National Institute of
BUILDING SCIENCES™
Innovative Solutions for the Built Environment

Mitigation Saves: Utilities and Transportation Infrastructure Investments Can Provide Significant Returns

EVERY AMERICAN FACES NATURAL HAZARDS, AND THE RISK IS GROWING

U.S. disaster losses from wind, floods, earthquakes, and fires now average $100 billion per year, and in 2017 exceeded $300 billion—25% of the $1.3 trillion building value put in place that year. Fortunately, there are affordable and highly cost-effective strategies that policymakers, building owners, and the building industry can deploy to reduce these impacts. These strategies include adopting and strengthening building codes, upgrading existing buildings, and improving utilities and transportation systems. The benefits and costs associated with these mitigation measures have been identified through the most exhaustive benefit-cost analysis of natural hazard mitigation to date and documented in Natural Hazard Mitigation Saves. The study was funded by three federal agencies and four private-sector sponsors and produced by the National Institute of Building Sciences – the nation's Congressionally chartered convener of experts from the building professions, industry, labor, consumer interests, and government. For the report and accompanying fact sheets, see www.nibs.org/mitigationsaves. This fact sheet summarizes the study findings and significant savings associated with various mitigation measures.

- **Adopting the latest building code requirements is affordable and saves $11 per $1 invested.** Building codes have greatly improved society's disaster resilience, while adding only about 1% to construction costs relative to 1990 standards. The greatest benefits accrue to communities using the most recent code editions.

- **Above-code design could save $4 per $1 cost.** Building codes set minimum requirements to protect life safety. Stricter requirements can cost-effectively boost life safety and speed functional recovery.

- **Private-sector building retrofits could save $4 per $1 cost.** The country could efficiently invest over $500 billion to upgrade residences with 15 measures considered here, saving more than $2 trillion.

- **Lifeline retrofit saves $4 per $1 cost.** Society relies on tele-communications, roads, power, water, and other lifelines. Case studies show that upgrading lifelines to better resist disasters helps our economy and society.

- **Federal grants save $6 per $1 cost.** Public-sector investment in mitigation since 1995 by FEMA, EDA, and HUD cost the country $27 billion but will ultimately save $160 billion, meaning $6 saved per $1 invested.

National Institute of BUILDING SCIENCES™	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

TABLE 1. Nationwide average benefit-cost ratio by hazard and mitigation measure. BCRs can vary geographically and can be much higher in some places. Find more details in the report.

UTILITY AND TRANSPORTATION INFRASTRUCTURE MITIGATION

The project team sought to use Economic Development Administration (EDA) grants to look at how the agency's mitigation efforts to address four potential perils and four categories of utilities and infrastructure might benefit communities. Of the 859 EDA grants the project team reviewed, only 16 related to natural-hazard mitigation of utilities and transportation lifelines. Of these, the team acquired sufficient data to estimate benefit cost ratios (BCRs) for 12 mitigation investments.

Because too few EDA grants were available to provide statistical value, the project team modified its objectives to analyze the grants as case studies. Since the grants did not represent all common retrofit measures (particularly in regard to earthquakes), the project team also analyzed potential mitigation measures to address the gaps.

The EDA grants studied by the project team included:

- Flood mitigation for roads and railroads (five grants), with BCRs ranging between 2.0 and 11.0 for four grants, and one grant exhibiting a BCR of 0.2.
- Flood mitigation for water and wastewater facilities (four grants), which produced BCRs between 1.3 and 31.0.
- Wind mitigation for electric and telecommunications (two grants). These grants were estimated to produce BCRs of approximately 8.5.
- Flood mitigation for electric and telecommunications (one grant). This grant produced an estimated BCR of 9.4.

Note: While not statistically valid, these grants, when viewed as case studies, offer anecdotal evidence of the potential value of such types of mitigation.

In light of the unexpectedly limited grant data, the project team supplemented the analysis of grants by studying a few leading options for natural-hazard mitigation of utilities and transportation infrastructure. These included:

- Replace specific water supply pipeline segments to create a “resilient water-supply grid” that better resists earthquakes. (At least two West Coast water utilities are designing a resilient grid.) The project team estimated this measure would save up to $8 per $1 spent, depending on local seismic hazard.
- Strengthen electric substation equipment to better resist earthquake loads and to create a “resilient electric grid.” (At least three West Coast electric utilities have been developing a resilient electric grid.) The project team estimated this measure would save up to $8 per $1 spent, depending on local seismic hazard.
- Strengthen highway bridges to better resist earthquake loads. The project team estimated this measure would produce a benefit of $3 per $1 spent.
- Perform prescribed burns in the watershed of water utilities to reduce wildfire and inhibit soil-carrying runoff that can cause turbidity in reservoirs. The project team found that this measure is unlikely to be cost effective, and that water utilities have less-expensive options available to address turbidity resulting from runoff after wildfires.

In addition to the specific projects examined, the study provides new analysis methods that can be readily applied to other projects to support consistent means for determining BCRs.

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HAZARD	PROJECT DESCRIPTION	BCR
FLOOD (from actual EDA grants)	Elevate rail, Iowa	2:1
	Elevate rail, Missouri	2:1
	Elevate road, Nebraska	7:1
	Elevate road and reconstruct bridge, Iowa	11:1
	Reconstruct bridge, New Mexico	0.2:1
	Elevate water treatment plant equipment, Virginia	10:1
	Relocate water treatment plant, Iowa	1:1
	Relocate wastewater treatment plant, Iowa	4:1
	Protect water and wastewater treatment plants, North Carolina	31:1
	Mitigate electric and telecommunications substation, Wisconsin	9:1
WIND (from actual EDA grants)	Replace aboveground power lines, Vermont	6:1
	Improve electric power lines, Texas	6:1
EARTHQUAKE (based on project team analysis))	Implement resilient water distribution grid, San Francisco, CA	8:1
	Implement resilient water distribution grid, Los Angeles, CA	6:1
	Implement resilient water distribution grid, Portland, OR	0.6:1
	Implement resilient water distribution grid, Seattle, WA	2:1
	Retrofit Electric substations, San Francisco, CA	8:1
	Retrofit Electric substations, Los Angeles, CA	8:1
	Retrofit Electric substations, Portland, OR	6:1
	Retrofit Electric substations, Seattle, WA	2:1
	Improve columns and footings of highway bridges, California	3:1

TABLE 1. BCRs for select infrastructure mitigation measures (based on actual EDA grants and project team analysis forpotential resilience initiatives).