Hazard Mitigation Assistance

Mitigation Action Portfolio

FEMA

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The Mitigation Action Portfolio (MAP), was prepared in compliance with Section 508 of the Rehabilitation Act of 1973. The MAP contains publicly available data for project descriptions, costs, and partnerships. The MAP was first published in August, 2020. This document may be periodically updated with additional content after its original release date.

When you see this icon throughout this portfolio, hover over the image to learn more!

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FEMA Community Lifelines Addressed per Case Study

The table below displays the community lifelines addressed by the case studies in this portfolio, organized by primary hazard. The community lifeline that is considered the "primary community lifeline" is shaded for each case study in red.

HAZARD	PROJECT NAME	COMMUNITY LIFELINES						
		Safety & Security	Food, Water, Shelter	Health & Medical	Energy (Power & Fuel)	Communications	Transportation	Hazardous Material
All Hazards (4 Case Studies)	Blue Lake Rancheria Tribe Microgrid	x	x		x			
	Bronzeville Microgrid Project	x	x		x	x	x	
	ConnectArlington Communication Infrastructure Upgrades	x		x		x	x	
	Massachusetts State Hazard Mitigation and Climate Adaptation Plan	x	x	x	x	x	x	x
Coastal Flooding (5 Case Studies)	LaGuardia Airport Flood Control	x			x		x	
	NYU Langone Medical Center Flood Resilience Projects	x	x	x	x			
	Mexico Beach Recovery and Resiliency Partnership	x	x				x	
	Relocation of Newtok Village	x	x	x	x	x	x	
	Virginia Point Wetland Protection Project	x			x		x	
Drought (1 Case Study)	Salinas Aquifer Storage and Recovery	x	x					
Earthquakes (3 Case Studies)	Alaska Building Codes	x	x					
	Berkeley Seismic Vulnerability Retrofits	x	x					
	Earthquake Safety Retrofits at Good Samaritan Hospital	x	x	x				
Hurricanes (4 Case Studies)	Florida Building Codes	x	x					
	Nicklaus Children's Hospital Hurricane Retrofits	x	x	x				
	NY Rising Community Reconstruction: Recovery and Resiliency Initiative	x	x	x			x	
	Renovation of Alexander Theater	x	x					
Inland Flooding (15 Case Studies)	Atlanta Stormwater Ordinance and Green Infrastructure Program	x					x	
	Bidwell Paiute Tribal Reservation Flood Mitigation Project	x	x		x		x	
	Buffalo, WY Flood Control	x					x	
	Cleveland and Northern Ohio Regional Stormwater Management and Flood Mitigation Program	x	x					
	Cuyahoga Falls Rain Garden Reserve	x	x					
	Exploration Green Stormwater Park	x	x	x			x	
	Harris County Flood Control District Voluntary Acquisition Program	x	x					
	Lincoln Wastewater Treatment Plant Flood Mitigation	x	x	x				
	Minot Water Treatment Plant Floodwall	x	x					
	Northwest Resiliency Park	x	x				x	
	Petaluma Payran Reach Flood Control and Floodways	x	x	x			x	
	Resilient Shelby's Greenprint for Resilience	x	x				x	
	Resilient St. Vrain Nature-Based Flood Protection	x	x	x			x	
	Spring Creek Drainage Improvement Project	x					x	
	Worthington County Ditch 12 Flood Mitigation Project	x	x					
Landslides (3 Case Studies)	American Samoa Rockfall Mitigation Project	x					x	x
	Rocky Boy's Reservation Lagoon Relocation	x	x	x				
	Washington DOT Landslide Mitigation Action Plan and Rail Corridor Improvements	x					x	x
Tornadoes (1 Case Study)	Mercy Hospital Rebuild	x	x	x				
Tsunamis (2 Case Studies)	Alaska DHS and EM Tsunami Education, Mapping, and Siren Check	x	x	x				
	Shoalwater Bay Tribe Tsunami Evacuation Structure	x	x					
Wildfires (2 Case Studies)	Camptonville Biomass Plant	x			x			
	Colorado Springs Wildfire Mitigation	x	x	x				
Winter Storms (1 Case Study)	Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects	x			x			

Introduction & Background

In recent years, Americans have witnessed the enormous and devastating effects of hurricanes, floods, wildfires, earthquakes, and other events. The increasing duration, intensity, and severity of such disasters—which are exacerbated by changes in population, land use, and weather patterns—are alarming and highlight one of the most important emergency management challenges facing the United States.

As a result, the effort to build resilience to natural hazards has shifted from a post-disaster discussion to one of improved pre-disaster actions. The impacts of natural hazards on communities, families, individuals, and our economy makes it imperative to invest in creating infrastructure and communities more resilient to natural hazards.

In response to these alarming impacts, the Mitigation Framework Leadership Group, which includes representatives from the federal, state, local, tribal, and territorial governments and is chaired by FEMA, produced the National Mitigation Investment Strategy. The National Mitigation Investment Strategy is a single national strategy for advancing mitigation investment to reduce risks posed by—and increase the nation's resilience to—natural hazards, such as sea level rise, droughts, tornadoes, hurricanes, floods, wildfires, and earthquakes.

The Investment Strategy encourages the whole community, including individuals, to invest in pre- and post-disaster mitigation by adopting the Investment Strategy's three shared goals:

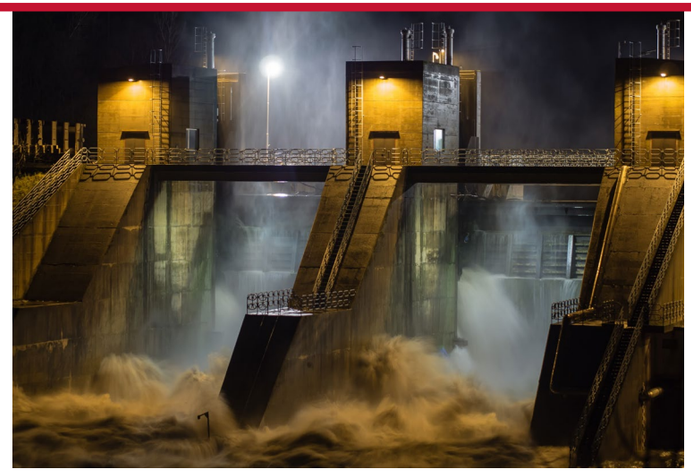
- **Show how mitigation investments reduce risk**
- **Coordinate mitigation investments to reduce risk**
- **Make mitigation investments standard practice**

This portfolio showcases mitigation projects to provide practitioners with examples of activities that integrate the Investment Strategy's goals and reflect the guiding principles of the Disaster Recovery Reform Act of 2018 (DRRA). Beginning in 2020, the Building Resilient Infrastructure and Communities (BRIC) grant program, which was created as part of DRRA, replaced the existing Pre-Disaster Mitigation (PDM) program and is funded by a six percent set-aside from federal post-disaster grant expenditures.

Through BRIC, FEMA will invest in a wide variety of mitigation activities, including community-wide public infrastructure projects. Moreover, FEMA anticipates BRIC will fund projects that demonstrate innovative approaches to partnerships, such as shared funding mechanisms and/or project design. For example, an innovative project may bring multiple funding sources or in-kind resources from a range of private and public sector stakeholders. It also may offer multiple benefits to a community in addition to risk reduction.

Ultimately, BRIC funding will not be able to meet all mitigation needs across the nation. Rather, in order to achieve the full intent of the Investment Strategy, BRIC will look to public partners at the state, local, tribal, and territorial levels and in the private sector to share responsibility in amplifying the impact of federal investment in mitigation by coordinating and connecting funding and resources to move resilience projects forward.

Each year, FEMA plans to develop the annual Notice of Funding Opportunity (NOFO) and provide technical assistance and additional implementation materials so that state, local, tribal, and territorial partners have the information they need to submit successful applications aimed at hazard mitigation that creates more disaster-resilient infrastructure and communities. Additional information on BRIC is available online at www.fema.gov/BRIC.



Dam releasing water during a storm

Source: Photo by Jani Brumat on Unsplash

Purpose and Intended Use of this Mitigation Action Portfolio

This portfolio has been created to introduce stakeholders to the BRIC program and the array of eligible hazard mitigation activities that can benefit stakeholders. For nearly 20 years, FEMA has provided almost $1.5 billion in pre-disaster mitigation funds, supporting and implementing numerous hazard mitigation projects to address all types of natural hazards spanning all levels of government, including tribal and territorial governments. FEMA-developed project descriptions, guidebooks, and other informational documents, many of which are available at https://www.fema.gov/hazard-mitigation-assistance, have been created to describe hazard mitigation projects. Rather than include all BRIC-eligible project types, this portfolio is intended to showcase select innovative hazard mitigation projects for different hazards to highlight a wide range of possibilities of projects to fund under the new BRIC program.

FEMA hopes these project examples inspire stakeholders to think big and bold in addressing natural hazards, while also considering additional benefits that can be achieved beyond reducing economic and human costs from disasters. For example, project design should consider how community lifelines, such as safety and security, transportation, and energy, can be incorporated in the implementation and outcome of the hazard mitigation project. In addition, the BRIC program will support eligible projects that utilize nature-based solutions to reduce risk and produce environmental and community benefits.

Projects highlighted in this portfolio are meant to exemplify successful hazard mitigation that also enhances a culture of preparedness and holistic disaster resilience.

This portfolio can be a resource to help Applicants and subapplicants (state, local, tribal, and territorial governments) apply for a grant under BRIC. In addition, it may generate ideas and be useful in considering projects for other FEMA Hazard Mitigation Assistance (HMA) programs, such as the Hazard Mitigation Grant Program (HMGP), or for other mitigation focused, federal funding opportunities through the Department of Housing and Urban Development, the Department of Energy, and the National Oceanic and Atmospheric Administration.

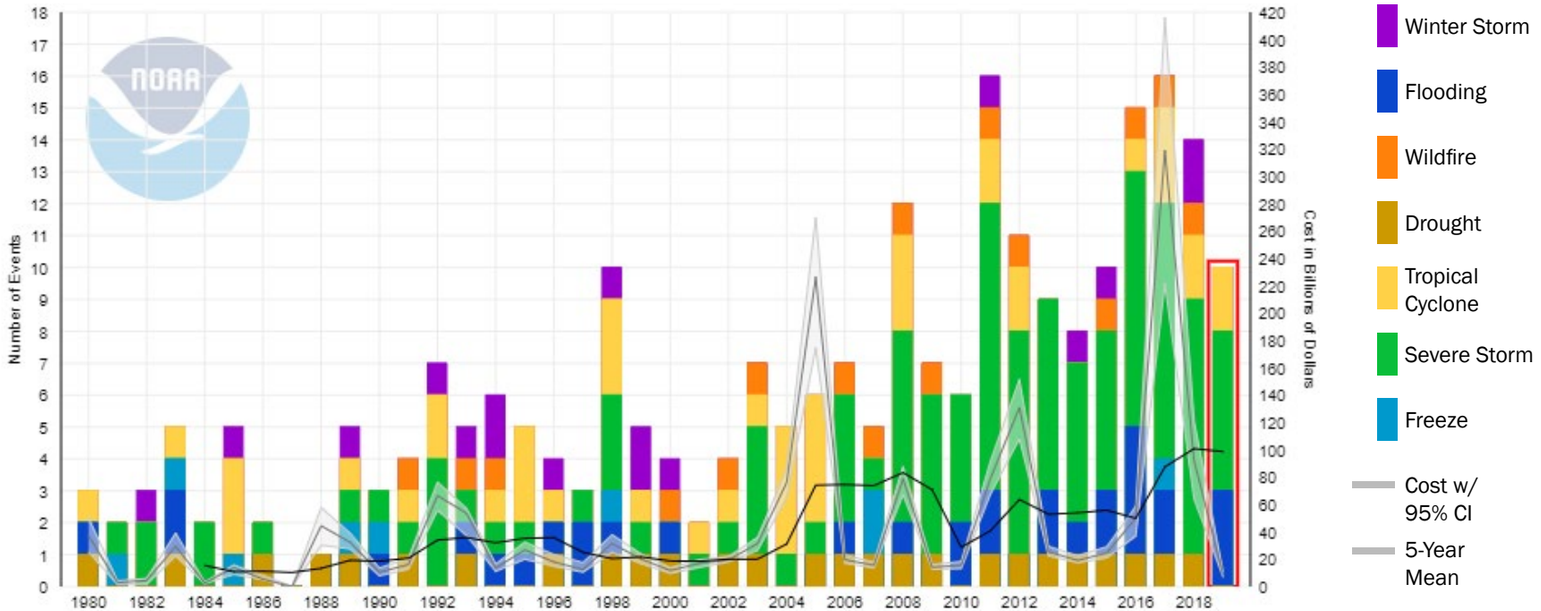
Other private and non-governmental partners in the hazard mitigation community may find this resource helpful, particularly in brainstorming opportunities to collaborate with the public sector to create more disaster resilient communities and infrastructure. This portfolio highlights partnerships to emphasize the importance of collaboration across and between governments, private-sector entities, and non-governmental organizations towards achieving effective hazard mitigation and disaster resilience.

Through the mitigation planning process and beyond, we encourage you to imagine what is possible to increase disaster resilience in your communities and to view relevant project sheets in consideration of activities that could be designed and/or implemented to address local hazards.

Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)

The number (bars, left axis), type (colors), and annual cost (right vertical axis) of U.S. billion-dollar disasters from 1980-2018. Running annual cost (gray line), along with the 95% confidence interval, and 5-year average costs (black line). The number and costs of disasters are increasing. Inland flooding (blue bars) and severe storms (green bars) are making in increasingly large contribution to the number of U.S. billion-dollar disasters.

Source: NOAA, https://www.climate.gov/sites/default/files/barchart-billions.png

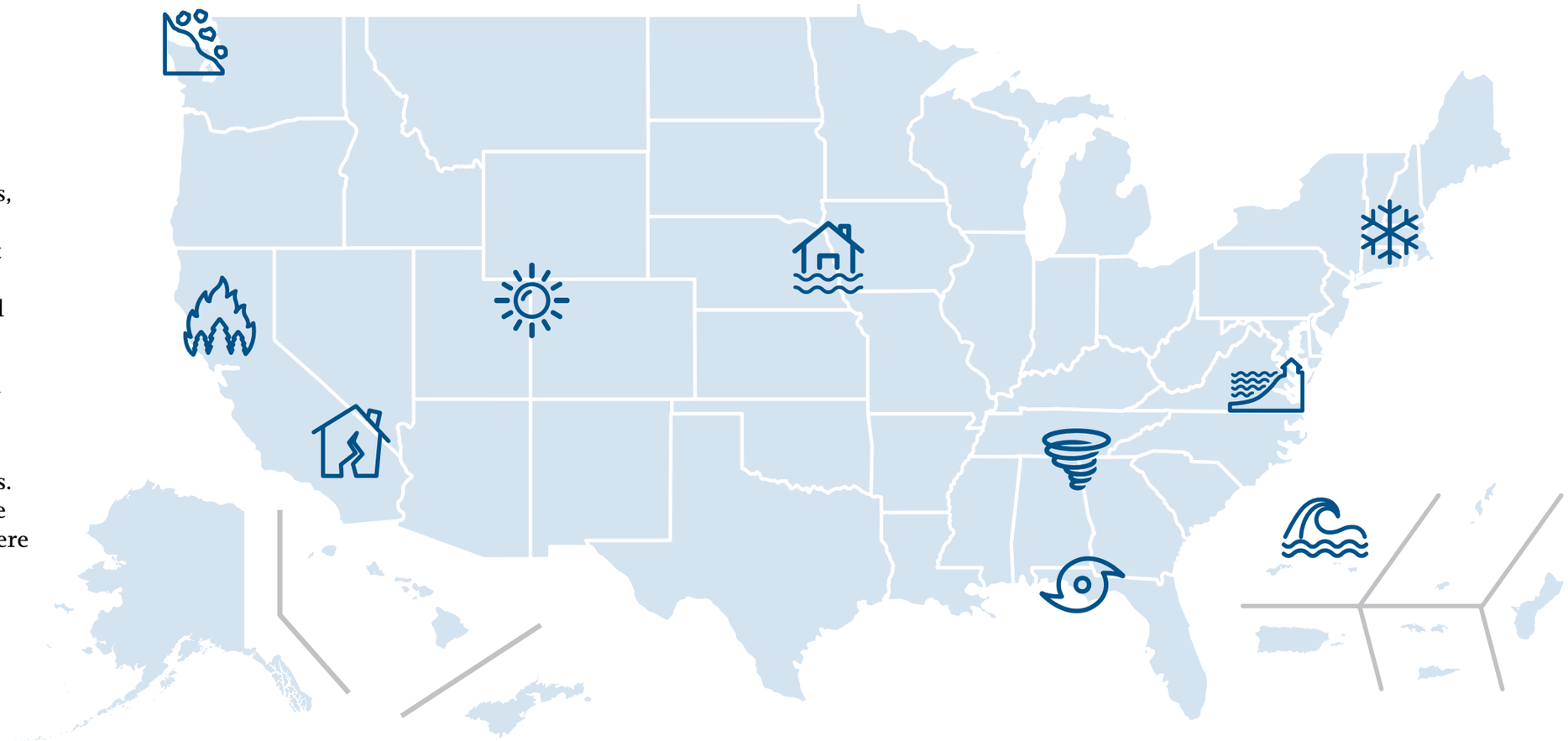


Hazards

From 1980 to 2018, natural hazards in the United States led to an average annual $42.8 billion of property damage and insurance claims, thousands of deaths, as well as injuries, displacements, and livelihood disruptions. With the increase in extreme events in recent years, the average cost per year more than doubles to $99 billion for 2014 to 2018. Not all hazards impact equally. Different hazards are responsible for disparate consequences and there is significant variation in the geography of where hazards occur. This map displays the geographic distribution of the 10 most impactful hazards, based on financial damages. Icons are placed where significant events have occurred in the past, but do not represent where those hazards are limited to.

Hover over each hazard icon on the map to learn more.

References for the information on this page can be found at the end of this document.



Wildfires

From 1980 to 2018, 16 billion-dollar wildfires were responsible for more than ~$79 billion in damages and 344 deaths.

Earthquakes

More than half of the notable earthquakes in the U.S. have occurred in California and Alaska. The damages caused by large earthquakes can range from $2 million to more than $232 billion.

Drought

From 1980 to 2018, 26 billion-dollar droughts were responsible for more than $244 billion in damages and the second highest number of deaths of all hazards with 2,993 deaths.

Inland Flooding

From 1980 to 2018, there were 29 billion-dollar flood events that were responsible for over $123.5 billion in damages and 543 deaths.

Tornadoes

U.S. tornadoes cause $400 million in damages and kill about 70 people every year.

Hurricanes

From 1980 to 2018, hurricanes caused the most damage ($920 billion) and caused the most deaths (6,487). Each event averages $22 billion in damages.

Coastal Flooding

Coastal floods are caused by events such as high tides, storm surges, strong waves, and heavy precipitation. The average frequency of high-tide flooding is already 50% greater than in year 2000.

Tsunamis

Since 1800, tsunamis have caused more than 700 deaths and ~$2 billion in damages to U.S. coastal states and territories.

Winter Storms

From 1980 to 2018, 16 billion-dollar winter storm events were responsible for more than $47 billion in damages and 1,044 deaths.

Landslides

U.S. landslides cause over $1 billion in damages and kill 25 to 50 people every year. They affect all 50 states and U.S. territories.

Community Lifelines

To help communities better monitor disruptions to critical services and systems following a disaster and reduce cascading impacts across government and business functions, FEMA launched the community lifelines framework. This framework has served as a driving force behind two of the agency's strategic goals: building a culture of preparedness and readying the nation for catastrophic disasters.

Since the seven community lifelines and their respective components, as graphically shown on this page, were introduced, they have resonated strongly in response and recovery circles to organize both day-to-day operations and strategic planning after a disaster. Community lifelines can also be a powerful tool for state, local, tribal, and territorial governments to use in evaluating risk and developing strategies to reduce hazard impacts. However, the use of community lifelines has not been fully integrated into all phases of the emergency management cycle. As FEMA conducted stakeholder engagement sessions through the summer of 2019, it was discovered that the connection between community lifelines and hazard mitigation, particularly pre-disaster risk reduction activities, is not widely understood.

BRIC offers a unique opportunity for FEMA to apply its community lifelines concept to hazard mitigation practices so that communities can build resilience to both the direct and cascading impacts of a disruptive event. This portfolio will be a useful resource to inspire change by profiling a broad spectrum of activities ranging from small-scale projects to large-scale initiatives.

These demonstrate how one project or activity can have community-wide disaster resilience benefits and mitigate risk across multiple community lifelines. Leveraging community lifelines in hazard mitigation planning and project implementation can be transformational in terms of a community's ability to respond to and recover from the impacts of natural hazards and ensure long-term resilience outcomes.

"A lifeline enables the continuous operation of critical business and government functions and is essential to human health and safety or economic security."

FEMA Community Lifelines

Source: fema.gov/media-library/assets/documents/177222

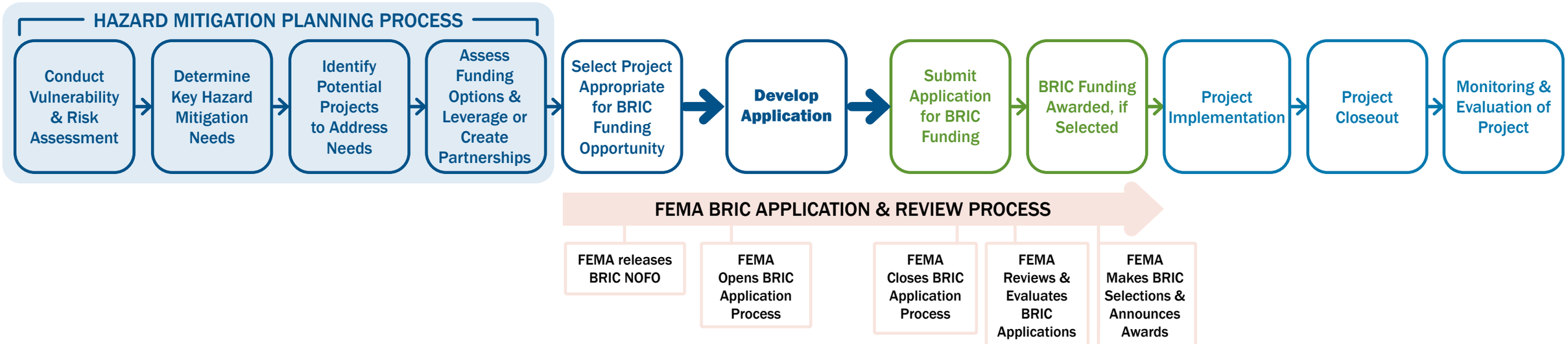
Hazard Mitigation: Reducing Risk and Increasing Resilience

One of FEMA's primary objectives is to support risk reduction and increase community resilience through funding of hazard mitigation projects and activities. A BRIC-eligible project that is effective at reducing risk and improving long-term resilience to disasters will require a thorough and thoughtful development process.

Project development should identify hazards that need to be addressed, local partners and funding opportunities, and specific options to address specific needs. Furthermore, projects should attempt to maximize benefits, both hazard mitigation and broader community, economic, and environmental benefits. The graphic below provides a simplified version of the general steps an Applicant or subapplicant might take, from hazard mitigation project development to BRIC application submittal, to implementation of a project, if awarded. The arrow below the top row signifies the general programmatic flow of FEMA's actions and engagement during the BRIC application and review process.

Numerous actions can be taken, and hazard mitigation interventions put in place, to minimize the impacts of natural hazards and reduce the overall risk of disasters, while also increasing community resilience.

Some actions cut across multiple hazards; others are uniquely designed to address a single hazard. Hazard mitigation projects can come in the form of a plan or an ordinance, coastal wetland protection, or an engineered and built structure. Furthermore, hazard mitigation projects can come in different sizes—actions can be very localized to address a targeted issue, such as an enlarged culvert to allow for greater waterflow or an individual saferoom to provide shelter from a tornado. But projects can also have a wider geographic impact, such as a hazard mitigation plan, city ordinance, or flood mitigation action that reduces area-wide flooding. Building codes, when properly enforced, are uniquely effective at reducing impacts and losses from all types of hazards. Municipalities and states have taken different steps to ensure base-level hazard risk reduction through adopting building codes as a hazard mitigation intervention, as described in the next section.



Building Codes: Low-Cost, High-Impact Hazard Mitigation

Many states and communities regulate the construction of buildings by adopting and enforcing building codes that set forth the minimum acceptable requirements necessary for protecting the public health, safety, and welfare in the built environment. Communities with up-to-date and enforced building codes have demonstrated fewer devastating losses in terms of both property and human life.

A 2013 report, *Including Building Codes in the National Flood Insurance Program: Report to Congress* (available at https://www.fema.gov/media-library-data/1385728818014-f08e55ee83590650103995b2c66e2285/Incl_Bldg_Codes_NFIP2.pdf), found that model building codes are effective in reducing flood-related building damage because of specific design requirements and, in some cases, the inclusion of additional elevation (freeboard) and foundation improvements. A nationwide study, *Building Codes Save: A Nationwide Study of Loss Prevention*, that culminates a decade of research and quantifies the physical and economic losses that were avoided due to buildings being constructed according to modern, hazard-resistant building codes and standards will soon be released. More information is available at: https://www.fema.gov/emergency-managers/risk-management/building-science/building-codes/save-study. The results clearly demonstrate the effectiveness of modern building codes in reducing damages: (1) average annual avoided losses related to flooding were estimated to be $86 million (based on 183,000 parcels); (2) average annual avoided losses related to hurricanes were estimated to be $402 million (based on 702,000 parcels); and (3) average annual losses avoided related to seismic activity were estimated to be $940 million (based on 28,000 parcels).

Although most locally adopted building codes in the United States are based on model building codes, states and local jurisdictions often incorporate amendments and revisions to address local hazards. For example, the Florida Building Code (FBC) contains separate (more stringent) wind, structural, and testing requirements for a special zone called the High-Velocity Hurricane Zone (HVHZ) in order to better protect buildings constructed in this hurricane-prone area.

Hurricane destruction surrounding a standing house
Source: Jocelyn Augusitno/FEMA / Public domain, https://upload.wikimedia.org/wikipedia/commons/5/55/Hurricane_Ike_Gilchrist_damage_edit.jpg

Lack of code enforcement often leads to building performance that is less robust than anticipated. FEMA's Mitigation Assessment Teams (MATs) conduct building performance studies after disasters and routinely conclude that damage observed after disasters is partly attributable to lack of sufficient building code enforcement and implementation. As a part of the effort to reform federal disaster programs and build the nation's capacity to better mitigate the impacts of catastrophic events, the BRIC program is uniquely positioned to encourage building code adoption and enforcement.

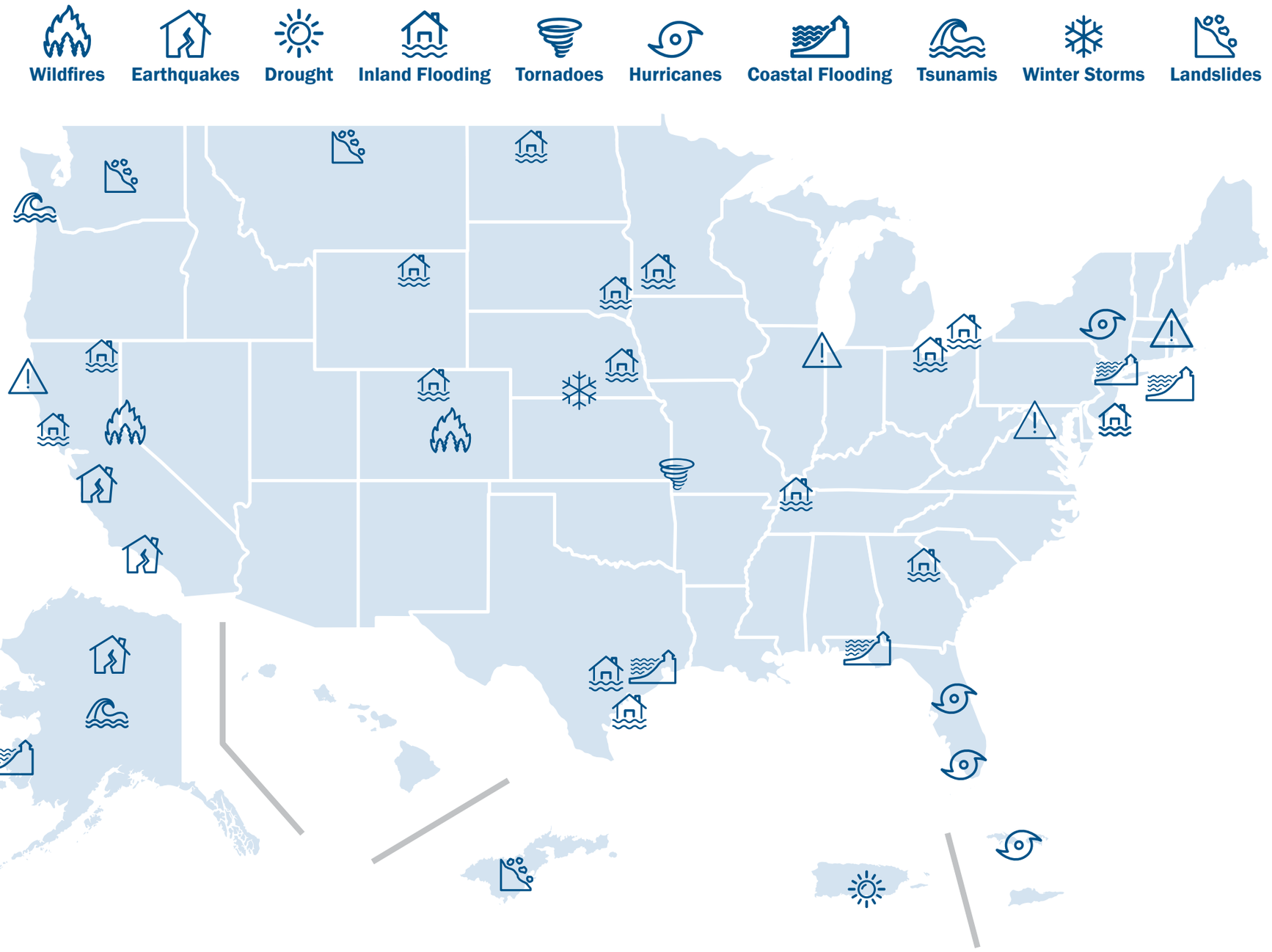
Damages in Texas after Hurricane Harvey (2017) demonstrated clearly the advantage of adopting local floodplain management regulations:

- **For buildings built BEFORE adoption: 365 buildings had average claim of $175,028**
- **For buildings built AFTER adoption: 308 buildings had average claim of $86,870**

Case Study Geography

The projects showcased in this portfolio are just a small subset of the hundreds of successful hazard mitigation projects implemented by communities to increase community resilience. Projects were sought out that met key criteria related to BRIC goals. All of the hazard mitigation projects selected achieve, or are designed to achieve, hazard risk reduction; however, each project also addresses one or multiple community lifelines and improves the disaster resilience of the community in which it is located. Projects shown here are also meant to exemplify risk reduction activities that can produce value beyond their primary hazard mitigation purpose, and to inspire stakeholders to replicate or tailor activities shown to be applicable and possible for their relevant and local context. Projects selected have been funded from a range of sources, including federal funding from agencies such as FEMA or Housing and Urban Development (HUD), as well as non-federal funding, like states or municipalities. In all, these projects are demonstrable examples of BRIC's ambition to think holistically and at scale when it comes to hazard mitigation and disaster resilience.

Hover over each hazard icon on the map to learn more. Click on the icon to go to that case study's page.



Case Study Guide

Highlight Section
This section features primary highlights from the project, including unique or exemplary components and quantitative and qualitative impacts.

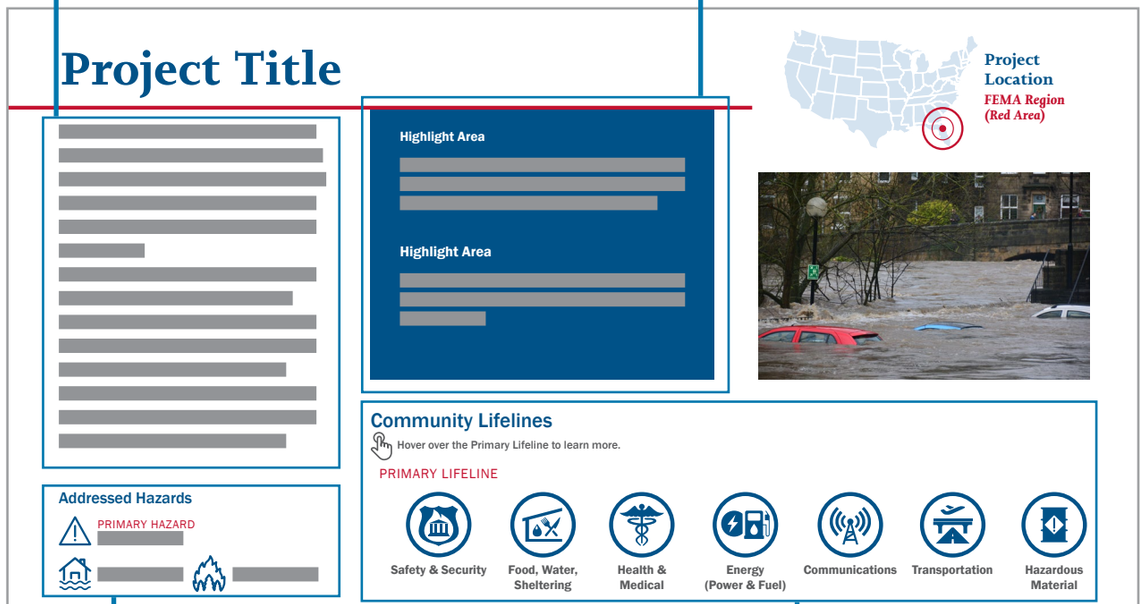
Project Description
This section provides an overview of the case study project.

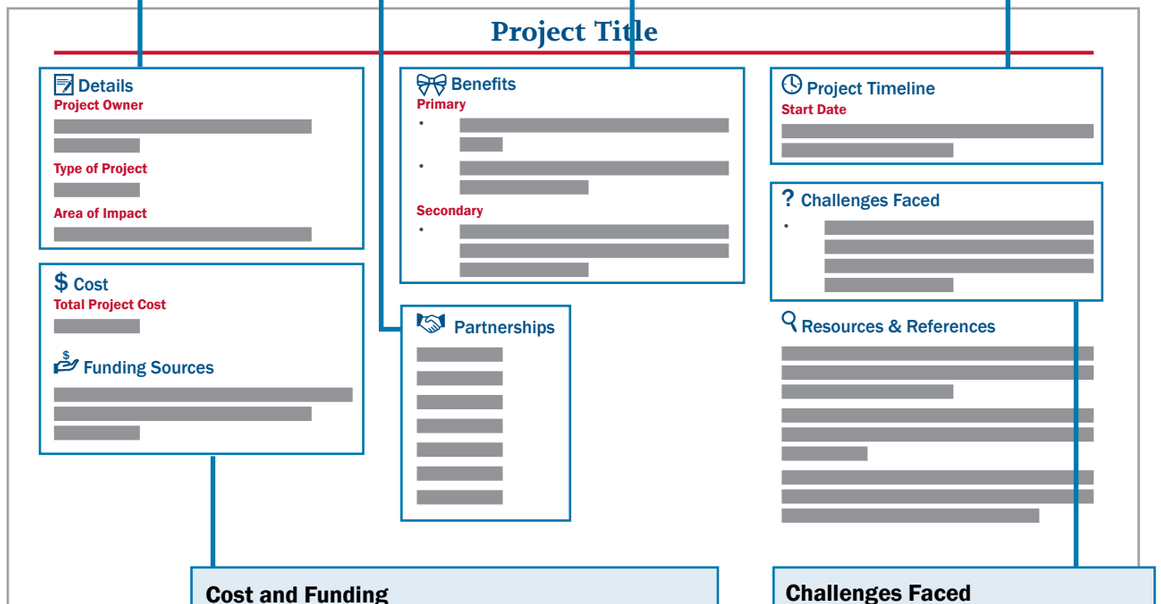
Details Section
This section presents several project details, including who owns the project, such as a local government body or a specific organization, and what type of project it is. The area of impact represents the total geographic area that the project encompasses, such as a building, a neighborhood, or a city. When available, the number of people impacted is also presented here.

Benefits
Primary and secondary benefits of the project are presented here. This includes both benefits to the community, as well as to any local infrastructure.

Partnerships
A list of partners involved in the project is presented here.

Timeline
This section lists the project timeline, including the start date, current status, and completion date. If the project is still in progress, an anticipated completion date is presented if known.





Addressed Hazards
This highlights the primary hazard that the project addresses, as well as any secondary hazards addressed or potentially addressed by the project, if applicable. Potential hazards addressed by case studies include wildfires, earthquakes, drought, inland floods, tornadoes, hurricanes, coastal floods, tsunamis, winter storms, and landslides. For projects intended to address multiple hazards at once, there is an all-hazards designation.

Community Lifelines
This shows the FEMA Community Lifelines that are addressed by the project. The highlighted lifeline is considered the primary lifeline and includes a brief description as to why it's considered primary.

Hover over the Primary Lifeline to learn more.

Cost and Funding
These sections provide information on the overall cost of the project. Sources of funding are also provided when available, as well as any details on how much each source contributed.

Challenges Faced
This section presents challenges faced during project planning, implementation, and follow up. Challenges were identified by using public project documents and are only presented when available.

⚠ All Hazards

Blue Lake Rancheria Tribe Microgrid

Humboldt Bay, CA
FEMA Region IX

The Blue Lake Rancheria (BLR) is a Native American reservation located in an area subject to heavy rainstorms, forest fires, and frequent power outages. The reservation constructed a low-carbon community microgrid in 2017 to bolster its resilience to these outages. It helps power government offices, economic enterprises, and several Red Cross safety shelter-in-place facilities. The BLR microgrid integrates a solar array, battery storage, and control systems to allow the Rancheria campus to operate in tandem with, or islanded from, the main utility grid. This provides resiliency to the community because if the main grid experiences a power outage, the microgrid will automatically disconnect and go into island mode.

The system prioritizes clean generation, but if needed it will bring a 1-megawatt isochronous backup generator online to support the photovoltaic (PV) array and battery. The solar array also generates renewable energy regardless of whether or not it is in island mode, providing both carbon emission and electricity cost savings. The microgrid is projected to save $150,000 a year and reduce 150 tons of carbon dioxide emissions annually.

Innovative Energy Solution Tested and Proven in 2019

When a nearby wildfire caused a power outage in October 2019, the microgrid successfully islanded and kept the facilities from experiencing a blackout. During the outage, the microgrid served 10,000 people, about 10 percent of the county's population, and is credited with saving four lives.

Leveraging Partnerships for Tribal Lifeline Resilience

By leveraging public and private partnerships, this project utilizes the latest in microgrid technology to mitigate cascading impacts to an entire tribal community.

Addressed Hazards

PRIMARY HAZARD
All Hazards

Inland Flooding

Wildfires

Workers installing the racking for the Blue Lake Rancheria's 500-kilowatt solar system in June 2016. The solar system is a cornerstone of the tribe's low-carbon community microgrid project.
Source: U.S. Department of Energy Flickr https://www.flickr.com/photos/37916456@N02/27365396111

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Energy (Power & Fuel)

Blue Lake Rancheria Tribe Microgrid

Details

Project Owner
The Schatz Energy Research Center and the Blue Lake Rancheria Tribe

Type of Project
Microgrid

Area of Impact
Over 10 percent of Humboldt County, CA
(Total Pop: 136,754 in 2017)

$ Cost

Total Project Cost
$6.3 million

Funding Sources

Non-Federal Funding
California Energy Commission R&D grant through Electric Program Investment Charge (EPIC) Program: $5 million

The Blue Lake Rancheria: $1.3 million

Benefits

Primary
- Less frequent physical damage to system components, less frequent system outages from natural hazards, and better overall system performance and resiliency
- Targets a low-income community facing impacts from future conditions

Secondary
- Lower costs for meter reading and usage monitoring, social benefits associated with more reliable electric power, and better business continuity following major disasters that typically would have caused outages for several days or weeks

Partnerships

- The California Energy Commission (major funder)
- The Blue Lake Rancheria (site host and major funder)
- Humboldt State University's Schatz Energy Research Center
- Pacific Gas & Electric (local utility)
- Siemens (Microgrid Management System [MGMS])
- Tesla (battery energy storage system)
- Idaho National Laboratory (testing and simulation)
- Robert Colburn Electric (electrical contractor)
- REC Solar (turnkey PV system)
- McKeever Energy & Electric (PV installation)
- GHD, Inc. (electrical engineering)
- Kernen Construction (civil construction for the project)

Project Timeline

Start Date
100 percent design completed September 15, 2016; granted full permission to operate July 26, 2017

? Challenges Faced

- Challenges with installing new microgrid infrastructure over an existing built environment
- Need for electricians with institutional knowledge of existing systems

Resources & References

California Energy Commission. 2019."California Energy Commission Final Project Report." January 2019. https://ww2.energy.ca.gov/2019publications/CEC-500-2019-011/CEC-500-2019-011.pdf.

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Bronzeville Microgrid Project

Chicago, IL
FEMA Region V

The Bronzeville microgrid is a pilot project implemented by Illinois' Commonwealth Edison Company (ComEd) to keep power flowing in the event of an emergency and provide support for solar infrastructure for residents of the historic Bronzeville neighborhood in Chicago's South Side, including its vulnerable populations. The project includes 1,000 residences, businesses and public institutions. The Bronzeville Microgrid project is part of ComEd's broader Community of the Future initiative.

This project:

- **Improves energy security, resilience to future conditions, and sustainability**
- **Provides grid modernization and "smart city" technologies to improve community livability**
- **Includes extensive stakeholder outreach and engagement within the Bronzeville community**

Technology-Driven Resilience Creates Community-Wide Benefits

A modern energy grid that uses "smart city" technology to mitigate risk across multiple community lifelines, and will reduce vulnerability for an entire neighborhood and the surrounding economy.

Bronzeville, Chicago metro stop station
Source: Shutterstock

Bronzeville, Chicago
Source: Shutterstock

Addressed Hazards

PRIMARY HAZARD
All Hazards

Inland Flooding

Winter Storms

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Energy (Power & Fuel)

Transportation

Communications

Bronzeville Microgrid Project

Details

Project Owner
Commonwealth Edison Company

Type of Project
Microgrid

Area of Impact
1,000 residences, businesses and public institutions

$ Cost

Total Project Cost
$29.6 million

Funding Sources

Non-Federal Funding
Commonwealth Edison Company

Federal Funding
Federal grant funding of more than $4 million to date from U.S. Department of Energy

Benefits

Primary
- Reduces system outages from natural hazards
- Improves overall system performance, reliability, and resilience for customers within the service area, and potentially neighboring customer areas
- Provides more reliable electric service to the target customers, but also can provide better resiliency to neighboring customer areas that have not had microgrid systems installed

Secondary
- Enhances community livability associated with increased reliability in electric power
- Improves business continuity resulting from reduced outages and disruptions in electric power

Partnerships

Chicago Housing Authority
(manages Dearborn Homes Community in Bronzeville)

Illinois Institute of Technology

Argonne National Laboratory

Project Timeline

Start Date
Plan approved by Illinois Commerce Commission on February 28, 2018

Status
In progress

Project Completion Date
Targeted December 2020

? Challenges Faced

- Securing regulatory and stakeholder approval
- Ongoing community outreach to identify priorities and opportunities to leverage smart grid technology, address challenges and enhance quality of life
- Meeting requirements for a solar installation with a generation capacity of 750 kilowatts at Chicago's first public housing community

Resources & References

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Commonwealth Edison Company. 2020. "Bronzeville Community Microgrid." Accessed March 16, 2020. https://bronzevillecommunityofthefuture.com/project-microgrid/.

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ConnectArlington Communication Infrastructure Upgrades

Arlington, VA
FEMA Region III

Arlington County, VA, created its own fiber optic network through the ConnectArlington Program. Approved by the county board in 2011, the program replaced 52 miles of copper wiring with 60+ miles of fiber optics to link county facilities, school facilities, and traffic signals. The County also created additional capacity for the business community for high-speed, secure data transmission through "dark fiber." The new network offers transmission rates that are at least 100 times faster than previously existing internet access and meet the highest technical standards. This increased the communications resilience in the County.

Before this project was implemented the County relied on radio communications via towers and microwave for 911 operations. When a storm would hit, there was the potential for signal and service disruption. The new fiber optic cables resolved this. In addition, radio towers can be connected terrestrially for the highest quality of coverage in the event of an emergency. This allows campuses to provide in-building public safety radio communications to all buildings from a single source, reducing miscommunication and lag time.

Addressed Hazards

PRIMARY HAZARD
All Hazards

Inland Flooding

Winter Storms

Improving Emergency Response Efficiency

The new system allows real-time traffic monitoring, so ambulatory services can know which roads to avoid for the safest and fastest travel. The County's emergency vehicle preemption system also enables the County to turn lights green for emergency vehicles at 31 major intersections.

Excavation for the laying of optical fiber
Source: Shutterstock

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Health & Medical

PRIMARY LIFELINE

Communications

Transportation

ConnectArlington Communication Infrastructure Upgrades

Details

Project Owner
Arlington County

Type of Project
Infrastructure

Area of Impact
Entire County of Arlington (Total Pop: 234,965 in 2018)

$ Cost

Total Project Cost
Estimated at $50 million (in 2014)
(Dark fiber network component = $4.2 million)

Annual operating expenses are estimated to be $700,000-$800,000

Funding Sources

Federal Funding
Federal Highway Administration (FHWA)

Non-Federal Funding
Arlington County Capital Improvement Plan budget: $1.6M in FY15

Benefits

Primary
- Avoidance of physical damage to communication system components
- Reduction in loss of service to communication systems, especially during disaster events
- Life-safety benefits of reduced injuries and deaths with more reliable communication system

Secondary
- Social benefits of peace-of-mind with a more reliable emergency response system and options for better real-time communication during an event
- Better coordination of emergency services during disaster events

Project Timeline

Start Date
Board approved in 2011

Project Completion Date
Dark fiber construction completed in fall 2015

? Challenges Faced

- Restrictive state laws on leasing dark fiber out to businesses

Resources & References

Arlington County Broadband Advisory Committee. 2019. "Dark Fiber Leasing Report and Recommendations." Appendix II. https://arlingtonva.s3.amazonaws.com/wp-content/uploads/sites/6/2020/01/BAC-Document-14-JAN-19-FINAL.pdf

Arlington Virginia Departments & Offices. 2020. "ConnectArlington" Accessed March 16, 2020. https://departments.arlingtonva.us/dts/connectarlington/.

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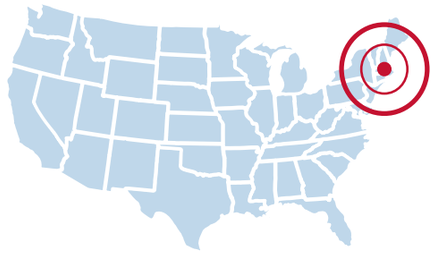
National Association of Counties. 2014. "Improving Lifelines: Protecting Critical Infrastructure for Resilient Counties." November 2014. http://naco.org/sites/default/files/documents/NACo_ResilientCounties_Lifelines_Nov2014.pdf.

Massachusetts State Hazard Mitigation and Climate Adaptation Plan



State of Massachusetts
FEMA Region I

The 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) is Massachusetts' first all-hazard mitigation plan that fully integrates climate adaptation. In addition to being compliant with federal standards for hazard mitigation plans, this fulfills Governor Baker's Executive Order 569 and comprehensively integrates climate change impacts and adaptation strategies. As part of the plan, an extensive risk-assessment process was undertaken for the state, using downscaled climate data in a GIS spatial analysis as well as a State Agency Vulnerability Assessment Survey Tool, as two of the many tools used to capture and address the state's vulnerability to natural hazards. It takes projected changes in precipitation, temperature, sea-level rise, and extreme weather into account when evaluated all risks. A "prioritization tool" was also developed to weight and score hazard mitigation/climate adaptation actions for the plan.

The plan is a "living document" that is being continually updated as new information comes available. The plan has received awards from both the Massachusetts chapter of the American Planning Association and the Climate Change Business Journal.

The planning process was managed through the Executive Office of Energy and Environmental Affairs (EOEEA), the Executive Office of Public Safety and Security (EOPSS), and the Massachusetts Emergency Management Agency (MEMA), and involved a Project Management Team composed of several key state agencies. The plan also includes five overarching goals, including investing in performance-based solutions, and 108 specific hazard mitigation and climate adaptation "actions" stemming from each of the five goals. The online portal for the plan offers an "Action Tracker" tool designed to allow the public to track progress on each of the 108 actions proposed as part of the plan's implementation.

First Plan of Its Kind

This is the first of its kind where the plan comprehensively integrates future condition impacts and adaptation strategies with hazard mitigation planning. It also complies with federal requirements and maintains Massachusetts' eligibility for federal disaster recovery and hazard mitigation funding under the Stafford Act.

Addressed Hazards

PRIMARY HAZARD
All Hazards

Coastal Flooding

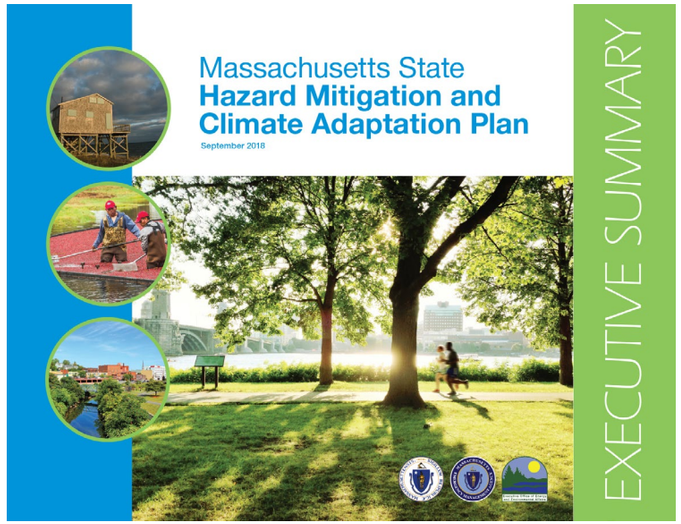
Winter Storms

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

- **Safety & Security**
- **Food, Water, Sheltering**
- **Health & Medical**
- **Energy (Power & Fuel)**
- **Communications**
- **Transportation**
- **Hazardous Material**



Online plan document

Source: https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf

Massachusetts State Hazard Mitigation and Climate Adaptation Plan

Details

Project Owner
Commonwealth of Massachusetts

Type of Project
Hazard Mitigation and Climate Adaptation Plan

Area of Impact
Entire Commonwealth of Massachusetts
(Total Pop: 6.9 million in 2017)

$ Cost

Total Project Cost
$479,340 (plan contract)

The cost of developing new plans includes community staff time and any outside consultants to provide technical support and associated analysis. For this plan for statewide mitigation and climate adaption, adding new local requirements may increase initial project costs, but will result in lower long-term costs for many projects due to increased resiliency and lower maintenance and repair costs.

Funding Sources

Non-Federal Funding
Massachusetts state funding

Benefits

Primary
- Allows the state to evaluate relative risk geographically and between hazards to cover all major concerns for the state
- Leverage opportunities to address current and future concerns within planning and project efforts

Secondary
- Provides a platform for state and local communities to coordinate activities, host periodic meetings, conduct monitoring, and update the list of possible activities which can all in turn facilitate the grant application and project implementation process

Partnerships

Executive Office of Energy and Environmental Affairs (EOEEA)

Executive Office of Public Safety and Security (EOPSS)

Massachusetts Emergency Management Agency (MEMA)

Project Timeline

Start Date
Plan adopted on September 17, 2018

? Challenges Faced

- Constantly changing climate science and projections
- Recognized obstacles to overcome to further increase state and local capacity to address future conditions and natural hazards
- Robust and extensive stakeholder engagement

Resources & References

Massachusetts Emergency Management Agency. 2018. "Massachusetts State Hazard Mitigation and Climate Adaptation Plan." September 2018. https://www.mass.gov/files/documents/2018/10/26/SHMCAP-September2018-Full-Plan-web.pdf.

Resilient Massachusetts. 2020. "Massachusetts State Hazard Mitigation & Climate Adaptation Plan: A First-of-its-Kind Integrated State Plan." Accessed March 16, 2020. http://resilientma.org/shmcap-portal/index.html#/.

Coastal Flooding

LaGuardia Airport Flood Control

New York City, NY
FEMA Region II

Flooding from Superstorm Sandy in 2012 forced LaGuardia airport in New York City to shut down for three days, which resulted in 3,300 canceled flights and impacted 250,000 passengers. The airport handles between 20 and 30 million passengers yearly, is a hub for Delta Airlines, and serves as a major economic engine for the region. In addition to $9 million in capital funding from the Port Authority, the State of New York received over $28 million in Hazard Mitigation Grant Program (HMGP) funding in 2015 for retrofits and upgrades to protect the airport from the impacts of future storms. The overall airport renovation project will also include many other non-flood-related improvements, including creating a new central terminal, combining two existing terminals currently serving Delta Airlines, and adding additional concourses and gates, among others.

Improvements include a floodwall around the airport's west end substation, gravity drainage systems, upgrades to the airport's backup electrical substations, and the installation of larger, more efficient backup power generators throughout the airport. Project designs follow the climate resilience standards first established by the Port Authority in 2009 (updated in 2015 and 2018). These standards take into account FEMA base flood elevations, sea level rise projections, and future increases in precipitation intensity and quantity to establish the design flood elevations of structures and the drainage capacity requirements for flood and stormwater infrastructure. Technological innovation, while addressing flood hazards, is a key focus of not only this project, but the ongoing massive redevelopment of the entire airport. These innovations including the following:

- New approaches to construction phasing with building on top of current facilities to create a single, unified terminal
- More resilient electrical power generation, usage, and backup systems
- Major improvements to airport access, including a future AirTrain, expected to be completed in 2021

Retrofits to Safeguard Community Lifelines & Jobs

Improvements to reduce LaGuardia's vulnerability to future storms, such as fortifying on-site energy systems, will allow the airport to continue serving travelers following severe weather events and in turn minimize impacts to the livelihoods of the airport's thousands of employees.

Addressed Hazards

PRIMARY HAZARD
Coastal Flooding

Hurricanes

Winter Storms

Aerial image of LaGuardia Airport
Source: Patrick Handrigan / CC BY-SA (https://creativecommons.org/licenses/by-sa/4.0)

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Energy (Power & Fuel)

PRIMARY LIFELINE

Transportation

LaGuardia Airport Flood Control

Details

Project Owner
Port Authority of New York

Type of Project
Flood Mitigation Infrastructure

Area of Impact
Potential impacts to a significant percentage of Queens residents (Total Pop: 2.3 million in 2017)

$ Cost

Total Project Cost
$37.5 million (flood control measures – overall renovation estimated at $8 billion+)

Funding Sources

Federal Funding
FEMA HMGP: $28.1 million

Non-Federal Funding
Port Authority of New York and New Jersey: $9 million

Benefits

Primary
- Reduces costs caused by the loss of function associated with airport closure, canceled flights, and potential loss of service for the businesses that operate in the airport
- Avoids physical damage to airport facilities and equipment
- Reduces loss of service from canceled flights and airport closure; loss of service would be expected for all businesses associated with the airport, including those located off-site, such as shuttle and bus services
- Offers project effectiveness for smaller, more frequent events as well as larger, less frequent events such as Superstorm Sandy
- Although the project's focus may be to address larger, less frequent events in the future, even small drainage improvements could provide fewer delays from more frequent storm events
- These smaller reductions from more frequent events tend to be a main source of the benefits in a benefit-cost analysis

Secondary
- Provides benefits to businesses that rely on regular airport function, especially the tourism and financial sectors
- Reduces closure times, which benefits areas in the vicinity of the airport, where many airport workers live
- Reduces congestion to other NYC area airports and area transportation systems (railways and subways) that could be caused by increased traffic from a prolonged airport closure

Partnerships

State of New York

Port Authority of New York

FEMA

Project Timeline

Start Date
Planning began in 2013; funding awarded in 2015

Project Completion Date
Construction expected to be completed by 2022

? Challenges Faced

- Complex project, involving flood mitigation measures as well as other major upgrades

Resources & References

Barone, Vincent and Lauren Cook. 2019. "LaGuardia Airport construction explained: Renovation plans, timeline, funding and more." AMNY. September 2019. https://www.amny.com/transit/laguardia-airport-construction-explained-renovation-plans-timeline-funding-and-more-1-12268455/.

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A Whole New LGA. 2020. "A Whole New Airport for New York." Accessed March 16, 2020. https://www.anewlga.com/.

NYU Langone Medical Center Flood Resilience Projects

New York City, NY
FEMA Region II

New York University's (NYU's) Langone main hospital campus was forced to evacuate over 300 patients as a result of Hurricane Sandy devastating New York City, including many in critical care. The hospital's main campus was engulfed by more than 15 million gallons of water, which disrupted services and destroyed critical facilities, equipment, and research. The damages were estimated to be $1.4 billion. It took the hospital months to resume full care services.

Following Sandy, NYU Langone Health has been restoring and upgrading its facilities to build resilience. As the first line of defense, NYU is installing a flood barrier with both horizontal and vertical mitigation measures protecting the envelope of all campus buildings. These are built to bridge the gaps between buildings where a flood barrier is not a part of the building's structural wall system. As a second line of defense, NYU is installing internal layers of protection around critical building systems and specialized equipment. This includes building compartmentalization, emergency power, and elevation of critical elements. Several critical utilities, communication networks, and clinical and research programs are being raised above vulnerable levels as well. All gaps along the perimeter of the hospital campus are being filled and walls are being reinforced to protect the building. They have also developed a robust emergency management and continuity planning process.

The medical center is also aiming to mitigate the project's impact on climate change by seeking Leadership in Energy and Environmental Design (LEED) and WELL certification and reducing its carbon emissions and water consumption.

The primary hazard this project addressed was flooding, specifically storm surge and smaller stormwater flood events. The elements of the project that address backup power generation can be considered all hazards, since this backup capacity can provide electrical power regardless of what hazard may cause a power outage.

Award-Winning Upgrades Safeguard Critical Systems

Recognizing system vulnerabilities and leveraging various types of mitigation measures to keep critical infrastructure and specialized equipment operational during a flood earned the Langone Medical Center the Practice Greenhealth Climate and Health Innovation Award.

Addressed Hazards

PRIMARY HAZARD
Coastal Flooding

Hurricanes

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Energy (Power & Fuel)

NYU Langone Medical Center Generators
Source: FEMA

NYU Langone Medical Center Flood Resilience Projects

Details

Project Owner
New York University

Type of Project
Building Retrofits

Area of Impact
Has potential to impact a significant percentage of the population of the borough of Brooklyn
(Total Pop: 2.6 million in 2017)

$ Cost

Total Project Cost
$1.13 billion

Funding Sources

Federal Funding
FEMA

- Public Assistance ($150 million)
- Section 428 Capped Grant ($411 million for repair/restoration; $589 million for hazard mitigation)

Other Federal Agencies

National Flood Insurance Program

HHS Social Services Block Grant Program

Non-Federal Funding
Ronald O. Perelman

Benefits

Primary
- Avoidance of physical damage to the hospital building and contents such as large medical equipment
- Life-safety benefits, including a reduction in potential injuries/deaths for hospital patients
- Reduction/elimination of the need to relocate patients during disaster events

Secondary
- Social benefits of providing a place from which to mobilize resources during a disaster
- Reduction in stress on staff and patients, potentially resulting in faster patient recoveries and a reduction in disaster-related or exacerbated medical conditions

Partnerships

Partnership helped align funding from FEMA (Public Assistance and Section 428 grant), HHS Social Services Block Grant Program, and Ronald O. Perelman.

Project Timeline

Status
In progress

Project Completion Date
On target to be completed by August 2021

? Challenges Faced

- The need to equip Langone to manage its typical patient load, as well as an influx as a result of a natural disaster

Resources & References

FEMA. 2017. "NYU Langone Medical Center." Last modified October 28, 2017. https://www.fema.gov/nyu-langone-medical-center.

Healthcare Without Harm. 2018. "Safe haven in the storm: Protecting lives and margins with climate-smart health care." January 2018. https://noharm-uscanada.org/sites/default/files/documents-files/5146/Safe_haven.pdf.

Healthcare Without Harm. 2019. "NYU Langone Health protecting patients by investing in resilience." Last modified June 18, 2019. https://noharm-uscanada.org/articles/news/us-canada/nyu-langone-health-protecting-patients-investing-resilience.

Mexico Beach Recovery and Resiliency Partnership

In 2018, Hurricane Michael slammed into Mexico Beach, FL, causing widespread damage and destruction. Three people were killed, and more than three-quarters of the homes in Mexico Beach were destroyed or severely damaged. In 2019, the City of Mexico Beach teamed up with the U.S. Environmental Protection Agency (EPA) and FEMA, as part of the Recovery and Resiliency Partnership Project (RPP), to help the community develop a vision for a more sustainable future, through better stormwater management and urban design, resulting in the Recovery and Resiliency Partnership Stormwater Management and Greenspace Project for Mexico Beach.

To develop this vision, the City and the RPP initiated a significant public engagement process, and then undertook existing conditions and needs/opportunities analyses in order to establish the framework for the six design projects proposed as a result of the engagement process. The proposed projects include creating a regional stormwater detention network, utilizing existing wetlands; establishing several wetland parks; converting an existing canal to a stormwater pond; extending an existing greenway; creating a greenway-blueway trail system throughout the city; and restoring a local park that was partially destroyed during Hurricane Michael. Although the outcomes of these proposed projects are not yet known, the process has produced a variety of implementable projects that community stakeholders can support.

Addressed Hazards

PRIMARY HAZARD
Coastal Flooding

Hurricanes

Community-Driven Plan for Action

This effort brought together community stakeholders to collaboratively develop creative nature-based solutions for stormwater management. The wide range of implementable and scalable projects proposed focus on leveraging existing conditions to reduce flood risk while creating open space and improving recreational amenities.

Damage caused by Hurricane Michael in Mexico Beach, FL
Source: Shutterstock

Mexico Beach, FL
FEMA Region IV

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Transportation

Mexico Beach Recovery and Resiliency Partnership

Details

Project Owner
City of Mexico Beach

Type of Project
Stormwater Management Plan

Area of Impact
Has potential to impact all of Mexico Beach (Total Pop: 1,198 in 2017)

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Federal Funding
FEMA's Public Assistance Grant Program: $2.7 million

Benefits

Primary
- Reduces physical damage to buildings and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems

Secondary
- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Offers social benefits of providing the surrounding community with a park for recreation and green space

Partnerships

FEMA

City of Mexico Beach

U.S. EPA

Project Timeline

Start Date
Stakeholder and community engagement process began in September of 2019

Project Completion Date
Final report released December 2019

Resources & References

Allen, Greg. 2019. "Recovery Is Slow In The Florida Panhandle A Year After Hurricane Michael." October 10, 2019. NPR. https://www.npr.org/2019/10/10/768722573/recovery-is-slow-in-the-florida-panhandle-a-year-afterhurricane-michael.

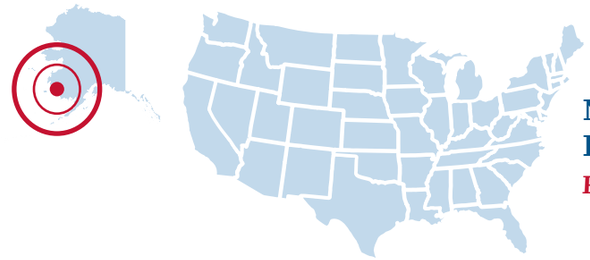
FEMA. 2019. "Federal Emergency Management Agency awards City of Mexico Beach $2.7 million for Hurricane Michael expenses." March 17, 2019. https://www.fema.gov/news-release/2019/03/18/fema-awards-city-mexico-beach-27-million-hurricane-michael-expenses#.

Haughey, John. 2019. "Florida to use $633 million federal 'disaster mitigation' grant for resilience planning." *The Center Square*. October 18, 2019. https://www.thecentersquare.com/florida/florida-to-use-million-federal-disaster-mitigation-grantfor-resilience/article_5dc147fc-f1ce-11e9-9e77-432ad7c92799.html.

Recovery and Resiliency Partnership. 2019. "Mexico Beach Stormwater Management and Greenspace Project." December 2019. https://mexicobeach.skeo.com/wp-content/uploads/2020/02/Mexico-Beach-Report-Final.pdf.

Damage caused by Hurricane Michael in Mexico Beach, FL
Source: Shutterstock

Relocation of Newtok Village



Nelson Island, AK
FEMA Region X

Progressive shoreline erosion along the Ninglick River, combined with permafrost degradation and seasonal storm flooding, began to seriously threaten the very land on Nelson Island that the Village of Newtok, AK (with a population of 354 persons as of the 2010 Census) sits on. Erosion studies done for the Village found no permanent/cost-effective solution that would allow the village to remain in its current location. Therefore, in 2006, the Village formed a planning group to initiate the process of relocating the Village to higher ground. The new site, called Mertarvik, is nine miles upriver from Newtok. The Village already owned the land, which was acquired in a land swap with the U.S. Fish and Wildlife Service in 2003.

Construction on basic infrastructure at Mertarvik was completed in 2014. In lieu of building brand new housing, the Village decided to retrofit old military barracks from Joint Base Elmendorf-Richardson in Anchorage to serve as housing. In October of 2019, the first residents from Newtok moved into their new homes in the Village of Mertarvik. A total of 130 people have relocated thus far.

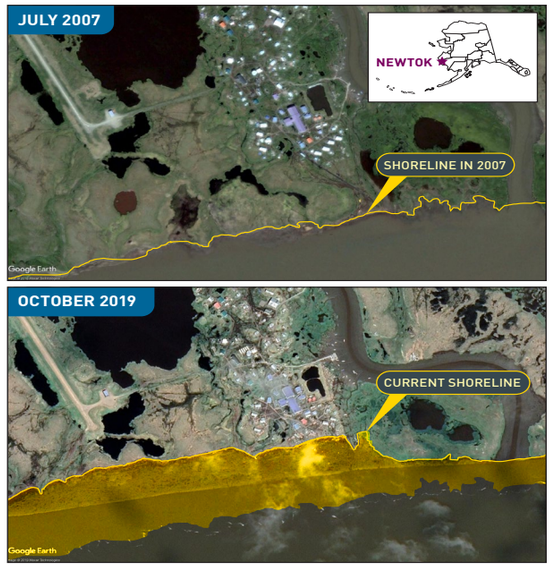
Addressed Hazards

PRIMARY HAZARD
Coastal Flooding

Winter Storms

Community-Scale Relocation Reduces Vulnerability

This holistic approach to community relocation will ensure that people, property, and tribal resources are protected from natural hazard risk. This project provides a unique approach to acquisitions that embraces managed retreat rather than the traditional model of single-parcel buyouts that often results in checker-boarding.



Shoreline changes over 12-year period
Source: AECOM

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Energy (Power & Fuel)

Communications

Transportation

Relocation of Newtok Village

Details

Project Owner
Village of Newtok, AK

Type of Project
Managed Retreat/Relocation

Area of Impact
Impacts all of Newtok Village (Total Pop: 354 in 2010)

$ Cost

Total Project Cost
$150 million +

Funding Sources

Non-Federal Funding
State of Alaska: $10.8 million

Federal Funding
Bureau of Indian Affairs: $5.1 million

Denali Commission: $4.7 million

FEMA: $3 million

U.S. Department of Housing and Urban Development (HUD): $2.3 million

The total additional funds needed to develop Mertarvik is approximately $130 million.

Benefits

Primary
- Reduces or eliminates potential physical damage to all structures and infrastructure in the village from future storms/flooding and offers associated life-safety benefits
- Affords greater effectiveness than alternatives that only repair/strengthen existing buildings or infrastructure in place, as erosion conditions/hazard risks continue to worsen

Secondary
- Maintains the social fabric of the village (social and cultural benefits), rather than allowing a slow decline, or even eventual total abandonment, of the community

Partnerships

State of Alaska

Bureau of Indian Affairs

Denali Commission

HUD

FEMA

Project Timeline

Start Date
2006

Status
Ongoing

? Challenges Faced

- Estimated $130 million in additional funding needed as of December 2017
- Multiple stakeholders from local, state, and federal government

Resources & References

Alaska Department of Commerce, Community, and Economic Development Division of Community and Regional Affairs. 2020. "Newtok Planning Group." Accessed March 16, 2020. https://www.commerce.alaska.gov/web/dcra/PlanningLandManagement/NewtokPlanningGroup.aspx.

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Virginia Point Wetland Protection Project

Galveston County, TX
FEMA Region VI

The 3,000-acre Scenic Galveston Coastal Preserve is one of the largest privately owned contiguous nature preserves on the upper Texas coast. Since the 1960's the northern shore of the bay, including at Virginia Point, has experienced shoreline erosion between 7 to 10 feet per year. This continued erosion has also impacted the fragile estuarine habitat along the shoreline, which is home to many different species of birds, as well as a rich benthic community of shrimp, different species of fish, and blue crabs.

This project restored roughly 10,000 feet of the Virginia Point shoreline and 25 acres of marsh in Galveston Bay. The project installed rock breakwaters to protect the shoreline and encourage sediment accretion and restored 25 acres of marsh through the planting of native seedlings and other plant material. This project helps to provide additional protection for Galveston County, and serves as a second line of defense for the existing hurricane levee that wraps around the city. The restored wetland also helps serve as a "buffer zone" for the Galveston Causeway, and helps protect the Bayport Industrial Wastewater Treatment Facility located nearby. The 3-year monitoring report, completed in October 2019, showed that the project has successfully mitigated shoreline erosion, and the accumulation of sediment is occurring as intended. In 2019, the Virginia Point Wetland Protection Project received the "Best Restored Shore" award from the American Shore & Beach Preservation Association.

A study by two University of California, San Diego economists, released in March of 2020, has found that natural buffers like wetlands should be valued at an average of $1.8 million per square-kilometer, based on the protections they provide for people and property against hurricane/storm damage.

Addressed Hazards

PRIMARY HAZARD
Coastal Flooding

Hurricanes

Award-Winning Nature-Based Mitigation Measure Shows Results

Despite the devastating impacts of Hurricane Harvey, this large-scale project remained intact and earned it an award from the American Shore and Beach Preservation Association in 2019. By incorporating nature-based solutions, the project was able to provide additional environmental benefits and recreational amenities.

West Galveston Bay Shoreline
Source: AECOM

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Transportation

Energy (Power & Fuel)

Virginia Point Wetland Protection Project

Details

Project Owner
Texas General Land Office

Type of Project
Marsh/Wetland Restoration

Area of Impact
Has the potential to serve much of the Galveston County population (Total Pop: 342,139 in 2019)

$ Cost

Total Project Cost
$4.6 million

Funding Sources

Federal Funding
National Fish and Wildlife Foundation (NFWF): $2,000,000

Texas General Land Office's Coastal Erosion Planning and Response Act: $675,000

Non-Federal Funding
$1.8 million

Scenic Galveston, Inc.

Texas Parks & Wildlife Department

Texas Commission on Environmental Quality

Benefits

Primary
- The state benefit cost analysis that found the project benefit-cost ratio to be 12.5 included economic and financial benefits associated with commercial and recreational fishing, tourism, and ecotourism (wildlife viewing)
- Also included economic benefits based on improved water quality, carbon sequestration, beach recreation, and storm protection

Secondary
- Analysis accounted for out-of-state spending associated with the project, including spending by visitors from outside the state associated with tourism

Partnerships

U.S. Fish and Wildlife Service

Texas Parks & Wildlife Department

National Oceanic & Atmospheric Administration

Scenic Galveston, Inc.

Texas Commission on Environmental Quality

Project Timeline

Start Date
Funding received 2014

Project Completion Date
Construction completed 2016

3-year monitoring completed 2018

? Challenges Faced

- Shoreline restoration projects can sometimes require complex and/or conflicting permit processes

Resources & References

American Shore & Beach Preservation Association. 2020. "Winners of inaugural Best Restored Shore award illustrate innovation in successful coastal restoration." Accessed March 16, 2020. https://asbpa.org/2019/09/09/winners-of-inaugural-best-restored-shore-award-illustrate-innovation-in-successful-coastal-restoration/.

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Virginia Point Wetland Restoration Project, aerial view

Source: AECOM

Drought

Salinas Aquifer Storage and Recovery

Puerto Rico was experiencing severe drought in 2015 when the Salinas aquifer water level dropped to the lowest level on record. The Town of Salinas' 31,000 residents, industries, farms, schools, hospitals, and the Camp Santiago National Guard training base all exclusively rely on this aquifer for their water supply. Following this, the Town of Salinas was awarded a FEMA Pre-Disaster Mitigation Grant in 2017 to fund its Aquifer Storage and Recovery Program.

The program proposes to divert water from the nearby Patillas Reservoir (that normally goes directly into the sea) and store it in an existing aquifer. In order to accomplish this, they plan to create a canal system to transport the water. The water captured in the aquifer would be used for both agriculture and municipal drinking water. Once the project is in operation, the average recharge volume should provide the aquifer with twice as much water as is currently withdrawn, supporting the rehabilitation of the local economy and community. It will also provide additional water storage in case of drought, but it will make the water supply for the Salinas municipality more resilient to other types of hazards, such as hurricanes and flooding.

Addressed Hazards

PRIMARY HAZARD
Drought

Coastal Flooding

Hurricanes

Maximizing Existing Resources to Protect Water Supply

Creating a new cost-effective water recharge system to protect water resources will ensure that critical community lifelines are not adversely impacted in a severe weather event and that cascading impacts to nearby military and agricultural operations and surrounding communities are mitigated.

The Aquifer Storage & Recovery project will divert overflow water from the Patillas Reservoir, about 20 miles east of Salinas. The diverted spillover will be directed via canals to the Salinas area to recharge the aquifer.

Source: https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico

Salinas, Puerto Rico
FEMA Region II

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Salinas Aquifer Storage and Recovery

Details

Project Owner
Town of Salinas

Type of Project
Water Supply System Design and Construction

Area of Impact
Project serves all residents of the Salinas municipality (Total Pop: 31,039 in 2017)

$ Cost

Total Project Cost
$2.85 million

Funding Sources

Federal Funding
FEMA: $2.1 million

Non-Federal Funding
Puerto Rican government: $714,053

Benefits

Primary
- Reduced loss of function of the potable water system from pre-mitigation conditions versus post-mitigation conditions with additional water supply and storage
- Reduced loss of economic value associated with loss of water services to residential customers

Secondary
- Reduced loss of function for businesses and government agencies dependent on the same water sources
- Reduced losses to the tourism sector and other industries highly reliant on water supply

Project Timeline

Status
Received funding in August 2017

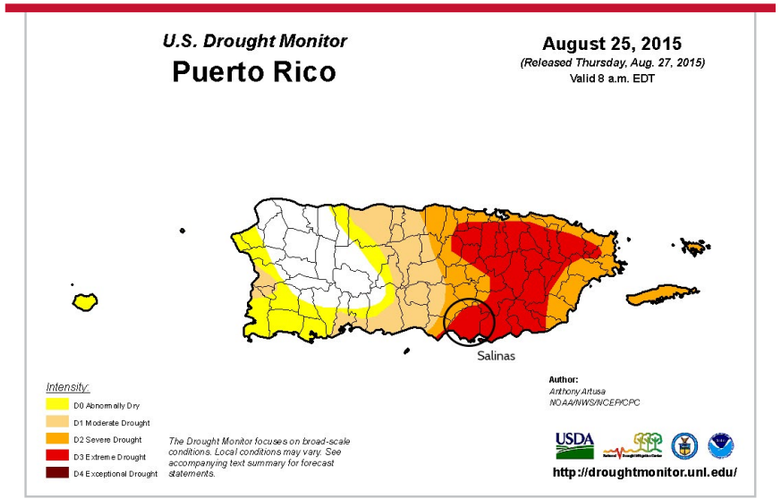
? Challenges Faced

- Careful planning to avoid the possibility of contaminants in the aquifer, such as arsenic and nitrates, and to meet safe drinking water standards

Resources & References

FEMA. 2015. "Aquifer Storage and Recovery Climate Resilient Mitigation Activities." Accessed March 16, 2020. https://www.epa.gov/sites/production/files/2016-04/documents/fema_aquifer_storage_recovery_fact_sheet-sept_2015.pdf.

United States Global Change Research Program. 2019. "Aquifer Storage and Recovery: A Strategy for Long-Term Water Security in Puerto Rico." U.S. Climate Resilience Toolkit. Last modified October 28, 2019. https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico.

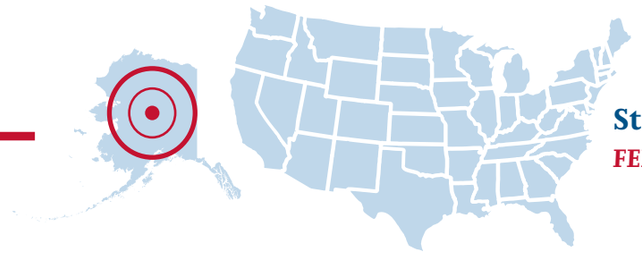


This map from the U.S. Drought Monitor shows that much of eastern Puerto Rico—including Salinas—was experiencing extreme drought in August 2015.

Source: https://toolkit.climate.gov/case-studies/aquifer-storage-and-recovery-strategy-long-term-water-security-puerto-rico

Earthquakes

Alaska Building Codes



State of Alaska
FEMA Region X

Alaska averages 40,000 earthquakes a year of various scales, with more large quakes than all other 49 states combined. Following the 1964 earthquake, which was the most powerful on record in the United States, the State of Alaska adopted stricter building codes. These codes outlined specific measures so buildings would be designed to resist possible ground motion determined by location and earthquake histories. Beams, columns, and other structural connections must be reinforced to resist damage from shaking.

When the 7.0-magnitude quake hit in 2018, the Anchorage area experienced extreme shaking and suffered major damage to roadways. However, no large buildings collapsed and only a small handful of structural fires had to be put out. Many homes and businesses suffered damage, but there was no loss of life. Experts credit this minimal damage to the effectiveness of the building codes at withstanding earthquake and aftershock conditions. The costs and benefits of seismic building codes and seismic retrofits have been well-documented. In 2000, FEMA conducted a study that estimated that the U.S. loses an estimated $4.4 billion every year to repairing and replacing buildings and their contents, as well as in economic losses, to earthquake events. Stronger building codes with seismic requirements, such as the State of Alaska's, could help prevent a significant percentage of those losses.

Addressed Hazards

PRIMARY HAZARD
Earthquakes

Proactive Statewide Building Standards Increase Earthquake Resilience

Continual updates to statewide building codes demonstrate Alaska's commitment to resilience. Indeed, these modern disaster-resistant building codes were credited with mitigating damage and cascading impacts when the state was hit by a 7.0-magnitude earthquake in 2018.

Aerial view of Anchorage, Alaska
Source: Shutterstock

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Alaska Building Codes

Details

Project Owner
State of Alaska

Type of Project
Building Codes

Area of Impact
Building code applies to the entire state of Alaska (Total Pop: 737,000 in 2017)

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Benefits

Primary
- Reduces associated reduced injuries and deaths from earthquake events with little to no advanced notice
- Reduces physical damage to structures and their contents
- Addresses a wide range of construction practices that encourage the use of non-structural practices that can reduce or minimize damage, depending on earthquake severity

Secondary
- Addresses ways that different infrastructure systems can be designed with features (i.e., break-away connections) that can lessen damage and associated costs (and possible injuries)
- Reduces social impact/trauma from earthquakes and the need to temporarily or permanently relocate due to building damage

Project Timeline

Status
Implemented after 1964 earthquake

? Challenges Faced

- Development community pushback on more restrictive statewide building codes and potential increased cost of compliance

Resources & References

D'Oro, Rachel and Mark Thiessen. 2018. "Strict building codes helped Anchorage withstand quake." *Associated Press News*. December 1, 2018. https://apnews.com/018a78f7cfb646b8a6653766a953cacd.

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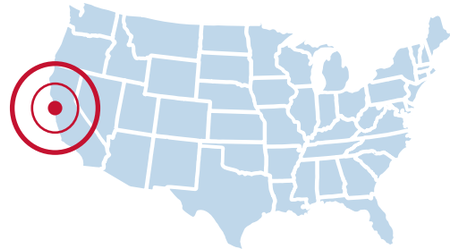
Lukasik, Tara. 2018. "Alaska hails building codes after quake." *Building Safety Journal*. December 12, 2018. https://www.iccsafe.org/buildingsafety-journal/bsj-dives/alaska-hails-building-codes-after-quake/.

Berkeley Seismic Vulnerability Retrofits



Berkeley, CA
FEMA Region IX

In 2018, the City of Berkeley received a $1.2 million Hazard Mitigation Grant Program (HMGP) grant from FEMA to create a grant program for building owners to retrofit seismically vulnerable buildings to better withstand earthquake impacts. The program provides grants, paid out as reimbursements, for upgrades for certain types of commercial and multi-family residential buildings (including buildings with nonductile concrete, tilt-up, soft story, and unreinforced masonry).

The program is designed to encourage property owners to be proactive, rather than reactive, in implementing seismic retrofits by offering direct compensation for a large percentage of total costs incurred to the building owner. Grants from the program pay for up to 75 percent of design and 40 percent of construction costs, depending on the project. If implemented properly, this program could not only prevent serious property damage from earthquakes, but also prevent injuries and even loss of life due to structures not being properly secured against earthquake impacts. To date, the program has contributed to seismic retrofits of 48 buildings containing over 400 apartment units.

Addressed Hazards

PRIMARY HAZARD
Earthquakes

Incentivizing Retrofits to Reduce Vulnerability

By leveraging federal funds, this program incentivizes proactive mitigation measures for commercial and multi-family building owners who want to make their buildings safer and more resilient to earthquakes.

Berkeley, CA
Source: Shutterstock

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Berkeley Seismic Vulnerability Retrofits

Details

Project Owner
City of Berkeley, CA

Type of Project
Building Retrofits

Area of Impact
Program eligibility encompasses the City of Berkeley (Total Pop: 122,324 in 2017)

$ Cost

Total Project Cost
$1.2 Million

Funding Sources

Federal Funding
FEMA HMGP

Non-Federal Funding
California Governor's Office of Emergency Services

Benefits

Primary
- Reduced damage to structural and non-structural components and contents of buildings, and associated reduction in injuries and deaths
- Varying levels of reduction in damage, depending on the severity of the earthquake

Secondary
- Buildings that provide better shelter during earthquakes
- Potential reduction in damage to infrastructure attached to structures
- Potential reduction in emergency services costs for responding to incidents involving larger structures

Partnerships

FEMA

City of Berkeley

CA Governor's Office of Emergency Services

Project Timeline

Start Date
Grant program began in 2018

Property owners had to apply for grants by June 25, 2018

? Challenges Faced

- Providing adequate public outreach to ensure that property owners are aware that these resources are available to them
- Continuing the program after grant funding runs out

Resources & References

Black, Margaret. 2018. "New grant gives Berkeley $1.2 million to retrofit seismically vulnerable buildings." *The Daily Californian*. June 22, 2018. https://www.dailycal.org/2018/06/21/new-grant-gives-berkeley-1-2-million-retrofit-seismically-vulnerable-buildings/.

City of Berkeley Building and Safety Division. 2020. "Retrofit Grants." Accessed March 16, 2020. https://www.cityofberkeley.info/retrofitgrants/.

City of Berkeley. 2020. "Retrofit Grants for Seismically Vulnerable Buildings." Accessed March 16, 2020. https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Building_and_Safety/Retrofit%20Grants%20Brochure.pdf.

Earthquake Safety Retrofits at Good Samaritan Hospital

The Good Samaritan Hospital is a first-tier hospital in the National Disaster Medical System, meaning the staff are trained to receive and treat victims of mass casualty events, such as an earthquake. However, the hospital itself, particularly the essential medical equipment and critical support systems that are needed to treat survivors, is susceptible to damage caused by earthquakes or earthquake related vibrations and need protection as well.

The Good Samaritan Hospital was awarded funding through FEMA's Hazard Mitigation Grant Program (HMGP) to complete non-structural bracing and anchoring of medical equipment, communications hardware, and supporting infrastructure essential to ensure continued post-earthquake operations. Installation of bolts, straps, anchors, hangers and similar reinforcements has enabled Good Samaritan to continue the provision of critical services to surrounding communities in their greatest times of need.

Addressed Hazards

PRIMARY HAZARD
Earthquakes

Building Resilience in the National Disaster Medical System

The proposed retrofits will protect sensitive medical equipment, improve the hospital's resilience to earthquakes and lead to more reliable patient care during and following seismic activity.

Good Samaritan Hospital, Los Angeles, CA
Source: Shutterstock

Los Angeles, CA
FEMA Region IX

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Health & Medical

Earthquake Safety Retrofits at Good Samaritan Hospital

Details

Project Owner
Good Samaritan Hospital

Type of Project
Hospital Retrofits

Area of Impact
Hospital facility

$ Cost

Total Project Cost
$2.3 Million

Funding Sources

Federal Funding
FEMA HMGP: $1.7 Million

Non-Federal Funding
Non-federal sources: $600,000

Benefits

Primary
- Reduces damage to non-structural components and high-value contents, such as medical equipment and communications hardware
- Provides additional life-safety benefits, including reduced injuries or deaths, due to disabled or unusable medical equipment

Secondary
- Reduces impact injuries during earthquake event as a result of bracing and anchoring of non-structural components and other contents
- Reduces emergency services costs from need to use other emergency facilities

Partnerships

California Governor's Office of Emergency Services (Cal OES)

The City of Los Angeles

Project Timeline

Start Date
Project funds awarded January 2020

Resources & References

FEMA. 2020. "FEMA Funds Earthquake Safety for Los Angeles Hospital." https://www.fema.gov/news-release/2020/01/17/fema-funds-earthquake-safety-los-angeles-hospital

Hurricanes

Florida Building Codes

State of Florida
FEMA Region IV

The State of Florida's coasts are extremely vulnerable to impacts from hurricanes and strong storms and will only become more vulnerable as sea levels continue to rise. In 2002, the state adopted a statewide building code that enacted strict standards for buildings to withstand hurricane impacts. According to an analysis done by the Wharton School at the University of Pennsylvania, homes built in the state since the building code's adoption drove total losses to hurricanes down by 68 percent relative to the homes built in the decade prior to implementing the new code.

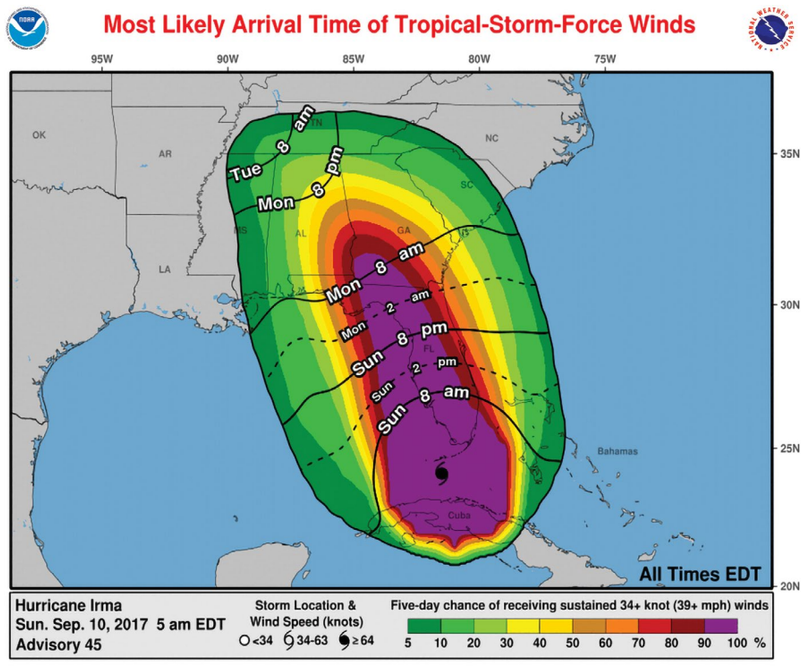
Requirements vary throughout the state, depending on where peak winds tend to be strongest. For instance, Miami-Dade and Broward Counties, which have experienced substantial damage from past hurricanes, are part of a "High-Velocity Hurricane Zone," meaning that their local codes require that the entire building envelope be wind-resistant. According to the Insurance Institute for Business & Home Safety, Florida has the strongest residential building code out of 18 other coastal states, including Virginia, South Carolina, and New Jersey.

Addressed Hazards

PRIMARY HAZARD
Hurricanes

Statewide Adoption of Building Codes Enables Stronger Local Codes

By having a base statewide building code, communities can then develop building standards that are tailored to mitigate their location-specific risk. For example, Miami-Dade and Broward Counties have instituted hazard-specific codes to reduce hurricane damage.



Florida regularly sustains storm force winds, as projected here during Hurricane Irma in September of 2017.

Source: NOAA NHC

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Florida Building Codes

Details

Project Owner
State of Florida

Type of Project
Building Codes

Area of Impact
Entire State of Florida population
(Total Pop: 21.3 million in 2018)

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses of construction components, practices, and short- and long-term maintenance costs.

Benefits

Primary
- Reduced physical damage to structures and their contents from both wind and flood, and the associated life-safety benefits of reduced injuries and deaths
- Reduced damage to utility infrastructure

Secondary
- Reduced loss of function and downtime associated with business and government services following a hurricane event
- Reduced short- and long-term shelter needs and the social aspects of reduced need to relocate temporarily or permanently

Partnerships
State of Florida

Florida Building Commission

Project Timeline
Start Date
Adopted 2002

? Challenges Faced
- Additional development costs of applying stronger standards, especially an issue for affordable housing

Resources & References

Henson, Bob. 2018. "South Florida's Hurricane Building Code is Strong—And North Florida's Could Be Stronger." *Weather Underground*, October 16, 2018. https://www.wunderground.com/cat6/South-Floridas-Hurricane-Building-Code-StrongAnd-North-Floridas-Could-Be-Stronger.

Martin, Susan Taylor. 2018. "Florida leads other hurricane-prone states in quality of its building codes." *Tampa Bay Times*, April 25, 2018. https://www.tampabay.com/news/business/realestate/Florida-leads-other-hurricane-prone-states-in-quality-of-its-building-codes-_167654069/.

Simmons, Kevin M., Jeffrey Czjkowski, and James Done. 2017. "Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida." (May 2017): 1-64. http://dx.doi.org/10.2139/ssrn.2963244.

Two properties side-by-side that show how stronger building codes can protect properties
Source: Shutterstock

Nicklaus Children's Hospital Hurricane Retrofits

In 2000, a resilience assessment of the Nicklaus Children's Hospital showed that it was highly vulnerable to wind speeds associated with a Category 2 Hurricane. The process of retrofitting the hospital to withstand a Category 4 Hurricane began soon after and was completed in 2004. In addition to the funds it had already set aside, the hospital received additional funding for the project through FEMA's Hazard Mitigation Grant Program (HMGP). The hospital is now wrapped in a hurricane-resistant "shell," which encases the entire structure in pre-molded panels of glass fiber-reinforced concrete, which are anchored to the support structure of the original building. The retrofits also included impact-resistant windows and additional roof support. The hospital can now withstand winds of up to 200 miles per hour.

The retrofits have already been successful in the face of Florida's many hurricanes. The hospital did not need to evacuate patients and families during Hurricanes Frances and Jeanne in 2004, and was actually able to host patients evacuated from the Florida Keys. During Hurricane Frances, the hospital sheltered well over 1,000 patients, employees, and family members. During Hurricanes Katrina and Wilma, the hospital again hosted medical evacuees and families who were displaced during and after the storms.

Addressed Hazards

PRIMARY HAZARD
Hurricanes

Hurricane Retrofits Realize Co-Benefits

Innovative building construction techniques were used to fortify the hospital so that it was not only able to remain operational during Hurricanes Frances and Jeanne, but also served as a shelter for patients, families, staff, spouses and families of storm-duty staff, and storm evacuees.

Nicklaus Children's Hospital
Source: Google Earth Pro, used under license

Miami, FL
FEMA Region IV

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Health & Medical

Nicklaus Children's Hospital Hurricane Retrofits

Details

Project Owner
Nicklaus Children's Hospital

Type of Project
Hurricane Retrofits

Area of Impact
Hospital facility (also provided shelter for employees and family members during Hurricanes Frances and Irma)

$ Cost

Total Project Cost
$11.3 million

Funding Sources

Federal Funding
FEMA HMGP: $5 million

Non-Federal Funding
Nicklaus Children's Hospital

Benefits

Primary
- Avoids potential physical damage to the hospital building and contents, such as large medical equipment
- Offers life-safety benefits, including a reduction in potential injuries/deaths for hospital patients
- Reduces/eliminates the need to relocate patients during disaster events
- Enables the hospital to host patients from other hospitals during disaster events, increasing the number of people protected by mitigation actions

Secondary
- Provides social benefits of a place from which to mobilize resources during a disaster
- Reduces stress on staff and patients, potentially resulting in faster patient recoveries, and a reduction in disaster-induced or exacerbated medical conditions

Partnerships

FEMA

Miami-Dade County Office of Emergency Management

Florida Division of Emergency Management

Project Timeline

Start Date
Process begun in 2000

Project Completion Date
Construction completed in 2004

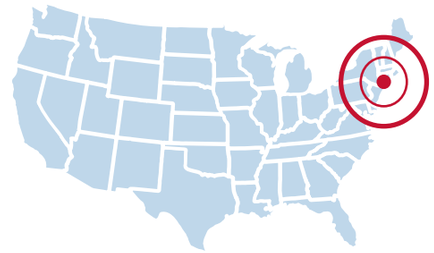
? Challenges Faced

- Undertaking all construction activity without disrupting medical services by working in phases

Resources & References

United States Global Change Research Program. 2020. "Retrofitting a Children's Hospital with a Hurricane-Resistant Shell." U.S. Climate Resilience Toolkit. Last modified February 10, 2020. Accessed March 16, 2020. https://toolkit.climate.gov/case-studies/retrofitting-childrens-hospital-hurricane-resistant-shell.

NY Rising Community Reconstruction: Recovery and Resiliency Initiative



Hempstead, NY
FEMA Region II

In June 2013, the Governor's Office of Storm Recovery (GOSR) was established to administer New York State's recovery and resiliency programs for Superstorm Sandy, Hurricane Irene, and Tropical Storm Lee. Supported by $4.5 billion in Community Development Block Grant–Disaster Recovery (CDBG-DR) funding from the U.S. Department of Housing and Urban Development (HUD), GOSR—from its earliest days—sought to address immediate rebuilding needs, while also making strategic investments into the long-term sustainability of the State.

As one of the hallmark programs of the GOSR portfolio, the NY Rising Community Reconstruction (NYRCR) Program was rooted in a participatory planning process that engaged 650 New Yorkers on 66 NYRCR Planning Committees across New York City, Long Island, the Hudson Valley, Mohawk Valley, Capital Region, and Southern Tier. These committees developed proposals to enhance recovery and resiliency. Eligible projects prioritized for implementation are now being brought to fruition in partnership with a variety of local subrecipients, including municipal and county governments.

Completed in 2019, the $3.8 million Path to the Park Project is an example of the NYRCR Program in action—having transformed a beloved stretch of public greenway along the northwestern shoreline of South Valley Stream in Nassau County. Innovative in its ability to effectively marry several goals—improved coastal resiliency, recreational opportunities, and public access—the project blended green and gray infrastructure to create a space that was both resilient and functional. As part of the effort, bioswales and overflow structures were installed to provide stormwater retention, and a new living shoreline was created. The project facilitated the removal of a bridge abutment and the construction of a berm for additional surge protection. A pedestrian pathway was also beautified with educational signage, scenic overlook areas, wild flower plantings, and a pollinator garden.

Not only does the park now serve as a natural coastal buffer to surrounding neighborhoods, but it has also become a destination for visitors and local residents alike.

Building Resilience through Holistic Mitigation Integration

NYRCR Plans can serve as valuable roadmaps for helping communities to mitigate future risks and address vulnerabilities exposed by one of the three covered storms. In Hempstead, green and gray infrastructure were blended to create a space that was both resilient to extreme weather events and functional, providing community and environmental benefits.

Addressed Hazards

PRIMARY HAZARD
Hurricanes

Inland Flooding

Coastal Flooding

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Transportation

Natural coastal buffer designed to reduce erosion and sedimentation and improve wildlife habitat
Source: NYRCR

NY Rising Community Reconstruction: Recovery and Resiliency Initiative

Details

Project Owner
State of New York

Type of Project
Recovery and Resiliency Initiative

Area of Impact
South Valley Stream, Town of Hempstead (Total Pop: 768,103 in 2018)

$ Cost

Total Project Cost
$3.8 Million

Funding Sources

Federal Funding
CDBG-DR funds from HUD

Benefits

Primary
- Provision of flood, hurricane, and stormwater control
- Reduction of erosion and sedimentation
- Improvement of wildlife habitat

Secondary
- Creation of a natural coastal buffer for surrounding neighborhoods
- Enhanced community access to the space

Partnerships
Town of Hempstead

Project Timeline

Start Date
Community Reconstruction Planning Committee formed Fall 2013

Project Completion Date
Project Completion announced by Governor Andrew M. Cuomo in September 2019

? Challenges Faced
- Competing funding sources caused conflicting requirements in reporting and other concerns that took a long time to overcome

Resources & References

Governor Andrew Cuomo. 2013. "Governor Cuomo Designates 102 New York Rising Communities Eligible to Receive More Than $750 Million for Storm Reconstruction." July 18, 2013. https://www.governor.ny.gov/news/governor-cuomo-designates-102-new-york-rising-communities-eligible-receive-more-750-million.

Governor Andrew Cuomo. 2019. "Governor Cuomo Marks Completion of $3.8 Million Path to the Park Project in South Valley Stream." September 12, 2019. https://www.governor.ny.gov/news/governor-cuomo-marks-completion-38-million-path-park-project-south-valley-stream

New York State Governor's Office of Storm Recovery. 2020. "NY Rising Community Reconstruction Program FAQs." Accessed March 16, 2020. https://stormrecovery.ny.gov/sites/default/files/crp/community/documents/Final%20FAQs_12211.pdf.

New York State Governor's Office of Storm Recovery. 2020. "The Program." Accessed March 16, 2020. https://stormrecovery.ny.gov/community-reconstruction-program.

U.S. Department of Housing and Urban Development. 2020. "National Disaster Resilience." HUD Exchange. Accessed March 16, 2020. https://www.hudexchange.info/programs/cdbg-dr/resilient-recovery/.

Natural coastal buffer designed to reduce erosion and sedimentation and improve wildlife habitat
Source: NYRCR

Renovation of Alexander Theater

Christiansted, St. Croix, U.S. Virgin Islands
FEMA Region II

The Saint Croix Foundation (SCF) is planning to renovate the historic Alexander Theater in Christiansted, St. Croix. The renovation will increase its performing arts space and allow it to serve as an emergency shelter for up to 310 people. The renovations will include a safe room that can withstand hurricane force winds. The theater received FEMA Hazard Mitigation Grant Program (HMGP) funding for the renovations in May 2019. The renovated theater will also include space for a job training center for young people who are pursuing careers in hospitality, theater, and video and music production.

There are two phases planned for the project, Phase I: Technical Feasibility Study and Phase II: Theater Restoration. Phase I will include designs and wind and seismic mitigation analyses. Phase II will include the actual renovations to meet FEMA standards, Americans with Disabilities Act (ADA) compliance, and security standards. The final building will have an emergency generator, HVAC unit, and other equipment necessary to fully operate in an emergency.

Creative Use of Acquired Property Drives Economic Development

On a space-constrained island, students can go without access to formal education for months following a severe storm while their schools are used as shelters. This project capitalizes on an opportunity to build community resilience by revitalizing a historic cultural amenity to foster economic development while creating much-needed shelter space.

Addressed Hazards

PRIMARY HAZARD
Hurricanes

Earthquakes

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Alexander Theater in Christiansted, St. Croix
Source: http://www.stxfoundation.org/communitydevelopment/the-old-alexander-theatre/

Renovation of Alexander Theater

Details

Project Owner
Saint Croix Foundation (SCF)

Type of Project
Emergency Shelter

Area of Impact
Christiansted population (Total Pop: 3,000 in 2017)

$ Cost

Total Project Cost
$12.5 million

Funding Sources

Federal Funding
FEMA HMGP: $12.5 million

Benefits

Primary
- Avoidance of potential physical damage to the theater and its contents
- Life-safety benefits, including a reduction in potential injuries/deaths for those using the theater as a shelter during events
- Reduced emergency response burden for the area

Secondary
- A place to shelter and mobilize resources during disaster events, and decrease the loss of theater downtime, resulting in a reduction of potential lost revenue
- Reduced potential downtime for the job training center being built as part of this project

Partnerships

FEMA

Virgin Islands Territorial Emergency Management Agency (VITEMA)

TALLER LARJAS, LLC

Project Timeline

Start Date
Design begun June 2019

Status
In progress

Project Completion Date
Completion scheduled for September 2021

? Challenges Faced

- Potential issues associated with rebuilding a historic structure

Resources & References

Clinton Foundation. 2020. "Healing Humanities: Rebuilding with Resiliency in Mind." Clinton Global Initiative. Accessed March 16, 2020. https://www.clintonfoundation.org/clinton-global-initiative/commitment/healing-humanities-rebuilding-resiliency-mind.

St. Croix Foundation for Community Development. 2020. "The Alexander Theater: Approved for Renovation & Retrofit!" Accessed March 16, 2020. http://www.stxfoundation.org/communitydevelopment/the-old-alexander-theatre/.

Inland Flooding

Atlanta Stormwater Ordinance and Green Infrastructure Program

The City of Atlanta's Department of Watershed Management amended its Post-Development Stormwater Management Ordinance to require the use of green infrastructure on new and redevelopment projects in the City. This includes a volume-based runoff reduction requirement, where commercial and single-family residential developments must capture the first one inch of runoff and reduce the volume through on-site infiltration, evapotranspiration, or rainwater harvesting and reuse. As of mid-2017, the City has permitted nearly 3,500 construction projects that utilize green infrastructure. Common projects include rain gardens, green roofs, forest conservation, and urban tree preservation. These projects reduce the volume of polluted runoff by approximately 600 million gallons annually.

Atlanta has also prioritized and integrated green infrastructure into its work throughout the City. The City is constructing its own projects and working through the City's Green Infrastructure Task Force to support green infrastructure projects by other City departments and partners. One example of a large-scale project is the Capacity Relief Pond at the Historic Fourth Ward Park. This project provides stormwater drainage relief to the area within a 300-acre drainage basin with artistic elements to aerate and recycle pond water instead of drainage pipes. This serves as the park's centerpiece and is surrounded by walking trails, native plantings, and an amphitheater. More projects are available through the City of Atlanta Green Infrastructure Program's interactive site: https://coadwm.maps.arcgis.com/apps/MapSeries/index.html?appid=db24b57c2d7146c2a3f039d37d539737

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Integrating Nature-Based Solutions with Development Standards

This program provides a solution for residents by requiring use of nature-based solutions, utilizing quantitative metrics, and incentivizing stormwater management best practices, the City has reduced the volume of polluted runoff by approximately 600 million gallons annually and created mechanisms to mitigate risk from severe rain events.

Community Lifelines

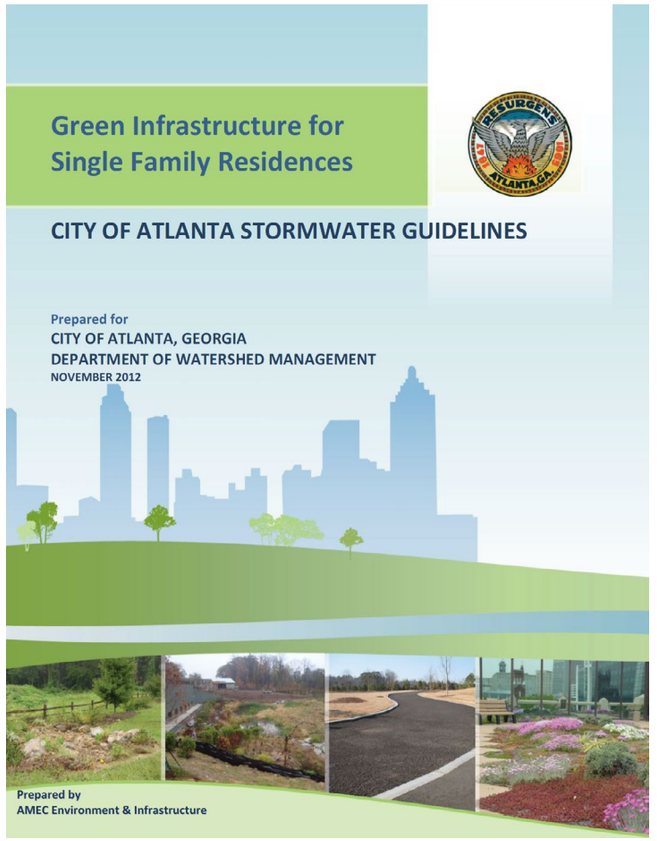
Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Transportation

Atlanta, GA
FEMA Region IV



Atlanta Stormwater Guide
Source: City of Atlanta, Georgia Department of Watershed Management

Atlanta Stormwater Ordinance and Green Infrastructure Program

Details

Project Owner
City of Atlanta Department of Watershed Management

Type of Project
Ordinance

Area of Impact
Atlanta population (Total Pop: 486,290 in 2017); 3,500 projects as of mid-2017

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances includes community staff time and any outside consultants to provide technical support and associated analysis. For this project, the added requirements for green infrastructure may increase initial project costs, but long-term costs will likely be lower because long-term maintenance of large stormwater retention facilities would no longer be needed.

Funding Sources

Non-Federal Funding
City of Atlanta

Benefits

Primary
- Reduced stormwater flows and subsequent physical damage to stormwater and transportation infrastructure
- Decreased damage primarily from more frequent events, and reduced the need to increase storage capacities for existing infrastructure design to handle more infrequent events

Secondary
- Less severe social impact from flood events, such as reduced need for temporary shelters, better water quality protection (and reduced cost for measures to remove pollutants), and more green space, which can help reduce urban heat island impacts on health

Partnerships

City of Atlanta's Environmental and Construction Enforcement Division

Project Timeline

Start Date
Ordinance adopted by Atlanta City Council on February 13, 2013

? Challenges Faced

- Potential for concern about restrictions within the development community

Resources & References

City of Atlanta Department of Watershed Management. 2012. "Green Infrastructure for Single Family Residences: City of Atlanta Stormwater Guidelines." AMEC Environment & Infrastructure. November 2012. https://drive.google.com/file/d/1RsmhfASwRnxsJ_CBjwhSMrFXhRB8YFxi/view.

City of Atlanta Department of Watershed Management. 2018. "Green Infrastructure Strategic Action Plan." 2018. https://drive.google.com/file/d/1u65BWi5qBFA-iYQmdBLm9wAVE7yHJnyf/view.

City of Atlanta Department of Watershed Management. 2020. "City of Atlanta Green Infrastructure Program." Accessed March 16, 2020. https://coadwm.maps.arcgis.com/apps/MapSeries/index.html?appid=db24b57c2d7146c2a3f039d37d539737.

City of Atlanta Department of Watershed Management. 2020. "Post-Development Stormwater Management Ordinance." Accessed March 16, 2020. https://www.atlantawatershed.org/stormwaterordinance/.

Bidwell Paiute Tribal Reservation Flood Mitigation Project

Modoc County, CA
FEMA Region IX

The Fort Bidwell Tribal reservation, located in Modoc County, CA, and home to the Bidwell Paiute Tribe, has experienced severe recurrent flooding in recent years. Over time, the flooding has caused serious damage, closing roadways and eroding the earthen hydroelectric dam that sits directly upstream of the reservation. The dam was designed to manage approximately 450,000 cubic feet of water and houses a hydroelectric system and generator to moderate water volume. Heavy rains damaged these systems and disrupted supply lines and access roads leading to the dam.

The Tribal Council applied for and received a FEMA Hazard Mitigation Grant Program (HMGP) grant to address the impacts of heavy rains on the dam. The project placed a concrete gutter to redirect stormwater runoff into nearby Soldier Creek and buried a hydroelectric water supply pipe, which had previously collapsed into Soldier Creek. A timber retaining wall with compacted stone was also constructed, and the earthen ditches on either side of Dam Road were lined with concrete, or replaced with corrugated metal pipes, to prevent further erosion.

Consequently, this project was able to successfully mitigate the risk of further damage to the upstream dam facility and reduce the potential of electricity loss to the community during storm events. It also reduced the risk of damage to supply lines and access roads leading to and from the dam.

Low Cost, Significant Benefits

The Bidwell Paiute Tribe was able to leverage just under $14,000 in funding to protect its main source of electricity, an earthen hydroelectric dam (along with its supply lines and access roads), avoiding over $100,000 in future damages, according to a FEMA estimate.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Energy (Power & Fuel)

Transportation

Pit River, Modoc County

Source: https://en.wikipedia.org/wiki/Modoc_County,_California#/media/File:Pit_River_Valley.jpg

Bidwell Paiute Tribal Reservation Flood Mitigation Project

Details

Project Owner
Bidwell Paiute Tribe

Type of Project
Infrastructure Flood Protection

Area of Impact
Entire tribal population (119, according to 2014–2018 American Community Survey Estimates)

$ Cost

Total Project Cost
$13,635

Funding Sources

Federal Funding
FEMA HMGP

Benefits

Primary
- Avoids physical damage to earthen dam, culverts and pipes, and roads
- Prevents loss of function to dam (including hydroelectric system) and roads due to flooding impacts

Secondary
- Provides life-safety benefits as a result of a reduction in potential injuries and deaths from possible dam or road failures
- Protects cultural and historical resources and allows the tribe to maintain access to important tribal facilities

Partnerships

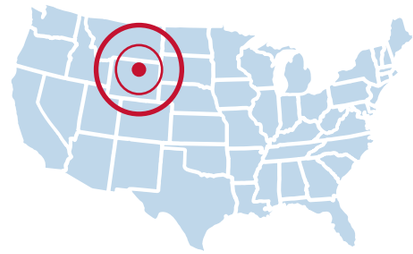
FEMA

Resources & References

FEMA. n.d. "Flood Mitigation Project Protects Bidwell Paiute Tribal Reservation." https://www.hsdl.org/?view&did=788210

Wikipedia. 2020. " Fort Bidwell Indian Community of the Fort Bidwell Reservation of California." https://en.wikipedia.org/wiki/Fort_Bidwell_Indian_Community_of_the_Fort_Bidwell_Reservation_of_California

Buffalo, WY Flood Control



Buffalo, WY
FEMA Region VIII

Since 1980, four flood events have caused damage to Buffalo, WY, with the worst damage in 2015. In June 2015, the community suffered a severe sheet flooding event from high rainfall caused by a sudden thunderstorm. This rain fell west of the city on previously saturated soils, which caused rapid runoff into town, down city streets, and into dozens of structures. Several families required police assistance to leave their properties. Over 400 structures, homes, and businesses were flooded during this event and most local roads had damage as well. The City of Buffalo declared a state of emergency.

In 2017, the City received funding from FEMA to study implementing a project to build an earthen dam and 6-acre detention pond, in order to safely detain and release stormwater runoff away from Buffalo's more densely-populated areas. This project addresses the risk from sheet flooding after major rainfall events in Buffalo. The City's existing stormwater conveyance infrastructure is not sufficient to protect residential and commercial properties from major damage from flooding. Rainfall is channeled through Dump Draw, across the City's golf course, through a 4-foot culvert, under private properties, and then into Clear Creek. In heavy rainfall events, the culvert is overwhelmed, water backs up, and the water flows down city streets into an area of older residences with basements and homes built at ground level.

The Environmental Assessment conducted for the proposed project determined that the potential environmental impacts caused by building the earthen dam and detention pond could be mitigated through the use of best management practices, and the project was allowed to move forward. The project has not yet been completed, but was put out for bid in January of 2019.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Landslides

Updating an Obsolete System

Once completed, this project will greatly improve stormwater management for the City of Buffalo, WY, and protect life and property. The City's current infrastructure is inadequate and outdated, and was overwhelmed during the 2015 flood.

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Transportation

Environmental Assessment

Buffalo Hazard Mitigation Project
Buffalo, Johnson County, Wyoming
August 2017

Prepared by
Booz Allen Hamilton
8283 Greensboro Drive
McLean, VA, 22102

Prepared for
FEMA Region VIII
Denver Federal Center
Building 710, Box 25267
Denver, CO 80225-0267

FEMA

Buffalo, WY Flood Control Project Document
Source: FEMA, https://www.fema.gov/media-library-data/1503587227654-d1c60a034904707b3182137105e32283/01_BuffaloEA_08232017.pdf

Buffalo, WY Flood Control

Details

Project Owner
City of Buffalo, WY

Type of Project
Flood Mitigation Infrastructure

Area of Impact
52 acres; Buffalo, WY population (Total Pop: 4,584 in 2017)

$ Cost

Total Project Cost
$648,291

Funding Sources

Federal Funding
FEMA Pre-Disaster Mitigation Funding: $486,219

Non-Federal Funding
Local Share: $162,072

Benefits

Primary
- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts

Secondary
- Reduced loss of function for transportation systems
- Reduced loss of function to non-residential structures and their associated businesses or organizations impacted by road closures
- Decreased need for emergency response during flood events

Partnerships

FEMA

City of Buffalo

Project Timeline

Status
Received FEMA HMGP funds in 2016; project put out for construction bid in January 2019

Resources & References

FEMA Region VIII. 2017. "Environmental Assessment Buffalo Hazard Mitigation Project." Booz Allen Hamilton. August 2017. https://www.fema.gov/media-library-data/1503587227654-d1c60a034904707b3182137105e32283/01_BuffaloEA_08232017.pdf.

Mayor Shane Schrader. 2019. "Public Notice." *Buffalo Bulletin*, January 14, 2019. http://www.buffalobulletin.com/news/public_notices/article_e105bfa0-19b9-11e9-a9ba-3fa0791ef253.html.

Cleveland and Northern Ohio Regional Stormwater Management and Flood Mitigation Program

The Northeast Ohio Regional Sewer District administers a comprehensive regional stormwater management program for 62 member communities in the Northeast Ohio/Cleveland area region. In addition to administering a stormwater fee credit program for the region, the Sewer District also manages a Community Cost-Share Program to help communities in the region implement stormwater best management practices; a Green Infrastructure Grant program that provides funding for green infrastructure projects to member communities, non-profits, and businesses in the combined sewer area; and a Member Community Infrastructure Program, which provides funding opportunities to member communities for sewer infrastructure repair and rehabilitation. The Sewer District also tracks all stormwater projects approved for construction in its member communities, which keeps communities up-to-date on ongoing projects in neighboring localities, and allows for better collaboration and cooperation across the region.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Regional Partnerships Support Mitigation Actions

This regional effort leverages multiple programs that incentivize residents and communities to implement nature-based solutions based on stormwater management best practices.

Project Tracking System Enables Cross-Jurisdictional Coordination

By tracking stormwater projects across its member communities through a central repository, the Sewer District is able to monitor implementation and facilitate better cooperation across the Region as communities collaborate on resilience measures.

Retention pond used to manage stormwater runoff
Source: Shutterstock

Cleveland & Northern OH
FEMA Region V

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Cleveland and Northern Ohio Regional Stormwater Management and Flood Mitigation Program

Details

Project Owner
Northeast Ohio Regional Sewer District

Type of Project
Regional Stormwater Management Program

Area of Impact
62 communities across the Northeast Ohio Region

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Non-Federal Funding
Northeast Ohio Regional Sewer District

Benefits

Primary
- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts
- Increased water reuse and associated decrease in drought risk

Secondary
- Reduced loss of function for transportation systems and water infrastructure
- Reduction in loss of function to non-residential structures and their associated businesses or organizations impacted by road closures and loss of potable water services
- Decreased need for emergency response during flood events

Partnerships

62 member communities across the Northeast Ohio Region

Resources & References

Northeast Ohio Regional Sewer District. 2020. "Community Cost-Share Program." Accessed March 16, 2020. https://www.neorsd.org/community/community-cost-share-program/.

Northeast Ohio Regional Sewer District. 2020. "Green Infrastructure Grant Program." Accessed March 16, 2020. https://www.neorsd.org/stormwater-2/green-infrastructure-grant-program/.

Northeast Ohio Regional Sewer District. 2020. "Regional Stormwater Management Program." Accessed March 16, 2020. https://www.neorsd.org/stormwater-2/stormwater-management-program/.

Cuyahoga Falls Rain Garden Reserve

The City of Cuyahoga Falls, OH, experienced two 500-year storm events in 2003 and 2004 that caused millions of dollars in damages to properties. The City, in collaboration with FEMA and the Ohio Emergency Management Agency, purchased and demolished four homes that had experienced repetitive flooding losses. The open space left was used to build a 24,000-square-foot municipal rain garden that receives drainage from 3.17 acres. It can hold and filter up to 30,000 gallons of water. The garden now serves the community with walking paths, solar lighting bollards, and endless educational and recreational opportunities.

This project was the first of its kind approved for FEMA Region V. It required extensive public involvement to alleviate concerns about aesthetics and mosquitoes. Neighborhood support was gained through a series of educational series and visualizations.

On May 12, 2014, a storm event dumped four inches of rain within 45 minutes on Cuyahoga Falls. This caused widespread damage across the City; however, there was no reported damage in the neighborhood surrounding the rain garden.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Community-Supported Nature-Based Mitigation

This relatively low-cost mitigation project demonstrates a scalable solution that smaller communities could adapt to mitigate against severe rainfall events by removing large amounts of impervious surfaces and creating a rain garden.

Rain Garden Reserve
Photo credit: Alisha Goldstein, EPA

Cuyahoga Falls, OH
FEMA Region V

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Cuyahoga Falls Rain Garden Reserve

Details

Project Owner
City of Cuyahoga Falls, OH

Type of Project
Strategic Buyouts

Area of Impact
Neighborhood

$ Cost

Total Project Cost
$157,000

Funding Sources

Federal Funding
FEMA Hazard Mitigation Grant Program (HMGP): $107,000

Non-Federal Funding
Donations supported by community organizations, residents, and local businesses: $50,000 (donated materials)

Ongoing maintenance is performed by the City (estimated $700/year)

Benefits

Primary
- Acquisition projects provide complete protection from future flood events by removing structures and associated utility infrastructure from high-risk areas
- Rain gardens reduce stormwater runoff flows, which can cause damage to properties and roads

Secondary
- Additional stormwater storage and green space, and reduction of need for emergency response services during flood events
- Recreational benefits from having more "pocket parks" and less need for costly large parks

Partnerships

Ohio Emergency Management Agency

FEMA

Project Timeline

Project Completion Date
April 25, 2008

? Challenges Faced

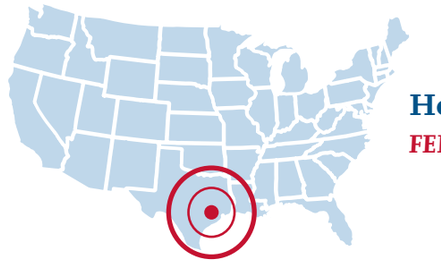
- Community concerns about aesthetics of the rain garden and the potential for mosquito breeding habitat

Resources & References

Environmental Protection Agency. 2020. "The Rain Garden Reserve." Accessed March 16, 2020. https://epa.ohio.gov/Portals/41/storm_workshop/retrofit/Cuyahoga%20Falls%20Rain%20GardenReserve%20Flyer.pdf.

Naturally Resilient Communities. 2017. "Cuyahoga Falls, Ohio." http://nrcsolutions.org/cuyahoga-falls-ohio/.

Exploration Green Stormwater Park



Houston, TX
FEMA Region VI

Houston, TX, has experienced significant flooding and related impacts over the last several decades, most notably from Hurricane Harvey in 2017. However, as a result of the completion of the first phase of the new Exploration Green Stormwater Park just prior to the storm, 150 homes in the area around the park that might otherwise have been flooded were protected.

When the rest of the project is complete, the park will cover 200 acres of what was once a golf course, and will include five large detention basins/ponds, along with a large drainage ditch spanning the length of the property to provide extra storage capacity. In total, the park's detention basins will be able to manage up to 1,680 acre-feet of water. The plan for the five-phase park includes recreational facilities, multi-use paths, nature areas, a visitor's center, and practice fields that will serve neighborhood pools. The project will also restore several former wetland areas, which will provide another means of managing stormwater quality in the area. The park is expected to be completed in 2022.

The project is expected to contribute to managing stormwater for an area of approximately 8,000 acres and will reduce flood risk for the approximately 30,000 people who live within one-half mile of the park, in addition to multiple business and community facilities located in the vicinity.

Award-Winning Innovative Stormwater Management

Exploration Green has won nine awards since its inception for its innovative use of stormwater management that has not only significantly reduced flood risk to the community, but has also created multiple recreational and social benefits for Houston residents.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Hurricanes

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Transportation

Volunteers planting wetlands vegetation

Photo credit: FEMA. Exploration Green! A Case Study in Effective Floodplain Management. https://agrilife.org/gift/files/2019/09/Exploration-Green.pdf

Exploration Green Stormwater Park

Details

Project Owner
Clear Lake City Water Authority (CLCWA)

Type of Project
Stormwater Park

Area of Impact
Significantly reduces flood risk to approximately 30,000 Houston residents

$ Cost

Total Project Cost
$38 Million (estimate)

Funding Sources

Non-Federal Funding
CLCWA bonds

Texas Parks and Wildlife

Multiple private foundations/civic clubs

Harris County Flood Control District

City of Houston

Benefits

Primary
- Decreases potential for physical damage to structures and their contents
- Reduces residential displacement and associated short-term shelter needs
- Reduces damage to stormwater and flood infrastructure, including roads and culverts

Secondary
- Reduces loss of function for transportation systems
- Creates additional stormwater storage and green space
- Reduces the need for emergency response services during flood events
- Reduces the potential loss of function to non-residential structures and their tenant businesses and organizations

Partnerships

City of Houston

CLCWA

The Exploration Green Conservancy

The Galveston Bay Foundation

Trees for Houston

Sea Grant Texas at Texas A&M University

Texas A&M AgriLife Extension

The Texas Coastal Watershed Program

Project Timeline

Start Date
Golf Course purchased by CLCWA in 2005

Status
Phase 1 of Exploration Green completed in 2017

Project Completion Date
Expected completion of all five phases in 2022

? Challenges Faced

- This multi-phase project has faced some delays as a result of concerns about its proximity to Ellington Airport; however, those issues have been resolved, and the project is once again moving forward

Resources & References

Exploration Green. 2020. "Exploration Green." Accessed May 12, 2020. https://www.explorationgreen.org/

FEMA. "Exploration Green prevents flooding, enhances Houston-area community." October 10, 2019. https://www.fema.gov/news-release/2019/10/10/exploration-green-prevents-flooding-enhances-houston-area-community

FEMA. *Exploration Green! A Case Study in Effective Floodplain Management*. Houston: FEMA, 2018. https://agrilife.org/gift/files/2019/09/Exploration-Green.pdf

Magee, Jake. 2019. "Despite hiccups, Exploration Green project on track for 2021 completion." *Community Impact Newspaper*. https://communityimpact.com/clear-lake-league-city-nassau-bay/development-construction/2019/08/09/despite-hiccups-exploration-green-project-on-track-for-2021-completion/

Harris County Flood Control District Voluntary Acquisition Program

The voluntary acquisition program for homes at risk for repetitive flood losses in Harris County, TX, has acquired over 3,000 properties since 1995. Since the arrival of Hurricane Harvey, a Category 4 hurricane that struck Texas in 2017, the program has acquired 420 additional eligible properties. The program is managed by the Harris County Flood Control District, which also manages other projects and programs designed to reduce flood risk in Harris County. This highly successful program also faces a challenge of keeping up with demand; the County currently has a waiting list of over 1,000 residents who have applied to have their homes acquired through the program. In 2018, voters approved $148 million for property acquisition as part of a $2.5 billion bond measure to finance stormwater and flood protection measures in Harris County.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Hurricanes

Protecting Life & Property

This program provides a solution for residents whose homes are at risk for repetitive flood losses for whom other options to protect their families and property are severely limited.

Restoring the Floodplain

Not only do these home acquisitions protect life and property, but they also allow portions of the natural floodplain to be restored, reducing impervious area and providing other ecosystem benefits.

Hurricane Harvey flood damage to homes in Harris County, TX
Source: Shutterstock

Harris County, TX
FEMA Region VI

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Harris County Flood Control District Voluntary Acquisition Program

Details

Project Owner
Harris County Flood Control District

Type of Project
Property Acquisition

Area of Impact
Over 3,000 properties acquired so far; program open to eligible residents of Harris County, TX (Total Pop: 4.7 million in 2017)

$ Cost

Total Project Cost
Unknown

Funding Sources

Federal Funding
FEMA Flood Mitigation Assistance (FMA)

Non-Federal Funding
Harris County

Benefits

Primary
- Eliminates physical damage to structures and their contents
- Reduces injuries and deaths (life-safety benefits) for projects that buyout entire neighborhood or area where past emergency response has been required
- Reduces loss of function and downtime for non-residential structures and associated businesses or organizations

Secondary
- Minimizes social impacts of flood events, such as temporary and long-term shelter needs
- Increases green space since acquired properties are required to remain undeveloped, or dedicated as park space
- Improves community resiliency with shortened recovery from flood events

Partnerships

FEMA

Harris County Flood Control District

Project Timeline

Start Date
Begun 1995

Status
Program ongoing

? Challenges Faced

- With a waitlist of over 1,000 resident, there is more demand for buyouts than available funding can support

Resources & References

Harris County Flood Control District. 2020. "Home Buyout Program." Last modified January 2020. Accessed March 16, 2020. https://www.hcfcd.org/Hurricane-Harvey/Home-Buyout-Program.

Weber, Anna. 2019. "Blueprint of a Buyout: Harris County, TX." NRDC, September 17, 2019. https://www.nrdc.org/experts/anna-weber/buyout-case-study-harris-county-texas.

Lincoln Wastewater Treatment Plant Flood Mitigation

In 2000, Lincoln, NE's, Theresa Street Wastewater Treatment Plant (WWTP) received a FEMA Hazard Mitigation Grant Program (HMGP) grant to provide flood protection around the electrical substation and transformers required to operate the plant. City officials realized that, without flood protection for this critical infrastructure, recurrent flooding posed a significant threat to the plant's operation during and after severe storms. The HMGP grant contributed to the cost of constructing a 6-foot brick and concrete wall to protect the substation, which was also fitted with an entrance that could be blocked with "stop logs" (removable flood shields) after a flood warning has been issued for the region. The grant also helped pay for the cost of raising the existing electrical transformer by 3 feet above the 100-year flood elevation and helped cover retrofits to the plant's below-grade stairwells to protect them from flooding during storm events.

In the intervening years, these improvements have helped Lincoln's WWTP continue to function, even during severe storms, protecting the health and safety of residents and preventing contamination of local creeks and streams.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Winter Storms

Health, Safety, and Environmental Co-Benefits

This project not only helped protect infrastructure critical to the health, safety, and welfare of the residents of Lincoln, but has also helped prevent serious environmental impacts to Salt Creek due to plant failure.

Lincoln, NE's Theresa Street Wastewater Treatment Plant
Source: https://www.lincoln.ne.gov/city/ltu/wastewater/treatment.htm

Lincoln, NE
FEMA Region VII

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Health & Medical

Lincoln Wastewater Treatment Plant Flood Mitigation

Details

Project Owner
City of Lincoln, NE

Type of Project
Infrastructure Flood Protection

Area of Impact
City of Lincoln, NE population (287,401 as of 2018)

$ Cost

Total Project Cost
$230,000

Funding Sources

Federal Funding
FEMA HMGP: $172,500

Non-Federal Funding
City of Lincoln, NE: $57,500

Benefits

Primary

- Avoids potential physical damage to WWTP equipment, including electrical supply and control components, from future storms/ flooding
- Reduces loss of economic value associated with loss of WWTP services to residential customers
- Curtails the need for repairs to equipment and reduces potential clean-up costs from contamination during flood events

Secondary

- Reduces losses to commercial and industrial sectors highly reliant on wastewater treatment
- Provides environmental benefits by avoiding the release of untreated wastewater into local water bodies during flood events

Partnerships

FEMA

City of Lincoln, NE

Project Timeline

Start Date
Received funding 1998

Project Completion Date
Project completed in 2003

Resources & References

FEMA. 2010. "*Mitigation of Essential Structures Helps to Keep Water Treatment Plant Open.*" December 9, 2010. https://www.hsdl.org/?view&did=13096.

Minot Water Treatment Plant Floodwall

In 2011, major flooding devastated parts of North Dakota, including the City of Minot and its water treatment plant. City officials were forced to implement a "boil water" order, causing concern about adverse health impacts from drinking the contaminated water. In 2013, FEMA's Hazard Mitigation Grant Program (HMGP) awarded the City of Minot with $2,081,629 to fund the construction of a 14-foot floodwall to protect the water treatment plant. This project was the first permanent floodwall ever erected in Minot and will protect the drinking water from future flooding impacts for years to come. In December 2017, the U.S. Army Corps of Engineers approved a new project as part of Minot's flood protection plan, the Souris River Flood Protection Project, which will provide flood mitigation benefits to a much larger swath of the City, in addition to the area around the water treatment plant.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Catalyzing Other Projects

This project was one of the first in a series of flood mitigation projects in the City of Minot, and its success has helped drive the Souris River Flood Protection Project forward.

Protecting Drinking Water

The Minot Water Treatment Plant Floodwall project will help ensure that the City's drinking water is safe for residents to consume during and after major flood events.

Water floods a neighborhood in Minot, ND, June 23, 2011.

Source: Staff Sgt. Sharida Jackson of The National Guard, https://commons.wikimedia.org/wiki/File:Aerial_view_of_flooding_in_a_Minot,_N.D.,_residential_area.jpg

Minot, ND
FEMA Region VIII

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Food, Water, Sheltering

Safety & Security

Minot Water Treatment Plant Floodwall

Details

Project Owner
City of Minot

Type of Project
Flood Mitigation Infrastructure

Area of Impact
Minot population (Total Pop: 47,822 in 2017)

$ Cost

Total Project Cost
$2.8 million

Funding Sources

Federal Funding
FEMA HMGP: $2.1 million

Non-Federal Funding
City of Minot: $693,876

Benefits

Primary

- Avoids physical damage to potable water treatment facilities and associated large equipment, including electrical supply and control components
- Prevents loss of potable water treatment services associated with physical damage and repair time
- Reduces clean-up costs from possible contamination onsite and downstream

Secondary

- Reduces loss of function for businesses and critical facilities that rely on potable water treatment functionality, especially schools, for which excessive closures can have a ripple effect across all businesses as parents have to handle unexpected work absences

Partnerships

FEMA

City of Minot

Project Timeline

Start Date
Project received FEMA funding in 2013

Project Completion Date
Floodwall completed in 2017

Resources & References

FEMA. 2014. "FEMA Provides $2 Million for Minot Floodwall Project." March 19, 2013. Last modified October 28, 2014. https://www.fema.gov/news-release/2013/03/19/fema-provides-2-million-minot-floodwall-project.

Rank, Stephanie. 2017. "Army Corp of Engineers approves permits for Minot's Flood Protection Project." *West Dakota Fox*, December 20, 2017. https://www.kfyrtv.com/content/news/Army-Corp-of-Engineers-approves-permits-for-Minots-Flood-Protection-Project-465513683.html.

Skurzewski, Joe. 2017. "State, local leaders celebrate Minot's water treatment plant floodwall." *West Dakota Fox*, August 11, 2017. https://www.kfyrtv.com/content/news/State-local-leaders-celebrate-Minots-water-treatment-plant-floodwall--439955473.html.

Souris River Joint Board. 2019. "Mouse River Plan." Last modified 2019. Accessed March 16, 2020. https://www.mouseriverplan.com/.

Springgate, Jack. 2019. "Minot flood walls taking shape with first concrete pour." *West Dakota Fox*, May 7, 2019. https://www.kfyrtv.com/content/news/Minot-flood-walls-taking-shape-with-first-concrete-pour--509619301.html.

Northwest Resiliency Park

The Northwest Resiliency Park will be the largest park in Hoboken, New Jersey at 5.4 acres, providing the City with recreation and public space. It will have strategic installations of green infrastructure and innovative stormwater management measures to alleviate the City's stormwater infrastructure system and reduce nuisance flooding. A large tank and filtration system built underground will house one million gallons of rainwater that will be released back into the system after the storm.

The City undertook an extensive community engagement process to ensure the park would be well-adapted to the needs of the surrounding community and the entire City of Hoboken. This engagement included a survey, public participation events, a community design charette, and many public meetings.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Hurricanes

Innovative Stormwater Solution Incorporates Community Amenities

The Park will be Hoboken's largest park and one of the only resiliency parks in the nation. The Park will manage at least one million gallons of stormwater, greatly minimizing nuisance flooding in the community. Developed through a community design charette, the Park is an example of how to reduce inflows to the combined sewer-stormwater management system while creating a wide range of recreational amenities.

Site of future Northwest Resiliency Park
Source: Google Earth Pro, used under license

Hoboken, NJ
FEMA Region II

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Transportation

Northwest Resiliency Park

Details

Project Owner
City of Hoboken

Type of Project
Flood Mitigation Infrastructure / Nature-Based Solution

Area of Impact
5.4-acre park and surrounding Hoboken population (Total Pop: 55,131 in 2017)

$ Cost

Total Project Cost
$50 million

Funding Sources

Federal Funding
FEMA Pre-Disaster Mitigation Funding ($10 million)

U.S. Department of Housing and Urban Development (HUD)

Non-Federal Funding
City of Hoboken ($30 million)

Hudson County ($500,000)

Benefits

Primary

- Reduces physical damage to buildings and infrastructure from nuisance flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems

Secondary

- Reduces loss of service to businesses and other organizations from short-term road closures
- Offers social benefits of providing a park to the surrounding community, including recreation and green space

Partnerships

City of Hoboken

Hudson County

Project Timeline

Start Date
Property acquisition began in 2016

Project Completion Date
The City broke ground on the Park in October 2019 with completion anticipated in the fall of 2022

? Challenges Faced

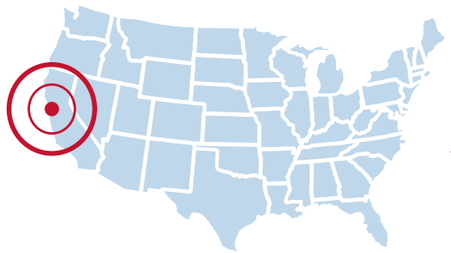
- Robust stakeholder engagement required extensive coordination

Resources & References

City of Hoboken. 2020. "Northwest Resiliency Park." Accessed March 16, 2020. http://nwpark-cityofhoboken.opendata.arcgis.com/.

Zeitlinger, Ron. 2019. "Hoboken breaks ground on Northwest Resiliency Park." NJ.com, October 4, 2019. https://www.nj.com/hudson/2019/10/hoboken-breaks-ground-on-northwest-resiliency-park.html.

Petaluma Payran Reach Flood Control and Floodways



Petaluma, CA
FEMA Region IX

Multiple residential neighborhoods in the City of Petaluma, CA, along the Payran Reach, a 3,600-foot reach of the Petaluma River, experienced repetitive flooding and flood losses during the 1980s and 1990s. This flooding repeatedly impacted hundreds of homes and businesses in Petaluma. In 1998, FEMA approved a Hazard Mitigation Grant Program (HMGP) grant to fund a project to protect these neighborhoods from flooding and flood impacts.

This multi-part mitigation project was designed to eliminate potential flood damage within the project area from floods of up to 100-year flood levels. As part of the project, two bridges were replaced at an elevated level, two additional bridges were elevated, and one bridge was relocated. A concrete channel constriction weir was constructed upstream of the project site to reduce the possibility of bank erosion from floodwaters. A total of 3,300 feet of floodwall was constructed (1,650 feet on each side of the Petaluma River). Over 10 acres of mitigation planting was installed at locations along the riverbanks and within the channel, in order to support riparian habit and stabilize banks at risk of eroding. The existing storm drain system was modified to allow for additional flow through the floodwalls, and the pipes were constructed to prevent backflow. A new pump station was also installed upstream as part of the project.

In 2008, FEMA conducted a Loss Avoidance Study, and concluded that $44,170,317 (in 2008 dollars) in loss of function and emergency management costs were avoided as a result of this project.

Comprehensive Approach Allows Major Losses to be Avoided

The comprehensive approach taken by this project, combining the construction of multiple hard infrastructure interventions and the use of substantial nature-based solutions, allowed significant losses of life and property to be avoided in Petaluma, CA, as a result of flooding impacts.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Winter Storms

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Transportation

Northern California Flood Control Mitigation
Source: FEMA. Loss Avoidance Study: Northern California Flood Control Mitigation

Petaluma Payran Reach Flood Control and Floodways

Details

Project Owner
City of Petaluma, CA

Type of Project
Infrastructure Project

Area of Impact
City of Petaluma, CA (Total Pop: 61,917 in 2018)

$ Cost

Total Project Cost
$39.9 million

Funding Sources

Federal Funding
FEMA HMGP: $2.9 million

U.S. Army Corps of Engineers (USACE): $5 million

Non-Federal Funding
City of Petaluma, CA: $32 million

Benefits

Primary
- Significantly reduces the potential for physical damage to river channels and buildings and their contents due to flooding
- Avoids residential displacement/reduced short-term shelter needs
- Reduces potential damage to stormwater and flood infrastructure, including road culverts, due to future flood events

Secondary
- Reduces loss of function to non-residential structures and their associated tenants (businesses and other organizations) due to road closures caused by flood events
- Decreases need for emergency response during flood events
- Offers return on investment of 98% of original mitigation project cost (based on post-project study for losses avoided for single post-mitigation flood event)

Partnerships

FEMA HMGP

USACE

City of Petaluma, CA

Project Timeline

Start Date
HMGP Grant Approved in 1998

Project Completion Date
Project completed in 2004

? Challenges Faced

- This was a high-cost, multi-part project with a long project timeline, which created both funding and coordination challenges for the multiple stakeholders involved

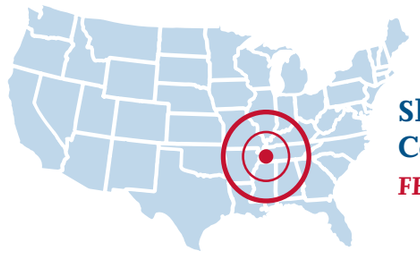
Resources & References

FEMA. 2008. "Loss Avoidance Study: Northern California Flood Control Mitigation." https://www.fema.gov/media-library-data/1492193978598-8b228ed3251229b6a86dac730e56e925/FEMA_Factsheet_Northern_Cal_LAS_508.pdf.

Northern California Flood Control Mitigation

Source: FEMA. Loss Avoidance Study: Northern California Flood Control Mitigation

Resilient Shelby's Greenprint for Resilience



Shelby County, TN
FEMA Region IV

Following a series of severe storms and flooding in 2011, Shelby County, TN applied to the U.S. Department of Housing and Urban Development's (HUD's) Community Development Block Grant-Disaster Recovery (CDBG-DR) funding to improve its resilience. The County was awarded $60 million for its *Greenprint for Resilience Project*, which includes three scalable resilience projects along the areas that were hardest hit during the 2011 floods, Big Creek, Wolf River, and South Cypress Creek. These projects are further described below.

- **Big Creek Millington:** This project will build a large floodway between the existing levee and elevated highway to provide a floodplain so floodwaters would bypass the local community. Trees removed for this project will be replaced at a ratio of 4:1. This floodplain will also serve as a recreational area and a sustainable wildlife area with wetlands and natural features. The project will also provide connectivity to greenway trails, walking paths, and ball fields.
- **Wolf River Memphis:** This project features a series of open space and infrastructure upgrades along with wetland reestablishment and preservation to three locations in Memphis. Rodney Baber Park will be raised above the floodplain with added flood storage and recreational facilities. Kennedy Park's wetlands will be expanded and park amenities upgraded. Orchi Road will have a section elevated and will become a Complete Street with bicycle facilities and a new wetland pond.
- **South Cypress Creek Memphis:** This project will "make room for the river" by creating wetlands, stormwater lots, and protective berms; restoring the streams; and buying out vulnerable homes. Vacant lots will be reused to support the community's goals. There will also be new bike lanes and neighborhood trails.

The *Greenprint for Resilience Project* also includes a regional resilience plan to model and plan for flood impacts and other climate risks across the County and tri-state region. The plan was funded through a HUD Sustainable Communities Regional Planning Grant.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Three Major Nature-Based Solutions in the FEMA Region IV Memphis Region

All three projects focus on increasing floodwater storage through nature-based solutions, including wetland restoration or establishment and building floodplains and stormwater lots. All will be able to divert floodwaters from neighboring communities in future flood events.

Improved Connectivity and Open Space for Low- to Moderate-Income Communities

All three projects will improve connectivity in the low- to moderate-income communities they serve through greenway trails, walking paths, bicycle facilities, and park upgrades.

2011 flooding in downtown Memphis, TN
Source: Thegreenj / CC BY-SA (https://creativecommons.org/licenses/by-sa/3.0)

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Transportation

Resilient Shelby's Greenprint for Resilience

Details

Project Owner
Shelby County Office of Resilience

Type of Project
Floodwater Storage Establishment and Repair

Area of Impact
Greater Memphis metropolitan area population (Total Pop: 1.3 million in 2010)

$ Cost

Total Project Cost
$74.7 million

Funding Sources

Federal Funding
HUD CDBG-DR:

- Big Creek – $25.1 million
- Wolf River – $7.3 million
- South Cypress – $8.99 million

HUD Sustainable Communities Regional Planning Grant: $2.6 million

Non-Federal Funding
State of Tennessee:

- Big Creek – $6 million

Shelby County:

- Big Creek – $3 million

City of Memphis:

- Wolf River – $1.5 million
- South Cypress – $1.6 million

Benefits

Primary
- Reduces physical damage to buildings and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems
- Reduces the need to temporarily relocate during flood events (in those areas with at-risk populations)

Secondary
- Offers social benefits of providing the surrounding community with a park for recreation and green space
- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Decreased need for emergency response during flood events

Partnerships

HUD
Shelby County
City of Memphis
State of Tennessee
Memphis Metropolitan Planning Organization

Project Timeline

Status
HUD Funding began being awarded in 2013
Resilience Plan released December 2019
Construction on projects has not started

? Challenges Faced

- Extensive public involvement and NEPA processes

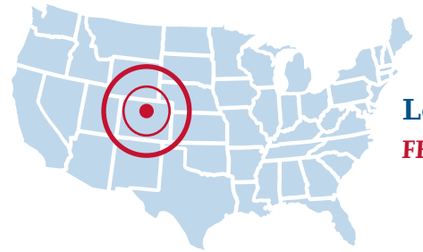
Resources & References

Resilient Shelby. 2020. "Overview." Accessed March 16, 2020. https://resilientshelby.com/overview/.

Resilient Shelby. 2020. "Resilience Activities." Accessed March 16, 2020. https://resilientshelby.com/overview/resilience-activities/.

Shelby County Resilience Council. 2019. "Mid-South Regional Resiliency Master Plan." December 2019. https://resilientshelby.com/wp-content/uploads/2020/01/Final_MRRP_Low_Res_Spreads.pdf.

Resilient St. Vrain Nature-Based Flood Protection



Longmont, CO
FEMA Region VIII

In 2013, eight straight days of continual rain damaged hundreds of homes and businesses, blocked streets, and impacted the functioning of critical infrastructure in Longmont, CO. In 2016, the City decided that they needed to switch their focus from recovery and response efforts to more forward-thinking future flood mitigation and resilience planning. Multiple projects resulted from these efforts, but the most notable is the Resilient St. Vrain effort, which aimed to restore the St. Vrain Creek Greenway Trail System, and implement channel improvements to the creek to help mitigate the impacts of future flooding.

The project included physically widening the creek, rebuilding two existing bridges, and replacing a water diversion structure that washed out during the 2013 flooding with nine smaller structures, which created a unique opportunity for recreation for residents and visitors. Called Dickens Farm Nature Area, this section of the creek and the land around it were converted into a nature preserve with kayak launches, shelters, restrooms, and a "nature discovery area" for children. This project not only helped protect life and property, but also created multiple co-benefits for the community, in the form of recreation and environmental benefits.

Award-Winning, Comprehensive Approach to Mitigating Flood Risk

In 2018, Resilient St. Vrain won the Sustainability Award for a Large Community from the Colorado chapter of the American Public Works Association for its "efficient delivery of infrastructure in an environmentally and socially responsible way," that achieves multiple co-benefits for the natural environment and surrounding community.

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Winter Storms

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Transportation

Resilient St. Vrain Flood Project
Source: FEMA

Resilient St. Vrain Nature-Based Flood Protection

Details

Project Owner
City of Longmont, CO

Type of Project
Flood Mitigation Infrastructure

Area of Impact
Potential to benefit entire City of Longmont, CO (Total Pop: 96,577 in 2018)

$ Cost

Total Project Cost
$136 million

Funding Sources

Federal Funding
FEMA Hazard Mitigation Grant Program (HMGP)

Federal Highway Administration (FHWA)

Community Development Block Grant-Disaster Recovery (CDBG-DR)

Non-Federal Funding
City of Longmont Storm Drainage Bonds

Boulder County

State of CO

Great Outdoors Colorado (GOCO)

Benefits

Primary
- Reduces physical damage to creek channel, buildings, and infrastructure from stormwater and flood events
- Reduces loss of service to infrastructure, especially roads and other transportation systems
- Reduces the need to temporarily relocate at-risk populations during flood events

Secondary
- Benefits the surrounding community with a green space for recreation and improves water quality
- Reduces associated loss of service to businesses and other organizations from short-term road closures
- Decreases need for emergency response during flood events

Partnerships

City of Longmont

Boulder County

State of Colorado

FEMA

U.S. Army Corps of Engineers

FHWA

HUD CDBG-DR

GOCO

Project Timeline

Start Date
Project planning initiated in 2013; construction begun 2016

Status
Future phases of the project remain unfunded, so project end date is unknown

? Challenges Faced

- Future phases of this comprehensive, multi-part project remain unfunded; because the cost to implement the full Resilient St. Vrain plan is so high, attaining enough funding to complete the project has been a significant challenge

Resources & References

Brendza, Will. "From recovery to resilience to recreation." Boulder Weekly, February 22, 2018. https://www.boulderweekly.com/special-editions/longmont-insider/recovery-resilience-recreation/

City of Longmont. "Resilient St. Vrain Project." Accessed May 12, 2020. https://www.longmontcolorado.gov/departments/departments-n-z/water/stormwater-drainage/resilient-st-vrain

Sherman, Josh. "Resilient St. Vrain Project." City of Longmont. Accessed May 12, 2020. http://www.floods.org/Files/Conf2018_ppts/B4-Sherman.pdf

Spina, John. "Bill to focus federal funding for disaster recovery projects on resiliency, not replication." Daily Camera, January 30, 2020. https://www.dailycamera.com/2020/01/30/boulder-longmont-neguse-bill-to-focus-federal-funding-for-disaster-recovery-projects-on-resiliency-not-replication/

Spring Creek Drainage Improvement Project

Lincoln County, SD
FEMA Region VIII

This project, which included upsizing culverts at various railroad crossings, was initiated in 2012 after a major flood event in 2010 caused extensive damage in Lincoln County, SD. The flood damaged roads, homes, and infrastructure near Spring Creek and Spring Creek Tributary. Hydrological models predict flooding to continue to cause additional damage and erosion in this area in the future. This project was designed to mitigate future flood risk and damage in the most at-risk areas. Several alternatives were considered, but the Environmental Assessment found that upsizing culverts at several railroad crossings in the project area, in conjunction with increasing flow capacity for parts of the existing channel, had the fewest adverse impacts.

A $1.8 million Hazard Mitigation Grant Program (HMGP) grant from FEMA made this project possible. The project, which altered the floodplain (Letter of Map Revision, effective on August 11, 2017), ultimately removed all homes in the project area from the floodplain.

Multi-Hazard Mitigation Activities Reduce Future Flood Risk Without Acquisition

Rather than utilizing traditional acquisition methods to remove homes from the flood plain, Spring Creek developed an engineered solution that reduced flooding vulnerability and protected access to the neighborhoods.

Flooding in southeast South Dakota
Source: Shutterstock

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Transportation

Spring Creek Drainage Improvement Project

Details

Project Owner
Lincoln County

Type of Project
Flood Mitigation Infrastructure

Area of Impact
Six residential subdivisions, covering approximately 320 acres

$ Cost

Total Project Cost
$2.4 million

Funding Sources

Federal Funding
FEMA HMGP: $1.8 million

Non-Federal Funding
Lincoln County: $683,000

Benefits

Primary
- Reduces physical damage to structures and their contents
- Reduces residential displacement and short-term shelter needs
- Reduces damage to stormwater and flood infrastructure, including road culverts

Secondary
- Reduces loss of function for transportation systems
- Reduces loss of function to non-residential structures and associated businesses or organizations impacted by road closures
- Decreases need for emergency response during flood events

Partnerships

FEMA

Lincoln County

Project Timeline

Start Date
Study/project planning begun in 2012

Project Completion Date
Project completed in 2017

Resources & References

FEMA Region VIII. 2012. "Draft Environmental Assessment for Spring Creek Tributary Floodplain Mitigation Project." Lincoln County. September 2012. https://www.lincolncountysd.org/Page.cfm/Information/110/Spring-Creek-Tributary-Flood-Mitigation-Project.

FEMA Region VIII. 2017. "Spring Creek Tributary Coordinated Drainage Area Drainage Project Summary of Costs." Lincoln County. June 9, 2017. https://www.lincolncountysd.org/Page.cfm/Information/110/Spring-Creek-Tributary-Flood-Mitigation-Project.

South Dakota Office of Emergency Management. 2020. "Application for Hazard Mitigation Grant." Accessed March 16, 2020. https://lincolncountysd.org/userfiles/file/GIS/Floodplain/Spring%20Creek%20Tributary/Spring%20Creek%20Tributary%20HMGP%20Application.pdf .

Worthington County Ditch 12 Flood Mitigation Project

Worthington, MN
FEMA Region V

The City of Worthington, MN and its surrounding areas have experienced repeated flooding impacts from heavy rains over the past several decades, impacting homes, businesses, and crops. The City itself sits on Okabena Lake, which also floods during prolonged periods of heavy rain. In 2018, Worthington's City Council authorized a $4.6 million project to create a detention basin west of the Shopko area of the City. The project would also include new, upsized box culverts on several City streets. FEMA provided $2.5 million in Hazard Mitigation Grant Program (HMGP) funding to help the City plan and implement this project, which should ultimately allow the City to protect hundreds of homes and businesses currently in the flood zone from future flood impacts. The City of Worthington funded the remaining $2.1 million in project costs from local sources. If the project is implemented as planned, the City should be able to apply for an official Letter of Map Revision from FEMA, which would also substantially reduce flood insurance costs to property owners currently in the flood zone.

Mitigation Solutions To Repetitive Losses

Confronted by decades of flooding impacts, Worthington County developed a series of mitigation solutions that will reduce future flood risk to several hundred homes and businesses currently in the Lake Okabena floodplain. Once complete, these properties will no longer be in the floodplain, thereby reducing the insurance cost burden for the community, yet will maintain the economic tax base that would otherwise be reduced by traditional acquisition and relocation solutions.

City of Worthington, MN, and Okabena Lake in the background
Source: Shutterstock

Addressed Hazards

PRIMARY HAZARD
Inland Flooding

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Worthington County Ditch 12 Flood Mitigation Project

Details

Project Owner
City of Worthington, MN

Type of Project
Flood Mitigation Infrastructure

Area of Impact
Worthington population (Total Pop: 13,247 in 2017)

$ Cost

Total Project Cost
$4.6 million (estimate)

Funding Sources

Federal Funding
FEMA HMGP: $2.5 million

Non-Federal Funding
City of Worthington, MN: $2.1 million

Benefits

Primary
- Reduced physical damage to structures and their contents and associated residential displacement and short-term shelter needs
- Reduced damage to stormwater and flood infrastructure, including road culverts

Secondary
- Reduced loss of function for transportation systems
- Reduced loss of function to non-residential structures and their associated businesses or organizations impacted by road closures
- Decreased need for emergency response during flood events

Partnerships

FEMA

City of Worthington, MN

Project Timeline

Start Date
FEMA HMGP funding received in 2017

Status
Project approved by Worthington City Council in April 2018

Resources & References

City of Worthington. 2020. "Engineering Construction Projects." Accessed March 16, 2020. http://www.ci.worthington.mn.us/biddersinformation.

Evers-Hillstrom, Karl M. 2018. "Flood mitigation project gets city nod." *The Globe*, April 25, 2018. https://www.dglobe.com/news/4436317-flood-mitigation-project-gets-city-nod.

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Landslides

American Samoa Rockfall Mitigation Project

In 2015, the American Samoa Department of Public Works received $3.3 million in FEMA Hazard Mitigation Grant Program (HMGP) funds to implement rockfall mitigation at four locations on Tutuila, where landslides are a persistent problem, particularly along Highway 001, due to steep and rocky slopes. Landslides are a hazard for both pedestrians and vehicles. The project removed loose rocks from the four sites and used wire mesh to stabilize the slopes. Best management practices were used to ensure pedestrian and vehicular safety, and to protect against adverse impacts to the environment, cultural resources, and air and water quality.

Addressed Hazards

PRIMARY HAZARD
Landslides

Earthquakes

Non-Traditional Mitigation Solution to Protect Critical Infrastructure

In American Samoa, landslides are a large threat to the island's transportation network. Throughout the implementation of this project, the Territory utilized best management practices to develop solutions that stabilized the hillsides and ensured pedestrian safety and transportation access while minimizing adverse impacts to the environment, cultural resources, and air and water quality.

Final Environmental Assessment

Rockfall Mitigation Project

FEMA-DR-1859-AS, HMGP 1859-9

Territorial Office of Fiscal Reform
American Samoa Department of Public Works

September 2014

FEMA

Environmental assessment document for the American Samoa Rockfall Mitigation Project

Source: FEMA, https://www.fema.gov/media-library-data/1418329013340-9b34f50ef7d174c0fca1e14ce3a06a0c/Rockfall_EA_Final_508.pdf

Tutuila, American Samoa
FEMA Region IX

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Transportation

Hazardous Material

American Samoa Rockfall Mitigation Project

Details

Project Owner
American Samoa Department of Public Works

Area of Impact
Four sites: Site A (0.50-acre site); Site B (0.45-acre site); Site C (0.60-acre site); Site D (1.32-acre site)

$ Cost

Total Project Cost
$3.6 million

Funding Sources

Federal Funding
FEMA HMGP: $3.3 million

Non-Federal Funding
American Samoa Department of Public Works: $363,000

Benefits

Primary
- Reduces loss of function of infrastructure systems, such as roads
- Reduces cost for cleanup following rockfall events
- Prevents direct damage to structures in more developed areas
- Provides life-safety benefits associated with reduced injuries and deaths
- Reduces rockfall occurrence and the potential for roadways to be blocked
- Reduces the cost of maintenance

Secondary
- Curtails the necessary cleanup and repair of roadways and vehicles as a result of accidents

Partnerships

FEMA

American Samoa Department of Public Works

Project Timeline

Status
Final Environmental Assessment completed in 2014; FEMA funding approved in January 2015

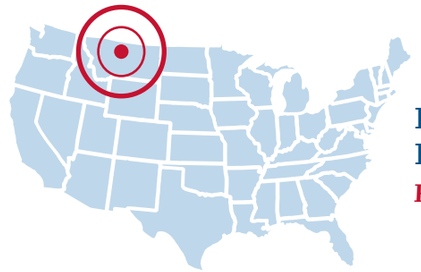
? Challenges Faced

- Phasing the project construction in order to minimize route closures and impacts to residents

Resources & References

FEMA Region IX. 2014. "Final Environmental Assessment for Rockfall Mitigation Project." AECOM. September 2014. https://www.fema.gov/media-library-data/1418329013340-9b34f50ef7d174c0fca1e14ce3a06a0c/Rockfall_EA_Final_508.pdf.

Rocky Boy's Reservation Lagoon Relocation



Rocky Boy's Reservation, MT
FEMA Region VIII

The Chippewa Cree Tribe of the Rocky Boy's Reservation's wastewater treatment plant (WWTP) serves approximately 1,200 people and relies on several lagoon cells to function. The embankment that supports the lagoon system has a history of issues with slumping, landslides, and erosion following heavy rains events. In June 2010, the Rocky Boy's Reservation received 4.8 inches of precipitation, which caused major flooding and a federal disaster declaration. The floods damaged around 500 homes, and left 300 without running water. Flooding destroyed many bridges, culverts and roads, including the road leading to the health clinic and tribal offices. The majority of the damage associated with the event was due to slope failure/mass movement. Several roads also failed due to over-saturation from the heavy rainfall.

This mass movement and associated erosion extended to the area around the WWTP. One of the lagoons was located near a bluff overlooking Box Elder Creek, and had begun to slide towards the creek. The embankment supporting another lagoon had also been slumping and sliding downhill toward the bluff due to over-saturation. It also appeared that several lagoons had been leaking into the surrounding groundwater, contributing to the saturation issue and speeding up the soil erosion process. The 2010 event also caused sinkholes to form in the area, causing concerns of a complete lagoon failure if a new sinkhole were to form from lagoon leakage.

The project, first proposed in 2012 and completed in 2015 and 2016, had the tribe relocate the two at-risk lagoons to more stable locations approximately two miles from previous locations. The two new lagoons were constructed in more stable soils and lined to prevent groundwater leakage. Since one lagoon from the old system was maintained, the project also included several miles of force main pipes to carry wastewater from the old lagoon to the two new lagoons. This project resulted in a lagoon system serving the Rocky Boy's Reservation WWTP that will withstand the impacts of heavy rains, soil erosion, and mass movement well into the future.

Protecting Public Health through Mitigation

Safeguarding the Reservation's wastewater treatment plant operations means that the entire tribal community is not at risk of losing access to potable water due to soil erosion and heavy rain events.

Addressed Hazards

PRIMARY HAZARD
Landslides

Inland Flooding

Rocky Boy's Indian Reservation Lagoon

Source: FEMA (https://www.fema.gov/media-library-data/1439835838622-0c6e6de8945a52b841378ecb0b7754bc/508_Draft_RckyBysLgnReloc_12Aug15.pdf)

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Health & Medical

Rocky Boy's Reservation Lagoon Relocation

Details

Project Owner
Chippewa Cree Tribe

Type of Project
Infrastructure

Area of Impact
Potential to impact at least 1,200 residents of Rocky Boy's reservation (Total Pop: 3,794 people in 2017)

$ Cost

Total Project Cost
$3.8 million

Funding Sources

Federal Funding
FEMA Hazard Mitigation Grant Program (HMGP)

Benefits

Primary
- Avoidance of physical damage to wastewater treatment facilities and associated large equipment, including electrical supply and control components
- Loss of wastewater treatment services associated with physical damage and repair time
- Clean-up costs from possible contamination on site and downstream

Secondary
- Reduced loss of function for businesses and critical facilities that rely on wastewater treatment functionality. This is especially true with schools, where excessive closures can have a ripple effect across all businesses if parents have to handle unexpected work absences.

Partnerships

FEMA

Bureau of Indian Affairs (BIA)

U.S. Environmental Protection Agency (EPA)

Project Timeline

Status
Draft Environmental Assessment completed in 2015

Resources & References

FEMA. 2015. "Draft Environmental Assessment: Rocky Boy's Reservation Lagoon Relocation." August 2015. https://www.fema.gov/media-library-data/1439835838622-0c6e6de8945a52b841378ecb0b7754bc/508_Draft_RckyBysLgnReloc_12Aug15.pdf.

Washington DOT Landslide Mitigation Action Plan and Rail Corridor Improvements

The Washington State Department of Transportation (DOT) 2014 Landslide Mitigation Action Plan was implemented to address landslides along the Pacific Northwest Rail Corridor. In the past, these landslides have interrupted rail service, created issues with traffic congestion, and threatened the safety of passengers and railway employees. This plan lays out mitigation strategies designed to reduce the occurrence and impact of landslides along this route.

In 2016, BNSF Railway and Washington State DOT completed six federally funded projects at several locations near Mukilteo and Everett, WA, to stabilize slopes and add catchment walls, reduce landslide occurrence, and protect the railway tracks. This work included constructing catchment walls to "catch" landslide debris before it hits the tracks, slide detection fences to give early warning of active landslides, improved drainage systems, and erosion control measures. Since the projects were completed in 2016, no landslides have reached the tracks in those locations.

Addressed Hazards

PRIMARY HAZARD
Landslides

Inland Flooding

Mitigation Plan Implementation Protects Critical Community Lifelines

Recognizing that passenger rail service is disrupted for a minimum of 48 hours each time a landslide covers the tracks near the coastal bluffs, the State of Washington developed a mitigation plan that identified rail segments particularly at risk and mitigation measures that would help alleviate the costs and interruption of service. Following the adoption of this plan, the state immediately began implementation of it, completing six landslide mitigation projects in less than two years, securing the rail corridor from future disruptions and damage.

Landslide Mitigation retention wall: The finished metal and concrete landslide retention wall helps keep debris from covering the tracks.
Source: Washington State Dept of Transportation, https://www.flickr.com/photos/wsdot/19725323513

State of Washington
FEMA Region X

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Transportation

Hazardous Material

Washington DOT Landslide Mitigation Action Plan and Rail Corridor Improvements

Details

Project Owner
BNSF Railway and Washington DOT

Type of Project
Corridor Improvements and Landslide Mitigation Plan

Area of Impact
Pacific Northwest rail corridor segment in Washington State

$ Cost

Total Project Cost
$17.75 million

Funding Sources

Federal Funding
American Recovery and Reinvestment Act Grant Program: $17.75 million

Benefits

Primary
- Reduced loss of function of the rail system
- Reduced cost for cleanup following landslide events
- Reduced maintenance costs associated with landslide occurrence and blocked road
- Reduced loss of function will also directly benefit railroad customers

Secondary
- Life-safety benefits associated with a reduction in injuries/deaths to railroad workers and customers in the unlikely, but not improbable, event of a landslide that directly strikes a train or vehicle or the occurrence of an undetected landslide that may cause accidents and/or derailments
- Avoided costs associated with cleanup, rail equipment repair, and potential environmental impacts

Partnerships

BNSF Railway

Sound Transit

Amtrak

Federal Railroad Administration

Several municipal and state agencies

Project Timeline

Start Date
Process begun 2012-2013 winter season

Plan adopted 2014

Project Completion Date
Projects completed in 2016

? Challenges Faced

- Coordinating rail closure/track changes during construction
- Multiple partnerships between track owners, service operators, and those who maintain equipment

Resources & References

Washington Department of Transportation. 2014. "Landslide Mitigation Action Plan." 2014. https://www.wsdot.wa.gov/sites/default/files/2017/03/08/LandslideMitigationActionPlan.pdf.

Washington Department of Transportation. 2020. "Rail Projects." Accessed March 16, 2020. https://www.wsdot.wa.gov/rail/projects.

Tornadoes

Mercy Hospital Rebuild

The May 2011 tornado in Joplin, MO, killed 161 people, left approximately 1,371 injured, and destroyed thousands of homes, businesses, and other buildings, including St. John's Regional Medical Center (now called Mercy Joplin), where six people were killed. Although the hospital's outer structure remained relatively intact, the windows shattered during the storm, destroying the building's interior. The hospital's electrical equipment also sustained heavy damage, because it was housed outside the building.

Work on the replacement hospital began in 2012 and was completed in 2015. The new hospital includes two underground levels and eight above-ground levels. One of the key features of the new hospital is windows that are designed to resist 250 mile-per-hour winds. These windows were installed in critical care areas, such as intensive care and neonatal intensive care. Architects also designed the new facility to rely on a stand-alone, hardened central utility plant, which houses two generators that can each independently power the entire hospital. Architects and engineers also included a reinforced building core, with interior stairwells equipped with emergency lighting, multiple elevator banks (which helps reduce the risk of all elevators being disabled during a disaster), and redundant power and water feeds.

In addition to building a new, tornado/high-wind-resistant structure, the hospital also changed some of its day-to-day operations to improve disaster-readiness, including storing supplies on each floor instead of in the basement, so that staff do not have to travel far to get the supplies they might need in an emergency.

Addressed Hazards

PRIMARY HAZARD
Tornadoes

Multi-Lifeline Mitigation Provides Community with a Safe Space

Reconstruction of this major community hospital incorporated significant mitigation solutions designed to reduce risk from future tornadoes, and ensure that the community has a safe haven in case of future events. This project represents a "complete solution" for mitigation; improvements included wind-resistant glass in critical areas, hardened and enhanced power generation systems, and protected water transmission lines. Additionally, operational improvements were incorporated to improve the emergency readiness of the hospital and its staff.

St. John's Regional Medical Center immediately after the 2011 tornado

Source: FEMA P-908, Tornado Outbreak of 2011, Materials Assessment Team Report

Joplin, MO
FEMA Region VII

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

Food, Water, Sheltering

PRIMARY LIFELINE

Health & Medical

Mercy Hospital Rebuild

Details

Project Owner
Mercy Hospital Joplin

Type of Project
Structural

Area of Impact
Entire hospital; has the potential to impact entire Joplin community (Total Pop: 52,288 in 2017)

$ Cost

Total Project Cost
$465 million

Funding Sources

Non-Federal Funding
Mercy Hospital Joplin

Benefits

Primary
- Reduces physical damage to the hospital as well as injuries and deaths to hospital occupants (life-safety benefits)

Secondary
- Offers the social benefits of providing a safe place for refuge during a tornado and dual usage of the structure as a safe room and a hospital

Project Timeline

Start Date
Rebuild begun in 2012

Project Completion Date
New hospital completed in 2015

? Challenges Faced

- Tight timeline
- Regular and consistent communication between hospital officials and design team
- Costly hazard-resistant upgrades

Resources & References

DiPietro, Ben. 2017. "Tornado-Ravaged Hospital Took Storm-Smart Approach During Rebuild." *The Wall Street Journal*, August 30, 2017. https://blogs.wsj.com/riskandcompliance/2017/08/30/tornado-ravaged-hospital-took-storm-smart-approach-during-rebuild/.

Fentem, Sarah. 2018. "7 years after Joplin tornado, Mercy builds hospitals with disaster in mind." KCUR 89.3, June 21, 2018. https://www.kcur.org/post/7-years-after-joplin-tornado-mercy-builds-hospitals-disaster-mind#stream/0.

McCarthy. 2015. "Promise of New Mercy Hospital Joplin is Delivered as Hospital Opens in Record Time." March 6, 2015. https://www.mccarthy.com/insights/promise-new-mercy-hospital-joplin-delivered-hospital-opens-record-time.

United States Global Change Research Program. 2019. "Wind-Resistant Construction Key to Rebuilding for Resilience." U.S. Climate Resilience Toolkit. Last modified October 24, 2019. Accessed March 16, 2020. https://toolkit.climate.gov/case-studies/wind-resistant-construction-key-rebuilding-resilience.

Rebuilt Mercy Hospital as it looks today

Source: U.S. Climate Resilience Toolkit
https://toolkit.climate.gov/case-studies/wind-resistant-construction-key-rebuilding-resilience

Tsunamis

Alaska DHS and EM Tsunami Education, Mapping, and Siren Check

With fiscal year 2019 funding from National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) Tsunami Activities Financial Assistance, the Alaska Department of Homeland Security and Emergency Management (DHS & EM) conducted community outreach with tsunami education materials, conducted workshops with community leaders and emergency managers, and checked tsunami sirens across the state. The DHS & EM has extensive online resources to help the public with tsunami preparedness, including evacuation maps by community with tsunami potential and siren information, educational materials for schools and educators, as well as extensive materials for individuals (i.e., "Tips for the Elderly").

The University of Alaska Fairbanks (UAF), was the subgrantee of this grant, meaning they received a portion of these funds to work with the Alaska DHS & EM. They conducted high-resolution mapping, modeled tsunami currents, and published technical reports. The UAF's Alaska Earthquake Center has been working in partnership with the DHS & EM and the Alaska Division of Geological and Geophysical Surveys to map tsunami inundation zones along the Alaskan coast since 1998. These maps are now accessible through the new Alaska Tsunami Hazard Map Tool. This tool should help communities understand their risk and better prepare for disasters.

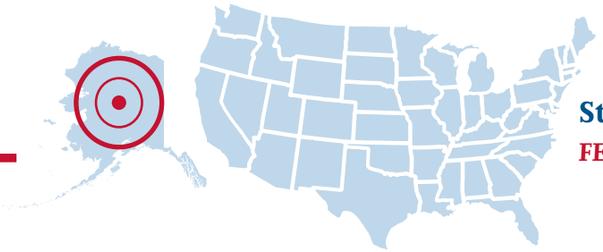
Addressed Hazards

PRIMARY HAZARD
Tsunamis

Non-Traditional Mitigation Activities Enhance Community Safety

Utilizing funding from NOAA, the State of Alaska was able to conduct extensive tsunami education and has also significantly upgraded its Tsunami Educational Portal and Hazard Maps. The digital enhancements provide greater access to the information for rural communities, greatly enhancing the state's educational outreach.

Signs like this can be used to make people aware of the risk of tsunamis in their area.
Source: NOAA Flickr Image ID: wea04399, NOAA's National Weather Service (NWS) Collection
Photographer: Dr. John Cloud, Historian, NOAA Central Library



State of Alaska
FEMA Region X

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Alaska DHS and EM Tsunami Education, Mapping, and Siren Check

Details

Project Owner
Alaska Department of Homeland Security and Emergency Management

Type of Project
Information Campaign

Area of Impact
Alaskan population (Total Pop: 737,438 in 2017)

$ Cost

Total Project Cost
The cost of developing new plans, codes, or ordinances include community staff time and any outside consultants to provide technical support and associated analysis. Changes will typically include economic analyses looking at construction components, practices, and short- and long-term maintenance costs.

Funding Sources

Federal Funding
NOAA/NWS Tsunami Activities Financial Assistance Program (FY19 budget of $5.36 million)

Benefits

Primary
- Reduces injuries/deaths (life-safety benefits)
- Provides education on what to do during an event to prevent/reduce the possibility of injuries/deaths

Secondary
- Incentivizes community coordination activities, allowing communities to work together on safety measures
- Provides warning system that could potentially be used for other types of risks as well

Partnerships

UAF

Project Timeline

Status
FY19 NOAA/NWS Tsunami Financial Assistance for the performance period from September 1, 2019, through August 31, 2020

? Challenges Faced

- High percentage of rural difficult to reach communities along Alaskan coastline

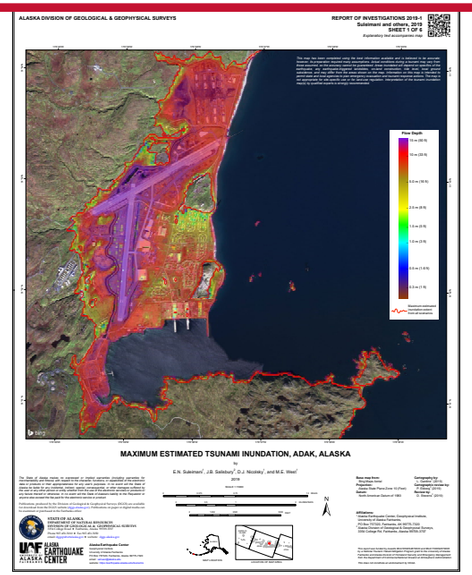
Resources & References

Alaska Division of Homeland Security and Emergency Management. 2020. "Earthquake and Tsunami Preparedness." Accessed March 16, 2020. https://ready.alaska.gov/Preparedness/Outreach/Eqprep.

Freudenberger, Fritz. 2019. "New tsunami map tool empowers Alaskans to plan for the worst." *University of Alaska Fairbanks*, September 17, 2019. https://news.uaf.edu/new-tsunami-map-tool-empowers-alaskans-to-plan-for-the-worst/.

National Tsunami Hazard Mitigation Program. 2019. "NOAA/NWS Tsunami Activities Financial Assistance." Last modified October 8, 2019. Accessed March 16, 2020. https://nws.weather.gov/nthmp/grants/2019grants/index.html.

Suleimani, E.N., Salisbury, J.B., Nicolsky, D.J., and West, M.E., 2019, Tsunami inundation maps for Adak and Atka, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2019-1, 63 p., 6 sheets. http://doi.org/10.14509/30186



Tsunami inundation maps for Adak and Atka, Alaska
Source: http://doi.org/10.14509/30186

Shoalwater Bay Tribe Tsunami Evacuation Structure

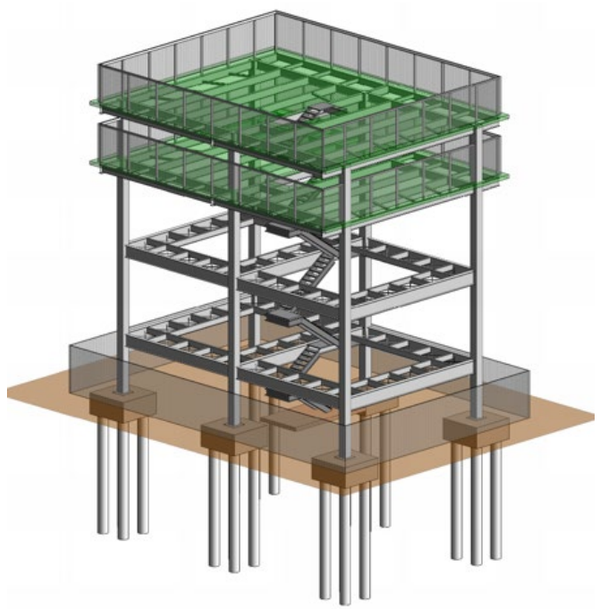
The Shoalwater Bay Tribe is in the process of constructing a tower designed to serve as a tsunami evacuation structure. The 50-foot-high structure will be designed to hold 486 people in the event of a tsunami. The Shoalwater Bay Tribe has 70 official members with a total reservation population of 120, which leaves room for tribal neighbors in the tower. The tribe envisions equipping the tower with solar panels in order to communicate during a long-term event and stocking the tower with emergency supplies. The tribe has received a $2.2 million Pre-Disaster Mitigation (PDM) grant from FEMA and is contributing $1 million of its own funds. This will be the second vertical evacuation structure built on the Washington coast.

Addressed Hazards

PRIMARY HAZARD
Tsunamis

Tribal-Led Regional Protection

This tsunami mitigation project, currently under construction, demonstrates how a tribe developed a mitigation solution for its population that also provides protection for the wider community. When complete, this tower will be able to serve four times the reservation's population in the event of a tsunami or other major flood.



The Shoalwater Bay tsunami evacuation tower would stand at least 50 feet tall and is designed to hold 486 people.
Source: FEMA News Photo

Tokeland, WA
FEMA Region X

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Food, Water, Sheltering

Shoalwater Bay Tribe Tsunami Evacuation Structure

Details

Project Owner
Shoalwater Bay Tribe

Type of Project
Safe Shelter/Structure

Area of Impact
Shoalwater Bay Tribe (Total Pop: 120) and neighboring communities

$ Cost

Total Project Cost
$3.2 million

Funding Sources

Federal Funding
FEMA's PDM Program: $2.2 million

Non-Federal Funding
Shoalwater Bay Tribe: $1 million

Benefits

Primary
- Reduces injuries/deaths (life-safety benefits)

Secondary
- Offers social benefits of providing a safe place of refuge during a Tsunami event, and the potential for dual usage of the structure for emergency services or even recreation

Partnerships

University of Washington

Hart Crowser

Degenkolb Engineers

Project Timeline

Start Date
Received funding in 2018

Project Completion Date
Target project completion in October 2020

? Challenges Faced

- Zoning concerns about the tower's height exception leading to people building very tall houses
- Potential for seismic impacts to structure and need for additional soil studies

Resources & References

Doughton, Sandi. 2018. "This tiny Washington town has little hope of escaping a tsunami, so one tribe is building them all a tower." *The Seattle Times*, July 23, 2018. Last modified July 24, 2018. https://www.seattletimes.com/seattle-news/science/shoalwater-bay-tribe-will-build-washington-states-second-tsunami-refuge-a-tower-at-willapa-bay/.

"Lots of hands involved in the Tokeland tsunami tower project." 2019. *The Daily World*. September 18, 2019. https://www.thedailyworld.com/news/lots-of-hands-involved-in-the-tokeland-tsunami-tower-project/.

Washington Military Department. 2018. "Celebrating a new tsunami vertical evacuation refuge for the Shoalwater Bay Indian Tribe." June 28, 2018. https://mil.wa.gov/news/celebrating-a-new-tsunami-vertical-evacuation-refuge-for-the-shoalwater-bay-indian-tribe.

Wildfires

Camptonville Biomass Plant

Camptonville, CA

FEMA Region IX

The Camptonville Community Partnership is developing a 5.5-megawatt biomass plant in Camptonville, CA. This plant will support healthy forests by generating electricity from materials removed from forests that are overstocked or suffering from tree die-off. The project provides incentives for fuel reduction activities and otherwise utilizing forest waste. It includes a power-purchase agreement with the local utility (PG&E) to purchase electricity created by the biomass facility. This plant will provide a market focused on sustainable forest management projects, reducing forest fuels, and minimizing the threat of wildfire. This plant will provide a market focused on sustainable forest management projects, reducing forest fuels and minimizing the threat of wildfire.

Addressed Hazards

PRIMARY HAZARD

Wildfires

Incentivizing Wildfire Mitigation Activities & Providing Power Generation and Economic Development

Forestry best management practices routinely include the removal of dead material and other forest waste production, particularly in dense forests susceptible to tree die-off. While this is effective at reducing the amount of fuel that wildfires feed on, it can be costly and time consuming. This project offers a financial incentive to offset the costs of material removal while providing a mechanism to use collected materials for power generation, ultimately decreasing loads on the existing grid.

Local forestland near Camptonville, CA

Source: Shutterstock

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Energy (Power & Fuel)

Camptonville Biomass Plant

Details

Project Owner
The Camptonville Community Partnership

Type of Project
Energy Efficiency/Conservation

Forest Management

Area of Impact
Yuba County

$ Cost

Total Project Cost
$5.1 million

Funding Sources

Non-Federal Funding
California Energy Commission as part of its Electric Program Investment Charge (EPIC) grant program: $4.9 million

Yuba Water Agency: $186,500

Benefits

Primary
- Reduced physical damage to structures and their contents, as well as infrastructure in at-risk areas
- Life-safety benefits for areas with potential rapid wildfire risk due to a reduction in injuries and deaths
- An alternative power-generation source that both generates power and provides jobs
- Potential to result in long-term wildfire fuels reduction, without the need for multiple mitigation grants

Secondary
- Reduced fire suppression costs and emergency response costs

Partnerships

The Camptonville Community Partnership

Yuba Water Agency

PG&E

Project Timeline

Start Date
Partnership began for biomass plant in 2013

Status
Grants awarded in 2017 and 2018

Plant and location accepted by Planning Commission in 2019

? Challenges Faced

- The original site, proposed for the 3-megawatt plant, was deemed unusable because of the cost to interconnect PG&E near the Celestial Valley. The partnership had to find a new location in 2019. This new location also increased the capacity to 5.5 megawatts. This change was accepted by the Yuba Planning Commission on June 19, 2019.

Resources & References

Camptonville Community Partnership. 2017. "Camptonville Forest Bioenergy Facility awarded $4.9 Million in California Energy Commission Funding." *YubaNet.com*, March 29, 2017. https://yubanet.com/regional/camptonville-forest-bioenergy-facility-awarded-4-9-million-in-california-energy-commission-funding/.

County of Yuba Community Development and Services Agency. 2019. "Planning Commission Staff Report." June 19, 2019. https://www.yuba.org/CUP2019-0002%20-%20Staff%20Report%20Package.pdf.

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Yuba Water Agency. 2018. "Grant helps Camptonville biomass project." *The Union*, December 20, 2018. https://www.theunion.com/news/local-news/grant-helps-camptonville-biomass-project/.

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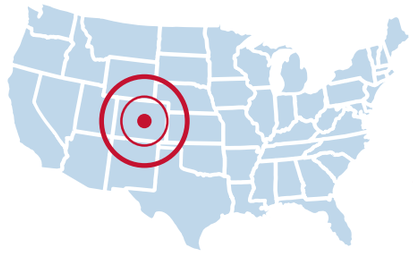
Colorado Springs Wildfire Mitigation



Colorado Springs, CO
FEMA Region VIII

FEMA released a Story Map on Colorado Springs' Wildfire Mitigation in the wake of the 2012 Waldo Canyon Fire. This Story Map provides an interactive summary of the wildfire mitigation activities in Colorado Springs, CO. Prior to the 2012 fire, Colorado Springs used Pre-Disaster Mitigation grants to implement a wildfire mitigation plan, saving an estimated $75 million and 250 homes. However, even with these efforts, 346 homes were destroyed by the Waldo Canyon Fire. Since then, the community has taken more actionable steps to mitigate against future damage by adopting a stronger fire-resistive building code, mapping wildfire risk, and participating in strategic community engagement.

The City of Colorado Springs Fire Department collaborated with the Colorado Springs Housing and Building Association to identify ways to mitigate the impacts of wildfires on residential buildings. This information lead to Ordinance No. 18-50, which amended the International Fire Code to address wildland/urban interface mitigation requirements for high-risk areas. The Story Map covers codes and guidelines for design, construction, and structural elements, including roofing, exterior siding, overhangs and projections, doors and windows, and decks.

Colorado Springs put collaboration at the heart of all wildfire mitigation activities by partnering internally, as well as with residents and business owners. Colorado Springs developed a Wildfire Risk webmap to help residents understand and mitigate their own individual risk. This webmap supports the idea of "sharing the responsibility" that the City keeps central to its work.

Addressed Hazards

PRIMARY HAZARD
Wildfires

Wildfire Mitigation Through Education, Planning, and Stronger Building Codes

This innovative educational program, spurred by the adoption of enhanced building code ordinances, has resulted in web-mapping upgrades and the development of outreach and informational campaigns. These non-structural mitigation activities have been credited with saving the community over $75 million in damages and over 250 families from losing their homes in the 2012 Waldo Canyon Fire.

Wildfire mitigation flyer
Source: FEMA

Community Lifelines

Hover over the Primary Lifeline to learn more.

PRIMARY LIFELINE

Safety & Security

Food, Water, Sheltering

Health & Medical

Colorado Springs Wildfire Mitigation

Details

Project Owner
City of Colorado Springs, CO

Type of Project
Informational Campaign

Building Codes

Area of Impact
Colorado Springs population (Total Pop: 464,474 in 2017)

$ Cost

Total Project Cost
$1.33 million

Funding Sources

Federal Funding
FEMA PDM: $1 million

Non-Federal Funding
Local Share: $330,000

Benefits

Primary
- Reduced physical damage to structures and their contents
- Reduced damage for other types of assets associated with protected infrastructure
- For areas with potential rapid wildfire risk, life-safety benefits, including a reduction in potential injuries/deaths

Secondary
- Retained timber values and reduced fire suppression costs
- As more structures are built with more fire-resistant materials in the area, decreased costs for materials and installation

Partnerships

City of Colorado Springs Fire Department

Colorado Springs Housing and Building Association

FEMA

Project Timeline

Start Date
Ordinance enacted in 2012

? Challenges Faced

- Despite mitigation actions undertaken by the City of Colorado Springs, the Waldo Canyon Fire still caused significant damage in the area

Resources & References

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Winter Storms

Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects

The Southwest Public Power District (SWPPD) and the City of Kiowa, KS completed two mitigation projects in the States of Nebraska and Kansas to address the impacts of winter storms/ice on electrical infrastructure. The improvements made in Nebraska included strengthening/replacing single poles and installing stronger conductors on an 11-mile stretch of 69-kilovolt lines along U.S. Highway 61. In Kansas, the City of Kiowa upgraded 15 blocks of power distribution infrastructure that supply power to approximately 1,200 customers. They replaced open conductors with insulated cables and installed lightning arrestors at connection points. In 2008, FEMA completed a study to assess the effectiveness of these projects. The study found that the infrastructure upgrades helped the states avoid approximately $1.33 million in losses to physical damage/loss of system function, for a total project investment of $1.15 million, and a net project benefit of $1.15 million.

Addressed Hazards

PRIMARY HAZARD
Winter Storms

Tornadoes

Regional Partnership Protects Power Transmission

This multi-jurisdictional approach to mitigation allowed Nebraska and Kansas to cooperatively protect critical energy transmission facilities to ensure uninterrupted power flow during heavy winter storms.

Ice covers electrical sources
Source: Shutterstock

State of Nebraska & Kansas
FEMA Region VII

Community Lifelines

Hover over the Primary Lifeline to learn more.

Safety & Security

PRIMARY LIFELINE

Energy (Power & Fuel)

Nebraska and Kansas Electrical System Ice and Wind Storm Mitigation Projects

Details

Project Owner
SWPPD and City of Kiowa, KS

Type of Project
Infrastructure Improvements

Area of Impact
11-mile stretch of Hwy 61 in Nebraska; 15 blocks within the City of Kiowa, KS

$ Cost

Total Project Cost
$1.5 million

Funding Sources

Federal Funding
NE project: $482,723 in 2002 dollars or $556,358 in 2007 dollars

KS project: $345,768 in 2006 dollars or $355,616 in 2007 dollars

FEMA Hazard Mitigation Grant Program (HMGP)

Benefits

Primary
- Avoided physical damage to electric system components including poles, power lines, and transformers
- Reduced loss of service to electric utility customers

Secondary
- Reduced loss of service for potable water and wastewater, since many rural customers rely on wells and septic systems
- Reduced loss of service for business customers
- Life-safety benefits for reduced injury and deaths from cold temperatures during these winter events

Partnerships

Southwest Public Power District (SWPPD)

City of Kiowa, KS

Project Timeline

Start Date
Projects begun 2006

Project Completion Date
Completed in 2007

Study completed by FEMA in 2008

? Challenges Faced

- Challenges with data for cost avoidance studies, including determining the severity of an event without direct measurements from the field (i.e., ice radius, maximum wind speeds)

Resources & References

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Serious storm damage on a high voltage power line after a strong storm
Source: Shutterstock

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Hazard Mitigation Assistance

Mitigation Action Portfolio

FEMA