely Precursors

A review would be needed of waivers applied post–Irma and Maria to determine the appropriate length of extensions. This course of action should be considered in conjunction with HSS 16 (Address Food Insecurity by Ensuring Flexible Nutrition Assistance Programs), as transitioning to SNAP could affect waivers needed and available.

HSS 18
Improve Programs to Prevent and Address Abuse of Children and Seniors After a Disaster

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Children and seniors may experience an increased risk of abuse following a disaster.

Description

This course of action would mount public-education campaigns to raise awareness of child and senior abuse, and how to report it, and it would provide training to staff at integrated service centers and disaster shelters to detect and address abuse. This course of action would also train local officials or other professionals with expertise in eldercare and childcare issues to provide this training and serve as liaisons with centers and shelters. In the short term, detection and reporting efforts could be included in a disaster case management system.

Potential Benefits

The educational component of this course of action would be aimed at preventing physical, mental, and emotional abuse, and the training component would increase the availability of services for victims of abuse.

Potential Spillover Impacts to Other Sectors

Decreasing the occurrence of abuse could lower the burden on the health care system.

Potential Costs

Potential up-front costs: $370,000–$630,000 in estimated up-front costs
Potential recurring costs: $6.9 million–$15 million in estimated recurring costs
Potential total costs: $7.3–$16 million in total estimated costs

This estimated up-front cost includes $250,00–$500,000 per year for marketing—public-service announcements, brochures, etc.—and $124,600 for 2 full-time equivalents (FTEs) at implementing agency. The recurring cost includes the same marketing cost as year 1, plus 2–14 FTEs.

Potential Funding Mechanisms

U.S. Department of Health and Human Services Administration for Children and Families Administration for Community Living, Office of the Ombudsman for the Elderly, Puerto Rico Department of the Family

Potential Implementers

Office of the Ombudsman for the Elderly, Puerto Rico Department of the Family

Potential Pitfalls

Funding variations from year to year could limit the potential impact.

Likely Precursors

Review existing training available to relevant staff. Review relevant training provided in other regions.

HSS 19
Create Flex-Funding for Social Service Centers

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Running a generator for a few days could rapidly deplete a facility's budget, which could lead to avoidable facility closures and loss of service for service recipients, in the absence of a resilient power grid.

Description

This course of action would assess the landscape of social service center facilities to develop an inventory of critical facilities, and it would create a flexible funding mechanism to help critical facilities and technology-dependent children and elders who are being cared for at home bear the costs of long periods of generator use poststorm.

Potential Benefits

Assisting centers with fuel costs would avoid facility closures due to loss of fuel, allowing for the continuance of service provision to populations disproportionately affected by disasters and reducing the need to relocate shelters.

Potential Spillover Impacts to Other Sectors

Providing fuel supports to child- and eldercare facilities would enable their continuity of operation and consistent provision of services, which could reduce emergency room visits and other avoidable burdens on the health care system resulting from avoidable morbidity.

Potential Costs

Potential up-front costs: $180,000–$310,000 in estimated up-front costs
Potential recurring costs: $11 million–$980 million in estimated recurring costs (11 years)
Potential total costs: $11 million–$980 million in total estimated costs

The up-front cost is estimated using 3–5 full-time equivalents (FTEs) to coordinate critical facility inventory development efforts. The estimates for annual costs range from $11 million to $980 million. This would include generators at $562,800 per week for every 1,000 centers running 5.5 kW generators, $89 million per week for every 1,000 centers running 2,500 kW generators, and $186,900–$311,500 for 3–5 FTEs.

Potential Funding Mechanisms

U.S. Department of Energy, Puerto Rico Emergency Management Agency, Puerto Rico Electric Power Authority, U.S. Department of Health and Human Services Administration for Children and Families, private sector

Potential Implementers

Puerto Rico Department of the Family, Puerto Rico Emergency Management Agency

Potential Pitfalls

This course of action should be viewed as a stop-gap measure and not as a long-term alternative to strengthening the power grid. This course of action could result in fraudulent claims and abuse. Costs would increase rapidly with lengthy recovery periods. For this course of action to have an impact, there must be adequate fuel supply available.

Likely Precursors

The need for generators depends on the robustness and resiliency of the power grid. Facility-specific power needs should be determined to estimate costs. It would be important to ensure that all relevant facilities have a generator and know how to access the funds. An adequate and accessible fuel supply would be essential.

HSS 20
Improve Supports for Seniors, Particularly Those Living Alone

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Elderly individuals may experience increased vulnerability because of fewer economic opportunities and decreasing health status, and those who live alone may be at even greater risk following a disaster.

Description

This course of action would increase the resilience of seniors by providing supports during normal circumstances and targeted support postdisaster. Predisaster components include building on existing support systems for seniors to design predisaster response and recovery support plans to ensure that seniors, their families, and their communities have clear contingency plans for major disruptions to key lifelines. This would enable families, communities, and neighborhoods to provide direct aid to seniors who live alone and may face challenges in a disaster.

Potential Benefits

Providing support prestorm could increase the resiliency of the elderly population. Ensuring that seniors living alone are able to access services could avoid the worsening of chronic conditions caused by insufficient medicines or nutrition and thus could promote overall well-being.

Potential Spillover Impacts to Other Sectors

Connecting seniors to economic opportunities could decrease their reliance on assistance programs and increase their participation in the labor market. Assisting seniors in obtaining aid and conducting wellness check-ins could decrease avoidable emergency care, thereby lowering the burden on the health care system. This type of formal network could lead to a greater sense of community cohesion and overall resilience.

Potential Costs

Potential up-front costs: $5.2 million in estimated up-front costs
Potential recurring costs: $57 million in estimated recurring costs (11 years)
Potential total costs: $62 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Health and Human Services, Office of the Ombudsman for the Elderly, Puerto Rico Department of the Family, Community Development Block Grant–Disaster Recovery

Potential Implementers

Oficina del Inspector General de Permisos (Office of Inspector General of Permits), Office of the Ombudsman for the Elderly, Puerto Rico Emergency Management Agency, Puerto Rico Department of the Family

Potential Pitfalls

Reimbursement of home care visits and similar services could increase the number of seniors living alone.

Likely Precursors

The investigation of home care visit reimbursement could be done as part of efforts to reduce the gap in Medicaid reimbursement (HSS 7, Reduce Gap in Medicaid/Medicare Reimbursement Rate). A reliable local volunteer base would be needed to conduct mapping and wellness visits.

HSS 21
Improve Public Awareness of Proper Storage of Insulin Post-Disaster

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Diabetes care is a high priority given its relatively high prevalence, and individuals dependent on insulin might not be aware that it can be stored outside a refrigerator (56°–80° Fahrenheit) for 28 days.

Description

This course of action would increase public knowledge about guidelines for storing insulin by training disaster shelter managers and health care providers to provide relevant information, conducting media campaigns, and sending text messages to patients. This course of action would build on a current project in the recovery mission to identify appropriate messaging for the public education component.

Potential Benefits

Decreased medication gaps for insulin-dependent individuals would reduce negative health impacts. This course of action would also decrease medication wastage and strain on insulin supply.

Potential Spillover Impacts to Other Sectors

This course of action would specifically target insulin but could be expanded to other medications for chronic conditions, all of which could ease the burden on the health care system.

Potential Costs

Potential up-front costs: $640,000 in estimated up-front costs
Potential recurring costs: $1.9 million in estimated recurring costs
Potential total costs: $2.6 million in total estimated costs

The estimate for up-front costs is based on 0.25 full-time equivalents (FTEs) to develop shelter staff training ($15,575), 2 FTEs for development and implementation of a public-education campaign ($124,600), and the development of a mass-media campaign ($500,000). The estimate for annual costs is $175,600.

Potential Funding Mechanisms

U.S. Department of Health and Human Services, Puerto Rico Department of Health, private sector, nongovernment sources

Potential Implementers

Health care providers, Puerto Rico Department of Health, private sector

Potential Pitfalls

Suggesting that insulin can be stored at room temperature could cause confusion with regard to preferred cold-storage procedures, or it could be misunderstood as being more broadly applicable to other pharmaceutical products. This could lead to improper storage and subsequent use of expired medicines. If a patient roster is needed for text messaging, it could result in privacy and security concerns and ongoing effort to ensure accuracy and completeness.

Likely Precursor

A patient roster might need to be created or compiled from extant patient records and securely stored.

HSS 22
Move to a More Regionally-Integrated Approach to Emergency Planning, Exercising, Response, and Recovery

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Unstable economic and health care infrastructures were further diminished by the hurricanes.

Description

This course of action would develop resilient, regionalized, and exercised health care systems and infrastructure to respond to disasters. This course of action would create a disaster preparedness, response, and recovery network that would prepare hospitals and health care facilities to assist each other to surge during disasters. This course of action includes hiring 2 people in each of the 7 health regions to facilitate the regional planning and preparedness approach, including reviewing and improving plans for ensuring power, water, oxygen, and other critical supplies postincident.

Potential Benefits

This network would likely help protect patients and communities from poor outcomes, reduce morbidity and mortality, ensure more-efficient use of resources, and save costs.

Potential Spillover Impacts to Other Sectors

This course of action would actively engage critical infrastructure sectors (e.g., Communications and Information Technology, Transportation, Housing) in emergency preparedness initiatives, as well as tie in efforts related to the Community Planning and Capacity Building sector.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $10 million in estimated recurring costs
Potential total costs: $10 million in total estimated costs

The estimate for annual costs is $872,000 per year for 2 full-time equivalents in each of the 7 health regions.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Health and Human Services, Administración de Seguros de Salud de Puerto Rico (Puerto Rico Health Insurance Administration), Puerto Rico Department of Health

Potential Implementers

Puerto Rico Department of Health, hospital systems, other health care organizations

Potential Pitfalls

Not all health care organizations have the immediate financial capabilities or motivation to prioritize or participate in investing in making their systems more resilient through the suggested mechanisms. Some health care facilities or organizations could be unwilling to collaborate or cooperate with other health care entities.

Likely Precursors

Success of this course of action might be influenced by the quality and spread of existing partnerships and organizational affiliations; degree of integration among primary, second, and tertiary providers; prior market incentives to compete or collaborate across business units; and preexisting expertise in emergency preparedness.

HSS 23
Review and Improve Systems and Processes for Managing Volunteers and Donated Supplies

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

The management of volunteers and related donations was an impediment during the response to the hurricanes. Systems need to be better organized for future disasters.

Description

This course of action would strengthen systems for volunteer management and coordination, and it would implement systems to better track donations, including inventorying of supplies and other assets. This course of action has a particular focus on health and social service volunteers and health care supplies.

Potential Benefits

Volunteer management would be key to disaster response and recovery. Well-organized volunteer and donations systems would facilitate quicker deployment of assets and minimize confusion and duplication of services and could help match assets to areas of greatest needs.

Potential Spillover Impacts to Other Sectors

Effective volunteer and donations management could streamline and improve disaster management and may improve efficiencies in how quickly sectors could get back online or transition to routine services.

Potential Costs

Potential up-front costs: $210,000 in estimated up-front costs
Potential recurring costs: $3.9 million in estimated recurring costs
Potential total costs: $4.1 million in total estimated costs

The up-front cost is estimated based on 3 full-time equivalents (FTEs) (at $70,000 per year each) for initial database setup. The estimate for annual costs is $350,000, including 2 FTEs (at $70,000 per year each) for database maintenance and 3 FTEs (at $70,000 per year each) for ongoing volunteer training, with particular focus on maintaining competencies among those addressing health and social service needs.

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementers

Puerto Rico Department of Health

Potential Pitfalls

It would be necessary to clearly establish the criteria for the volunteer registry (e.g., basic information needed, key criteria for volunteers) to ensure that those interested in offering their services understand the parameters. It is also important to have clear guidelines about what supplies can and cannot be donated.

Likely Precursors

It would be important to build on and merge any existing volunteer registries for this effort and be clear about volunteers, monitored in databases by the government of Puerto Rico, versus those who are part of nongovernmental organizations (but could be integrated).

HSS 24
Increase the Child Welfare Investigative Workforce

Sector Impacted

Health and Social Services

Issue/Problem being solved

In 2016, the Puerto Rico Department of the Family employed 148 child welfare investigators and received 17,643 reports requiring investigation. As of June 2016, the department reported a backlog of 6,787 cases requiring investigation. This deficit means that children remain in potentially unsafe living situations and may be at increased risk of further abuse in the postdisaster period, increasing the chance that they may receive lasting harm. Child maltreatment consists of physical, emotional, and sexual abuse. There are indications that, following a disaster, the incidence of child abuse increases.

Description

This course of action would increase funding to the Puerto Rico Department of the Family to hire additional child welfare investigators to manage existing caseloads of child maltreatment.

Potential Benefits

This course of action would lead to a decreased backlog of child maltreatment cases and promote the long-term safety of children.

Potential spillover impacts to other sectors

Promoting the long-term safety of children would have far-reaching effects throughout Puerto Rican society as a whole, given that they are the future workforce, as well as social and political leaders. Early intervention also could lead to reduced health care and other social costs by warding off physical and mental health impacts later in life or tendencies toward criminal or other nondesirable behaviors.

Potential Costs

Potential up-front costs: $19 million in estimated up-front costs (2 years)
Potential recurring costs: $49 million in estimated recurring costs (11 years)
Potential total costs: $68 million in total estimated costs

The up-front cost is estimated for 150 full-time equivalents (FTEs). The estimate for annual costs is based on 75 FTEs (over at least 3 years).

Potential Funding Mechanisms

Government of Puerto Rico, Puerto Rico Department of the Family

Potential Implementers

Puerto Rico Department of the Family

Potential Pitfalls

Because this course of action would be wholly dependent on the commonwealth budget, it would be susceptible to the Financial Oversight and Management Board for Puerto Rico actions. Turnover rate for social workers generally is high,[104] so there may be additional hiring and training costs required to maintain the workforce.

Likely Precursors

This should be combined with efforts to prevent child abuse and should be considered in conjunction with HSS 18 (Improve Programs to Prevent and Address Abuse of Children and Seniors After a Disaster).

[104] Child Welfare Information Gateway, Children's Bureau, U.S. Department of Health and Human Services, "Worker Turnover," webpage, undated (as of January 29, 2019: https://www.childwelfare.gov/topics/management/workforce/retention/turnover/).

HSS 25
Establish a Collaborative Agreement Between PRDF and WIC for Infant Formula Storage and Distribution

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Because of inadequate storage and distribution arrangements, following Hurricanes Irma and Maria, there was limited accessibility to powdered milk formula and "ready to feed" formula for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program participants.

Description

This course of action would establish a collaborative agreement between WIC and the Puerto Rico Department of the Family (PRDF) to arrange appropriate climate-controlled storage, handling, and distribution of milk formulas for WIC participants who are also Nutrition Assistance Program beneficiaries. This agreement would ensure that supplies are properly stored and strategically located around Puerto Rico to ensure adequate availability for all communities.

Potential Benefits

Ensuring an adequate supply of formula would provide a key support for infants, a population that is particularly vulnerable during a disaster.

Potential Spillover Impacts to Other Sectors

Ensuring nutrition support could avoid negative health and development outcomes caused by hunger. Additionally, it could reduce emergency room visits and other avoidable burdens on the health care system resulting from avoidable morbidity.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

This collaborative agreement would incur no cost, although it could result in increased warehousing costs if implemented.

Potential Funding Mechanisms

Not applicable

Potential Implementers

PRDF, U.S. Department of Agriculture, WIC

Potential Pitfalls

None anticipated

Likely Precursors

This agreement should be part of a larger effort to integrate social and health services.

HSS 26
Review and Improve Systems for Stockpiling and Distributing Supplies and Pharmaceuticals Post-Disaster

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Following the hurricanes in Puerto Rico, there were concerns among service providers about the adequacy of systems to source emergency supplies.

Description

This course of action would designate approximately 10 key health care facilities as Healthcare Disaster Resource Centers, which would be equipped with extra supplies needed during a disaster.

Potential Benefits

Ensuring that basic services are available postdisaster could avoid increased morbidity and mortality among electricity-dependent individuals. Ensuring that emergency response supplies are stored as efficiently as possible would make them more readily available after a disaster, and setting clear emergency plans would improve interagency coordination during and after a disaster.

Potential Spillover Impacts to Other Sectors

Stockpiling could affect Public Buildings. Water and Energy might be affected by the review of plans to ensure services and any subsequent actions.

Potential Costs

Potential up-front costs: $20 million in estimated up-front costs
Potential recurring costs: $2.8 million in estimated recurring costs (11 years)
Potential total costs: $23 million in total estimated costs

The up-front cost is estimated as $2 million per cache (based on the Disaster Resource Center program within Los Angeles County's Emergency Management Services Agency) for 10 caches. The estimated annual cost is $250,000 for maintenance of cache (replacement of expired supplies that cannot be rotated).

Potential Funding Mechanisms

U.S. Department of Health and Human Services, Puerto Rico Emergency Management Agency, Puerto Rico Department of Health

Potential Implementers

Puerto Rico Department of Health, Puerto Rico Emergency Management Agency

Potential Pitfalls

Cache supplies, particularly pharmaceuticals, are subject to expiration. If rotating cache supplies with everyday supplies were not done to minimize the cost of replenishing older materiel, this could be an issue. While caches are designed to supplement a health care facility's normal supplies during a disaster, they would become exhausted if supply lines were disrupted for an extended period.

Likely Precursors

Caches require secure storage locations at the designated Healthcare Disaster Resource Center facilities. Coordination of the regional cache program would be one of the duties performed by regional planning staff hired under HSS 22 (Move to a More Regionally-Integrated Approach to Emergency Planning, Exercising, Response, and Recovery).

HSS 27
Improve Current Epidemiological Surveillance to Better Respond to Natural and Man-Made Disasters

Sectors Impacted

Health and Social Services, Water, Housing, Economic, Communications and Information Technology

Issue/Problem Being Solved

Natural or man-made disasters could exacerbate current health risks, threats, or disease outbreaks, as well as bring emerging conditions to which the health care system would need to respond in a timely and appropriate manner to decrease excess morbidity and mortality.

Description

This course of action would improve the current epidemiological surveillance system, which would increase Puerto Rico's capacity to monitor short- and long-term adverse health effects. The improved surveillance capacity also would strengthen emergency response capacity for any future disasters.

Potential Benefits

A comprehensive surveillance capacity that draws together assets from existing systems, such as infectious diseases, chronic diseases, maternal and child health, environmental health, injury, occupational health, and behavioral health, could help improve Puerto Rico's ability to develop and implement effective, timely public health responses. Measures taken to improve epidemiological capacity would allow prompt public health action by conducting diagnostic and investigative activities in response to possible health problems and health hazards in the community, therefore reducing disease burden and health-related costs.

Potential Spillover Impacts to Other Sectors

This course of action would involve establishing collaborative agreements with numerous commonwealth, state, and federal agencies, cross-training on surveillance, and establishing data reporting and monitoring protocols.

Potential Costs

Potential up-front costs: $9 million in estimated up-front costs, for labor and equipment.
Potential recurring costs: $90 million in estimated recurring costs (11 years)
Potential total costs: $100 million in total estimated costs

The estimate for annual costs is $8.5 million, for labor and equipment.

Potential Funding Mechanism

Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, nongovernment sources

Potential Implementers

Puerto Rico Department of Health, FEMA, U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Defense, U.S. Department of Health and Human Services

Potential Pitfalls

Puerto Rico Department of Health technological infrastructure does not support current programmatic information technology needs.

Likely Precursors

Fully functional epidemiological surveillance systems would depend on continuous capacity building of the current Puerto Rico Department of Health workforce. Identifying specific surveillance needs and determining current capacity would drive the design, and cost, of this course of action.

HSS 28
Support the Development of a Suicide Prevention Campaign

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

There was a spike in suicide and suicidal ideation in Puerto Rico following Hurricanes Irma and Maria.

Description

This course of action would initiate a 6-part suicide prevention campaign: (1) promoting wellness and self-care through a public-awareness campaign (this campaign would incorporate both earned media and paid media, which would be deployed with a focused message on safety and well-being and which would include positive narratives in the form of actions, solutions, successes, and resources and not include any references in pictures or words to modes of suicide), (2) identifying people who are at risk of suicide, (3) identifying and addressing barriers to appropriate care for suicidality, (4) providing appropriate care procedures (both acutely on the suicide hotline and in emergency rooms and long-term care), (5) promoting procedures for responding to suicide, and (6) procedures for addressing environmental factors associated with suicide. This would build off of the previous work from Puerto Rico's Commission for the Implementation of Public Policy in the Prevention of Suicide, which included a public awareness campaign, increased coordination and planning between agencies, surveillance research, and training workshops.

Potential Benefits

A suicide prevention campaign for natural-disaster victims would help stem an increasing suicide epidemic in Puerto Rico. Increased awareness of suicide risk factors could improve overall health outcomes and timely referral to behavioral health services and other resources.

Potential Spillover Impacts to Other Sectors

This course of action has the potential to spill over into the Education sector, especially if screening is expanded to schools.

Potential Costs

Potential up-front costs: $250,000 in estimated up-front costs, for a media campaign
Potential recurring costs: $73 million in estimated recurring costs
Potential total costs: $73 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Health and Human Services Substance Abuse and Mental Health Services Administration grants, Medicaid, nongovernment sources

Potential Implementers

Puerto Rico Department of Health, Puerto Rico's Commission for the Implementation of Public Policy in the Prevention of Suicide

Potential Pitfalls

Ensuring the deployment and full implementation of evidence-based practice would take time. This course of action would require having training materials that are culturally and linguistically appropriate for Puerto Rico. Additionally, increased screening has the potential to increase the number of people who are identified as needing care. There is a shortage of providers in Puerto Rico, so even if screening were effective for identifying individuals, access to care could still be an issue. For this reason, this course of action would be most effective if executed with HSS 11 (Add Incentives and Other Supports to Increase and Retain Supply of Health Care Providers and Public Health Practitioners).

Likely Precursors

Cooperation with media outlets to use appropriate language around discussions of suicide, providers who are ready and willing to train in appropriate care for suicidality, and hiring and training additional staff for the suicide hotline and to provide behavioral health treatment services because of the lack of access to care

HSS 29
Revise Regulations on Food Stockpiling at Child- and Elder-Care Facilities

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Current food stockpiling guidelines require a 7-day supply, but this was inadequate at child- and eldercare homes following the hurricanes, particularly for those with special needs.

Description

This course of action would change current policy to require a minimum 14-day, healthy, shelf-stable food supply at all licensed facilities, and it would provide guidance on stockpile content.

Potential Benefits

Residents of care facilities would benefit directly via increased availability of food postdisaster, as well as decreased salty and sugary foods.

Potential Spillover Impacts to Other Sectors

Improved health of the population living in residential care homes could lessen reliance on emergency room visits, in both disaster and nondisaster times.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

This course of action incurs no costs to Puerto Rico unless it purchases the food supplies. Reconfiguration of the food supply chain could incur some up-front costs at the local facility level. Local facilities may also incur cost for additional food supplies or storage.

Potential Funding Mechanisms

U.S. Department of Agriculture, Puerto Rico Department of the Family

Potential Implementers

Puerto Rico Department of the Family, child- and eldercare facilities

Potential Pitfalls

Reliance on shelf-stable foods, which are often highly processed, could lead to different product-sourcing arrangements that expand this practice outside of times of disaster. The burden of maintaining an expanded on-site food stockpile falls largely on facilities, which may already be resource constrained.

Likely Precursors

Adequate on-site storage space, funds to purchase larger food stockpile, and memoranda of understanding for backup suppliers

HSS 30
Review and Improve Plans, Systems, and Processes for Tracking and Responding to Physical and Mental Health Needs of First Responders

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

First responders may not have access to adequate supports that attend to their own health and well-being during disaster response and recovery.

Description

This course of action would ensure that first responders, who are key in disaster response and recovery, have the appropriate supports to attend to their health needs during disaster management activities. This includes the physical and emotional needs of Puerto Rico Department of Health employees during the recovery.

Potential Benefits

Programs to support the physical and mental health of first responders lessen negative health impacts of the highly stressful circumstances of disaster response and recovery. By attending to responder needs early and often, supports would improve responder well-being and keep responders prepared.

Potential Spillover Impacts to Other Sectors

Ensuring that new health issues among responders are not added to the concerns of those immediately affected by disaster could effectively lessen the costs associated with long-term health services.

Potential Costs

Potential up-front costs: $140,000 in estimated up-front costs
Potential recurring costs: $18 million in estimated recurring costs (11 years)
Potential total costs: $18 million in total estimated costs

The up-front cost is estimated for 2 full-time-equivalent staff (average salary of $70,000) to set a survey that can be administered periodically with responders to track health symptoms over time. The estimate for annual costs is $1.6 million per year, for approximately 20 counselors (average salary of $80,000) providing monthly support for responders.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Health and Human Services, government of Puerto Rico, Puerto Rico Department of Health, nongovernment sources

Potential Implementers

Puerto Rico Department of Health, FEMA

Potential Pitfalls

It would be important to make services available in ways that reduce stigma for first responders who may feel uncomfortable seeking services for self-care.

Likely Precursors

Identifying an accurate count of responders or the responder cohort that may be eligible, and ensuring that counseling is using evidence-based practice

HSS 31
Review and Improve Systems for Administration and Finance of Response-Related Activities

Sector Impacted

Health and Social Services

Issue/Problem Being Solved

Hurricane-related delays in billing caused delays in reimbursement to hospitals and clinics. For clinics already experiencing financial stress, this sometimes affected the ability to provide patient care. There were also reports from stakeholders of confusion about other regulations, including whether ambulances were permitted to transfer patients from facility to facility.

Description

The aftermath of the storm provides an opportunity to review and address gaps and barriers in a range of regulations that affect medical and health responses to large-scale emergencies. This course of action would review existing regulations related to medical response and, where indicated, implement temporary waivers for a range of emergency health service needs, including, but not limited to, authorization, payment deadlines, prescription coverage, enrollment, and mortuary services. This course of action would also initiate awareness campaigns to increase understanding of relevant regulations, and it would improve the capacity of the Puerto Rico Department of Health and health care facilities, providers, and specialists to understand and implement the existing emergency health services.

Potential Benefits

This course of action ensures uninterrupted access to care postdisaster and prevents potential delays in time-sensitive care.

Potential Spillover Impacts to Other Sectors

Revisions to regulations directly affecting health care could also affect how other sectors (e.g., Transportation, Housing) are regulated.

Potential Costs

Potential up-front costs: $250,000 in estimated up-front costs (2 years)
Potential recurring costs: $7.9 million in estimated recurring costs (11 years)
Potential total costs: $8.1 million in total estimated costs

The up-front cost is estimated for 2 full-time equivalents ($124,600 per year) for negotiations with the Centers for Medicare and Medicaid Services and the development and implementation

of information campaigns for patients and providers. The estimate for annual costs is $750,000 per year for marketing materials—i.e., brochures ($250,000 per year) and television and radio public-service announcements ($500,000 per year).

Potential Funding Mechanisms

U.S. Department of Health and Human Services, government of Puerto Rico, nongovernment sources

Potential Implementers

Administración de Seguros de Salud de Puerto Rico (Puerto Rico Health Insurance Administration), U.S. Department of Health and Human Services, Centers for Medicare and Medicaid Services

Potential Pitfalls

Funding for existing federal and state programs may be exhausted earlier because of expedited spending or funds allocation. Safeguard measures would need to be in place to ensure accurate or appropriate billing to prevent health care waste and fraud.

Likely Precursors

None

Housing Sector

COA Number	Title
HOU 1	Assess, Repair, Rehabilitate, or Relocate Substantially-Damaged, Owner-Occupied Homes
HOU 2	Assess, Repair, and Mitigate Damaged Subsidized Rental Housing
HOU 3	Assess Vulnerability of Non-Substantially Damaged Homes
HOU 4	Make Owner-Occupied Homes More Resilient (Less Vulnerable to Natural Hazards)
HOU 5	Collect, Integrate, and Map Housing Sector Data
HOU 6	Enforce Land Use Plans and Improve Compliance with Building Permitting
HOU 7	Assess Need for—and Adopt and Implement Programs to Provide—Additional Subsidized Rental Housing and Special Housing
HOU 8	Increase Adoption of Adequate Wind and Flood Insurance for Homeowners and Renters
HOU 9	Reduce Mortgage Delinquencies and Foreclosures
HOU 10	Assess and Renovate Vacant and Blighted Properties
HOU 11	Improve the Address System
HOU 12	Register Properties and Resolve Titling Issues

HOU 1
Assess, Repair, Rehabilitate, or Relocate Substantially-Damaged, Owner-Occupied Homes

Sectors Impacted

Housing, Communications and Information Technology, Community Planning and Capacity Building, Economic, Education, Energy, Health and Social Services, Municipalities, Transportation, Water

Issue/Problem Being Solved

Many residential structures suffered substantial damage from Hurricanes Irma and Maria and need to be either repaired in place or replaced by homes in neighborhoods and communities that are safe, resilient, and affordable and have access to economic and educational opportunities, as well as transit and health care.

Description

This course of action would assess the condition of owner-occupied homes that were substantially damaged or destroyed in the hurricanes.[105] If the structures could be made reasonably safe from natural hazard risk at reasonable cost, they would be repaired, rehabilitated, or rebuilt to code on site. If not, homeowners would be offered relocation assistance to move to an existing home (potentially a formerly vacant home) in a lower-risk location, or they would be temporarily housed while a new home is constructed in a lower-risk location. Damaged structures would then be acquired and demolished. Relocation would take place only if the risk conditions of the site cannot be reasonably mitigated. This course of action would have an income-eligibility cutoff to target low-income households. Rebuilding and relocating would emphasize safe, resilient, affordable communities with access to good schools, jobs, transit, and health care.

Potential Benefits

This course of action builds Puerto Rico back better by making these homes better able to withstand future storms. Successful relocation and rebuilding should be community-oriented and in accordance with approved land use plans.

Potential Spillover Impacts to Other Sectors

Depending on the extent of buyouts and relocations, demand could shift for certain services—such as power, water, transportation, and schools—as some areas are depopulated and

[105] Structures are considered substantially damaged if the cost of repair is 50% or greater of the structure's preevent market value.

other areas gain in population. Former residential areas should become open-space nature areas to prevent occupation by new residents.

Potential Costs

Potential up-front costs: $12 billion–$13 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $12 billion–$13 billion in total estimated costs

Modeling of storm damage (as described in HSOAC's damage and needs assessment for the Housing sector) projects that approximately 164,000 structures were substantially damaged or destroyed in Hurricanes Irma and Maria.[106] This COA applies only to owner-occupied properties, so the target number of structures will likely be much less than the approximately 164,000 structures. If 21 percent of housing units are vacant and 69 percent of occupied housing units are owner-occupied, the number of substantially damaged owner-occupied structures drops to 55 percent of the 164,000 total, or 90,000 units.

Potential Funding Mechanisms

FEMA Individual Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Housing and Urban Development, Small Business Administration, U.S. Department of Agriculture, private insurance, nongovernment sources, national and state funds for site improvement

Potential Implementers

Puerto Rico Department of Housing, municipal governments

Potential Pitfalls

Establishing title, ownership, or legality is needed to determine whether the homeowner would be eligible for a repair or buyout grant. Relocation of households would be politically sensitive and could affect the social fabric and economy of a local community. Low-income communities may perceive that higher-income communities were left intact because of preference or income as opposed to the fact that many lower-income communities are sited in more-vulnerable zones, and also that higher-income households may have the resources to build to code. Limited availability of temporary housing and replacement housing in low-risk areas could be barriers.

[106] HSOAC Puerto Rico Recovery Team, *After Hurricane Maria: Predisaster Conditions, Hurricane Damage, and Recovery Needs in Puerto Rico*, Santa Monica, Calif.: RAND Corporation, RR-2595-DHS, 2019

Likely Precursors

Likely precursors are determining whether reconstruction, relocation, or mitigation is the best course of action for an existing structure based on the level of damage sustained and natural hazard risk; determining ownership of the home and land title; and determining site risk conditions and the ability of the risks to be mitigated.

HOU 2
Assess, Repair, and Mitigate Damaged Subsidized Rental Housing

Sectors Impacted

Housing, Municipalities, Energy, Economic

Issue/Problem Being Solved

Assess damage and resiliency improvement needs for public housing and privately owned rental housing that receives government subsidies. Rehabilitate or modernize subsidized rental housing to accommodate people with or without disabilities, such as people with access and functional needs, seniors, veterans, and homeless people.

Description

This course of action would repair or mitigate damaged public housing and move public housing that is vulnerable to natural hazards. It would assist owners of private buildings that provide subsidized rental housing and homeless shelters with repairs or mitigation to damaged structures, or with moving structures that are vulnerable to natural hazards. It would also rehabilitate existing public housing units and privately owned buildings that provide subsidized rental housing and homeless shelters to be more resilient to natural hazards (such as by converting first-floor units subject to recurring flooding to common space, elevating equipment, adding site perimeter flood-proofing, hardening windows and doors, adding hurricane straps tying roof structures to foundations) and to accommodate people with or without disabilities, such as people with access and functional needs, seniors, and veterans.

Potential Benefits

This course of action would provide safe and secure housing for low-income and homeless residents. In addition to repairing damaged units and properties, this course of action could also include funding for upgrades, such as energy conservation and the implementation of measures to mitigate damage from future storm events.

Potential Spillover Impacts to Other Sectors

This course of action would provide safe and secure housing for those living in subsidized rental housing and homeless housing/shelters. It would provide employment for the construction trades, as well as Section 3 employment opportunities for residents of these communities.[107] It would provide increased resilience of structures as they are mitigated or rebuilt. Bringing damaged and offline units back online would lessen the strain on municipalities and nonprofit service providers working to house and support dislocated residents.

[107] Section 3 refers to the Housing and Urban Development Act of 1968 (Pub. L. 90-448).

Potential Costs

Potential up-front costs: $900 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $900 million in total estimated costs

These estimates are based on the following assumptions: wind and flood damage to public housing ($411 million, less $288 million in estimated insurance proceeds = $123 million); relocating residents and replacing units in highly vulnerable locations ($160 million); constructing permanent shelters ($160 million); resiliency measures for public housing ($3.6 million per average project × 90 projects = $328 million); postdisaster centers with electricity ($75 million); construction of temporary shelters and other mitigation activities ($75 million); privately owned subsidized rental housing and homeless shelters, with gap financing from Puerto Rico Housing Finance Authority ($200 million); and comprehensive needs assessment and strategy development ($2 million).

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, U.S. Department of Housing and Urban Development, private insurance

Potential Implementers

Puerto Rico Public Housing Authority, U.S. Department of Housing and Urban Development, Puerto Rico Housing Finance Authority, U.S. Department of Agriculture Rural Development Program

Potential Pitfalls

Some of the federal funding mechanisms may require that the Puerto Rico Public Housing Authority's existing Capital Fund Financing debt be paid down proportionately.

Likely Precursors

To implement this course of action, a needs assessment of the damaged properties providing subsidized rental housing should be conducted to triage the damaged housing stock into categories; set priorities; review insurance proceeds available; analyze whether mixed-finance, Rental Assistance Demonstration Program, or Section 18 works better for given properties;[108] and determine whether leveraging debt and tax credit equity, along with capital funds of the Puerto Rico Public Housing Authority, would constitute appropriate leverage for recovery funding, and to develop initial scopes of work.

[108] Section 18 of United States Housing Act of 1937 (Pub. L. 75-412) applies to the disposition of public housing property.

HOU 3
Assess Vulnerability of Non-Substantially Damaged Homes

Sectors Impacted

Housing, Community Planning and Capacity Building, Transportation, Water, Energy, Municipalities

Issue/Problem Being Solved

Many structures not damaged, or only minorly damaged, by Hurricanes Irma and Maria remain vulnerable to future natural hazards, such as wind, floods, landslides, and earthquakes.

Description

This course of action would (1) develop a robust, rapid, and comprehensive assessment tool; (2) train community and engineering assessors; (3) assess housing stock in high-risk areas through property inspections; (4) develop strategies to determine which structures can be secured through mitigation and which households need to be relocated, and to where; and (5) document vacant structures for repurposing, as detailed in HOU 10, Assess and Renovate Vacant and Blighted Properties. This commonwealth-wide program would entail a larger effort in the beginning to initially inspect properties and then a smaller, ongoing effort to continually assess mitigation needs.

Potential Benefits

This course of action would give communities a better understanding of which residents are at risk, and it would allow communities to develop plans and policies to move people out of harm's way or make structures more resilient. Working with community groups and municipalities, homeowners and builders of housing would have an improved understanding both of risk from natural hazards and of options for mitigating that risk to make homes safer and stronger. The insurance industry would have a better sense of true risk, enabling it to better meet the needs of potential customers. Other sectors would benefit from more-efficient housing that is safer and more able to shelter households safely, reducing lag time during recovery and ensuring both community continuity and economic continuity.

Potential Spillover Impacts to Other Sectors

If a mitigation assessment exposes previously unknown risks that are not able to be mitigated, it is possible that individual homeowners or entire communities would need to be relocated. This would affect all other features of the built environment (transportation, land, water, public buildings).

Potential Costs

Potential up-front costs: $30 million–$80 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $30 million–$80 million in total estimated costs

Estimates range from $30 million to $80 million, with the best estimate at $40 million. This estimate includes funds for municipalities to work with experienced community-based organizations or nongovernmental organizations to conduct comprehensive assessments of housing structures in high-risk areas, develop mitigation strategies, and work with homeowners to understand their individualized risk and how it can be mitigated. Costs should include an education and outreach campaign to homeowners, development or purchase of an assessment tool, and creation and hosting of a central data platform to store information and to develop and provide centralized guidance on assessment methodology.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, nongovernment sources

Potential Implementers

Puerto Rico Planning Board, Puerto Rico Department of Housing, municipal governments

Potential Pitfalls

A shortage of adequately trained building inspectors or inadequate assessment tools that do not detail true structural damage could lead to incomplete or low-quality inspections. Buildings, particularly those built informally, might not be able to be sufficiently retrofitted to comply with code, which could lead to a building that is only partially code-compliant or that would require a complete reconstruction.

Likely Precursors

Mapping of areas vulnerable to natural hazard risks to determine where inspections are needed

HOU 4
Make Owner-Occupied Homes More Resilient (Less Vulnerable to Natural Hazards)

Sectors Impacted

Transportation, Economic, Communications and Information Technology, Community Planning and Capacity Building, Energy, Health and Social Services, Municipalities, Water

Issue/Problem Being Solved

Owner-occupied housing units that were not substantially damaged by Hurricanes Irma and Maria may still be at considerable risk of damage in future weather and climate events.

Description

In concert with funding for identifying structures most vulnerable to flood, wind, landslide, and earthquake hazards (HOU 3, Assess Vulnerability of Non-Substantially Damaged Homes), this course of action would provide funding to improve these structures to better withstand these risks or to relocate households to safer areas. This could include mitigation work to protect groups of structures or to relocate groups of households, where it is cost-effective to do so. Relocation should take place only if the risk conditions of the site cannot be reasonably mitigated. This program would have an income-eligibility cutoff to target lower-income households.

Potential Benefits

A more resilient housing stock would lessen the impact of future disasters for residents and communities, reducing the human and economic toll that disasters inflict and reducing dependency on federal programs to support repair and recovery. An example of such a program is the Home Protection Roofing Program, which was implemented after Hurricane Marilyn in 1995 in the U.S. Virgin Islands using Hazard Mitigation Grant Program funding. No structural damage was observed in homes with the new roof design as a result of Hurricane Maria. This course of action would seek to leverage existing federal programs, such as the U.S. Department of Energy Weatherization Program, to potentially reduce costs of the program and maximize the federal dollars coming into Puerto Rico.

Potential Spillover Impacts to Other Sectors

Reshaping the footprint of the built environment has the chance to make infrastructure delivery more efficient, affecting the Water, Transportation, and Energy sectors. If mitigation efforts are extended to entire communities, there is significant need for municipal and capacity building to gain residents' buy-in for the mitigation process. This course of action could also

affect the Health and Social Services sector. Community needs in these sectors may shift as mitigation alleviates problems, such as recurring infections due to mold.

Potential Costs

Potential up-front costs: $7.7 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $7.7 billion in total estimated costs

The best estimate is $7.7 billion. This COA applies only to owner-occupied structures and might be expected to apply to roughly 55 percent of the 940,000 structures. An initial estimate of the cost of this COA for the resulting 516,000 structures would be on the order of $7.7 billion (55 percent of $14.0 billion). Restricting the program to households with income below a certain level would further reduce the cost of the program, but additional analysis is needed to provide an estimate of the extent of the reduction.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, FEMA Pre-Disaster Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, private insurance, nongovernment sources

Potential Implementers

Puerto Rico Department of Housing, municipal governments

Potential Pitfalls

Uncertain property titles could pose hurdles because a title is a prerequisite for receiving federal assistance for structure repair or mitigation.

Likely Precursors

Coordinate with the infrastructure sectors (Energy, Water, Transportation) to ensure that no undue burden is placed on those resources and that relocation or rebuilding is in line with approved land-use plans. Assess whether reconstruction, relocation, or mitigation is the best course of action for an existing structure or group of structures in a community, based on future natural hazard risk (HOU 3, Assess Vulnerability of Non-Substantially Damaged Homes). Development, outreach, education, and enforcement of mitigation standards are also precursors.

HOU 5
Collect, Integrate, and Map Housing Sector Data

Sectors Impacted

Housing, Municipalities, Community Planning and Capacity Building

Issue/Problem Being Solved

There is a lack of consistent and centralized housing data available to the public, the government of Puerto Rico, and municipalities for making planning-related decisions.

Description

This course of action would conduct research, data analysis, planning, and integrated mapping of housing data through the creation of an integrated database. This course of action would integrate databases from multiple federal and local government sources and private sources, including cadaster information (property taxes), titling information and permitting information, natural disaster vulnerabilities, and mapping of informal housing.

Potential Benefits

An integrated permitting, property tax, and titling system overlaid with physical characteristics would allow the government to know the location and status of all structures. The data integration that indicates residential locations and population centers would aid civic planning for the efficient location and delivery of emergency and other public services, such as police, fire, hospitals, and schools. It would also improve overall state and municipal government efforts to increase property tax revenues.

Potential Spillover Impacts to Other Sectors

Sectors that rely on housing data would be positively affected by this course of action. Commonwealth agencies and municipal governments, as well as communities and individuals who need to clarify title/ownership, would benefit from an integrated housing data system. Planners in the Puerto Rico Department of Housing and municipal offices would also benefit from this course of action. Governmental agencies dealing with economic development and management would benefit from faster permitting systems and property tax collection.

Potential Costs

Potential up-front costs: $30 million–$50 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $30 million–$50 million in total estimated costs

The cost of a permitting system developed by municipalities is around $400,000. The cost of using a centralized Oficina de Gerencia de Permisos (Office of Permit Management; OGPe) system and integrating property tax and titling systems should be around $31.2 million ($400,000 × 78 municipalities). Available vacant and rental housing information would require integration from several sources, including banks, realtors, insurance companies, and social network apps. Costs of integration for an application to collect and display housing data would be an approximation using cost information from other apps in the market. The cost should be around $3 million–$5 million. That estimate is based on predicted costs from municipalities, mapping tax properties (with the Statewide Longitudinal Data System), and industry experts and center on the following tasks and assumptions: Permitting, titling, and taxing information is available from government of Puerto Rico agencies and is already in digital format. This budget assumes that OGPe, the Statewide Longitudinal Data System, and the Puerto Rico Department of Justice have digitized data ready to use.

Adding the mapping component could cost an additional $5 million, as the Puerto Rico Planning Board may need to add to its data and staffing capabilities.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery

Potential Implementers

Puerto Rico Planning Board, Puerto Rico Department of Housing, Puerto Rico Department of Justice, OGPe, Municipal Revenues Collection Center, private-sector firms (banks, insurance)

Potential Pitfalls

Data integration in government is always a challenge. Cooperation from data originators, the government of Puerto Rico, municipalities, and the private sector is crucial, as is support from other sectors. Data on the housing market (sales, rentals, foreclosures) are mostly maintained by third parties, such as realtors and banks. Obtaining these data from these sources would likely require legislation to have them readily share with government agencies.

Likely Precursors

Efforts from Municipal Revenues Collection Center and housing cadastral mapping to integrate titling information with tax property information

HOU 6
Enforce Land Use Plans and Improve Compliance with Building Permitting

Sectors Impacted

Housing, Water, Energy, Communications and Information Technology, Transportation, Health and Social Services, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

There is a lack of concurrence between municipal plans and the Puerto Rico Land Use Plan, and a lack of compliance with building codes and enforcement of regulations during construction.[109]

Description

This course of action would provide funding for municipalities to update and align their existing municipal land use plans with the State Land Use Plan of 2015. This would ensure concurrence in planning for high-risk areas so that zoning and regulations clearly identify what land use and construction are permitted. This course of action would also provide funding to develop municipal land use plans for municipalities that still lack them. It also implements the goals established in the State Land Use Plan, which includes the broad strategy to align housing with centers of economic activity.

This course of action would also improve the permitting process by increasing capacity at both the commonwealth and municipal levels to approve permits and inspect projects in process. This is intended to reduce delays and costs in the building permit process (including liability issues). Additionally, this course of action would implement a program for the licensing of contractors, intended to reduce the number of informal builders who might be contributing to noncompliance with building codes.

Potential Benefits

Construction in risky areas would be avoided. Alignment of housing with centers of economic activity would provide residents with connectivity to local jobs, services (education, health, recreation, etc.), and transportation hubs. This would also reduce the burden of providing additional services for new construction and housing in remote areas.

Having a housing stock that is code compliant would result in families and communities that are more resilient to natural hazards. Creating a path toward code-compliance of nonpermitted structures would allow homeowners and building owners and landlords to access financial resources and tools, insurance, and postdisaster funds that they previously could not.

[109] Puerto Rico Planning Board, *Puerto Rico Land Use Plan*, 2015.

Potential Spillover Impacts to Other Sectors

Land-use plans and building code compliance would affect the infrastructure and services covering those homes (Energy, Water, Transportation, Education, Health and Social Services). Land-use controls and construction code enforcement would likely affect the market value of housing, a significant sector of the economy.

Potential Costs[110]

Potential up-front costs: $25 million–$64 million in estimated up-front costs
Potential recurring costs: $77 million–$250 million in estimated recurring costs (11 years)
Potential total costs: $100 million–$320 million in total estimated costs

The best estimate of up-front costs is $53 million, with a range between $25 million and $64 million. The best estimate of ongoing costs is $144 million, with a range between $77 million and $250 million (over 11 years, at which time the program is assumed to become self-supporting). Thus, the best estimate for total costs is $197 million, with a range between $100 million and $320 million.

The up-front costs include $16 million in one-time programs—$5 million for community education campaigns in conjunction with community-based organizations and nongovernmental organizations and $11 million for preparing or updating municipal land-use plans and aligning with the Puerto Rico–wide plan. The up-front costs also include the first year of subsidy that would be needed for expanding the capacity of agencies, such as the Puerto Rico Planning Board and the Office of Permit Management, for full-fledged land-use and building code enforcement divisions. The ongoing operating costs include year 2 through year 10 of program implementation for this capacity expansion. This estimated the annual operating costs that would bring the entirety of Puerto Rico up to a spending level that is consistent with other jurisdictions in the continental United States.

Potential Funding Mechanism

Community Development Block Grant–Disaster Recovery, Hazard Mitigation Grant Program, government of Puerto Rico, nongovernment sources

Potential Implementers

Puerto Rico Planning Board, Office of Permit Management, municipal governments

[110] We have subtracted $9 million from these costs to account for the "Advance Assistance—Code Enforcement" recovery funding that has been allotted but not yet obligated by the FEMA DR 4339 Hazard Mitigation Grant Program for the purpose of supporting the Puerto Rico Planning Board's enforcement mission.

Potential Pitfalls

Challenges to this course of action would include inability to access or train qualified inspectors, inability to incentivize the informal housing sector to transition to being part of the formal housing sector, opposition of environmentalists to fast-tracking the permitting process and the reluctance to change from those who currently participate in inefficient steps in the permitting process, loss of permit fees associated with eliminating irrelevant permits as the permitting process is improved, and opposition by informal builders to training and certification.

Likely Precursors

HOU 5 (Collect, Integrate, and Map Housing Sector Data) would be especially important for coordinating enforcement. Assessment and evaluation to approximate the numbers of inspectors, adjudicators, planners, and administrators would be necessary. Capacity building at the municipal level would also be necessary to prepare for implementation of the State Land Use Plan.

HOU 7
Assess Need for—and Adopt and Implement Programs to Provide—Additional Subsidized Rental Housing and Special Housing

Sectors Impacted

Housing, Energy, Water, Transportation, Economic

Issue/Problem Being Solved

The current and long-term demand for quality affordable rental and homeless housing in Puerto Rico.

Description

Puerto Rico has 57,500 public-housing units. Approximately 30,000 residents use Section 8 Housing Choice vouchers, and 18,778 live in project-based Section 8 units. Another 31,258 are on the Puerto Rico Public Housing Authority waiting list, and roughly 10,000 are on the Section 8 waiting list. This course of action would address the existing and future supply of public or subsidized rental and homeless housing for lower-income households and special housing for people with or without disabilities, such as people with access and functional needs, seniors, veterans, and homeless people.

Potential Benefits

This course of action would reduce the public- and assisted-housing waiting list by increasing the inventory of affordable housing.

Potential Spillover Impacts to Other Sectors

Providing stable housing would have a positive impact on health, access to education, and economic self-sufficiency.

Potential Costs

Potential up-front costs: $250 million–$1.7 billion in estimated up-front costs
Potential recurring costs: $1.1 billion–$2.8 billion in estimated recurring costs
Potential total costs: $1.4 billion–$4.4 billion in total estimated costs

Additional annual costs to provide gap financing and rental assistance funds are estimated at $155 million.

Compared with the continental United States, construction costs in Puerto Rico are higher, because of the cost of imported materials. The hurricanes have created more volatility in construction pricing. Equity raised from low-income-housing tax credits and debt underwritten with rental income is insufficient to cover the development cost of new affordable units. There is

a gap between the total development cost and the debt and equity that can be supported by the project and that must be financed with other "soft" sources, such as grants or silent second mortgages. The rough cost estimate is $120,000 in gap financing per unit. For example, to produce the 14,000 new affordable units described in the *Puerto Rico State Housing Plan: Fiscal Years 2014–2018*,[111] gap funds costing $1,680,000,000 are required. The underwriting income in Puerto Rico that produces new housing also requires an additional award of new Section 8 project-based vouchers. Accounting for 14,000 new vouchers for a 20-year initial Housing Assistance Payment contract would equal $1,411,200,000 in rental assistance.

Potential Funding Mechanisms

U.S. Department of Housing and Urban Development, Low-Income Housing Tax Credit, Puerto Rico Public Housing Authority, nongovernment sources, U.S. Department of Agriculture

Potential Implementers

Puerto Rico Housing Finance Authority, Puerto Rico Public Housing Authority, U.S. Department of Housing and Urban Development, U.S. Department of Agriculture Rural Development Program

Potential Pitfalls

Recapitalizing existing affordable housing properties and producing new affordable housing must rely on more-deliberate capital investment in subsidized housing. The lack of additional funding sources may make reaching the goal difficult.

Likely Precursors

Conduct a needs assessment of the overall demand for subsidized rental housing and special housing for people with or without disabilities, such as people with access and functional needs, seniors, veterans, and homeless people. Provide technical assistance to housing agencies to maximize utilization of existing financing tools, such as Rental Assistance Demonstration Program funding. Provide technical assistance to local community housing development organizations and nonprofit developers to use the financing sources available and to identify potential developer partners to assist in predevelopment financing of new affordable housing.

[111] Governor of Puerto Rico, *Puerto Rico State Housing Plan: Fiscal Years 2014–2018*, San Juan: Government of Puerto Rico, November 2014.

HOU 8
Increase Adoption of Adequate Wind and Flood Insurance for Homeowners and Renters

Sectors Impacted

Housing, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

More properties need to be insured to improve recovery and enhance resiliency. Only about 30% of homes in Puerto Rico carry wind insurance. About 4% of households have flood insurance, even though approximately 10% of residential structures are in high-risk flood areas.

Description

This course of action would increase the number of homeowners and renters with wind and flood insurance by (1) increasing education and outreach campaigns about insurance coverages and their cost, (2) studying whether other types of low-cost insurance products should be developed, and (3) identifying financial assistance options and funding an assistance program to help purchase or reduce the cost of insurance.

Potential Benefits

Increasing the number of properties in Puerto Rico with insurance could lower the reliance on federal and state aid after a storm. Higher take-up rates could also result in a speedier recovery for the resident, the community, and the commonwealth after a future natural disaster.

Potential Spillover Impacts to Other Sectors

Insurance introduces dollars back into the community more quickly than many types of federal and state aid, thereby accelerating the economic recovery.

Potential Costs

Potential up-front costs: $10 million–$40 million in estimated up-front costs
Potential recurring costs: $495 million–$935 million in estimated recurring costs (11 years)
Potential total costs: $500 million–$1.1 billion in total estimated costs

The up-front cost covers education campaigns and studies. An affordability program that provides partial premium subsidies to lower-income households is projected to cost $65 million annually.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, FEMA National Flood Insurance Program, Hazard Mitigation Grant Program, private insurance, Puerto Rico Housing Financing Authority, Puerto Rico Department of Housing

Potential Implementers

Office of the Commissioner of Insurance, Office of the Commissioner of Financial Institutions, insurance companies

Potential Pitfalls

Insurance that is not mandatory has historically had low take-up rates. In addition, many households living in the high-risk Special Flood Hazard Areas are low income. These households might not be able to afford to move to lower-risk areas or to take on the additional cost of insurance. Without a mandatory purchase requirement, Puerto Rico might not see much of an increase in wind and flood insurance take-up.

Likely Precursors

An integrated data system on housing (HOU 5, Collect, Integrate, and Map Housing Sector Data) would provide information regarding where homes are located related to natural hazard risks, who is in informal structures, and the location of special communities, which would help target the education and outreach campaign.

HOU 9
Reduce Mortgage Delinquencies and Foreclosures

Sectors Impacted

Housing, Economic

Issue/Problem Being Solved

Mortgage foreclosures and delinquencies rose sharply following Hurricane Maria, peaking in November and December 2017 and recovering moderately in the first half of 2018. As of April 2018, approximately 50,600 hurricane-related delinquencies remained. About 41,100 are considered severe delinquencies (more than 90 days past due),[112] which indicates households in greater economic distress. The mortgage delinquency and foreclosure landscape is unlikely to change significantly without intervention. A moratorium on mortgage payments that was issued after the hurricane by the Federal Housing Administration was extended until August 16, 2018, and lenders are unsure what portion of borrowers would resume payments.

Description

This course of action would limit the number of delinquencies and foreclosures, which have increased since Hurricanes Irma and Maria, by implementing monthly payment-assistance programs.

Potential Benefits

This course of action is intended to stabilize rates of foreclosure to prehurricane levels. Beyond immediate housing needs, this course of action would aid the well-being of owners by promoting their financial and residential stability.

Potential Spillover Impacts to Other Sectors

This course of action would positively affect the Economic sector because stable housing helps encourage stable economic conditions for residents. In the long term, this would lessen the need for government assistance and strengthen the commonwealth economy.

Potential Costs

Potential up-front costs: $85 million–$180 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $85 million–$180 million in total estimated costs

[112] Black Knight, *Black Knight's April 2018 Mortgage Monitor*, June 4, 2018.

This estimate assumes that 20,000 households with hurricane-related mortgage delinquencies as of August 2018 are, on average, 6 months behind on payments, with an average mortgage of $500 per month.[113] The low and high estimates assume enrolling households that are 3-months and 6-months delinquent, on average.

Estimates also include $10 million for administrative costs and cost-effective financial counseling programs.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, private sector, nongovernment sources

Potential Implementers

Puerto Rico Housing Finance Authority, Puerto Rico Department of Housing, Mortgage Bankers Association, private lenders, insurance companies

Potential Pitfalls

This course of action could fail because mortgage holders remain unaware of the loss-mitigation program opportunities. Communication about these programs with the general population, and specifically those individuals most at risk, is key.

Likely Precursors

The full impact of the moratorium would need to be assessed, as would the underlying reasons why borrowers have become delinquent on their payments. This course of action would also need to incorporate insurance information. Homeowner's insurance premiums on mortgaged properties tend to be bundled as part of a mortgage payment. So, if households are late on their mortgage payments, they are also likely delinquent on insurance payments. This can jeopardize the homeowner's ability to make insurance claims.

[113] This number of households reduces the assumption of 50,000 households with hurricane-related delinquencies from April 2018 to 20,000 households based on August 2018 data.

HOU 10
Assess and Renovate Vacant and Blighted Properties

Sectors Impacted

Housing, Economic, Education, Energy, Health and Social Services, Municipalities, Public Buildings, Transportation, Water

Issue/Problem Being Solved

In 2016, there were an estimated 336,000 vacant properties in Puerto Rico. Of these, 178,000 were not listed on long-term rental, short-term rental, or sale markets. Vacancies are expected to continue increasing as a result of foreclosure trends and people moving to the continental United States after the hurricanes.

Description

This course of action would rehabilitate, redevelop, or demolish abandoned and blighted residential and commercial properties. This course of action would assess the true extent of the problem by creating a database to inventory and classify vacant properties (e.g., unoccupied vacation, for-sale, long-term abandoned). It would then develop strategies to clarify legal ownership of properties and develop pathways to incentivize redevelopment or acquire properties for demolition or rehabilitation. With community engagement, this course of action would determine end uses of properties, including the development of affordable rental housing, rent-to-own programs, community gardens, and side lots for adjacent owners. The community should consider giving priority to preserving properties listed, or eligible for listing, on the National Register of Historic Places.

Potential Benefits

The removal of blighted properties either through demolition or renovation increases the value of surrounding properties, increasing economic and community opportunities. Rehabilitating vacant properties reintroduces those properties into the private marketplace and could provide housing to persons displaced by the hurricanes and those families that are underhoused.

Potential Spillover Impacts to Other Sectors

This course of action would affect community planning and capacity building and municipalities by engaging the community in the decisionmaking process to determine the outcome of these properties. It would also improve social cohesion by removing structures that portray a sense of blight, reduce property values, and increase crime. This course of action should add to the economic development of the community and should affect health and social

services and education, as housing is better aligned with centers of economic activity and social services.

Potential Costs

Potential up-front costs: $2 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2 billion in total estimated costs

This estimate assumes that 60% of the 178,000 vacant properties not for sale or on the rental market would be rehabilitated by families in need of alternative housing (HOU 1, Assess, Repair, Rehabilitate, or Relocate Substantially-Damaged, Owner-Occupied Homes, and HOU 4, Make Owner-Occupied Homes More Resilient [Less Vulnerable to Natural Hazards]) or are not habitable and need to be demolished. Additionally, 40% of the properties would be covered under this course of action and need approximately $25,000 in mitigation costs. Estimates also include $10 million for an assessment inventory and inspection of properties across all municipalities and $10 million for strategies and legal assistance for gaining proper ownership of properties.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of the Interior, private sector, nongovernment sources

Potential Implementers

Puerto Rico Housing Finance Authority, Puerto Rico Department of Housing, Puerto Rico Planning Board, municipalities, State Historic Preservation Office

Potential Pitfalls

Potential pitfalls of this course of action include the lack of a systematic way of identifying and verifying ownership, a lack of capacity within municipalities to engage in potentially lengthy legal proceedings and negotiations, a burden on the court system, high legal and transaction costs, political controversy over what to do with the structures, and unknown historical status of the property.

Likely Precursors

HOU 5 (Collect, Integrate, and Map Housing Sector Data) and HOU 3 (Assess Vulnerability of Non-Substantially Damaged Homes). This course of action would be dependent on private-sector construction workers, civil engineers, and architects who can build and repair the structures, as well as an oversight function to ensure that all structural changes are made to code.

HOU 11
Improve the Address System

Sectors Impacted

Housing, Municipalities, Community Planning and Capacity Building, Water, Energy, Transportation

Issue/Problem Being Solved

Puerto Rico has an inconsistent and inaccurate address system.

Description

Puerto Rico has an inconsistent, inaccurate address system, which poses several challenges. The first is that the 2-line address does not comport with standard forms, especially federal forms. Many programs need to match addresses to verify eligibility, which has resulted in denial of services for residents of Puerto Rico. The poor address system also creates problems for first responders in locating emergencies, hampers the efforts of planners and social scientists to analyze the built environment, and hampers the operations of service and utility providers and package delivery services.

Potential Benefits

A less complex street address system would improve the ability of emergency responders to locate structures. It would also improve the ability of planners and social service providers to map and analyze urban problems and develop solutions. A better address system would also improve the day-to-day efficiency of mail delivery and simplify the operations of entities, such as water and electricity providers, that rely on a property address to provide or bill for services.

Potential Spillover Impacts to Other Sectors

Every sector that relies on addresses to provide or bill for services would be positively affected by this course of action. Commonwealth agencies and local governments would benefit from an improved address system.

Potential Costs

Potential up-front costs: $75 million–$200 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $75 million–$200 million in total estimated costs

The midpoint estimate is based on the following assumptions:

Five staff are needed for 2 years in each municipality, on average, to develop the new street name and numbering system, which would include soliciting public input. This amounts to

approximately $48 million (78 municipalities × 5 staff per municipality × 2 years × $62,000 per staff position).

One crew of 3 people can install new street signs and address numbers for an average 50 residential units a day (10,000 per year). For the approximately 1.5 million housing units, this comes to $28 million (150 crew years × [3 × $62,000 per crew year]).

Printed street signs, poles, and administration costs are estimated to cost $30 million (10,000 signs and poles at $200 each), with up to an additional $10 million in administrative and oversight costs.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Puerto Rico Department of Housing, Puerto Rico Planning Board, Puerto Rico Department of Justice, Municipal Revenues Collection Center, Office of Permit Management, municipal governments, U.S. Postal Service

Potential Pitfalls

Permanently revising the address system would disrupt current systems of record keeping and legal records. This could result in legal challenges and could trigger latent challenges to unresolved title issues.

Likely Precursors

None

HOU 12
Register Properties and Resolve Titling Issues

Sectors Impacted

Housing, Municipalities, Community Planning and Capacity Building, Economic, Water, Energy, Transportation

Issue/Problem Being Solved

Many property owners in Puerto Rico lack titles to their properties. This is true for both structures and land and for both formally and informally built housing, and where titles exist, there are often incomplete property registries. Currently, there is no requirement to register properties and obtain titles.

Description

This course of action would resolve homeowner title issues, improve the titling process, and promote the registration of all titles in the official property registry maintained by the government. This effort should reduce future uncertainty related to property ownership. It would create a consistent process for determining title, including specifying what types of documentation would be acceptable. It would also create and disseminate information describing the title registration process; the importance and benefits of obtaining a clear property title; and potential downsides for failing to establish title and register properties.

Potential Benefits

The immediate benefit of registering and titling residential properties in Puerto Rico would be to allow more homeowners affected by Hurricanes Irma and Maria to get access to disaster recovery funds that they have been denied because of an inability to prove ownership. Likewise, future disaster recovery funds would be distributed more rapidly because of clarified home ownership. Clear title would also provide other opportunities for homeowners to use their homes as equity, such as access to loans and other financing.

Requiring property registration would aid in knowing the full number of residential structures on the island, and the data drawn from this process could be applied to a variety of purposes, including building a unified parcel registry; developing a robust addressing system for the island, therefore enabling effective emergency services responses and mail delivery; improving the collection of property taxes; and developing a better land-use plan.

Potential Spillover Impacts to Other Sectors

By improving property tax collection, this course of action could provide a more stable source of funding for government services. Additionally, this course of action would likely

create large demand for real estate lawyers and extra demands on the court system to resolve property disputes.

Potential Costs

Potential up-front costs: $800 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $800 million in total estimated costs

The midpoint estimate assumes the following: municipal administration and operation at a cost $10 million for each of the 78 municipalities; $24.1 million for 1 new administrative staff per municipality for 5 years, on average, to promote, manage, and administer the property titling process and resolution of titling issues (78 municipalities × 1 staff per municipality × 5 years × $62,000 per staff position); and a commonwealth-wide outreach and education campaign via television ($250,000 for development and $390,000 per year for 260 spots at $1,500), radio (free public service announcements), and community and social media ($250,000 per year). These are approximations based on discussions with informed stakeholders and published estimates.

Potential Funding Mechanisms

Individual Assistance, Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Municipal governments, Puerto Rico Department of Justice, Office of Permit Management, Puerto Rico Planning Board, Municipal Revenues Collection Center, Puerto Rico Department of Housing

Potential Pitfalls

Households with long-standing residence at a location may be denied title to the unit or the land, prompting legal battles and possibly widespread unrest and pressure on politicians and public-sector employees to relax the titling process or create exemptions. There would be a need to ensure that the information technology infrastructure at the Puerto Rico Department of Justice and Municipal Revenues Collection Center could accommodate a massive uptick of property (land or house) registrations.

Likely Precursors

HOU 5 (Collect, Integrate, and Map Housing Sector Data) and an assessment of the most-common issues that informal housing would face in securing title, as well as a cost estimate by building typology of the corrective actions needed to secure title.

Municipalities Sector

COA Number	Title
MUN 1	Establish an Emergency Fund for the Government of Puerto Rico and Municipalities
MUN 2	Create Regional Economic Development Plans
MUN 3	Provide Technical Assistance to Repopulate Urban Centers
MUN 4	Build the Capacity of Municipalities to Apply for, Secure, and Manage Grants
MUN 5	Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance
MUN 6	Create and Maintain Central Repository of Municipal Assets and Associated Conditions
MUN 7	Create and Implement a Model of Regional Service Delivery and Planning
MUN 8	Provide Municipalities with Technical Assistance and Support for Best Practices in Public Management and Operations
MUN 9	Enhance Transparency and Improve Service Delivery Through Municipal Service Request Fulfillment and Tracking Systems
MUN 10	Provide Technical Assistance to Improve Municipal Finances by Generating Additional Revenues, Reducing Costs, and Balancing Budgets
MUN 11	Develop and Publicly Report Key Municipal Performance Indicators

MUN 1
Establish an Emergency Fund for the Government of Puerto Rico and Municipalities

Sectors Impacted

Municipalities, Economic, Community Planning and Capacity Building

Issue/Problem Being Solved

Many municipal governments are in financial distress and lack the economic means to address expenses from emergencies and natural disasters.

Description

This course of action would establish an emergency fund for the government of Puerto Rico and municipalities for responding to and recovering from disasters. This would allow each municipality to access financial assistance for extraordinary expenses not immediately covered by day-to-day operating budgets or by insurance in the event of emergencies and natural disasters. The emergency fund could be used and replenished as needed, but it should be governed by rules restricting its use to emergencies and natural disasters. Benefits would occur during the next major emergency and would be ongoing and accrue to all of Puerto Rico.

Potential Benefits

This course of action would improve municipal governments' fiscal resilience in future emergencies and would improve the speed of response and recovery.

Potential Spillover Impacts to Other Sectors

This course of action would improve municipal credit and financial-worthiness ratings, provide budget relief, and promote local economic development.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

No costs: The emergency fund would be financed with commonwealth and municipal revenues and the appropriation of existing resources.

Potential Funding Mechanisms

Not applicable

Potential Implementers

Governor of Puerto Rico, Legislative Assembly, Puerto Rico Public Buildings Authority

Potential Pitfalls

This course of action could reduce funding available for other purposes. It may require legal or legislative changes at the commonwealth or municipal level. It may be difficult to determine how to allocate limited funding after an emergency. Also, it could be a disincentive to invest in existing municipal-level emergency funds.

Likely Precursors

None

MUN 2
Create Regional Economic Development Plans

Sectors Impacted

Municipalities, Economic

Issue/Problem Being Solved

Municipalities need to foster economic development to increase tax receipts, reduce unemployment, and fully recover from Hurricanes Irma and Maria, but many municipalities do not have economic development plans.

Description

This course of action would provide technical assistance to municipalities to create municipal-level and regional economic plans that align with the overall economic development goals of the government of Puerto Rico. Regional economic development plans would include assessments of the available workforce and would identify which industry areas have the highest potential in each region. The plans would encourage drawing on locally available workforces, providing additional education and training where needed, and identifying infrastructure needed to support industry locally. Benefits would begin after 1 year, with 10 years until full benefits, and with benefits accruing to all of Puerto Rico.

Potential Benefits

Regional economic development planning would ensure that each municipality has—or is part of—a plan for economic development to improve its workforce's outcomes and increase the underlying level of economic activity, thereby allowing for additional revenues to support municipal government and local economies.

Potential Spillover Impacts to Other Sectors

This course of action could improve outcomes across multiple sectors by fostering the development of a skilled workforce matched to area-appropriate industries throughout Puerto Rico.

Potential Costs

Potential up-front costs: $6 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $6 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Department of Labor, municipal governments

Potential Implementers

Government of Puerto Rico, municipal governments, Small Business Administration

Potential Pitfalls

Economic development plans are difficult to develop in any context because markets, technology, and other factors change rapidly and may defy prediction. Municipal governments may lack the capacity to follow through; people may leave Puerto Rico at too rapid a pace; and local workforces may not be a match for industry needs.

Likely Precursors

None

MUN 3
Provide Technical Assistance to Repopulate Urban Centers

Sectors Impacted

Municipalities, Community Planning and Capacity Building, Economic, Education, Energy, Health and Social Services, Transportation, Water

Issue/Problem Being Solved

Mayors report that urban centers across Puerto Rico have been affected by people leaving Puerto Rico, and there are often significant stocks of underutilized or abandoned housing and public buildings. Many municipalities also have small, remotely located communities that are difficult to access but are home to aging populations or populations who were disproportionately affected by the hurricanes. Compared with urban centers, remote communities are more prone to loss of power, potable water, and other resources after natural disasters because of their remoteness and lack of centralized infrastructure.

Description

This course of action would provide technical assistance to set up incentives for individuals and families living in outlying communities to relocate to urban centers, where it is easier and more efficient to provide services to citizens. This course of action would also make it easier for municipalities to reclaim and repurpose abandoned properties in urban centers. Benefits would begin after 1 year and would accrue throughout Puerto Rico.

Potential Benefits

Relocating families to urban centers would reduce the costs of providing services by concentrating populations in areas that are easier for governments to access and provide services to, including emergency response and wellness checks. Reducing the amount of blight and abandoned property and increasing populations in urban areas would also spur economic activity and development.

Potential Spillover Impacts to Other Sectors

Relocating families to urban centers could increase economic activity, improve access to education and health care, reduce the need to maintain remote roads and provide energy and water to remote communities, and make municipalities more resilient all around. Urban centers promote human interaction, which is also important for community resilience.

Potential Costs

Potential up-front costs: $1.9 million in estimated up-front costs (3 years)
Potential recurring costs: —

Potential total costs: $1.9 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Governor of Puerto Rico, municipal governments

Potential Pitfalls

Encouraging citizens to move out of their existing communities and into urban centers could generate political controversy. Many individuals may not wish to relocate, regardless of the type or amount of incentive provided.

Likely Precursors

None

MUN 4
Build the Capacity of Municipalities to Apply for, Secure, and Manage Grants

Sectors Impacted

Community Planning and Capacity Building, Economic, Transportation, Housing, Public Buildings, Water, Health and Social Services, Energy, Communications and Information Technology, Education, Natural and Cultural Resources

Issue/Problem Being Solved

Many municipalities lack the capacity and training to adequately apply for, secure, and manage federal and other grants, hindering their ability to receive and effectively manage much-needed funding.

Description

This course of action would provide technical assistance to increase municipal governments' capacity to successfully apply for, secure, and manage grants from all sources (e.g., federal government, private foundations, other public or private sources). This course of action would assess individual municipal governments' current capacity to apply for and manage grants and would provide training and posttraining mentoring to municipal staff where needed.

Potential Benefits

This course of action would improve the ability of municipal governments throughout Puerto Rico to access and successfully execute grant funding of all types, including—most important—federal grants available for recovery efforts. Implementation of this course of action would improve the overall financial health of municipal governments by increasing funding for health, education, and other services, while also promoting fiscal accountability. Building a successful record of managing grant funds would make it easier to obtain funding in the future.

Potential Spillover Impacts to Other Sectors

Improvements in grant application and management would likely lead to improvements in the overall capacity of municipal governments to effectively manage their resources and budgets, which could have wide-ranging benefits. In addition, the impacts of any additional grant funds received because of improved capacity to acquire grants could accrue to any sector and reach well beyond recovery issues.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $3.4 million in estimated recurring costs (11 years)

Potential total costs: $3.4 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Central Office of Recovery, Reconstruction, and Resiliency; Puerto Rico Office of Management and Budget; University of Puerto Rico; municipal governments

Potential Pitfalls

The impact of this course of action could be affected by Puerto Rico's overall lack of a track record in grantmaking, although some municipalities have more experience and success than others and could be looked to as models. So-called brain drain, associated with the hurricanes and already problematic municipal budgets, could limit the availability of the personnel needed to benefit from technical assistance.

Likely Precursors

None

MUN 5
Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance

Sectors Impacted

Municipalities, Economic, Public Buildings, Health and Social Services

Issue/Problem Being Solved

Many public buildings are being closed or are abandoned and could be used by municipal governments for other purposes.

Description

This course of action would reduce barriers to transferring property to municipal governments and provide technical assistance to help municipalities navigate the process. The government of Puerto Rico is closing more than 200 schools, and almost every municipality has a number of other closed or unused public buildings. These buildings have the potential to be an eyesore and a public safety hazard, and the costs of maintaining empty buildings are a drain on scarce government resources. Benefits would begin within 1 year and would accrue across all of Puerto Rico.

Potential Benefits

This course of action would reduce costs to the commonwealth associated with maintaining closed facilities, reduce potential risk to municipalities from abandoned facilities, and provide municipalities and the communities they serve with additional facilities at low cost. This course of action would put previously made public investments back into active use.

Potential Spillover Impacts to Other Sectors

Depending on how reclaimed facilities are used, they could create benefits to the economy and across multiple sectors.

Potential Costs

Potential up-front costs: $2.7 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $2.7 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery

Potential Implementers

Government of Puerto Rico, municipal governments

Potential Pitfalls

It may be unclear which public buildings are needed by the commonwealth and municipalities. It may be more lucrative to sell facilities to third parties than to transfer them to municipal governments.

Likely Precursors

None

MUN 6
Create and Maintain Central Repository of Municipal Assets and Associated Conditions

Sectors Impacted

Municipalities, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

There is no central repository for data on assets that are owned and maintained by municipalities. The lack of a central database or repository of municipally owned assets has affected Puerto Rico's ability to respond to and recover from Hurricanes Irma and Maria. This is particularly true in areas where ownership of buildings, roads, and other infrastructure is important for filing claims with the federal government.

Description

This course of action would create and maintain a central repository of municipal assets and their associated conditions. Data on ownership of buildings, roads, and other infrastructure may already exist at the local level, but they need to be updated, standardized, and made readily accessible. Benefits would begin within 1 year and would accrue across all of Puerto Rico.

Potential Benefits

This course of action would help municipalities and the government of Puerto Rico deconflict asset management, effectively leverage recovery resources, and make better use of existing assets.

Potential Spillover Impacts to Other Sectors

Clarifying and resolving asset ownership—and making this information readily accessible—could identify underused or unneeded resources, which could be repurposed or potentially sold to third parties.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $13 million in estimated recurring costs (11 years)
Potential total costs: $13 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, Community Development Block Grant–Disaster Recovery, nongovernment sources

Potential Implementers

Government of Puerto Rico, municipal mayors

Potential Pitfalls

There may be significant ambiguity regarding the ownership of some assets that may be difficult to resolve. There may be resistance to centralizing information or adopting a standardized platform.

Likely Precursors

None

MUN 7
Create and Implement a Model of Regional Service Delivery and Planning

Sectors Impacted

Municipalities, Community Planning and Capacity Building, Communications and Information Technology, Energy, Health and Social Services, Natural and Cultural Resources, Transportation

Issue/Problem Being Solved

Substantial overlap in service delivery between the government of Puerto Rico and municipal governments complicated the response to the hurricanes. Municipalities are in financial distress but are not leveraging economies of scale for planning or delivering services. Municipalities also lack an institutional framework that could provide technical assistance for determining and implementing best practices, identifying opportunities for effective partnerships at the regional level, and facilitating coordination and communication with the government of Puerto Rico. Puerto Rico has previously considered regional planning and service delivery across municipalities to more cost-effectively plan and deliver services. A few municipalities have created consortiums to explore sharing services, with some success. As municipal budgets decline from falling tax receipts, people leaving Puerto Rico, and decreasing government subsidies, municipalities would need to find efficiencies in their operating budgets to continue delivering basic quality services.

Description

This course of action would conduct a transparent, finite decisionmaking process that engages the government of Puerto Rico (including the Oficina de Gerencia de Permisos [OGPe; Office of Permit Management] and Centro de Recaudación de Ingresos Municipales [CRIM; Municipal Revenue Collection Center]), the 78 municipal governments, citizens, and other stakeholders and culminates in adopting and funding a regional service delivery and planning model. This would include creating regionally based intergovernmental commissions, made up of mayors in the region and OGPe and CRIM representatives, to act as a coordinating body between municipal and commonwealth agencies to recommend, support, and carry out regional and municipal initiatives.

Potential Benefits

This course of action would help municipalities plan more effectively and deliver services more efficiently, saving taxpayer dollars, reducing duplication and waste, filling service gaps, and improving transparency. Additionally, forming a midlevel, regionally based coordinating body between municipal governments and the government of Puerto Rico could lead to

improvements in overall governance effectiveness, harness the strengths of both levels, and significantly raise the probability of success for regional and municipal initiatives for development.

Potential Spillover Impacts to Other Sectors

This course of action could positively impact multiple sectors of Puerto Rico's economy.

Potential Costs

Potential up-front costs: $7.8 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $7.8 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico, municipal governments

Potential Implementers

Government of Puerto Rico, municipal governments

Potential Pitfalls

Political disagreement on the degree of regionalization of service delivery and Potential Implementers may be a challenge. There may also be legal or other administrative barriers to consolidation or reorganization of some services or jurisdictions. Other barriers would be lack of capacity at the municipal level to build and staff regional coalitions and disagreement regarding which services should be shared and what delivery structure they should follow.

Likely Precursors

None

MUN 8
Provide Municipalities with Technical Assistance and Support for Best Practices in Public Management and Operations

Sectors Impacted

Municipalities, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

The capacities of Puerto Rico's 78 municipal governments vary significantly, and there is little standardization or systematic sharing of best practices in municipal operations, human resources, and public resources management.

Description

This course of action would provide municipal governments with technical assistance and other forms of support to implement best practices in public management. Technical assistance would address human resources, government operations, and management issues. This course of action would help municipalities improve their workforces by sharing best practices on how to standardize salary rates, position descriptions, and qualification requirements and by providing professional development and training. This course of action would improve management at the municipal level by providing training to improve core municipal operations, including financial management (balancing budgets, allocating funds for operations and maintenance and emergency use, etc.) and effective implementation of public service programs. Benefits would begin as soon as the course of action was implemented and would accrue across all of Puerto Rico.

Potential Benefits

This course of action would improve the ability of municipal governments to effectively provide an array of services to citizens and maintain their fiscal well-being. It could also lead to a more highly skilled, professionalized workforce; allow exchange of personnel across municipal lines; and make recruitment and hiring easier.

Potential Spillover Impacts to Other Sectors

Improving the management of municipal budgets and operations could spur economic activity by increasing business confidence in government, including the willingness to do business with or in municipalities. This course of action would also have workforce development benefits, as it would provide training and professional development to municipal government employees.

Potential Costs

Potential up-front costs: $3.5 million in estimated up-front costs (2 years)
Potential recurring costs: —
Potential total costs: $3.5 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Labor

Potential Implementers

Government of Puerto Rico, municipal governments

Potential Pitfalls

Puerto Rico's 78 municipal governments vary substantially in their size, the nature of services they provide, the characteristics of their locally available workforce, and their financial health. Many municipalities may be unwilling or unable to standardize positions and pay rates and may not have the workforce or resources required to implement some best practices.

Likely Precursors

None

MUN 9
Enhance Transparency and Improve Service Delivery Through Municipal Service Request Fulfillment and Tracking Systems

Sectors Impacted

Municipalities, Economic

Issue/Problem Being Solved

Municipal services are not transparent or easily accessible.

Description

This course of action would enhance access to, and the transparency of, government services by instituting e-government portals, 311 systems, and other technology-based means of making government services more transparent and accessible. Currently, 75% of municipalities do not have a strong online presence, and those municipalities that have online portals rarely include critical information that should be readily available to the public, such as financial statements. This course of action would facilitate the creation of government of Puerto Rico and municipal government e-portals and 311 system that would allow citizens to access information about and from their governments, submit and track requests for services, and interact with their governments online. Benefits would begin after 1 year, with 10 years until full benefits, and benefits would accrue across all of Puerto Rico.

Potential Benefits

This course of action would help municipalities deliver services more efficiently, saving taxpayer dollars and improving service outcomes for citizens. Municipal government would be more transparent and accessible.

Potential Spillover Impacts to Other Sectors

To the extent that this course of action could help municipalities reduce costs and deliver services more efficiently, it could improve municipal and commonwealth finances and encourage economic growth in Puerto Rico.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $110 million in estimated recurring costs (11 years)
Potential total costs: $110 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Labor, U.S. Department of Education, private sector, nongovernment sources

Potential Implementers

Government of Puerto Rico

Potential Pitfalls

Lack of technical capacity at the municipal level to operate and maintain web portals and 311 services could be a challenge. Also, there could be significant and rapid increases in requests for services and in citizen's expectations, which could exceed municipal capacities.

Likely Precursors

No other courses of action are precursors. However, information campaigns and trainings related to online services and operations that target populations disproportionately affected by disaster and the community in general could make this course of action more successful.

MUN 10
Provide Technical Assistance to Improve Municipal Finances by Generating Additional Revenues, Reducing Costs, and Balancing Budgets

Sectors Impacted

Municipalities, Economic

Issue/Problem Being Solved

Many of Puerto Rico's municipalities are in financial distress because of limited tax receipts, people leaving Puerto Rico, and the elimination of subsidies from the government of Puerto Rico. Municipalities are facing severe budget constraints and must find innovative ways to generate additional revenue, cut unnecessary costs, increase productivity, and improve their ability to predict revenue and spending.

Description

This course of action would provide technical assistance to help municipalities improve their finances by generating additional revenues, reducing costs, and balancing their budgets. Benefits of technical assistance begin after 1 year, with 10 years until full benefits, and benefits would accrue across all of Puerto Rico.

Potential Benefits

Helping municipalities balance their budgets would improve their capacity to function and deliver services for their citizens; this, in turn, would improve the fiscal situation throughout Puerto Rico.

Potential Spillover Impacts to Other Sectors

This course of action could help municipalities deliver better services, foster economic activity, expand public-private partnerships and municipal corporations, and improve Puerto Rico's economic situation. However, measures to increase revenues must be balanced with their potential to increase costs for others.

Potential Costs

Potential up-front costs: $6 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $6 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery

Potential Implementers

Independent research partner, municipal governments

Potential Pitfalls

Municipalities may find it difficult to cut costs more than they already have. Adverse economic conditions, tax exemptions, recent changes to tax laws in Puerto Rico, and popular opposition could limit municipalities' ability to increase revenues.

Likely Precursors

None

MUN 11
Develop and Publicly Report Key Municipal Performance Indicators

Sectors Impacted

Municipalities, Community Planning and Capacity Building, Economic

Issue/Problem Being Solved

A lack of publicly available information on what services citizens request from municipal governments and the commonwealth government, and how well governments provide these services, makes it difficult to properly manage service delivery and allocate resources.

Description

This course of action would develop a set of key performance indicators (KPIs) for services provided by municipal governments and the government of Puerto to citizens. KPIs would be developed in consultation with mayors and municipal officials and citizens groups. Municipalities and the commonwealth government would be required to track and publicly report KPIs at a reoccurring interval (monthly, or more frequently) in a standardized format through an online platform. Benefits would begin with KPI reporting and would increase as KPIs are refined and as they are used to improve the management of service delivery and allocation of resources. Benefits would accrue across all of Puerto Rico.

Potential Benefits

Tracking and reporting KPIs would improve government transparency, citizen confidence, and government performance management. Tracking and reporting KPIs on a regular (frequently recurring) basis would allow rapid identification of issues and reallocation of resources to more effectively meet citizen needs across an array of services.

Potential Spillover Impacts to Other Sectors

Publicly available KPIs and expected improvements in service provisions could boost business confidence in government, leading to increased investment and other forms of economic development.

Potential Costs

Potential up-front costs: $1.9 million in estimated up-front costs (3 years)
Potential recurring costs: —
Potential total costs: $1.9 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, private sector

Potential Implementers

Government of Puerto Rico, municipal governments

Potential Pitfalls

Robust baseline data on which services municipal governments and the commonwealth provide are not currently available. Tracking and reporting services across 78 municipal governments would be logistically difficult. The selection of specific KPIs may be controversial.

Likely Precursors

None

Natural and Cultural Resources Sector

COA Number	Title
NCR 1	Historic and Cultural Properties and Collections Preservation
NCR 2	Arts Recovery
NCR 3	General Archives Mitigation and Modernization
NCR 4	Caribbean Cultural Collections Preservation, Research, and Safe Storage Center
NCR 5	Forest Recovery in Rural Protected Areas, Private Forests, Critical Watersheds, and Urban Areas
NCR 6	Implement Individual At-Risk Species Recovery Activities
NCR 7	Develop Partner Networks for Recovering Plant and Animal Species
NCR 8	Increase Landfill Capacity to Dispose of Hurricane-Related Waste and to Properly Manage Future Waste
NCR 9	Landfill Repair and Closure
NCR 10	Clean Up and Eliminate Use of Unpermitted, Unregistered Dumps
NCR 11	Establish a Long-Term, Sustainable, Integrated Solid Waste Management Program
NCR 12	Develop Forest Products Industry
NCR 13	Reduce Sediment Pollution and Risk from Landslides
NCR 14	Water Quality Improvements at the Watershed Scale
NCR 15	Coral Reef and Seagrass Protection and Restoration
NCR 16	Wetlands Restoration
NCR 17	Reduce Coastal Erosion and Provide Disaster Protection Through Beaches and Dunes
NCR 18	Establish the San Juan Barrier Reef as a Marine Protected Area
NCR 19	SHPO and ICP Staffing to Meet Project Review Requirements
NCR 20	Redesign, Reorganize, and Rebuild Puerto Rican Parks
NCR 21	Strategic Watershed, Landscape, and Conservation Corridor Approaches
NCR 22	Promote Alternative Tourism for Economic Development
NCR 23	Protected Natural Area Land Management for Alternative Tourism
NCR 24	Enterprise Development for Alternative Tourism
NCR 25	Blue Shore Workforce Development
NCR 26	Resource Management Capacity Building
NCR 27	Expand Disaster Recovery Sister Cities Connections
NCR 28	Identify Funding for Natural and Cultural Resources Research
NCR 29	Enhance Public Participation and Education Through Museum Exhibits
NCR 30	Create an Accessible Data Repository of Natural and Cultural Resources

NCR 1
Historic and Cultural Properties and Collections Preservation

Sectors Impacted

Natural and Cultural Resources, Municipalities, Economic, Health and Social Services, Public Buildings

Issue/Problem Being Solved

Historic properties, museums, and other cultural sites and their collections are damaged; cultural patrimony, art, and intangible cultural heritage are at risk; and documentation, preservation, and protection of Puerto Rico's cultural resources are inadequate. These issues place Puerto Rico's heritage and position as a global tourist destination at extreme risk.

Description

This course of action would (1) implement a Puerto Rico–wide cultural resources management plan and undertake a stabilization program to restore and protect resources (buildings, landscapes, and collections) based on damage assessments, (2) encourage private-property preservation by establishing incentive programs and local historic districts, (3) train museum and archive staff in collection care and emergency planning and engage specially trained museum studies and library students to write emergency plans, and (4) run pilot training programs in historic building preservation.

Potential Benefits

Benefits of this course of action include reinvestment in and preservation of Puerto Rico's historic built environment and museum and archival collections, stable property values, extension of the life span of existing buildings in a cost-effective way, and improved preparedness of buildings and staff to mitigate future losses and shorten future recovery time. In addition, cultural heritage would be accessible to all citizens, creating opportunities for youth engagement, students, life-long learning, community empowerment, and economic growth. A sustainable labor force with historic preservation skills would be developed as a source of expertise for the future.

Potential Spillover Impacts to Other Sectors

Spillover impacts of this course of action include increased tourism, improved community engagement, increased educational value of historic sites and museums, higher property values of nearby buildings, and growth of a skilled labor force. Reinvestment may also lead to the growth of local industries, such as construction (especially firms devoted to preservation practices and techniques), ecotourism, and museum and conservation support services.

Potential Costs

Potential up-front costs: $460 million–$720 million in estimated up-front costs (5 years)
Potential recurring costs: $4.5 million–$9 million in estimated recurring costs (11 years)
Potential total costs: $460 million–$730 million in total estimated costs

The estimate for developing a cultural resources management plan is $1 million. The estimate for the up-front costs includes a stabilization program across Puerto Rico. Training sessions cost approximately $50,000 each, for a total estimated cost of $1 million. Climate-control upgrades cost $50,000–$75,000 per building, for a total estimated cost of $10 million–$16 million.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, U.S. Department of the Interior, Institute of Museum and Library Services, National Endowment for the Arts, National Endowment for the Humanities, National Archives and Records Administration, government of Puerto Rico, private insurance

Potential Implementers

State Historic Preservation Office, Institute of Puerto Rican Culture, individual property owners, Heritage Emergency National Task Force, Cultural Resources Advisory Committee members, U.S. Department of the Interior, University of Puerto Rico, Caribbean University

Potential Pitfalls

Building materials and specialized conservation equipment and materials can be both scarce and expensive. Specialized labor for historic preservation and collections care and conservation is in short supply. Municipal and private property owners may decide not to restore buildings or may decide to demolish them altogether. Staffing resources may be insufficient to implement necessary projects or to follow through on plan implementation and ongoing maintenance.

Likely Precursors

A project leader and task force committee are necessary for advancing the progress of a cultural resource management plan. Damage assessments, loss-of-revenue studies, stabilization, and reinvestment should occur as soon as possible to protect vulnerable resources. Collection-care workshops would need to be piloted, a network of trainers would need to be established, and resources would need to be translated into Spanish.

NCR 2
Arts Recovery

Sectors Impacted

Natural and Cultural Resources, Economic, Health and Social Services, Education, Housing

Issue/Problem Being Solved

Artists and arts organizations in all disciplines (visual, performing, literary, and media arts) incurred material and financial losses from the hurricanes, including loss of workspace, tools, artwork, materials, and markets.

Description

This course of action would aid artists and the recovery of arts organization through an integrated strategy that consists of recovery grants, workspace development, global arts exchange programs, preparedness and recovery training, development of a holistic arts service-sector "infrastructure," links between arts and tourism, and arts outreach to facilitate community recovery.

Potential Benefits

Artists and arts organizations would be able to resume their practice and livelihoods. Preparedness training would reduce future recovery costs and recovery time. Creating a service sector that incorporates art-specific disaster management mechanisms would stabilize artists and arts organizations and better integrate them into the broader economy to promote their sustainability and resiliency, decreasing recovery time in the future.

Potential Spillover Impacts to Other Sectors

A reinvigorated arts community would support recovery in the Economic, Health and Social Services, and Education sectors throughout Puerto Rico. Communities would benefit from tourist interest in cultural corridors. Arts engagement through workshops, performances, and so on provides additional academic and social benefits.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: $6 million in estimated recurring costs (11 years)
Potential total costs: $10 million in total estimated costs

The cost estimate for recovery funds for artists and arts organizations is $3.5 million–$5 million. The estimate for arts service-sector development is $150,000–$500,000. The estimate for preparedness and recovery training is $75,000, and the community arts programs is $250,000.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, Institute of Museum and Library Services, National Endowment for the Humanities, National Endowment for the Arts, National Archives and Records Administration, private sector, nongovernment sources

Potential Implementers

Government of Puerto Rico, Institute of Puerto Rican Culture, Heritage Emergency National Task Force, private foundations

Potential Pitfalls

Raising funds from individuals and private foundations would likely not meet the need. Puerto Rican arts organizations frequently lack federal 501(c)(3) status. Language barriers, lack of knowledge of available assistance, and lack of culture of sustainability could also be hindrances.

Likely Precursors

Identify or create new funders and strengthen those that currently serve the arts sector. Map the cultural ecosystem to provide a basis on which to proceed strategically. Work together with the Institute of Puerto Rican Culture, the State Arts Agency under the National Endowment for the Arts, which currently has a strategic plan in place.

NCR 3
General Archives Mitigation and Modernization

Sectors Impacted

Natural and Cultural Resources, Municipalities, Public Buildings, Economic

Issue/Problem Being Solved

The Archivo General de Puerto Rico (AG) is the official government entity charged with collecting and preserving Puerto Rico's historical record. The AG facility and its records and collections were damaged during the hurricanes, placing valuable records and collections at risk. Mitigation measures must be taken immediately to protect essential records and collections in the AG. Concurrently, the government of Puerto Rico and the Institute of Puerto Rican Culture are advised to undertake an architecture or engineering choosing-by-advantages planning and design process.

Description

This course of action would generate a building envelope, systems, and operational alternatives with associated costs for achieving a suitable museum environment for ever-expanding collections, and it would address the preservation needs of the 1885 National Register–listed AG structure.

Potential Benefits

The preservation of Puerto Rico's historical records and collections is vital to the continuity of the commonwealth government and also the protection of its heritage. Preservation and continued use of the 1885 structure would contribute to the historical character of San Juan and would benefit communities and tourism.

Potential Spillover Impacts to Other Sectors

The AG's collections are vital to Puerto Rico's governance, affecting municipalities and commerce.

Potential Costs

Potential up-front costs: $11 million–12 million in estimated up-front costs (3 years)[114]
Potential recurring costs: —

[114] The potential up-front costs are listed as $11.5 million in the recovery plan. That number is being corrected to show the cost range, using two significant figures.

Potential total costs: $11 million–$12 million in total estimated costs[115]

The estimated up-front costs include $750,000 for treatment of affected collections material, $500,000 for planning and designing a modernized archive facility, $5 million to $6 million for building stabilization, and $5 million for building modernization.

Potential Funding Mechanisms

National Archives, National Endowment for the Arts, National Endowment for the Humanities, Institute of Museum and Library Services, government of Puerto Rico, private sector, nongovernment sources

Potential Implementers

Institute of Puerto Rican Culture, National Archives and Records Administration

Potential Pitfalls

Difficulties include competing priorities at the Institute of Puerto Rican Culture, enacting an overarching preservation plan for AG facilities and collections, and lack of influence to secure the government of Puerto Rico's support for resources.

Likely Precursors

A designated project leader and advisory committee should be formed to advance facility planning and collections preservation planning.

[115] The total potential cost is listed as $11.5 million in the recovery plan. That number is being corrected to represent the cost range, based upon the estimated up-front costs.

NCR 4
Caribbean Cultural Collections Preservation, Research, and Safe Storage Center

Sectors Impacted

Natural and Cultural Resources, Municipalities, Education, Economic

Issue/Problem Being Solved

Cultural institutions are unprepared for future disasters. Cultural heritage—one of Puerto Rico's primary competitive advantages—is at risk because of a lack of skilled professionals and adequate preservation, conservation, and storage facilities. This puts the tourist economy at risk.

Description

This course of action would expand and fulfill the Institute of Puerto Rican Culture and State Historic Preservation Office plan to (1) identify criteria for a new conservation center that provides preservation planning and conservation services for museums, libraries, and archives; private-client collections; and historic properties in Puerto Rico (as well as the U.S. Virgin Islands and the entire Caribbean region); (2) identify potential sites and funding sources; and (3) develop and execute plans. The center should house several Institute of Puerto Rican Culture institutions.

Potential Benefits

A regional conservation center would serve as a local source of professional preservation advice and conservation treatment, reducing the need for and reliance on outside specialists. It would also employ professionals to provide preservation and curation training to cultural institutions.

Potential Spillover Impacts to Other Sectors

The center's extended local community would benefit from preparedness, mitigation, and conservation advice. Other benefits would include increased tourism driven by facility tours and jobs created by the center itself.

Potential Costs

Potential up-front costs: $130 million–$200 million in estimated up-front costs (5 years)
Potential recurring costs: $18 million in estimated recurring costs (11 years)
Potential total costs: $140 million–$210 million in total estimated costs

The up-front costs are estimated for the building and start-up of the Institute of Puerto Rican Culture and State Historic Preservation Office plan. The estimate for the museum and exhibition

parts of the center, if not covered by the self-sustaining parts of the institution, is $2 million per year in government support.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, National Archives and Records Administration, National Endowment for the Humanities, National Endowment for the Arts, Institute of Museum and Library Services, National Science Foundation, public-private partnerships, nongovernment sources

Potential Implementers

Institute of Puerto Rican Culture, State Historic Preservation Office, Heritage Emergency National Task Force, Regional Alliance for Preservation, various foundations and donors

Potential Pitfalls

The center would eventually need to be self-sustaining, both financially and programmatically. A location would need to be secured and developed and would take years to fully develop. The region must sustain sufficient interest in professional educational programming and sufficient need for fee-based services, such as artifact conservation or object storage.

Likely Precursors

Needs assessment should be conducted in the U.S. territories and in neighboring Caribbean islands.

NCR 5
Forest Recovery in Rural Protected Areas, Private Forests, Critical Watersheds, and Urban Areas

Sectors Impacted

Natural and Cultural Resources, Economic, Municipalities, Water

Issue/Problem Being Solved

Hurricanes Irma and Maria damaged Puerto Rico's rural forests (protected areas, private forests, and working lands), urban forests, and tree nurseries and seed bank (which are critical for reforestation).

Description

This course of action would develop and implement strategic forest recovery and conservation strategies throughout Puerto Rico to restore the function and structure of rural protected forests, ecological corridors, private forested lands, agroforestry, and urban forests. This incorporates planting more than 2.4 million trees over approximately 5 years in 43,200 acres of protected forests, 2 million acres in private forests in critical watersheds, and 6,250 acres in agroforestry plots; urban forest planting; and acquiring conservation easements over a 1- to 10-year period. In addition, the forest recovery would increase diversity and resilience to future high-intensity disturbances, use native and naturalized species where appropriate, and identify and mitigate potential pest and disease impacts.

Potential Benefits

The benefits of forest recovery include restored ecological functions and the provision of ecosystem services, including habitat connectivity and quality for species; increased wildlife habitat availability; reduced threat of invasive species; and land stabilization through sedimentation control. Forests could also provide a source of economic activity through agroforestry and private-landowner involvement in conservation strategies, as well as employment opportunities associated with forest recovery actions. The removal of tree hazards would improve public safety and reduce the risk for pest and disease damage.

Potential Spillover Impacts to Other Sectors

Restored forest function could improve water quality, reduce stormwater runoff, lower energy needs by mitigating the so-called urban heat island effect, and provide economic (such as ecotourism, agroforestry, and payments for conservation practices on private lands) and recreational opportunities.

Potential Costs

Potential up-front costs: $70 million–$120 million in estimated up-front costs (5 years)
Potential recurring costs: $4.5 million in estimated recurring costs (11 years)
Potential total costs: $75 million–$120 million in total estimated costs

These costs could be reduced if NCR 25 (Blue Shore Workforce Development) is implemented and provides labor.

Potential Funding Mechanisms

U.S. Department of the Interior, U.S. Department of Agriculture, public-private partnerships, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, municipal governments, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, U.S. Forest Service, municipal governments

Potential Pitfalls

Completed damage assessments are not representative of forest damage across Puerto Rico.

Likely Precursors

Damage assessment for forests and natural protected areas

NCR 6
Implement Individual At-Risk Species Recovery Activities

Sectors Impacted

Natural and Cultural Resources, Water, Economic

Issue/Problem Being Solved

Hurricane Maria damaged ecosystems throughout Puerto Rico with consequences to species of greatest conservation need, threatened and endangered species, and other wildlife. The hurricane's impacts were direct loss of individuals species, loss of habitat, changes in habitat structure and function, and increased impact of invasive species on both flora and fauna. Long-term cascading consequences consist of a decrease in Puerto Rico's biodiversity and more species at risk of extinction. Hurricane impacts also reduced ecotourism and other economic productivity related to species (such as bird watching and pollination services for agricultural crops).

Description

This course of action would develop and implement individual proposed recovery actions for each of the 10–15 threatened and endangered species or species of greatest conservation need known to be significantly affected by Hurricane Maria and needing help through this process. These plans would include a species-appropriate combination of restoring habitat quality and availability, increasing the wild population of the species, and minimizing invasive-species competition or predation.

Potential Benefits

Benefits include more-functional and more-resilient habitats in general (but especially for select species that are at risk of extinction), recovery to more-resilient and more-sustainable species population levels, and an improvement in overall biodiversity. There would also be associated ecological benefits, such as water quality improvements, economic benefits from tourism, synergies with agricultural production, and protection of culturally important species.

Potential Spillover Impacts to Other Sectors

This course of action would help the economy by contributing to tourism, agricultural production, and sustainability. It would also support improvements in water quantity and quality. Reforestation activities for some species would also deter landslides and loss of soil, recharge aquifers, and minimize surface runoff and floods.

Potential Costs

Potential up-front costs: $5.5 million in estimated up-front costs

Potential recurring costs: —
Potential total costs: $5.5 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of the Interior, U.S. Department of Agriculture, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, municipal governments, private sector, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, U.S. Fish and Wildlife Services, other federal agencies, nongovernmental organizations, universities

Potential Pitfalls

Agriculture recovery activities implemented without considering the impact to habitat and species' health, and economic development activities that overdevelop habitat areas of interest

Likely Precursors

Human capital would be needed for species and habitat restoration and management. Roads and trails must be cleared enough so people can access the sites where species recovery activities need to occur.

NCR 7
Develop Partner Networks for Recovering Plant and Animal Species

Sectors Impacted

Natural and Cultural Resources, Water, Health and Social Services, Economic

Issue/Problem Being Solved

Hurricane Maria decreased ecosystem health across Puerto Rico, leading to loss and degradation of habitats, populations of threatened and endangered species or species of greatest conservation need, and other fish and wildlife species, as well as putting more species at risk of extinction and reduced long-term resiliency. The hurricane also reduced species, forest, nature-related tourism, and related economic activities (such as pollination of agricultural crops). Puerto Rico lacks sufficient human capacity and collaborative networks to recover the species, given hurricane damage and current government staff and resource investments.

Description

This course of action would develop a comprehensive network of partners to work together to help fund actions for plant and animal species preservation, develop human capital and capacity in species management, educate the public, and develop experiential and tourism opportunities. Such partners would consist of commonwealth agencies, local government, nongovernmental organizations, federal agencies, universities, and private-sector entities.

Potential Benefits

Benefits would include more-efficient and more-effective management of plant and animal species and improved linkages to expand, enhance, and identify educational, tourism, and other economic activities. Students and community members would learn about the benefits of species and their habitats, ranging from cultural to economic. Ultimately, this course of action would help keep species from becoming extinct by recovering populations to more-resilient and more-sustainable levels and recovering habitats for threatened and endangered species and other species of greatest conservation need and game species.

Potential Spillover Impacts to Other Sectors

This course of action would help improve watershed and forest health and would help with water and air quality and erosion control. Human health benefits would result from the improvements in air and water quality. Economic impacts would include increased tourism and agriculture.

Potential Costs

Potential up-front costs: $120,000–$360,000 in estimated up-front costs (3 years)

Potential recurring costs: —
Potential total costs: $120,000–$360,000 in total estimated costs

The cost estimate includes 4–12 workshops a year, for the first 3 years, with a modest level of administrative support after that to keep the networks going.

Potential Funding Mechanisms

U.S. Department of the Interior, U.S. Department of Agriculture, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, municipal governments, private sector, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, federal agencies, University of Puerto Rico, nongovernmental organizations

Potential Pitfalls

Agriculture recovery activities could be implemented without considering the impact to habitat and species' health, and economic development activities could overdevelop natural areas of interest.

Likely Precursors

Roads and trails would need to be cleared enough so people could access the sites where species and habitat recovery activities need to occur.

NCR 8
Increase Landfill Capacity to Dispose of Hurricane-Related Waste and To Properly Manage Future Waste

Sectors Impacted

Natural and Cultural Resources, Community Planning and Capacity Building, Municipalities, Housing, Health and Social Services

Issue/Problem Being Solved

There is insufficient legal, lined, compliant landfill capacity available to meet the waste management needs of Puerto Rico. Estimated remaining capacity is 2–4 years, depending on additional debris disposal, and current routine waste generation rates.

Description

This course of action would allow the Environmental Quality Board to meet permitting and inspection needs, as well as the landfill capacity needs of Puerto Rico, including transfer stations. Hiring and training staff and opening new lined cells would help Puerto Rico meet its present and future landfill capacity demands in ways that best protect the environment and public health. Alternate disposal options are also needed, such as establishing recycling plants, which could be addressed through a sustainable waste management plan (NCR 11, Establish a Long-Term, Sustainable, Integrated Solid Waste Management Program).

Potential Benefits

New staff would allow for increased permitting of new lined landfills, transfer stations or recycling facilities, existing dumps put into compliance with federal regulations, and increased inspection of existing landfills or other waste management facilities to ensure adequate disposal of debris generated by Hurricane Maria. Constructing new lined cells at strategic locations throughout Puerto Rico would help meet Puerto Rico's capacity needs and would improve environmental quality and public health.

Potential Spillover Impacts to Other Sectors

Meeting waste management capacity needs in Puerto Rico would improve environmental quality and public health, with spillover impacts on municipal operations, the local economy, and tourism.

Potential Costs

Potential up-front costs: $176 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $176 million in total estimated costs

These up-front costs are an estimate of increasing landfill capacity.

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, municipal governments

Potential Pitfalls

Opening new lined landfills would result in the closure of unlined, uncompliant landfills, but it would also encourage recycling, since the cost to dispose in uncompliant landfills is significantly lower than recycling. Closing of these uncompliant landfills would result in job loss, although this should be offset by new jobs created at new lined cells and in the recycling industry with direct and indirect jobs.

Likely Precursors

Training materials would likely need to be translated into Spanish. Environmental studies would need to be completed for new lined cells.

NCR 9
Landfill Repair and Closure

Sectors Impacted

Natural and Cultural Resources, Community Planning and Capacity Building, Municipalities, Health and Social Services, Water

Issue/Problem Being Solved

Hurricanes Irma and Maria damaged infrastructure at landfills and open dumps, which affected surrounding ecosystems and natural resources. Additionally, unlined open dumps, which are not in compliance with local regulations and threaten public health and the environment, are in operation throughout Puerto Rico.

Description

This course of action would repair landfills and open dumps throughout Puerto Rico that sustained damage during the hurricanes. This course of action would also close unlined open dumps throughout Puerto Rico.

Potential Benefits

Repairing damage to landfills and open dumps would reduce or eliminate impacts to natural resources and would help bring lined landfills back into compliance. For unlined landfills, repairs would help reduce the environmental impacts associated with hurricane damage.

Potential Spillover Impacts to Other Sectors

Spillover impacts would be most notable in the Water and Health and Social Services sectors. Closure of open dumps would also better protect drinking water supply, air quality, soil quality, water quality, and also the tourism industry.

Potential Costs

Potential up-front costs: $160 million in estimated up-front costs
Potential recurring costs: —
Potential costs: $160 million in total estimated costs

The up-front cost estimate covers landfill closure and repair.

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, municipal governments, Solid Waste Authority

Potential Pitfalls

There are no perceived pitfalls associated with repairing damaged landfills and open dumps. Closure of unlined open dumps could reduce capacity around Puerto Rico if new lined cells are not brought online.

Likely Precursors

None

NCR 10
Clean Up and Eliminate Use of Unpermitted, Unregistered Dumps

Sectors Impacted

Natural and Cultural Resources, Community Planning and Capacity Building, Municipalities, Health and Social Services, Water

Issue/Problem Being Solved

Illegal open dumps, which are unpermitted and unregistered, are located throughout Puerto Rico and are challenging to locate and routinely monitor. These dumps need to be cleaned up and closed, as they pose threats to human health and the environment and provide disincentives for the use of compliant landfills.

Description

This course of action would identify, sort, recycle, and dispose of waste at the 1,600–2,000 illegal dumps throughout Puerto Rico. Steps must also be identified to help prevent the recurrence of illegal dumps.

Potential Benefits

Cleaning up the dumps would remove environmental and public health threats to the people of Puerto Rico. It would also help ensure the overall success of a sustainable solid waste management plan.

Potential Spillover Impacts to Other Sectors

Improvements to environmental quality and public health would have positive impacts on tourism.

Potential Costs

Potential up-front costs: $104 million in estimated up-front costs (2 years)
Potential recurring costs: —
Potential total costs: $104 million in total estimated costs

The up-front cost estimate covers the assessment and cleanup of all illegal dumps in Puerto Rico.

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, U.S. Environmental Protection Agency

Potential Pitfalls

Cleaning up illegal dumps would use extra capacity in existing lined landfills. New illegal dumps could be established if the current ones were cleaned up and closed.

Likely Precursors

Sorting, recycling, and disposing of the waste in illegal dumps would requires an assessment of their location, size, and general composition.

NCR 11
Establish a Long-Term, Sustainable, Integrated Solid Waste Management Program

Sectors Impacted

Natural and Cultural Resources, Community Planning and Capacity Building, Municipalities, Health and Social Services, Water

Issue/Problem Being Solved

Puerto Rico suffered from poor solid waste management prior to Hurricanes Irma and Maria; the hurricanes exacerbated this situation. The 2007 Solid Waste Management Plan (not publicly available) needs to be revised to include a disaster debris management plan and address changes to waste streams after storms, including diverting organic and recyclable waste from landfills.

Description

This course of action would update Puerto Rico's Solid Waste Management Plan to address poststorm solid waste needs and to create an economically viable and sustainable approach to solid waste management throughout Puerto Rico. The revised Solid Waste Management Plan would include the development of a food waste and organics diversion program to reduce the waste going to landfills and produce compost. Also, this course of action would develop nonorganic waste recycling options throughout Puerto Rico. The revised Solid Waste Management Plan would consider available markets and shipping costs to help ensure economic viability and infrastructure for material collection, handling, and processing. Storm-related vegetative debris management would be addressed through composting, as well as alternative minimum daily cover at landfills and applications for agricultural lands.

Potential Benefits

Implementation of a revised Solid Waste Management Plan would extend the life of landfills and help ensure that Puerto Rico is managing solid waste in a sustainable, economically viable, and compliant manner. This would benefit the public and the natural environment by reducing waste going to unlined landfills and subsequent environmental impacts. Addressing vegetative debris would benefit farms and the public and provide economic opportunities.

Potential Spillover Impacts to Other Sectors

Increased compost availability would help enhance soil quality in nutrient-poor areas, benefiting agriculture and homeowners with gardens. Reduced landfill usage would positively affect public health and air, soil, and water quality. Decreased landfill demand would favor the closure of open dumps.

Potential Costs

Potential up-front costs: $101 million in estimated up-front costs (2 years)
Potential recurring costs: $263 million in estimated recurring costs (11 years)
Potential total costs: $363 million in total estimated costs

The potential costs include a revision of the solid waste management plan, estimated at $300,000 as an up-front cost. Waste characterization is estimated at $300,000 as an up-front cost, and $100 million for the start-up cost (including infrastructure) is an up-front cost. The annual cost for a recycling program to be implemented for 10 years is estimated at $25 million.

Given that the solid waste management plan from 2007 can be revised, and does not need to be developed from scratch, it is estimated that $300,000 will be sufficient. Implementation costs for a food waste and organic diversion program include creating a curbside pickup program and development and/or enhancement of composting facilities at strategic locations throughout Puerto Rico. Costs of the program will be offset by reduced landfill tipping costs and through the product value of the compost itself.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Housing and Urban Development, U.S. Department of Agriculture, public-private partnerships

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, U.S. Environmental Protection Agency, U.S. Department of Agriculture

Potential Pitfalls

In the past, Solid Waste Management Plans have not been fully implemented.

Likely Precursors

HSS 3 (Implement Integrated Waste Management Program and Expand Programs to Increase Recycling Rates) is a related course of action focused on recycling programs, compliance, and education and should be implemented with this course of action. There is likely some overlap in cost estimates that cannot be resolved given available information. The 2007 Solid Waste Management Plan would be used as the basis for an updated version. The Puerto Rico Integrated Solid Waste Management Strategy would inform a new Solid Waste Management Plan for Puerto Rico.[116]

[116] Puerto Rico Recycling Partnership, *Puerto Rico Integrated Solid Waste Management Strategy*, updated March 27, 2013.

NCR 12
Develop Forest Products Industry

Sectors Impacted

Natural and Cultural Resources, Community Planning and Capacity Building, Municipalities, Health and Social Services, Public Buildings, Economic

Issue/Problem Being Solved

Woody debris from Hurricanes Irma and Maria created hazards, caused flooding, blocked trail and road access for response, and overwhelmed landfills and dumps. The current forest products industry lacks the capacity to address the volume of woody debris created by the hurricanes, including the ability to appropriately use precious hardwoods downed by the storms.

Description

This course of action would build on a pilot U.S. Forest Service project to (1) manage valuable wood gathered in the posthurricane vegetation waste removal process and (2) revive local markets for hardwoods. This course of action would build long-term capacity and expertise to manage woody debris and reduce vulnerability of waste stream management systems to future storm events.

Potential Benefits

Valuable wood would be available to restore and rebuild historic structures, supply local artisans, provide resources to the business and educational community to develop new wood products, and be used to build local capacity in wood handling. Other vegetative debris could be used to produce compost and mulch to restore nutrients to farms and other lands. These actions would reduce the amount of material going to landfills. Processed wood would provide economic, cultural, educational, ecological, and research benefits to the people of Puerto Rico.

Potential Spillover Impacts to Other Sectors

Having locally sourced valuable wood available for local artisans could stimulate the economy through the development of new and innovative wood products for the local and global markets.

Potential Costs

Potential up-front costs: $10 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $10 million in total estimated costs

The estimate for up-front costs is for fully collecting, inventorying, processing, and utilizing downed wood.

Potential Funding Mechanisms

U.S. Department of the Interior, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Tourism Company

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, U.S. Forest Service, Institute of Puerto Rican Culture

Potential Pitfalls

Because of current capacity in the industry for wood products, there are challenges in moving, processing, and obtaining value from 45,000 to 100,000 logs. Key support would be needed to understand the potential market(s) for processed wood products, develop training, share best practices, and build capacity.

Likely Precursors

Geospatial database of where debris is located, log salvage to date, and existing capacity, as well as mechanisms to develop and distribute wood products

NCR 13
Reduce Sediment Pollution and Risk from Landslides

Sectors Impacted

Natural and Cultural Resources, Transportation, Energy, Water, Housing, Health and Social Services

Issue/Problem Being Solved

Extensive landslides occurred in mountainous regions across Puerto Rico during Hurricane Maria. Landslides generated by the hurricane were, and continue to be, a public safety hazard: They are threatening homes, blocking transportation networks, and isolating many communities, and their impact on natural habitats for freshwater and marine plant and animal species is contributing to sedimentation loads that reduce storage capacity in key reservoirs.

Description

This course of action would stabilize soils and slopes in landslide-affected areas through vegetative, bioengineering, and structural approaches to protect these areas from additional landslides during future storms. The highest-risk areas for landslides are in mountainous regions, but there are downstream impacts as well. This course of action would identify the highest-risk communities and develop strategies to reduce risk from future landslides, including the development of mitigation and response plans and longer-term land-use planning decisions.

Potential Benefits

Landslides are a threat to public safety and can damage property and block roads and other lifeline infrastructure. Slope stabilization would reduce the amount of sediment mobilized by future storms (thus mitigating water quality problems), restore native habitat for species, provide earth materials for other applications, and protect infrastructure and communities from additional damage in the future.

Potential Spillover Impacts to Other Sectors

Improved community risk characterization and landslide and soil stabilization would reduce the impact that future landslides could have on infrastructure, homes, and human health.

Potential Costs

Potential up-front costs: $1.05 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.05 billion in total estimated costs

The estimate for up-front costs includes restoring and rehabilitating 4,000 landslide sites across Puerto Rico, based on a study of the landslides in the Dos Bocas watershed.[117]

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, U.S. Army Corps of Engineers, U.S. Department of Transportation

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, federal agencies

Potential Pitfalls

Landslides are a natural disturbance process in Puerto Rico, so although it is possible to reduce landslide susceptibility, it would not be possible to prevent all landslides.

Likely Precursors

Geospatial data and maps showing landslide occurrence and depicting landslide hazard to determine priority areas at greatest risk

[117] U.S. Department of Agriculture, Natural Resources Conservation Service, "Assessment of Puerto Rico's Erosion and Sedimentation Impacts after Hurricane Maria," fact sheet, 2018.

NCR 14
Water Quality Improvements at the Watershed Scale

Sectors Impacted

Natural and Cultural Resources, Water, Housing, Municipalities, Transportation, Energy, Community Planning and Capacity Building

Issue/Problem Being Solved

Water quality after Hurricanes Irma and Maria was dramatically degraded. Sewage discharges, sanitary overflows, and excessive sedimentation from storm runoff altered hydrological systems, created transportation hazards, reduced drinking water reservoir capacity and quality, created flood hazards, and caused broad ecological effects in both freshwater and marine environments.

Description

This course of action would implement watershed restoration and management strategies in 4 priority watersheds (Arecibo, San Juan Metropolitan Area, Cabo Rojo/Guánica, and Northeast Corridor) and in highly sensitive coastal areas. Depending on the location, this course of action would include activities aimed at reducing flooding hazards by restoring natural flow paths or wetlands; reducing the threat of landslides, erosion, and sediment deposition; reducing the threat of sewage contamination; and making watersheds more resilient to future storms. This course of action would support watershed-scale coordination of site-scale projects.

Potential Benefits

This course of action would reduce the potential for excessive sedimentation from future storm runoff, reduce pollution in waterways, improve soil retention, reduce landslide risk (which threatens human life and infrastructure), maintain reservoir storage capacity, provide ecological corridors for terrestrial species, improve water quality for freshwater and marine species, and restore coastal areas that are important recreational and tourism sites.

Potential Spillover Impacts to Other Sectors

Reduced erosion and sedimentation could increase reservoir capacity for drinking water; improve the quality of drinking water sources (reducing water treatment costs at water treatment plants); and reduce impacts on agriculture, as well as on the Health and Social Services, Transportation, Energy, and Housing sectors.

Potential Costs

Potential up-front costs: $142 million in estimated up-front costs
Potential recurring costs: —

Potential total costs: $142 million in total estimated costs

The up-front estimate covers watershed restoration costs for 4 priority watersheds and coastal areas.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, U.S. Department of Agriculture, U.S. Environmental Protection Agency, U.S. Department of the Interior, National Oceanic and Atmospheric Administration, Environmental Quality Board

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, federal agencies

Potential Pitfalls

There is no overarching strategy that would work across Puerto Rico; strategies would need to be tailored to specific areas.

Likely Precursors

Identify and select watershed coordinator. WTR 27 (Protect and Rehabilitate Groundwater Systems) and WTR 28 (Secure Drinking Water Sources Against Contamination) are precursors.

NCR 15
Coral Reef and Seagrass Protection and Restoration

Sectors Impacted

Natural and Cultural Resources, Water, Economic, Municipalities, Community Planning and Capacity Building, Public Buildings, Housing, Health and Social Services

Issue/Problem Being Solved

Coral reefs have an average economic value of nearly $1.1 billion per year and provide an average of 97% wave attenuation, which provides storm protection. Coral reefs also provide habitat and recreational services. Seagrass is a habitat for multiple commercially important marine species and supports a wide range of recreational activities. Hurricanes Irma and Maria had a severe impact on coral reefs and seagrasses. Hurricane damage disturbances negatively affected the ecosystem services that corals and seagrasses contribute to protecting coastal infrastructure, including the reduction of wave energy and surface currents and soft-bottom sediment stabilization.

Description

This course of action would restore 5 affected coral reef sites to enhance protection of coastal communities, human safety, and health and to invigorate the economy. This course of action would establish coral farms and nurseries to grow and to outplant corals to severely affected reef sites, helping reefs recover significantly faster than naturally (i.e., 5 years compared with more than 20 years). Outplanting live corals would prevent further erosion of the reefs and create a habitat for important reef fishes, as well as provide additional reef height and increased coastal protections as the corals grow to 1 meter tall over 5 years.

This course of action would protect and restore seagrasses by creating new marine benthic habitat maps from high-resolution imagery; conducting field assessments and a long-term monitoring program to determine seagrass health, density, diversity, and area; and implementing recovery actions that protect or restore seagrass habitats damaged by hurricane-related vessel groundings, coastal erosion, sedimentation, and enhanced pollution, among other causes.

Potential Benefits

Coral reefs provide storm protection through an average 97% wave attenuation; reef restoration is cost-effective and much less expensive than constructed breakwaters. This course of action would directly create jobs and contribute to many more (e.g., boat manufacturing, maintenance). Reefs also provide an important and highly biodiverse habitat for multiple species and also enhance the fishery, tourism, and recreation economies.

Seagrasses are a facet of Puerto Rico's strong ocean-dependent socioeconomic activities, which are a key coastal economic driver. A better understanding of seagrass distributions,

monitoring of the habitats posthurricanes, and recovery of lost seagrass would help ensure the sustainability of their economic and ecological contributions to human and coral communities, provide data for marine and emergency planning, and recover lost seagrass ecological services.

Potential Spillover Impacts to Other Sectors

Reef restoration would support other sectors through coastal protection and averted flood inundation. Restoration also benefits Puerto Rico's $1.1 billion coral reef–associated economy, including tourism and fisheries. Imagery and habitat maps to support seagrass restoration could support various sectors' activities. Pollution reduction and coastal community restoration coordinated across multiple sectors could also support other courses of action' goals, especially when it comes to the ocean and visitor economy.

Potential Costs

Potential up-front costs: $13.5 million–$14.5 million in estimated up-front costs (8 years)
Potential recurring costs: —
Potential total costs: $13.5 million–$14.5 million in total estimated costs

The up-front cost estimate covers coral reef restoration and is $8.9 million, depending on labor and site approval. (Note that $22 million in labor is included in NCR 25, Blue Shore Workforce Development.) The up-front estimate also includes a cost estimate for mapping, monitoring and assessments, and restoration for seagrasses in the range of $4.7 million–$5.7 million.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, U.S. Coast Guard, U.S. Army Corps of Engineers, U.S. Department of the Interior, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, National Oceanic and Atmospheric Administration

Potential Pitfalls

Coral reefs are sensitive ecosystems that may be damaged by ocean acidification, thermal stressors, pollutants, additional storm and wave impacts, and human impacts, such as anchor drops or high tourist traffic. Long-term success may depend on putting in place plans and protections, such as creating a marine protected area or marine management areas, although this

may reduce the social and economic value of the restoration sites if access were restricted. Onshore pollution prevention would also increase likelihood of success.

Seagrasses may be damaged further by land-based pollution or high levels of sedimentation. Increased biodiversity might increase human traffic, which could cause vessel damage to seagrasses. Seagrasses are linked to other coastal habitats, such as corals and wetlands, and thus their success would depend on the successful restoration of these other habitats as well.

Likely Precursors

Precursors include planning, such as evaluation of methods and site selection for monitoring, and design of restoration. The lower cost estimate for coral restoration is dependent on labor availability from NCR 25 (Blue Shore Workforce Development).

Note: It is recommended that coral reefs and seagrasses, beaches and dunes and wetlands be restored in tandem. Although each of these systems is technically a separate ecosystem, the benefits for coastal protection, biodiversity and commercial fishing, and recreation are all increased if all 3 systems are healthy and functional.

NCR 16
Wetlands Restoration

Sectors Impacted

Natural and Cultural Resources, Water, Transportation, Housing, Energy, Public Buildings, Economic, Municipalities

Issue/Problem Being Solved

Puerto Rico's coastal wetlands, which protect the coasts from flooding and erosion, suffered detrimental impacts from high winds and flooding during and after Hurricanes Irma and Maria. The wetlands no longer function fully to protect human health and infrastructure. Hurricane Maria caused significant impacts to all classes of wetlands, but flooding and wind damage were most severe for forested wetlands. Wetland conditions remained significantly affected after 7 months.

Description

This course of action would restore the capacity, resiliency, and ecological functions and services of 10 of Puerto Rico's priority coastal wetlands, in areas selected because of the communities they protect, as well as their economic and ecological value. Each wetland would have site-specific actions with an appropriate combination of revegetation, passive monitoring, and, if needed, hydrology restoration. Monitoring would measure density, diversity, and area covered by wetland vegetation. Restoration would be extended to remove anthropogenically induced changes to selected wetlands to ensure long-term resiliency. Priority locations are Isabela, Punta Tuna, Cuchariallas, Pinones, Punta Santiago, Martín Peña, Fajardo, and pterocarpus forests in Dorado Beach, Punta Viento in Patillas, and Palmas del Mar in Humacao.

Potential Benefits

Benefits in the short term (2–5 years) include protection from coastal storm surge, erosion control, sediment trapping, protection of wildlife habitat important to pollinators and fisheries, water filtration, and floodwater absorption. Long-term benefits include habitat recovery and improved function of wetlands as an interface between land and aquatic ecosystems.

Potential Spillover Impacts to Other Sectors

Wetlands protect power generation sites at several coastal locations. They support recreation by protecting coastal water quality and reefs, and they provide aesthetic value for tourism. They also protect infrastructure and agricultural lands from flood damage. By preventing flooding and erosion, wetlands reduce transportation maintenance costs and help maintain house prices.

Municipalities need to participate in planning and land-use policies and regulations and implementation, as they are important actors in the decisionmaking and implementation process and local integrated services.

Potential Costs

Potential up-front costs: $24.8 million–$31.4 million in estimated up-front costs (5 years)
Potential recurring costs: —
Potential total costs: $24.8 million–$31.4 million in total estimated costs

The up-front cost estimates range from $24.8 million to $31.4 million, including potential costs of $1.5 million for a wetlands assessment, $200,000 for Department of Natural and Environmental Resources planning, and $23.1 million–$29.7 million for restoration and monitoring of priority sites. These costs would be lower if NCR 25 (Blue Shore Workforce Development) were implemented and provided the labor.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of the Interior, U.S. Department of Agriculture, National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, U.S. Army Corps of Engineers

Potential Pitfalls

Private owners may not want wetlands restored if that means they could not use the land as they wished.

Likely Precursors

Precursors include previous wetlands policies and plans for potential actions, coordination and incentives for private owners of wetlands, and an assessment of the value of wetlands in the protection of life and infrastructure.

This course of action should be coordinated with the Water sector. Wetlands recharge ground water and filter out pollutants. Flood-control pumps can negatively affect wetlands hydrology when not properly managed; therefore, stormwater, flood-control, and wetlands policies would need to be coordinated. In addition, the Water sector manages sewage discharge to wetlands.

NCR 17
Reduce Coastal Erosion and Provide Disaster Protection Through Beaches and Dunes

Sectors Impacted

Natural and Cultural Resources, Economic, Public Buildings, Municipalities

Issue/Problem Being Solved

Coastal dunes were significantly eroded during the 2017 hurricane season. Prior to this, the natural-barrier protection provided by the dunes had been weakened by illegal sand harvesting, foot and vehicle traffic, and coastal development. Additionally, Hurricane Maria reduced beach width and elevation in the majority of beaches in Puerto Rico, significantly increasing coastal flooding risks.

Description

This course of action would restore Puerto Rico's priority beaches and coastal dunes so that they are stable and resilient to storms and sea-level rise. This course of action would involve (1) a poststorm beach assessment that measures storm damage, identifies high-erosion areas appropriate for restoration work, and partners with the U.S. Army Corps of Engineers on a sediment flow analysis; (2) the creation of coastal plans and policy that protect both beaches and coastal development and identify specific restoration actions with community input; (3) beach and dune restoration activities, including installation of biomimicry sand accretion systems, exclusion fencing, wooden boardwalks, information signs, planting of dune vegetation to strengthen the dunes, development of a sand management plan that includes sand relocation programs for displaced sand, development of an efficient law enforcement action plan to reduce illegal sand extraction, and an outreach and environmental education program to increase community involvement and buy-in; and (4) the creation of a clearly identified and consistently applied permitting process for dune and beach restoration.

Potential Benefits

Restored beaches and dunes would increase coastal resilience and hazard mitigation and would protect human life, property, and critical infrastructure on coastal areas. Restored beaches and dunes could support biodiversity and such activities as tourism and recreation, and they would help improve the livelihoods of coastal communities. This course of action would also provide habitat protection to endangered species, such as sea turtles.

Potential Spillover Impacts to Other Sectors

Ocean economy development opportunities, human safety, public buildings, infrastructure, tourism and recreation

Potential Costs

Potential up-front costs: $80 million–$82 million in estimated costs (11 years)
Potential recurring costs: —
Potential total costs: $80 million–$82 million in estimated costs

For dune restoration, the up-front cost estimate for on-the-ground ecological restoration activities ranges from $2.1 million to $4 million, along with an estimate for management planning ranging from $540,000 to $900,000 (for 9 municipalities) and an estimate for environmental education component for $100,000. Minimal funding would be required for long-term maintenance and repairs.

For beach restoration, the up-front cost estimate for debris removal and disposal, over approximately 2 years, is $75 million. The estimate also includes interventions at San Juan metro area beaches, for $52 million, and restoration at Rincon beach, for $20 million. A U.S. Army Corps of Engineers regional sediment budget has been funded already at $3 million.

These costs could be lower if NCR 25 (Blue Shore Workforce Development) were implemented and provided the labor.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of the Interior, U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, municipal governments, U.S. Army Corps of Engineers

Potential Pitfalls

Law enforcement is not sufficient to prevent illegal sand extraction and illegal all-terrain vehicle traffic. Rangers lack understanding and education and impede efforts by requiring special permits.

Beaches are dynamic systems with natural waxing and waning cycles. Restoration efforts should be focused on those beaches in accretion cycles, or efforts and money may be wasted on inappropriate restoration. Inappropriate restoration projects would “steal” sand from neighboring areas, which may cause unintended damages. Future storms could erode restoration efforts.

Likely Precursors

Cleanup would be needed of storm debris, such as marine debris, broken tree branches, and sand fencing. Sedimentation studies must be done first. Beach restoration would be most

successful in conjunction with coral reef and seagrass restoration projects. Policies should promote healthy beaches and resilient coastal development.

Note: It is recommended that coral reefs and seagrasses, beaches and dunes, and wetlands are restored in tandem. Although each of these systems is technically a separate ecosystem, the benefits for coastal protection, biodiversity and commercial fishing, and recreation are all increased if all 3 systems are healthy and functional.

NCR 18
Establish the San Juan Barrier Reef as a Marine Protected Area

Sectors Impacted

Natural and Cultural Resources, Economic, Housing, Health and Social Services

Issue/Problem Being Solved

The San Juan Barrier Reef, which provides coastal protection in the highest population-density area in Puerto Rico and is of high tourism value, was damaged by Hurricane Maria. Without intervention, it would not recover quickly, reducing its protective and economic functions and stressing the biodiversity of the reef system.

Description

This course of action would declare the San Juan Barrier Reef a Commonwealth of Puerto Rico marine protected area, restrict fishing to support sustainable commercial and recreational fisheries, and provide other protections to the restoration investment and the reef system's long-term health and resiliency.

Potential Benefits

This course of action would provide long-term protection of high-value infrastructure, tourism sites, and housing in San Juan, as well as health benefits to the community through reduced flooding. This course of action would also provide opportunities for ecotourism and protect beach assets.

Potential Spillover Impacts to Other Sectors

Coastal storm protection provided by reef systems (Housing and infrastructure), local community involvement in protecting health and housing (Community Planning and Capacity Building), and protection of resources valuable for tourism (Economic)

Potential Costs

Potential costs: $500,000–$1 million in estimated up-front costs
Potential costs: —
Potential costs: $500,000–$1 million in total estimated costs

The up-front cost estimate for start-up costs consists of equipment (marker buoys, signage), the management plan, education and outreach, and management staff.

Potential Funding Mechanisms

National Oceanic and Atmospheric Administration, U.S. Department of the Interior, government of Puerto Rico, public-private partnerships, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, National Oceanic and Atmospheric Administration

Potential Pitfalls

There could be weak enforcement and management caused by unstable funding. Depending on the degree of protection and restrictions, some or many of the social and economic benefits could be reduced.

Likely Precursors

Precursors include the availability of research and community and stakeholder buy-in, as well as a clear and transparent focus on community and stakeholder input (the best and most-successful marine protected areas are developed with holistic and effective community and stakeholder participation).

NCR 19
SHPO and ICP Staffing to Meet Project Review Requirements

Sectors Impacted

All

Issue/Problem Being Solved

The Puerto Rico recovery plan would create an excess burden on State Historic Preservation Office (SHPO) and Institute of Puerto Rican Culture (Instituto de Cultura Puertorriqueña, ICP) to review any projects affecting historic properties.

Description

This course of action would enable the SHPO and the ICP to hire extra staff to handle the burden of reviewing projects that affect historic properties, ensuring that they are in compliance with necessary regulations and that they are eligible for certain funds. The number of such projects that arise during the hurricane recovery process is expected to be large.

Potential Benefits

Recovery projects that potentially affect historic properties—including those in historic districts and near underwater sites—could proceed with minimal delay from the review process.

Potential Spillover Impacts to Other Sectors

The ability of other sectors to implement their courses of action would depend on the efficiency of the Section 106 review process.[118]

Potential Costs

Potential up-front costs: —
Potential recurring costs: $5.5 million–$11 million in estimated recurring costs (11 years)
Potential total costs: $5.5 million–$11 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico

[118] This refers to the process mandated by Section 106 of the National Historic Preservation Act of 1966 (Pub. L. 102-575). The act requires federal agencies review the effects of their undertakings and afford the Advisor Council on Historic Preservation the opportunity to comment on those undertakings. This process must be completed prior to expenditure of federal funds. Further description is available at the National Park Service, "Federal Legislation: National Historic Preservation Act of 1966 (NHPA), as Amended," webpage, last updated May 16, 2019 (as of May 16, 2019: https://www.nps.gov/archeology/afori/crm_fed2.htm).

Potential Implementers

SHPO, ICP

Potential Pitfalls

Expertise in historic properties and historic preservation, including legal expertise relevant for the review process, is scarce. Qualified candidates may be difficult to find or may take time to train.

Likely Precursors

Development of job description and posting of job position and interviews of qualified applicants

NCR 20
Redesign, Reorganize, and Rebuild Puerto Rican Parks

Sectors Impacted

Natural and Cultural Resources, Health and Social Services, Transportation, Water, Economic, Municipalities, Public Buildings, Community Planning and Capacity Building

Issue/Problem Being Solved

Parks sustained significant damage during Hurricanes Irma and Maria and require repair. In addition, parks in Puerto Rico were especially vulnerable to extreme weather conditions because of a confluence of physical and organizational misalignments, including misalignment with community needs, missed opportunities to provide greenways, and misalignments in governance, operations, and maintenance.

Description

This course of action would reengineer and reorganize parks to more effectively provide recreational services and to withstand extreme-weather events. This course of action would include assessments of green infrastructure potential and park governance and requires additional function-driven assessments to understand how the park system can be more efficient while meeting community needs. These assessments would help the system rebuild to more-resilient standards and to act as protective green infrastructure.

Potential Benefits

This course of action would reduce health care costs through the provision of active recreation, reduce infrastructure burden through the provision of green infrastructure, and reduce future extreme-weather damage costs through code-compliant rebuilding. It bolsters economic value by attracting tourism, attracting commerce, and elevating property values. Research demonstrates that parks are effective in providing these services and are highly cost-efficient, relative to alternatives. This course of action would enable parks to resume services and take steps to enhance service provision, bolstering future hurricane resiliency.

Potential Spillover Impacts to Other Sectors

Positive impacts from parks could be health benefits, relief from traffic congestion, and cost-effective means for handling stormwater and purifying runoff, even during power failures. Parks could also catalyze public-private partnerships, increase home values, and attract tourism, businesses, and customers. Park reform could lower municipalities' operating costs and clarify ownership.

Potential Costs

Potential up-front costs: $335 million–$651 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $335 million–$651 million in total estimated costs

The estimate for the up-front costs includes community needs ($12 million), green infrastructure ($2 million), greenway ($2 million), and organizational reform ($2 million). The cost estimate for the facility rebuilding is >$300 million (uncertain until assessed).

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of the Interior, U.S. Environmental Protection Agency, U.S. Department of Transportation, public-private partnerships, private insurance, nongovernment sources

Potential Implementers

Department of Sports and Recreation, Puerto Rico Department of Natural and Environmental Resources

Potential Pitfalls

Governance reform may be politically contentious. Material and labor shortages may delay reconstruction.

Likely Precursors

This course of action assumes that NCR 22 (Promote Alternative Tourism for Economic Development) would address the tourism potential of the sites and therefore does not recommend a tourism assessment.

NCR 21
Strategic Watershed, Landscape, and Conservation Corridor Approaches

Sectors Impacted

Natural and Cultural Resources, Water, Health and Social Services, Economic

Issue/Problem Being Solved

Hurricane Maria decreased natural and agro-ecosystem health across Puerto Rico by significantly damaging agriculture lands, forests, watersheds, and coastal areas. This resulted in habitat loss for threatened and endangered species and other flora and fauna and population declines and exacerbated threats from invasive species. These impacts also reduced tourism and other economic activities derived from natural areas (such as bird watching).

Description

This course of action would develop and implement strategies to restore Puerto Rico's natural resources and support human health, infrastructure, and economic outcomes, including the creation of land and river conservation corridors and implementation of other strategic approaches at watershed and landscape scales for key natural and agro-ecosystems, forests, and indicator, umbrella, or guild species.

Potential Benefits

This course of action would likely improve agricultural production, tourism, access to fresh drinking water, recreation opportunities, watershed and ecosystem health, and ecological services, such as air and water quality, pollination services, and the minimization of sedimentation runoff issues. It would also help protect some species of greatest conservation need, help recover forests and other natural areas, and help improve overall biodiversity. By ensuring that lands and waterways are protected, the natural systems would be more resilient to future natural disasters and would provide some hazard mitigation.

Potential Spillover Impacts to Other Sectors

This course of action would likely improve agricultural production and tourism and would lower water and other infrastructure operations costs and investment needs through air and water quality and other ecological services.

Potential Costs

Potential up-front costs: $20 million–$75 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $20 million–$75 million in total estimated costs

The cost estimate for up-front costs includes land purchases for $800–$15,000 per acre, depending on the total area. For the central-mountain-area corridor, the cost estimate for the purchase of 25,000 acres (at a cost of $800–$3,000 per acre) is $20 million–$75 million. The transfer of state lands action has minimal costs.

Potential Funding Mechanisms

National Oceanic and Atmospheric Administration, U.S. Department of the Interior, U.S. Department of Agriculture, U.S. Environmental Protection Agency, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, federal agencies, land trusts, nongovernmental organizations

Potential Pitfalls

Inconsistent land uses, such as agriculture recovery activities that do not consider the impact to ecosystems, and economic development activities that have negative impacts on ecosystems within priority areas for protection

Likely Precursors

Studies to determine the critical watershed and conservation corridor areas

NCR 22
Promote Alternative Tourism for Economic Development

Sectors Impacted

Natural and Cultural Resources, Municipalities, Infrastructure, Health and Social Services

Issue/Problem Being Solved

Hurricanes Irma and Maria negatively affected short-term business opportunities—especially small and medium enterprises. Moreover, many of the affected communities lack individuals with entrepreneurial skills. Current business development programs in the tourism industry are focused primarily on limited tourism market niches, such as sun and sand tourism and day trips for cruise passengers. The long-term effects of these forms of tourism result in further damage to the condition of historic, natural, and cultural assets, as well as the businesses that rely on these resources to create economic growth. The sustainability of these assets and the formation of a market and economic model based on alternative tourism is key to recovering from the damage caused by the hurricanes, including lost income, business interruption, and reduction of capital. Limited efforts have been focused on alternative forms of tourism as an engine for development and economic development. For economic growth to occur, the effects of the hurricanes on this market segment need to be addressed.

Description

This course of action would increase alternative forms of tourism in Puerto Rico by developing a geographically focused destination strategy that capitalizes on existing assets, seeks to create a supplementary and sustainable market that supports economic growth, and protects key historic, cultural, and natural assets. The course of action would respond to the increasing global trend for experience-based tourism, which capitalizes on visitors seeking authentic experiences and encourages interaction with the local environment, people, and communities.

This course of action would be based on a series of geographically identified destinations organized in an interrelated system of hubs with alternative tourism potential. These hubs would offer destinations and experiences that promote longer visitation and higher spending while preserving the integrity of those assets, creating local co-benefits, and diminishing capital needs required by mass-tourism models. The top 3 priority hubs are Río Grande-Fajardo-Humacao, Aguadilla; Aguada, Moca; and Adjuntas, Peñuelas.

This course of action would include activities that facilitate institutional, financial, and market development; develop human capital for capacity building and entrepreneurship; improve tourism infrastructure to benefit local business, population, and visitors; and develop strategies for environmental conservation and land management.

Potential Benefits

This course of action would create business opportunities and support entrepreneurs and small and medium enterprises associated with the visitor economy; foster a resilient and inclusive economic growth strategy for local communities outside San Juan that uses existing natural, cultural, and historic assets and experiences as alternative destinations to mass tourism; create spillover effects on communities, reduce economic insecurity, and improve services provision; increase the efficiency of public investments by focusing on areas with greatest economic return and where benefits reach the most people, while reducing exposure to climate threats; ensure adequate protection and maintenance of Puerto Rico's natural capital, sustaining ecosystem services and function, which reduces infrastructure costs and improves hazard mitigation; provide easier and greater access to points of interest for visitors, as well as residents; reduce migration and community insecurity associated with rural inequalities and poverty; create scalable and transformation mechanisms for citizenship and social inclusion; empower local business and communities to plan and develop their own future according to their local vision, supported by outside expertise and advice; support a locally driven creative process of launching enterprises that are cohesive and part of a regional plan; and create more than 4,100 jobs in the tourism industry, generating nearly $140 million in income over 10 years.

Potential Spillover Impacts to Other Sectors

This course of action would amplify several courses of action in the Economic and Education sectors and would generally improve the economic environment by developing human capital with both technical and entrepreneurial skills that can be used in a variety of businesses. Positive spillovers to infrastructure, as well as real estate, would be expected, as the sharing economy provides new income opportunities for private homeowners. Benefits would also be expected in a revalorization of real estate across properties in the hubs because of increased resources and improved management. This course of action could create a long-term model for economic and inclusive growth across several industries and dispersed territories.

Potential Costs

Potential up-front costs: $140 million–$233.4 million in estimated up-front costs (3 years)
Potential recurring costs: $3.457 million in estimated recurring costs (10 years)
Potential total costs: $143.5 million–$236.9 million in total estimated costs

This course of action was included in the recovery plan at 25% implementation.

The up-front costs are for the top 3 hubs based on estimates from the United States and other alternative tourism destinations. The estimate for annual costs for management of protected areas is $345,700 per year, for 10 years.

Included in the up-front costs are the implementation of a community and small and medium enterprise development fund ($15 million over 3 years) and natural and environmental

restoration costs ($125 million–$218.4 million). The restoration costs include beach renourishment ($43.6 million), wetlands restoration ($68.5 million–$94.8 million), and forest restoration ($12.8 million–$79.9 million). These costs would be offset by the services these systems provide to water quality, coastal protection, food production, and well-being.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, U.S. Department of Agriculture, U.S. Department of the Interior, National Oceanic and Atmospheric Administration, National Endowment for the Humanities, National Archives and Records Administration, Institute of Museum and Library Services, National Endowment for the Arts, U.S. Department of Labor

Potential Implementers

Institute of Puerto Rican Culture, Puerto Rico Tourism Company, U.S. Department of Commerce Economic Development Administration, Small Business Administration, Puerto Rico Department of Natural and Environmental Resources

Potential Pitfalls

This course of action would be dependent on the willingness of communities to seek alternative economic opportunities provided by alternative tourism and to maintain the necessary infrastructure that facilitates travel, as well as the cultural and natural resources that draw tourists.

Initial funding support to small and medium enterprises could create a dependency effect from programs by small and medium enterprises. Civil-society leadership and coordination would be essential to this plan.

Likely Precursors

This work would build on the research and experience provided by several pilot programs initiated by the Foundation for Puerto Rico on the development of alternative tourism in local communities.

NCR 23
Protected Natural Area Land Management for Alternative Tourism

Sectors Impacted

Natural and Cultural Resources, Municipalities

Issue/Problem Being Solved

Hurricanes Irma and Maria affected the ability of public, private, and community land co-managers to establish protocols for the use of public and private protected natural areas and other areas of ecological value for tourism. Appropriate planning systems for tourism are required on public, community, and land trust lands to ensure that natural resources are protected in the long term, revenue is generated from tourism for conservation and community benefits, and appropriate systems for monitoring tourism on public and community/private lands are in place.

Description

This course of action would advise on the required policies and actions for the Puerto Rico Department of Natural and Environmental Resources, the prominent land trust Para la Naturaleza, and other public or community land-management efforts in Puerto Rico that seek to support and help manage the development of alternative tourism. The goals of this course of action would be (1) protecting natural resources in the long term; (2) creating legal instruments that would set terms for private-sector use of public, trust, or community lands; (3) creating revenue generation systems for private use of public land that support conservation of natural resources, sustain the well-being of local people, and promote interpretation and education; (4) developing consistent monitoring programs that work via the limits of acceptable change principles; (5) implementing concession policies for ecolodges and other projects requiring substantial investment to build and operate on public land; and (6) developing concepts for public-private impact investment financing for projects requiring significant capital investment for alternative tourism programs.

Potential Benefits

Good management of tourism in protected natural areas and other areas of ecological value results in long-term benefits for conservation and local well-being. The benefit of creating laws and legal tools to manage tourism on public land is clear. Legal oversight is required to ensure that private users do not overuse or damage natural and cultural resources. Laws and legal tools set the terms for how public resources are used. They can also ensure that there is revenue generated from private use of public lands. Without a legal framework, Puerto Rico is lacking appropriate mechanisms to generate revenue from tourism on public lands. On a larger scale, if proper planning were put in place for the public-land system, there could be new ways to raise

capital for facilities via a concession law, which would greatly enhance the potential for alternative tourism to generate local economic benefits and employment.

Potential Spillover Impacts to Other Sectors

This course of action would amplify several courses of action in the natural resource industries and would generally improve the ability of government to manage public-land resources in a manner that is well structured, well financed, and has long-term potential to expand and create a full-fledged alternative tourism economy.

Potential Costs

Potential up-front costs: $3 million–$4 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $3 million–$4 million in total estimated costs

The up-front cost estimate includes managing tourism on public land.

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Institute of Puerto Rican Culture, Para La Naturaleza, other nongovernmental organizations

Potential Pitfalls

Efforts to galvanize a structured, legal approach to managing tourism on public lands would depend on the willingness of the government of Puerto Rico to prioritize this approach.

Efforts to galvanize an impact investment fund for alternative tourism for community or land trust lands would require cooperation between local communities and land managers in ways that foster benefits for local people and result in possible co-management approaches.

Likely Precursors

The work done by Para La Naturaleza to create well-managed conservation land is the most important precursor of this work in terms of the capacity to manage the planning processes recommended here. The work with Puerto Rico Department of Natural and Environmental Resources would require a strong, high-level commitment to establishing a legal framework for the management of tourism on public lands.

NCR 24
Enterprise Development for Alternative Tourism

Sectors Impacted

Natural and Cultural Resources, Economic, Municipalities, Education

Issue/Problem Being Solved

Hurricane Maria had long-term impacts on businesses related to tourism because of a downturn in international and domestic markets. This has created cash-flow shortages for small and medium enterprises dependent on tourism. Many communities in Puerto Rico have never built entrepreneurial skills related to tourism markets and would require specialized assistance. A creative incubation and specialized training program for populations disproportionately affected by disasters would help build resilience, pride, and a more diversified tourism economy for Puerto Rico in the long term.

Description

This course of action would develop micro, small, and medium enterprises as the primary engine for the development of alternative tourism in proposed alternative tourism hubs. This course of action would (1) support business incubation and a market-visioning program via facilitated sessions in each hub for 1 year; (2) foster business exchange programs with experts in alternative tourism to introduce hub products and allow for feedback from market experts on hub products; (3) establish small-loan and capitalization grant programs for hub enterprises built on experience in Puerto Rico with micro, small, and medium enterprise financing; (4) finalize the process with the launch of alternative tourism products for Puerto Rico at a special event, in collaboration with a major alternative tourism association; and (5) finalize a strategy for financing long-term alternative tourism marketing.

Potential Benefits

This course of action would empower local communities to plan their own futures according to their local visions, and it would give them the opportunity to bring in outside expertise for economic growth and social benefits.

Potential Spillover Impacts to Other Sectors

This course of action would amplify several courses of action in the Economic and Education sectors and would generally improve the economic environment by developing human capital with both technical and entrepreneurial skills that could be used in a variety of businesses.

Potential Costs

Potential up-front costs: $2.2 million–$3.4 million in estimated up-front costs (3 years)[119]
Potential recurring costs: —
Potential total costs: $2.2 million–$3.4 million in total estimated costs[120]

The up-front cost estimate covers 3 hubs. In the first year, the visioning and strategy development is estimated at $1 million for all 3 hubs. In the second year, the estimated cost ranges from $400,000 to $800,000 per hub for a business exchange program, product development, and an alternative tourism market launch.

Potential Funding Mechanisms

U.S. Department of Commerce Economic Development Administration, nongovernment sources, private insurance

Potential Implementers

Destination Marketing Organization, Institute of Puerto Rican Culture, Puerto Rico Tourism Company, municipal governments, nongovernmental organizations

Potential Pitfalls

Coordination of the appropriate bodies at the community level would be required to achieve a new market vision for each hub region, but facilitation would be required. Civil-society leadership and coordination would be essential to this plan. Support from the Puerto Rico Tourism Company and coordination with the new Destination Marketing Organization would be required. Additional work on tourism statistics would be required to ensure that proper market information is available to the effort—not only for mainstream tourism but also for alternative tourism.

Likely Precursors

The Foundation for Puerto Rico has undertaken substantial work on the visitor economy. Its program provides guidance on the development of alternative tourism in local communities, and its research provides guidance on the management of the visitor economy in future work with local communities.

[119] The potential up-front costs should be $2.2 million–$3.4 million and were inadvertently reported in the recovery plan as $1.2 million–$2.4 million, omitting $1 million in estimated costs for the three hubs.

[120] The potential total cost is corrected here. The recovery plan inadvertently omitted $1 million from the estimated up-front costs.

NCR 25
Blue Shore Workforce Development

Sectors Impacted

Natural and Cultural Resources, Economy, Community Planning and Capacity Building

Issue/Problem Being Solved

Puerto Rico does not have the human capital for restoration activities—across sectors and including Natural and Cultural Resources—at the scale needed after Hurricanes Irma and Maria, and this has been exacerbated by people who left Puerto Rico after the hurricanes.

Description

This course of action would create and utilize a locally sourced, skilled labor force to bring jobs to the region and support recovery efforts with habitat restoration and other recovery needs as both a short- and a long-term strategy for workforce development. The long-term workforce development strategy would build the skills and experience to support the strategic objectives of the government in the long term, such as construction, visitor economy, and education. The course of action would use a comprehensive workforce development approach, as opposed to separate, programmatic approaches.

Potential Benefits

This course of action would lead to job creation and facilitate skill development, as well as provide labor for recovery and restoration needs. It would also lead to more-effective and more-efficient use of training and skill development investments, greater skill development opportunities, and greater availability of needed human capital for restoration and long-term goals.

Potential Spillover Impacts to Other Sectors

This course of action would affect community capacity building (stakeholder awareness), as well as the Economic and Education sectors.

Potential Costs

Potential up-front costs: $35 million in estimated up-front costs (7 years)
Potential recurring costs: —
Potential total costs: $35 million in total estimated costs

The up-front cost estimate includes project management and contracting ($1.8 million) and labor for coral restoration and other programs ($33 million).

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Commerce Economic Development Administration, U.S. Department of Labor, Puerto Rico Department of Economic Development and Commerce

Potential Implementers

Puerto Rico Department of Labor and Human Resources, U.S. Department of Commerce Economic Development Administration

Potential Pitfalls

If jobs do not materialize, trained people could leave Puerto Rico.

Likely Precursors

Making linkages among the skills needed for restoration and those needed for the long-term strategic objectives, such as visitor economy, education, and construction

NCR 26
Resource Management Capacity Building

Sectors Impacted

Natural and Cultural Resources, Water, Education, Economy

Issue/Problem Being Solved

Puerto Rico's natural and cultural resource decisionmakers, managers, and operators have received insufficient support in the past for planning and executing management strategies and disaster preparedness. This might have contributed to the scale of some hurricane-related damage and could delay response efforts and resilience in the face of future disasters. (This may represent a broader limitation in capacity building across sectors, in which case this course of action could be expanded or integrated to meet cross-sector capacity building needs.)

Description

This course of action would provide a strategy-to-tasks framework for resource management and future disaster response approaches. It would update resource management plans and guidance, including training support to resource managers and operators, to incorporate new recovery courses of action and enhance resilience in future disasters. This course of action would enable professional information exchange and create the foundation for making data discoverable and actionable through an overarching data management plan. It would also link resource management organizations with middle-school, high-school, and college student programs to foster greater capacity for natural resource monitoring and data gathering, as well as enable educational opportunities.

Potential Benefits

This course of action would strengthen support to natural and cultural resource decisionmakers, managers, and operators in Puerto Rico.

Potential Spillover Impacts to Other Sectors

Some of the organizations involved in this capacity building may also play a role in the Water and Economic sectors. The approach also has the potential to expand to other sectors that experience capacity-building challenges.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs
Potential recurring costs: $11 million in estimated recurring costs (11 years)
Potential total costs: $16 million in total estimated costs

The estimate of costs includes time for people to design and participate in capacity-building activities, travel expenses as needed, and the production and dissemination of documents and guidance. Other potential costs include facility rental for training events, time for people to participate, data management, cloud or other hosting capability, and tool development to help with data conditioning, manipulation, and visualization.

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementers

Puerto Rico Tourism Company, nongovernmental organizations, communities

Potential Pitfalls

If not managed correctly, actions within this course of action may actually (or appear to) interfere with aspects of the status quo that work well.

Likely Precursors

A strong understanding of existing guidance, plans, practices, and data sources would be needed.

NCR 27
Expand Disaster Recovery Sister Cities Connections

Sectors Impacted

Natural and Cultural Resources, Economic, Municipalities, Education

Issue/Problem Being Solved

Puerto Rico can benefit from lessons identified elsewhere about disaster recovery and preparedness. However, there appear to be limited opportunities for Puerto Ricans to build capacity by interfacing with decisionmakers, managers, and operators in other parts of the world who have participated in disaster recovery and preparedness.

Description

This course of action would establish plans for twinning San Juan and other Puerto Rican cities with other disaster-affected places around the world for professional exchanges about disaster recovery and preparedness, as well as cultural and economic exchanges typical of other sister city programs. Example candidates for twinning include New Orleans, Louisiana; Seaside Heights, New Jersey; Miyako, Japan; Zandvoort, Netherlands (or other coastal areas in the Netherlands); and Abidjan, Côte D'Ivoire.

Potential Benefits

Expanding the twinning program in Puerto Rico and specifically targeting cities and areas around the world with similar experience with disasters and recovery—and, in some cases, natural resource management opportunities and challenges—would help ensure the continued success of the recovery effort and enable better future disaster preparedness by facilitating the exchange of information with others who have had to similarly recover. Benefits may include professional development and capacity building for Puerto Rico's institutions and staff, as well as economic and cultural exchange benefits.

Potential Spillover Impacts to Other Sectors

Sister city connections could help enable tourism opportunities and provide support to specific municipalities chosen for the program. They could also enable educational opportunities, including for schools in program areas that might facilitate letter or other exchanges with schools in the sister areas.

Potential Costs

Potential up-front costs: $2.4 million in estimated up-front costs
Potential recurring costs: $11 million in estimated recurring costs (11 years)
Potential total costs: $13 million in total estimated costs

Up-front and sustainment costs would be largely related to personnel time, travel expenses, and location rental fees (as well as catering and materials) for exchange events.

Potential Funding Mechanisms

Nongovernment sources

Potential Implementers

Government of Puerto Rico, nongovernmental organizations, communities

Potential Pitfalls

This course of action could be a waste of time if the program were not leveraged.

Likely Precursors

Decisions about which partners to include and making agreements and planning for the types of engagements and the timelines along which they should happen so as to best benefit Puerto Rico's recovery

NCR 28
Identify Funding for Natural and Cultural Resources Research

Sectors Impacted

Natural and Cultural Resources, Economic, Municipalities, Education, Health and Social Services, Transportation, Housing, Energy, Water

Issue/Problem Being Solved

Recovery of Puerto Rico's natural resources for the purposes of land protection and stabilization, human health, economy, and other services would require additional research and monitoring to ensure that it continues to meet the goals of the recovery plan. Although some courses of action outline research needs for monitoring and adaptive management, relatively little funding is available or has been requested to study the recovery of natural resources as a system or to consider areas that might have been affected by the hurricanes but for which damage assessments could not be initiated or fully completed.

Description

This course of action would establish a multisource (public and private) fund for additional scientific research to support Puerto Rico's strategic objectives for recovery, including an enhanced understanding of the effects of Hurricanes Irma and Maria and adaptive management and monitoring. Specific issues that this course of action would address include land stability and impacts on road networks and rebuilding practices; environmental factors contributing to the spread of mosquito-borne illness; damage to the built environment and the implications for solar panel installation; long-term effects on coral reefs, seagrasses, and mangroves and the implications for sustainable management and the ocean economy; the vulnerability of homes and communities to beach and dune loss and potential improvements to natural infrastructure; and lessons for rebuilding parks and recreation sites.

Potential Benefits

This course of action would establish a source of funding for innovative, multidisciplinary research that supports Puerto Rico's recovery by providing timely information on relevant topics to inform decisionmaking about recovery projects and future plans and actions. This course of action would benefit Puerto Rico's research community, students, and the public.

Potential Spillover Impacts to Other Sectors

This course of action would support research on topics related to natural resources, health, transportation, energy, housing, water, and cultural heritage. Benefits associated with research activities could be economic (jobs), in addition to supporting municipalities' planning.

Potential Costs

Potential up-front costs: $7.5 million–$15 million in estimated up-front costs
Potential recurring costs: $1.1 million in estimated recurring costs (11 years)
Potential total costs: $8.6 million–$16 million in total estimated costs

The up-front cost estimate assumed 15 to 30 research projects funded at $500,000 per project.

Potential Funding Mechanisms

Private sector, nongovernment sources

Potential Implementers

Puerto Rico Tourism Company, Institute of Puerto Rican Culture

Potential Pitfalls

Research must remain in line with the goals of Puerto Rico's recovery plan. It would also be important to pay attention to the potential for conflicts of interest.

Likely Precursors

The precursors could be identification of priority research areas related to the recovery plan, but not explicitly accounted for in other courses of action; determination of which funding programs to route money through; identification of factors other than research merit that should be considered in funding decisions; and coordination of different funds so that calls for research and funding awards could be made according to a timeline relevant for the recovery.

NCR 29
Enhance Public Participation and Education Through Museum Exhibits

Sectors Impacted

Natural and Cultural Resources, Water, Economic, Education

Issue/Problem Being Solved

Many of the proposed Natural and Cultural Resources courses of action—for example, those having to do with landfill and sewage problems, enabling sustainable agriculture and tourism, and supporting cultural heritage—would depend on the participation and partnership of the Puerto Rican public. This public participation would require an education element to demonstrate institutional commitment to key areas and to enable needed shifts in approaches to thinking about waste disposal, recreation, and resource use, among other activities.

Description

This course of action would design and implement in-depth exhibits at museums, such as the Parque de las Ciencias, on how different aspects of the hurricane recovery plans work in terms of natural and cultural resources and what the benefits and drawbacks are. Unlike some other methods of communication (e.g., town hall meetings, flyers), this approach would allow people to access the information through recreational activities that would also provide a draw for tourism and education. To determine the exhibits, this course of action would identify priority focus areas for exhibits and possible locations, conduct survey or focus groups to identify topics of interest and effective means of presentation, develop agreements with museums and existing sites to host the exhibits, and create a communications strategy. (This idea could also be expanded to recovery in other sectors, such as Water, Communications and Information Technology, and Transportation.)

Potential Benefits

These exhibits would enable continued dialogue and commitment to recovery and disaster preparedness.

Potential Spillover Impacts to Other Sectors

The proposed exhibits would facilitate education and tourism opportunities. There is potential to create exhibits related to other sectors as well—for example, a celebration of culture and heritage based on different municipalities and engineering exhibits related to telecommunications.

Potential Costs

Potential up-front costs: $1.7 million–$3.3 million in estimated up-front costs (2 years)
Potential recurring costs: $7.9 million–$17 million in estimated recurring costs
Potential total costs: $9.6 million–$20 million in total estimated costs

The cost estimate for up-front costs consists of exhibit design, materials, promotion, and any required facility alterations. The cost estimate for recurring costs consists of exhibit upkeep and updating.

Potential Funding Mechanisms

Private sector, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Institute of Puerto Rican Culture, universities, host museums

Potential Pitfalls

The exhibits must be interesting and participatory or they could risk not reaching enough people or being viewed as propaganda.

Likely Precursors

Determine priority focus areas for exhibits and possible locations. Conduct surveys or focus groups to identify topics of interest and effective means of presentation. Form agreements with museums and existing sites to host exhibits. Develop a communications strategy.

NCR 30
Create an Accessible Data Repository of Natural and Cultural Resources

Sectors Impacted

Natural and Cultural Resources, Water, Education, Economic

Issue/Problem Being Solved

Puerto Rico's natural and cultural resource decisionmakers, managers, and stakeholders do not have comprehensive data on the characteristics and locations of key natural resources needed to perform postdisaster damage assessments. Lack of reliable and accessible information on natural resources weakens effective management of these resources, informed land-use decisions, compliance with existing laws and regulations, community and stakeholder awareness, and scientific research.

Description

This course of action would create a complete and accessible georeferenced data repository of Puerto Rico's natural and cultural resources, using established data standards and accessible and redundant data systems (such as cloud-based computing) to facilitate response and recovery in the future and to inform investment decisions for natural, human, and economic resources. This course of action would integrate the data system with the Planning Board's Puerto Rico Interactive Map and train human capital to gather and supply data and to perform disaster damage assessments.

Potential Benefits

This course of action would provide stronger support to natural and cultural resource decisionmakers, managers, and operators in Puerto Rico.

Potential Spillover Impacts to Other Sectors

This course of action would affect infrastructure (siting and land-use decisions), community capacity building (stakeholder awareness), economics, and education.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $12 million in estimated recurring costs (11 years)
Potential total costs: $12 million in total estimated costs

Estimated recurring costs include labor to coordinate data standards and collection with researchers, citizen-science organizations, and commonwealth and federal agencies, as well as to gather data generated for other purposes.

Potential Funding Mechanisms

U.S. Department of the Interior, U.S. Geological Survey, National Oceanic and Atmospheric Administration, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, State Historic Preservation Office

Potential Implementers

Government of Puerto Rico agencies (e.g., Department of Natural and Environmental Resources, State Historic Preservation Office, Institute of Puerto Rican Culture), nongovernmental organizations (Puerto Rico Science, Technology, and Research Trust), Puerto Rico Tourism Company

Potential Pitfalls

Funding and data availability

Likely Precursors

A strong understanding of existing guidance, plans, practices, and data sources would be needed.

Public Buildings Sector

COA Number	Title
PBD 1	Compile a Public Buildings Inventory
PBD 2	Right-Size Public Buildings
PBD 3	Establish Integrated Services Centers
PBD 4	Realign Public Building Ownership
PBD 5	Move Public Services to Public Buildings
PBD 6	Study Whether Externalizing PRIDCO Would Improve Its Ability to Support Economic Development
PBD 7	Refurbish Community Centers and Community Technology Centers
PBD 8	Mitigate Flood Risk for Critical Government Functions
PBD 9	Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria
PBD 10	Incentivize State-of-the-Art Building Design, Practices, and Technologies
PBD 11	Bring Public Buildings Up to Code
PBD 12	Develop Secondary Power Guidelines

PBD 1
Compile a Public Buildings Inventory

Sector Impacted

Public Buildings

Issue/Problem Being Solved

Lack of access to information about the government of Puerto Rico's real estate inventory presents a substantial barrier to building inventory management and consolidation, maintenance and repair, structural retrofitting and other risk mitigation activities, damage assessment and recovery planning after natural disasters, and other infrastructure management needs.

Description

This course of action would create a comprehensive, centralized database of buildings and undeveloped properties owned by the commonwealth government. The database would include a number of different building characteristics, thereby allowing straightforward analysis for assessing both emergency response needs and general operational decisionmaking.

Potential Benefits

A commonwealth-wide database would provide clear visibility of complete building inventories for functional systems (e.g., schools, courts, prisons) to facilitate system-wide infrastructure-related decisionmaking. It would also support hazard mitigation programs, damage assessment, and recovery from natural disasters.

Potential Spillover Impacts to Other Sectors

A commonwealth-wide database would be a useful resource for municipalities in their infrastructure planning efforts.

Potential Costs

Potential up-front costs: $2 million in estimated up-front costs
Potential recurring costs: $1 million in estimated recurring costs (11 years)
Potential total costs: $4 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, Puerto Rico Planning Board

Potential Implementers

Puerto Rico Planning Board, Puerto Rico Infrastructure Financing Authority

Potential Pitfalls

This course of action would require good coordination among the many agencies that own public buildings.

Likely Precursors

This course of action should be coordinated with MUN 6 (Create and Maintain Central Repository of Municipal Assets and Associated Conditions), an important precursor to other courses of action.

PBD 2
Right-Size Public Buildings

Sectors Impacted

Public Buildings, Health and Social Services

Issue/Problem Being Solved

Poor economic conditions and decreasing population have led to low occupancy or capacity underutilization in public buildings. Consolidation of commonwealth agencies would further reduce demand. The size and design features of public buildings are not consistent with current needs.

Description

This course of action would analyze the demand for government services to estimate the appropriate building capacity, program requirements, and proposed improvements for government operations. It would also repurpose, reallocate, and refurbish buildings to implement this realignment, as well as sell or demolish unneeded vacant buildings.

Potential Benefits

This course of action would provide income from the sale of buildings and reduce operations and maintenance costs, and it would improve the effectiveness of government operations and the delivery of services. It would also remove the blight of long-abandoned, vandalized buildings.

Potential Spillover Impacts to Other Sectors

Consolidation and shedding of unneeded buildings could provide opportunities to municipalities, other sectors, and private business to acquire properties for productive uses.

Potential Costs

Potential up-front costs: $200 million–$500 million in estimated up-front costs (10 years)
Potential recurring costs: —
Potential total costs: $200 million–$500 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, government of Puerto Rico

Potential Implementers

Puerto Rico Planning Board

Potential Pitfalls

Agencies slated to lose building space may protest this course of action. Restrictions on building use imposed by municipal bonds may limit sale and repurposing options.

Likely Precursors

PBD 1 (Compile a Public Buildings Inventory) must be completed first. In addition, this course of action would need to be closely coordinated with PBD 5 (Move Public Services to Public Buildings), PBD 8 (Mitigate Flood Risk for Critical Government Functions), PBD 9 (Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria), PBD 11 (Bring Public Buildings Up to Code), PBD 7 (Refurbish Community Centers and Community Technology Centers), and MUN 5 (Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance).

PBD 3
Establish Integrated Services Centers

Sectors Impacted

Public Buildings, Health and Social Services, Municipalities, Economic, Transportation

Issue/Problem Being Solved

Government and social services are often spread out and not easily accessible to the public.

Description

This course of action would support ongoing efforts by the commonwealth—specifically the Puerto Rico Department of State—to cluster public services in a way that makes them more efficient and accessible to the public. The implementation of this course of action has already begun, with an operating Integrated Services Center (Centro de Servicios Integrados, CSI) in San Juan.

Potential Benefits

Clustering services together improves public access and would make maintenance easier.

Potential Spillover Impacts to Other Sectors

Improving access to services would have mostly positive spillover impacts in Health and Social Services, Municipalities, and Economic. The CSIs are seen as economic drivers.

Potential Costs

Potential up-front costs: $5 million–$10 million in estimated up-front costs (2 years)
Potential recurring costs: $7 million in estimated recurring costs (11 years)
Potential total costs: $10 million–$20 million in total estimated costs

There would likely be costs in the form of refurbishing new buildings and in changing the building format. The long-term benefits of these forms of investments, which should increase the efficiencies of operations, should theoretically offset the cost.

Potential Funding Mechanisms

The commonwealth is currently funding this course of action, at least partially, and will likely remain the primary source of funding. Other potential funders are FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, government of Puerto Rico, U.S. Department of Agriculture

Potential Implementers

Puerto Rico Department of State, Puerto Rico Public Buildings Authority

Potential Pitfalls

This course of action could be at risk as a result of municipal frustration and politics.

Precursors

Precursors are already largely met. This course of action should be implemented in coordination with PBD 2 (Right-Size Public Buildings), PBD 5 (Move Public Services to Public Buildings), and PBD 8 (Mitigate Flood Risk for Critical Government Functions).

PBD 4
Realign Public Building Ownership

Sectors Impacted

Public Buildings, Municipalities, Health and Social Services, Education, Economic

Issue/Problem Being Solved

Buildings of the same type may be owned by different agencies, complicating coordination.

Description

This course of action would transfer ownership of buildings so that buildings of the same type (e.g., schools or government centers) are all owned by the same agency.

Potential Benefits

This course of action would improve government efficiency, accessibility, and communication.

Potential Spillover Impacts to Other Sectors

This course of action could lead to efficiency gains for Health and Social Services, Education, Municipalities, and potentially other sectors. It would also support the implementation of other courses of action, such as PBD 2 (Right-Size Public Buildings) and PBD 11 (Bring Public Buildings Up to Code).

Potential Costs

Potential up-front costs: $60,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $60,000 in total estimated costs

Potential Funding Mechanisms

Puerto Rico Planning Board

Potential Implementers

Office of the Governor, Legislative Assembly

Potential Pitfalls

This course of action could encounter opposition from negatively affected parties. The agency taking over ownership of a building must also be capable of taking on the financial responsibilities associated with that building. Without PBD 1 (Compile a Public Buildings Inventory), some buildings might not be identified.

Likely Precursors

PBD 1 (Compile a Public Buildings Inventory)

PBD 5
Move Public Services to Public Buildings

Sectors Impacted

Public Buildings, Economic, Municipalities, Health and Social Services

Issue/Problem Being Solved

Many public services are currently housed in private buildings. Public buildings are used inefficiently.

Description

This course of action would house government agencies in public buildings rather than in privately owned buildings.

Potential Benefits

By avoiding paying building rental costs to the private sector when acceptable publicly owned buildings are available, this course of action would ensure that public funds are used more efficiently.

Potential Spillover Impacts to Other Sectors

This course of action would have long-term economic effects, in both the public and private sectors.

Potential Costs

This course of action is designed to ensure cost savings from reduced spending on private-sector rent and vacant building maintenance to offset the additional costs of public-sector rent and moving costs in the long run, resulting in no net cost to the government of Puerto Rico as a whole.

Potential Funding Mechanisms

None, beyond individual agencies that are refurbishing the buildings

Potential Implementers

Office of the Governor, Legislative Assembly

Potential Pitfalls

This course of action could fail if the private sector were heavily reliant on the public services housed in their buildings.

Likely Precursors

PBD 1 (Compile a Public Buildings Inventory) is a necessary precursor. Also, this course of action should be implemented in coordination with PBD 2 (Right-Size Public Buildings), PBD 8 (Mitigate Flood Risk for Critical Government Functions), PBD 7 (Refurbish Community Centers and Community Technology Centers), and MUN 5 (Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance).

PBD 6
Study Whether Externalizing PRIDCO Would Improve Its Ability to Support Economic Development

Sectors Impacted

Public Buildings, Economic

Issue/Problem Being Solved

Government competition in an otherwise healthy market can crowd out private-sector activity. However, if market failures or critical externalities exist, government intervention may improve social welfare.

Description

This course of action would undertake an independent analysis of whether converting the Puerto Rico Industrial Development Company (PRIDCO) into a nongovernmental entity would improve or reduce its ability to support economic development through the private-sector real estate market in Puerto Rico. This analysis would be undertaken by a third-party entity with expertise in economic development, real estate markets, and the Puerto Rican context.

Potential Benefits

This course of action would determine whether or not there are potential significant economic gains that could be achieved through converting PRIDCO into a nongovernmental entity.

Potential Spillover Impacts to Other Sectors

This study could lead to increased economic development through improved market efficiency.

Potential Costs

Potential up-front costs: $500,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $500,000 in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementers

Independent research partner

Potential Pitfalls

Stakeholders may be hesitant to discuss this subject because it is politically sensitive; this would make it difficult to conduct a well-informed study. Also, stakeholders may be hesitant to implement the suggestions of such a study.

Likely Precursors

None beyond identifying funding

PBD 7
Refurbish Community Centers and Community Technology Centers

Sectors Impacted

Public Buildings, Municipalities

Issue/Problem Being Solved

Community centers and community technology centers have fallen into disrepair and were further damaged by Hurricanes Irma and Maria.

Description

This course of action would rebuild or refurbish 300 community centers in low-income communities and 172 community technology centers throughout the commonwealth, including providing them with generators for backup power and building them to withstand hurricanes and earthquakes.

Potential Benefits

As described in the *Build Back Better Puerto Rico* report,[121] restoring community centers would provide improved access to several important services to communities. Community centers often act as emergency shelters in disasters, provide limited medical services, provide computers with internet access, provide trainings and capacity-building initiatives, and host community events.

Potential Spillover Impacts to Other Sectors

This course of action is expected to have important benefits for municipalities.

Potential Costs

Potential up-front costs: $20 million in estimated up-front costs (5 years)
Potential recurring costs: —
Potential total costs: $20 million in total estimated costs

The estimate is based on the *Build Back Better Puerto Rico* report.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery

[121] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Implementers

Puerto Rico Planning Board

Potential Pitfalls

This course of action would need to be coordinated with Municipalities sector courses of action.

Likely Precursors

Precursors would be PBD 1 (Compile a Public Buildings Inventory) and MUN 6 (Create and Maintain Central Repository of Municipal Assets and Associated Conditions). Also, this course of action would need to be coordinated with PBD 2 (Right-Size Public Buildings), PBD 5 (Move Public Services to Public Buildings), PBD 8 (Mitigate Flood Risk for Critical Government Functions), PBD 9 (Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria), PBD 11 (Bring Public Buildings Up to Code), and MUN 5 (Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance).

PBD 8
Mitigate Flood Risk for Critical Government Functions

Sectors Impacted

Public Buildings, Municipalities, Health and Social Services

Issue/Problem Being Solved

Some critical public functions are currently located in buildings that are in flood hazard zones.

Description

This course of action would either relocate critical public functions to buildings outside flood hazard zones or elevate buildings in which the functions are currently housed.

Potential Benefits

This course of action would resolve the issue of critical public services becoming unavailable because of flooding. It would also reduce costs of maintaining buildings in flood zones.

Potential Spillover Impacts to Other Sectors

This course of action could reduce maintenance costs (Municipalities) and improve reliability of services (Health and Social Services).

Potential Costs

Potential up-front costs: $2 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $2 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Education

Potential Implementers

Puerto Rico Planning Board

Potential Pitfalls

Without PBD 1 (Compile a Public Buildings Inventory), some critical public functions housed in flood zones might not be identified.

Likely Precursors

Precursors are PBD 1 (Compile a Public Buildings Inventory) and PBD 4 (Realign Public Building Ownership). This course of action may need to coordinate with PBD 2 (Right-Size Public Buildings), PBD 5 (Move Public Services to Public Buildings), PBD 11 (Bring Public Buildings Up to Code), PBD 7 (Refurbish Community Centers and Community Technology Centers), MUN 5 (Reduce Barriers to Transferring Property to Municipal Governments and Provide Technical Assistance), and EDU 4 (Multisector Analysis to Support Resource Allocation Decisions Related to Schools).

PBD 9
Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria

Sectors Impacted

Public Buildings, Health and Social Services, Municipalities

Issue/Problem Being Solved

Hundreds of public buildings were damaged by Hurricanes Irma and Maria.

Description

This course of action would complete repairs to all essential public buildings that were damaged by Hurricanes Irma and Maria. It would ensure that all repairs meet current building safety codes for wind, flood, and seismic risks.

Potential Benefits

By ensuring that repairs meet current building safety codes for wind, flood, and seismic risks, public buildings would be more resilient against future hurricanes and other natural disasters.

Potential Spillover Impacts to Other Sectors

Public buildings are used by multiple sectors, so this course of action could improve operations and the delivery of services for Education, Health and Social Services, Municipalities, and other sectors.

Potential Costs

Potential up-front costs: $1 billion in estimated up-front costs (5 years)
Potential recurring costs: $700 million in estimated recurring costs (11 years)
Potential total costs: $2 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, private insurance

Potential Implementers

Puerto Rico Infrastructure Financing Authority

Potential Pitfalls

The effectiveness of this course of action would depend on strong building code enforcement.

Likely Precursors

The precursor is PBD 1 (Compile a Public Buildings Inventory). Also, this course of action would need to coordinate with PBD 2 (Right-Size Public Buildings), PBD 5 (Move Public Services to Public Buildings), PBD 8 (Mitigate Flood Risk for Critical Government Functions), PBD 11 (Bring Public Buildings Up to Code), PBD 7 (Refurbish Community Centers and Community Technology Centers), EDU 11 (Rebuilding of Public [PRDE & Municipal] PreK–12 School Infrastructure), EDU 12 (Consolidate and Rebuild University of Puerto Rico Infrastructure), and EDU 13 (Landscape Analysis and Rebuilding of Private Non-Profit [PNP] PreK–12 School Infrastructure).

PBD 10
Incentivize State-of-the-Art Building Design, Practices, and Technologies

Sectors Impacted

Public Buildings, Education, Health and Social Services, Municipalities, Economic

Issue/Problem Being Solved

Slow adoption of state-of-the-art building design, practices, and technologies has resulted in buildings that use resources inefficiently, are not hazard resilient, and often do not best fit their intended purpose.

Description

This course of action would modify existing policies and programs or develop new policies and programs that (1) establish clear standards for energy and water efficiency in public buildings and (2) provide incentives for energy and water efficiency, renewable energy systems, increased resilience to natural hazards, and innovative redesign or reconfiguration of spaces to better support delivery of critical public services.

Potential Benefits

This course of action would reduce resource use and life-cycle building costs, help meet commonwealth energy goals, reduce potential future damages, increase reliability of critical public services, and potentially create new jobs.

Potential Spillover Impacts to Other Sectors

Reduced costs of operations, maintenance, and repair over the life cycle of the building and improved ability to reliably provide critical public services

Potential Costs

Potential up-front costs: —
Potential recurring costs: $7 million in estimated recurring costs (11 years)
Potential total costs: $7 million in total estimated costs

The estimated annual cost of labor is approximately $632,000, only to operate the program, not including the costs of incentives.

Potential Funding Mechanisms

Government of Puerto Rico, U.S. Department of Energy

Potential Implementers

Government of Puerto Rico agencies, municipal governments

Potential Pitfalls

This course of action would depend on stable economic conditions, identification of specific programs, and sufficient funding.

Likely Precursors

Completing PBD 1 (Compile a Public Buildings Inventory) would ensure that the full inventory of public buildings is included in the review and development of policies and programs. This is important for determining appropriate financial incentives.

PBD 11
Bring Public Buildings Up to Code

Sectors Impacted

Public Buildings, Education, Health and Social Services, Municipalities

Issue/Problem Being Solved

Deficiencies in building code enforcement create vulnerabilities to natural hazards in public buildings.

Description

This course of action would conduct an assessment of building safety code compliance for wind, flood, and seismic risks across the inventory of public buildings. Designated buildings would be retrofitted with the appropriate structural hardening. Where feasible, other code upgrades (e.g., energy performance) would also be included.

Potential Benefits

Investing in strengthened building resilience to natural hazards would increase the likelihood that public buildings would perform within public building owners' risk tolerances and would withstand extreme-weather events and natural hazards. Improved energy and water performance would reduce building life-cycle costs.

Potential Spillover Impacts to Other Sectors

This course of action could reduce the costs of operations, maintenance, and repair over the life cycle of public buildings (Municipalities) and improve the reliability of government services (Education, Health and Social Services).

Potential Costs

Potential up-front costs: $900 million–$2 billion in estimated up-front costs (5 years)
Potential recurring costs: —
Potential total costs: $900 million–$2 billion in total estimated costs

The low estimate covers basic roofing and seismic retrofits, whereas the high estimate covers a multihazard retrofit.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, government of Puerto Rico, U.S. Department of Education

Potential Implementers

Government of Puerto Rico agencies, municipal governments

Potential Pitfalls

The effectiveness of this course of action would depend on strong building code enforcement, sufficient funding, a complete inventory of public buildings, and building risk and suitability assessments that inform right-sizing, location, and use of buildings.

Likely Precursors

Precursors are PBD 1 (Compile a Public Buildings Inventory), PBD 2 (Right-Size Public Buildings), and PBD 8 (Mitigate Flood Risk for Critical Government Functions). This course of action could also supplement the work performed in PBD 9 (Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria).

PBD 12
Develop Secondary Power Guidelines

Sectors Impacted

Public Buildings, Health and Social Services, Energy

Issue/Problem Being Solved

Lack of guidelines for designing and implementing secondary power systems could result in a lack of backup power and a subsequent inability to maintain essential services during a grid outage.

Description

This course of action would develop guidelines for the design of secondary power systems for public buildings. Existing standards for emergency and standby power systems could be used as a resource for guideline development.[122]

Potential Benefits

This course of action would facilitate the design of appropriate backup power systems for essential public services and result in redundant energy supply.

Potential Spillover Impacts to Other Sectors

This course of action would develop guidelines for secondary power generation that could improve the reliability of services (Health and Social Services). Microgrid designs for backup systems could affect the Energy sector.

Potential Costs

Potential up-front costs: $400,000 in estimated up-front costs
Potential recurring costs: —
Potential total costs: $400,000 in total estimated costs

Potential cost assumes 6 full-time equivalents to develop guidelines. This cost does not include system components and installation required to implement these guidelines.

[122] Existing standards are IEEE, *IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, IEEE Std. 446-1995, Piscataway, N.J., December 1995; National Fire Protection Association, *Standard for Emergency and Standby Power Systems*, NFPA 110, Quincy, Mass., 2016; National Fire Protection Association, *The National Electrical Code*, NFPA 70, Quincy, Mass., 2016.

Potential Funding Mechanisms

Puerto Rico Energy Commission, Puerto Rico Electric Power Authority, FEMA Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery

Potential Implementers

State Office of Energy Policy, Office of Permit Management

Potential Pitfalls

Lack of oversight, funding, maintenance, and enforcement would significantly decrease the impact of this course of action.

Likely Precursors

Implementation of this course of action would require as input a current inventory and classification of functions provided by public buildings (PBD 1, Compile a Public Buildings Inventory) to determine the appropriate backup power design to sustain these functions.

Transportation Sector

COA Number	Title
TXN 1	Refine and Enforce Design Standards for Roads and Bridges
TXN 2	Harden Vulnerable Transportation Infrastructure
TXN 3	Redevelop Rafael Hernández Airport
TXN 4	Repair Airport Damage
TXN 5	Road Maintenance and Repair Program
TXN 6	Update the Airport Emergency Plans
TXN 7	Incentivize a Variety of Mobility Options
TXN 8	Improve Bus Service
TXN 9	Develop an Intelligent Transportation System
TXN 10	Develop Redundant Seaport Capacity
TXN 11	Support Infrastructure Asset Management
TXN 12	Repair Damage to Ports and Ferry Terminals
TXN 13	Reassess the Maritime Transportation System Recovery Plan
TXN 14	Long-Term Planning to Develop Port of Ponce as a Regional Transshipment Hub
TXN 15	Consolidate Port Ownership
TXN 16	Repair Damage to Surface Transportation Network
TXN 17	Provide High-Capacity Transit Service to San Juan Airport
TXN 18	Provide High-Capacity Transit Service Between San Juan and Caguas
TXN 19	Extend PR-5
TXN 20	Extend PR-22
TXN 21	Complete PR-10
TXN 22	Increase Port Facility Resilience

TXN 1
Refine and Enforce Design Standards for Roads and Bridges

Sector Impacted

Transportation

Issue/Problem Being Solved

Road maintenance, increased infrastructure resilience, safer traffic

Description

This course of action would collect and refine guidance on road design, develop a set of engineering standards, and ensure that roads meet these standards. The standards would cover geometric design standards for roads and bridges published by the American Association of State Highway and Transportation Officials, as well as more-novel standards on signage, roadway marking, and lighting, drainage, and signals. The standards would cover innovative treatments, such as the use of solar-powered signs and signals. Ensuring that roads meet the standards would require enforcement efforts—including the enforcement of appropriate truck weight limits—and the application of numerous engineering treatments.

Potential Benefits

Increased use of roadway marking, signage, and lighting would improve safety. Improved roadway drainage systems would lead to reductions in maintenance costs, longer roadway life, and reductions in the possibility of major damage during future hurricanes. Better bridge standards should reduce risks from flooding and sedimentation. Better sidewalks and bicycle infrastructure should encourage more people to walk and bicycle, thus reducing congestion.

Potential Spillover Impacts to Other Sectors

This course of action would provide near-term employment opportunities on engineering and construction projects. It would also lead to better health for people who can use active transportation (walking and bicycling).

Potential Costs

Potential up-front costs: $2 million–$100 million in estimated up-front costs (3 years)
Potential recurring costs: $3 million–$4 million in estimated recurring costs (11 years)
Potential total costs: $6 million–$100 million in total estimated costs

The up-front cost estimate assumes roughly 50 small-scale projects—e.g., adding street lighting and lane markings for the high estimate. Additional recurring costs of approximately

$375,000 per year would be needed to maintain an office to enforce the refined road design standards.

Potential Funding Mechanisms

U.S. Department of Transportation

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

This course of action would require a trained and motivated workforce. Staff turnover could be an issue. Contractor capacity could also be an issue, particularly if numerous other civil engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 2
Harden Vulnerable Transportation Infrastructure

Sector Impacted

Transportation

Issue/Problem Being Solved

Increased physical resilience of roadway infrastructure

Description

This course of action would analyze transportation infrastructure to identify exposure to natural hazards and then undertake engineering projects to mitigate risk. This effort would begin with hydrological and geotechnical evaluations, including floodplain and landslide risk mapping. This course of action would identify the most-vulnerable infrastructure assets and propose beneficial engineering works, including the relocation of roads; bridge, pavement, and culvert reconstruction; and projects to increase the structural strength of certain roads or to reroute traffic toward more-resilient infrastructure. This course of action would also undertake a portfolio of particularly cost-effective projects to harden transportation infrastructure. Two potential highway projects are PR-25R and PR-187.

Potential Benefits

This course of action would increase the chances that the transportation system would function well after future a natural disaster.

Potential Spillover Impacts to Other Sectors

This course of action would offer employment opportunities in the short term and reduce the chances of transportation infrastructure failure in the long term, benefiting the Economic sector in particular.

Potential Costs

Potential up-front costs: $1.3 million–$380 million in estimated up-front costs (10 years)
Potential recurring costs: —
Potential total costs: $1.3 million–$380 million in total estimated costs

This action was costed at 25% implementation in the recovery plan.[123]

[123] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

The estimate is based on 4 similar infrastructure hardening projects proposed, and favorably reviewed, in California. The cost of implementing this course of action would vary with the scope of the analysis and, in particular, the engineering works undertaken to harden infrastructure assets.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Transportation, U.S. Department of Energy

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

This course of action would involve analysis and engineering work that requires specialized expertise. It would be important to recruit and retain a skilled workforce for project management. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 3
Redevelop Rafael Hernández Airport

Sectors Impacted

Transportation, Economic

Issue/Problem Being Solved

Some of the nicest beaches in Puerto Rico are located in the Porta del Sol region in western Puerto Rico. However, access to this potential tourist draw remains difficult, and the closest major airport, Rafael Hernández Airport in Aguadilla, has only limited passenger services and mainly focuses on cargo transport.

Description

This course of action would upgrade and expand Rafael Hernández Airport with a new runway, taxiway, apron areas, terminals, and a control tower, all of which would increase flight capacity and better position the airport to serve passengers.

Potential Benefits

An expanded Rafael Hernández Airport could increase passenger travel to Aguadilla—a municipality in the Porta del Sol region—and it could boost local economic activity, both for the municipality and for the entire region. This could generate local employment opportunities, expand tourist revenues, and generally stimulate economic growth in the region. An expanded Rafael Hernández Airport could also potentially reduce air traffic and airport congestion at San Juan Airport.

Potential Spillover Impacts to Other Sectors

A larger airport with more-regular passenger service would increase the demand for tourism and lead to growth in maritime and other ocean economy activities. However, the expansion and associated economic benefits would need to be weighed against potential environmental costs.

Potential Costs

Potential up-front costs: $400 million–$500 million in estimated up-front costs (10 years)
Potential recurring costs: —
Potential total costs: $400 million–$500 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.

Since the investments in redeveloping Rafael Hernández Airport would likely take place over a decade, maintenance costs are not being considered at this point.

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, U.S. Department of Transportation, Puerto Rico Ports Authority, municipal governments, public-private partnerships, private insurance

Potential Implementers

Puerto Rico Ports Authority

Potential Pitfalls

The benefits of expanding the capacity of the Rafael Hernández Airport hinge on the extent to which it would stimulate greater local economic activity and increase tourism. Environmental damage is also possible.

Likely Precursors

None

TXN 4
Repair Airport Damage

Sector Impacted

Transportation

Issue/Problem Being Solved

Repairs are needed to allow for the safe and efficient operation of the airports in Puerto Rico.

Description

This course of action would make repairs to airport facilities that were damaged during Hurricanes Irma and Maria, including roofs, fences, and electrical systems.

Potential Benefits

Allowing for continued operation of the airports in Puerto Rico would, in turn, allow for the delivery of recovery supplies. This course of action would be essential for the local economy. Some of the repairs—for example, related to perimeter fencing and lighting—would improve safety.

Potential Spillover Impacts to Other Sectors

Repairing the airports would allow for continued air travel to Puerto Rico, improving the outlook for tourism and the economy more generally.

Potential Costs

Potential up-front costs: $250 million in estimated up-front costs (3 years)
Potential recurring costs: $12 million in estimated recurring costs (11 years)
Potential total costs: $270 million in total estimated costs

The estimate for up-front costs is based on damage assessments as of June 15, 2018. The estimated cost of ongoing maintenance is $1.2 million per year.

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Transportation, private insurance

Potential Implementers

Puerto Rico Ports Authority, Aerostar (San Juan Airport operator), private sector

Potential Pitfalls

Temporary, minor repairs would not be a substitute for major repairs or reconstruction. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 5
Road Maintenance and Repair Program

Sector Impacted

Transportation

Issue/Problem Being Solved

Road maintenance, increased physical resilience of roadway infrastructure, and safer traffic

Description

This course of action would (1) mandate that road maintenance and repair projects be given priority over the construction of new, or expansion of existing, facilities; (2) adopt a "fix it first" policy; and (3) select and implement a portfolio of such projects. Projects would improve the condition of roadways and would also include safety or operational improvements. This course of action would select projects based on their cost-effectiveness, drawing on the judgment of pavement engineers. Relevant similar projects include Michigan's pioneering Preserve First Program and portions of the more-recent State Highway Operation and Protection Program in California and "Let's Go CT!" in Connecticut.

Potential Benefits

Improved road conditions would lower vehicle operating costs, travel times, travel time variance, accident rates, the severity of accidents, pollutant emissions, and future road maintenance expenditures while increasing resilience.

Potential Spillover Impacts to Other Sectors

Reductions in vehicle operating costs, travel times, and travel time variance should benefit the economy.

Potential Costs

Potential up-front costs: $100 million–$5.5 billion in estimated up-front costs (5 years)
Potential recurring costs: $900 million in estimated recurring costs (9 years)
Potential total costs: $1.0 billion–$6.4 billion in total estimated costs

Estimated up-front costs assume that 1,000 lane-miles of pavement are repaired, 1,000 are rehabilitated, and 1,000 are reconstructed. (There are more than 16,500 centerline miles of paved roads in Puerto Rico.) Successful implementation would produce some cost savings in out years, but to ensure that maintenance remains a priority, we would nonetheless recommend increasing annual maintenance spending. The rough cost estimate for the increase in recurring cost is $100 million a year.

Potential Funding Mechanisms

U.S. Department of Transportation, Puerto Rico Department of Transportation and Public Works

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Failure to train, attract, and retain a skilled workforce could limit benefits. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 6
Update the Airport Emergency Plans[124]

Sectors Impacted

Transportation, Community Planning and Capacity Building

Issue/Problem Being Solved

There is a lack of both coordination and documentation of multijurisdictional activities that have been identified as significant for effective emergency management.

Description

This course of action would reevaluate and update airport emergency plans to assign key roles to partners to identify reserve capacities and pre-positioned response assets, develop a communications protocol for first responders during a disaster, and implement prestorm protection measures in an integrated fashion to ensure the safety of, and emergency services for, the airport populace and the community in which the airport is located.

Potential Benefits

Updated airport emergency plans would take advantage of lessons learned during Hurricanes Irma and Maria to further develop a pre-coordinated disaster recovery plan for the various airports around Puerto Rico. Updated plans would ensure that Puerto Rico can recover quickly in the event that a future disaster disables or disrupts port activity with cascading effects to health, safety, and security of the population.

Potential Spillover Impacts to Other Sectors

Some elements of emergency planning should be integrated with the Energy and Communications and Information Technology sectors, since ensuring adequate backup electricity generation and communications channels would likely be an important component. Successful plans should also minimize economic disruption postdisaster.

Potential Costs

Potential up-front costs: $4 million in estimated up-front costs
Potential recurring costs: $1 million in estimated recurring costs (11 years)
Potential total costs: $5 million in total estimated costs

[124] The recovery plan uses the title “Update the All-Airports Emergency Plan.” However, each airport has an individual plan, so that title is being modified here to avoid the misperception that there is a single plan covering all airports.

The estimate for reassessing and updating the airport emergency plans is $500,000. Estimates for implementing portions of the plans, including pre-positioning assets and establishing an integrated operations center, range from $2 million to $5 million. The estimate for ongoing costs (e.g., conducting exercises) is $100,000 annually.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Transportation, Puerto Rico Ports Authority

Potential Implementers

Puerto Rico Ports Authority, Aerostar (San Juan Airport operator)

Potential Pitfalls

Establishing consensus among partners on final approval of the plans may present challenges.

Likely Precursors

None

TXN 7
Incentivize a Variety of Mobility Options

Sector Impacted

Transportation

Issue/Problem Being Solved

Increase travel options for people who do not drive

Description

This course of action would provide additional travel options for people who do not drive or who prefer to use other options. Puerto Rico has fairly limited public transit service, especially outside San Juan and no scheduled intercity transportation, and ride-hailing (e.g., Uber) is not available in all areas or may be cost-prohibitive. Mobility options would include ride-hailing and ride-sharing, expanded "publico" (jitney) service, intercity bus service, bike and scooter-sharing, and peer-to-peer car-sharing.

Potential Benefits

Benefits to individuals and households would vary. People who do not drive would enjoy increased mobility options, which could lead to a variety of improvements in their quality of life—increased ability to visit friends and family, seek health care, and so forth. Increased use of nonmotorized modes would also improve health for some people, as active transportation provides exercise. Use of nonmotorized modes could also contribute to reduced air pollution if pedestrians and bicyclists switch from driving.

Potential Spillover Impacts to Other Sectors

Mobility options focused on active transportation could contribute to improved health outcomes.

Potential Costs

Potential up-front costs: $450,000–$17 million in estimated up-front costs
Potential recurring costs: $4.4 million–$170 million in estimated recurring costs (11 years)
Potential total costs: $4.9 million–$190 million in total estimated costs

Most of these strategies have individual start-up and annual operating costs between $500,000 and $2 million.

Potential Funding Mechanisms

U.S. Department of Transportation, users, private sector

Potential Implementers

Puerto Rico Highway and Transportation Authority, private companies, Puerto Rico Metropolitan Bus Authority

Potential Pitfalls

Lack of demand, technological unreliability, technological change, and lack of popular support could present challenges.

Likely Precursors

To promote walking and bicycling, it would be helpful to implement the "Complete Streets" standards in TXN 1 (Refine and Enforce Design Standards for Roads and Bridges). It would also be helpful to conduct a study regarding how new mobility options, expanded bus service, and Tren Urbano could be better integrated.

TXN 8
Improve Bus Service

Sector Impacted

Transportation

Issue/Problem Being Solved

Bus service is often slow and unreliable, and many people who do not drive face severely limited mobility options.

Description

This course of action would improve existing bus service in 6 ways: (1) transit signal priority (which gives buses additional time to cross a signalized intersection), (2) provision of real-time arrival information, (3) upgrades to bus stops, (4) smart-card fare media, (5) dedicated bus lanes, and (6) an expanded bus fleet.

Potential Benefits

This course of action would lead to more-reliable and more-comfortable bus service. Improving bus service would also provide a useful alternate mode of transportation to people who cannot, or choose not to, drive.

Potential Spillover Impacts to Other Sectors

Increased use of transit could reduce air pollution produced by single-occupant vehicles. Within the Transportation sector, transit signal priority could be developed alongside other traffic management systems and preemption for emergency response vehicles.

Potential Costs

Potential up-front costs: $200,000–$79 million in estimated up-front costs (2 years)
Potential recurring costs: $7.9 million–$650 million in estimated recurring costs (11 years)
Potential total costs: $8 million–$730 million in total estimated costs

Implementing all 6 proposed improvements would cost approximately $63 million, with costs of individual components ranging from $200,000 (real-time arrival information) to $39 million (new buses). Operating costs are estimated to cost around $48 million annually.

Potential Funding Mechanisms

U.S. Department of Transportation, users, advertising, public-private partnerships

Potential Implementers

Puerto Rico Metropolitan Bus Authority

Potential Pitfalls

Lack of demand (leading to reduced bus service revenue and benefits), need for operating funds, technological unreliability limiting benefits, and technological change causing improvements to be outdated

Likely Precursors

It would be helpful to conduct a study regarding how new mobility options, expanded bus service, and Tren Urbano could be better integrated.

TXN 9
Develop an Intelligent Transportation System

Sector Impacted

Transportation

Issue/Problem Being Solved

This course of action would improve capacities for detection, response, and clearing of traffic incidents to restore the flow of traffic, reducing congestion.

Description

This course of action would develop the capabilities of transportation agencies to provide real-time traveler information to highways and to manage traffic through optimized traffic signalization. In addition to developing the informational capacity, this course of action would include incident management, which is designed to clear incidents (e.g., crashes, roadway obstructions) on roadways and safely restore traffic capacity as quickly as possible.

Potential Benefits

Intelligent transportation systems, coupled with incident management systems, could divert traffic away from incidents, decrease incident response time, and reduce probabilities of crashes after an initial incident.

Potential Spillover Impacts to Other Sectors

Intelligent transportation systems could benefit the Economic sector by mitigating costs associated with roadway incidents and potentially increasing productivity previously affected by congestion and incident related delays.

Potential Costs

Potential up-front costs: $30 million in estimated up-front costs (2 years)
Potential recurring costs: $48 million in estimated recurring costs (11 years)
Potential total costs: $78 million in total estimated costs

The up-front cost estimate is between $20 million and $40 million, depending on the level of coverage the project aims to achieve. The best estimate consists of an up-front cost of $30 million and an annual cost of $4.6 million.

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Transportation

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Lack of skilled workers, interagency communication, and interagency cooperation could limit benefits.

Likely Precursors

Fiber optic cable may need to be upgraded.

TXN 10
Develop Redundant Seaport Capacity

Sectors Impacted

Transportation, Economic, Community Planning and Capacity Building, Energy

Issue/Problem Being Solved

Puerto Rico lacks adequate redundant seaport capacity. Because of Puerto Rico's dependence on arrival of goods by sea, a major disruption (natural disaster, vessel sinking, or other similar shock) that damages the seaport of San Juan could lead to cascading impacts for food security, energy distribution, and community sustainability.

Description

This course of action recommends additional development at an existing seaport to create a sustainable redundant capacity for the arrival of maritime goods in the event of the loss of the seaport of San Juan because of a natural or man-made disaster. The ports of Ceiba (Roosevelt Roads), Ponce, and Mayaguez are prime candidates, based on their strategic locations and available capacity.

Potential Benefits

This course of action could help prevent devastating losses to the economy and population in the event of another disaster that affects the capability of the Port of San Juan to receive food and fuel supply.

Potential Spillover Impacts to Other Sectors

There could be positive impacts to the Economic, Community Planning and Capacity Building, and Energy sectors. Developing a redundant port would provide job opportunities, competition, diversification, community development, and redundancy and resiliency in supply of fuels for the Energy sector.

Potential Costs

Potential up-front costs: $87 million–$160 million in estimated up-front costs (5 years)
Potential recurring costs: $14 million–$23 million in estimated recurring costs (11 years)
Potential total costs: $100 million–$180 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.[125]

[125] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

Estimates for the Ports of Ceiba and Mayaguez are $174 million and $315 million, respectively, based on detailed estimates from the Maritime Administration and U.S. Department of Transportation. These estimates includes structural improvements; dredging; cargo, ferry, and fueling operations; acquisition of additional land; and pier structures to support humanitarian assistance/disaster response operations. The estimated annual operating cost (for any selected port) is $4 million.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Port Security Grants, Puerto Rico Ports Authority, private sector, private insurance

Potential Implementers

Puerto Rico Ports Authority, port authorities and operators

Potential Pitfalls

There is high potential for a redundant port to fall into disrepair—and thus be unable to perform as a redundant port—if not used regularly for private commerce or government use.

Likely Precursors

Creation of a public-private partnership and associated project management plans

TXN 11
Support Infrastructure Asset Management

Sector Impacted

Transportation

Issue/Problem Being Solved

Road maintenance, increased physical resilience of infrastructure, safer traffic

Description

This course of action would support public agencies' efforts to inventory the transportation infrastructure assets that they manage and develop or improve systems for tracking the conditions of these assets and for selecting and scheduling maintenance, repair, and rehabilitation activities. Assets may include pavements, bridges, and ancillary assets, such as culverts and signage. Support includes dedicated funding for, and the arranging of, inventory surveys, asset condition testing, infrastructure asset management software system development, and staff training.

Potential Benefits

Infrastructure asset management systems have, historically, led to reductions in asset maintenance costs and improvements in the serviceability offered by transportation assets. Improvements in serviceability could lead to reductions in vehicle operating costs, travel times and travel time variance, crash rates and the severity of crashes, and emissions of pollutants.

Potential Spillover Impacts to Other Sectors

This course of action would raise the profile of infrastructure management. The Water and Energy sectors are the most likely to be affected, as well as the Communications and Information Technology, Public Buildings, and Housing sectors.

Potential Costs

Potential up-front costs: $5 million in estimated up-front costs (2 years)
Potential recurring costs: $1 million in estimated recurring costs (11 years)
Potential total costs: $6 million in total estimated costs

The estimated up-front cost is split evenly between efforts to inventory assets and improve asset management systems and system use. Studies indicate that successful implementation of this project would produce cost savings, agency-wide, in out-years, although it may cost on the order of $125,000 per year for a trained professional to manage such a system or systems.

Potential Funding Mechanisms

U.S. Department of Transportation

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Failure to train, attract, and retain a skilled workforce could limit benefits, as could failure to integrate asset management into decisionmaking.

Likely Precursors

None

TXN 12
Repair Damage to Ports and Ferry Terminals

Sector Impacted

Transportation

Issue/Problem Being Solved

Puerto Rico's ports and ferry terminals sustained substantial damage during Hurricanes Irma and Maria. In many cases, there was damage from before the hurricanes or conditions that were worsened by the hurricanes.

Description

This course of action would repair damage to Puerto Rico's ports and ferry terminals that constrains their current use—specifically the import of key goods, such as food and fuel.

Potential Benefits

Repairing Puerto Rico's ports and ferry terminals should keep them in a state of good repair so that they can be available at their full capacity in the future. In addition, it provides some redundant capacity in the event that a major port is unavailable during or after a natural disaster or after some other major disruption.

Potential Spillover Impacts to Other Sectors

Ensuring that the ports are fully functional would be beneficial to Puerto Rico's economic well-being, given its reliance on imports. Engineering and construction could also provide short-term employment opportunities.

Potential Costs

Potential up-front costs: $940 million in estimated up-front costs (10 years)
Potential recurring costs: $46 million in estimated recurring costs (11 years)
Potential total costs: $990 million in total estimated costs

These cost estimates are based on assessments conducted by the U.S. Department of Transportation Maritime Administration (cruise ship and cargo ports) and the Federal Transit Administration (ferry terminals) as of May 31, 2018.

Potential Funding Mechanisms

FEMA Public Assistance, U.S. Department of Transportation, Community Development Block Grant–Disaster Recovery, private sector, private insurance

Potential Implementers

Puerto Rico Ports Authority, Port of Ponce Authority, Mayaguez Ports Commission, private port operators, Puerto Rico Maritime Transportation Authority

Potential Pitfalls

Lack of demand, ongoing maintenance needs, and lack of coordination could pose challenges. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects are undertaken at the same time.

Likely Precursors

None

TXN 13
Reassess the Maritime Transportation System Recovery Plan

Sector Impacted

Transportation

Issue/Problem Being Solved

Contingency planning for the Port of San Juan is not fully coordinated with all critical stakeholders. Comprehensive coordination of response activities has not been accomplished. There is a lack of both coordination and documentation of multijurisdictional activities that have been identified as significant for effective emergency management.

Description

This course of action would reevaluate the Maritime Transportation System recovery plan to (1) assign key roles to partners to identify reserve capacities and pre-positioned response assets, (2) establish an integrated operations center, (3) develop a communications protocol for first responders during a disaster, and (4) implement prestorm protection measures in an integrated fashion to protect critical resources.

Potential Benefits

An updated Maritime Transportation System recovery plan would take advantage of lessons learned during Hurricanes Irma and Maria to further develop a precoordinated disaster recovery plan for the various ports around Puerto Rico.

Potential Spillover Impacts to Other Sectors

This course of action could have a positive impact on all sectors, since maritime trade either directly or tangentially influences every aspect of life on an island. A more robust recovery plan would ensure that maritime trade and port operations are resilient and responsive to disasters.

Potential Costs

Potential up-front costs: $100,000–$300,000 in estimated up-front costs
Potential recurring costs: $200,000 in estimated recurring costs (11 years)
Potential total costs: $300,000–$500,000 in total estimated costs

Reassessing the Maritime Transportation System recovery plan would incur minimal costs. Implementation, including pre-positioned assets and the establishment of an integrated operations center, may cost up to $250,000, but these estimates may vary depending on new regulations that could be imposed.

Potential Funding Mechanisms

U.S. Coast Guard, FEMA Pre-Disaster Mitigation Grant Program, Puerto Rico Ports Authority

Potential Implementers

Puerto Rico Ports Authority, U.S. Coast Guard, maritime stakeholders

Potential Pitfalls

Establishing consensus among partners on final approval of the plan could be challenging.

Likely Precursors

None

TXN 14
Long-Term Planning to Develop Port of Ponce as a Regional Transshipment Hub

Sector Impacted

Transportation

Issue/Problem Being Solved

Investment in the Port of Ponce could help the port keep pace with forecast changes in worldwide shipping, both increasing resiliency and allowing the port to eventually serve as a major Caribbean transshipment hub, while providing regional feeder services to the eastern and southern Caribbean.

Description

This course of action would invest in the Port of Ponce and provide an economic incentive through reduced taxes or government subsidy for shipping agencies to use the Port of Ponce as a primary transshipment point for South and North America on a proposed circum-equatorial distribution network.

Potential Benefits

This course of action could lead to long-term, sustained economic growth within the maritime transportation sector, as well as reliable revenue streams in the growing container-shipping transshipment market. This course of action could make Puerto Rican ports more attractive for investors, shipping lines, and port operators, as well as provide a reliable and sustainable revenue stream with second-order effects over the next decade or more.

Potential Spillover Impacts to Other Sectors

Transshipment would have implications for many other sectors, but most directly for the Economic sector.

Potential Costs

Potential up-front costs: $50 million–$300 million in estimated up-front costs (8 years)
Potential recurring costs: $50 million–$200 million in estimated recurring costs (11 years)
Potential total costs: $100 million–$500 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.[126]

[126] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

The range of estimates is based on previous efforts to position the port as a transshipment hub. Potential cost estimates are both complex and highly variable, depending on market forces and the overall marketing strategy used by the Ponce Port Authority, strategic partners, and stakeholders. Costs could also vary if the Port of Ponce were selected as a redundant seaport, as proposed in TXN 10 (Develop Redundant Seaport Capacity).

Potential Funding Mechanisms

Private sector, nongovernment sources

Potential Implementers

Port of Ponce Authority, Puerto Rico Ports Authority

Potential Pitfalls

The key drivers of transshipment include (1) being located at the crossroads of principal maritime trade routes, (2) productivity of stevedoring operations, (3) a guarantee of berths, (4) control of operations, (5) safety and security, (6) dedicated feeder services. Degradation to any of the key drivers to transshipment would negatively influence the prospect of a Caribbean hub port. Avoiding such degradation would require active management and investment. In addition, competition from other Caribbean ports may make it difficult to attract new business.

Likely Precursors

Completing repairs and resilience improvements to the Port of Ponce is a precursor to transshipment capacity development—these costs would be incurred as part of TXN 12 (Repair Damage to Ports and Ferry Terminals) and TXN 22 (Increase Port Facility Resilience).

TXN 15
Consolidate Port Ownership

Sector Impacted

Transportation

Issue/Problem Being Solved

Maritime subject-matter experts and recent port assessments unanimously cite the current ownership and oversight structure of Puerto Rico's ports as a significant detriment to port improvement plans, response and recovery operations, collaborative efforts, and overall Maritime Transportation System resiliency.

Description

This course of action would consolidate port ownership and oversight across Puerto Rico's 9 main ports to better manage the Maritime Transportation System as a whole.

Potential Benefits

This course of action would lead to more-efficient and more-profitably run ports; greater cohesion between port owners and, thus, greatly simplified coordination; and improved resiliency for response and recovery operations. This course of action would make Puerto Rico's ports more attractive for investors, shipping lines, and port operators, and it could increase Puerto Rico's port competitiveness as a regional transshipment hub.

Potential Spillover Impacts to Other Sectors

Port ownership consolidation would have implications for many other sectors, but it would most directly affect the Economic sector.

Potential Costs

Since this is a policy decision, it would incur no cost. Consolidating ownership or port operations oversight would most likely require complex incentives and negotiations. Gaining a full understanding of the potential costs would be based on consolidation decisions that would then require additional research and analysis.

Potential Funding Mechanisms

Puerto Rico Ports Authority, private sector

Potential Implementers

Puerto Rico Ports Authority, private sector

Potential Pitfalls

Coordination among current owners and operators could prove challenging.

Likely Precursors

A full understanding of port ownership across all of Puerto Rico's ports is needed. Significant research must be completed by a third party with access to historical records, lease agreements, titles, local relationships, and an understanding of local port culture.

TXN 16
Repair Damage to Surface Transportation Network

Sector Impacted

Transportation

Issue/Problem Being Solved

Hurricanes Irma and Maria caused extensive damage to Puerto Rico's surface transportation network. The main immediate effect was debris blocking roads, but more than 6,000 incidents were reported to the Puerto Rico Department of Transportation and Public Works, including landslides and collapsed or weakened bridges. Roadside signs were destroyed, and many traffic signals were physically damaged or rendered nonoperational. Bus and rail service in San Juan were suspended.

Description

This course of action would make repairs to roads that remain blocked, including the road that serves the U.S. Federal Aviation Administration tower in El Yunque, and it would replace bridges that failed or sustained significant damage during the hurricanes. It would also repair transit systems to meet codes.

Potential Benefits

Restoring Puerto Rico's surface transportation network to its prehurricane levels of functionality is vital to ensuring the efficient transportation of people, goods, and services throughout the commonwealth.

Potential Spillover Impacts to Other Sectors

Ensuring that Puerto Rico's surface transportation network is restored to its prehurricane functionality would have a range of positive impacts, given that roads are needed for economic activity, access to social services, and for maintaining other infrastructure.

Potential Costs

Potential up-front costs: $800 million in estimated up-front costs (3 years)
Potential recurring costs: $16 million in estimated recurring costs (11 years)
Potential total costs: $820 million in total estimated costs

The recurring-cost estimate includes ongoing surface transit maintenance costs.

Potential Funding Mechanisms

U.S. Department of Transportation, FEMA, government of Puerto Rico

Potential Implementers

Puerto Rico Department of Transportation and Public Works, Puerto Rico Highway and Transportation Authority

Potential Pitfalls

There are few potential pitfalls to repairing the damage to Puerto Rico's surface transportation network. However, one concern is that, because of population displacement and permanent migration, some road linkages that would be repaired by this course of action might not be used frequently enough to justify repair costs.

Likely Precursors

None

TXN 17
Provide High-Capacity Transit Service to San Juan Airport

Sector Impacted

Transportation

Issue/Problem Being Solved

There is currently very limited transit service—there are only 3 bus routes with relatively infrequent service—to Puerto Rico's largest airport, Luis Muñoz Marín International Airport, in San Juan.

Description

This course of action would construct a high-capacity transit service (bus rapid transit or light rail) to Luis Muñoz Marín International Airport, in San Juan. An exact alignment has not been identified.

Potential Benefits

Light rail or bus rapid transit would provide an alternative means of transportation to Puerto Rico's busiest airport that could reduce emissions and congestion.

Potential Spillover Impacts to Other Sectors

Health outcomes and environmental conditions could be improved with reductions in emissions from car traffic. The extent of the benefit would depend on the extent of the reduction.

Potential Costs

Potential up-front costs: $400 million in estimated up-front costs (8 years)
Potential recurring costs: $170 million in estimated recurring costs (11 years)
Potential total costs: $570 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.[127]

The cost estimate for providing light-rail transit is $800 million, based on a preliminary environmental study of this corridor. The cost estimate for annual operating costs for light-rail transit is $38 million, based on similar light-rail systems. The cost estimate for up-front costs for the bus rapid transit is $185 million, with annual operating costs of $12 million.

[127] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

Potential Funding Mechanisms

U.S. Department of Transportation, public-private partnerships, Puerto Rico Department of Transportation and Public Works

Potential Implementers

Puerto Rico Public-Private Partnerships Authority, Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Building new transit systems may entail construction-cost overruns and lower-than-anticipated ridership, leading to lower revenues and benefits. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

It would be helpful to conduct a study regarding how new mobility options, expanded bus and fixed-route service, and Tren Urbano could be better integrated, including assessments of demand for new transit services.

TXN 18
Provide High-Capacity Transit Service Between San Juan and Caguas

Sector Impacted

Transportation

Issue/Problem Being Solved

There is currently no scheduled transit service between San Juan and Caguas, an adjoining municipality of approximately 130,000 people.

Description

This course of action would construct a high-capacity transit service (bus rapid transit or light rail) between San Juan and Caguas, probably along the route of PR-52.

Potential Benefits

Bus rapid transit or light rail would provide an alternative means of transportation between San Juan and Caguas that could reduce emissions and congestion.

Potential Spillover Impacts to Other Sectors

Health outcomes and environmental conditions could be improved with reductions in emissions from car traffic. The extent of the benefit would depend on the extent of the reduction.

Potential Costs

Potential up-front costs: $200 million in estimated up-front costs (3 years)
Potential recurring costs: $170 million in estimated recurring costs (11 years)
Potential total costs: $370 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.[128]

The cost estimate for light-rail transit between San Juan and Caguas is $400 million, based on the 2040 Islandwide Long Range Transportation Plan, adopted in 2013.[129] The cost estimate for annual operations is $38 million. The estimate for up-front costs for bus rapid transit is $225 million, with annual operating costs of $12 million.

[128] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

[129] Puerto Rico Department of Transportation and Public Works, *Puerto Rico 2040 Islandwide Long Range Transportation Plan*, San Juan, December 2013.

Potential Funding Mechanisms

U.S. Department of Transportation, public-private partnerships, Puerto Rico Department of Transportation and Public Works

Potential Implementers

Puerto Rico Public-Private Partnerships Authority, Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Building new transit systems may entail construction cost overruns and lower-than-anticipated ridership, leading to lower revenues and benefits. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

It would be helpful to conduct a study regarding how new mobility options, expanded bus and fixed-route service, and Tren Urbano could be better integrated, including assessments of demand for new transit services.

TXN 19
Extend PR-5

Sector Impacted

Transportation

Issue/Problem Being Solved

Increasing resilience and improving road safety and the serviceability offered by the road network around Bayamon.

Description

This course of action would extend PR-5 in Bayamon, between PR-199 and PR-167, ensuring that environmental risks are mitigated and a resilient design is used.

Potential Benefits

This course of action would improve mobility options in one part of Puerto Rico. As the *Build Back Better* request for funding notes, this course of action would "allow efficient transportation from the Metropolitan Area to mountain municipalities allowing logistics flow during critical climate events."[130]

Potential Spillover Impacts to Other Sectors

This course of action would improve economic opportunities for people around Bayamon. It would spur additional development in the area, affecting the Housing, Water, Energy, and Economic sectors.

Potential Costs

Potential up-front costs: $220 million in estimated up-front costs (9 years)
Potential recurring costs: —
Potential total costs: $220 million in total estimated costs

The estimate for up-front costs includes construction costs. The estimate for ongoing maintenance costs is $50,000 per year. However, this road is currently operated by a private firm that is responsible for operations and maintenance costs that are funded in part by toll collection. Assuming that this arrangement continues, no additional public funds would be required for operations and maintenance.

[130] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, San Juan: Government of Puerto Rico, November 2017.

Potential Funding Mechanisms

U.S. Department of Transportation, public-private partnerships, Puerto Rico Department of Transportation and Public Works

Potential Implementers

Puerto Rico Public-Private Partnerships Authority, Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Design and construction of this road extension would be challenging because of existing development in the area. Congestion mitigation impacts might not be sustained in the long run. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 20
Extend PR-22

Sector Impacted

Transportation

Issue/Problem Being Solved

Increasing resilience and improving road safety and the serviceability offered by the road network in the northwest region of Puerto Rico

Description

PR-22 currently goes from San Juan to Arecibo in the north of Puerto Rico. The existing road is currently operated by a private firm. PR-22 and PR-2, to the west, connect San Juan to the western half of the island. This course of action would extend PR-22 for roughly 40 kilometers in the area currently served by PR-2, ensuring that environmental risks are mitigated and a resilient design is used.

Potential Benefits

This course of action would benefit the northwest region of Puerto Rico. In particular, it would improve mobility and accessibility. It is also likely to improve resilience and road safety in the area. Finally, it would support efforts to attract traffic to the Rafael Hernández Airport in Aguadilla and to further develop the local tourism industry.

Potential Spillover Impacts to Other Sectors

This course of action could improve economic opportunities for people living in the northwest region of Puerto Rico. It also could spur additional development in the area, affecting the housing, Water, Energy, and Economic sectors.

Potential Costs

Potential up-front costs: $1 billion in estimated up-front costs (10 years)
Potential recurring costs: —
Potential total costs: $1 billion in total estimated costs

The cost estimate for up-front costs includes construction costs, which would depend on the chosen design alternative. The cost estimate for ongoing maintenance costs is $420,000 per year. However, this road is currently operated by a private firm that is responsible for operations and maintenance costs that are funded in part by toll collection. Assuming that this arrangement continues, no additional public funds would be required for operations and maintenance.

Potential Funding Mechanisms

U.S. Department of Transportation, public-private partnerships, Puerto Rico Department of Transportation and Public Works

Potential Implementers

Puerto Rico Public-Private Partnerships Authority, Puerto Rico Highway and Transportation Authority

Potential Pitfalls

The extension would need to be built in an environmentally sensitive area. Certain areas are densely developed, particularly along the current route of PR-2, presenting engineering challenges and raising concerns related to equity. The topography is also challenging in other areas. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 21
Complete PR-10

Sector Impacted

Transportation

Issue/Problem Being Solved

Increasing resilience and improving road safety and the serviceability offered by the road network in the west of Puerto Rico.

Description

This course of action would fill in a gap in the strategic highway network of Puerto Rico. PR-10 is an important route in the road network of Puerto Rico, one of the few north-south routes on the island. It is particularly important for connecting settlements in the interior of the west of Puerto Rico to the rest of the commonwealth. This course of action would complete this route, ensuring that environmental risks are mitigated and a resilient design is used.

Potential Benefits

This course of action would improve mobility options between the interior regions and both the north and south coasts. This would produce local economic benefits. In addition, this project would likely improve resilience and road safety.

Potential Spillover Impacts to Other Sectors

This course of action would improve economic opportunities for people living in the west of Puerto Rico. It would spur additional development in the area, affecting the Housing, Water, Energy, and Economic sectors.

Potential Costs

Potential up-front costs: $370 million in estimated up-front costs (10 years)
Potential recurring costs: $510,000 in estimated recurring costs (11 years)
Potential total costs: $370 million in total estimated costs

The estimate for up-front costs includes construction costs, and the estimate for recurring costs includes maintenance costs.

Potential Funding Mechanisms

Puerto Rico Department of Transportation and Public Works, public-private partnerships

Potential Implementers

Puerto Rico Highway and Transportation Authority

Potential Pitfalls

Design and construction of this road extension would be challenging because of the local terrain. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time.

Likely Precursors

None

TXN 22
Increase Port Facility Resilience

Sector Impacted

Economic

Issue/Problem Being Solved

The resilience of Puerto Rico's port facilities is limited. Restoring the Maritime Transportation System to its prehurricane condition would not ensure any of the additional resiliency that is recommended in anticipation of forecast storms of increasing intensity and frequency over the next decade or more. Existing infrastructure could be enhanced or upgraded for increased redundancy across multiple port complexes, hardening against the effects of storm surge, high winds, and the anticipated rise in sea level, as well as for maintaining ports that are poised to capitalize on global shipping trends, including the increased size, capacity, and drafts of post-Panamax ships.

Description

This course of action would improve and rehabilitate piers, fendering systems, rip-rap, and associated buildings at ports across the commonwealth to increase the Maritime Transportation System's overall resilience to future storms and sea-level rise.

Potential Benefits

This course of action would help to ensure continuity of operations at the piers and increase the overall structural integrity of port infrastructure into the future. An increase to overall port capacity, reliability, and capability would make Puerto Rico more competitive as a potential transshipment hub and to regional and foreign investment. Rehabilitation of Puerto Rico's marine transportation infrastructure would also support improvements to humanitarian assistance/disaster response operations and the overall Maritime Transportation System resiliency.

Potential Spillover Impacts to Other Sectors

Port consolidation would have implications for many other sectors, but it would most directly affect the Economic sector. However, virtually all sectors would be directly or indirectly affected by this course of action because the entire island and its population are dependent on the movement of supplies, food, resources, and people through the Maritime Transportation System.

Potential Costs

Potential up-front costs: $360 million–$540 million in estimated up-front costs (9 years)
Potential recurring costs: —

Potential total costs: $360 million–$540 million in total estimated costs

This action was costed at 50% implementation in the recovery plan.[131]

This estimate was based on 49 separate and comprehensive assessments of resiliency projects, addressing the 10 major ports, as defined within the National Geospatial-Intelligence Agency's World Port Index.

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration

Potential Implementers

Puerto Rico Ports Authority, Port of Ponce Authority, Mayaguez Ports Commission

Potential Pitfalls

Construction and repair costs could be high. Contractor capacity could also be an issue, particularly if numerous other civil-engineering projects were undertaken at the same time. Impacts from tourism would be dependent on external demand.

Likely Precursors

Assessment would be needed of relative benefits of resilience upgrades, as well as a cost-benefit analysis; some upgrades would likely have more benefit than others.

[131] Governor Puerto Rico, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan: Government of Puerto Rico, August 2018.

Water Sector

COA Number	Title
WTR 1	Resilient Repair or Replacement of the PRASA Drinking Water System
WTR 2	Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems
WTR 3	Enhance the Efficiency and Resilience of PRASA Electricity Services
WTR 4	Enhance Ability to Transfer Potable Water Among PRASA Service Zones
WTR 5	Improve Treatment and Storage Capacity to Handle High Turbidity Events
WTR 6	Expand PRASA Service to Unconnected Areas
WTR 7	Strengthen PRASA's Asset Management Program
WTR 8	Implementation of New Initiatives to Achieve Financial Sustainability for PRASA
WTR 9	Conduct a Water Rebuild by Design Competition
WTR 10	Curtail Unauthorized Releases into Sanitary Sewers
WTR 11	Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems
WTR 12	Enhance Electricity Reliability and Redundancy for Non-PRASA and Non-Regulated Systems
WTR 13	Develop Reuse Practices for Treatment Byproducts
WTR 14	Improve Equity in Drinking Water Provision for Non-Regulated Systems
WTR 15	Improve Reliability and Safety of Non-PRASA Systems
WTR 16	Build Capacity of Non-PRASA Systems
WTR 17	Reduce Incidence of Raw Sewage Exposure
WTR 18	Invest in Stormwater System Management
WTR 19	Reduce Urban Nuisance Flooding
WTR 20	Relocate or Redesign Assets in Flood Zones
WTR 21	Centralize Stormwater System Support and Management
WTR 22	Upgrade Reservoir and Dam Safety Management
WTR 23	Evaluate, Repair, and Improve Flood Control Infrastructure
WTR 24	Reduce Sedimentation of Water Bodies
WTR 25	Rationalize Ownership and Management of Flood Control Infrastructure
WTR 26	Build Trust and Engage PRASA Clients
WTR 27	Protect and Rehabilitate Groundwater Systems
WTR 28	Secure Drinking Water Sources Against Contamination
WTR 29	Strengthen Redundancy and Diversify Water Supply Sources
WTR 30	Enhance PRASA's Emergency Management Operations

WTR 1
Resilient Repair or Replacement of the PRASA Drinking Water System

Sector Impacted

Water

Issue/Problem Being Solved

The reliability and safety of drinking water services were disrupted by the hurricanes. Drinking water infrastructure and management already faced challenges prior to the hurricanes that affected service delivery and will continue to affect future resilience.

Description

This course of action would repair or replace Puerto Rico Aqueduct and Sewer Authority (PRASA) drinking water system assets and facilities—including treatment plants, pump stations, storage tanks, and distribution pipes—to address legacy deficiencies and storm damage to enhance future resilience to extreme events. Implementation of this course of action would address 3 needs: (1) addressing infrastructure needs to maintain the compliance of PRASA systems with regulatory requirements, including routine maintenance and necessary facility upgrades; (2) addressing storm damage caused by Hurricanes Irma and Maria; and (3) implementing projects and strategies to enhance long-term resilience of PRASA drinking water systems.

Potential Benefits

Robust, reliable, and safe drinking water and service delivery systems are critical to support Puerto Rico's economy, including tourism and industry, and are essential for maintaining public health. This course of action would help ensure that PRASA drinking water services maintain regulatory compliance in terms of quality, safety, and reliability. With greater investments, interventions could prepare PRASA drinking water systems for future threats and opportunities, including large-scale replacement of aging infrastructure and systems. Such actions would contribute to increased safety, increased efficiency, and potential lower operating costs. Addressing issues associated with nonrevenue water by reducing water lost from the system would also contribute to reducing costs.

Potential Spillover Impacts to Other Sectors

Given that water represents a critical infrastructure sector, recovery of the sector would likely generate positive spillover effects for Health and Social Services and Natural and Cultural Resources, as well as on the broader economy. These sectors would need to consider prioritization of projects to ensure consistency with future needs.

Potential Costs

Potential up-front costs: $1.34 billion in estimated up-front costs
Potential recurring costs: $3.621 billion in estimated recurring costs (11 years)
Potential total costs: $4.961 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Department of Agriculture, government of Puerto Rico, PRASA, private insurance

Potential Implementers

PRASA, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Implementation of these recovery actions is associated with large capital costs and additional debt financing, which is uncertain given the utility's current debt burden and revenue. In addition, full implementation course of action would require multiple years, and the feasibility of plans that are not currently in the PRASA budget would need to be revisited as recovery proceeds.

Likely Precursors

Implementing this course of action would be contingent on PRASA meeting revenue targets, developing a robust asset management system, building capacity, and developing community education and engagement. Additional prerequisites include WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 29 (Strengthen Redundancy and Diversify Water Supply Sources), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 2
Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems

Sector Impacted

Water

Issue/Problem Being Solved

Management challenges faced by the Puerto Rico Aqueduct and Sewer Authority (PRASA) even prior to the hurricanes affected operational efficiency and service delivery and will continue to affect future resilience.

Description

This course of action would improve the operational efficiency of PRASA's drinking water and wastewater systems by leveraging technology, enhancing monitoring, developing the workforce development, and building capacity to strengthen the use of industry best practices to improve quantity and quality of service. Operational strengths and weaknesses of the PRASA water distribution and wastewater conveyance systems would be assessed, along with the opportunities for improving operations and system efficiency and their costs for deployment. Based on this information, process improvement strategies would be implemented along with water-loss mitigation mechanisms, capacity building, and enhanced monitoring and reporting systems and infrastructure.

Potential Benefits

Robust, reliable, efficient, and safe drinking water and wastewater systems are critical to support Puerto Rico's economy, including tourism and industry, and are essential for maintaining public health and the quality and health of the natural environment. Implementation of this course of action would reduce operational costs and overall performance for PRASA, enabling it to efficiently deliver services to customers while helping to achieve financial sustainability.

Potential Spillover Impacts to Other Sectors

This course of action has the potential for positive spillover effects on Health and Social Services and Natural and Cultural Resources, as well as on the broader economy.

Potential Costs

Potential up-front costs: $1.449 billion in estimated up-front costs
Potential recurring costs: $16.4 million in estimated recurring costs (11 years)
Potential total costs: $1.465 billion in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, government of Puerto Rico, PRASA, public-private partnerships

Potential Implementers

PRASA, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Restoration actions are contingent on improving PRASA's operational efficiency, fiscal health, and cooperation with other entities, such as municipalities, Puerto Rico Electric Power Authority, and U.S. Environmental Protection Agency.

Likely Precursors

Precursors that are relevant regardless of the level of implementation include WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 10 (Curtail Unauthorized Releases into Sanitary Sewers), WTR 11 (Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems), WTR 29 (Strengthen Redundancy and Diversify Water Supply Sources), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 3
Enhance the Efficiency and Resilience of PRASA Electricity Services

Sectors Impacted

Water, Energy, Natural and Cultural Resources, Economic

Issue/Problem Being Solved

The Water sector was disrupted during Hurricane Maria, largely because of the loss of electricity. In addition, electricity represents a significant cost to the Puerto Rico Aqueduct and Sewer Authority (PRASA); therefore, improving electricity efficiency is an important element of reducing operating costs.

Description

This course of action would enhance the efficiency and resilience of electricity services for PRASA assets and facilities by developing an energy diversification strategy that ensures adequate backup power for essential facilities and reduces electricity demand through a suite of cost-effective, demand-side measures to ensure the provision of essential water services. Measures include expanding backup generators for critical assets, deploying off-grid distributed energy and storage with a heavy emphasis on solar PV (photovoltaics), expanding the use of hydropower, and implementing a broad range of demand management measures to reduce electricity needs and costs.

Potential Benefits

Robust, reliable, efficient, and safe drinking water and wastewater systems are critical to support Puerto Rico's economy, including tourism and industry, and are essential for maintaining public health and quality and health of the natural environment. Implementation of this course of action would increase the reliability of electricity services to PRASA facilities and reduce operational costs associated with electricity use. This would enable PRASA to efficiently deliver services to customers while helping to achieve financial sustainability.

Potential Spillover Impacts to Other Sectors

Positive spillover effects would be seen on Health and Social Services, Energy, and Education, as well as on the broader economy. The expenditures associated with this course of action would likely grow the "clean tech" industries in Puerto Rico and have spillover or multiplier effects for other economic industries.

Potential Costs

Potential up-front costs: $2.183 billion in estimated up-front costs
Potential recurring costs: —

Potential total costs: $2.183 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, U.S. Department of Agriculture, Community Development Block Grant–Disaster Recovery, government of Puerto Rico, PRASA

Potential Implementers

PRASA, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Recovery actions would be contingent on improving PRASA's operational efficiency, fiscal health, and coordination with other entities, such as municipalities, Puerto Rico Electric Power Authority, and the U.S. Environmental Protection Agency.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation include WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 26 (Build Trust and Engage PRASA Clients), and WTR 30 (Enhance PRASA's Emergency Management Operations).

WTR 4
Enhance Ability to Transfer Potable Water Among PRASA Service Zones

Sector Impacted

Water

Issue/Problem Being Solved

The course of action will capitalize on opportunities to flexibly move water among the Puerto Rico Aqueduct and Sewer Authority's (PRASA's) service zones to balance supply and demand. PRASA's potable water network is complex, but in that complexity lies opportunities to capitalize on redundancies and interconnections that exist among different service areas to facilitate the movement of water in response to the dynamics of supply and demand.

Description

This course of action enhances the transfer of the water supply among PRASA service zones by improving their interconnections and operations. The course of action is aimed at identifying priority regions for building connections between service areas, assessing the infrastructure needed to implement connections, designing and constructing infrastructure, and subsequently managing operations of service area interconnections.

Potential Benefits

Robust drinking water and service delivery systems are critical to support Puerto Rico's economy, including tourism and industry, and are essential for public health and social services. Greater flexibility would increase system resilience by allowing service areas to leverage supply in neighboring service areas to support risk management.

Potential Spillover Impacts to Other Sectors

Enhanced flexibility and reliability would have positive spillover effects on Health and Social Services and Natural and Cultural Resources, as well as on the broader economy.

Potential Costs

Potential up-front costs: $1.45 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.45 billion in total estimated costs

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, government of Puerto Rico, PRASA

Potential Implementers

PRASA, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Successfully implementing this course of action would depend on multiple factors. In particular, the capacity to facilitate water transfers between service zones on demand would likely necessitate improving PRASA's operational efficiency and asset management (see below, on precursors) to optimize service zone interconnections. In addition, because this course of action is not an explicit response to hurricane damage but rather a mechanism for adding resilience to future disasters, U.S. Department of Housing and Urban Development Community Development Block Grant–Disaster Recovery funds might not be the appropriate funding mechanism, compared with other options (e.g., FEMA hazard mitigation grants).

Likely Precursors

Prerequisite courses of action for this effort are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 5
Improve Treatment and Storage Capacity to Handle High Turbidity Events

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

High turbidity water that results from extreme rainfall events can pose challenges to water treatment processes: Turbidity can interfere with disinfection processes, increasing the risk of waterborne disease, including bacteria, viruses, and parasites. Water utilities are required to monitor turbidity levels because the potential health risks associated with high turbidity water entering drinking water distribution systems.

Description

This course of action would upgrade drinking water treatment plants in vulnerable service zones and expand source protection to improve treatment and storage capacity to handle high turbidity events. Necessary steps would include identifying priority reservoirs and surface water systems for treatment interventions and evaluating treatment options and source protection measures, followed by implementing treatment enhancements or source protection measures for priority water resources. Enhancing the capacity of the Puerto Rico Aqueduct and Sewer Authority (PRASA) to successfully treat high turbidity surface water has been identified as a priority for the utility and is consistent with efforts made by water utilities elsewhere to increase the resilience of water distribution systems and the range of conditions with which they can cope.

Potential Benefits

This course of action has the potential to reduce the risks associated with high turbidity water and therefore increase the safety of PRASA drinking water services. Safe drinking water and service delivery systems are critical to support Puerto Rico's economy, including tourism and industry, and are essential for public health. This course of action also has potential benefits for environmental health and conservation through its provisions for source-water protection.

Potential Spillover Impacts to Other Sectors

Increasing the safety and reliability of drinking water disinfection processes would have positive spillover effects on Health and Social Services, as well as on the broader economy.

Potential Costs

Potential up-front costs: $183.5 million in estimated up-front costs
Potential recurring costs: —

Potential total costs: $183.5 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, government of Puerto Rico, PRASA

Potential Implementers

PRASA, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Implementation of this course of action is contingent on improving PRASA's financial sustainability and building its capacity to effectively manage upgrades to treatment infrastructure and processes. In addition, cooperation with other agencies, such as the Department of Natural and Environmental Resources, would be an important component of implementing source-protection plans to ensure those efforts do not conflict with ongoing land management and water resource management initiatives.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 6
Expand PRASA Service to Unconnected Area

Sector Impacted

Water

Issue/Problem Being Solved

Puerto Rico Aqueduct and Sewer Authority (PRASA) drinking water services reach 97% of Puerto Rico's population, but the remaining 3% operate their own household systems or rely on community systems: Many of these non-PRASA and nonregulated drinking water systems are out of compliance with the Safe Drinking Water Act (Pub. L. 93-523) requirements. PRASA wastewater services are concentrated in urban areas within municipalities, which constitutes 59% of Puerto Rico's population. Areas outside these zones lack a centralized and centrally managed wastewater system and, instead, often dispose of wastewater in septic tanks. Poor construction and maintenance have led to leakage and human health impacts. In addition, the 18 publicly operated wastewater treatment systems across Puerto Rico are undermaintained and poorly operated, posing additional risks to human health and the environment. Similarly, an unknown number of private sanitary pumping stations are also undermaintained and underperforming.

Description

This course of action would improve drinking water quality for Puerto Rico's population not on PRASA's drinking water system by connecting feasible communities and converting non-PRASA systems to PRASA, where possible. The course of action would also reduce raw sewage leakage and human exposure by connecting communities with septic tanks and publicly owned wastewater systems to PRASA sewerage, where feasible, and would study the feasibility of transferring the ownership, maintenance, and operations of sanitary infrastructure to PRASA.

Potential Benefits

In connected communities, this course of action would eliminate risk of discharge of untreated wastewater into the environment and centralize operation and maintenance of sanitary infrastructure, ensuring proper operation and maintenance. In addition, the centralization of feasible drinking water systems into PRASA would improve the quality of service and health outcomes for connected populations.

Potential Spillover Impacts to Other Sectors

This course of action would benefit Health and Social Services and Natural and Cultural Resources.

Potential Costs

Potential up-front costs: $1.249 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.249 billion in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture

Potential Implementers

PRASA, non-PRASA systems, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Conversion of some non-PRASA to PRASA systems might introduce risk and additional cost for PRASA that may make the conversion process difficult or infeasible. Past efforts to convert systems from non-PRASA to PRASA have been met with resistance, as non-PRASA and nonregulated drinking water systems typically provide lower-cost services. For wastewater systems, the additional costs of incorporating new zones could be impractical for PRASA. Additionally, no legal framework requires private sanitary pump stations to connect to PRASA. Finally, this course of action would depend on consolidation of PRASA-owned wastewater treatment plants and PRASA's ability to acquire additional sanitary infrastructure.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), and WTR 11 (Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems).

WTR 7
Strengthen PRASA's Asset Management Program

Sector Impacted

Water

Issue/Problem Being Solved

The Puerto Rico Aqueduct and Sewer Authority (PRASA) lacks comprehensive information about its water and wastewater treatment, distribution, conveyance, and storage infrastructure and could benefit from improvements to its planning processes for the repair, upgrade, replacement, and divestment of assets.

Description

This course of action would implement an asset needs assessment and enhance PRASA's asset management program to decrease life-cycle costs and improve performance by procuring asset management software and infrastructure to support program development and staff training to enhance capacity to implement asset management best practices.

Potential Benefits

Improvements to asset management would support day-to-day operational decisionmaking, strategic planning and investment, and emergency management efforts. They would enable systemic examinations of assets and operations at risk, key vulnerabilities and impacts, and the interventions needed to restore services. Understanding assets, their characteristics, and their performance is therefore essential for enhancing system optimization and efficiency to reduce operating costs. To that end, asset management would help support robust drinking water and wastewater service delivery, which would support Puerto Rico's economy, including tourism and industry, and is essential for human and social services.

Potential Spillover Impacts to Other Sectors

Because of its role in supporting other management objectives, improving asset management could have positive spillover effects on Health and Social Services (e.g., water safety and emergency response), Natural and Cultural Resources (e.g., water quality and ecosystem health), as well as on the broader economy.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $11.5 million in estimated recurring costs (11 years)
Potential total costs: $11.5 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, PRASA, U.S. Department of Labor, U.S. Environmental Protection Agency, U.S. Department of Agriculture, nongovernment sources

Potential Implementers

PRASA, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

The critical pitfall with implementing an enhanced asset management capability is ensuring that the effort is adequately resourced in terms of both human and physical capital to ensure its sustainability and effectiveness. In the absence of such capacity building or with inadequate capacity building, the potential benefits may not be realized.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems); WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 8
Implementation of New Initiatives to Achieve Financial Sustainability for PRASA

Sector Impacted

Water

Issue/Problem Being Solved

The Puerto Rico Aqueduct and Sewer Authority's (PRASA's) revenue is declining, and the utility is constrained with respect to taking on additional debt, necessitating aggressive action to be able to meet its operational and financial objectives while building resilience for the long term.

Description

This course of action would improve the financial sustainability of PRASA by developing and implementing plans that include divesting assets, reducing operating costs and customer delinquencies, enhancing revenue collection, and exploring alternative pricing mechanisms and public-private partnerships. This course of action would ensure long-term financial sustainability and access to the capital markets and that PRASA could meet its obligations by implementing a viable, updated fiscal plan that increases revenues, reduces costs, restructures public and private debt, and incorporates posthurricane adjustments. The main components for revenue increases would be moderate but affordable rate increases, a public-private partnerships to replace and improve PRASA's metering and customer service systems, and increased collection rates on government accounts. The main components for cost reduction would be physical loss reduction, optimized hydroelectric generation, and other expense reduction. The main components of debt restructuring would be implementation of interest and principal forbearance agreements.

Potential Benefits

The ability of PRASA, as Puerto Rico's dominant water and wastewater service provider, to maintain the reliability and quality of water and drinking water services is critical to support Puerto Rico's economy, including tourism and industry, and is essential for public health and social services. Maintaining a viable water utility that could make the investments needed to enable compliance, reliability, resilience, and innovation would therefore be in the broader interest of Puerto Rico

Potential Spillover Impacts to Other Sectors

Given that water represents a critical infrastructure sector, recovery of the sector would likely generate positive spillover effects for Health and Social Services and Natural and Cultural Resources, as well as on the broader economy. However, at the same time, this course of action

would be associated with various policy changes that could have negative consequences, such as greater frequency of nonpayment, which could have negative impacts on revenue enhancement goals. Similarly, the need for debt restructuring, though necessary over the short term, could have negative impacts on future debt financing.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $1.8 million in estimated recurring costs (11 years)
Potential total costs: $1.8 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, PRASA, U.S. Department of Agriculture, nongovernmental sources

Potential Implementers

PRASA

Potential Pitfalls

The primary pitfall associated with this course of action would be its reliance on the successful application of multiple mechanisms for achieving financial sustainability. Delays in implementing any class of mechanism or underperformance in terms of delivering expected cost savings may require more-stringent measures in the future to make up funding shortfalls. Various aspects of the fiscal plan involve uncertainty, including the public's willingness to accept rate increases, demographic outflow that may reduce revenue collection, the ability to restructure debt, and larger economic conditions in Puerto Rico.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 9
Conduct a Water Rebuild by Design Competition

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

Puerto Rico's water infrastructure experienced system depreciation, underinvestment, lack of maintenance, and incomplete monitoring prior to the hurricanes. Innovative and creative solutions to building resilience into Puerto Rico's water infrastructure are limited by available partnerships, experience, and funding.

Description

This course of action would fund the implementation of projects under the new Rebuild by Design process to spur innovative resilience projects in the Water sector that are collaboratively developed by community members, civic leaders, and nationally recognized design and engineering firms. Rebuild by Design would convene a mix of sectors—including government, business, nonprofit, and community organizations—to gain a better understanding of how overlapping environmental and human-made vulnerabilities put regions at risk. The methodology would require true public-private partnerships to bring together local communities and international experts. This process would uncover vulnerabilities and design evidence-based solutions unique to a given community that address long-standing vulnerabilities and those exposed by the Hurricane Maria.

Potential Benefits

This program would connect local communities with some of the nation's leading design firms to collaboratively identify and solve problems and address vulnerabilities that were exposed by Hurricane's Maria and Irma in the Water sector.

Potential Spillover Impacts to Other Sectors

This course of action could be implemented across all infrastructure categories as a larger Rebuild by Design competition. In this case, designs and projects might focus broadly on resilience, and interdependencies across sectors would be a primary focus.

Potential Costs

Potential up-front costs: $300 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $300 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery funds explicitly for disaster mitigation, U.S. Department of Energy's Critical Water Issues Prize Competition

Potential Implementers

Government of Puerto Rico, U.S. Department of Housing and Urban Development

Potential Pitfalls

This process could lead to designs and infrastructure that require costly maintenance: Failure to provide maintenance would accelerate the depreciation of assets and enhance the risk of their failure or early retirement. This course of action would require coordination among multiple governmental layers and agencies: Ensuring collaboration and inclusion of all parties involved in permitting, regulations and implementation from the onset would be critical.

Likely Precursors

This course of action could be broadly applied across the Water sector and is contingent on available funding and available capacity among government officials and local firms to partner with international design and engineering experts. CPCB 10 (Incentivize Resilient, Creative Design Solutions for Addressing Hazards) specifically addresses the administrative aspects of establishing the Rebuild by Design initiative.

WTR 10
Curtail Unauthorized Releases into Sanitary Sewers

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

More than 27,000 sanitary sewer overflows occur each year because of poor maintenance and disposal practices. Sanitary collection systems often have buildup and clogging because of disposal of fats, oils, and grease (FOG) that react with other constituents in wastewater to form blockages that result in sewage overflows. Other unauthorized releases into sanitary collection systems result in contamination of receiving waters or human exposure to contaminants.

Description

This course of action would curtail the disposal of FOG and unauthorized releases into wastewater collection systems to improve the performance of these systems, minimize the reduction of hydraulic capacity, reduce overflow events, and improve the quality of receiving waters. Routine cleaning and inspection of collection systems and enforcement of the Puerto Rico Aqueduct and Sewer Authority's (PRASA's) pretreatment program would improve the management of unauthorized releases and mitigate their impacts. Additional activities of this course of action would be (1) educating the public on proper FOG disposal and the consequences of improper disposal on overflow events and receiving waters, (2) introducing unauthorized release mitigation measures and programs, and (3) creating financial incentives that prevent the disposal of FOG in the wastewater system.

Implementation would include establishing routine cleaning schedules of PRASA's sanitary collection systems to identify and address problem areas where FOG has been disposed, effectively enforcing PRASA's Pre-Treatment Program to mitigate unauthorized or out-of-compliance releases into the sanitary sewer collection system, and developing and conducting educational and outreach programs across Puerto Rico's 78 municipalities for residential and commercial customers.

Potential Benefits

Curtailing the principal cause of sanitary sewer overflows would result in fewer backups into residences and streets. Fewer sanitary sewer overflows would also reduce raw sewage exposure and improve human health in affected communities. For PRASA, this course of action would also decrease operational and maintenance cost for wastewater systems.

Potential Spillover Impacts to Other Sectors

This course of action would improve the quality of life for residents in municipalities and reduce impacts on the environment. The principal sectors with spillover effect would therefore be Health and Social Services, Municipalities, and Natural and Cultural Resources.

Potential Costs

Potential up-front costs: $500,000
Potential recurring costs: $23.5 million in estimated recurring costs (11 years)
Potential total costs: $24 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, PRASA, U.S. Environmental Protection Agency, U.S. Department of Agriculture

Potential Implementers

PRASA, Environmental Quality Board, U.S. Environmental Protection Agency

Potential Pitfalls

This course of action would require consistent attention and enforcement of regulations. Reducing the disposal of FOG would require effective community education and engagement by the public, which would entail additional cost for PRASA.

Likely Precursors

Prerequisite courses of action that would be relevant regardless of the level of implementation would be WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 11 (Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 11
Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

Damage to the Puerto Rico Aqueduct and Sewer Authority's (PRASA's) wastewater treatment plants during Hurricane Maria reduced wastewater treatment capacity. In addition, PRASA has been cited in the past for noncompliance with the Clean Water Act because of repeated incidents of untreated wastewater discharges and overflows that adversely affect water quality and pose risks to human health. Meanwhile, existing wastewater sewer systems are fragile, with insufficient capacity to manage additional flows during extreme events.

Description

This course of action would repair, replace, and update wastewater treatment plants, as well as sanitary and combined sewer systems, to maintain regulatory standards in a manner that anticipates future capacity needs and follows industry best practices. This course of action would optimize system design through the integration of technology and sensors, comply with current operational standards and best practices, and protect critical system infrastructure components and illicit discharge detection and elimination (IDDE). Implementation would require identifying system vulnerabilities and recovery needs, reviewing technology options and capacity needs, and evaluating proposals, options, and the costs and benefits of system improvements (including expansions and consolidations).

Potential Benefits

This course of action would restore wastewater management capabilities and eliminate discharge of untreated sewage to the environment, reducing risk of closures of beaches and waterways because of contamination.

Potential Spillover Impacts to Other Sectors

Positive spillover impacts are likely for Energy and Natural and Cultural Resources, as well as for the broader economy.

Potential Costs

Potential up-front costs: $1.017 billion in estimated up-front costs
Potential recurring costs: $1.813 billion in estimated recurring costs (11 years)
Potential total costs: $2.83 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, government of Puerto Rico, PRASA, private insurance

Potential Implementers

PRASA, Environmental Quality Board, U.S. Environmental Protection Agency

Potential Pitfalls

Implementation of these recovery actions would be associated with large capital costs and additional debt financing, which is uncertain given the utility's fiscal situation regarding debt burden and revenue. In addition, the outlook for implementation of some projects is post-2025; thus, full implementation of this course of action would require multiple years, and the feasibility of implementing actions that are not currently in the PRASA budget would need to be revisited as recovery proceeds.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation are WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 29 (Strengthen Redundancy and Diversify Water Supply Sources), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 12
Enhance Electricity Reliability and Redundancy for Non-PRASA and Non-Regulated Systems

Sectors Impacted

Water, Energy

Issue/Problem Being Solved

More than half of the assessed non–Puerto Rico Aqueduct and Sewer Authority (PRASA) water systems incurred some damage during Hurricanes Irma and Maria, with more than a quarter of these systems losing power. Although several water systems had backup generators, many had only one source of electricity, resulting in single points of failure. Moreover, these communities were slow to recover because of their remote locations, limited inventories of backup assets, and, in some cases, inadequate training to restore water systems.

Description

This course of action would enhance electricity reliability for non-PRASA and nonregulated systems under both normal and emergency operations by assessing opportunities for resilient energy systems; providing solar hybrid generation to diversify energy sources; upgrading electrical systems; right-sizing water supply equipment; providing backup generation and storage assets in locations that reduce single point of failures; and training communities to install, operate, and maintain off-grid energy systems.

Potential Benefits

The course of action would increase the reliability and resilience of rural drinking water systems by diversifying energy sources, providing energy storage, providing backup generation and storage assets in locations that reduce single point of failures, and training community members to install and maintain off-grid energy systems. A combination of conventional diesel generators and solar panels would provide $n + 1$ redundancy with respect to operating energy sources (that is, resilience in the form of at least one backup system). The course of action would also train members of non-PRASA communities to install, operate, and maintain next-generation energy technologies. Research and practice have shown that rural water systems are more resilient when water supply infrastructure is installed, operated, and maintained by community members. Moreover, such skills might have broader educational and economic development benefits for non-PRASA communities, as Puerto Rico is expected to transition to renewable energy systems during its recovery from hurricane damages.

Potential Spillover Impacts to Other Sectors

By reducing the use of diesel, this course of action would improve energy independence for Puerto Rico and reduce emissions, some of which have negative health effects. This course of action would also improve health outcomes by providing more-reliable drinking water systems. Other sectors are likely planning provisions for temporary power. Thus, coordination across sectors is needed to ensure that the commonwealth does not overcompensate with respect to backup inventories of power assets and that grid integration can be completed where sensible.

Potential Costs

Potential up-front costs: $54 million in estimated up-front costs
Potential recurring costs: $9.8 million in estimated recurring costs (11 years)
Potential total costs: $63.8 million in total estimated costs

Potential Funding Mechanisms

U.S. Department of Agriculture Rural Energy for America; U.S. Department of Agriculture Rural Development Water and Environment Program

Potential Implementers

Non-PRASA and nonregulated system operators, Puerto Rico Department of Health

Potential Pitfalls

The transition from diesel generation to hybrid solar systems would increase capital investment but decrease operating costs. This cash-flow shift from operating costs to capital expenditures would increase the risks of underinvestment in infrastructure assets needed to maintain more-resilient energy systems, particularly in backup inventories. Depending on the costs of backup inventories, the course of action may increase short-term electricity costs. The course of action recommends sharing backup inventories to diversify risks of single point of failures and reduce the costs of resilience; however, it may be difficult to share costs and ownership of these assets, particularly during an emergency. This course of action would assume that non-PRASA communities have one peak day of storage for flow equalization. Communities without storage would need to draw supplies during periods of adequate solar availability, which may not be practicable.

Likely Precursors

The prerequisite that would be relevant regardless of the level of implementation is WTR 16 (Build Capacity of Non-PRASA Systems).

WTR 13
Develop Reuse Practices for Treatment Byproducts

Sector Impacted

Water

Issue/Problem Being Solved

Wastewater and drinking water treatment by-products, or biosolids, constitute a significant expense for the Puerto Rico Aqueduct and Sewer Authority (PRASA) because of the cost of biosolid movement and disposal.

Description

This course of action would identify economically viable uses for treatment biosolid by-products by developing reuse practices and processes that enable the use of biosolids in the energy, industrial, and agricultural sectors.

Implementation of this course of action would involve finding a technology and by-product combination that can produce value, implementing that technology at each wastewater treatment plant, and then arranging to sell the by-product.

Potential Benefits

This course of action would mitigate the costs associated with by-product disposal and develop an additional revenue stream for PRASA.

Potential Spillover Impacts to Other Sectors

Municipalities and industrial purchasers of treatment by-products could be affected. Natural and Cultural Resources would also be affected because of the decrease in sludge disposal requirements.

Potential Costs

Potential up-front costs: $90 million in estimated up-front costs
Potential recurring costs: —
Potential total costs: $90 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, public-private partnerships, government of Puerto Rico, PRASA

Potential Implementers

PRASA, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

This course of action would depend on PRASA's organizational capacity to process, utilize, or sell treatment by-products, as well as the support of regulatory and other agencies involved. If technology changes, the end use of treatment by-products, such as biogas for energy production, might no longer be needed.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation would be WTR 7 (Strengthen PRASA's Asset Management Program) and WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA).

WTR 14
Improve Equity in Drinking Water Provision for Non-Regulated Systems

Sector Impacted

Water

Issue/Problem Being Solved

Isolated rural populations typically rely on community water systems. Although many larger community water systems are regulated by the Puerto Rico Department of Health and U.S. Environmental Protection Agency as non–Puerto Rico Aqueduct and Sewer Authority (PRASA) systems, a small universe of systems remains that is not regulated by the Puerto Rico Department of Health and U.S. Environmental Protection Agency. Unregulated systems face similar challenges to non-PRASA regulated systems—related to inadequate infrastructure and water treatment capacity, as well as a lack of adequately trained staff and financial resources—but are at a further disadvantage without water quality testing, posthurricane assistance, and other resources that registered non-PRASA systems receive.

Description

This course of action would mandate that an existing government entity or nongovernmental organizations develop equitable, reliable, and resilient solutions to household drinking water provision in geographically remote areas and expand mechanisms to coordinate and fund nongovernmental organizations and municipal efforts for the provision of safe drinking water in nonregulated drinking water systems. Nonregulated water systems would be identified and assessed to determine current disparities in service provision and cost among different communities of water users, impacts of those differences on hurricane vulnerability, needs for differential recovery options across communities, and differential constraints on their deployment. The public health risks of unreliable or untreated water supply would also be assessed. Implementing partners would convene to determine water supply and treatment needs and feasibility based on the assessments of nonregulated systems, and a coordinated implementation plan engaging nongovernmental, municipal, and grassroots organizations would designate geographic areas in which support would be delivered and conduct implementation to cover all areas with nonregistered systems.

Potential Benefits

Potential benefits would be increased equity in water service provision, improvement in overall water system performance, and increased awareness and demand for safe and reliable water supply. Communication of water system hurricane vulnerability to system owners and

operators, local authorities, and the population served would raise awareness of the need for climate-resilient water systems.

Potential Spillover Impacts to Other Sectors

Positive benefits for Health and Social Services, as well as the broader economy

Potential Costs

Potential up-front costs: $7 million in estimated up-front costs
Potential recurring costs: $5.5 million in estimated recurring costs (11 years)
Potential total costs: $12.5 million in total estimated costs

Potential Funding Mechanisms

Puerto Rico Community Foundation and other nongovernmental organizations, U.S. Environmental Protection Agency Drinking Water State Revolving Fund, U.S. Department of Agriculture Emergency Community Water Assistance grants, other U.S. Department of Agriculture sources

Potential Implementers

Nonregulated systems, nongovernmental organizations, Puerto Rico Department of Health, Puerto Rico Public Service Commission, universities, Puerto Rico Department of Natural and Environmental Resources

Potential Pitfalls

Nonregulated systems are vulnerable to climate variability and change and have less capacity to recover from climate-related shocks. Water sources with fewer than 15 connections are under limited institutional jurisdiction. This course of action would require long-term implementation, implying the need for a steady stream of funding and community support. Nonregulated systems that choose not to register, consolidate, or be represented might not be eligible for funding.

Likely Precursors

Prerequisites for this course of action that are relevant regardless of the level of implementation would be WTR 15 (Improve Reliability and Safety of Non-PRASA Systems) and WTR 12 (Enhance Electricity Reliability and Redundancy for Non-PRASA and Non-Regulated Systems).

WTR 15
Improve Reliability and Safety of Non-PRASA Systems

Sectors Impacted

Water, Health and Social Services

Issue/Problem Being Solved

Non–Puerto Rico Aqueduct and Sewer Authority (PRASA) drinking water systems routinely face exceptional challenges. They are typically located in rural areas and rely on both surface water and groundwater for supply. Many water sources are improperly protected from chemical, microbial, and heavy metal contamination, which compromises water quality and safety. Treatment, distribution, and revenue collection are performed by the communities themselves and are not routinely conducted. Because community members are not typically certified operators or utility managers, financial sustainability and regulatory compliance remain challenges. Thus, non-PRASA systems have historically failed to comply with drinking water quality standards for total coliform, turbidity, and Safe Drinking Water Act monitoring and reporting requirements. Further, because of their often-unofficial legal status as drinking water utilities, many non-PRASA drinking water systems are ineligible for federal grants and loans.

Description

This course of action would repair or replace distribution system infrastructure, improve water treatment, enhance monitoring, and expand contingency planning to improve reliability and safety of water provision for non-PRASA drinking water systems. This course of action would also strengthen and improve water collection and treatment infrastructure based on water source type, current and projected population demand, and hurricane vulnerability. An important aspect of this implementation is ensuring improved record keeping for water quality monitoring to support compliance with the Safe Drinking Water Act and other guidelines and regulations.

Potential Benefits

Increased capacity for the reliable provision of safe drinking water and improved compliance with the Safe Drinking Water Act are critical for maintaining public health.

Potential Spillover Impacts to Other Sectors

Health and Social Services, Economic

Potential Costs

Potential up-front costs: $10.4 million in estimated up-front costs
Potential recurring costs: $11 million in estimated recurring costs (11 years)
Potential total costs: $21.4 million in total estimated costs

Potential Funding Mechanisms

U.S. Environmental Protection Agency, U.S. Department of Agriculture, government of Puerto Rico

Potential Implementers

Non-PRASA drinking water systems, Puerto Rico Public Service Commission, U.S. Environmental Protection Agency, Puerto Rico Department of Health (Potable Water Division, Environmental Health Regional Offices), nongovernmental organizations

Potential Pitfalls

This course of action would have a high sensitivity to climate variability and change and population and demographic changes, and it would have limited institutional jurisdiction over water sources that serve small populations.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation would be WTR 14 (Improve Equity in Drinking Water Provision for Non-Regulated Systems), and WTR 16 (Build Capacity of Non-PRASA Systems).

WTR 16
Build Capacity of Non-PRASA Systems

Sector Impacted

Water

Issue/Problem Being Solved

Technical, managerial, and financial capacity for non–Puerto Rico Aqueduct and Sewer Authority (PRASA) systems is limited. High energy costs, lack of certified operators and treatment equipment, and limited funding rank high among the principal challenges in managing non-PRASA systems. Many small systems do not have meters and consequently charge a flat monthly service rate: Various sources have reported rates ranging from $3 to $20 per customer per month, and it has been reported that some systems do not charge any fee, leaving inadequate resources for compliance, repairs, or maintenance. These issues collectively contribute to inefficiencies, inconsistent reliability, and risks to public health.

Description

This course of action would build technical, managerial, administrative, and financial capacity of non-PRASA communities and their users by enhancing and institutionalizing communication and outreach to non-PRASA system operators and communities. The implementation of this course of action would involve equipping an existing government entity or nongovernmental organizations to address oversight mechanisms and expansion of a continuous and permanent rural assistance program that provides financial, operational and technical assistance, education, and training. The success of this course of action would require institutionalizing capacity building and, therefore, the development of a sustainable and self-governed association, along with professional training and certification. Knowledge needs and technical capacity would be assessed across communities.

Potential Benefits

Capacity building programs give community members the skills and experience to run their system themselves, resulting in better service. Well-trained operators, leaders, and a reliable public notification system are essential to protecting public health. Further, the improvements from this course of action would result in better operational performance of the system and improved service provision to the communities in both normal and emergency situations.

Potential Spillover Impacts to Other Sectors

There are potential positive spillover effects on Health and Social Services and Natural and Cultural Resources.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $13.9 million in estimated recurring costs (11 years)
Potential total costs: $13.9 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, government of Puerto Rico

Potential Implementers

Non-PRASA systems, Puerto Rico Public Service Commission, nongovernmental organizations, U.S. Environmental Protection Agency, Puerto Rico Department of Health

Potential Pitfalls

Because this course of action would involve a vulnerable population with minimal adaptive capacity, it would depend greatly on establishing a functioning, sustainable association for the non-PRASA system operators and an effective governance system among the communities served.

Likely Precursors

A prerequisites that is relevant regardless of the level of implementation would be WTR 15 (Improve Reliability and Safety of Non-PRASA Systems).

WTR 17
Reduce Incidence of Raw Sewage Exposure

Sector Impacted

Water

Issue/Problem Being Solved

A substantial cause of public health and environmental problems in watersheds in Puerto Rico is individual household wastewater disposal systems (IHWDSs) that fail to prevent raw sewage from entering populated areas and water sources. Raw sewage presents a major health risk for gastrointestinal infections.

Description

This course of action would identify and prioritize areas most at risk for public health and environmental problems related to raw sewage exposure and would aim to reduce that exposure through regulatory and capacity-building actions and replacement and repair programs for IHWDSs and commercial property on-site wastewater treatment systems.

Potential Benefits

The benefits of this course of action could be reduced exposure to harmful bacteria in raw sewage and ensuing health risks and improved community and environmental stewardship.

Potential Spillover Impacts to Other Sectors

This course of action would affect the Housing sector through improvement of substandard IHWDSs. This course of action would have positive spillover impacts on the Health and Social Services sector through the reduction of water borne diseases. The course of action would also have positive spillover impacts on the Natural and Cultural Resources sector through improved compliance with environmental laws for watershed protection and waste disposal.

Potential Costs

Potential up-front costs: $1.801 billion in estimated up-front costs
Potential recurring costs: $11 million in estimated recurring costs (11 years)
Potential total costs: $1.812 billion in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, homeowners

Potential Implementers

U.S. Environmental Protection Agency, Office of Permit Management, Office of Inspector General of Permits (Oficina de Gerencia de Permisos), Environmental Quality Board, nongovernmental organizations

Potential Pitfalls

This course of action would depend on the role and responsibilities of the IHWDSs and commercial on-site wastewater treatment system inspectors and their ability to deter the population from continuing to dump raw sewage through regulatory action, including enforcement of citations and fines. Investment in infrastructure improvement would not reduce raw sewage exposure in the absence of effective regulation and population willingness to comply.

Likely Precursors

Relevant Water sector prerequisites would be WTR 18 (Invest in Stormwater System Management) and WTR 27 (Protect and Rehabilitate Groundwater Systems).

WTR 18
Invest in Stormwater System Management

Sector Impacted

Water

Issue/Problem Being Solved

Municipal stormwater systems require regular, preventative maintenance to clear blockages that reduce performance, as well as monitoring to enable the early identification of problems. Debris and blockages in the systems have led to urban nuisance flooding and impairments in receiving water because of contaminated urban stormwater runoff. These issues were exacerbated by Hurricanes Irma and Maria. Flood-control pumping stations that are interconnected to stormwater infrastructure also suffer from maintenance, capacity, and energy reliability issues that worsen urban flooding. No comprehensive assessment of stormwater systems across Puerto Rico has been completed to fully understand the scope of challenges these systems are facing.

Description

This course of action invests in annual stormwater system cleaning and monitoring, as well as maintenance, planning, and assessment, including comprehensive and routine asset mapping, hydrologic and hydraulic analyses, illicit discharge detection and elimination (IDDE) program expansion, education and technical assistance, assessment of system capacity and condition, the removal of debris and blockages, the development and implementation of a stormwater mitigation program, and inventory management of parts and equipment. The maintenance components of this program are intended to cover regular maintenance.

Potential Benefits

Benefits could be reduced risk of flooding and flood damage; reduced risk of sewage overflows; reduction in human contact with contaminated stormwater, sewage, and other waterborne diseases; and improved surface-water quality. Financial benefits could be reduced federal and Puerto Rican agency expenditures to safeguard the public before and after flood events, reduced household and business expenditures associated with structural and nonstructural loses after flood events, and reduced flood insurance claims.

Potential Spillover Impacts to Other Sectors

Potential benefits would also accrue for Natural and Cultural Resources, Health and Social Services, and Municipalities. Budgets in municipalities are likely constrained, and this course of action could be weighed against other options to improve infrastructure and community resilience to extreme-rainfall events.

Potential Costs

Potential up-front costs: $121 million in estimated up-front costs
Potential recurring costs: $297.7 million in estimated recurring costs (11 years)
Potential total costs: $418.7 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture

Potential Implementers

Municipal governments, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Aqueduct and Sewer Authority, U.S. Environmental Protection Agency, U.S. Geological Survey, Puerto Rico Planning Board, Office of Permit Management, National Oceanic and Atmospheric Administration, Environmental Quality Board, Puerto Rico Department of Transportation and Public Works, private industry and nongovernmental organizations

Potential Pitfalls

Regular maintenance programs would require a trained workforce of stormwater practitioners. The accuracy of stormwater systems assessments would depend on the hydrologic guidelines used in performing assessments. Assessments of stormwater system capacity would depend on the magnitude and frequency of both chronic and extreme precipitation events, which may be exacerbated by climate change, as well as current land uses, future development, and land-use changes.

Likely Precursors

Implementing this course of action would require adequate and continuous funding, a timely bidding process for vacuum truck purchases, and the timely hiring of private contractors for the initial stages of implementation. In the longer term, workforce training and availability would be important precursors for maintenance and asset management programs. The proposed fees in WTR 21 (Centralize Stormwater System Support and Management) could be an avenue for continuous funding for stormwater management activities.

WTR 19
Reduce Urban Nuisance Flooding

Sectors Impacted

Water, Natural and Cultural Resources, Municipalities

Issue/Problem Being Solved

Urban nuisance flooding is frequent in many parts of Puerto Rico, and the poor quality of urban stormwater runoff contributes to surface-water and coastal degradation, negatively affects human health, and damages roadways and other critical infrastructure. Traditional stormwater systems in Puerto Rico have relied on extensive conveyance infrastructure that is expensive to maintain and build and lacks treatment capability. Hurricanes Irma and Maria contributed to extensive stormwater sewer system damage.

Description

This course of action would reduce urban nuisance flooding, curb erosion, and reduce sedimentation. It would also mitigate the discharge of contaminated stormwater runoff into surface-water bodies by improving stormwater infrastructure design standards; incorporating structural retrofits to catch, store, and infiltrate stormwater runoff; enhancing stormwater permitting processes and land-use regulations to implement green infrastructure; right-sizing system capacity, including conveyances and all connected flood-control pump stations; instituting incentive programs for stormwater retention; and implementing public outreach and education programs and campaigns. The first priority of this course of action would be repairing storm damage, followed by improving stormwater infrastructure design standards to include development of streamlined stormwater permitting processes and enforcement of land-use regulations to implement green infrastructure and mitigate expansion of pervious areas in highly flood-prone regions. In addition, public outreach and education programs and campaigns would need to be implemented.

Potential Benefits

The principal benefits would be improved water and environmental quality and human health because of reduced urban flooding and runoff, as well as reduced damage to public and private property from urban flood events. Incentivizing green infrastructure would provide the additional benefits of minimizing the amount of effluent at the outlet of stormwater systems, improving the quality of effluent, and lowering capital costs.

Potential Spillover Impacts to Other Sectors

Reduction in urban flooding would have a number of spillover impacts, most notably to Municipalities, Natural and Cultural Resources, and Health and Social Services.

Potential Costs

Potential up-front costs: $964.2 million in estimated up-front costs
Potential recurring costs: $40.7 million in estimated recurring costs (11 years)
Potential total costs: $1.005 billion in total estimated costs

Potential Funding Mechanisms

U.S. Environmental Protection Agency, Hazard Mitigation Grant Program, U.S. Department of Agriculture, government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources

Potential Implementers

Municipal governments, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Aqueduct and Sewer Authority, U.S. Environmental Protection Agency, U.S. Geological Survey, Puerto Rico Planning Board, Office of Permit Management, National Oceanic and Atmospheric Administration, Environmental Quality Board, Puerto Rico Department of Transportation and Public Works, private industry, and nongovernmental organizations

Potential Pitfalls

Pitfalls could be challenges in funding regular maintenance, changes in water quality and stormwater regulations and enforcement, the need for greater coordination among—and investments by—municipalities to implement stormwater system standards, more-intense and more-frequent rainfall events, and growth or retraction of urban areas.

Precursors

Prerequisite courses of action would be WTR 18 (Invest in Stormwater System Management) and WTR 21 (Centralize Stormwater System Support and Management). The assessments and hydrologic and hydraulic analyses in WTR 18 are a necessary precursor for any infrastructure repairs, upgrades, or deployments across the urban landscape.

WTR 20
Relocate or Redesign Assets in Flood Zone

Sector Impacted

Water

Issue/Problem Being Solved

Many of Puerto Rico's water infrastructure assets currently located in flood zones are at risk of repeated damage and service interruptions, which would worsen as climate change increases the intensity and frequency of flood events.

Description

This course of action would relocate or redesign coastal and littoral assets in flood zones according to building standards that are based on hydrologic guidelines and incorporate both updated hydrology and consideration of future floods, which would reduce the likelihood of service disruption or infrastructure failure. Updated hydrologic and hydraulic guidelines and floodplain boundaries should be based on forward-looking analyses that include a future-conditions assessment of the impacts of sea-level rise, the increased magnitude and frequency of extreme-precipitation events, and land-use changes. Initial analyses would (1) determine which critical assets are in current or future flood zones that are vulnerable to damage or service interruption and (2) identify alternative sites for assets and facilities.

Potential Benefits

The rebuilding or relocation of critical water infrastructure assets would decrease flood risk and increase the Water sector's resilience to future disasters through avoidance of asset inundation, damage, and service interruption. The redesign of assets based on updated hydrology and relocation following updated flood maps that consider climate change would ensure that investments made in recovery perform under changing conditions.

Potential Spillover Impacts to Other Sectors

The redesign and relocation of water infrastructure assets would have spillover impacts in the Energy, Natural and Cultural Resources, and Economic sectors.

Potential Costs

Potential up-front costs: $1.183 billion in estimated up-front costs
Potential recurring costs: —
Potential total costs: $1.183 billion in total estimated costs

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Department of Agriculture

Potential Implementers

Puerto Rico Aqueduct and Sewer Authority, Puerto Rico Electric Power Authority, Puerto Rico Department of Natural and Environmental Resources, municipal governments, Puerto Rico Department of Transportation and Public Works, non–Puerto Rico Aqueduct and Sewer Authority systems, FEMA

Potential Pitfalls

This course of action would require a highly coordinated effort among commonwealth and federal agencies. Cost-effectiveness of this course of action would depend on the projected magnitude and frequency of future flood risk and the expected life span and value of at-risk assets.

Likely Precursors

Prerequisites would be hydrologic and hydraulic analyses that incorporate downscaled climate model output to delineate future floodplains and analyses to determine a set of feasible relocation sites and appropriate rebuilding standards.

WTR 21
Centralize Stormwater System Support and Management

Sectors Impacted

Water, Municipalities

Issue/Problem Being Solved

Stormwater infrastructure systems are highly decentralized, with responsibilities for stormwater management divided among Puerto Rico's municipalities and nonconventional system operators. A legacy of a lack of maintenance and oversight of these systems among most municipal and nonmunicipal systems exacerbates urban flooding. Although some municipalities have funded capacity improvements or cleaning and maintenance from their general funds, poor funding for stormwater management often further compounds efforts to mitigate urban flooding.

Description

This course of action would enhance the performance of stormwater systems by centralizing stormwater management, building a workforce of stormwater practitioners, streamlining permitting processes, and enhancing technical capacity, community outreach, and best practices for stormwater management. A newly appointed commission would review management processes, identify best practices, assess workforce needs, and develop new protocols and capacities for stormwater management.

Potential Benefits

This course of action would enhance performance of stormwater systems through improvements in infrastructure, operations, and maintenance; reduced impacts on human health and the environment; expansion of a trained workforce for stormwater management; reduced risk of flooding in urban areas; reduced urban runoff; and improved financial sustainability through fee collection. Centralization would benefit community outreach and education, both for community members and system operators. As operations improve, disadvantaged communities would experience fewer and smaller flood events.

Potential Spillover Impacts to Other Sectors

This course of action would largely affect municipalities. Currently, the majority of stormwater system operations, maintenance, and improvements are funded through the general fund of municipalities. By centralizing support and management to a separate entity capable of generating revenue, this course of action could free up capital in municipal general funds for other purposes.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $67.7 million in estimated recurring costs (11 years)
Potential total costs: $67.7 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, Puerto Rico Department of Natural and Environmental Resources, municipal governments, U.S. Department of Agriculture

Potential Implementers

Municipal governments, governor-appointed special commission

Potential Pitfalls

This course of action would be administrative, focused on integrating planning, management, and technical assistance. Any changes in the interest, capacity, or resources of governmental entities—or any changes in the capacity of citizens to pay stormwater fees—could lead to an ineffective stormwater utility. The capacity of stormwater management could largely be affected if weather becomes more severe and frequent. However, because this course of action would be administrative in nature, climate and extreme weather would largely be a secondary impact. Stormwater management and measures could mitigate urban nuisance flooding that is the result of increased development and higher percentages of impervious surfaces in the urban landscape. If cities retract or grow, the percentage of pervious and impervious surfaces may change and alter urban hydrology.

Likely Precursors

The prerequisites for this course of action would be WTR 19 (Reduce Urban Nuisance Flooding) and WTR 18 (Invest in Stormwater System Management).

WTR 22
Upgrade Reservoir and Dam Safety Management

Sector Impacted

Water

Issue/Problem Being Solved

Most of Puerto Rico's 36 dams serve multiple purposes, including flood control, water supply, and hydropower generation, but their operational plans were largely designed to optimize hydropower generation.

Description

This course of action would upgrade reservoir management rules to improve and optimize operations across multiple water management objectives, including drinking water supply, flood control, dam safety, and hydroelectric generation. Additionally, it would ensure that emergency action plans are updated and exercised annually and that dam performance reports are current. Implementing agencies would survey existing dam functions, structural conditions, and downstream populations and apply operations optimization techniques to improve overall management.

Potential Benefits

Improved dam safety and operational management of Puerto Rico's dams would minimize impacts to any one sector in the event of future extreme flood and seismic events and increase the resiliency of reservoir water supply.

Potential Spillover Impacts to Other Sectors

The modification of reservoir management rules could deemphasize use in other sectors. For example, a dam previously optimized for power generation may choose to reduce reservoir levels to mitigate flood risk.

Potential Costs

Potential up-front costs: $118 million in estimated up-front costs
Potential recurring costs: $7 million in estimated recurring costs (11 years)
Potential total costs: $125 million in total estimated costs

Potential Funding Mechanisms

U.S. Environmental Protection Agency Clean Water State Revolving Fund, U.S. Army Corps of Engineers, government of Puerto Rico, Puerto Rico Aqueduct and Sewer Authority, Puerto Rico Electric Power Authority, nongovernment sources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Aqueduct and Sewer Authority, U.S. Environmental Protection Agency, U.S. Geological Survey, Puerto Rico Electric Power Authority, U.S. Army Corps of Engineers

Potential Pitfalls

Implementation of new management standards may require the involvement and approval of multiple governmental agencies. Successful mitigation of flood risk would require some estimate of future water-surge magnitudes during extreme weather, which are inherently uncertain, and these studies would require up-front funding. Implementing new control measures would require some capital investment and might not be prioritized over more-pressing flooding concerns. Demand for dam services would be a function of the local population, so management approaches may have to be adaptable as populations shrink, grow, or relocate.

Likely Precursors

Prerequisite courses of action that are relevant regardless of the level of implementation would be WTR 23 (Evaluate, Repair, and Improve Flood Control Infrastructure) and WTR 25 (Rationalize Ownership and Management of Flood Control Infrastructure).

WTR 23
Evaluate, Repair, and Improve Flood Control Infrastructure

Sector Impacted

Water

Issue/Problem Being Solved

Many flood-control systems were damaged by Hurricane Maria, and some may be underdesigned for the magnitude and frequency of extreme-precipitation events. These systems could be vulnerable to future extreme-weather events and climate change and might not adequately mitigate flood risk under future conditions. Additionally, 3 large flood control projects have not been completed because of funding limitations, making the protected areas vulnerable to flooding. Further, traditional grey infrastructure solutions to flood control—such as dams, channels, and levees—can disrupt natural habitats and diminish ecosystem benefits.

Description

This course of action would evaluate, repair, and improve the performance and resilience of flood-control infrastructure to safely manage 100-year-flood events, including monitoring and maintenance programs and considering the influence of increased magnitude and frequency of flood events because of climate change. Assets would be flood-risk management systems that consist of, but are not limited to dams, levees, channels, precipitation and stream gauges, and water-control structures. Further, the development and use of a real-time flood inundation mapping tool could serve as the digital framework needed to support the operations and maintenance of flood-control infrastructure. This tool would also support the goals of WTR 22 (Upgrade Reservoir and Dam Safety Management). This course of action would identify and evaluate options for natural river systems to manage flooding in future extreme-weather events, including how these options could reduce dependency on levees and other physical infrastructure.

Potential Benefits

The most significant benefits would be a reduction in flood risk for communities and assets and associated risks to people and property.

Potential Spillover Impacts to Other Sectors

Reduced flood risk benefits Natural and Cultural Resources, Health and Social Services, and any sectors protected by flood-control infrastructure.

Potential Costs

Potential up-front costs: $4.639 billion in estimated up-front costs

Potential recurring costs: $27.7 million in estimated recurring costs (11 years)
Potential total costs: $4.667 billion in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Army Corps of Engineers, private insurance

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Planning Board, Puerto Rico Emergency Management Agency, municipal governments, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Geological Survey

Potential Pitfalls

Given the state of flood-control infrastructure prior to Hurricane Maria, adequate risk mitigation would likely need major infrastructure investments. System improvements would be considered successful only if they could adequately mitigate risk in the face of an uncertain future climate.

Likely Precursors

Prerequisites to implementing this course of action would be clearance of debris and blockages and inventory of asset ownership and status, including comprehensive damage assessments of all infrastructure assets.

WTR 24
Reduce Sedimentation of Water Bodies

Sector Impacted

Water

Issue/Problem Being Solved

Puerto Rico's reservoirs and channels have suffered lost capacity over time because of sedimentation, making it difficult to simultaneously ensure water quality and maintain flood-control capability. The following reservoirs have lost more than 40% of their total storage capacities because of sedimentation, based on 2013 U.S. Geological Survey estimates:[132] Dos Bocas, Guayabal, Loco, Carraízo, Lucchetti, Prieto, and Yahuecas. These estimates do not include the sedimentation that resulted from Hurricane María.

Description

This course of action would ensure the downstream water quality of reservoirs and channels while simultaneously maintaining flood-control capacity through erosion control, sediment control plans and reduction measures, and dredging. It would also aim to discourage or prohibit land development in estuarial and coastal regions and some uses of land in floodplains and watershed buffer zones to manage sedimentation rates. To meet these objectives, this course of action would require enforcing sediment control plans and reduction measures, land-use plans, and soil conservation practices to preserve capacity, maintain the flood-control properties of dams and channels, and limit the sedimentation of water bodies. If necessary, dredging of channels and dams to restore reservoir capacity would be performed.

Potential Benefits

The benefits of this course of action include improved flood control without compromising water quality, water supply, and reservoir capacity and potential reductions in sustainment costs in the future if alternative sedimentation and erosion control measures prove cost-effective.

Potential Spillover Impacts to Other Sectors

Potential benefits to Natural and Cultural Resources, but also potential adverse effects associated with dredging operations

Potential Costs

Potential up-front costs: $3.715 billion in estimated up-front costs

[132] L. Soler-López, "Sedimentation Survey Results of the Principal Water Supply Reservoirs of Puerto Rico," in W. F. Sylva, ed., *Proceedings of the Sixth Caribbean Islands Water Resources Congress*, Mayagüez, Puerto Rico, 2001.

Potential recurring costs: —
Potential total costs: $3.715 billion in total estimated costs

Potential Funding Mechanisms

Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Army Corps of Engineers, Department of Commerce Economic Development Administration, Government of Puerto Rico, Puerto Rico Aqueduct and Sewer Authority, Puerto Rico Electric Power Authority, Puerto Rico Department of Natural and Environmental Resources, nongovernment sources

Potential Implementers

U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Geological Survey, FEMA, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Aqueduct and Sewer Authority, Puerto Rico Electric Power Authority, Puerto Rico Planning Board, Environmental Quality Board, municipal governments, Puerto Rico Department of Health

Potential Pitfalls

Dredging and sluicing affect the water quality of downstream communities and require recurring operations and maintenance expenditures. Implementation of other sedimentation and erosion control measures depends on the enforcement and monitoring power of institutions, and imposed standards are a function of the timing, quantity, and intensity of precipitation events, as well as any climate-induced changes to the suitability of land for agriculture. In a depressed economy, strict regulations on land use and agricultural practices, while beneficial in the long term, could become burdensome to the private sector and individuals. In addition, changes in population and demographics could reduce the effectiveness or need for these regulations. Strictly implementing this course of action could lead to disruption of residents in floodplains, removal of land from development, and high costs to relocate people and infrastructure. Also, government entities that impose land development restrictions may be exposed to legal liability over claims. Finally, this course of action would require sufficient waste disposal infrastructure to manage dredging products and, as necessary, the capability to dispose of contaminated wastes.

Likely Precursors

A prerequisite would be WTR 25 (Rationalize Ownership and Management of Flood Control Infrastructure).

WTR 25
Rationalize Ownership and Management of Flood Control Infrastructure

Sectors Impacted

Water, Energy, Natural and Cultural Resources

Issue/Problem Being Solved

Ownership and management authority for major water infrastructure are divided among commonwealth agencies. Operations might not be optimized to meet current demands or to balance multiple objectives.

Description

This course of action would rationalize ownership and management of hydroelectric dams and facilities and other flood-control infrastructure, including the transfer of ownership of dams owned by the Puerto Rico Electric Power Authority (PREPA) to the Puerto Rico Aqueduct and Sewer Authority (PRASA), and would enhance cooperative management to increase operational efficiencies and achieve multiple objectives. As an initial step, the course of action would require assessing the financial and management implications of alternative asset-ownership plans.

Potential Benefits

This course of action would enhance operational efficiency, asset management, fiscal health, and thus the overall resilience of drinking water distribution and flood-control systems.

Potential Spillover Impacts to Other Sectors

Asset rationalization that results in the transfer of ownership of dams from PREPA to PRASA could have implications (positive or negative) for the future management of those dams for hydropower.

Potential Costs

Potential up-front costs: $2.8 million in estimated up-front costs
Potential recurring costs: $336.6 million in estimated recurring costs (11 years)
Potential total costs: $339.4 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, PRASA (costs for asset acquisition and future operations and maintenance could be derived from PRASA revenue for transferred dams and reservoirs and from municipal revenue for transferred pumps)

Potential Implementers

PRASA, PREPA, Puerto Rico Department of Natural and Environmental Resources, municipal governments

Potential Pitfalls

Asset rationalization would be highly contingent on the decisionmaking and investment processes of PRASA, the Department of Natural and Environmental Resources, and municipalities, as well as other actors, including regulators. A key concern would be maintaining sufficient revenues to adequately fund ongoing operations and maintenance of additional assets, if they were to be acquired.

Likely Precursors

A prerequisite for implementing this course of action would be consensus among PRASA, PREPA, the Department of Natural and Environmental Resources, and municipalities regarding the terms and conditions of asset transfers. For PRASA and PREPA, agreements might also be contingent on future decisions regarding use of hydropower in Puerto Rico: If investments were made to repower dams, the value proposition of asset ownership from PREPA to PRASA may be diminished.

WTR 26
Build Trust and Engage PRASA Clients

Sector Impacted

Water

Issue/Problem Being Solved

Hurricane recovery efforts have revealed the inadequacy of communication between the Puerto Rico Aqueduct and Sewer Authority (PRASA) and its clients and customers.

Description

This course of action would enhance communication, education, and outreach to PRASA customers on conservation and emergency preparedness strategies and increase public understanding of water and wastewater system planning, performance, and investments to foster strong relationships between PRASA and its clients. Steps would include identifying key stakeholders and clients, developing marketing and communications materials and campaigns, and engaging stakeholders on PRASA operations and decisions.

Potential Benefits

The anticipated benefits of this course of action are twofold. First, it would help develop a strategic approach by which PRASA could communicate its management priorities to clients and customers so they can better understand the value of water and the opportunities, constraints, and rationales behind management decisions. Second, it would provide a mechanism by which clients and customers can play a more active role in helping PRASA meet its objectives, such as in emergency management situations.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $66.3 million in estimated recurring costs (11 years)
Potential total costs: $66.3 million in total estimated costs

Potential Funding Mechanisms

Government of Puerto Rico, PRASA, nongovernment sources

Potential Implementers

PRASA

Potential Pitfalls

Enhancing transparency around PRASA's management practices, operations, and strategic planning would create potential vulnerabilities by giving the public, customers, and clients the opportunity to reflect on the status and trends of the utility and to voice preferences for and against different decisions. This effort could enhance public support for PRASA but could also increase the politicization of investment decisions, which could slow decisionmaking and innovation.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation would be WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), and WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA).

WTR 27
Protect and Rehabilitate Groundwater Systems

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

Groundwater resources in Puerto Rico are exposed to contaminants, particularly in the North Coast Karst Aquifer because of its high level of hydraulic conductivity and the concentration of contaminant sources in the region. Groundwater levels across the commonwealth have largely been in decline, according to monitoring data from the U.S. Geological Survey,[133] although many were recharged significantly following Hurricanes Irma and Maria.

Description

This course of action would protect and rehabilitate groundwater systems—including karst systems with higher hydraulic conductivity—from saltwater intrusion, contamination, and overexploitation and would implement artificial recharge programs, monitoring networks, and groundwater modeling. Implementation would first require assessing the status, trends, and dynamics of groundwater resources to identify opportunities to improve groundwater availability or groundwater quality. Options would include remediation, artificial recharge, and ongoing monitoring and modeling for groundwater sustainability. Remediation of contaminant plumes and contaminated sites should prioritize those areas hydraulically connected to drinking water or irrigation wells. A long-term, structured groundwater management plan could encompass and manage these activities.

Potential Benefits

The benefits of this course of action could include the securing of the quantity and quality of groundwater supply sources for agricultural and residential uses, groundwater-dependent ecosystem protection, and mitigation of the negative impacts of groundwater exploitation, including sinkholes, land subsidence, and increasing costs of extraction. Expansion of groundwater monitoring networks and groundwater modeling efforts, in a centralized location, would allow for management and policy decisions to be based on up-to-date and technically defensible information.

[133] U.S. Geological Survey, "USGS Water Data for the Nation," webpage, last updated May 17, 2019 (https://nwis.waterdata.usgs.gov/nwis?).

Potential Spillover Impacts to Other Sectors

This course of action would benefit Natural and Cultural Resources and may make land above remediated sites available for development.

Potential Costs

Potential up-front costs: $162.3 million in estimated up-front costs
Potential recurring costs: $25.6 million in estimated recurring costs (11 years)
Potential total costs: $187.9 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Bureau of Reclamation, Puerto Rico Department of Natural and Environmental Resources

Potential Implementers

Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, U.S. Geological Survey, U.S. Environmental Protection Agency

Potential Pitfalls

Groundwater rehabilitation and management requires effective and collaborative governance for it to be realized, funded, and implemented effectively over the long term. Because this course of action would focus on ensuring adequate future groundwater supply, if the climate becomes hotter and drier, groundwater demand could significantly increase and make this course of action more challenging to implement. Higher than anticipated sea-level rise could also make saltwater intrusion barriers less effective.

Likely Precursors

A prerequisite course of action could be WTR 28 (Securing Drinking Water Sources Against Contamination).

WTR 28
Secure Drinking Water Sources Against Contamination

Sectors Impacted

Water, Natural and Cultural Resources

Issue/Problem Being Solved

Sources of surface water for drinking are degraded across Puerto Rico because of industrial, agricultural, wastewater, and stormwater contamination. In rural areas, many water sources are improperly protected from contamination, which compromises water quality and safety.

Description

This course of action would secure drinking water sources against contamination from domestic, agricultural, and industrial wastewater and hazardous waste sites by raising awareness of source-water protection measures, enforcing land-use restrictions, quantifying nutrient loads in water-supply reservoirs, and remediating contaminated areas near water sources. The course of action could also increase the protection of surface-water resources from contamination from legacy environmental contaminants, as well as from current agricultural and industrial activities to protect human health and natural ecosystems. This effort would involve consideration for the potential mobilization of contaminants from the U.S. Environmental Protection Agency's designated Superfund sites, brownfields, and other industrial and agricultural facilities during extreme events, such as floods and hurricanes. Steps would consist of identifying water-quality protection needs by analyzing key sources of contamination, prioritizing interventions to address water contamination, quantifying nutrient import loads by the main tributaries of at-risk reservoirs, remediating and containing contaminated areas, enforcing land-use regulations and industrial and agricultural practices, and developing educational campaigns to raise awareness of and change behaviors regarding water protection.

Potential Benefits

Improved water-source protection would safeguard the water supply, human health, and ecosystem services. The costs of treatment for drinking water sources would decline as source-water quality is improved. Educational campaigns and public awareness could foster a culture of environmental stewardship.

Potential Spillover Impacts to Other Sectors

This course of action would affect Health and Social Services and Natural and Cultural Resources.

Potential Costs

Potential up-front costs: $39.4 million in estimated up-front costs
Potential recurring costs: $9.9 million in estimated recurring costs (11 years)
Potential total costs: $49.3 million in total estimated costs

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant–Disaster Recovery, U.S. Department of Commerce Economic Development Administration, U.S. Environmental Protection Agency, U.S. Bureau of Reclamation, U.S. Department of Agriculture

Potential Implementers

Puerto Rico Aqueduct and Sewer Authority, non–Puerto Rico Aqueduct and Sewer Authority systems, Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Addressing multiple sources of contamination to water resources necessitates collaboration among actors and stakeholders with responsibility for the management of different sectors and water systems, and close coordination should be prioritized. Climate and weather can significantly influence how contaminants are distributed in soils, surface water, and groundwater, as well as the mobility of those contaminants. More-frequent and more-intense extreme precipitation events would amplify the necessity for this course of action.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation would be WTR 11 (Repair, Replace, and Improve PRASA Wastewater Treatment Plants and Sanitary Sewer Collection Systems), WTR 17 (Reduce Incidence of Raw Sewage Exposure), WTR 19 (Reduce Urban Nuisance Flooding), WTR 27 (Protect and Rehabilitate Groundwater Systems), and NCR 14 (Water Quality Improvements at the Watershed Scale).

WTR 29
Strengthen Redundancy and Diversify Water Supply Sources

Sectors Impacted

Water, Energy, Natural and Cultural Resources

Issue/Problem Being Solved

Puerto Rico's water resources are at risk of drought, contamination, and changing or escalating demand. During periods of scarcity and during emergency response efforts, surface-water supply may be less available or degraded, and water managers need to maintain a dependable water supply, including alternative supply sources. At the same time, Puerto Rico depends heavily on surface-water resources for residential, industrial, and agricultural needs.

Description

This course of action would ensure the sustainability of water-supply sources by developing and implementing integrated water management plans that include conservation and demand management strategies and balance environmental needs with the demands of communities, industry, and agriculture, while also enhancing resilience to drought events and climate change through alternative water supply planning and adoption of water efficiency standards. The first step would be developing comprehensive plans for the management and conservation of water resources, as well as development of alternative water-supply sources, including greater use of raw water and the implementation of water recycling programs.

Potential Benefits

Reliable drinking water services are critical to support Puerto Rico's economy, including tourism and industry, and are essential for maintaining public health and other social services.

Potential Spillover Impacts to Other Sectors

Enhanced security of supply could have positive spillover effects on Health and Social Services by increasing water security and on Natural and Cultural Resources through the maintenance of minimum environmental flows, as well as on the broader economy (e.g., industrial activity and agriculture). However, there is the potential for negative externalities for electricity costs.

Potential Costs

Potential up-front costs: $1.466 billion in estimated up-front costs
Potential recurring costs: $11 million in estimated recurring costs (11 years)
Potential total costs: $1.477 billion in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, U.S. Department of Agriculture, public-private partnership, government of Puerto Rico, Puerto Rico Aqueduct and Sewer Authority

Potential Implementers

Puerto Rico Aqueduct and Sewer Authority, Puerto Rico Department of Natural and Environmental Resources, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

Implementing programs and projects associated with water diversification are contingent on improving the Puerto Rico Aqueduct and Sewer Authority's operational efficiency, fiscal health, and cooperation with other entities such as municipalities, the Puerto Rico Electric Power Authority, and the U.S. Environmental Protection Agency.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation would be WTR 1 (Resilient Repair or Replacement of the PRASA Drinking Water System), WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 4 (Enhance Ability to Transfer Potable Water Among PRASA Service Zones), WTR 7 (Strengthen PRASA's Asset Management Program), WTR 27 (Protect and Rehabilitate Groundwater Systems), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 28 (Secure Drinking Water Sources Against Contamination), WTR 30 (Enhance PRASA's Emergency Management Operations), and WTR 26 (Build Trust and Engage PRASA Clients).

WTR 30
Enhance PRASA's Emergency Management Operations

Sector Impacted

Water

Issue/Problem Being Solved

Hurricane Maria resulted in loss of power to assets and facilities; damage to pipes, pumps, and treatment plants; and damage to offices and laboratories, demonstrating the vulnerability of critical assets to such events and the time and effort needed to recover.

Description

This course of action would enhance the Puerto Rico Aqueduct and Sewer Authority's (PRASA's) capacity to effectively manage extreme events and service disruptions by increasing preparedness through more-robust emergency management planning, protocols, and training. These efforts might include plan development, staff training, and coordination with critical clients and commonwealth and federal agencies to prioritize response and recovery efforts.

Potential Benefits

The establishment of emergency response plans and protocols is a core component of having a resilient Water sector. They can act as tools for mitigating adverse consequences during extreme events and can reduce the time required for emergency response and recovery. Therefore, enhancing emergency management could support Puerto Rico's economy, including tourism and industry, as well as maintain public health and safety.

Potential Spillover Impacts to Other Sectors

Enhancing emergency management planning and responses could have positive spillover effects on public health and safety, as well as the broader economy. Because this course of action is a routine best practice, negative spillover impacts are unlikely.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $8.8 million in estimated recurring costs (11 years)
Potential total costs: $8.8 million in total estimated costs

Potential Funding Mechanisms

Community Development Block Grant–Disaster Recovery, government of Puerto Rico, PRASA

Potential Implementers

PRASA, Puerto Rico Department of Natural and Environmental Resources, Environmental Quality Board, Puerto Rico Department of Health, U.S. Environmental Protection Agency

Potential Pitfalls

A robust emergency management plan effectively represents a “win-win” option with few pitfalls, if appropriately implemented and sustained over the long term.

Likely Precursors

Prerequisites that are relevant regardless of the level of implementation would be WTR 2 (Improve the Operational Efficiency and Performance of PRASA Water and Wastewater Systems), WTR 3 (Enhance the Efficiency and Resilience of PRASA Electricity Services), WTR 4 (Enhance Ability to Transfer Potable Water Among PRASA Service Zones), WTR 5 (Improve Treatment and Storage Capacity to Handle High Turbidity Events), WTR 7 (Strengthen PRASA’s Asset Management Program), WTR 8 (Implementation of New Initiatives to Achieve Financial Sustainability for PRASA), WTR 29 (Strengthen Redundancy and Diversify Water Supply Sources), and WTR 26 (Build Trust and Engage PRASA Clients).