Public Buildings in Puerto Rico After Hurricane Maria

Prestorm Challenges, Hurricane Damage, and Suggested Courses of Action for Recovery

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Preface

On August 8, 2018, the government of Puerto Rico submitted to Congress their Economic and Disaster Recovery Plan as required by the Bipartisan Budget Act of 2018. Under contract with the Federal Emergency Management Agency (FEMA), the Homeland Security Operational Analysis Center (HSOAC) provided substantial support in developing the plan by soliciting and integrating inputs from a wide variety of stakeholders, contributing analysis where needed, and assisting in drafting the plan. The plan included an overview of damage and needs, courses of action to meet those needs, costs of the courses of action, and potential funding mechanisms for those costs.

To support federal agencies evaluating and funding recovery actions, HSOAC is releasing this detailed volume for the public building sector. The purpose of this document is to provide decisionmakers greater detail on the conditions in Puerto Rico prior to the 2017 hurricane season, the damage incurred from Hurricanes Irma and Maria, and courses of action that were identified to help the sector (and, more broadly, Puerto Rico) recover in a resilient manner. The data and other findings presented in this report were generally collected between October 2017 and July 2018; the most current date differs among the findings.

This document will likely also be of interest to other stakeholders funding or implementing recovery activities in Puerto Rico, including commonwealth and local agencies, nongovernmental organizations, and the private sector. Furthermore, this body of material contributes to the larger literature about disaster recovery and resilience, and may be of interest to other communities planning for or recovering from similar disasters.

This research was sponsored by FEMA and conducted within the Strategy, Policy, and Operations Program of the Homeland Security Operational Analysis Center's federally funded research and development center (FFRDC). 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.

About the Homeland Security Operational Analysis Center

The Homeland Security Act of 2002 (Section 305 of Public Law 107–296, as codified at 6 U.S.C. § 185), authorizes the Secretary of Homeland Security, acting through the Under Secretary for Science and Technology, to establish one or more FFRDCs to provide independent analysis of homeland security issues. The RAND Corporation operates HSOAC as an FFRDC for the U.S. Department of Homeland Security (DHS) under contract HSHQDC-16-D-00007.

The HSOAC FFRDC provides the government with independent and objective analyses and advice in core areas important to the department in support of policy development,

decisionmaking, alternative approaches, and new ideas on issues of significance. The HSOAC FFRDC also works with and supports other federal, state, local, tribal, and public and private sector organizations that make up the homeland security enterprise. The HSOAC FFRDC's research is undertaken by mutual consent with DHS and is organized as a set of discrete tasks. This report presents the results of research and analysis conducted under Task Order 70FBR218F00000032, "Puerto Rico Economic and Disaster Recovery Plan: Integration and Analytic Support."

The results presented in this report do not necessarily reflect official DHS opinion or policy. For more information on HSOAC, see www.rand.org/hsoac. For more information on this publication, visit www.rand.org/t/RR2606.

Contents

Preface ... iii
Figures ... vi
Tables ... vii
Summary ... viii
Acknowledgments ... xiv
Abbreviations ... xv
1. Introduction ... 1
2. Public Buildings in Puerto Rico ... 3
    Structure and Key Assets ... 4
    Data Sources and Methods ... 6
    Pre-Storm Conditions ... 8
3. Description of Damage ... 16
    Summary of Key Impacts ... 16
    Damage, by Building Owner ... 18
    Damage by Building Type ... 22
    Impact of Damage and Status of Recovery Activity ... 28
4. Identifying Courses of Action ... 30
    Recovery Plan ... 31
    The Path Forward ... 35
Appendix. Courses of Action for Recovery Plan ... 37
References ... 85

Figures

Figure 2.1. Building Classification 4
Figure 2.2. Historical and Projected Populations of Puerto Rico, 1950–2060 9
Figure 2.3. Labor Force in Puerto Rico 10
Figure 2.4. Puerto Rico's Population by Age Group, 2010 Versus 2016 11
Figure 2.5. Puerto Rico's Government Revenue and Expenses, Fiscal Years 2002 to 2014 12
Figure 2.6. Puerto Rico Infrastructure Financing Authority Bond Prices 13
Figure 2.7. Puerto Rico Public Buildings Authority Bond Prices 13
Figure 3.1. Federal Share of Obligated Public Assistance Funds for Public Buildings as of July 2018, by FEMA PA Service Category 17
Figure 3.4. Distribution of Number of Damage Types per PRIDCO Building 19
Figure 3.5. Total Cost Estimates for Different Damage Types for PRIDCO Buildings 20
Figure 3.6. Percentage of PBA Buildings with Various Categories of Damage 21
Figure 3.7. Distribution of Number of Damage Categories per PBA Building 21
Figure 3.8. Total Cost Estimates for Different Damage Categories for PBA Buildings 22
Figure 3.9. Functional Status of State Police Stations as of November 2017 23
Figure 3.10. Percentage of Police Stations with Various Types of Damage 23
Figure 3.11. Distribution of Number of Issues per Police Station 24
Figure 3.12. Percentage of Schools with Damage and Other Issues 25
Figure 3.13. Distribution of Number of Issues per School 25
Figure 3.14. Total Losses and Roof Losses for Fire Stations 26
Figure 3.15. Range of Damage for Individual Corrections Facilities 27
Figure 3.16. Percentage of Corrections Facilities with Different Types of Damage 27
Figure 4.1. Interdependency of Public Building COAs 35

Tables

Table S.1. Courses of Action for the Public Building Sector xi
Table 2.1. Public Assistance Applicants in Public Building Sector 5
Table 2.2. Numbers of Public Buildings by Selected Owners and Building Purposes 6
Table 2.3. Summary of Data Sources for Public Buildings 7
Table 4.1. Courses of Action for the Public Building Sector 32
Table A.1. Potential Costs of Establishing Integrated Services Centers 47
Table A.2. Number and Type of PBA Buildings in Flood Zones 61
Table A.3. Approximate Cost of Mitigation Options 61
Table A.4. Potential Costs for Bringing Public Buildings up to Code 77

Summary

Introduction

On September 19 and 20, 2017, Hurricane Maria caused widespread destruction across the U.S. Commonwealth of Puerto Rico. Making landfall just two weeks after Hurricane Irma, Maria—a strong Category 4 storm—significantly damaged local infrastructure and interrupted the provision of services to the people of Puerto Rico. A supplemental appropriations bill passed by Congress on February 8, 2018, required the Governor of Puerto Rico, in coordination with the Federal Emergency Management Agency (FEMA), the Department of Treasury, the Department of Energy, and other federal agencies with responsibilities under the National Disaster Recovery Framework, to submit a report to Congress within 180 days of enactment of the legislation that describes Puerto Rico's 12- and 24-month Economic and Disaster Recovery Plan.

The government of Puerto Rico's recovery plan,[1] published in August 2018, lays out the priorities, goals, and expected outcomes of the recovery effort in Puerto Rico. The plan implements FEMA's Public Assistance (PA) Alternative Procedures Guide for Permanent Work (Section 428), which authorizes the recovery efforts to include alternatives to strictly repairing damage from the storms. This guide would allow Puerto Rico to "build back better." An overarching goal of the recovery plan is to mitigate vulnerabilities to future disasters and increase community resilience. The recovery plan is intended to provide Puerto Rico a path toward economic sustainability, growth, and resilience as it reconstructs and recovers from the impact of Hurricanes Irma and Maria.

FEMA asked the Homeland Security Operational Analysis Center (HSOAC) to provide analytical support to the government of Puerto Rico in its formulation of the recovery plan.[2] This report summarizes the information gathering and analysis that HSOAC conducted to support the public building part of the recovery plan. To support federal agencies evaluating and funding recovery actions, HSOAC is releasing this detailed volume for the public building area. The purpose of this document is to provide decisionmakers greater detail on the conditions in Puerto Rico prior to the 2017 hurricane season, damage from Hurricanes Irma and Maria, and courses of action that were identified to help the sector (and, more broadly, Puerto Rico) recover in a resilient manner.

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[1] Central Office for Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan, P.R.: Central Office for Recovery, Reconstruction, and Resiliency, Government of Puerto Rico, August 8, 2018.

[2] 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.

Public Buildings in Puerto Rico

Puerto Rico's public buildings house the multitude of operations conducted by the government. They are workspaces for government employees, bases of operation for services that operate in the field, and places where the public engages with government services. They are the physical face of the government, from municipal town halls and schools to the capitol building ("el capitolio") in Old San Juan.

The assemblage of public buildings intersects with the entire array of government services, such as emergency services, education, public health, the judicial system, the National Guard, tax collection, and State Department, as well as the private sector. While in some cases the government agency that performs a particular function is also responsible for the buildings that house that function, in other cases responsibility for buildings falls under an agency other than the one using them. This fragmentation makes it difficult to clearly define "public buildings" for the recovery process and complicates efforts to collect data on building conditions and needs and to develop recovery plans.

For the purposes of long-term recovery, it is useful to think about public buildings in terms of both legal responsibility and function. This report therefore presents results from both perspectives. Some data are presented in terms of building owner or legal operator, while others are presented in terms of building function. This dual approach makes it possible to understand damage (discussed in Chapter 3) and recovery (discussed in Chapter 4) from both perspectives.

The scope of public buildings for the purposes of long-term recovery planning includes state police and fire stations, publicly owned hospitals, libraries, National Guard facilities, judiciary buildings, government offices, prisons, archives, recreation centers, government-owned buildings leased by the private sector, and public schools. Recovery planning for other types of public buildings and facilities are being managed through other efforts and are described in other reports being published as part of this series.[3]

Because of the fragmented building ownership structure, compounded by incomplete and inconsistent documentation, disentangling which agencies own specific buildings is complex, and a clear inventory of public buildings and owners in Puerto Rico is difficult to compile. Our analysis of damage and recovery needs is limited by the incomplete public building inventory available. This inventory will need to be improved prior to commencing substantial recovery efforts.

Can We Determine the Extent of the Damage?

Much of the data that contributed to the damage assessment came from FEMA PA requests. Based on PA application data as of July 2018, a total of $148 million of federal funds had been

[3] Links to other reports being published as part of this series can be found at the project's website: www.rand.org/hsoac/puerto-rico-recovery.

obligated to 115 requests from 39 applicants in the public building sector, and an additional $624 million has been requested in over 10,000 requests from 38 applicants in the public building sector.

Categorizing the kinds of damage is challenging because different methods were used to categorize and report damage. For example, for police stations and schools, the U.S. Army Corps of Engineers (USACE) provided preliminary damage assessments based on early inspections. In other cases, damage was assessed by building owners without any sort of standardized method or reporting template. As of July 2018, the majority of obligated federal funds for public building sector PA applicants were for emergency protective measures ($118 million), followed by state management costs ($18 million) and debris removal ($12 million). As of July 2018, the majority of the outstanding applications to FEMA for PA are for permanent work repairing damage to public buildings and contents ($349 million), followed by emergency support of the National Guard ($189 million), other repairs ($36 million), emergency protective measures ($33 million), and debris removal ($16 million). For buildings owned by the Puerto Rico Industrial Development Company (PRIDCO, one of the two largest government building owners), roof damage accounted for the vast majority of estimated costs.

Perhaps most challenging is trying to assess the impact of damage. Most agencies described damage but did not describe functional impairment. Hence little information was available on the overall impact of storm damage on the function of buildings and the services they provide.

What Courses of Action Were Identified?

The courses of action (COAs) for recovery for the public building sector were developed in close coordination with the FEMA Public Buildings Sector team; the Infrastructure Recovery Support Function Team, led by USACE; the government of Puerto Rico representative to the federal recovery effort; and several government agencies, including PRIDCO and the Puerto Rico Public Buildings Authority (PBA).

Some of the most pressing needs in the public building sector stem from long-standing issues caused by poor economic conditions and declining population. Limited government funds led to a lack of building maintenance, building upgrades, or new structures. These in turn created the conditions that left public buildings at high risk during the storms. Poorly maintained buildings are often more susceptible to storm damage, particularly roof damage. Many buildings predate modern building practices, materials, and codes designed to increase resilience to disasters; even newer buildings often fail to meet code, as these codes are unevenly enforced. Some badly damaged buildings have had to shut down, either temporarily for repair or permanently, resulting in loss of essential services. At the same time, Puerto Rico's declining population means the size, number, design, or location of some public buildings no longer matches the needs of the population.

The damage that the storms inflicted has provided the government of Puerto Rico an opportunity to reexamine Puerto Rico's public buildings and develop a new guiding vision. This vision, embodied in 12 COAs, is to reinvest in public building infrastructure not only to repair the damage caused by the 2017 hurricanes but also to modernize this infrastructure to increase resilience to natural hazards, improve energy efficiency, and improve functionality and user experience. The goals of the COAs can be grouped into three broad categories (see Table S.1):

- repair and reconstruction
- realignment and repurposing
- policy development and data collection to be used to improve future buildings.

An important challenge for implementation is interdependence—implementation parameters for several COAs depend on decisions made for other COAs. Planning and implementing these COAs therefore requires coordinated and integrated planning. Such planning will need to consider many factors, such as current models for service delivery, projected demand for capabilities and space, geographic distribution and access to facilities, risks from natural hazards, and desired building performance. Ideally, the government of Puerto Rico will develop an overall vision for a network of public buildings that will meet the needs of the population over the next several decades and identify the best strategy to achieve that vision.

Table S.1. Courses of Action for the Public Building Sector

COA Category	Title (COA #)	Description	Lead Agency
Repair and reconstruction	Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria (PBD 9)*	Complete repairs to essential public buildings that sustained hurricane damage, ensuring that repairs meet current building safety codes for wind, flood, and seismic events.	Puerto Rico Infrastructure Financing Authority
Repair and reconstruction	Bring Public Buildings up to Code (PBD 11)	Assess building safety code compliance for wind, flood, and seismic risks across the public building inventory and retrofit buildings with the appropriate structural hardening, making other code upgrades where needed.	Government of Puerto Rico agencies, municipal governments
Repair and reconstruction	Refurbish Community Centers and Community Technology Centers (PBD 7)	Rebuild or refurbish 300 community centers in low-income communities and 172 community technology centers, including providing them with generators for backup power and building them to withstand hurricanes and earthquakes.	Puerto Rico Planning Board
Realignment and repurposing	Mitigate Flood Risk for Critical Government Functions (PBD 8)	Relocate critical public functions to buildings outside of flood hazard zones or elevate the building in which the critical function is housed to prevent service disruptions and reduce damage due to flooding.	Puerto Rico Planning Board

COA Category	Title (COA #)	Description	Lead Agency
Realignment and repurposing	Right-Size Public Buildings (PBD 2)	Analyze demand for government services to estimate the appropriate building capacity, program requirements, and proposed improvements for government operations. Repurpose, reallocate, and refurbish buildings. Sell or demolish unneeded vacant buildings where possible.	Puerto Rico Planning Board
Realignment and repurposing	Establish Integrated Services Centers (PBD 3)	Continue supporting the government of Puerto Rico's ongoing project to cluster public services in a single location to improve efficiency and accessibility to the public. A center is already operating in San Juan, where residents can access a variety of social services in a single location.	Public Buildings Authority, Puerto Rico Department of State
Realignment and repurposing	Realign Public Building Ownership (PBD 4)	Transfer ownership of buildings so that buildings of the same type (e.g., schools or government centers) are all owned by the same agency.	Office of the Governor, Legislative Assembly
Realignment and repurposing	Move Public Services to Public Buildings (PBD 5)	House government agencies in public buildings rather than privately owned buildings.	Office of the Governor, Legislative Assembly
Policies and data	Incentivize State-of-the-Art Building Design, Practices, and Technologies (PBD 10)	Modify or develop policies and programs that establish clear standards for energy and water efficiency in public buildings and 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.	Government of Puerto Rico agencies, municipal governments
Policies and data	Develop Secondary Power Guidelines (PBD 12)	Develop guidelines for the design of secondary power systems for public buildings, possibly using existing standards for emergency and standby power systems as a resource.	State Office of Energy Policy, Office of Permit Management
Policies and data	Study Whether Externalizing PRIDCO Would Improve Its Ability to Support Economic Development (PBD 6)	Commission an independent analysis by a third party of whether externalizing PRIDCO (i.e., converting it into a nongovernmental entity) would improve or reduce its ability to support economic development through the private sector real estate market.	Independent research partner
Policies and data	Compile a Public Buildings Inventory (PBD 1)	Create a comprehensive, centralized database of buildings owned by the government of Puerto Rico that includes building characteristics, which will allow analysis of emergency response needs and general operational decisionmaking.	Puerto Rico Planning Board, Puerto Rico Infrastructure Financing Authority

NOTE: *The index numbers assigned to the COAs are arbitrary: they are the numbers used in the recovery plan, and we have retained them here for consistency.

The Path Forward

Implementing the public building COAs will be a challenge for the government of Puerto Rico, requiring a variety of stakeholders to coordinate efforts on limited budgets. In addition to internal coordination among the public building COAs, implementation of some COAs will require coordination with other sectors, such as Education, Health and Social Services, Municipalities, and Transportation. Efforts are underway to organize forums and sessions to discuss implementation plans with local leaders.

Assigning implementation responsibility for individual COAs is an important first step. Each COA lists agencies or organizations that the government of Puerto Rico identified as potentially implementing the COA. Implementers should begin by creating realistic timing and funding plans, identifying prerequisites and funding sources. Finally, an oversight process should be established to ensure COA/infrastructure owners are making progress on specific implementation plans, that they are coordinating as appropriate with other COA implementers within and among sectors, and that they have access to assistance if needed.

Even with these COAs, public building owners in Puerto Rico will continue to face serious challenges. Overcoming debt-related issues will require long-run economic stability paired with prudent public spending decisions. Services delivered by the government organizations located within public buildings are key parts of a functioning polity, so investments in these facilities is an important part of support for recovery.

Acknowledgments

We acknowledge the steadfast support and encouragement of our project sponsor Michael Byrne, FEMA's Acting Caribbean Area Division Director and the federal coordinating officer and federal disaster recovery coordinator for Hurricane Irma and Maria response and recovery in Puerto Rico. From Puerto Rico, we are particularly grateful for the inputs of Omar Marrero Diaz and Laura Femenias Jove, the director and associate director of the Central Office for Recovery, Reconstruction, and Resilience.

Our sector analysis relied on the collaboration and support of many other experts from FEMA and other federal agencies. We greatly appreciate the support of Patrick Briggs, Danna Planas Ocasio, and the rest of FEMA's Public Buildings Sector team for providing data central to this analysis as well as valuable input and feedback on the damage assessment and courses of action. We also thank Johann Sasso of the U.S. Army Corps of Engineers and the Infrastructure Recovery Support Function field director, who contributed damage assessment data.

This work was strengthened by contributions from Juan Alicea of the Puerto Rico Public Buildings Authority; Jorge Morales of the Puerto Rico Industrial Development Company; Eduardo Rivera Cruz, Leonardo Torres, and José Basora Fagundo of the Puerto Rico Infrastructure Financing Authority; and Lisa Escobales Jimenez and Santos Guzman Santiago of the Puerto Rico National Guard, who provided data that improved our understanding of the local context, helped us access data that made the damage and needs assessments as complete as possible, and helped us identify appropriate recovery actions.

We also thank Mike Flood and his team at WSP for their support in providing data, guidelines, best practices, and general building industry subject matter expertise that supported the development of the courses of action.

The authors of this report were part of a much larger project team, and the analysis contained here benefited from data collected by other sectors and by other participants on the project. Principal among these were Andrew Lauland, Terry Marsh, Michael Kennedy, Cynthia Cook, Justin Hodiak, and Lara Schmidt.

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Abbreviations

COA	course of action
CSI	Centro de Servicios Integrados (Integrated Service Centers)
DTOP	Department of Transportation and Public Works
ESPC	Energy Savings Performance Contracts
FEMA	Federal Emergency Management Agency
FTE	full-time equivalent
HSOAC	Homeland Security Operational Analysis Center
NFPA	National Fire Protection Association
OGPe	Puerto Rico Office of Permit Management
PA	public assistance
PBA	Puerto Rico Public Buildings Authority
PBD	public buildings (for COA coding)
PR	Puerto Rico
PRIDCO	Puerto Rico Industrial Development Company
PRIFA	Puerto Rico Infrastructure Financing Authority
USACE	U.S. Army Corps of Engineers

1. Introduction

On September 19 and 20, 2017, Hurricane Maria caused widespread destruction across the U.S. Commonwealth of Puerto Rico. Making landfall just two weeks after Hurricane Irma, Maria—a strong Category 4 storm—significantly damaged local infrastructure and interrupted the provision of essential and nonessential services to the people of Puerto Rico. A supplemental appropriations bill, passed by Congress on February 8, 2018, required the Governor of Puerto Rico, in coordination with the Federal Emergency Management Agency (FEMA), the Department of Treasury, the Department of Energy, and other federal agencies with responsibilities under the National Disaster Recovery Framework, to submit a report to Congress (within 180 days of enactment of the legislation) that describes Puerto Rico's 12- and 24-month Economic and Disaster Recovery Plan.

The government of Puerto Rico's recovery plan[1] was published in August 2018 and lays out the priorities, goals, and expected outcomes of the recovery effort in Puerto Rico. The plan implements FEMA's Public Assistance (PA) Alternative Procedures (Section 428), which authorizes the recovery efforts to include alternatives to strictly repairing damage from the storms, allowing Puerto Rico to "build back better." An overarching goal of the recovery plan is to mitigate vulnerabilities to future disasters and increase community resilience. The recovery plan is intended to provide Puerto Rico a path toward economic sustainability, growth, and resilience as it reconstructs and recovers from the impact of Hurricanes Irma and Maria.

FEMA asked the Homeland Security Operational Analysis Center (HSOAC) to provide analytical support to the government of Puerto Rico in its formulation of the recovery plan. This report summarizes the information gathering and analysis that HSOAC conducted to support the public building sector part of the recovery plan. The data and other findings presented in this report were generally collected between October 2017 and July 2018; the most current date differs among the findings. To support federal agencies evaluating and funding recovery actions, HSOAC is releasing this detailed volume for the public building area. The purpose of this document is to provide decisionmakers greater detail on the conditions in Puerto Rico prior to the 2017 hurricane season, damage from Hurricanes Irma and Maria, and courses of action (COAs) that were identified to help the sector (and, more broadly, Puerto Rico) recover in a resilient manner.[2]

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[1] Central Office for Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan, P.R.: Central Office for Recovery, Reconstruction, and Resiliency, Government of Puerto Rico, August 8, 2018.

[2] 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.

The remainder of this report is organized into four chapters. Chapter 2 describes how public buildings are characterized and provides some historical context. Chapter 3 presents an assessment of the damage to public buildings stemming from the 2017 hurricanes. Chapter 4 describes the COAs identified for recovery and describes the way forward.

2. Public Buildings in Puerto Rico

Puerto Rico's public buildings house the multitude of operations conducted by the government. They are workspaces for government employees, bases of operation for services that operate in the field, and places where the public engages with government services. They are the physical face of the government, from municipal town halls and schools to the capitol building ("el capitolio") in Old San Juan.

The assemblage of public buildings intersects with the entire array of government services, such as emergency services, education, public health, the judicial system, National Guard, tax collection, and the State Department. Public buildings in Puerto Rico also house nongovernment services: one of the largest building owners in the government, the Puerto Rico Industrial Development Company (PRIDCO), leases most of its buildings to private sector companies to support economic development. At the same time some government services are housed in buildings leased from the private sector.

The relationship between public buildings and government functions in Puerto Rico is not always straightforward. While in some cases the government agency that performs a particular function is also responsible for the buildings that house that function, in other cases responsibility for buildings falls under an agency other than the one using them. For example, hundreds of public schools and health care facilities are owned and operated by the Puerto Rico Public Buildings Authority (PBA) and other agencies. Further, recovery planning for public buildings under the responsibility of some agencies is being handled through efforts associated with other sectors. These include the Departments of Education, Health, and Transportation and Public Works; the Puerto Rico Electric Power Authority; and the federal and municipal governments. This fragmentation makes it difficult to clearly define "public buildings" for the recovery process and complicates efforts to collect data on building conditions and needs and to develop recovery plans.

For the purposes of long-term recovery, it is useful to think about public buildings both in terms of legal responsibility and function. A long-term planner is concerned with the provision of services that public buildings support and, for this reason, cares about the number and location of schools, fire stations, judicial buildings, and other buildings that support the provision of public services, regardless of who owns the building housing that service. At the same time, undertaking recovery of the buildings that support these systems requires the involvement of the entities that have the authority and responsibility for the buildings themselves. This report therefore presents results from both perspectives. Some data are presented in terms of building owner or legal operator, while others are presented in terms of building function. This dual approach makes it possible to understand damage and recovery from both perspectives.

The scope of public buildings for the purposes of long-term recovery planning is summarized in Figure 2.1 and includes state police and fire stations, publicly owned hospitals, libraries, National Guard facilities, judiciary buildings, government offices, prisons, archives, recreation centers, government-owned buildings leased by the private sector, and public schools. As noted above, recovery planning for some types of public buildings and facilities are being managed through other efforts and are described in other reports being published as part of this series.[1] In the case of hospitals, the Health and Social Services Sector considers the provision of services, whereas the Public Buildings Sector considers issues surrounding the physical building infrastructure. In those cases, the sectors are working together to ensure that the plans for the physical building support the plans for the service.

Figure 2.1. Building Classification

NOTE: This figure appears in the 2018 congressionally mandated recovery plan for Puerto Rico: Central Office for Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, San Juan, P.R.: Central Office for Recovery, Reconstruction, and Resiliency, Government of Puerto Rico, August 8, 2018.

Structure and Key Assets

While the agency that owns and operates a building usually tends to be responsible for the service provided in the building, in some cases, the building owner has no association with the organization occupying the building. For example, two of the largest public building owners in Puerto Rico, PBA and PRIDCO, act only as building owners; activities in the buildings are operated by other government agencies or private business tenants. In another example, school buildings are owned by at least three different agencies: The Office for the Improvement of Public Schools of Puerto Rico, PBA, and the Department of Transportation and Public Works

[1] Links to other reports being published as part of this series can be found at www.rand.org/hsoac/puerto-rico-recovery.

(DTOP). Disentangling which agencies own specific buildings is complex, and a clear inventory of public buildings and owners in Puerto Rico is difficult to compile. One source of information on agencies that own public buildings is requests to FEMA for PA funding. PA applications are filed by the entity with the legal responsibility for the property. As of July 2018, 43 applicants for PA funding were assigned to the public building sector (see Table 2.1). Details of these applications are discussed further below.

Table 2.1. Public Assistance Applicants in Public Building Sector

911 System Government Board	PR Convention Center
Admin de Compansaciones por Accidentes de Auto	PR Department of Consumer Affairs/DACO
Administration of Corrections & Rehabilitation	PR Department of Labor
Centro de Recaudaciones de Ingresos Municipales	PR Fire Department
Comision Industrial de Puerto Rico	PR Horse Racing Sports Industry Administration
Cooperative Development Commission of PR	PR Land Administration
Corp. Projecto Enlace Cano Martin Pena	PR Land Authority
Corporation for Supervision and Insurance of Cooperatives of PR	PR National Guard
Department of Economic Development and Commerce	PR Police Department
Department of Treasury	PR Public Broadcast Corp.
Economic Development Bank for Puerto Rico	PR Retirement and Adjudication System
Ethics Government Office	PR State Department
General Services Administration	PR State Emergency Management Agency
Labor Relations Board of Puerto Rico	PRIDCO
Metro	Public Building Authority
Office for Socioeconomic and Community Development	Public Diffusion Corporation PR
Office of Management and Budget	Public Service Commission
Office of the Election Comptroller	Regulatory Board of Telecommunications
Office of the Governor	Solid Waste Authority
Office/Commissioner for Financial Institutions	State Insurance Corporation Funds
Parole Board	Trade and Exports Company
PR Human Resources Administration and Transformation Office	

Because inventories of public buildings are maintained by owners rather than users and inventories are not available from every owner, it is difficult to ensure an inventory list for any given type of public building is complete. For this reason, HSOAC focused on obtaining inventory and damage information from the largest owners of public buildings. In a few cases, HSOAC was able to compile numbers and locations of buildings from multiple sources. PBA and PRIDCO provided inventories of their properties as part of their damage assessments. Utilizing various sources, HSOAC was also able to ascertain numbers of buildings for a subset of building uses. Numbers of buildings by owner or building purpose are listed in Table 2.2. Data on the numbers of buildings for most of the applicants listed in 2.1 are not available.

Table 2.2. Numbers of Public Buildings by Selected Owners and Building Purposes

Owner or Purpose	Number of Buildings[a]	Source
PBA	735	PBA PA request to FEMA
PRIDCO	778	PRIDCO PA request to FEMA
Schools	1131	USACE[b] damage assessment
State police stations	196	USACE[b] damage assessment
State fire stations	95	FEMA Caribbean Area Division, compiled by FEMA Public Buildings Sector team
Emergency operations centers	82	Hazus,[c] compiled by FEMA Public Buildings Sector team

NOTES: [a] Numbers are not additive because PBA buildings are also included in other categories.
[b] U.S. Army Corps of Engineers.
[c] Federal Emergency Management Agency, 2018a.

Data Sources and Methods

Table 2.3 provides an overview of the data HSOAC obtained by July 2018 on damage to public buildings from Hurricanes Irma and Maria. As of that date, some building owners or tenants were still completing damage assessments or applications for PA, meaning further information will continue becoming available over the course of months or years. Few reliable sources of data are available to provide insight into inventories—and the extent—of damage to public buildings. HSOAC also pursued and acquired data derived from National Aeronautics and Space Administration satellite imagery and Google Maps but ultimately found those sources were not well suited for the purpose of recovery planning.

Thus, to conduct the analysis, HSOAC relied heavily on the preliminary damage data from PRIDCO and PBA. PRIDCO and PBA represent the largest stakeholders in the public building sector, and their combined inventory of buildings represents approximately half of the total buildings in the sector. Damage assessments were completed most quickly by the larger entities, such as PRIDCO and PBA; for this reason, much of the analysis we describe in the following chapters is based on those damage assessments. Analysis of these data, in addition to meetings with representatives from FEMA, government of Puerto Rico agencies, and other stakeholders and subject matter experts, provide the basis for the damage assessments included in this report.

Table 2.3. Summary of Data Sources for Public Buildings

Dataset	Source	Date	Notes
Inventories of public buildings by owner and by building function	PBA; PRIDCO; DTOP; USACE	March–May 2018	
Preliminary damage assessment reports for police stations	USACE	October–November 2017	Brief qualitative descriptions of damage
Preliminary damage assessment reports for schools	USACE	October–November 2017	Brief qualitative descriptions of damage
Damage assessment reports for fire stations	FEMA	As of May 2018	Brief qualitative descriptions of damage with cost estimates
Damage assessment reports for corrections facilities	FEMA	As of May 2018	Brief qualitative descriptions of damage with cost estimates
Damage assessment report for PRIDCO	PRIDCO	As of March 2018	Cost estimates distinguished by damage type
Damage assessment report for PBA	PBA	As of March 2018	Cost estimates distinguished by FEMA PA category
PA funding requests	FEMA	As of July 2018	Amounts incomplete

One of the key data gaps is the lack of a comprehensive inventory of public buildings by owner and building function. Given the complex and fragmented ownership conditions in Puerto Rico, it would be helpful to identify the total population of buildings to contextualize the extent of damage. For example, an inventory of state police stations from FEMA includes 163 records, whereas the USACE police station damage assessment report includes 196 records. We were able to match only 144 of these records in both databases, indicating that both databases contain records not included in the other. Such inconsistencies make it difficult to understand the extent of damage to a particular building type. HSOAC was informed during discussions with government of Puerto Rico agency representatives that incomplete record keeping for government real estate inventory is a known challenge in Puerto Rico, and no comprehensive inventory appears to exist. Improving the record keeping of government real estate, a task that may require specific procedural or policy changes, is an important action for the long-term recovery of this sector. However, in the short term, as noted above, the best way to use available data to assess the extent of damage to public buildings is to focus on obtaining inventory and damage information from the largest owners of public buildings.

Another important data gap is that of the damage itself. Although we obtained damage assessment reports from two of the largest public building-owning agencies and for a few building systems (schools, police stations, fire stations, corrections facilities), the quality of these assessments varies and except for the amount of PA requests, no data are available for several building owners and systems. Further, the format and level of detail of the data HSOAC has

obtained vary considerably, and their accuracy or interagency consistency could not feasibly be ascertained.

The extent of functional impairment of buildings would also have been very helpful in characterizing the impacts from the hurricanes on the public building sector. This information is often impossible to determine from a damage assessment report. Such data would help characterize the extent to which access to key services is limited or unavailable as well as to determine whether a structure can be repaired or must be demolished.

Pre-Storm Conditions

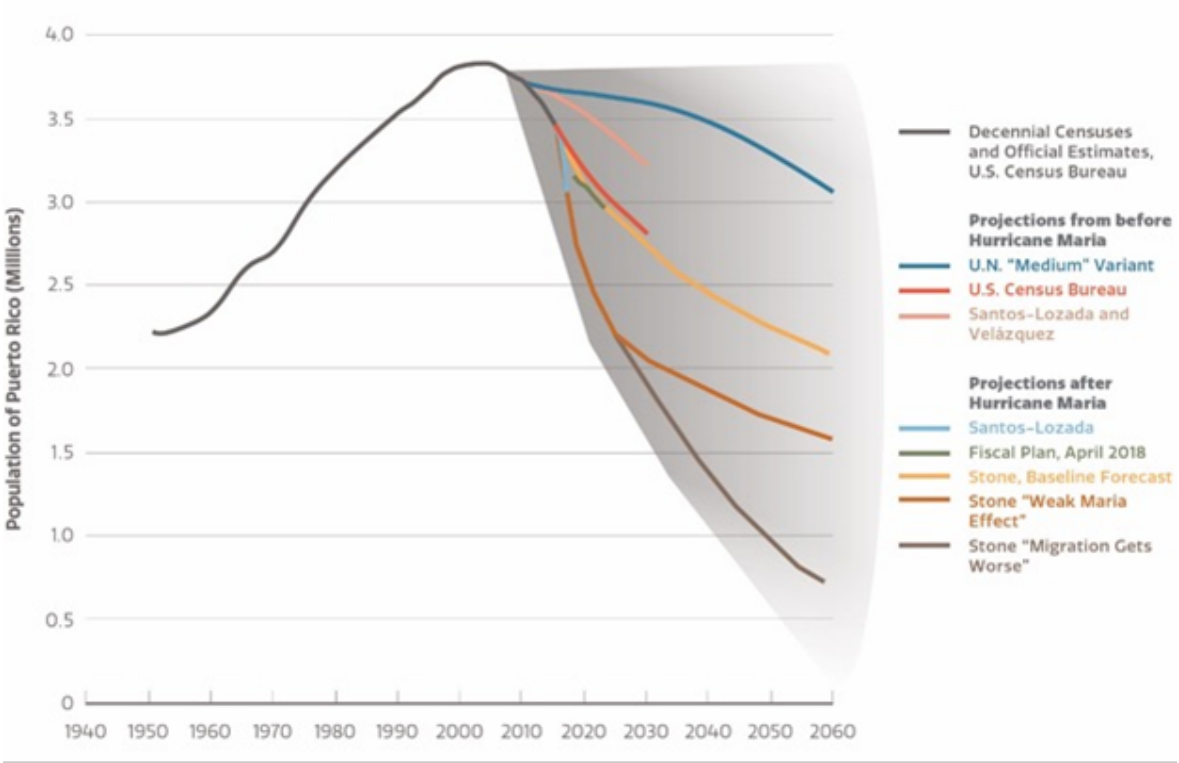
Financial Situation

Along with other sectors, Puerto Rico's public buildings have been negatively impacted by the interdependent effects of a struggling economy and a decreasing population. As shown in Figure 2.2, Puerto Rico's population reached a maximum of roughly 3.8 million people shortly after the year 2000 and has been steadily declining since. It is important to emphasize that this decline in population began before Hurricanes Irma and Maria, although the storms may have exacerbated the exodus. Regardless of the cause, a variety of different population projections suggest that Puerto Rico's population will continue to decline, meaning the demand for many public services will likely decline as well.

This population decline has been challenging in part because the decline is driven by a loss of current and future workers, and these workers are the tax base that provides revenue to finance the Puerto Rico's government, including public buildings. Puerto Rico's unemployment rate has long been highlighted as high compared with that of the mainland United States, although the percent of unemployed members of the labor force has been declining over the decades from approximately 20 percent unemployment in the late 1970s to approximately 10 percent unemployment today. However, the core story becomes clearer when looking at the sheer number of employed and unemployed labor force participants. According to data from the Bureau of Labor Statistics (shown in Figure 2.3), the number of unemployed labor force participants in Puerto Rico has remained largely unchanged for decades. The decline in the unemployment rate was due to a steady increase in the number of employed individuals, providing a growing income tax base for the government of Puerto Rico. However, the Great Recession in the late 2000s was particularly tough on Puerto Rico's economy. The number of employed individuals declined steeply, but it is not matched by an increase in the number of unemployed individuals. This indicates that these individuals exited the island, exited the labor force, or both. Given the decline in Puerto Rico's population at this time, it seems likely that the out-migrants were much more likely to have been previously employed (and tax-paying) residents of Puerto Rico. The outlook for recruiting future workers seems challenging because,

as Figure 2.4 shows, Puerto Rico's population of future workers (those currently under 18) has declined even more rapidly than its population of current workers.

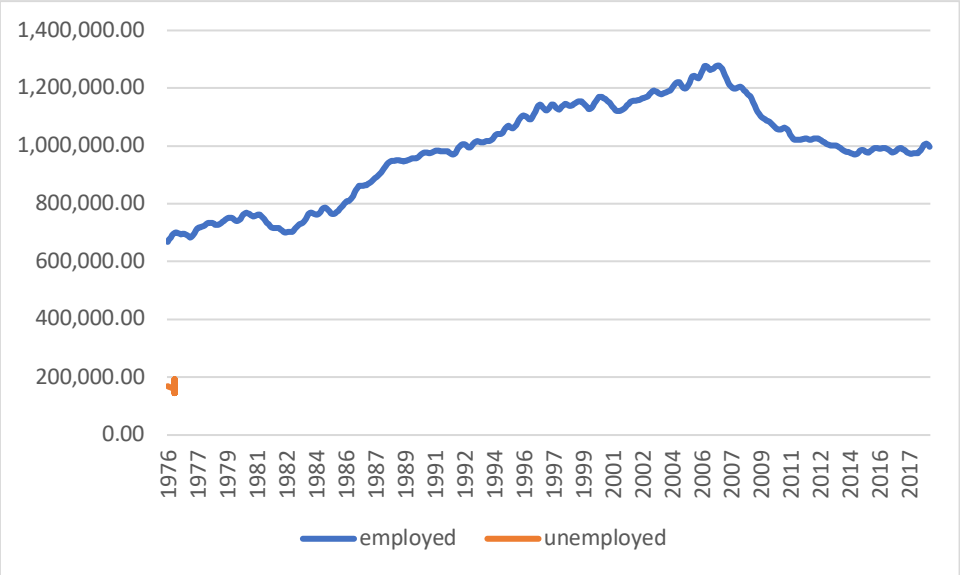
Figure 2.2. Historical and Projected Populations of Puerto Rico, 1950–2060



SOURCES: U.S. Census Bureau, 2018; U.N. Population Division, 2017; Fiscal Agency and Financial Advisory Authority, 2018b; A.R. Santos-Lozada and A.L. Velázquez-Estrada, *The Population Decline of Puerto Rico: An Application of Prospective Trends in Cohort-Component Projections*, San Juan, P.R.: Instituto de Estadísticas de Puerto Rico, Working Paper Series Vol. 2015–1, November 2015; Lyman Stone, "How Low Will Puerto Rico's Population Go?" *In a State of Migration—Medium*, November 17, 2017.

Population dynamics have restricted government revenue, resulting in government expenditures consistently outpacing revenues. In addition, the GAO has noted that, from 2002 to 2014, "Puerto Rico's agencies regularly spent more than the amounts Puerto Rico's legislature appropriated for a given fiscal year" (GAO, 2018). The tendency for public expenses to exceed public revenues led to an increasing deficit, as shown in Figure 2.5, and a decline in PR's credit rating.

Figure 2.3. Labor Force in Puerto Rico



SOURCE: HSOAC analysis of Bureau of Labor Statistics data.

Sensing troubled waters, financial firms began pulling out of Puerto Rico's bond market as early as 2012 (Amoroso, 2019). In December 2015, Puerto Rico acknowledged that it would default on portions of its debt. Specifically, Puerto Rico defaulted on "a $35.9 million payment on the Puerto Rico Infrastructure Financing Authority (PRIFA), and a $1.4 million payment on the Puerto Rico Public Finance Corporation (PRPFC)," meaning Puerto Rico failed to meet a scheduled payment that was due to the investors in those agencies' bonds (Giel, 2015). PRIFA was formed in 1988 to "issue bonds and provide loans, grants and other financial assistance for the construction, acquisition, repair, maintenance and reconstruction of infrastructure projects by [public entities],"[2] and PRPFC was founded in 1984 to issue bonds to fund various government of Puerto Rico agencies. Rum taxes are the intended source of funds to pay the PRIFA bonds. Those revenues would have been insufficient to cover the payments, and the government of Puerto Rico declared it would use those revenues to finance essential services instead of paying the PRIFA debt.[3] PRIFA has now defaulted several times, most recently in the summer of 2018.[4] As a result of these defaults, PRIFA's bonds have been degraded to the lowest possible ratings

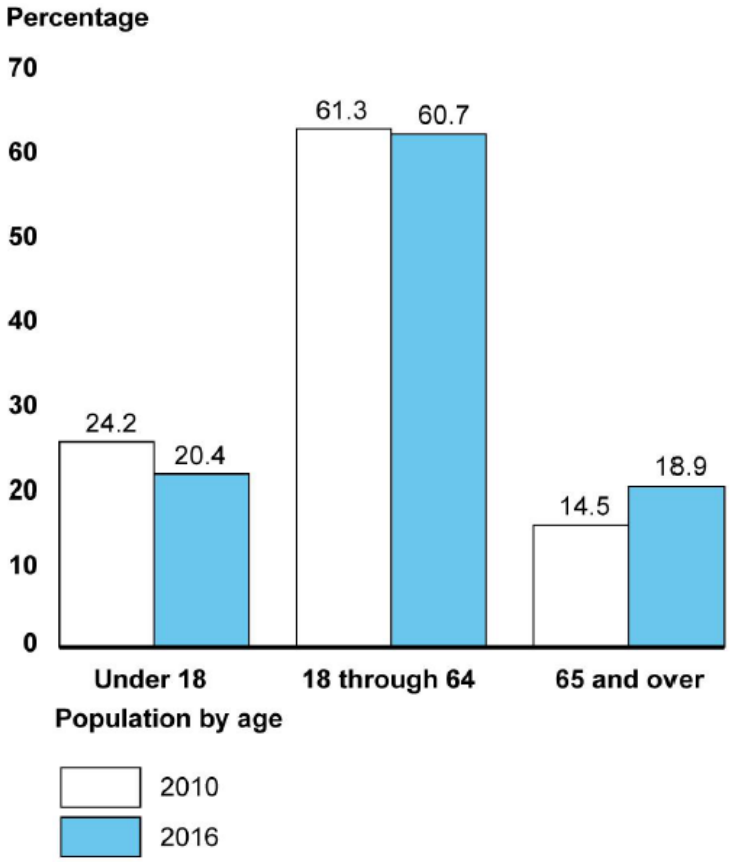
[2] Government Development Bank for Puerto Rico, "Puerto Rico Infrastructure Financing Authority (PRIFA)," website, undated-a.

[3] Sowjan Sivaloganathan and Michelle Kaske, "Puerto Rico Faces Record Default: A Look at the Bonds Due," *Bloomberg*, June 30, 2016.

[4] Eva Lloréns Vélez, "Puerto Rico Infrastructure Financing Authority Announces It Will Default," *Caribbean Business*, June 29. 2018.

by Moody's (C) and Standard & Poor's (D).[5] This action has made PRIFA's bonds essentially worthless, as shown in Figure 2.6. Following these defaults, PRIFA will likely find it very difficult to borrow additional funds at affordable interest rates because potential lenders would likely be extremely skeptical of PRIFA's ability to repay.

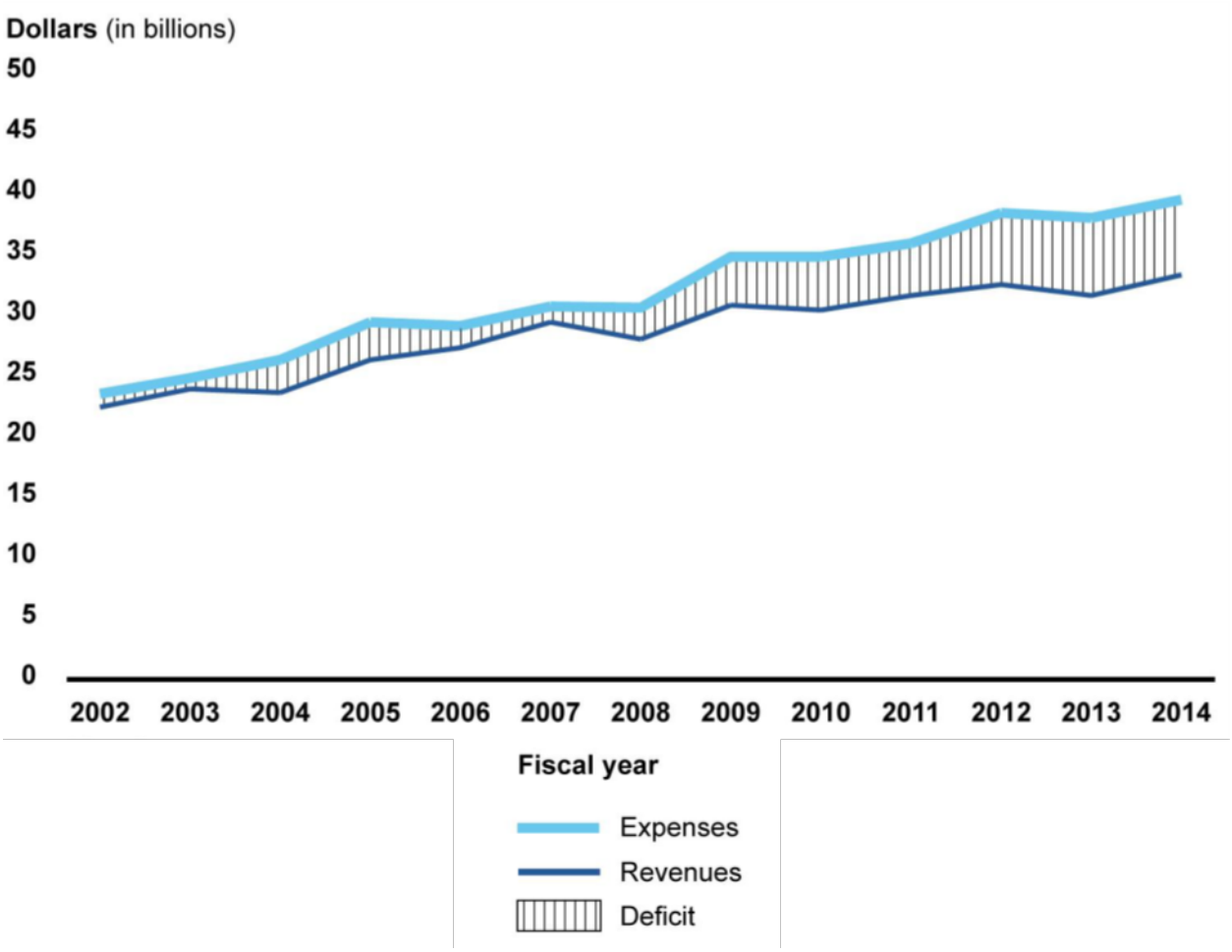
Figure 2.4. Puerto Rico's Population by Age Group, 2010 Versus 2016



SOURCE: GAO analysis of U.S. Census Bureau information; Government Accountability Office, *Puerto Rico: Factors Contributing to the Debt Crisis and Potential Federal Actions to Address Them*, Washington, D.C.: U.S. Government Accountability Office, GAO 18–387, May 2018.

[5] Government Development Bank for Puerto Rico, "Puerto Rico Infrastructure Financing Authority (PRIFA): A GDB Affiliate," website, undated-b.

Figure 2.5. Puerto Rico's Government Revenue and Expenses, Fiscal Years 2002 to 2014



SOURCE: GAO analysis of Puerto Rico's fiscal years 2002 to 2014 audited financial statements (GAO, 2018).

PBA faced similar default risk in 2016, although PBA debts were expected to "be mostly covered by reserve funds held by the trustee bank."[6] In theory, PBA's bonds "are repaid with rents that public agencies pay for their office buildings";[7] however, many of these buildings continue to have significant vacancies. Further, in December 2018, the Puerto Rico Oversight Board sued PBA to block PBA's collection of over $400 million in rent, threatening to cut off the revenue stream that PBA uses to pay off its debts.[8] This lawsuit further complicates bankruptcy proceedings that had been filed in November 2017, which had similarly reduced the

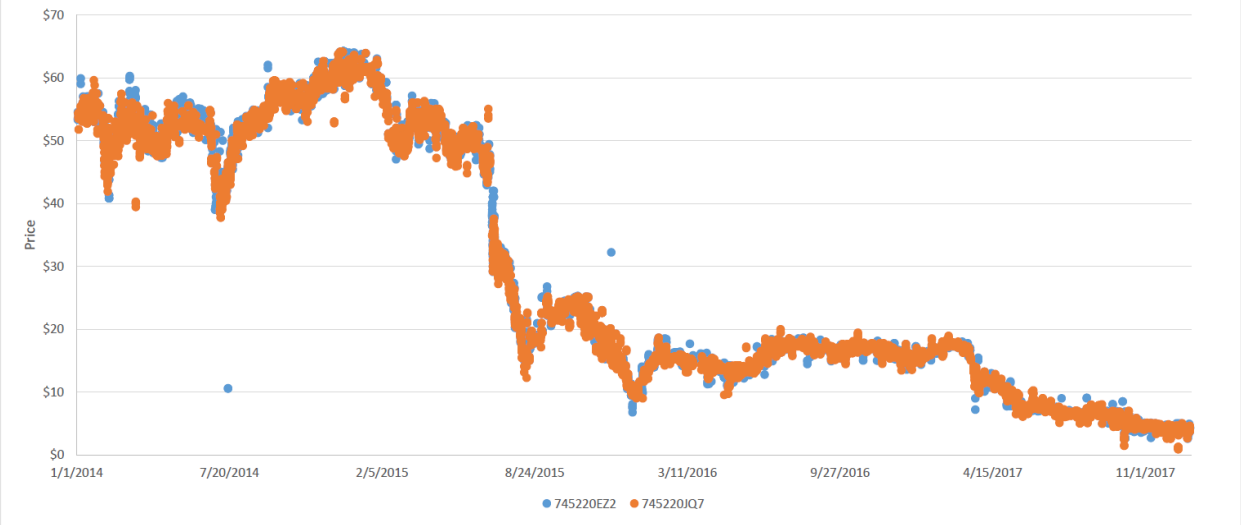
[6] Nick Brown, "Puerto Rico Says Will Default on $779 Million of Senior Debt," *Reuters*, July 1, 2016.

[7] Robert Slavin, "Puerto Rico Oversight Board Seeks to End Rent Revenues for PBA Bonds," *The Bond Buyer*, December 26, 2018.

[8] Joanisabel González, "The Oversight Board Sues Public Buildings," *El Nuevodia*, December 20, 2018; Slavin (2018).

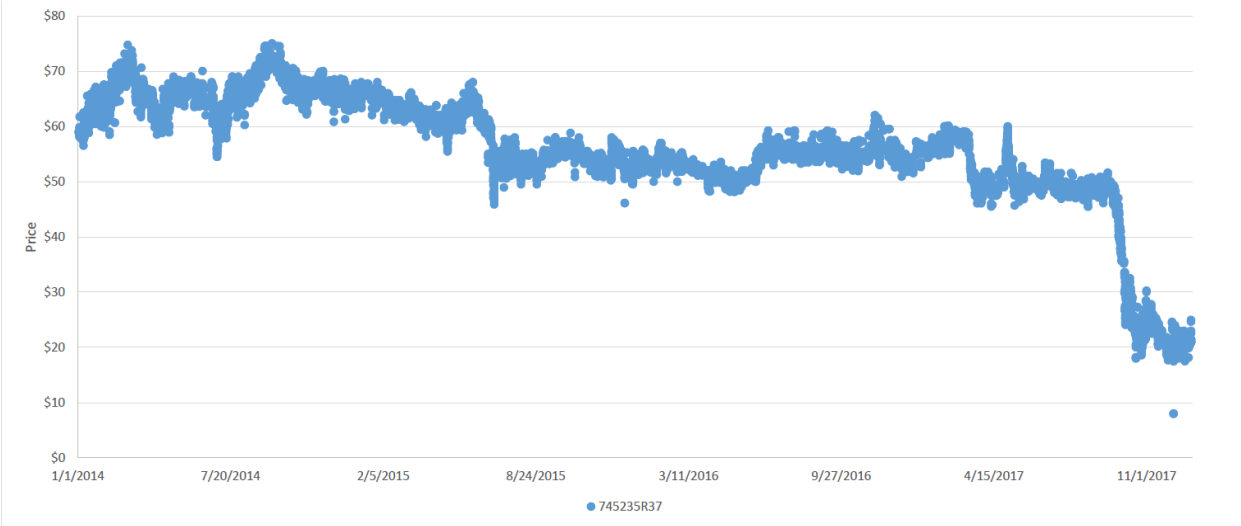
value of PBA's bond issuance due to concerns about default, as shown in Figure 2.7. The recent threat to cut off the funding source that pays these bonds likely decreased the bond value even further. Like PRIFA, PBA will likely find it very difficult to borrow additional funding from bond markets because lenders will be skeptical of PBA's ability to repay.

Figure 2.6. Puerto Rico Infrastructure Financing Authority Bond Prices



SOURCE: Municipal Securities Rulemaking Board, "Puerto Rico Bond Trading and Outstanding Debt," December 2017.

Figure 2.7. Puerto Rico Public Buildings Authority Bond Prices



SOURCE: MSRB (2017).

Many of Puerto Rico's public buildings are the collateral for these public bonds, similar to a house serving as collateral on a mortgage. This means the government cannot sell off excess public buildings unless it pays off or transfers the bond debt on those buildings. However, the value of these public buildings is now less than the remaining debt (i.e., they are "underwater"). Puerto Rico also cannot similarly rent vacant space in excess buildings to the private sector, because the bonds require that the buildings be used primarily for public purposes.[9]

The key takeaway from this financial situation, which predated Hurricanes Irma and Maria, is that Puerto Rico's public building agencies have insufficient funding to address standard operation and maintenance costs, much less storm damage. Borrowing additional funds has become essentially impossible for these agencies because their current debt obligations have not been reliably met.

Condition of Buildings

Assessing the condition of public buildings prior to the hurricanes has been affected by several challenges, some of which have been discussed above. First, fragmentation and confusion over building ownership has made it difficult to track and ascertain basic information about public buildings. We were told by government agency representatives from Puerto Rico that, when agencies first started experiencing financial hardships, they responded by leasing their buildings to other agencies. These leases were not recorded carefully, so the identities of the actual owners quickly became confusing. According to the January 2018 draft, New Fiscal Plan for Puerto Rico (Government of Puerto Rico, 2018a), "To date, with very few exceptions, the Government lacks a clear understanding of the number, type, location, legal status, and condition of the real estate assets it owns." While this statement does not appear in the version of the fiscal plan submitted to the Financial Oversight and Management Board (Government of Puerto Rico, 2018b), it reflects a general consensus among government of Puerto Rico representatives.

Another issue has been the substantial amount of underoccupied excess building inventory, likely a result of economic recession and declining population. In response, various initiatives to consolidate and right-size buildings have been proposed, including the School Modernization Program (Puerto Rico Public-Private Partnerships Authority, undated). This program, originally launched in 2010, was designed to respond to declining enrollment and poor conditions in Puerto Rico's schools. It was initially funded by the American Recovery and Reinvestment Act of 2009 and envisioned as a plan to renovate or reconstruct 81 of Puerto Rico's approximately

[9] Tax-exempt bonds are a common method used by state and local governments to finance major infrastructure projects. Investors in these types of bonds do not need to pay federal taxes on earned interest, meaning that investors are willing to lend to state and local governments at a lower interest rate. The federal government forgoes tax revenue—implicitly subsidizing the project—on the condition that the constructed infrastructure is mostly used for public, rather than private, purposes.

1,500 schools. Since that time, declining enrollment has led to the closure of hundreds of schools and further consolidation.

Another initiative, approved prior to the hurricanes, is to consolidate multiple government services into integrated service centers, but little information is available about the Centros de Servicios Integrados initiative (Governor of Puerto Rico, 2016; Plan Para Puerto Rico, 2016). Informal communication with the PBA and FEMA's Public Buildings Sector team indicates that the proposal includes plans to create about 30 integrated service centers throughout Puerto Rico. Centers will include services spanning insurance, business filings, police, motor vehicles, vital records, family services, and more (Government of Puerto Rico, 2016). Choosing where to house these centers and their implications for building demand and occupancy remains to be finalized.

Another major chronic issue affecting public buildings has been insufficient maintenance, most likely a result of insufficient funding and staffing to make repairs. While good documentation of the conditions of public buildings prior to the hurricanes was not available, evidence gleaned from FEMA PA applications and other sources suggests that poor maintenance was a central problem impacting building functionality. For example, lack of proper school maintenance has "led to the use of improvised maintenance services, the continued implementation of emergency repairs, and the loss of a significant amount of school days" (Puerto Rico Public-Private Partnerships Authority, undated).

3. Description of Damage

This section describes the damage to public buildings from Hurricanes Irma and Maria in 2017. In light of the challenges described above in the *Data Sources and Methods* section, we emphasize that these results vary in detail, reliability, and internal consistency and will require further verification prior to implementation of recovery activities.

Summary of Key Impacts

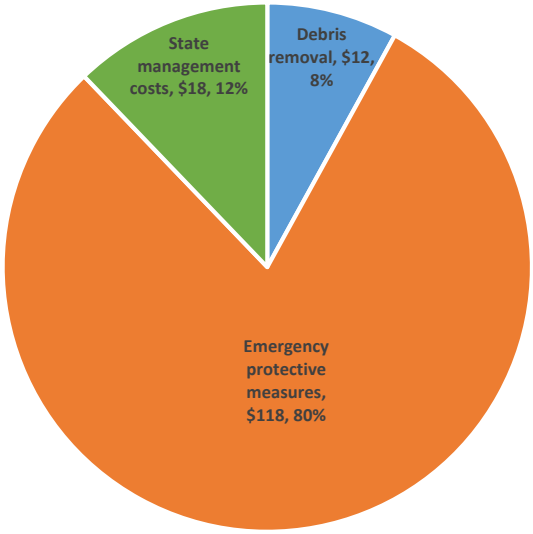
An important source of damage data is FEMA PA applications. As of July 2018, $148 million of federal funds had been obligated to 39 applicants via 115 applications (Figure 3.1). Ninety-six of the funded applications were for emergency protective measures (category B), 18 were for debris removal (category A), and one was for state management costs (category Z).[1] Emergency protective services included the provision of support for response and security after the hurricanes. Disbursements thus far have been as follows: $39 million in emergency protective measures and $18 million in state management costs went to the State Emergency Management Agency, most of which supports emergency responders from other states through Emergency Management Assistance Compacts; $37 million in emergency protective measures and $3 million in debris removal went to the PR National Guard; and $28 million in emergency protective measures went to the PR Police Department. The amount of federal spending will continue to grow as additional PA applications are submitted and processed.

In addition to the obligated funds, based on PA application data as of July 2018, $624 million had been requested in approximately 10,000 outstanding requests from 38 applicants (Figure 3.2). Approximately 90 percent of these applications were for permanent repair work to public buildings and contents (PA category E). Of the remaining requests, 676 were uncategorized requests from the National Guard, of which most are associated with emergency protective services provided by the Puerto Rico National Guard (personal communication with the Puerto Rico National Guard, June 7, 2018). Two hundred twelve requests were for other emergency protective measures (category B), 80 were for debris removal (category A), and 33 were for other purposes (categories B&E, C, F, G, and uncategorized). This total value of $624 million does not necessarily reflect the total cost of outstanding damage, as damage assessments and applications for PA were ongoing. Over 1,500 of the approximately 10,0000 applications still

[1] A definition of FEMA Public Assistance categories can be found at Federal Emergency Management Agency, "Public Assistance," fact sheet, 2018b.

had blank, “unknown,” or $0 listed as the approximate cost, and additional claims were continuing to be submitted.

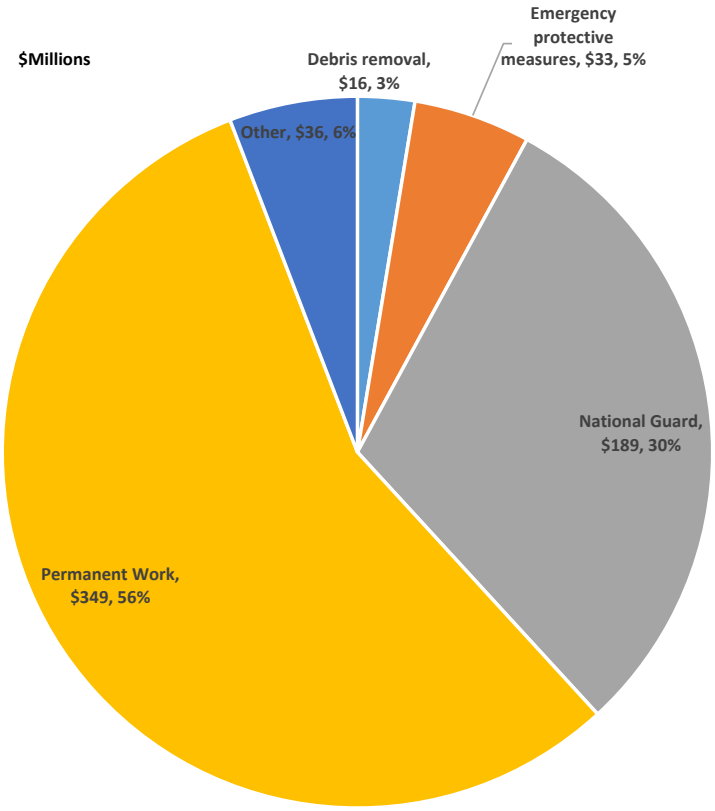
Figure 3.1. Federal Share of Obligated Public Assistance Funds for Public Buildings as of July 2018, by FEMA PA Service Category



As noted above, 43 different agencies with a stake in public buildings have thus far been identified, although not all had received obligated funding or submitted PA applications as of July 2018. Each stakeholder is responsible for their own assessment, and as of July 2018, stakeholders were at different stages in terms of completing damage reports. How much data each of these stakeholders has remains unknown. As a result, no uniform time line exists for completing damage assessments across the sector.

While a comprehensive inspection-based damage assessment is not available for the entire sector, we have been able to compile those assessments that are available. This information includes data by both building owner and building type. Given the complex building ownership situation, these data likely overlap (that is, some damage may appear both in owner data and building type data), but the extent of overlap is unknown.

Figure 3.2. Outstanding Public Assistance Requests for Public Buildings, by FEMA PA Service Category



SOURCE: HSOAC calculations based on PA claims data as of July 19, 2018.

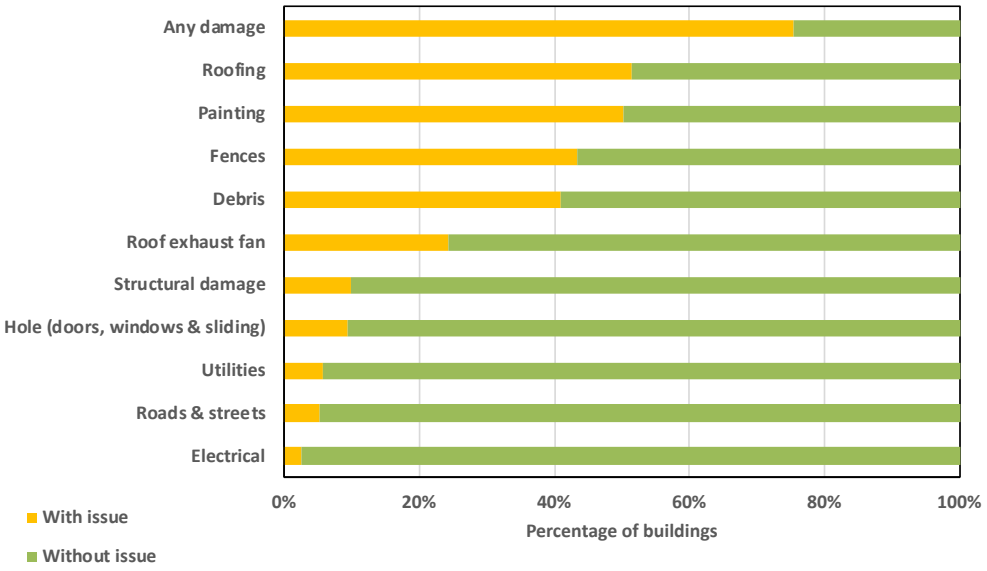
Damage, by Building Owner

As of July 2018, HSOAC had preliminary damage data from PRIDCO and PBA through their FEMA PA applications. PRIDCO and PBA represent the largest stakeholders in the public building sector, and we believe that their combined inventory of buildings (approximately 1,500) represents a large percentage of the sector.

PRIDCO Buildings

PRIDCO owns 778 buildings, 586 (75 percent) of which were reported as damaged. Damage assessments were conducted by lessees rather than PRIDCO, and assessment approaches and scopes were not standardized. Frequencies of different types of damage are shown in Figure 3.3. Damage to roofing, paint, and fencing and the need for debris removal are the most common types reported.

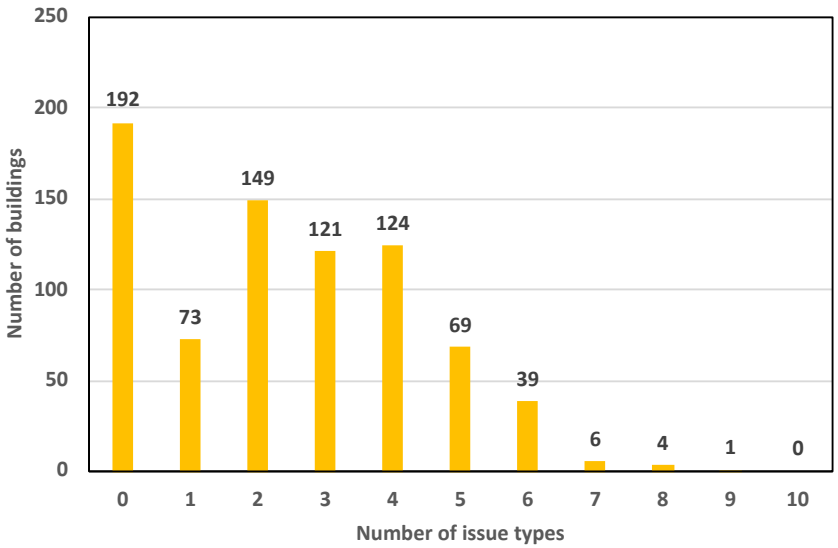
Figure 3.3. Percentage of PRIDCO Buildings with Various Types of Damage



SOURCE: HSOAC calculations based on PRIDCO data from March 2018.

Another way to view these data is in terms of the number of damage issues recorded for each building. Figure 3.4 shows the number of buildings by the number of different types of damage. While many buildings have only a single type of damage, many more have several different types of damage.

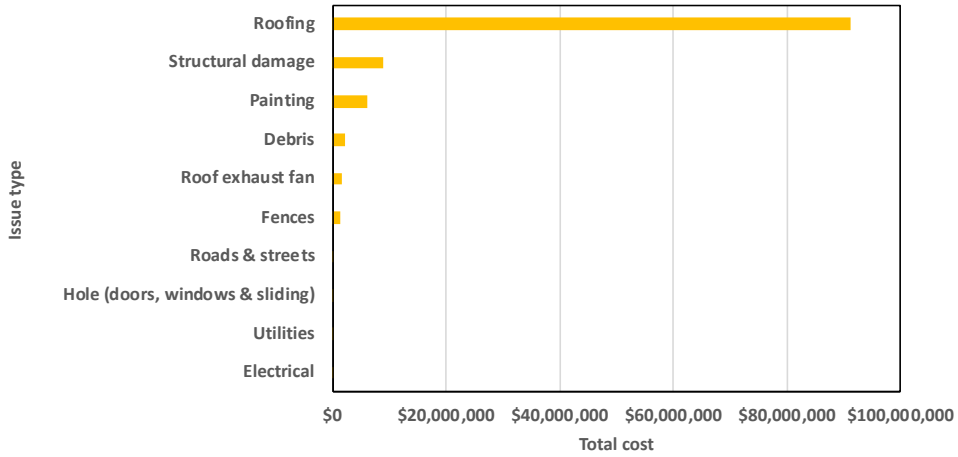
Figure 3.4. Distribution of Number of Damage Types per PRIDCO Building



SOURCE: HSOAC calculations based on PRIDCO data from March 2018.

The PRIDCO damage data also include cost estimates for each of the damage categories. These estimates are presented in Figure 3.5. Costs are overwhelmingly dominated by repairs to roofs, suggesting that roofing damage may represent a large proportion of damage costs across the public building sector. Identifying roof types that survived best and strengthening roofing in a systematic way may be key to helping reduce damage from future storms.

Figure 3.5. Total Cost Estimates for Different Damage Types for PRIDCO Buildings



SOURCE: HSOAC calculations based on PRIDCO data from March 2018.

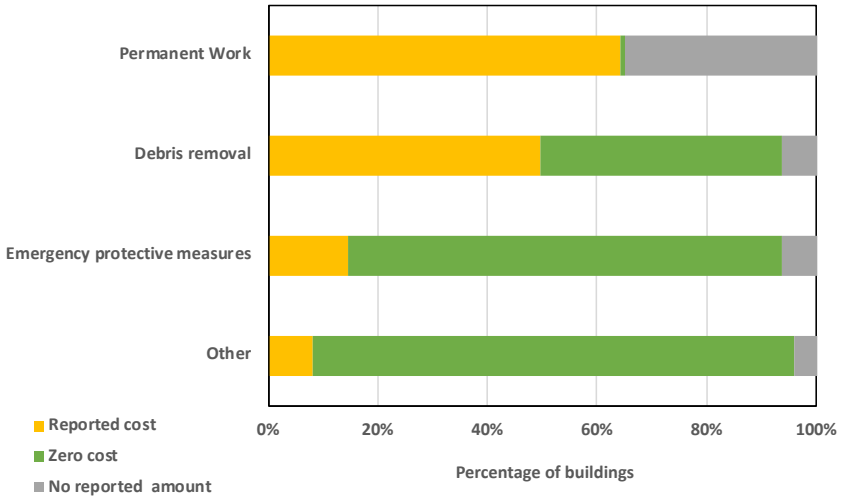
PBA Buildings

PBA owns 735 buildings, including over 400 schools, 49 government centers, 112 state police headquarters, 34 judicial centers, 17 health care centers, 12 fire stations, 7 penitentiaries, and more.

Damage data from PBA distinguish losses only by broad category, including debris removal, emergency protective measures, and permanent repair work to public buildings and contents (FEMA PA Categories A, B, and E, respectively; see Figure 3.1 and Figure 3.2), as well as other damage, such as emergency temporary roof installation work performed by the USACE. Frequencies of the different types of damage are shown in Figure 3.6, and the distribution of the number of damage types for buildings is shown in Figure 3.7.

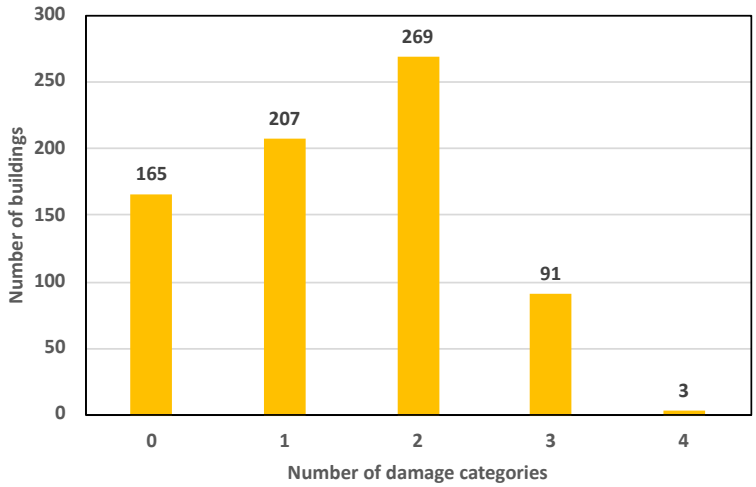
Cost estimates for each damage type are shown in Figure 3.8. Estimates for permanent repairs are far greater than those for emergency work.

Figure 3.6. Percentage of PBA Buildings with Various Categories of Damage



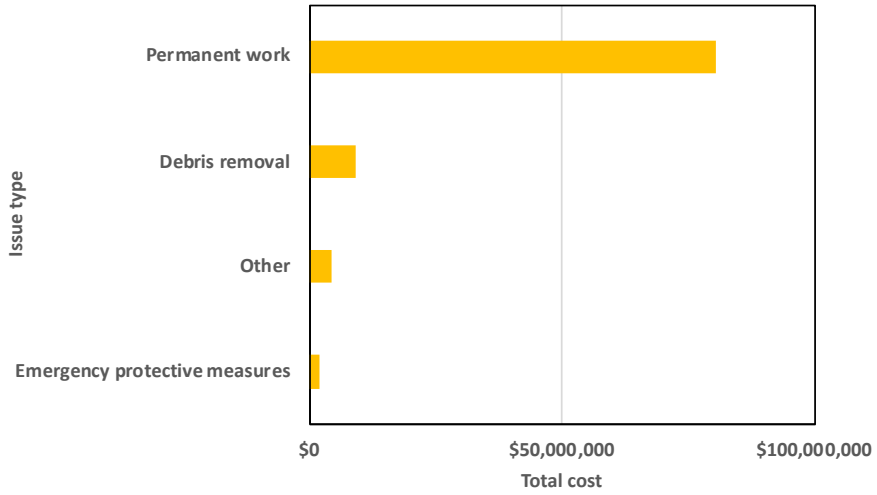
SOURCE: HSOAC calculations based on PBA data from March 2018.

Figure 3.7. Distribution of Number of Damage Categories per PBA Building



SOURCE: HSOAC calculations based on PBA data from March 2018.

Figure 3.8. Total Cost Estimates for Different Damage Categories for PBA Buildings



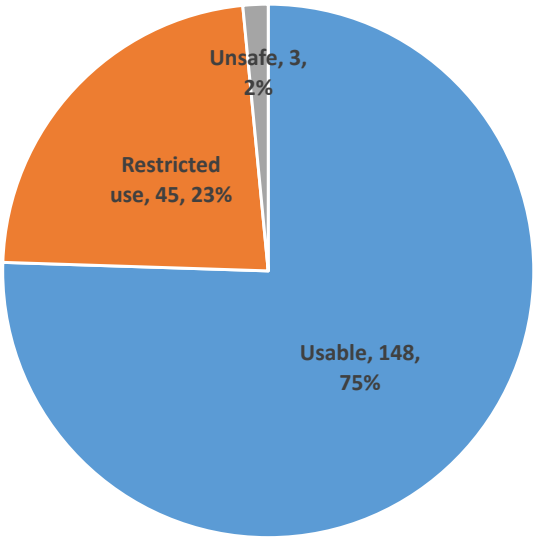
SOURCE: HSOAC calculations based on PBA data from March 2018.

Damage by Building Type

Police Stations

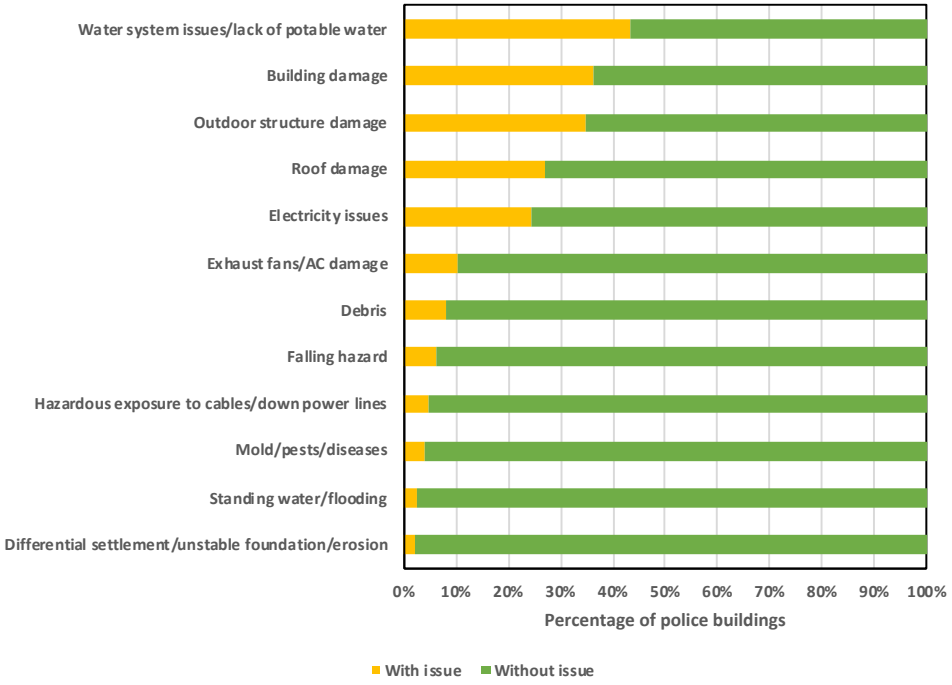
An additional source of damage data is the USACE, which provided assessments of 196 police stations. These data include brief descriptions of damage (a sentence or two) and a classification of the stations' functional status. Figure 3.9 shows the status of the stations as of November 2017. This figure shows that most stations were operational by that time—only three were closed, and fewer than a quarter had some (unspecified) functional restrictions. The data do not include cost estimates, images, or other details. We coded the text descriptions for the presence of particular issues (Figure 3.10). The most common damage issues are problems with water systems, general building damage, outdoor structural damage, and roof damage. Although we do not know the severity of each issue, Figure 3.11 shows the number of issues for each station.

Figure 3.9. Functional Status of State Police Stations as of November 2017



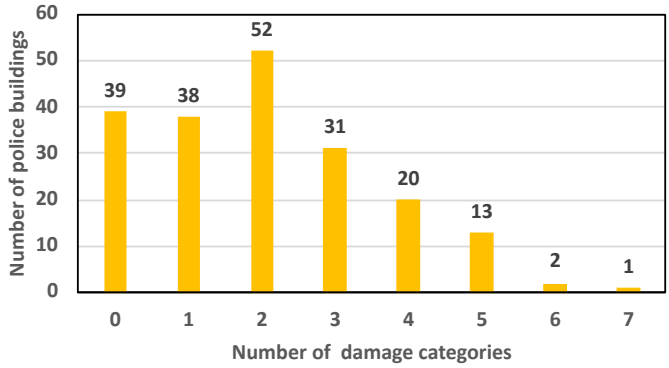
SOURCE: HSOAC calculations based on USACE data from November 2017.

Figure 3.10. Percentage of Police Stations with Various Types of Damage



SOURCE: HSOAC calculations based on USACE data as of November 2017.

Figure 3.11. Distribution of Number of Issues per Police Station



SOURCE: HSOAC calculations based on USACE data as of November 2017.

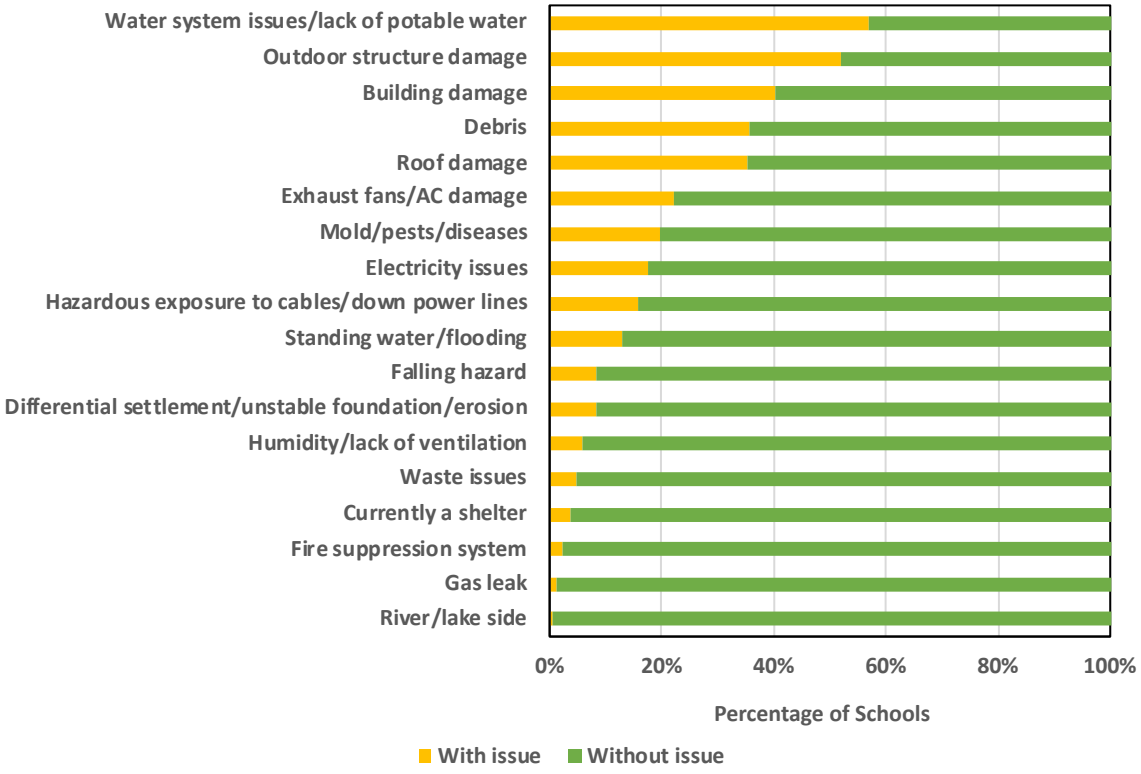
Schools

The USACE also provided emergency damage assessments for 1,131 public schools in Puerto Rico.[2] Similar to those for police stations, these damage data include brief descriptions of damage but do not provide information on functional impairment, cost estimates, images, or other details. While these assessments do not indicate the functional status, the Puerto Rico Department of Education reported that 1,094 of the 1,131 schools were open as of December 20, 2017 (Puerto Rico Department of Education, undated). Results of coded text descriptions are summarized in Figure 3.12, and the number of damage issues recorded for each school are shown in Figure 3.13. As with the police stations, the most common issues are problems with water systems, general building damage, outdoor structural damage, and roof damage.

Separately, the Governor's Build Back Better Puerto Rico report identifies $8.4 billion in damage for schools (Governor of Puerto Rico, 2017). This estimate was produced in November 2017 using preliminary property damage percentages estimated at the zip code level. The extent to which this method provides a reasonable proxy for the degree of damage at individual schools in those zip codes is unknown.

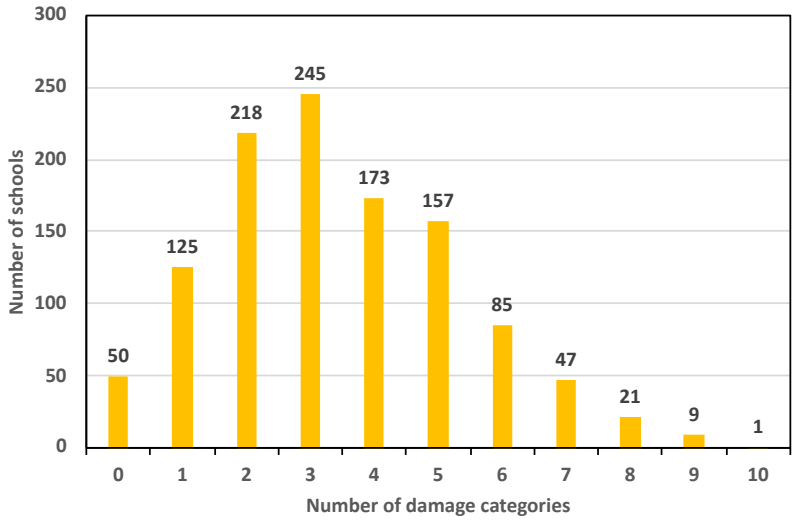
[2] Puerto Rico previously had approximately 1,500 public schools, but up to 400 schools have been closed since 2010 through the School Modernization Program. Current information available suggests that the number of schools that were open prior to the storm is approximately equal to the number of USACE damage inspections conducted (see Puerto Rico Public-Private Partnerships Authority, "Projects: Other Projects, School Modernization Program," undated).

Figure 3.12. Percentage of Schools with Damage and Other Issues



SOURCE: HSOAC calculations based on USACE data, as of November 2017.

Figure 3.13. Distribution of Number of Issues per School

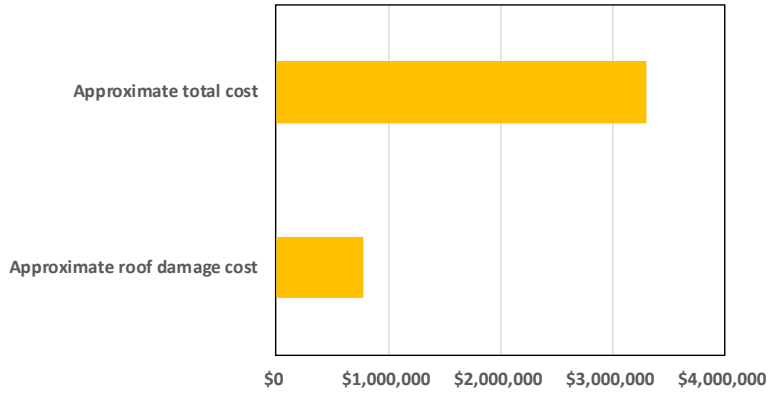


SOURCE: HSOAC calculations based on USACE data, as of November 2017.

Fire Stations

We also obtained some further details from FEMA on the PA applications for fire stations and corrections facilities. Fire stations suffered a variety of types of damage, with roof damage again being one of the most common types. Figure 3.14 shows the relative proportion of roof damage compared with total damage for 99 fire stations that submitted PA applications. The sum of damage for all stations was about $3.3 million. In contrast to the case for PRIDCO buildings, where roof damage accounted for 70 percent of the total damage (Figure 3.5), roof damage is about 23 percent of the total damage for fire stations. Part of the reason for this difference may be that a large proportion of the loss estimates for fire stations consists of building contents, whereas the PRIDCO loss estimates include only the building envelope, not the contents.

Figure 3.14. Total Losses and Roof Losses for Fire Stations

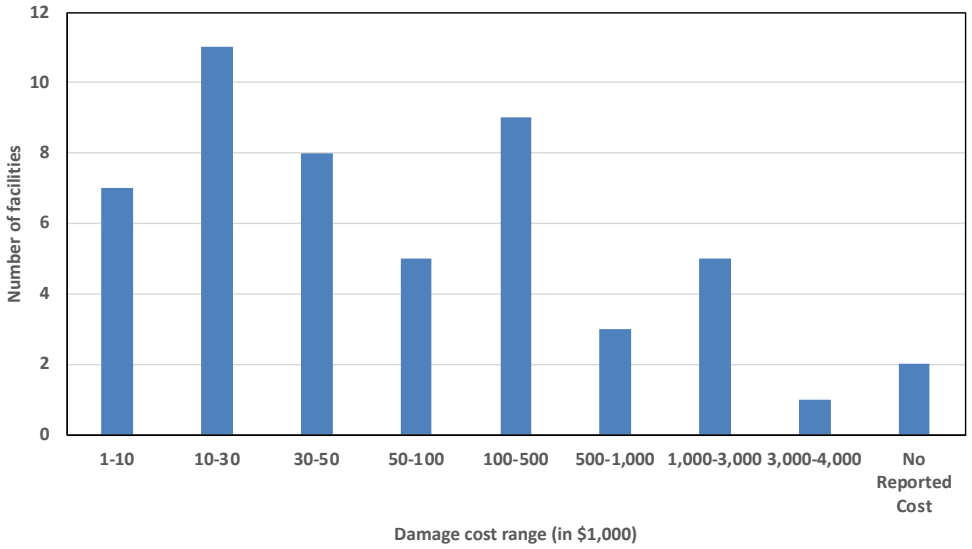


SOURCE: HSOAC calculations based on FEMA Public Assistance data, as of May 3, 2018.

Corrections Facilities

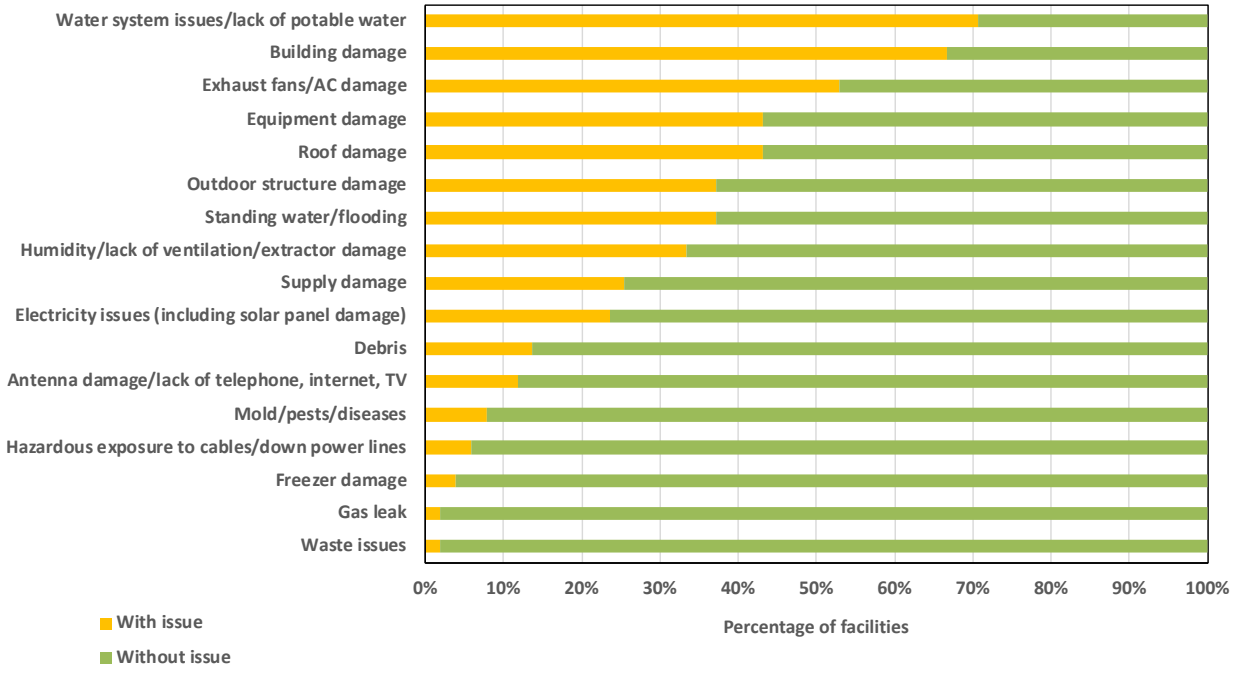
Damage to corrections facilities, as reported by the Department of Corrections and Rehabilitation, is summarized in Figures 3.15 and 3.16. Damage to individual facilities range from under $10,000 to over $3 million (Figure 3.15), with total reported damage of $15.2 million. The distribution of different types of damage by facility is summarized in Figure 3.16. The most common types of damage include water system issues, general building damage, air conditioning, roof damage, and damage to equipment.

Figure 3.15. Range of Damage for Individual Corrections Facilities



SOURCE: HSOAC calculations based on Correctional Health Damage Inventory, as of March 30, 2018.

Figure 3.16. Percentage of Corrections Facilities with Different Types of Damage



SOURCE: HSOAC calculations based on Correctional Health Damage Inventory, as of March 30, 2018.

Impact of Damage and Status of Recovery Activity

With the exception of our information on police station damage (Figure 3.9), we have little insight into the impact of the damage on buildings' functionality. As noted above, 1,094 of the 1,131 schools had reopened by the end of 2017, although reopening does not necessarily indicate that a building is undamaged or fully functional. The USACE damage data for police stations and schools indicate that public buildings sustained a substantial amount of structural damage that required repair. Approximately 75 percent of PRIDCO's buildings and about 65 percent of PBA's buildings were damaged, although we do not know the extent.

Recovery planning requires an understanding of the extent of damage, and this is not available. For the purposes of developing COAs for recovery and estimating their costs, we have made provisional, working estimates of the building inventory and extent of damage. The combined inventory of PRIDCO and PBA is approximately 1,500 buildings. According to the damage data from PBA, 460 of PBA's 735 buildings are schools. With approximately 1,100 schools in total, this implies that the minimum number of public buildings is around 2,150. Based on limited and incomplete inventories of buildings beyond schools and those owned by PRIDCO and PBA, we provisionally assume there are about 350 additional public buildings, giving a total inventory of 2,500 buildings, or approximately 1,400 nonschool public buildings and approximately 1,100 schools. The amount of damage to many of these buildings is unknown, but based on the damage data that we have collected, we provisionally assume an aggregated damage estimate of 15 percent.

We emphasize that these inventory and damage estimates are highly uncertain and will need to be further investigated before implementing recovery actions. Details aside, Puerto Rico is looking at the cost of repairing hundreds of public buildings, meaning the total cost will likely be billions of dollars. These significant expenses may not be fully addressed until many years after the storm. In 2010, five years after Hurricane Katrina, New Orleans received a $1.8 billion FEMA grant to build or renovate 87 school campuses, replacing the 127 that existed prior to Hurricane Katrina.[3]

The data we have collected as of July 2018 indicate that little damage repair had been undertaken. According to FEMA PA application data, as of July 2018, nearly all recovery activity for public buildings had been emergency work, including providing security, debris removal, and temporary repairs.

While some of this work may be underway, progress is complicated by the need to simultaneously address challenges associated with mitigating risks to future hazards and with underutilization of buildings (potentially through relocation or merging of functions and

[3] See Campbell Robertson, "Louisiana: $1.8. Billion for Schools Lost to Katrina," *New York Times*, August 25, 2010, and Cindy Chang, "$1.8 Billion from FEMA for Hurricane Katrina School Rebuilding Is 'Worth the Wait,' Sen. Mary Landrieu says," Nola.com, August 26, 2010.

associated renovation or demolition of buildings). Decisionmaking continues about what to do with damaged and excess public buildings following the storms. Education is one area in which specific plans have been announced: The government of Puerto Rico has reported that "student population has declined by over 40% since 2000 with an additional 16% decline expected by FY22" (Government of Puerto Rico, 2018a). The plan projected that Hurricanes Irma and Maria would cause student population to drop by an additional 10 percent in FY 2018–2019 alone and called for a consolidation from the current approximately 1,130 schools to 805 schools by 2022. The Puerto Rico Department of Education announced plans to close 283 schools at the end of the 2017–2018 school year but decreased the number of planned closures to 266 in March 2018 following pressure from stakeholders (Bruno Gómez, 2018). These consolidation plans were authorized in the recently passed education reform bill (Ujifusa, 2018). Choosing what to do with the hundreds of closed school buildings is a major public building issue that remains to be addressed. Analogous discussions are ongoing related to the other types of public buildings.

4. Identifying Courses of Action

Courses of action (COAs) for the public building sector were developed in close coordination with FEMA's Public Buildings Sector team, the Infrastructure Recovery Support Function team led by USACE, the government of Puerto Rico representative to the federal recovery effort, and selected government of Puerto Rico agencies, including PBA and PRIDCO.

In developing COA proposals in the public building sector, we sought to look beyond repairing immediate damage. We focused on identifying underlying issues that hampered the ability to effectively manage and maintain an inventory of public buildings that meet the needs of the population of Puerto Rico. We also considered existing needs and challenges that predate the 2017 hurricanes, ongoing initiatives involving public buildings, repair and reconstruction needs stemming directly from hurricane damage, and best practices for developing resilient and efficient building infrastructure.

Some of the most pressing needs in the public building sector stem from long-term issues that predate the 2017 hurricanes. Because of poor economic conditions and limited government funding, much of the public building infrastructure is aging and in disrepair. This issue has, in turn led to several challenges:

- Improperly maintained buildings may be more susceptible to damage from hurricanes.
- Many buildings predate the development of modern building codes and hence do not incorporate modern building practices, materials, and codes designed to increase disaster resilience and energy efficiency.
- Maintenance and disrepair have become so extensive that building shutdowns are sometimes needed to address them, resulting in schools and other buildings losing operational time, decreasing the availability of essential services.
- Building systems designed decades ago often do not meet current needs. The size, number, geographic distribution, and designs of buildings do not necessarily reflect the current population and demographics or accommodate current practices and technologies of the systems operating in the buildings. Schools, medical facilities, and correctional institutions are prime examples of this situation.

While these issues have needed attention for years, the shock of Hurricanes Irma and Maria has provided a fresh opportunity to reexamine and address them. Therefore, the guiding vision in developing COAs for public buildings was to reinvest in public building infrastructure not only to repair the damage caused by the 2017 hurricanes but also to modernize this infrastructure to increase resilience to natural hazards, improve energy efficiency, and improve functionality and user experience.

Recovery Plan

The recovery plan includes 12 COAs aimed at realizing this vision of going beyond repair (Table 4.1). These COAs span a variety of activities, which can be summarized in terms of three dimensions:

- ***Repair and reconstruction.*** The central element of reinvesting in public building infrastructure is the repair and reconstruction of buildings damaged by the high velocity winds, intense precipitation, and flooding from Hurricanes Irma and Maria. Hundreds of buildings sustained a wide range of types of damage, some so extensive that the buildings require complete reconstruction. The recovery plan commits resources to repair these damaged buildings. An additional aspect of this dimension is to retrofit all public buildings, regardless of hurricane damage, to meet current building safety codes for wind, flood, and seismic risks. Puerto Rico is at high risk for hurricanes and earthquakes, and infrastructure investment needs to address these risks. Repair and reconstruction work will necessarily be undertaken in coordination with the realignment and repurposing efforts to ensure that the purpose and needs for each building is considered.
- ***Realignment and repurposing.*** Much of Puerto Rico's public building infrastructure is old and misaligned with current needs. Consequently, an element of recovery planning is to take a comprehensive view of building demand, capacity, ownership, and hazard exposure to determine the best use of buildings to deliver government services efficiently, fairly, and safely. The overall task will require moving critical services out of buildings that are at high risk of flooding, reducing vacancy rates, centralizing common services, transferring agencies among buildings as appropriate for more efficient use, and moving government operations out of leased privately owned buildings. The realignment and repurposing may also entail selling or demolishing some public buildings. As such, it will need to be conducted in close coordination with the repair and reconstruction efforts to ensure that the purpose and need for each building are considered.
- ***Policies and data.*** An additional element of the recovery plan entails developing policies and collecting data to improve future buildings and building management. Improving approaches to incentivize the use of modern building practices, materials, and codes will ensure that public buildings are energy efficient, resilient to natural hazards, and safe and ensure that the public buildings meet users' needs. Standards for capacity and reliability of backup power systems will help ensure continuity of operations after natural disasters. Reconsidering the government's role as a major landlord to private sector businesses may increase efficiencies and stimulate economic development. And a commonwealth-wide database of public buildings' characteristics will support a number of activities, such as realignment and repurposing, structural mitigation for natural hazard resilience, evaluation of damage after disasters, and purpose-specific (i.e., schools, hospitals, prisons, etc.) infrastructure planning efforts.

The COAs are described in more detail in the appendix. The index numbers assigned to the COAs are arbitrary: they are the numbers used in the recovery plan and we have retained them here for consistency. In both Table 4.1 and the appendix, we have ordered them according to the bulleted dimensions above to which they correspond.

Table 4.1. Courses of Action for the Public Building Sector

COA Category	Title (COA #)	Description	Lead Agency
Repair and reconstruction	Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria (PBD 9)	Complete repairs to essential public buildings that sustained hurricane damage, ensuring that repairs meet current building safety codes for wind, flood, and seismic events.	Puerto Rico Infrastructure Financing Authority
Repair and reconstruction	Bring Public Buildings up to Code (PBD 11)	Assess building safety code compliance for wind, flood, and seismic risks across the public building inventory and retrofit buildings with the appropriate structural hardening, making other code upgrades where needed.	Government of Puerto Rico agencies, municipal governments
Repair and reconstruction	Refurbish Community Centers and Community Technology Centers (PBD 7)	Rebuild or refurbish 300 community centers in low-income communities and 172 community technology centers, including providing them with generators for backup power and building them to withstand hurricanes and earthquakes.	Puerto Rico Planning Board
Realignment and repurposing	Mitigate Flood Risk for Critical Government Functions (PBD 8)	Relocate critical public functions to buildings outside of flood hazard zones or elevate the building in which the critical function is housed to prevent service disruptions and reduce damage due to flooding.	Puerto Rico Planning Board
Realignment and repurposing	Right-Size Public Buildings (PBD 2)	Analyze demand for government services to estimate the appropriate building capacity, program requirements, and proposed improvements for government operations. Repurpose, reallocate, and refurbish buildings. Sell or demolish unneeded vacant buildings where possible.	Puerto Rico Planning Board
Realignment and repurposing	Establish Integrated Services Centers (PBD 3)	Continue supporting the government of Puerto Rico's ongoing project to cluster public services in a single location to improve efficiency and accessibility for the public. A center is already operating in San Juan where residents can access a variety of social services in a single location.	Public Buildings Authority, Puerto Rico Department of State

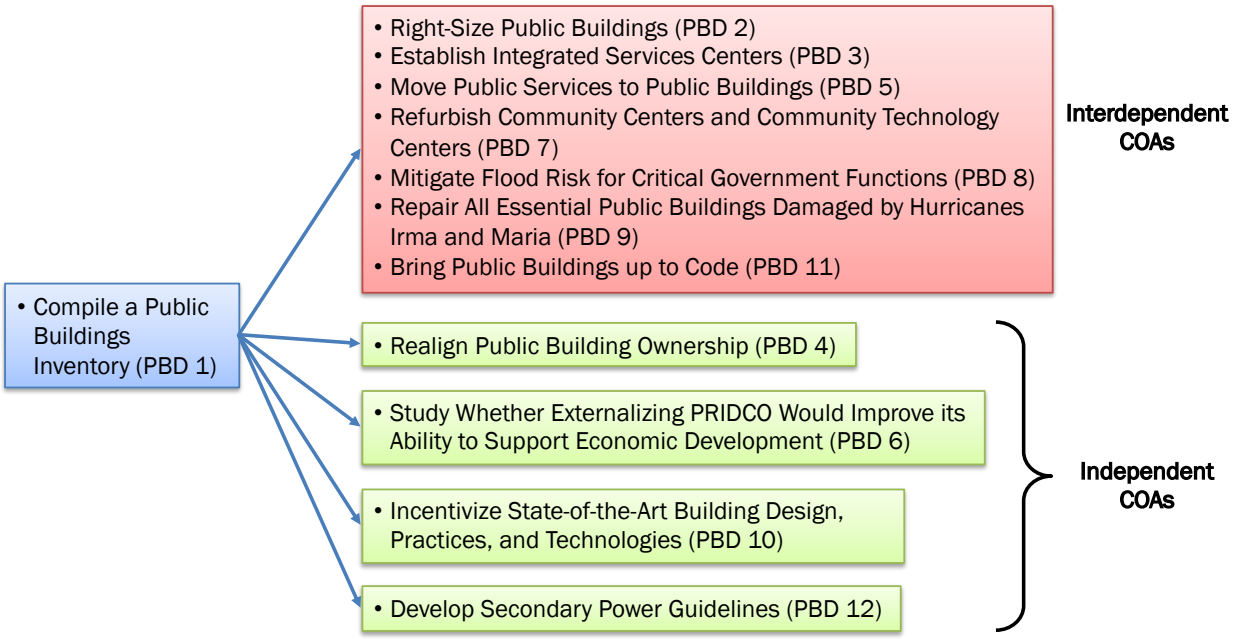
COA Category	Title (COA #)	Description	Lead Agency
Realignment and repurposing	Realign Public Building Ownership (PBD 4)	Transfer ownership of buildings so that buildings of the same type (e.g., schools or government centers) are all owned by the same agency.	Office of the Governor, Legislative Assembly
Realignment and repurposing	Move Public Services to Public Buildings (PBD 5)	House government agencies in public buildings rather than privately owned buildings.	Office of the Governor, Legislative Assembly
Policies and data	Incentivize State-of-the-Art Building Design, Practices, and Technologies (PBD 10)	Modify or develop policies and programs that establish clear standards for energy and water efficiency in public buildings and 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.	Government of Puerto Rico agencies, municipal governments
Policies and data	Develop Secondary Power Guidelines (PBD 12)	Develop guidelines for the design of secondary power systems for public buildings, possibly using existing standards for emergency and standby power systems as a resource.	State Office of Energy Policy, Office of Permit Management
Policies and data	Study Whether Externalizing PRIDCO Would Improve Its Ability to Support Economic Development (PBD 6)	Commission an independent analysis by a third party of whether externalizing PRIDCO (i.e., converting it into a nongovernmental entity) would improve or reduce its ability to support economic development through the private sector real estate market.	Independent research partner
Policies and data	Compile a Public Buildings Inventory (PBD 1)	Create a comprehensive, centralized database of buildings owned by the government of Puerto Rico that includes building characteristics, allowing for analysis of emergency response needs and general operational decisionmaking.	Puerto Rico Planning Board, Puerto Rico Infrastructure Financing Authority

Reviewing the complete list of COAs reveals that several are interdependent, and this has implications for how these activities are implemented and the substantial planning that will be needed. An important initial step in this planning effort will be the implementation of the COA, *Compile a Public Buildings Inventory* (PBD 1). Without a comprehensive inventory and characterization of the government of Puerto Rico's current real estate holdings, it will be difficult to plan and execute any of the remaining COAs. The remaining COAs generally fall into two groups: those that can proceed mostly independently and those for which the implementation parameters depend on decisions made for other COAs within the group. Planning and implementing these COAs therefore requires coordinated and integrated planning.

The relationship among the different COAs is shown schematically in Figure 4.1. Armed with the inventory, the COAs shown in the lower right can proceed largely independently of other COAs. Planning and design of the COAs in the upper right, however, must be coordinated. For example, repair or hazard mitigation may depend fundamentally on whether a building will maintain its existing role or be renovated and repurposed. And the requirements for buildings slated for demolition or sale would be fundamentally different as well. The number and location of integrated service centers will depend on and influence decisions about which services are and are not retained in existing buildings. The amount and types of services moved out of buildings in flood zones will influence the needs for renovation and repurposing of other space. In effect, these COAs all depend on having a comprehensive, integrated plan for public buildings. Such planning will need to consider many factors such as current models for service delivery, projected demand for capabilities and space, geographic distribution and access to facilities, risks from natural hazards, and desired building performance. Ideally, the government of Puerto Rico will develop an overall vision for a network of public buildings that will meet the needs of the population over the next several decades and identify the best strategy to achieve that vision. Such a comprehensive vision for the desired state of the public building system will facilitate planning at the individual building level.

Developing such a vision will involve complex interactions and trade-offs among competing desires and budgetary constraints and will require a dedicated effort by the government of Puerto Rico.

Figure 4.1. Interdependency of Public Building COAs



A related challenge in implementing the public building COAs is the lack of data on both the inventories and extent of damage. Interdependencies notwithstanding, it is impossible for the government of Puerto Rico to implement the COAs until it has relevant knowledge about the current situation:

- How many buildings were damaged?
- How extensive was the damage?
- How many are at risk for flooding?
- How many require building code upgrades?
- What are the occupancy rates?
- What are the projected demands for service and space going forward?

The detailed descriptions of the COAs in the appendix demonstrate that, in most cases, information on numbers of structures and extent of needs is lacking. This lack of information requires us to estimate levels of effort for various ranges of values. Information released since July 2018 might better constrain these estimates.

The Path Forward

Implementing these COAs will be a challenge for the government of Puerto Rico. A wide variety of stakeholders will need to coordinate efforts on limited budgets. In addition to requiring a comprehensive plan that coordinates repair planning with hazard mitigation and projected demand and building performance needs, implementation in many cases will require coordination with other sectors, such as Education, Health and Social Services, Municipalities,

and Transportation. Efforts are underway to organize forums and sessions to discuss implementation plans with local leaders.

Assigning implementation responsibility for individual COAs is an important step. Each COA lists agencies or organizations that the government of Puerto Rico identified as potentially implementing the COA. These agencies are listed in Table 4.1. Implementers should begin by creating realistic timing and funding plans and identifying prerequisites and funding sources. Finally, an oversight process should be established to ensure that COA/infrastructure owners are making progress on implementation plans, that they are coordinating as appropriate with other COA implementers within and among sectors, and that they have access to assistance if needed.

Even with the successful implementation of these COAs, public building owners in Puerto Rico will continue to face serious challenges. Long-run economic stability paired with prudent public spending decisions are required to overcome debt-related issues. Services delivered by the government organizations located within public buildings are key parts of a functioning polity, so investments in these facilities is an important part of support for recovery.

Appendix. Courses of Action for Recovery Plan

This appendix presents detailed descriptions of the 12 COAs for recovery of public buildings in Puerto Rico. For consistency across sectors, the COA descriptions use a standardized template that provided input into the recovery plan. In general, costs are rough order-of-magnitude estimates intended to support high-level planning and inform decisionmaking. Cost estimates for public buildings are rounded to a single significant digit. This appendix is intended to provide increased visibility on the assumptions and computations underlying the cost estimates included in the plan. Some costing assumptions were developed for the overall plan and applied by all sectors. These include using the 11-year period from FY 2018 through FY 2028, which was the same time horizon of the certified New Fiscal Plan (Government of Puerto Rico, 2018a), and the different levels of personnel costs. More information about how costs are calculated and aggregated in the recovery plan can be found in reports detailing the cost methodology and the identification of potential funding sources.[1]

[1] RAND Corporation, 2019.

PBD 1
Compile a Public Buildings Inventory

Sector Impacted

Public Buildings

Issue/Problem Being Solved

Lack of access to information about the government's real estate inventory presents a substantial barrier to the assessment of damage and the repair of publicly owned buildings after natural disasters. The lack of this information also impedes other important public building management activities, such as structural retrofitting and other risk mitigation activities, maintenance and repair, leasing, and title transfers. Public buildings are owned by a number of different agencies. Approaches to record keeping about properties vary among agencies, and information sharing is poor, both of which impede emergency response and recovery, planning, and decisionmaking.

Description

This intent of this COA is to create a comprehensive, centralized database of commonwealth government-owned buildings. The database would include a number of different building characteristics, thereby allowing straightforward analysis for assessing both emergency response needs and general operational decisionmaking. The database could feasibly be owned and managed by the planning board. Implementation would entail creating a dedicated office to compile the necessary data, maintaining and updating the data over time, making the data publicly available, and conducting analyses and creating reports as requested for specific purposes. The database would include buildings owned across the commonwealth and could be implemented within a year. A number of different commercial building asset management programs are available that could serve as a model for the database.[1]

Building characteristics that would be documented in the database could include

- building purpose
- current user
- owning agency
- occupancy status, including capacity utilization
- value
- existing liens and restrictions on use
- location (street address and geocode)
- zoning

[1] Capterra, "Fixed Asset Management Software," website, undated.

- vulnerability assessment results
  - seismic and geotechnical risks
  - windspeed projections
  - floodplain data and flood risks
- International Building Code building risk category
- year built
- dimensions (area, height, number of stories)
- construction characteristics (based on National Fire Protection Association [NFPA] construction type)
- subsurface conditions (e.g., garage or basement facilities)
- utility information
- condition and remaining life of building mechanical, electrical, lighting, roofing, elevator, and backup power systems
- energy efficiency and natural hazard mitigation features
- major repair and retrofit records
- historical landmark status.

Potential Benefits

One benefit of such a database is that it would provide clear visibility of complete building inventories for functional systems (e.g., schools, courts, prisons). Such visibility would facilitate infrastructure-related decisionmaking associated with such issues as demand, capacity, repurposing and consolidation, geographic distribution, maintenance and repair, energy efficiency, insurance, mitigation and improvements, and code compliance.

Another important benefit is that it would provide a comprehensive database to support hazard mitigation programs, damage assessment, and recovery from natural disasters. This would include managing emergency preparedness and resiliency efforts, evaluating the suitability of buildings as emergency shelters, and managing disaster repair and reconstruction efforts. Key elements of the database for natural disaster planning and recovery are assessments of natural hazard risks, building vulnerabilities,[2] and building risk categories as determined by the International Building Code building risk classification criteria.[3]

Potential Spillover Impacts to Other Sectors

Such a commonwealth-wide database could prove to be a useful resource for municipalities in their infrastructure planning efforts as well as for future emergency response efforts. Initial feedback from round tables with municipality representatives indicates that building ownership

[2] Guidance for conducting natural hazard vulnerability assessments is available from FEMA, "Hazard Identification and Risk Assessment," webpage, May 2, 2019.

[3] These risk categories are summarized in PBD 11. For specifics on these risk categories see the International Code Council, "Table 1604.5: Risk Category of Buildings and Other Structures," in *2018 International Building Code*, Washington, D.C.: International Code Council, August 2017.

and responsibility is similarly poorly documented at the municipality level. Clearer understanding of which buildings are commonwealth owned and which are municipality owned may facilitate planning efforts.

Potential Costs

Potential up-front costs: $2 million
Potential recurring costs: $1 million (over 11 years)
Potential total costs: $4 million[4]

Potential cost elements include time for staff to develop the database architecture, gather initial information, maintain and update the database, and create reports. Additional funding would be required to conduct vulnerability assessments to assess natural hazard risks. Given the long lifetime of building infrastructure, the database is expected to evolve slowly once it is initially completed such that ongoing maintenance and updating costs are anticipated to be low. Cost is estimated as follows:

- Develop database and populate with existing data: 20 full-time equivalent standard staff for one year at a cost of $1.2 million
- Conduct natural hazard vulnerability analysis: 20 full-time equivalent staff for one year at a cost of $1.2 million
- Maintain database: Two full-time equivalent standard staff at an annual cost of $120,000.

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant—Disaster Recovery, Puerto Rico Planning Board

Potential Implementer(s)

Puerto Rico Planning Board, Puerto Rico Infrastructure Financing Authority

Potential Pitfalls

Neither the ability to carry out this COA nor its benefit once implemented are likely to be susceptible to external events. It will require good coordination among the many agencies that own public buildings. It will also require coordination with the municipalities sector, which has a similar need that is being addressed through the COA MUN 6 (Create and Maintain Central Repository of Municipal Assets and Associated Conditions).

[4] Cost numbers do not always appear to add correctly because of rounding.

Likely Precursors

There are no obvious precursors to this COA, though it should be coordinated with MUN 6 (Create and Maintain Central Repository of Municipal Assets and Associated Conditions). Conversely, it may be an important precursor to other COAs.

References

Capterra, "Fixed Asset Management Software," website, undated. As of May 3, 2019: https://www.capterra.com/fixed-asset-management-software/

Federal Emergency Management Agency, "Hazard Identification and Risk Assessment," webpage, May 2, 2019. As of May 3, 2019: https://www.fema.gov/hazard-identification-and-risk-assessment

International Code Council, "Table 1604.5: Risk Category of Buildings and Other Structures," in *2018 International Building Code*, Washington, D.C.: International Code Council, August 2017. As of May 17, 2018: https://codes.iccsafe.org/public/document/IBC2018/chapter-16-structural-design

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 among public buildings. This situation will be exacerbated by the FOMB-mandated consolidation of government of Puerto Rico agencies as outlined in the 2018 Fiscal Plan. Vacancy data are incomplete, but as of the fall of 2018, there are expected to be over 500 vacant schools alone. PRIDCO cites a building vacancy rate of 25 percent to 30 percent. In addition, many public buildings are several decades old, and in many cases their size and design features are not consistent with current needs.

Description

Project the demand for government services, such as schools, public health services, police and fire protection, courts, and prisons, to estimate the appropriate building capacity, building designs and features, and geographic distribution for government operations. Use this information to conduct an alternatives analysis to determine the appropriate realignment of buildings and agency operations. Repurpose, reallocate, and refurbish buildings to implement this realignment. Sell or demolish unneeded vacant buildings. Recycle building materials from demolished buildings to reduce demand for new construction materials and to reduce impact on landfills. This would be a long-term effort; initial benefits could be seen within a year, with full benefits realized over ten years.

Potential Benefits

This COA will provide income to the government from the sale of buildings and reduce operations and maintenance costs by consolidating operations into fewer buildings. Having fewer buildings will also reduce the costs of other COAs such as repairing damage from the hurricanes and structural retrofitting. The amounts of these benefits will depend on the number of buildings closed and sold. Further, right-sizing is expected to improve the effectiveness of government operations and the delivery of services. It may also allow municipalities to acquire vacant commonwealth government-owned buildings to satisfy local space needs. It will 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 and private business to acquire properties for productive uses. Repurposing and

realignment could also involve other sectors with infrastructure needs, including housing, energy, water, transportation, communications, and natural and cultural resources.

Potential Costs

Potential up-front costs: $200 million–$500 million (over ten years)
Potential recurring costs: —
Potential total costs: $200 million–$500 million

This is a complex effort and the costs will depend on the disposition of buildings determined in the analysis. It will include the analysis of demand and building requirements. Refurbishment costs depend on how many buildings require work and how extensive the requirements are. We assume a refurbishment cost of $50 per square foot and compute costs for different numbers of 30,000-square-foot buildings. These capital costs are anticipated to span ten years. In general, we assume that buildings slated for demolition would be located in flood zones, and thus that their costs are accounted for in COA PBD 8 (Mitigate Flood Risk for Critical Government Functions).

- Analysis of demand and building requirements:
  24 full-time equivalent standard staff for one year — $1.5 million
- Refurbishment to meet current building needs:
  Low estimate: 100 buildings — $150 million
  Mid estimate: 200 buildings — $300 million
  High estimate: 300 buildings — $450 million
- Total:
  Low estimate: 100 buildings — $151.5 million
  Mid estimate: 200 buildings — $301.5 million
  High estimate: 300 buildings — $451.5 million

Potential Funding Mechanisms

FEMA Public Assistance, Community Development Block Grant—Disaster Recovery, Government of Puerto Rico

Potential Implementer(s)

Puerto Rico Planning Board

Potential Pitfalls

Agencies slated to lose building space may protest this COA, and some public sector workers (e.g., maintenance, security, building administration) may lose their jobs in the consolidation. However, initial inquiries to Autoridad para el Financiamiento de la Infraestructura (Authority for the Financing of the Infrastructure, or AFI) as well as PRIDCO and PBA, two of the largest government building owners, suggest there is general support for this COA. Sale of buildings may be impeded by the fact that most public buildings are collateral in municipal tax-free bonds

that require the building to be used by the public sector. Consequently, public buildings can only be sold to the private market if the debt they are held against is transferred elsewhere.

Likely Precursors

PBD 1, Compile a Public Buildings Inventory, would need to be completed before this COA would be possible, as it would be impossible to analyze demand and capacity utilization, or to design a consolidation plan, without having a clear and comprehensive inventory of public buildings. In addition, this COA would need to be closely coordinated with several other public building COAs to ensure that efforts to consolidate, repurpose, refurbish, retrofit, sell, or demolish buildings are all working with an integrated plan. These include 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. The COA aims to solve the issue of public accessibility to government and social services. By clustering services together, the population can more easily access important services. The Centro de Servicios Integrados (Integrated Service Centers, or CSI) initiative also enhances the process and experience for the public by creating a streamlined and accessible center in consolidated locations.

Description

The COA supports an ongoing project by the commonwealth to more effectively cluster public services in a way that is more efficient and accessible to the public.

The COA is being implemented by the Puerto Rico Department of State. However, it will be necessary to collaborate with agencies like PBA that own many of the buildings in which CSIs will be located, in addition to the multiple agencies that will have their services moved to these centers. The implementation of this COA has already begun with a successfully operating CSI in San Juan that has been very well received. The Department of State is already working on the setup of additional centers, and two other CSIs have now been opened in Vieques and Moca. Many objectives of the process, such as how many CSIs to establish, what buildings to put them in exactly, and the full list of services in each one, still remain somewhat unclear.

Benefits have already been seen and were almost immediate. The recently opened CSIs and additional centers likely to be opened up in the coming year will create further benefits because the San Juan center is overcrowded, and benefits will scale as more centers are developed and opened. Location wise, the first CSI is located in San Juan, and there will likely be at least 25 additional locations throughout different municipalities. There is a formulated list of likely locations for these centers by the State Department.

Potential Benefits

This COA allows for clustering services together, which creates ease of access for the population and simplifies maintenance. Additional spillover benefits from the creation of an economic hub are likely to emerge. There are large qualitative benefits to the public, as well as quantitative benefits in efficient uses of resources. An increase in traffic in these areas can spur economic benefits to the area. This in combination with building public trust in the community creates large impact.

Potential Spillover Impacts to Other Sectors

The COA will certainly have spillover impacts to the aforementioned sectors of health and social services, municipalities, and economics. Impacts will be mostly positive, as it creates easier access to services. The CSIs are seen as economic drivers because of the clustering of services and opportunities to build around these hubs. However, because of the limited locations and moving of services out of their current residence, there could be negative economic effects to certain areas left without CSIs. This could also affect transportation, as these locations may become transport hubs.

Potential Costs

Potential up-front costs: $5 million–$10 million (over two years)
Potential recurring costs: $7 million (over 11 years)
Potential total costs: $10 million–$20 million

Given the San Juan CSI has already been developed, the cost estimate of the San Juan center can be used as a basis for the average cost of development for a CSI. Information about other CSIs in development also helps provide a baseline going forward for the average development and operational costs of a CSI. There will likely be costs in the form of refurbishing new buildings and in changing the building format. Additionally, the government is likely to invest in transportation to make the CSIs more accessible. The long-term benefits of these forms of investments, which should increase the efficiencies of operations, should theoretically offset the cost.

With the information at hand, costing was done as follows. The number of CSIs has been mentioned as potentially 26 or 78 (one in each municipality). We take these two numbers to represent the low and high end of the costing estimate. The square footage of the current CSI in San Juan is used as a proxy to generate the average cost per building. This number is added to the cost of 15 full-time equivalent (FTE) workers for one year to generate a cost estimate for this COA. The costs of 15 FTEs are used to capture the effort and manpower needed to plan and implement the COA. The FTE cost is an up-front cost, and the annual cost will be much less. We will estimate five FTEs to continue annually to manage the CSI project. Transport, building change, and other fringe costs are captured as operating costs and are not captured in this measure. We assume that the 15 FTEs for planning and implementing would require unique technical expertise and hence use the higher level personnel cost of $124,600 per year for a total of approximately $1,900,000 per year.

The average CSI is estimated at 5,000 square feet, based off the San Juan site and others in development. Although the average cost for refurbishing old buildings can be as high as new construction, this is not the case with the buildings that are being selected to be CSIs. The buildings that are being selected as CSIs do not need large amounts of renovation, as they are already operational buildings. Discussions with the PBA and others involved in the development of the CSIs indicate that the average cost of preparing these buildings to be converted into CSIs is approximately $100,000, or $20 per square foot.

Based on all the above information, 26 CSI buildings would cost $4.5 million up front ($2.6 million for the buildings and $1.9 million for the FTE), and 78 CSI buildings would cost $9.7 million up front ($7.8 million for the buildings and $1.9 million for the FTE). For annual costs (assuming through 11 years for the total cost), annual labor is estimated at five FTEs. That is an additional cost of roughly $620,000 a year, which likely represents a savings from spending if CSIs were not implemented. This estimate creates a total cost of $6.9 million for the annual labor over the 11 years. This creates a lower bound of roughly just under $11.4 million and an upper bound of just over $16.6 million for the entire costs of the COA through 11 years. These cost estimates are summarized in Table A.1.

Table A.1. Potential Costs of Establishing Integrated Services Centers

	Lower Cost	Higher Cost
Initial FTE	$1.9 million	$1.9 million
Annual costs over 11 years	$6.9 million	$6.9 million
CSI buildings	26 buildings ($2.6 million)	78 buildings ($7.8 million)
Total cost	$11.4 million	$16.6 million

Potential Funding Mechanisms

This project is already funded at least partially by the commonwealth, which is likely to remain the primary source of funding. Other potential funders include FEMA PA, Community Development Block Grant—Disaster Recovery, government of Puerto Rico, and the U.S. Department of Agriculture.

Additionally, the agencies housed with the CSIs are likely to contribute some funding. The private sector is unlikely to play a role in this COA.

Potential Implementer(s)

Public Buildings Authority, Puerto Rico Department of State

Potential Pitfalls

The COA could be at risk as a result of municipal frustration and politics. If the Puerto Rico Department of State stays with the 26 CSI plan, that could upset municipalities that do not receive a CSI, causing issues. However, if they expand CSIs to all 78 municipalities, that can make this project ineffective because consolidation does not happen in that case. Additionally, there may be pushback from areas that lose public service jobs.

Precursors

Given this COA is already in place and beginning, precursors are already largely met. Municipal approval is likely a precursor that will need to continue to happen for each individual CSI, in addition to other procedural and funding requirements. This COA 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. A long-standing issue with public buildings in Puerto Rico is fragmentation and confusion over building ownership. For example, school buildings are owned by at least three different agencies: the Office for the Improvement of Public Schools of Puerto Rico, the PBA, and the Department of Transportation and Public Works. Government centers face similar issues. Two of the largest public building owners in Puerto Rico, PBA and PRIDCO, act only as building owners; activities in the buildings are operated by other government agencies or private business tenants. This makes it difficult to know which building is owned by which agency. In addition to confusion over ownership, this fragmentation has made it difficult to track and ascertain basic information about public buildings.

Description

This COA transfers ownership of buildings so that buildings of the same type (for example, schools or government centers) are all owned by the same agency. It may require executive action from the Governor or acts by the legislative assembly to be implemented; it is not currently clear exactly how ownership of public property would be transferred from one agency to another.

Potential Benefits

The COA, if fully implemented, would fully resolve the issue. The benefits are improved government efficiency, accessibility, and communication. Aligning building ownership with building purpose will enable building owners to implement changes that support the ability to offer standardized services, right-size buildings, and bring buildings up to code in a consistent manner. This creates an easier environment for those who use those services, such as the general public or private sector businesses. Benefits of implementation should appear both quickly and in the long run.

Potential Spillover Impacts to Other Sectors

Potentially large benefits to all sectors that use public buildings, such as education and health and social services. They will be able to manage their building inventory in a holistic way, potentially facilitating strategic planning.

Potential Costs

Potential up-front costs: $60,000
Potential recurring costs: —
Potential total costs: $60,000

Costs such as the cost of politicians' time put toward establishing such a process and the cost of agencies applying through that system are assumed to be part of those individuals' existing job expectations and are hence already covered by those individuals' salaries. We assume that one new full-time worker will be hired for one year to help process these transfers. The standard assumption in the recovery plan is that a full-time worker is an annual cost of $62,300 in fiscal year 2018. This assumption is represented as rounded to $60,000 for the potential up-front cost. If legal costs associated with title transfers exceed normal workloads, additional staff may be required.

Potential Funding Mechanisms

Puerto Rico Planning Board

Potential Implementer(s)

Office of the Governor, Legislative Assembly

Potential Pitfalls

Agencies that lose authority may not approve, and the new owner must possess the expertise and the financial capabilities associated with owning and managing buildings.

Without PBD 1 (Compile a Public Buildings Inventory), some buildings may not be identified.

Documentation for ownership does not always exist, which may complicate the transfer process. Further, an institutionalized process for transferring ownership between agencies in a way that can be properly tracked and recorded must be implemented.

Where buildings are being used as collateral on bond obligations, there may be restrictions on the ability to transfer building ownership.

Likely Precursors

Completing PBD 1 (Compile a Public Buildings Inventory) will assist with public buildings of the same type that are owned by different agencies.

This COA should be implemented in coordination with the reduction in the total number of agencies to avoid having to repeatedly transfer ownership of buildings.

PBD 5
Move Public Services to Public Buildings

Sectors Impacted

Public Buildings, Economic, Municipalities, Health and Social Services

Issue/Problem Being Solved

Government of Puerto Rico agencies face extremely limited budgets, requiring them to seek out the cheapest available location from which they can fulfill their mission. While this optimization is prudent from the perspective of the single agency, it is not necessarily the most cost-effective approach for the government of Puerto Rico as a whole. Because many public buildings have significant vacancies, in some cases the government is both renting space in private buildings and maintaining empty space in public buildings. In some cases, it may be cheaper for the government of Puerto Rico as a whole to shift public activities into public buildings rather than paying both private sector rental costs and maintenance expenses for empty buildings that cannot be demolished or rented to private entities.

Description

The government of Puerto Rico should provide incentives for government agencies to move from private buildings to public buildings where this would result in overall savings without disrupting the agencies' missions.

An efficient way to encourage only cost-saving moves is to offer carefully designed adjustments to agency budgets. Suppose an agency has a choice between renting space in a private building at monthly cost $R_{Private}$ or renting space in a public building at monthly cost R_{Public}. Moving from one location to the other requires the agency to pay a one-time moving cost, C. Meanwhile, the public building owner pays a monthly maintenance cost of M_{Vacant} to maintain a vacant space, or a monthly maintenance cost of $M_{Occupied}$ to maintain an occupied space. We assume the overall cost of maintaining the occupied public building is the same as the monthly rental cost

$$R_{Public} = M_{Occupied}.$$

If the agency's cost of renting from the public sector exceeds the agency's cost of renting from the private sector, the government of Puerto Rico will offer a budget increase, B, to an agency that chooses to move from a private building to a public building. Setting aside any other differences between locations, an agency that chooses to move to a public building will have more budget remaining after paying monthly rental costs if

$$R_{Private} > R_{Public} - B$$

or, equivalently, the agency's monthly budget is higher if the budget increase exceeds the additional rental cost

$$B > R_{Public} - R_{Private}.$$

The government as a whole faces a choice between both private rental costs and maintenance costs for a vacant space or only paying the costs for maintaining an occupied space. In the first case, the government provides the renting agency with a budget to rent from the private sector and the public building owner with a budget to maintain the vacant space. In the second case, the government of Puerto Rico provides a larger budget to the renting agency, and the renting agency uses this money to pay the public building owner to maintain the space. The public building owners receives rental payments from the renting agency rather than receiving budget allocations from the central government to maintain empty buildings. The government as a whole will have lower monthly expenses in the case where an agency moves from a private building to a public building if

$$R_{Private} + M_{Vacant} > R_{Public}$$

or, equivalently, the government of Puerto Rico can lower its monthly expenses if the increase in rental costs are less than the cost of maintaining the vacant space

$$M_{Vacant} > R_{Public} - R_{Private}.$$

If this opportunity exists, then the government of Puerto Rico can offer the renting agency a budget increase, B, that is sufficiently large to compensate for any increases in rent, but small enough that the government still obtains savings overall. In order to achieve savings, the government of Puerto Rico should not offer a budget increase that exceeds the amount the government of Puerto Rico is spending on maintaining that vacant space

$$R_{Public} - R_{Private} < B < M_{Vacant}.$$

The government of Puerto Rico would then receive overall monthly savings, S, from not having to spend money on maintaining a vacant space

$$S = M_{Vacant} - B.$$

The renting agency also bears a one-time moving cost, C. This one-time cost should also be covered by the government of Puerto Rico to ensure moving costs do not discourage agencies from making moves that save money in the long run. These one-time moving costs are an investment the government makes in order to receive the monthly savings described above. If the government wants to ensure the COA results in net savings in T months, the government should choose a budget increase such that the aggregate monthly savings over that time are sufficient to cover the one-time moving costs

$$C \leq T \times S$$

or equivalently

$$C \leq T \times (M_{Vacant} - B).$$

The government can ask public building owners who wish to fill their vacant spaces to provide maintenance costs for vacant (M_{Vacant}) and occupied ($M_{Occupied}$) buildings as well as their monthly rental fee (R_{Public}). Renting agencies that wish to take advantage of the budget increase can provide their current rental expenses ($R_{Private}$) and estimated moving costs (C). Based on these values and how quickly the program needs to result in net savings (T), the renting agencies and government of Puerto Rico can then use the above equations to identify an appropriate budget increase for each location change.

These budget adjustments and incentives will help ensure that only moves which reduce overall costs to the government of Puerto Rico are implemented. The amount of savings associated with this COA will depend on how many appropriate moving opportunities exist. It may take months or years to identify appropriate opportunities and physically move agencies' locations, and it make take additional months or years for the aggregate monthly savings to exceed the one-time costs of moving.

Potential Benefits

This COA ensures public funds are used more efficiently by reducing overall rental and maintenance expenses.

In addition to lowering overall building and maintenance costs, if a significant number of public services move to public buildings this could provide a much-needed increase in revenue for owners of currently underutilized public buildings. Some renting agencies may end up paying more in rent than they currently pay in private buildings, but these agencies should receive a budget increase to compensate for these expenses, and the overall expenses for the government of Puerto Rico should decline. The concept described above of shifting government budgets from maintaining vacant buildings to providing sufficient budgets for public agencies to rent from public building owners should provide a mechanism that incentivizes agencies to move when that results in net savings, and to stay in private buildings when it does not. Puerto Rico should simultaneously look for opportunities to right-size its portfolio of public buildings; this COA will help identify public buildings that are financially unattractive for use by public agencies.

Potential Spillover Impacts to Other Sectors

The COA provides the opportunity to reduce overall government expenses, creating savings that could be reinvested to continuously improve buildings or spent in other ways to benefit the public. The private sector may lose business in the short run and would need to attract new tenants. In the long run it may be more efficient for government agencies to rent from the private sector if the private sector can provide appropriate buildings at a lower price, but where the government of Puerto Rico is required to maintain the buildings it owns, it should ensure the space is used efficiently.

Potential Costs

Potential up-front costs: —
Potential recurring costs: —
Potential total costs: —

This COA is designed to ensure cost savings from reduced spending on private sector rent and vacant building maintenance 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. As described above, it may take months or years for the monthly savings to offset the one-time moving costs. We emphasize that the government of Puerto Rico should not offer budget increases that exceed the savings associated with not needing to pay to maintain vacant buildings, ensuring that the government of Puerto Rico as a whole saves money. It may be difficult to find opportunities for savings if the private sector is significantly more financially efficient than the public sector in maintaining buildings, if the government of Puerto Rico currently spends very little on maintaining vacant buildings, or if renting agencies find public buildings undesirable for other reasons such as the building location or design not being amenable to the public service that agency provides.

Another assumption is that the monthly rental payments to public building owners will request rent that is appropriate for maintenance costs and will be paid in full by the renting agency. Recent legal disputes, mentioned above, raise concerns that rental payments to publicly owned buildings might not be paid in full, as well as concerns about rental costs not being sufficiently clear and transparent. Moving more services into public buildings without providing the revenue to maintain those buildings could simply exacerbate existing maintenance problems. Moving services into public buildings without a clear understanding of future rental costs risks eliminating the cost-saving justification for the move.

It will be important to take proper precautions to ensure these assumptions are met. Due to the multitude of other factors that influence the decision of where to locate public agencies, the government of Puerto Rico should not force agencies to move but rather use budget increases to generate savings where it makes sense within a broader context.

Potential Funding Mechanisms

Agencies renting space in the public building would pay the owner of the public building rent to finance costs associated with building operations, maintenance, repairs, and refurbishment. The government of Puerto Rico would adjust agency budgets following the methods described above.

Potential Implementer(s)

Office of the Governor, Legislative Assembly

Potential Pitfalls

In addition to the concerns discussed above, the private sector would lose rental income. There may be implications for private investment in real estate and other areas that should not be overlooked. Members of the public, agency employees, or municipalities might react negatively to location changes.

Likely Precursors

PBD 1 (Compile a Public Buildings Inventory) would need to be implemented to ascertain building occupancy. In addition, this COA would need to be closely coordinated with several other COAs to ensure that efforts to consolidate, repurpose, refurbish, retrofit, sell, or demolish buildings are all working with an integrated plan. These include PBD 2 (Right-Size Public Buildings), PBD 8 (Mitigate Flood Risk for Critical Government Functions, which relocates to buildings outside of flood hazard zones or through structural retrofits), PBD 9 (Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria), and PBD 11 (Bring Public Buildings up to Code).

PBD 6
Study Whether Externalizing PRIDCO Would Improve its Ability to Support Economic Development

Sectors Impacted

Public Buildings, Economic

Issue/Problem Being Solved

The government of Puerto Rico currently acts as a real estate developer and landlord for private sector businesses via the Puerto Rico Industrial Development Company (PRIDCO). This is an unusual arrangement, as classic economic theory suggests a competitive private sector could provide these services more efficiently than the government. However, PRIDCO has earned a reputation as one of the most efficient and well-managed agencies in the government of Puerto Rico, and it is not clear whether private sector entities would be able to fill PRIDCO's role in the current context. Further independent analysis is necessary to understand the nuances of this situation, and to determine how the real estate market for private businesses can best support the economic development of Puerto Rico.

Description

This COA proposes further independent analysis of how to best support and manage the private sector real estate market in Puerto Rico. This analysis would be undertaken by an entity with expertise in economic development, real estate markets, and the context in Puerto Rico.

This analysis should be conducted by an independent nongovernmental entity, with recommendations resulting from the study being presented to the government of Puerto Rico. The funding agency for this study could be the Department of Economic Development and Commerce. Changes, if any, would be implemented following the completion of the study.

Potential Benefits

The COA will investigate whether there are potential significant economic gains that could be achieved through converting PRIDCO into a nongovernmental entity. Examples of possible outcomes of the study include the following:

- The existing structure and approach to governance is appropriate and efficient for the context in Puerto Rico and should be left as is.
- PRIDCO would operate more efficiently if it were converted from a government entity to a private sector entity.
- The lack of certain data is keeping the private sector from entering the market, and improved transparency and data access are needed.
- Government policies are restricting private sector involvement.
- Subsidies in the existing system enable the government to offer below-market rates, crowding out the private sector at the expense of the government.

Again, these are possible outcomes of such a study. The exact outcomes cannot be known in advance. Any study should consider implications not only for PRIDCO and the government of Puerto Rico but also for the functioning of the private real estate market as a whole.

Potential Spillover Impacts to Other Sectors

Impacts of the study might include increased economic development through improved market efficiency.

Potential Costs

Potential up-front costs: $500,000
Potential recurring costs: —
Potential total costs: $500,000

This study would take approximately one year for a research team with expertise in economic development, real estate markets, and the context in Puerto Rico. We estimate a cost of $500,000 based on the cost of an advanced subject matter expert for a quarter of the year, two mainland consultants for a half year each, and one full-time Puerto Rico–based expert for one year.

Potential Funding Mechanisms

Government of Puerto Rico, nongovernment sources

Potential Implementer(s)

Independent research organization.

Potential Pitfalls

Given the political sensitivity of the topic, both government and private sector stakeholders may be hesitant to discuss it, restricting the ability to conduct a well-informed study. Government stakeholders may also be hesitant to implement the suggestions of such a study.

Likely Precursors

No preliminary action is required to begin this COA.

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

Rebuild or refurbish 300 community centers in low-income communities and 172 community technology centers throughout the island, including providing them with generators for backup power. Since they are anticipated to act as shelters after natural disasters, they need to be built to withstand hurricanes and earthquakes. Benefits will be seen as soon as the work is completed at any site, with full benefits when all projects are complete, probably within about five years after they are started.

Potential Benefits

As described in the report *Build Back Better Puerto Rico*,[1] restoring community centers will 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, deliver trainings and capacity-building initiatives, and host community events.

Potential Spillover Impacts to Other Sectors

This COA is expected to have important benefits for municipalities.

Potential Costs

Potential up-front costs: $20 million (over five years)
Potential recurring costs: —
Potential total costs: $20 million

The estimated cost is based on the *Build Back Better Puerto Rico* report.

[1] Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, New York: n.p., November 2017.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, Community Development Block Grant—Disaster Recovery

Potential Implementer(s)

Puerto Rico Planning Board

Potential Pitfalls

The plan would need to be coordinated with municipality sector COAs.

Likely Precursors

PBD 1 (Compile a Public Buildings Inventory) and MUN 6 (Create and Maintain Central Repository of Municipal Assets and Associated Conditions) would need to be completed prior to being able to determine which buildings need repair. This COA would also need to be coordinated with several other public building COAs to ensure that efforts to consolidate, repurpose, refurbish, retrofit, sell, or demolish buildings are all working with an integrated plan. These include 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), and PBD 11 (Bring Public Buildings up to Code).

Reference

Governor of Puerto Rico, *Build Back Better Puerto Rico: Request for Federal Assistance for Disaster Recovery*, New York: n.p., November 2017. As of April 24, 2018: https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/Build_Back_Better_PR.pdf

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. This situation causes two problems. First, these services are more likely to be unavailable during a flood or hurricane, often when they are needed most. Second, the maintenance and repair costs of these buildings will be higher because they are more likely to be damaged.

Description

This COA involves relocating critical public functions to buildings outside of flood hazard zones or elevating the building in which they are housed. This COA will be implemented through coordination between multiple government agencies and objectives, coordinated by the Planning Board.

Critical public functions currently located in flood zones will either be moved to vacant buildings or new buildings outside of flood zones or have their current building elevated. Levees could affect flood zone locations.

Each building should go through a critical function assessment process that considers

1. whether safe alternative locations can be found in proximity that do not compromise service function, such as response time or service zones
2. whether elevating is cost-feasible given the building type
3. whether hardening the public buildings to damage, such as through ground floor filling, dry- or wet-proofing, or broader levee systems is cost-effective.

This COA will be implemented through coordination between the providers of critical public functions, who are typically building tenants, and the owners of public buildings. The government of Puerto Rico will identify a list of critical public functions to be assessed, such as emergency services like police and firefighters. Building owners will identify any such tenants that are currently located in flood zones and work with those tenants to perform the assessment and implement the appropriate flood response strategy.

It is important that decisions are made based on current and projected future flood risks. Existing FEMA floodplain maps for Puerto Rico date from 2009 or earlier.[1] Newer floodplain

[1] Michael Moriarty, Mitigation Division Director, FEMA Region II, "Guidance for the Use of Available Flood Hazard Information for the Commonwealth of Puerto Rico in Complying with FEMA Policy 104-008-2, 44 CFR § 9, and Executive Order 11988 (Floodplain Management)," memorandum to federal coordinating officer, October 10, 2017.

maps are being developed but have not yet been adopted. Flood risks in Puerto Rico will also be influencing several new flood-control projects underway.[2] Beyond existing flood hazard zones, plans should also consider the impacts of sea level rise for the next 50- to 100-year period and how that will increase the extent of flood risk zones. An alternative approach would be to use the process outlined in the Obama administration's Floodplain Executive Order for federal agencies to consider climate change impacts on major infrastructure projects that would likely be subject to the National Environmental Policy Act review.[3] Location decisions should also be made in conjunction with an updated land use plan that considers the merits and demerits of redevelopment, relocation, and new development zones across the impacted parts of Puerto Rico. Decisions should also consider any broader mitigation plans that affect risk, such as plans for the construction of levees by the USACE.

It is expected that in most cases it will be more cost-effective to move the public function than to harden or elevate buildings, because many vacant buildings are available, and elevation and hardening approaches can be expensive. In any case, the ultimate location should reflect the demand for that public function, as per COA PBD 2 (Right-Size Public Buildings). Buildings in flood zones that are vacated during this process should be repurposed or demolished per COA PBD 2. If a critical public function is currently located in a private building, it may need to be relocated to a public building as per PBD 5 (Move Public Services to Public Buildings). This process will take one to three years for elevations or moves to vacant buildings and two to ten years for moves involving new construction. This COA will affect critical public functions across the island, particularly for coastal regions or other areas prone to flooding.

Potential Benefits

This course of action will resolve the issue of critical public services becoming unavailable due to flooding. It will also reduce costs of maintaining buildings in flood zones. Benefits begin after one year; it will be ten years until full benefits are seen.

Potential Spillover Impacts to Other Sectors

This course of action could reduce costs of maintenance (Municipalities) and improve reliability of services (Health and Social Services). If critical public functions move but households do not, then critical public functions might be farther away from some populations.

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[2] Pam Radtke Russell, "$2.5B Worth of Flood Control Work Underway in Puerto Rico," *Engineering News-Record*, August 29, 2018.

[3] Exec. Order No. 13690 (Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input), 80 Fed. Reg. 6,425 (2015).

Potential Costs

Potential up-front costs: $2 billion
Potential recurring costs: —
Potential total costs: $2 billion

Table A.2. Number and Type of PBA Buildings in Flood Zones

Building Type	Number of PBA buildings known to be in floodplain
Police station	58
Prison	1
Miscellaneous	8
Diagnostic treatment centers	5
Family health care facilities	1
Hospital facilities	1
Government centers	11
Justice buildings	10
Office buildings	14
Fire stations	24
Emergency operations centers	19
Schools	69 (178 across all owners)

Table A.2 shows the number of PBA buildings in flood zones. We do not have information from other building owners; however, available data suggest there are 178 schools in flood zones, implying that PBA owns about 40 percent of school buildings in flood zones. If PBA generally owns 40 percent of all types of public buildings that are located in flood zones, a total of 570 public buildings in Puerto Rico are in flood zones.

Table A.3. Approximate Cost of Mitigation Options

Response option	Number of buildings using that response option	Cost per building ($M)	Number of buildings demolished	Cost of demolition per building ($M)	Total cost for buildings using that response option ($M)[a]
Implement flood mitigation	57	4	N/A	N/A	200
Move to vacant building	399	2	319	0.3	900
Build new building	114	6.75	91	0.3	800
Total	570	varies	410	0.3	2,000

NOTE: [a] Totals do not add due to rounding.

Table A.3 describes how we estimate the cost of addressing the flood issues associated with these 570 buildings. Cost estimates are rounded off to the nearest $100 million to emphasize their approximate nature. We assume 10 percent will implement flood mitigation measures, such as raising buildings, while 90 percent of buildings currently in flood zones will be vacated. For the 10 percent implementing flood mitigation measures, the average cost is assumed to be $4 million per building. Among the 90 percent that will be vacated, we assume that 399 of buildings in flood zones (70 percent) will move to vacant buildings, and we assume the average cost to move to a vacant building is $2 million. We assume 114 percent or 20 percent of buildings in flood zones will be replaced with new buildings, and we assume the average cost to build a new building is $6.75 million, based on a cost of $225 per square foot and an average building size of 30,000 square feet. The cost of $225 per square foot was selected based on consultation with subject matter experts and relevant agencies.

For the 90 percent of buildings in flood zones that are vacated, we assume that 20 percent of those buildings can be repurposed in such a way that the associated revenue or benefits exceed the cost of renovation. Estimating the costs associated with that repurposing is outside the scope of this COA. We assume the remaining 80 percent of vacated buildings in flood zones will remain vacant and that those buildings will be demolished to reduce urban blight. We assume a demolition cost of $10 per square foot (which includes transport and disposal), which for an average building size of 30,000 square feet implies a demolition cost of $300,000 per building.

The potential total cost is rounded to $2 billion to avoid giving a false sense of precision.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, Community Development Block Grant—Disaster Recovery, U.S. Department of Education

Potential Implementer(s)

Puerto Rico Planning Board

Potential Pitfalls

Without PBD 1 (Compile a Public Buildings Inventory), some critical public functions in flood zones may not be identified.

Likely Precursors

Completing COA PBD 1 (Compile a Public Buildings Inventory) will assist with identifying which critical public services are located in flood zones. Completing COA PBD 4 (Realign Public Building Ownership) will assist with more efficiently coordinating the location of public services relative to each other.

In addition, this COA would need to be closely coordinated with several other public building COAs to ensure that efforts to consolidate, repurpose, refurbish, retrofit, sell, or

demolish buildings are all working with an integrated plan. These include PBD (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).

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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.

While we do not have a complete inventory of public buildings and thus do not have a complete set of damage assessment reports, we do have damage assessments from the two largest public building owners, PRIDCO and the PBA. The combined inventory of these two organizations is about 1,500 buildings and accounts for a large percentage of the public building inventory; remaining buildings in the inventory are distributed among 43 stakeholders. Assessments from the larger entities will likely serve as representative of the sector as a whole. Approximately 75 percent of PRIDCO's 778 buildings appear on its FEMA Public Assistance request, with costs overwhelmingly dominated by roofing damage. PBA's damage assessment presents loss estimates for 735 buildings, distinguished by FEMA Public Assistance category. Over 60 percent of its buildings, including schools, police stations, fire stations, government centers, judicial centers, and many more, require permanent repair.

Further, evidence gleaned from FEMA Public Assistance applications and other sources suggests that poor maintenance is a central problem impacting building functionality. For example, lack of proper maintenance in schools has "led to the use of improvised maintenance services, the continued implementation of emergency repairs, and the loss of a significant amount of school days."[1]

Description

This COA will complete repairs to damage caused by Hurricanes Irma and Maria to all essential public buildings, ensuring that repairs meet current building safety codes for wind, flood, and seismic risks.

A risk assessment should be performed for each building to ensure that repair plans bring construction to a level that is able to withstand future weather and seismic events. Implementation of this COA may be phased to address the most immediate needs and most

[1] Puerto Rico Public-Private Partnerships Authority, "Projects: Other Projects, School Modernization Program," undated.

critical building types according to the International Building Code's risk classification criteria[2] first.

Potential Benefits

This COA will resolve the issue of damage caused by Hurricanes Irma and Maria. Additionally, by ensuring repairs meet current building safety codes for wind, flood, and seismic risks, public buildings will be more resilient against future hurricanes and other natural disasters.

Repairing building damage caused by Hurricanes Irma and Maria will allow public building occupants to resume full use of the space and, for many occupants, provide much-needed government services that affect the health and safety of the people of Puerto Rico. Additionally, repairing the damage to meet current building safety codes for wind, flood, and seismic risks will make public buildings more resilient to future hurricanes and other natural disasters, potentially reducing future costs. Benefits for individual building owners and occupants will be realized as soon as repairs are complete.

Potential Spillover Impacts to Other Sectors

Public buildings are used by multiple sectors, so this COA 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 (over five years)
Potential recurring costs: $700 million (over 11 years)
Potential total costs: $2 billion

The cost estimate includes only repair and operations and maintenance, while the COA consists of repairing damage; bringing buildings up to current safety codes for wind, flood, and seismic risks; and supplementing building operations and maintenance expenses. The costs of bringing buildings up to code are covered in COA PBD 11 (Bring Public Buildings up to Code).

An important source of damage data is FEMA PA applications. Based on PA application data as of July 2018, a total of $624 million has been requested in over 10,000 requests from 38 applicants. Approximately $350 million of this is for permanent repair work (PA category E),[3] and this value serves as our lower bound estimate for the cost of repairs. This excludes damage to school buildings: damage assessments to schools are ongoing, and the cost of repairing damaged public schools is covered by COA EDU 11 (Rebuilding of Public [PRDE & Municipal] Pre-K–12 School Infrastructure).

[2] These risk categories are summarized in PBD 11. For specifics on these risk categories, see International Code Council (2017).

[3] A definition of FEMA Public Assistance categories can be found at FEMA, "Public Assistance," fact sheet, 2018b.

To arrive at the middle estimate for repair costs, we assume an average building size of 30,000 ft^2, an average repair cost of \$225/ft^2, and a building inventory of 1,400 nonschool buildings and that, on average, each building is 15 percent damaged. This leads to a cost of \$1.4 billion.

Our high estimate for repair costs is taken from the *Build Back Better Puerto Rico* plan,[4] which includes \$3.4 billion for hospitals and health care clinics and \$0.5 billion for public safety facilities, for a total of \$3.9 billion.

We use a building operations and maintenance cost of \$7.77 per square foot per year taken from the International Facility Management Association,[5] which is the U.S. average total cost of operation (maintenance, janitorial, and utility costs). For 1,400 30,000-square-foot buildings, this gives an annual operations and maintenance cost of \$326 million. We assume that current operations and maintenance spending falls 25 percent short of the cost estimated here such that the additional required annual operations and maintenance cost is \$82 million.

The total cost is the sum of repair costs and supplemental operations and maintenance cost:

Low \$1.0 billion, Mid \$2.1 billion, High \$4.6 billion[6]

Potential Funding Mechanisms

FEMA Public Assistance, Hazard Mitigation Grant Program, Community Development Block Grant—Disaster Recovery, private insurance

Potential Implementer(s)

Puerto Rico Infrastructure Financing Authority

Potential Pitfalls

The effectiveness of this COA depends on strong building code enforcement. Puerto Rico's building codes include some of the strictest hurricane resistant standards and are being strengthened further with the expected adoption of new 2018 building codes. However, code enforcement is severely lacking across the island. It has been estimated that as much as 55 percent of the structures in Puerto Rico have not been built properly to code, causing more damage by Hurricanes Irma and Maria than would otherwise have resulted had the structures

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[4] Governor of Puerto Rico (2017).

[5] International Facility Management Agency, *Operations and Maintenance Benchmarks: International Facility Management Association (IFMA)*, Houston, Tex.: International Facility Management Association, September 2017.

[6] For consistency across all sectors, including public buildings, and operations and maintenance (O&M), costs are assumed to be steadily phased in over the course of five years. Specifically, O&M costs are one-fifth of the annual amount during the first year of a project, two-fifths of the annual amount during the second year, and so forth until full annual O&M costs begin in the fifth year. For more information about how costs are calculated and aggregated in the plan, see RAND Corporation (2019).

been built to code.[7] Building code enforcement is the responsibility of the Oficina de Gerencia de Permisos (OGPe, or Office of Permit Management) or autonomous municipalities when, by agreement, OGPe has delegated all its powers and responsibilities to a municipality.[8] Burby, May, and Paterson (2007) provide further discussion of options for improving compliance with local government regulations.[9]

Likely Precursors

The primary precursor is COA PBD 1 (Compile Public Buildings Inventory). In addition, this COA would need to be closely coordinated with several other public building COAs to ensure that efforts to consolidate, repurpose, refurbish, retrofit, sell, or demolish buildings are all working with an integrated plan. These include PBD 2 (Right-Size Public Buildings), PBD 5 (Move Public Services to Public Buildings), PBD 7 (Refurbish Community Centers and Community Technology Centers), PBD 8 (Mitigate Flood Risk for Critical Government Functions), and PBD 11 (Bring Public Buildings up to Code).

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[8] Oficina de Gerencia de Permisos (Office of Permit Management), *2011 Puerto Rico Building Code*, Revision, San Juan, P.R.: Oficina de Gerencia de Permisos, June 2012.

[9] Burby, Raymond J., Peter J. May and Robert C. Paterson, "Improving Compliance with Regulations: Choices and Outcomes for Local Government," *Journal of the American Planning Association*, Vol. 64, 1998, pp. 324–334.

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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 the intended purpose. Puerto Rico has implemented policies that encourage public agencies and public corporations to reduce energy and water consumption. For example:

- **Act 19–2012: Public Building Modernization Program** promotes the use of Energy Savings Performance Contracts (ESPCs) as a strategy for reducing energy and water consumption to meet the goal of 40 percent reduction by 2020.[1]
- **Law 57–2014: Chapter IV, Government's Energy Efficiency** requires that all public agencies implement strategies to reduce energy consumption and present a work plan with reduction goals to the Oficina Estatal de Política Pública Energética (State Office of Energy Policy). The law also promotes the use of ESPCs as a strategy to reduce energy and water consumption.
- **Law 66–2014: Chapter II, Measures to Cut Back on Spending in the Executive Branch** reaffirms the use of ESPCs as a strategy to cut energy and water use and thereby reduce utility spending.[2]
- **Act 229–2008** promotes energy and water efficiency in new and existing public buildings through high-performance architectural and construction methods.[3]

There are also policies and programs in place that provide incentives and tax benefits for eligible entities. For example,

- **Regulations 8653 and 8818** modify the Contribution or Payment in Lieu of Taxes mechanism (in which PREPA receives municipal tax exemptions in exchange for providing municipalities with power) by establishing a maximum ceiling to the contribution (reduced over time), above which municipalities will need to pay for the electricity. One of the objectives of the regulations is to provide incentives for

[1] Oficina Estatal de Política Pública Energética (State Office of Energy Policy), "Informe de Estatus y Planes (Status Report)," in *Government Transition Report 2016*.

[2] Ley Especial de Sostenibilidad Fiscal y Operacional del Gobierno del Estado Libre Asociado de Puerto Rico (An Act to Create the Government of the Commonwealth of Puerto Rico Special Fiscal and Operational Sustainability Act), No. 66–2014 P.R. Leyes.

[3] Puerto Rico House Resolution 476 ordered an investigation of Act 229–2008. One of the committee's recommendations was to tighten Act 229–2008 to the provisions of Act 19–2012. For more details, see La Resolución de la Cámara 476 (P.R. House Resolution 476), 17th A.L., November 6, 2013.

municipalities to reduce consumption through modifying behavior and investing in energy efficiency. These regulations support Law 57-2014, which requires that municipalities reduce energy consumption (5 percent per year, or 15 percent within the first three years).[4]

- **Act 83–2010: Green Energy Incentives Act of Puerto Rico** was created to further renewable energy generation, and provide incentives for meeting compliance goals, and establish a special "Green Energy Fund."[5]

However, adoption of state-of-the-art building design, practices, and technologies among public building owners is slow. This could be due to several factors, including the following:

- Incentives and tax credits (for private owners) might be insufficient to make projects cost-effective; up-front costs might be too high.
- The commonwealth fiscal challenges have stalled projects.
- Public building owners may not be aware of policies and programs or fully understand the benefits.
- Public building owners may not have appropriate technical resources available to them (e.g., contractors knowledgeable about building techniques and materials that improve resilience to natural hazards, facilities management personnel with sufficient knowledge to provide necessary support).
- Programs may not have appropriate monitoring processes in place or have established metrics that ensure benefits are realized.
- There may not be enough qualified energy savings companies in Puerto Rico to perform ESPC work.

Description

Modify existing policies and programs and/or develop new policies and programs that establish clear standards for energy and water efficiency in public buildings and 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. This COA will be implemented through coordination with commonwealth agencies (e.g., Oficina Estatal de Política Pública Energética [State Office of Energy Policy], Oficina de Gerencia de Permisos [Office of Permit Management]) and municipal governments.

The policies and programs developed in this COA should focus on resilience as a key objective, particularly with respect to utilities and design. In addition to hazard-resilient retrofits, resilience can be improved through decentralized off-grid systems and sustainable design

[4] Comisión de Energía de Puerto Rico (Puerto Rico Energy Bureau), Reglamento Sobre La Contribución en Lugar de Impuestos (CELI) (Regulation on Contribution in Lieu of Taxes [CELI]), Reg. Num. 8653, October 19, 2015; Comisión de Energía de Puerto Rico, Reg. Num. 8653 (Anulado por el Reg. Núm. 8818 [As amended by Regulation 8818]).

[5] Ley de Incentivos de Energía Verde de Puerto Rico (Green Energy Incentives Act of Puerto Rico), Law 83 of July 19, 2010, P.R. Laws Ann. tit. 13, §§ 10421–10446 (2007 & Supp. 2011).

principles; some examples include rooftop photovoltaic systems, solar water heaters, rainwater harvesting systems with cisterns, and passive daylighting and passive cooling designs. The commonwealth will need to strike a balance between incentive programs and policies that stipulate required and advisory building practices, given that incentives are limited for public buildings and the government is working with limited financial resources.

Policies and programs in other states may serve as a model for Puerto Rico. The following are potentially relevant examples:

- California's Bright Schools Program provides technical services, up to $20,000, to help "identify the most cost-effective energy saving opportunities." Services may include energy audits and feasibility studies, reviewing proposals and designs, developing equipment performance specifications, reviewing equipment bid specifications, and reviewing commissioning plans.[6]
- California's Proposition 39 allowed up to $550 million annually of tax revenue to be allocated to projects that "improve energy efficiency and expand clean energy generation in schools."[7]
- California's low-interest loans are available for schools, cities, counties, public colleges, and universities.[8]
- Rhode Island established an efficient building fund that provides to local governments technical, administrative, and financial assistance with energy efficiency and renewable energy projects in public buildings. The fund is supported through a loan loss reserve fund and electric and gas demand charges.[9]
- Numerous other state policies exist and are compiled by the American Council for an Energy Efficient Economy.[10]

It will also be important to develop outreach and educational programs surrounding new building codes, policies, and programs. This could include workshops, trainings, distributing brochures, and so on.

Potential Benefits

This COA will encourage reduced resource use and life-cycle building costs, achievement of commonwealth energy goals, reduction of potential future damage, increased reliability of critical public services, potential job creation. Increased energy and water efficiency in public buildings will reduce resource use and life-cycle building costs and will assist the commonwealth

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[6] See California Energy Commission, "The Bright Schools Program," CA.gov, undated-a.

[7] See California Energy Commission, "The California Clean Energy Jobs Act (Proposition 39 K-12 Program)," CA.gov, undated-b.

[8] See California Energy Commission, "Energy Efficiency Financing," CA.gov, undated-c.

[9] National Conference of State Legislatures, "Energy Efficiency State Legislative Update: 2015," webpage, January 5, 2016.

[10] America Council of Energy-Efficient Economy, State and Local Database, undated.

in meeting its energy goals. Hazard resilient design will reduce potential future damage and increase reliability of government services. This COA also has the potential to create jobs in the energy efficiency and renewable energy sector. State-of-the-art building design that considers the adaptability and suitability of spaces may result in public buildings that are better fit for their intended purpose, including improved educational environments and health care facilities that can utilize state-of-the-art equipment.

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. This COA may support the development of facilities that can more reliably provide critical public services. Examples include facilities capable of operating new health care technologies that are not supported by current facilities or schools that are better able to implement cutting-edge educational curricula that help to develop a twenty-first-century workforce.

Potential Costs

Potential up-front costs: —
Potential recurring costs: $7 million (11 years)
Potential total costs: $7 million

This cost estimate considers only the annual cost for labor to develop and run programs. Adhering to standards and providing incentives will also have costs that cannot be determined at this time. This cost estimate assumes ten standard government employees will work for 11 years.

Potential Funding Mechanisms

Government of Puerto Rico, U.S. Department of Energy

Potential Implementer(s)

Government of Puerto Rico agencies, municipal governments

Potential Pitfalls

This COA depends on stable economic conditions, identification of specific programs, and sufficient funding. Since this COA does not prescribe a set of modifications to policies or programs or new policies and programs, the implementation team for this COA will need to develop specific policies and programs for which the benefits exceed the costs and will be successful where previous attempts have failed.

Likely Precursors

Completing COA PBD 1 (Compile a Public Buildings Inventory) will ensure 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.

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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.

Puerto Rico's building codes include some of the strictest hurricane-resistant standards and will be strengthened further with the expected adoption of new 2018 building codes. However, code enforcement is severely lacking across the island. It has been estimated that as many as 55 percent of the structures in Puerto Rico have not been built properly to code, causing more damage by Hurricanes Irma and Maria than would otherwise have resulted had the structures been built to code.[1] Building code enforcement is the responsibility of the Oficina de Gerencia de Permisos (OGPe, or Office of Permit Management) or autonomous municipalities when, by agreement, OGPe has delegated all its powers and responsibilities to a municipality.[2]

Description

This COA entails an assessment of building safety code compliance for wind, flood, and seismic risks across the public building inventory and retrofits of buildings with the appropriate structural hardening. Where feasible other code upgrades (e.g., energy performance) should also be included. This COA will be implemented through collaboration of multiple government agencies and private entities. Increased energy efficiency performance will be realized immediately, and hazard-resilience benefits will be realized through reduced damage following future extreme weather events and natural hazards.

Risk assessments and land use suitability analyses should inform implementation of this COA. Prior to undertaking any retrofits, it is important that a building's condition is assessed, its location and vulnerability to hazards is evaluated, and that its disposition, design, and purpose going forward is determined. It is important that work is not performed on buildings slated to be sold, significantly renovated, or demolished. With respect to hazard evaluation, it is possible to delineate high-risk zones by hazard type (e.g., seismic, tsunami, wildfire, flood, storm surge, and landslide/debris flow) across the island so that appropriate retrofits are identified.

To ease the potential financial burden of implementing this COA, we suggest the COA follow a phased approach. Buildings and structures that fall within the International Building

[1] Nonko (2017).

[2] Oficina de Gerencia de Permisos (2012).

Code Risk Category III and IV should be prioritized over Category II and I. For reference, we include a brief description of the categories:[3]

- Category I includes "buildings and other structures that represent a low hazard to human life in the event a failure," such as agricultural buildings and storage facilities.
- Category II includes buildings and other structures that are not included in another risk category.
- Category III includes "buildings and other structures that represent a substantial hazard to human life in the event a failure," such as facilities with 300 or more people, educational facilities, power-generating stations, or other utility facilities not included in category IV.
- Category IV includes essential buildings and structures such as hospitals and emergency treatment facilities, emergency shelters, fire and police stations, power-generating stations, water storage and supply facilities, aviation facilities, and other critical facilities for civil and national defense.

Potential Benefits

Investing in strengthening building resilience to natural hazards will increase the likelihood that public buildings will perform within public building owners' risk tolerances and will withstand extreme weather events and natural hazards. Improved energy and water performance will reduce building life-cycle costs. Building codes outline the minimum legal design and construction requirements for quality, safety, and energy performance in any given jurisdiction. Structural components of buildings, including the foundation and building envelopes, are often in place for 50 years or more; thus, initial design and construction decisions have implications for the operation and maintenance costs over the life of the building. Using and enforcing a code framework that is based on sound engineering principles and is widely accepted can enhance Puerto Rico's protection against natural and human caused hazards.

Building codes

1. save lives
2. protect investments by reducing property and financial losses, supporting faster recovery and protecting a community's tax base
3. provide the insurance industry a way to estimate and manage risk
4. increase disaster resilience by protecting property and lives, supporting continued provisioning of critical services, and reducing recovery costs
5. improve the nation's building stock by regulating new construction and existing structures for structural integrity, materials, and fire protection against consistent standards.[4,5]

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[3] For specifics on these risk categories, see the International Code Council (2017).

[4] Federal Emergency Management Agency, Building Science Branch, "An Introduction to Building Codes for Property Owners," presentation, undated.

[5] Ellen Vaughan and Jim Turner, *The Value and Impact of Building Codes*, Washington, D.C.: Environmental and Energy Study Institute, September 30, 2013.

Damage to rooftops has been a primary cause of building performance issues during hurricanes,[6] and rooftops lost or damaged during Hurricane Maria due to high winds rendered numerous public buildings unsafe, unusable, or with restricted functional status. Investing in strengthened roofs on public buildings via replacement or retrofit will increase the likelihood that the physical structure of these buildings will withstand subsequent extreme weather events. Retrofitting rooftops to decrease the likelihood of rooftop damage or loss during a hurricane will in turn reduce wind and water damage to building contents and could help avoid disruption of critical public services.

Potential Spillover Impacts to Other Sectors

This COA could reduce the costs of operations, maintenance, and repair over the life cycle of the building (Municipalities) and improve reliability of government services (Health and Social Services).

Potential Costs

Potential up-front costs: $900 million–$2 billion (five years)
Potential recurring costs: —
Potential total costs: $900 million–$2 billion

The cost range estimated in this COA is based on the marginal cost to bring public buildings up to the expected new 2018 Puerto Rico Building Codes, which will largely be based on the 2018 International Building Codes. We do not include the costs of risk assessments or engineering studies that might be required to determine appropriate retrofits. Since we do not yet know the specific requirements that will be adopted in the codes and we do not know the current condition of the public building inventory, we use a percentage of construction cost as an estimator for basic code upgrades and seismic retrofits. These percentages are based on subject matter expertise gathered from architects and engineers, RS Means,[7] a construction cost estimating software, and FEMA documents.[8,9] Roofing estimates are based on intermediate

[6] Federal Emergency Management Agency, "Building Envelope Performance," in FEMA, *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*, Jessup, MD: Federal Emergency Management Agency, FEMA 549, July 2006.

[7] Estimates are based on *RS Means Data Online* from 2015 with a 4 percent compounded escalation to 2018 (Gordian, RS Means data, Version 8.7).

[8] Federal Emergency Management Agency, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 1: Summary, FEMA-156*, December 1994.

[9] Federal Emergency Management Agency, *Typical Costs for Seismic Rehabilitation of Existing Buildings, Volume 2: Supporting Documentation, FEMA-157*, September 1995.

roofing retrofit[10,11,12] costs for residential buildings sized approximately 1,600 ft^2, scaled to the average public building size.[13] From PBA's and PRIDCO's damage assessment data, we calculate the average public building to be approximately 30,000 ft^2. The parameterized cost estimates for code upgrades and hazard retrofits are additive. Costs for public schools are covered separately in COA EDU 11 (Rebuilding of Public [PRDE & Municipal] Pre-K–12 School Infrastructure). We assume that 50 percent of the 1,400 nonschool public buildings will need retrofitting.

Our cost estimate uses the following assumptions:

- Basic code upgrades (not including seismic and wind): 10 percent to 20 percent of new construction cost
- Seismic retrofits: 5 percent to 15 percent
- Roofing retrofits: $230,000–$300,000 per building
- Number of non-school public buildings: 1,400
- New construction cost (medium 10,000 ft^2 to 100,000 ft^2): $225 per ft^2

Based on these assumptions, we develop a low- and a high-cost estimate (see Table A.4).

Table A.4. Potential Costs for Bringing Public Buildings up to Code

	Lower cost ($ million)	Higher cost ($ million)
Basic code upgrades	472.5	945
Seismic retrofits	236.25	708.75
Roofing retrofits	161	210
Total	869.75[a]	1,864[b]

NOTES: [a] The calculation for this is ($225/ft2 × 30,000 ft2 × 10% × 700) + ($225/ft2 × 30,000 ft2 × 5% × 700) + ($230,000 × 700) = $472,500,000 + $236,250,000 + $161,000,000 = $869,750,000.
[b] The calculation for this is ($225/ft2 × 30,000 ft2 × 20% × 700) + ($225/ft2 × 30,000 ft2 × 15% × 700) + ($300,000 × 700) = $945,000,000 + $708,750,000 + $210,000,000 = $1,864,000,000.

Potential Funding Mechanisms

FEMA Public Assistance, FEMA Hazard Mitigation Grant Program, government of Puerto Rico, U.S. Department of Education

[10] Includes securing the roof deck, replacing the roof covering, installing and improving secondary underlayments, window and entry door protection, bracing of walls, and strengthening connections of attached structures.

[11] Federal Emergency Management Agency, *Wind Retrofit Guide for Residential Buildings, FEMA P-804*, December 2010.

[12] Federal Emergency Management Agency, "Cost Effectiveness Determination for Residential Hurricane Wind Retrofit Measures Funded by FEMA," Job Aid, undated.

[13] We recognize that residential roofing retrofits are very different from commercial roofing retrofits. In the absence of adequate commercial cost data, we chose the use residential cost estimates scaled to the average public building size as determined using AEPs and PRIDCO's data.

Potential Implementer(s)

Government of Puerto Rico agencies, municipal governments

Potential Pitfalls

The effectiveness of this COA depends 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.

As discussed above, it has been estimated that as many as 55 percent of the structures in Puerto Rico have not been built properly to code, causing more damage by Hurricanes Irma and Maria than would otherwise have resulted had the structures been built to code. Strict codes and standards do nothing if they are not properly enforced.

Additionally, if no consideration is given to land use suitability or the intended purpose of the building, it is possible that retrofits could be undertaken on buildings that are not properly sized for intended purpose or are unnecessarily located in hazard-prone areas, which is not a cost-effective use of limited financial resources.

For roof retrofits, rooftop installation of solar systems could result in a rooftop that is more susceptible to damage. For flat rooftops with solar systems installed on mounted brackets at an angle, the additional wind lift from the solar panels could result in rooftop damage that might not otherwise occur with a flat roof.[14] Additionally, installation of solar systems requires proper mounting procedures to maintain watertight sealing. Therefore, rooftop retrofitting should collaborate with decisionmaking in the energy sector to ensure that contractors hired to complete wind retrofitting jobs work in parallel with solar installers to ensure appropriate design and construction processes. Lack of coordination could result in rooftop failure during a storm.

Likely Precursors

Completing COAs PBD 1 (Compile a Public Buildings Inventory), PBD 2 (Right-Size Public Buildings), and PBD 8 (Mitigate Flood Risk for Critical Government Functions) is important for effective implementation. This COA can also supplement the work performed under PBD 9 (Repair All Essential Public Buildings Damaged by Hurricanes Irma and Maria).

Up-front costs to retrofit public buildings could be justified with a determination of the cost-effectiveness of this retrofit and assessing the value of assuring continuous functionality in these buildings. A complete inventory of public buildings and their functions will help identify which buildings should be prioritized for retrofitting. It will also be important that any right-sizing or relocation of buildings happens before undergoing retrofit construction and the work performed under this COA can be done in conjunction with repair work that happens under PDB 9. This COA should also be performed in conjunction with EDU 11 (Rebuilding of Public [PRDE &

[14] Eliza Hotchkiss, "How Is Solar PV Performing in Hurricane-Struck Locations?" NREL.gov, October 24, 2017.

Municipal] Pre-K–12 School Infrastructure), which performs similar retrofits for public buildings.

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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.

Standards for determining emergency power system requirements and guidelines for their implementation exist and can be used to help identify system performance specifications.

- Emergency power system classification is outlined in NFPA Standard for Emergency and Standby Power Systems and includes considerations for determining performance specifications based on level of criticality, length of autonomous operation required, and startup time.[1]
- IEEE has recommended practices for emergency and standby power systems that include a discussion of power needs and system configurations.[2]
- FEMA 543 contains general design guidelines for mitigating risk from natural disasters and refers to American Society of Civil Engineers (ASCE) building classifications to identify critical and essential facilities.[3]

Description

This COA develops guidelines for the design of secondary power systems for public buildings. It will require coordination among a number of organizations—including municipalities, the Oficina de Gerencia de Permisos (OGPe, or Office of Permit Management), and Oficina Estatal de Política Pública Energética (OEEPE, or State Office of Energy Policy)—to implement. Existing standards for emergency and standby power systems can be used as a resource for guideline development.[4] Increased resilience to power grid outages is realized on completion of power system design and installation.

Appropriate system design for backup power depends on many variables. Clear guidelines that consider relevant variables will enable the eventual installation of effective power systems

[1] National Fire Protection Association, *Standard for Emergency and Standby Power Systems, NFPA 110*, 2019 Edition.

[2] Institute of Electrical and Electronics Engineers, *IEEE 446-1995: Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, December 1995.

[3] Federal Emergency Management Agency, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds: Providing Protection to People and Buildings*, January 1, 2007.

[4] Existing standards include IEEE 446-1995 (1995), NFPA 110 (2019), and NFPA 70 (2016).

that create a redundant and secure energy supply for critical and essential functions. This COA will provide guidelines for identifying system performance specifications, including startup time, autonomy, and system protection requirements. These guidelines can then be used to make decisions about specific system components. For example, a building with a lower emergency backup power requirement can consider a small solar-charged battery. A system with a critical load during an emergency may require a traditional backup generator design.

Potential Benefits

This COA facilitates the design of appropriate backup power systems for essential public services and results in redundant energy supply if implemented.

Clear guidelines for backup power system design, if implemented, support the safety and health of personnel that rely on the functions housed by these public buildings. The appropriate design for a secondary power generation system will depend on the specific needs of the building during and following an emergency, and guidelines for classifying buildings and their emergency power standards requirements can be found in NFPA and ASCE documentation. The likelihood of having sufficient power to meet critical and essential functions can be increased by identifying the needs of these buildings and establishing clear requirements for backup systems to meet those needs. The guidelines produced via implementation of this COA will identify these requirements and serve as a necessary first step toward successful backup system design and installation.

Potential Spillover Impacts to Other Sectors

This COA would develop guidelines for secondary power generation that, if implemented, could improve the reliability of services (Health and Social Services, or HSS). Microgrid designs will need to coordinate with energy sector to establish interconnection guidelines.

Health and social services are supported by ensuring continuous operation of critical and essential public functions. If public buildings are earmarked for use during an emergency, backup power generation will support the continued operation of these emergency services during a grid outage. Further, critical medical support systems will have continuous power even during an outage, and essential services provided by police and fire departments will be more robust. If HSS functions can be categorized according to their specific power needs for maintaining a mission-critical level of operations, this can inform backup system design for each building that houses these functions.

The crossover to the energy sector may be a minimal consideration depending on the backup system design. If the building is using a backup generator, its use will occur only in the event of a grid outage and it is designed to operate independently from the grid. A switch will sense the loss of power in the event of an outage and initiate the backup power generation. However, if backup generation includes a microgrid concept that is tied to the grid, interconnection guidelines need to be followed as determined by the utility provider.

Potential Costs

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

Assuming six full-time equivalent staff persons will be required in labor hours to develop these guidelines, the cost would be approximately $0.4 million over the course of one year. This cost does not include system components and installation required to implement these guidelines. The cost of developing these guidelines will include labor hours to develop criteria for power levels and operational durations by building type as well as criteria for siting and hazard-proofing systems.

Potential Funding Mechanisms

Puerto Rico Energy Commission, Puerto Rico Electric Power Authority, FEMA Hazard Mitigation Grant Program, Community Development Block Grant—Disaster Recovery

Potential Implementer(s)

Oficina Estatal de Política Pública Energética (State Office of Energy Policy), Oficina de Gerencia de Permisos (OGPe, or Office of Permit Management)

Potential Pitfalls

Lack of oversight, funding, maintenance, and enforcement would significantly decrease the impact of this COA. Oversight and enforcement of these standards will require the assignment of these tasks to current personnel or hiring additional personnel for this specific task. If this is not done, the establishment of standards will not be effective. In addition, increased maintenance to ensure code compliance could be required. While photovoltaic arrays with battery backup do not require significant maintenance (it is generally recommended that photovoltaic arrays are cleaned and inspected annually to ensure optimal performance), generators should be inspected more frequently and tested at full load. Further, the cost of installing these backup systems to implement these guidelines would be significant and could inhibit the implementation of these guidelines.

Part of enforcement of this COA would ensure that backup systems themselves are appropriately protected from the effects of natural disasters. During Hurricane Sandy, many mechanical and power system failures were a result of inadequate protection of utility rooms on ground floors. While this requirement crosses over into PBD 11 (Bring Public Buildings up to Code) and multihazard mitigation, particular attention should be paid to ensuring that backup systems are able to operate during and following a natural disaster.

Likely Precursors

While not impacting the COA itself, implementation of this COA requires as input a current inventory and classification of functions provided by public building PBD 1 (Compile a Public Buildings Inventory) to determine the appropriate backup power design to sustain these functions. The guidelines developed by this COA would help identify appropriate system designs based on the functions and services they will support. For example, critical functions will need to be backed up by systems that have minimal startup times and maximum resilience. Identifying which buildings house these critical functions is essential for establishing standards for designing secondary generation systems that meet these functions.

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The government of Puerto Rico submitted an economic and disaster recovery plan to Congress on August 8, 2018, describing a strategic approach to recover from the destruction caused by Hurricanes Irma and Maria, build resilience to withstand future disasters, and restore the struggling economy. The Homeland Security Operational Analysis Center (HSOAC) provided substantial input for the plan by engaging with numerous stakeholders, conducting analyses, assessing damages and needs, deducing courses of action and costs, and identifying possible funding mechanisms. Acting in support of the Federal Emergency Management Agency's (FEMA) public buildings sector and the government of Puerto Rico, the HSOAC team compiled data from multiple sources on public building damage, analyzed the data, and identified gaps in the data for some public buildings. Additional analyses assessed recent changes in population and employment that might affect building use and needs. These analyses, coupled with discussions with FEMA, U.S. Army Corps of Engineers, and government of Puerto Rico agencies, informed the development of 12 courses of action represented in the recovery plan for the public buildings sector. These courses of action embody the public buildings sector vision of reinvesting in public building infrastructure not only to repair the damage caused by the 2017 hurricanes but also to modernize this infrastructure to increase resilience to natural hazards, improve energy efficiency, and improve functionality and user experience.

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