Putting Attention Where it is Needed Most –

Building Resiliency in Multi-Family Affordable Housing

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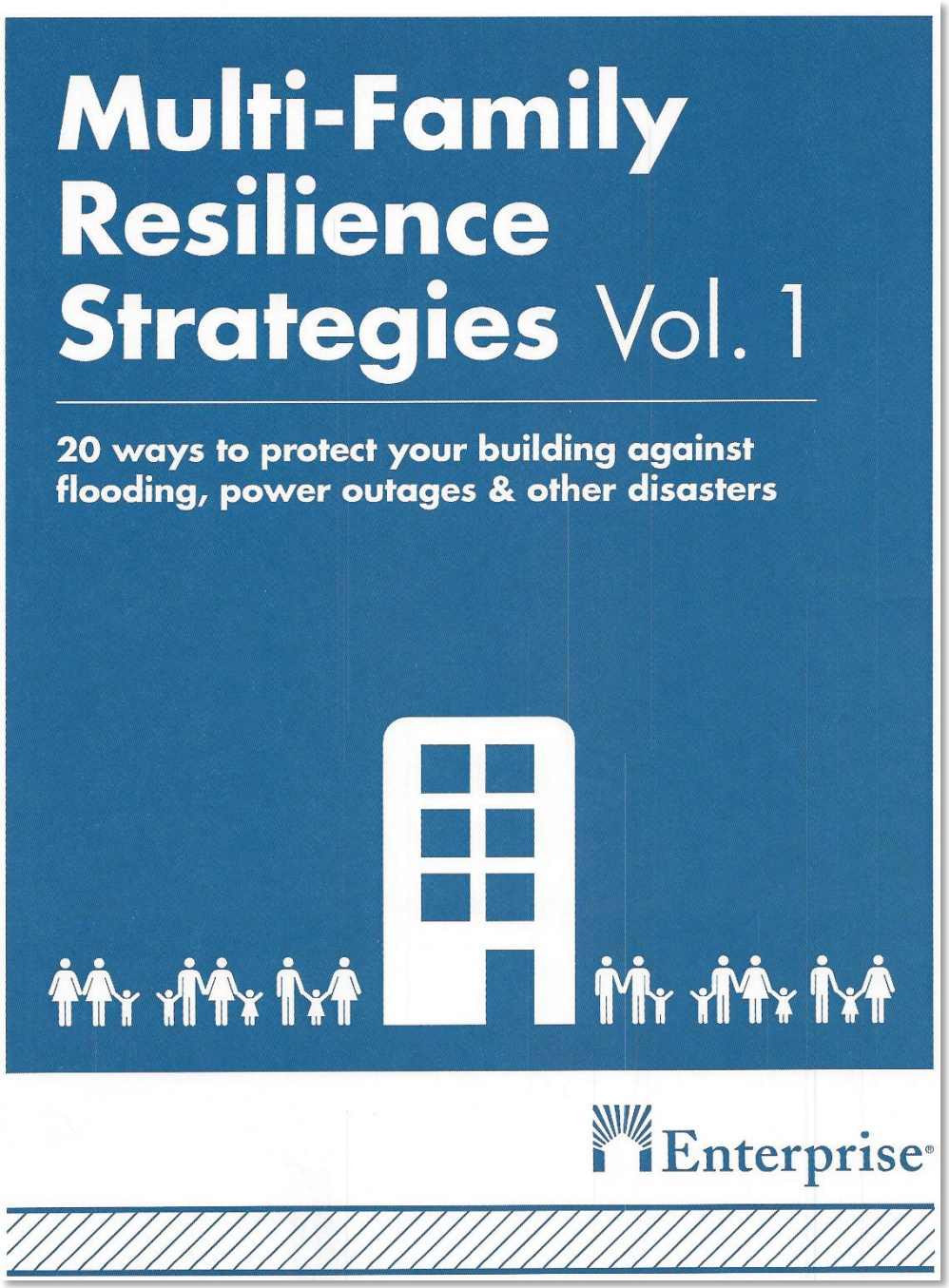
NESEA '15



20 Strategies

- Hardening
- Adaptation
- Redundancy
- Behavior Change

Strategies were developed from 56 building assessments after Superstorm Sandy

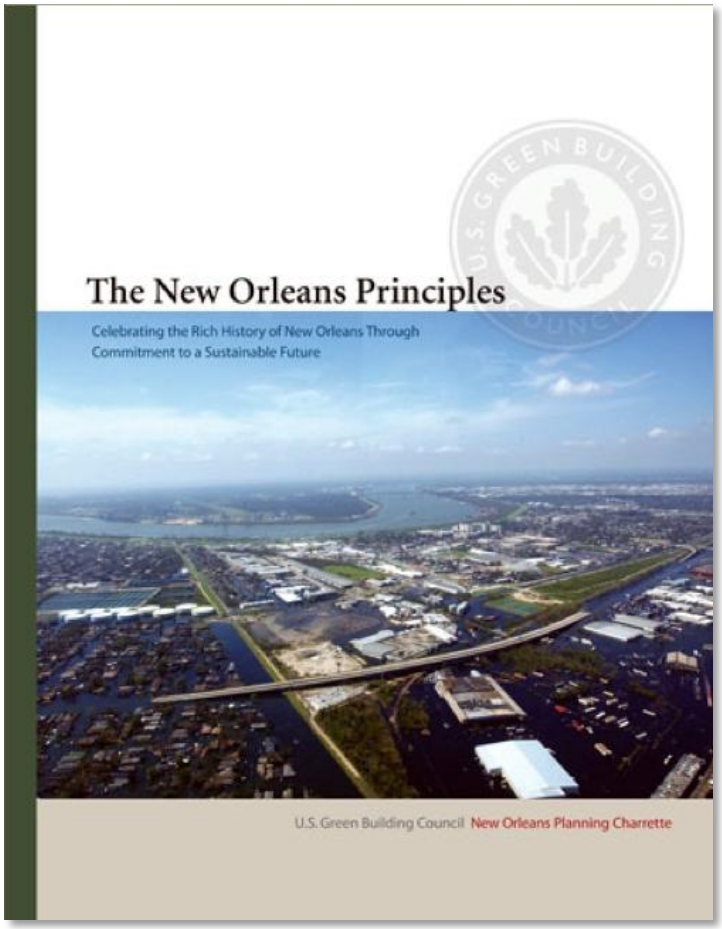
Purpose:

- Identify critical infrastructure vulnerable to climate-related emergency events which could compromise the property's ability to provide safe and sanitary housing
- Identify work already done to repair/replace critical infrastructure that had been compromised
- Recommend measures to strengthen the building's infrastructure during an emergency event such that it could be prepared for safe and timely evacuation and quick post-event recovery
- Provide estimated capital cost ranges for each recommendation

A focus on resilience – Hurricane Katrina

The aftermath of Hurricane Katrina in 2005.

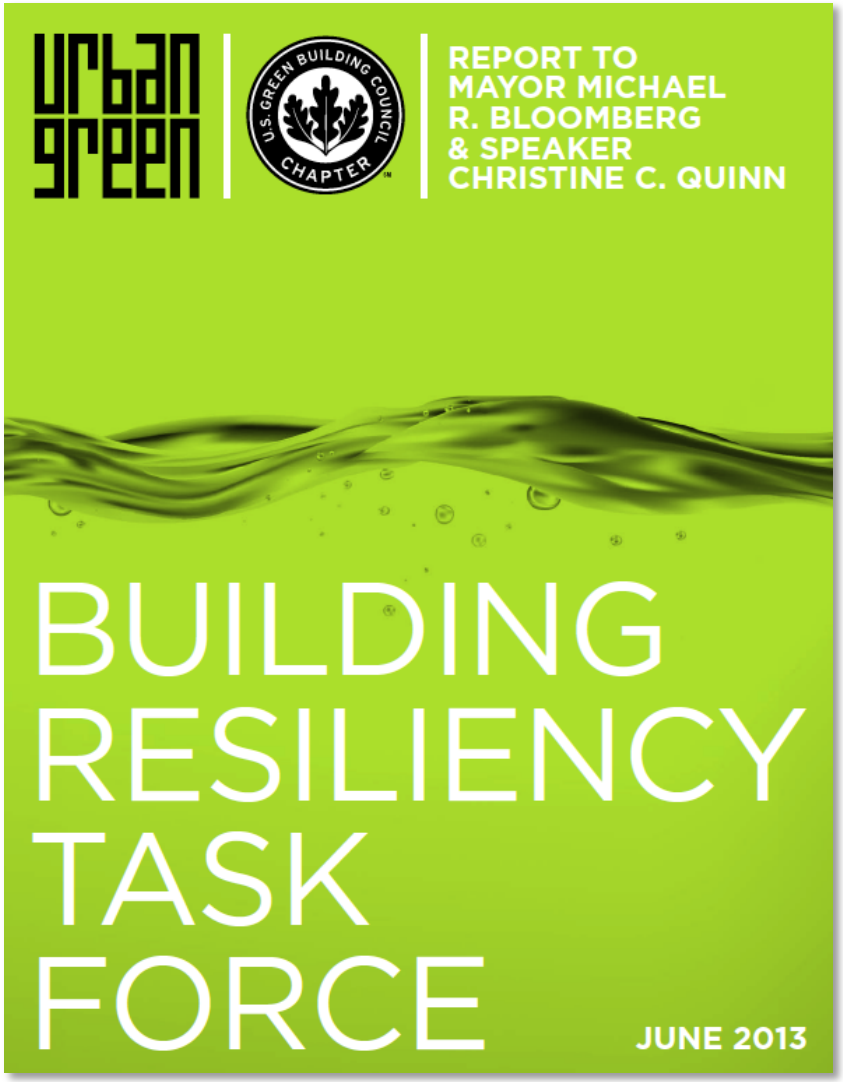
Photo Credit: Jocelyn Augustino, FEMA

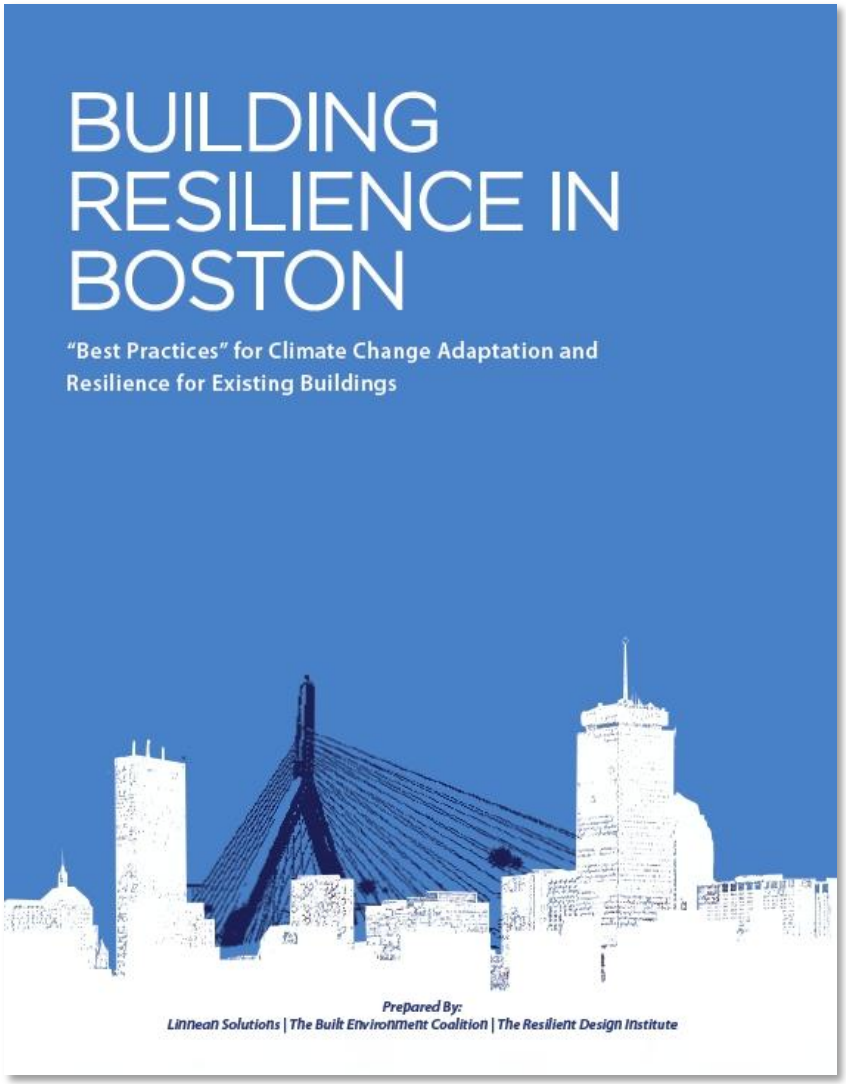


The New Orleans Principles,

U.S. Green Building Council, 2005

Addressing more resilient design in the Northeast





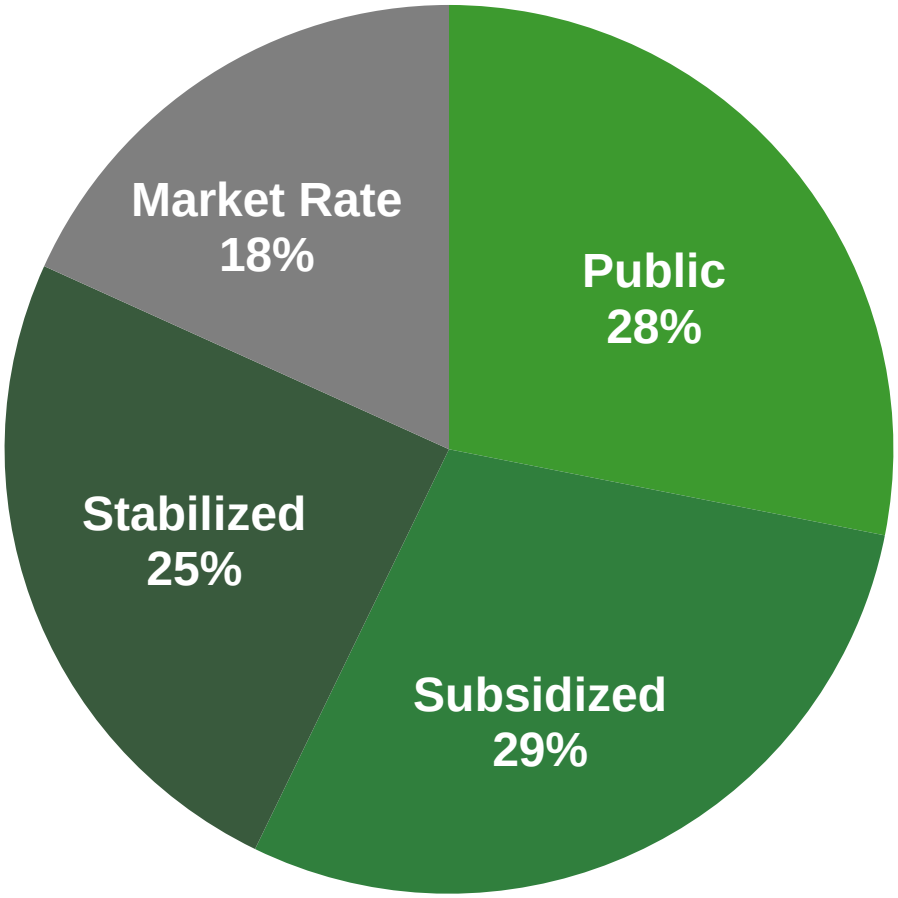
Storms and other disturbances have the greatest impact on those who can least afford it

Gas line in Brooklyn after the post-Sandy Nor'easter, New York, 11/7/12 – AP photo

Superstorm Sandy

Photo Credits: www.dnainfo.com/new-york/20121031/new-york-city/photos-nyc-reels-aftermath-of-hurricane-sandy#

80% of rental units at risk of flooding are public, subsidized, or stabilized



Source: Enterprise Community Partners

Flooding occurred in thousands of buildings in NYC with Superstorm Sandy

Operational equipment is seen flooded in the basements of buildings. *Photo Credits: Enterprise Community Partners*

Multi-Family Buildings:

TYPICAL USE TYPES

- Residential
- Residential with Ground Floor Retail
- Affordable housing
- Senior housing
- Formerly homeless
- People living with HIV/AIDS
- Physically and mentally handicapped

Photo Credits: Enterprise Community Partners

Damage Experienced:

TYPICAL EXPOSURE

- Loss of Utilities
- Damage to Critical Operating Systems
- Interior Building Damage

Typical Damage Experienced by Flood Zone

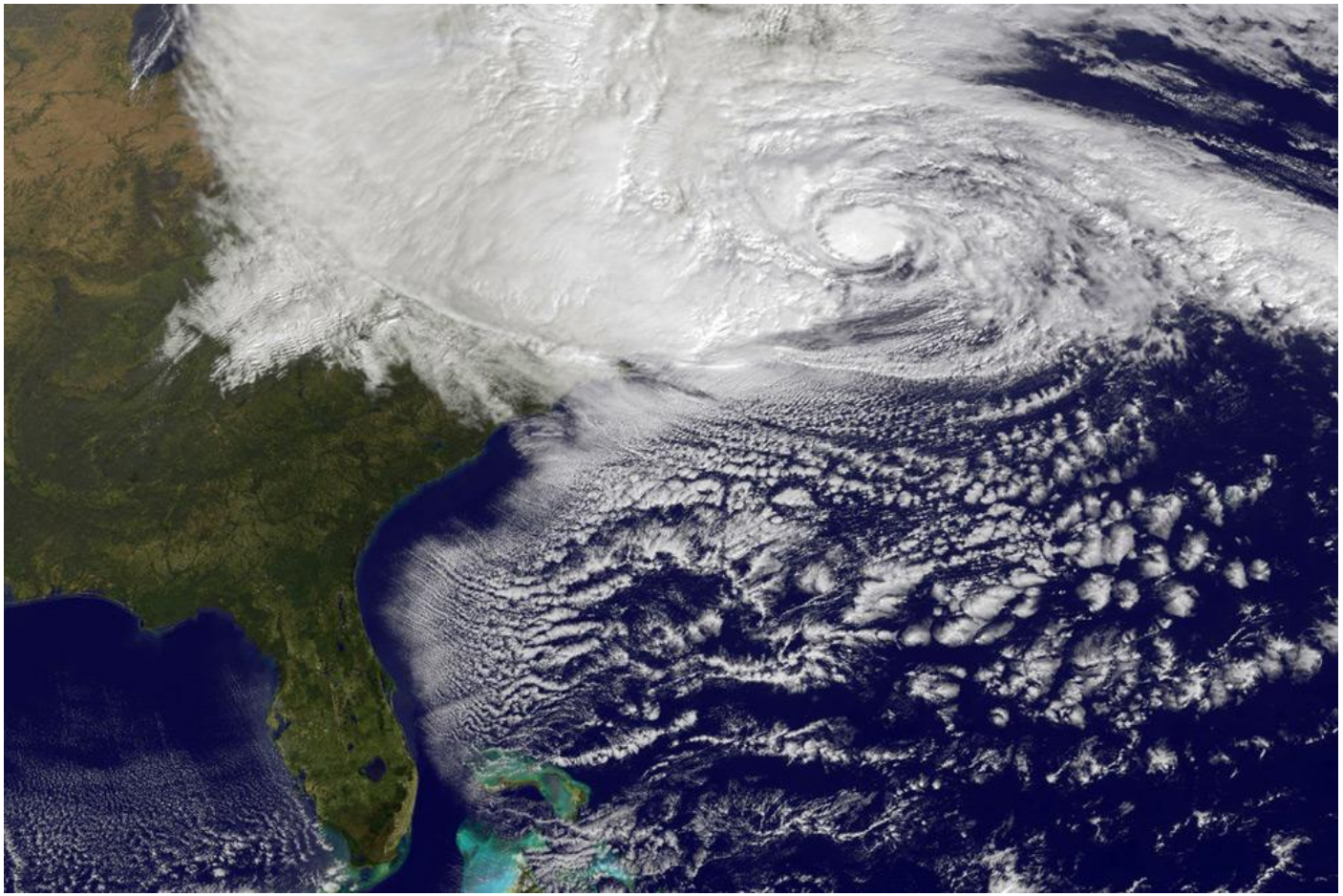
	Average Costs	Percent Flooded	Total Buildings	Flooded
AE	$ 578,380	**82%**	22	18
X	$ 7,040	**58%**	12	7
Not in Zone	$ 4,583	**18%**	17	3

Assessing Vulnerability

- Enterprise Community Partners assessed 56 buildings in New York and New Jersey
- Evaluated damage, proposed fixes
  - Average Total Cost per Building: $360,000
  - Average Total Cost per Square Foot: $17 psf
  - Average Total Cost per Unit: $6,000

Lower East Side Mutual People's Housing Association – photos: Enterprise Community Partners

Superstorm Sandy



Hurricane Sandy, Oct. 29, 2012, *Photo Credit: NASA GEOS Satellite*

Hardening

Strategies that reduce a facility's vulnerability to storm damage, such as high winds, flooding, and flying debris

- **Build protective barriers around buildings**

Flooding can impact a housing facility's habitability and impact critical equipment systems located under the Design Flood Elevation (DFE)

- **Incorporate Wet flood proofing measures under the Base Flood Elevation [BFE]**

Often buildings are not structurally able to withstand the velocity of floodwaters if water is not allowed to flow through, due to hydrostatic pressure exerted at the building level that cannot equalize

- **Keep water out of buildings**

Floodwaters can enter a building through many paths and cause extensive damage

Hardening *(Cont'd)*

Strategies that reduce a facility's vulnerability to storm damage, such as high winds, flooding, and flying debris

- **Raise the living space above the Base Flood Elevation**

Flooding can damage apartments and critical systems that are located at or below the Base Flood Elevation

- **Install sump pumps in basements**

Without sump pumps to rapidly dewater basements and elevator pits during and following flood events, significant long-term damage can occur

- **Develop resilient elevator systems**

Elevator pits typically extend well below the lowest floor of a building, leaving them especially susceptible to flooding. If elevators stop functioning during a power outage or as a result of flooding, entering and exiting a building can be challenging for residents

Install Sump Pumps

- Install sump pumps in basements, areas prone to flooding
- Consider legal restrictions for pumping water

Sump pumps are a great low-cost strategy to protect areas from flooding

Photo Credit: www.rona.ca

Adaptation

Strategies that improve a facility's ability to adapt with changing climate conditions

- **Boost envelope thermal performance to provide "passive survivability"**

Poorly insulated buildings will quickly get too cold in the winter and too hot in the summer during power outages, making buildings potentially unsafe for residents who shelter in place during storm events

- **Infiltrate stormwater onsite**

Stormwater runoff contributes to flooding and overloads in storm sewers; this is an especially significant concern in areas with combined storm/sanitary sewers

- **Provide shading systems for south, west, and east-facing windows**

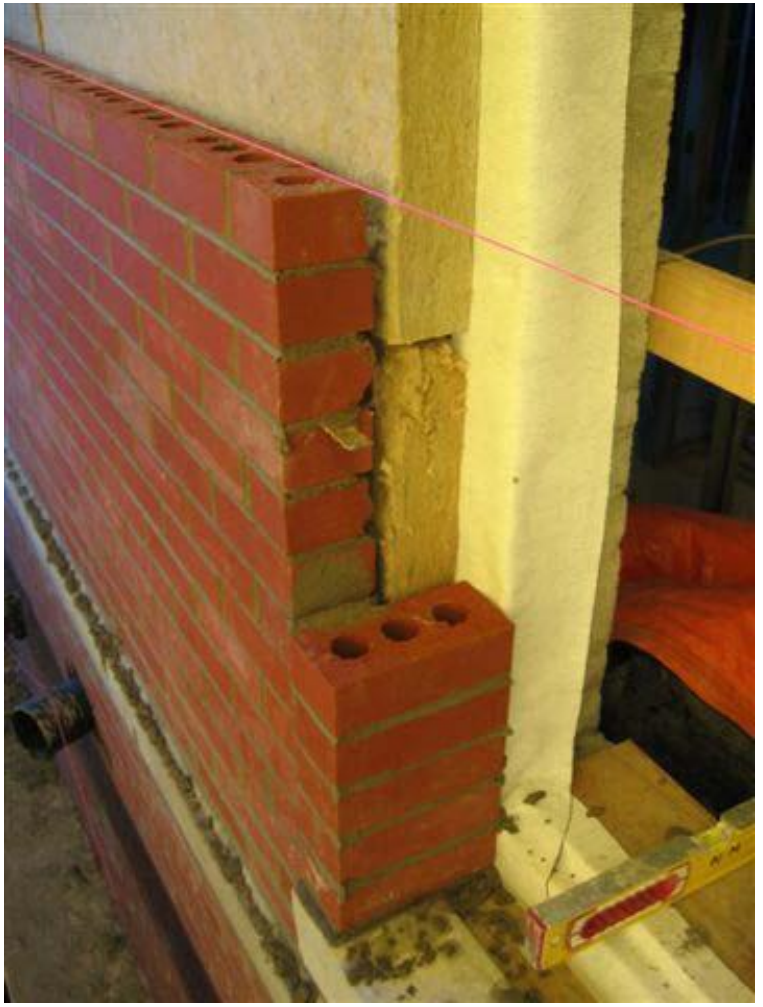
During power outages, air conditioning and fans do not function and solar gain through windows can quickly cause overheating in hot weather

Blackout of 2012 - New York City

New York City on October 29, 2012 – Photo Credit: Eric Chang

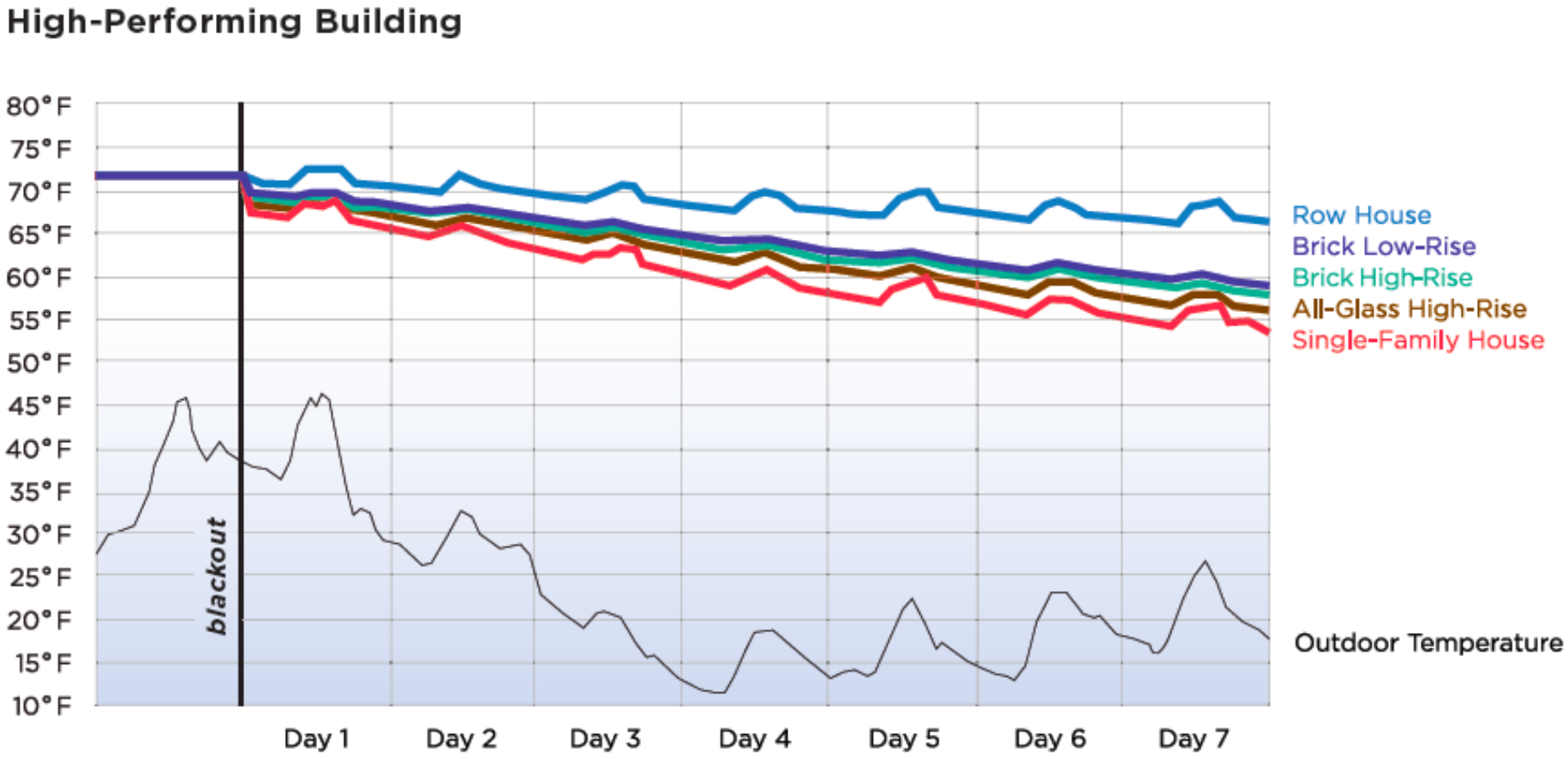
Boost Envelope Performance: Passive Survivability

- High insulation levels
- Tight construction
- High-performance glazings
- Cooling-load avoidance measures
- Passive solar design features



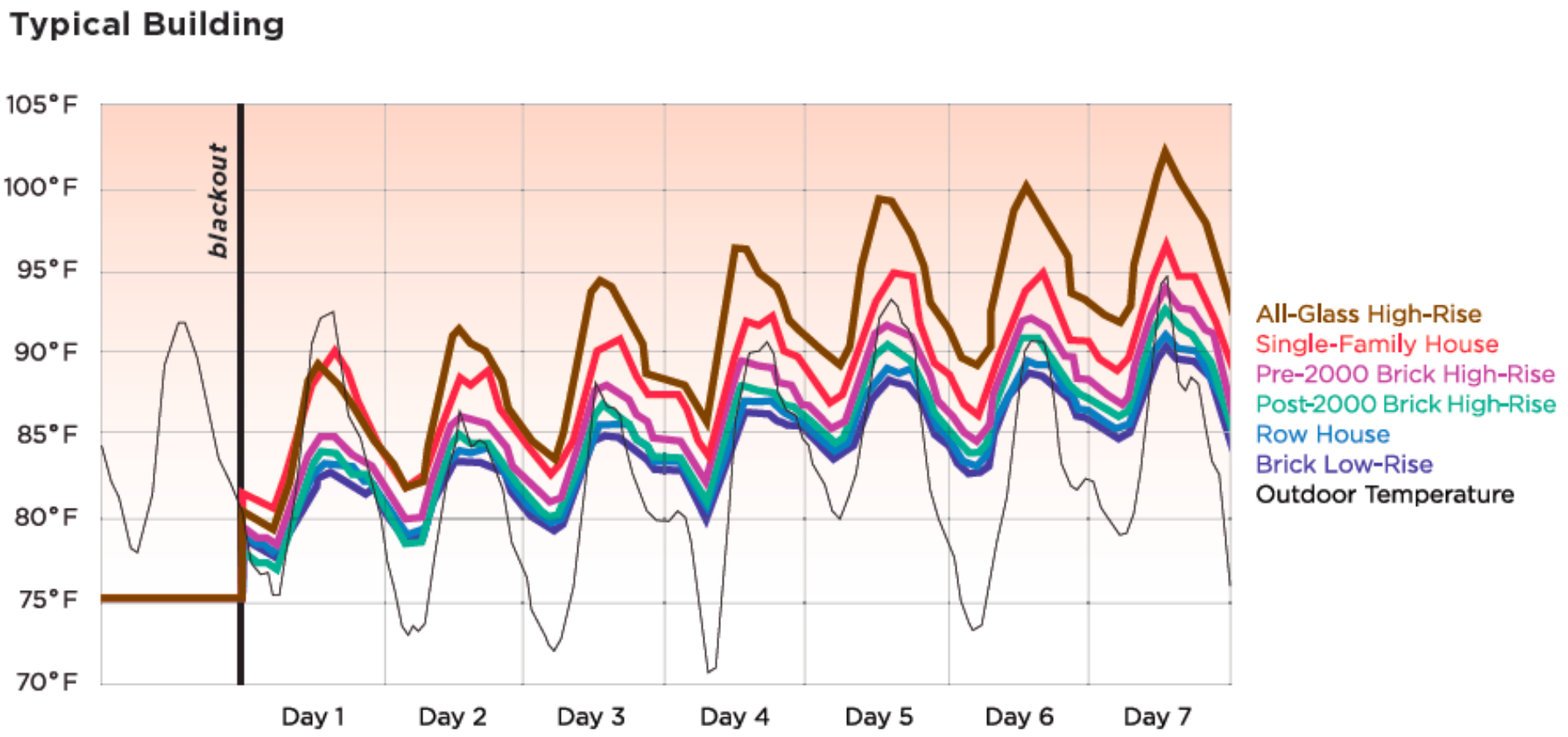
Superinsulated multifamily building in Brooklyn. Photo: Chris Benedict

Drift temperatures during outages – winter



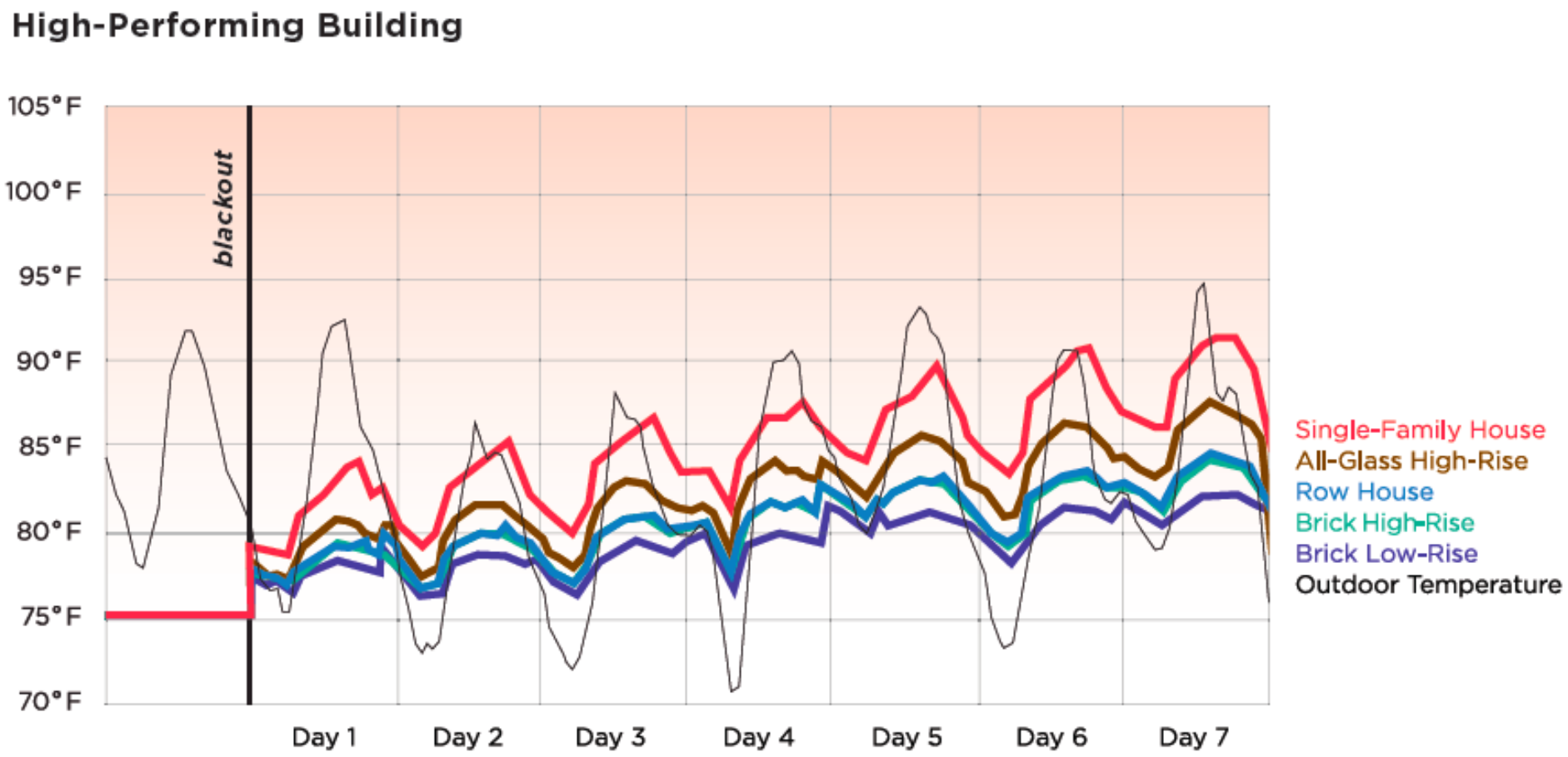
Temperature modeling by Atelier Ten for the report "Baby It's Cold Inside," Urban Green, NYC

Drift temperatures during outages - summer



Temperature modeling: Atelier Ten, New York City in "Baby It's Cold Inside," Urban Green Council

Drift temperatures during outages - summer



Temperature modeling: Atelier Ten, New York City in "Baby It's Cold Inside," Urban Green Council

Low-energy passive house will stay safe

Row houses in Brooklyn, NY. Find the Passive House! – *Photo Credit: Sam McAfee, sgBUILD.com*

Passive House retrofit of 1880s Brownstone in Brooklyn, NY. *Photo Credits: Prospect Architecture, PC*

High insulation levels – lots of options

Passive House new multifamily in Brooklyn, NY – Photo Credit: Chris Benedict, RA

Three-unit, spec condo being built to Passive House standards in Brooklyn, NY – Photo Credit: A Wilson

Redundancy

Strategies that provide critical needs for a facility in the event of a loss of power or other critical services

- **Provide backup power**

A loss of power can make a building uninhabitable and unsafe

- **Elevate mechanical and electrical equipment above Base Flood Elevation**

If flooded, mechanical and electrical systems that are critical to building function can be severely damaged and rendered inoperable

- **Provide for natural ventilation, provide operable windows**

During power outages, air conditioning and fans do not function and it may be necessary to rely on natural ventilation to keep apartments safe in hot weather

- **Provide access to potable water during power outages**

During power outages, building water systems may stop functioning, cutting off residents' water supply and creating an unsafe and unhygienic environment

Redundancy *(Cont'd)*

Strategies that provide critical needs for a facility in the event of a loss of power or other critical services

- **Replace central heating plant with distributed heating and cooling**

Flooding can cause tremendous damage to mechanical equipment, including central heating systems, which are typically located under buildings' base flood elevations. Due to the size of these systems, relocation is often difficult

- **Install backflow preventers on sewer lines**

Sewer backflow may occur during storm and flood events, particularly in locations with combined storm/sanitary sewers; this can create basement flooding and result in unhygienic and unsafe conditions

- **Ensure critical lighting is available during power outages**

Extended emergencies can push emergency lighting systems past their design life, leaving hallways and stairwells dark and dangerous; this is a concern primarily in situations in which buildings are not evacuated and residents shelter in place

Install Back-up Power

- Identify critical loads & demand
- Identify type of generator | natural gas, diesel, solar, battery
- Consider location (both generator and fuel)
- Consider dual systems

Temporary back-up power is cheaper, but after emergencies they may be hard attain.

Photo Credit: Equipment World

Spaulding Rehabilitation Center has dual back-up generators that can power the entire building, with enough fuel to last a week.

Photo Credit: John Gravelin

Behavior change

Strategies that encourage changes in behavior that will enhance resilience

- **Create a community-resilience space**

Facilities in which residents do not know one-another and there is limited sense of community do not respond as well to emergencies as those that have strong communities. Additionally, residents may fare worse before, during and after an emergency without a centralized gathering space that can provide critical supplies and services

- **Build community ties**

Multifamily housing facilities that are isolated with little connection to the larger community do not fare as well as facilities that are strongly tied to their larger communities; emergency responders may not provide services as quickly or efficiently

Behavior change *(Cont'd)*

Strategies that encourage changes in behavior that will enhance resilience

- **Create a resilience and emergency plan**

Housing facilities that nave no formal emergency plan are more vulnerable when a disaster occurs

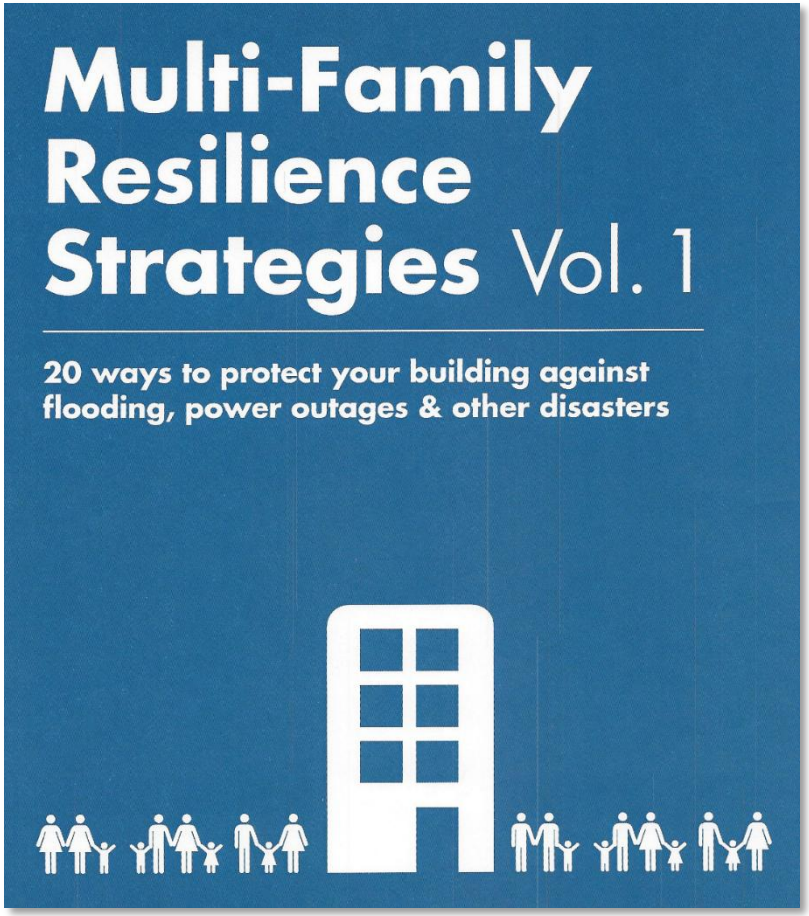
- **Establish peer-group learning collaborative for planning and support before and after an emergency event**

Multifamily affordable housing organizations have a specific and unique set of concerns and needs. Lack of access to a channel in which to share experiences, lessons learned, and best practices between similar organizations results in a lost opportunity for resilience

Provide Community Spaces

- Design 'Places of Refuge' that are safe, comfortable, multi-use spaces for people stay while help arrives.

- Provide basic services such as drinking water, operable toilets, emergency lighting and ventilation and emergency power.



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