An aerial photograph of a modern city skyline. In the foreground, a rooftop garden with various plants and palm trees is visible. The middle ground features several glass skyscrapers, some reflecting the sky and water. In the background, a large body of water (likely a bay or harbor) is visible under a blue sky with scattered clouds. The overall scene is bright and clear, suggesting a sunny day.

# Returns on Resilience

## THE BUSINESS CASE



**Urban Land Institute** Center for Sustainability

**Cover photo: A view of the green roof and main office tower at 1450 Brickell Avenue, with Biscayne Bay beyond.** *Robin Hill*

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**Recommended bibliographic listing:**

Urban Land Institute: *Returns on Resilience: The Business Case*. ULI Center for Sustainability. Washington, D.C.: the Urban Land Institute, 2015.

ISBN: 978-0-87420-370-7

# Returns on Resilience

## THE BUSINESS CASE

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**This report was made possible through the generous support of  
The Kresge Foundation.**

## About the Urban Land Institute

The mission of the Urban Land Institute is to provide leadership in the responsible use of land and in creating and sustaining thriving communities worldwide. Established in 1936, the Institute today has more than 35,000 members worldwide representing the entire spectrum of the land use and development disciplines. ULI relies heavily on the experience of its members. It is through member involvement and information resources that ULI has been able to set standards of excellence in development practice.

The Institute has long been recognized as one of the world's most respected and widely quoted sources of objective information on urban planning, growth, and development.

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## About the Center for Sustainability

The ULI Center for Sustainability is dedicated to creating healthy, resilient, and high-performance communities around the world. Through the work of ULI's Greenprint Center for Building Performance and Urban Resilience Program, the Center advances knowledge and catalyzes adoption of transformative market practices and policies that lead to improved energy performance and portfolio resilience while reducing risks due to a changing climate.

In 2014, ULI's board decided to create the new Center for Sustainability as a logical transition from the organization's previous work under the Climate, Land Use, and Energy (CLUE) program. The Center builds upon the work of CLUE and broadens its scope to address climate adaptation as well as mitigation.

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## About the Urban Resilience Program

ULI's Urban Resilience Program works to help communities prepare for increased climate risk in ways that allow a quicker, safer return to normalcy after an event but enable them to thrive going forward. Through careful land use planning, wise investment in infrastructure, and smart building design, we can protect the value we have created in our cities and be more robust in the face of adverse events. More information about the Urban Resilience Program can be found at [www.uli.org/resilience](http://www.uli.org/resilience).

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## About the Responsible Property Investment Council

U.S. Product Councils play a key role in ULI's mission of providing leadership in the responsible use of land and creating and sustaining thriving communities worldwide. Through the exchange of information and the sharing of best practices, council meetings offer industry leaders vital opportunities to further ULI's mission. ULI has 49 U.S. councils focusing on 23 areas of activity in development products, development processes, and international issues.

The Responsible Property Investment Council (RPIC) aims to accelerate adoption and firmly embed "triple bottom line" principles as a core part of any real estate investment strategy and decision-making process. What distinguishes the council is a proactive intent to deploy capital that generates risk-adjusted market-rate returns while creating social and/or environmental value.

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## Acknowledgments

The Urban Land Institute is grateful for The Kresge Foundation's generous support of ULI's Urban Resilience Program and of this publication. This report would not have been possible without the time and energy of a devoted group of volunteer members from the Responsible Property Investment Council, including Molly McCabe (chair) and Philip Payne (past chair), as well as Jim Batchelor, Uwe Brandes, Jack Davis, Bettina Mehnert, Roger Platt, Cherie Santos-Wuest, and Charu Singh. We are also grateful for the many ULI members who suggested projects to be considered in this report and to the project representatives who shared the details of their developments for inclusion.

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# Introduction

**WHAT STRATEGIES HAVE DEVELOPERS AND OWNERS PURSUED** to protect their properties from climate-related risks? Do these resilience investments make business sense as a development objective? What has the market response been? And how have developers and property owners measured their success?

## Why Worry about Resilience?

In the first 15 years of the 21st century, real estate development approaches have been altered dramatically by events such as Hurricane Katrina and Superstorm Sandy, which had devastating impacts in terms of lives lost and property damaged. The increasing frequency and intensity of extreme weather—from drought and wildfires on the West Coast to hurricanes and flooding on the East Coast

and costly and time-consuming efforts to restore land and property use and value. Climate risks also present widespread economic effects on other sectors, such as agriculture or tourism, that ripple through real estate markets. Although this report does not directly address certain events such as wildfires, tornados, snow and ice storms, and landslides, many of the same strategies for protecting property and continuing operations featured in this report—such as installing backup systems to maintain power when the electric grid fails—could be applied to enhance resilience in the face of those challenges.

With climate change, the past is not a clear predictor of the future. Weather patterns are changing, and with them the risks faced by developments everywhere. Building for resilience can help developers and property owners adjust to these changing times with some assurance that they are building well and wisely for the future. Development and redevelopment are being viewed as opportunities to reduce disaster-related risks, increase community resilience, enhance livability, and protect natural resources.

It stands to reason that if you are going to build a hospital next to Boston Harbor, you should be thinking about what happens when the storm surge comes up over the harbor wall. Planning a mixed-use town center in San Antonio, a part of the country prone to drought and extreme heat, means you would do well to conserve and recycle water typically wasted in buildings to nurture attractive amenities such as landscaped parks. Such strategies not only make sense, but they also make money for developers and owners. Resilience plays out not just in managing risk, but also in maintaining value.

## Defining Resilience

ULI defines resilience as “the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.” This definition was approved by ULI and organizations representing 750,000 industry professionals in the land use, planning, and development fields, including the American Institute of Architects, the American Planning Association, and the U.S. Green Building Council. This definition is part of a statement that also affirms that “the promotion of resilience will improve the economic competitiveness of the United States.”

and various natural disasters in between—have raised awareness of climate risks and have given rise to a new notion of “building for resilience,” so that buildings and sites can survive and thrive despite such threats.

Building for resilience involves following emerging best practices and lessons learned in land use, design, and construction to protect buildings and sites from increasing climate change risks. Climate-related threats—including those discussed in this report related to hurricanes, sea-level rise and coastal flooding, drought, wind, and extreme heat—can cause catastrophic property damage

There may be many drivers for these investments, including policy changes—all levels of government increasingly are recognizing climate risks and demanding that those risks be addressed in planning, design, and development through codes and ordinances requiring flood mapping, drought management plans, and other tools that indicate resilience preparedness. Both public and private sector involvement in resilience planning is essential for the creation of innovative solutions.

Investors and insurers are also demanding proof that assets are protected adequately. As noted in ULI San Francisco’s 2015 report *Tackling Sea-Level Rise: Best Practices in the San Francisco Bay Area*, building for resilience “is already being considered in new developments around the Bay Area because investors acknowledge the risks posed by climate change.” Consumer awareness and preferences for safe and sustainable homes, offices, and vacation destinations—and the competitive advantage resilience provides in the marketplace—argue for investments that help buildings and sites buffer and more successfully adapt to adverse weather.

The payback for resilience efforts can be measured in many ways, including cost savings from preventing damages and reducing operating costs, as well as revenue enhancements from improved marketing, company brand, and project image. These efforts also demonstrate the private sector commitment and leadership that is necessary for strong public/private collaborations in tackling climate change, including in reducing buildings’ contributions to global warming.

## Returns on Resilience: The Business Case

ULI’s Center for Sustainability and members of ULI’s Responsible Property Investment Council undertook this report to identify real estate projects designed to perform well in the face of climate-related threats and to illuminate ways in which investments in resilience strategies provide financial and other returns. The Center for Sustainability issued a call for case studies to ULI members and partners. Staff members then collaborated with council members to select projects; to interview project developers, property owners, and consultants; and to obtain supporting data about the business case for resilience.

This report includes ten detailed case studies based on interviews with developers and property owners about their motivation to protect buildings and sites against climate-related threats, their resilience strategies, their design and development processes, and their projects’ performance. It also includes one example of a solution that goes beyond the building scale to leverage collaboration on resilience efforts between the public and private sectors.

The case studies span a diverse range of geographical locations and climate-related risks, from inland flooding in Nashville to heat and drought in Tucson and San Antonio, to hurricane, wind, and storm surge on the coasts of Boston and Miami. The following table indicates the diverse types of projects and the risks addressed:

Project	Type	Location	Risks Addressed
Spaulding Rehabilitation Hospital	Medical institution	Boston, Massachusetts	Coastal storms, storm surge, sea-level rise
6 New Street	Residential, mixed use	Boston, Massachusetts	Coastal storms, storm surge, sea-level rise
Arverne by the Sea	Residential, mixed use, transit-oriented development	Queens, New York	Coastal storms, storm surge, sea-level rise
1450 Brickell	Office, mixed use	Miami, Florida	Hurricanes, tropical storm, storm surge
Ritz-Carlton, Grand Cayman	Resort, residential	Grand Cayman, Cayman Islands	Hurricanes, tropical storm, storm surge
South Florida Resort	Resort	South Florida	Hurricanes, tropical storm, storm surge
Gaylord Opryland/Grand Ole Opry	Resort, entertainment	Nashville, Tennessee	River flooding
The Residences at La Cantera	Master-planned community	San Antonio, Texas	Drought, heat
ENR2	Academic institution	Tucson, Arizona	Drought, heat, flooding
KB Home Double ZeroHouse	Residential	Lancaster, California	Drought, heat

### Beyond-the-Building Approach

Building Occupancy Resumption Program (455 Market Street)

## Highlights from This Report

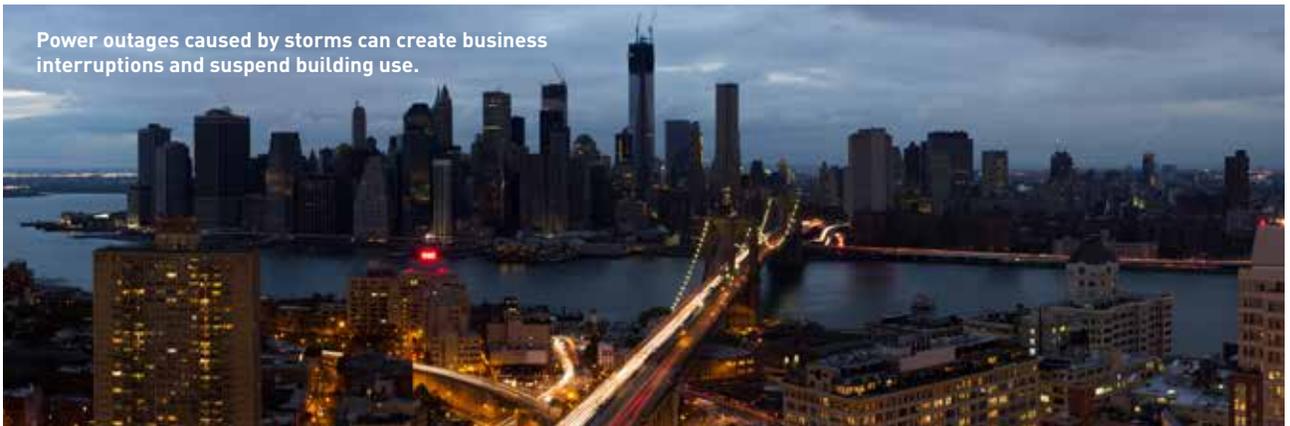
Common themes emerged from the profiled projects:

- \* **Code is not always adequate—be innovative:** City planning and construction codes generally evolve over time and do not always offer appropriate protection for sites and buildings, especially when environmental conditions are changing. Installing wind- and impact-resistant windows for a whole building or a generator that will run the power and air conditioning, even though the code requires less, could be the factor that protects people and property and allows operations to continue after a storm.
- \* **Learn from your own and others' experiences:** Choice locations that may be vulnerable to climate risks, such as harbor, beachfront, or riverfront sites, still have great value, but they may require additional layers of planning, construction, maintenance, and expense to improve their resilience. Doing your homework—learning from experience and from others who have dealt with climate-related events—can help developers and property owners understand and assess the value of strategies to deal with risks.
- \* **Taking a long view changes your perspective and actions:** Many of the case studies profiled are “long-holds” in which the desire of the developers and owners to maintain an investment over time has prompted a commitment to strategies that increase the probability that the asset will endure and increase in value. The likelihood of extreme weather is increasing, and these risks are nearly certain if you hold the property a long time. But a long hold period is not required for resilience strategies to generate value. While climate change unfolds over a long

time and impacts such as sea-level rise may creep in, extreme weather events should be a near-term wake-up call. Investing in prevention measures that generate value quickly and avoid catastrophic losses is a smart bet, and those measures can add to an asset's value regardless of the investment horizon.

- \* **Sustainability and resilience are good partners:** Some of the design and construction choices that can qualify a project for LEED certification or another green-building program do double duty for resilience and even triple duty for the project's bottom line. Multilayered impact-resistant windows can protect the building from the high winds and projectiles common to hurricanes and tropical storms while also saving energy and reducing electricity bills. Installing green roofs, recycling graywater, and using cisterns can help conserve precious water in dry climates, can enable projects to prepare for extreme or extended drought, and can also save on water costs for irrigating the landscape. Sustainability and resilience efforts, working in tandem, offer a high level of assurance that developers and owners are doing what they can to reduce their project's negative effect on the natural environment, including reducing their contribution toward climate-changing greenhouse gas emissions.
- \* **Resilience makes a property more attractive:** Projects built and maintained with resilience in mind enjoy advantages such as greater marketing, sales, and leasing success by offering assurance about the integrity of the project and its ability to continue to function through or recover quickly from severe weather. More resilient projects also can benefit from better financing options, more competitive insurance rates,

Power outages caused by storms can create business interruptions and suspend building use.



greater long-term savings on maintenance, and higher overall value compared to more vulnerable properties.

## Resilience Strategies in This Report

Strategies for select risks discussed in this report include the following:

- \* **Hurricane and Tropical Storm:** Installing impact-resistant glass can avoid exploding or imploding windows and doors during conditions of high winds and flying debris. A desalination unit and an underground water storage tank can provide potable water as well as water needed for cooling towers. Extra on-site and backup power capacity can help run the air conditioning that is essential to protect interior finishes from mold damage.
- \* **Storm Surge, Sea-Level Rise, and Flooding:** Locating the building's power center on an upper floor or rooftop (above the storm-surge elevation or floodplain) and providing a backup generator with fuel reserves can enable building operations such as lighting and air conditioning to continue or to recover quickly after extreme weather. Landscape features such as berms can act as natural barriers, whereas wetlands, mangroves, and swales with native plants can buffer wave energy and absorb water on site.
- \* **Extreme Heat and Cold:** Siting and shading a building to reduce heat gain is an important passive-energy solution to keep buildings cooler in hot climates. Super-insulated building envelopes and openings protect inhabitants from extreme heat or cold if building operations fail. Operable windows allow for ventilation in hot climates during power outages. Glass that deflects heat also keeps a building cool for additional resilience (and lower energy bills) in hot climates.
- \* **Drought and Lack of Water:** Graywater recycling—capturing water from showers, washing machines, bathroom and kitchen sinks—and rainwater cisterns used for irrigating the landscape help conserve precious treated water. Xeric landscapes with native trees and shrubs also conserve water compared with conventional lawns and gardens.



## Value Creation

ULI selected the projects in this report because they demonstrate that resilience strategies can create value. In this relatively new field of resilience, developers and property owners may not have solid metrics and clear financial analysis on the cost-effectiveness of their efforts because their design and construction strategies may not have had extensive testing by the elements. The case studies include some compelling metrics but also demonstrate emerging best practices for addressing climate risks. Not surprising, what many of these projects show is that, where resilience efforts are planned in tandem with sustainability measures, the results are likely to lead to success in better financing, faster and higher lease rates, more competitive insurance premiums, lower utility costs, and greater returns on investment.

As this publication shows, making the choice to build resilience into land use planning, site development, and building design and construction also demonstrates leadership. The developers and property owners of these projects agree that strategies that prepare for and mitigate climate risks are wise choices that lead to successful projects—and should be done “for all the right reasons,” including demonstrating good stewardship of the land and a commitment to reducing our contribution to global warming. For multiple reasons, building for resilience is establishing a new standard for the real estate industry and one that can lead to higher value for investments.

On-site power supplies can ensure business continuity in the face of power outages caused by extreme weather.

An aerial view of Arverne by the Sea on  
the Rockaway Peninsula in New York.  
*Averne by the Sea LLC*



An aerial photograph of a coastal city, likely New York City, showing a mix of residential and commercial buildings, a highway, and a beach area. A large blue semi-transparent overlay covers the right side of the image, containing the chapter title and a paragraph of text.

## CHAPTER 1

# Northeastern U.S. Coast

Along the Atlantic coast of the northeastern United States, hurricanes, nor'easters, and sea-level rise threaten lives and property from high winds, storm surges, coastal flooding, and results ranging from structural damage to loss of power and use of buildings. In recent years, hurricanes such as Superstorm Sandy have caused many deaths and billions of dollars in damages along the Atlantic coast. In New England, hurricanes happen, but nor'easters—occurring more frequently and extending for longer periods at slower speeds and over larger areas—are a more common threat. In this chapter, a mixed-use beachfront community on the Rockaway Peninsula in New York provides insight into resilience measures that withstood the test of Superstorm Sandy, and two new waterfront projects in Boston—a rehabilitation hospital and a mixed-use apartment building—demonstrate how design and construction with resilience in mind can protect both property and asset value.

# Spaulding Rehabilitation Hospital

## Boston, Massachusetts

### Project data

**PROJECT TYPE**  
Hospital/medical

**OWNER**  
Partners Healthcare

**DEVELOPMENT TEAM**  
Perkins + Will, Copley Wolff Design Group, Hoerr Schaudt Landscape Architects, Thompson Consultants Inc., BuroHappold Engineering

**PROJECT SIZE**  
262,000 square feet with 132 beds

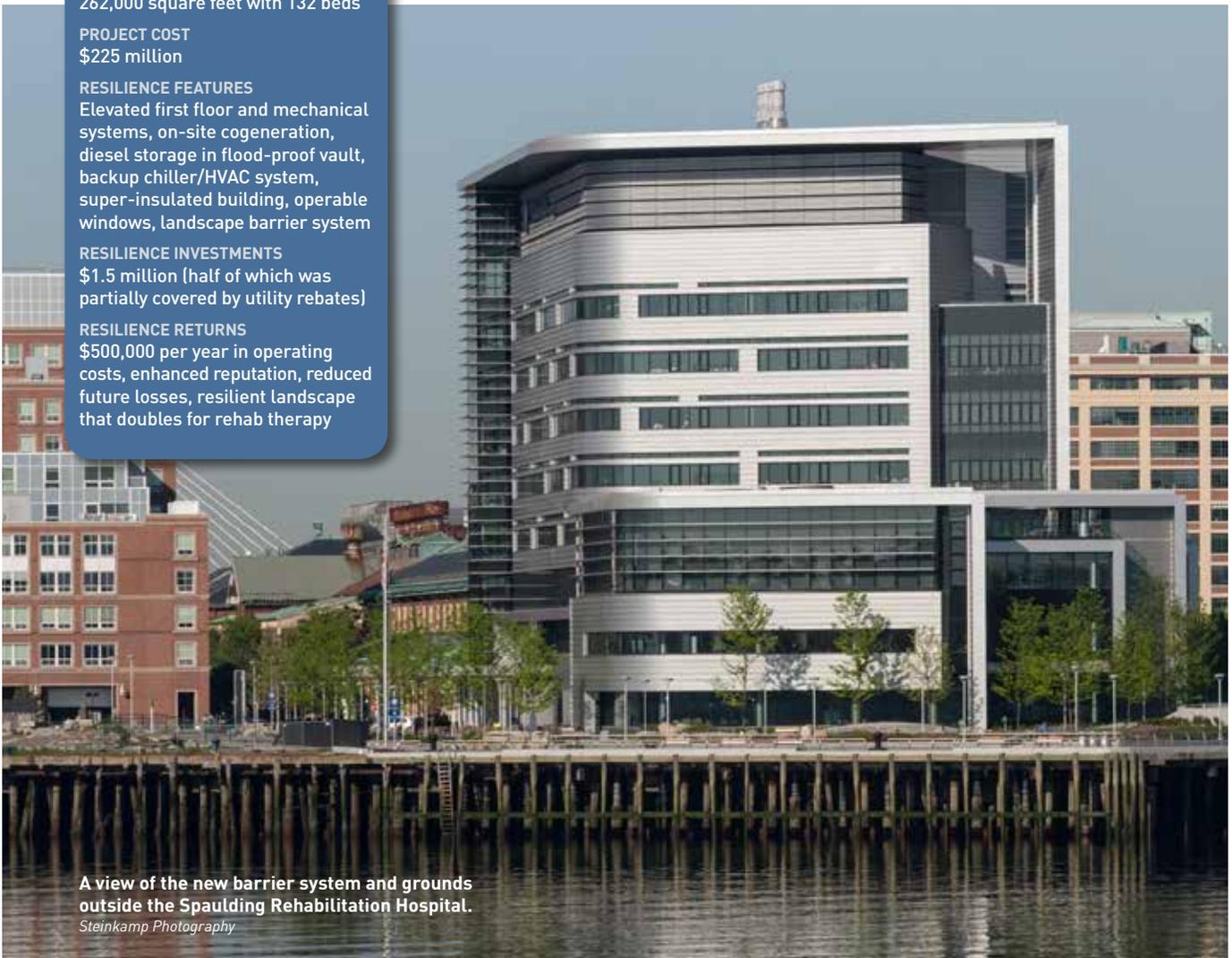
**PROJECT COST**  
\$225 million

**RESILIENCE FEATURES**  
Elevated first floor and mechanical systems, on-site cogeneration, diesel storage in flood-proof vault, backup chiller/HVAC system, super-insulated building, operable windows, landscape barrier system

**RESILIENCE INVESTMENTS**  
\$1.5 million (half of which was partially covered by utility rebates)

**RESILIENCE RETURNS**  
\$500,000 per year in operating costs, enhanced reputation, reduced future losses, resilient landscape that doubles for rehab therapy

**WHEN BOSTON-BASED PARTNERS HEALTHCARE**, one of the leading U.S. nonprofit hospital and physicians networks, set out to build the new Spaulding Rehabilitation Hospital a decade ago, it wanted a site on the Boston waterfront because water activities, including kayaking, were key to its rehab program. Just as planning was beginning, however, Hurricane Katrina struck New Orleans, causing deaths because of flooding and systems failures in that city's hospitals.



**A view of the new barrier system and grounds outside the Spaulding Rehabilitation Hospital.**

*Steinkamp Photography*

Partners HealthCare remained committed to the brownfield waterfront site it had found at the Charlestown Navy Yard, despite its vulnerability to similar risks of hurricanes, storm surges, and sea-level rise and the potential coastal flooding and power loss. But the harbor site and the events of Hurricane Katrina and other coastal storms caused the company to fundamentally shift its approach in designing and constructing the hospital to focus on sustainability *and* resilience. The shift has led to Partners working more consistently in all its health care facilities toward integrating sustainability with adaptation. “This is what the resilient hospital is about and [what] we should all be embracing,” says John Messervy, corporate director of design and construction for Partners HealthCare.

Completed in 2013, the eight-story, \$225 million, LEED Gold-certified Spaulding Rehabilitation Hospital is built on the remediated site. The hospital is exceptional not only for the care it provides—it is recognized as one of the nation’s top rehabilitation facilities for survivors of strokes and accidents, particularly those involving spinal cord and traumatic brain injuries—but also for its careful planning for resilience.

Located where the Little Mystic Channel meets Boston’s Inner Harbor, the 132-bed hospital’s greatest risks are wind and flooding from coastal storms. “[With the hospital] being on the waterfront, it is likely to be a nor’easter or a hurricane that will create the most difficulty in continuing to provide services,” says Messervy.

Lessons from Hurricane Katrina and Superstorm Sandy, which hit the East Coast while the Boston hospital was being constructed, were critically important to Partners’ resilience planning. “We were committed to learning all we could, not only from Katrina, but from subsequent river floods in Louisville and other events around the country that had impacted hospitals,” says Messervy. Partners identified the ability to withstand extreme weather as a key business strategy that should be replicated at all Partners HealthCare facilities, especially in acute hospitals where patients continually rely on emergency services and access to treatment programs.

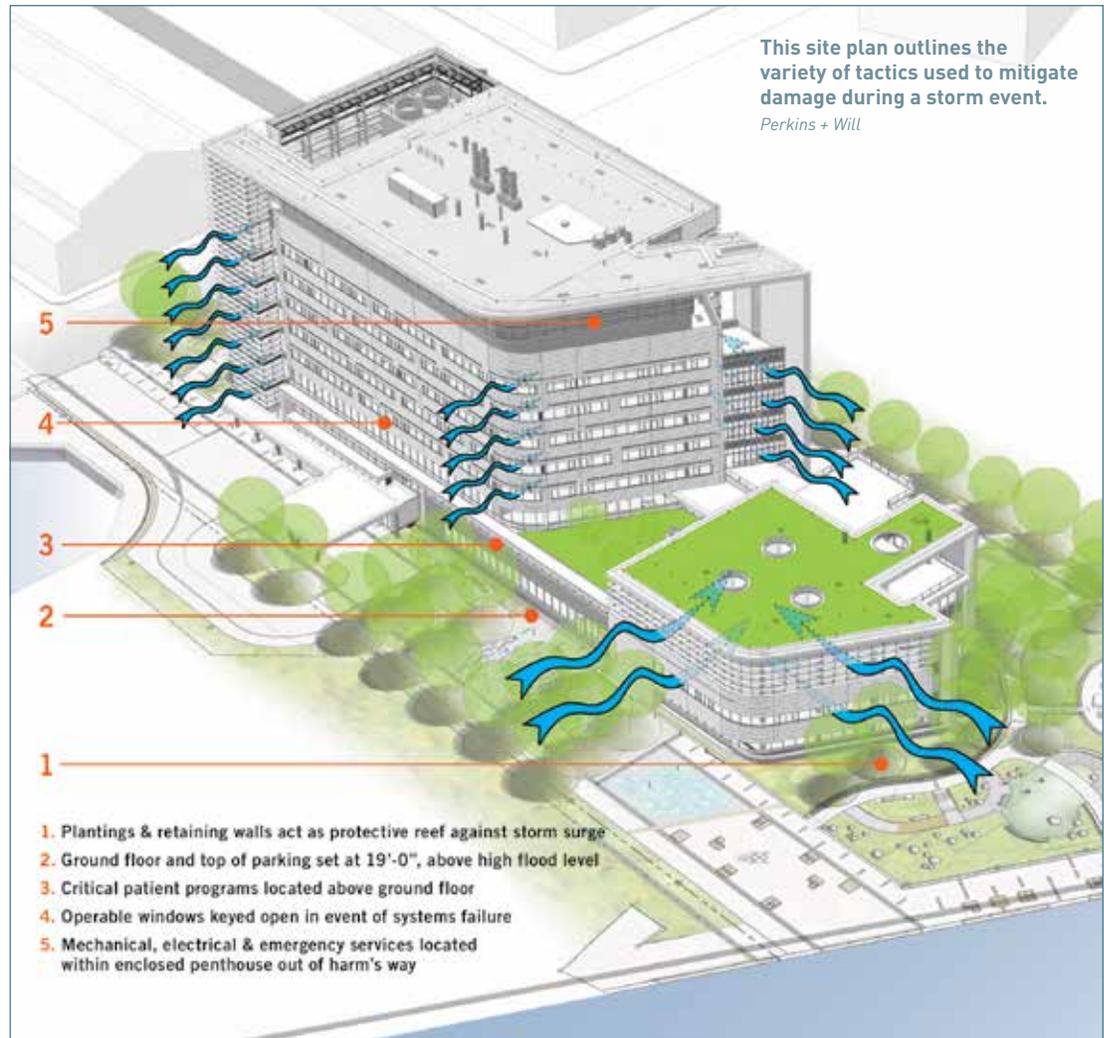
Partners created a library of documented evidence: data on Boston Harbor’s rising tide levels attributable to climate change and passing hurricanes, first-hand stories from Hurricane Katrina and other events, and information about the

kinds of systems failures that had affected other hospitals’ abilities to provide services. Partners assembled a panel of experts to advise on building resilience and used data to guide design—with the intent of being able to inhabit the building through a Category 3 hurricane—with winds from 111 to 129 mph and storm surges of between nine and 12 feet above normal.

## Mitigating Risks

Working with architects Perkins+Will, Partners took innovative steps to prepare for climate change and storms. The hospital was built with 90 percent of the resilience strategies Partners identified, including the following:

- \* The first floor is 30 inches above the 500-year flood level to safeguard against projected sea-level rise over the life of the building.
- \* All mechanicals—boilers, chillers, air handlers for ventilation—were installed on the roof or in a penthouse above the eight hospital floors to ensure operation during flooding.
- \* High-voltage electrical service is run to a penthouse transformer and is encased in a concrete chase.
- \* The primary diesel storage is in the basement, as per fire code, but it is housed in a flood-proof vault with a 150,000-gallon tank. A pump delivers the fuel to the penthouse to power generators for at least four days, or longer if electrical loads are conserved.
- \* High-efficiency mechanical systems, including a cogeneration system for heat and power that provides about 25 percent of the total power needed, reduce the building’s energy requirement to half that of comparable hospitals. These systems also help extend the supply of on-site power generation in case of outages.
- \* A secondary combined chiller and HVAC system provides redundancy in case of outages, thereby allowing either system to keep the building warm in winter and cool in summer. An enhanced free-cooling (economizer) system provides most of the winter cooling load to save energy.
- \* The building envelope is super-insulated with foam in the walls and triple-paned glass in patient rooms, thus avoiding the need for baseboard heating, which is typically required for Boston’s cold winters.



- \* Operable windows in patient rooms and activity areas allow for natural ventilation during power outages.
- \* Landforms such as swales and earth berms constructed of large granite blocks uncovered during the site excavation act as barrier reefs and deflect waves from hitting the building directly. An extensive drainage network allows floodwaters to dissipate quickly during flooding.
- \* A two-level, 200-car underground parking garage is protected by a berm and a barrier system.

Spaulding is designed to operate for at least four days in "island mode," with diesel fuel for emergency generators, natural gas cogeneration capability, and ample stores of food and other supplies. The entire first floor of the building—

including spaces for physical therapy and meetings, a swimming pool, and a cafeteria—could be flooded with only minor impact on operations, while the upper floors for patients remain fully occupied and operational.

Partners is conducting a resilience study of 30 of its clinical and research sites in Massachusetts for their exposure and ability to withstand extreme weather events. New buildings have communications, mechanical, electrical, and plumbing systems placed on higher floors, and older buildings are relocating them. "It is not an inexpensive proposition, and in many instances there is no payback, but we have to be able to provide medical service in the face of extreme events, and it is not acceptable for a facility to shut down," says Messervy.

## Creating Value

The premium for Spaulding’s resilience measures was about \$1.5 million on construction costs of \$160 million; half of that premium paid for encasing the high-voltage electrical riser through the building. The other \$750,000 paid for building systems upgrades, such as high-efficiency pumps and chillers, for which Spaulding received partial reimbursement through utility company rebates.

Investments in the building envelope and more efficient energy systems have had a relatively rapid payback. The cost of the on-site cogeneration, for example, will be recouped within eight years. The hospital shaved about \$400,000 off its first-year operating costs and anticipates consistently reducing costs by \$500,000 per year through additional fine-tuning of the mechanical system and an LED lighting retrofit.

Partners is one of the largest electricity consumers in the state, so the sustainability and resilience strategies that drive down day-to-day energy costs provide immediate return and also enable Partners’ hospitals to function longer in emergencies on their backup resources. Spaulding’s 250-kilowatt gas-fired combined heat and power plant provides power for the hospital and the local utility during peak periods and also heats the hospital’s water from the waste heat captured in the cogeneration process. Another sustainability/

resilience strategy, the hospital’s green roof helps insulate the building and absorb stormwater runoff. The highly energy-conserving building envelope, natural daylighting, gas-fired cogeneration system, and other features combine to keep the carbon emissions of the building far below those of most hospitals.

**“The mayor uses Spaulding as a poster child for resilient building design in the city of Boston. It is receiving recognition at a number of different levels, most importantly directly with the patients, who benefit from the services there.”**

—John Messervy

Resilience measures also are doing double duty to help heal patients, says Messervy: “Swales and berms will deflect waves from a direct hit on the building, and those landforms have become part of the therapy landscape that patients use during good weather to regain balance and mobility.” These unique attributes are contributing to public recognition and driving demand for Spaulding’s services, which has resulted in a patient waiting list.



# 6 New Street

## Boston, Massachusetts

### Project data

**PROJECT TYPE**  
Residential, mixed use

**DEVELOPMENT TEAM**  
Gerding Edlen, ADD Inc., Stantec, Copley Wolff Design Group, Suffolk Construction

**PROJECT SIZE**  
267,150 square feet on 4.4 acres

**PROJECT COST**  
\$132 million

**RESILIENCE FEATURES**  
Elevated grade and systems out of floodplain, cogeneration of heat and power, entrances limited on waterfront, ground-floor space protected by curb wall and planters, saltwater-hardy native landscape

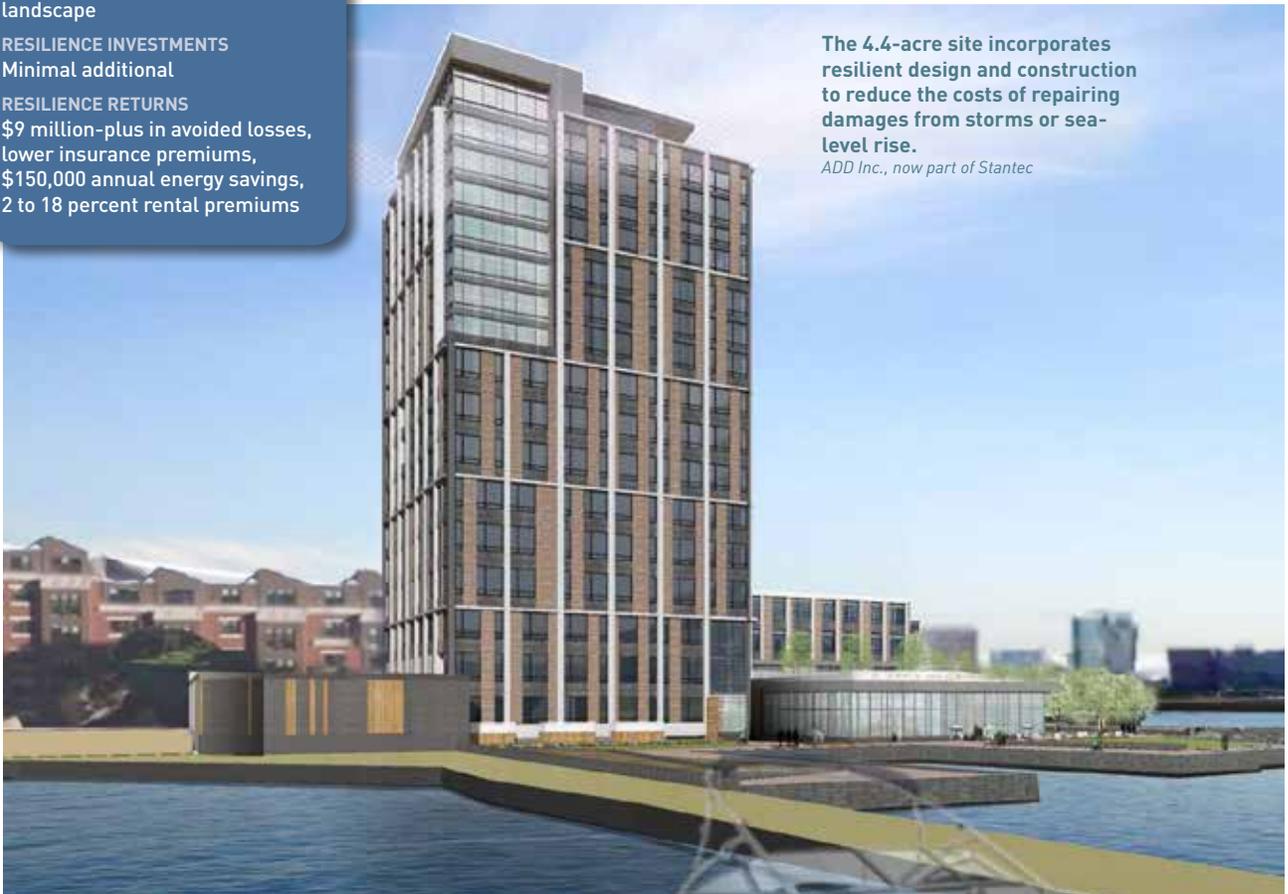
**RESILIENCE INVESTMENTS**  
Minimal additional

**RESILIENCE RETURNS**  
\$9 million-plus in avoided losses, lower insurance premiums, \$150,000 annual energy savings, 2 to 18 percent rental premiums

**DESIGN AND CONSTRUCTION** for the 267,150-square-foot, mixed-use 6 New Street redevelopment on 4.4 acres on East Boston's waterfront, "is about rebounding after a storm surge event," says Patrick Wilde, a partner with Portland, Oregon-based investment manager and developer Gerding Edlen. "How do we ensure that everything goes back to normal three days later?" In this emerging neighborhood of Boston, 6 New Street, under construction with 259 apartments, 5,000 square feet of ground-floor commercial space, and new public waterfront access, is being praised for bringing needed housing, economic vitality, and open space. The project also is being looked to as an example for the long term: resilient against storm surge, sea-level rise, and flooding in a site vulnerable to climate change.

The 4.4-acre site incorporates resilient design and construction to reduce the costs of repairing damages from storms or sea-level rise.

*ADD Inc., now part of Stantec*



The original plan for the site was to renovate and add floors to a former confectionary plant that had been vacant for decades. Gerding Edlen found structural deficiencies with the existing building, however, and chose instead to design and build a new one—a 16-story tower and a three-story addition for apartments, as well as two parking garages that accommodate 158 vehicles. Most of the tower building is out of the projected floodplain, so the site itself was the primary consideration for resiliency—making sure that the landscape and civic features would rebound quickly.

Designed by the Boston office of ADD Inc., which recently merged with Stantec, the project is set to be completed in 2016 and features ground-floor restaurant and retail space, a new ferry dock, and other waterfront improvements, including a 12-foot-wide extension to the East Boston Harborwalk. The redevelopment at 6 New Street is targeted for LEED Gold certification and includes amenities such as a communal chef's kitchen, rooftop pool, conference rooms, gallery exhibition spaces, dog wash, and water sports.

Gerding Edlen worked closely with the city of Boston and the local ADD team to demonstrate that the project would be “built to last” as opposed to “built to code.” This cooperation helped expedite the entitlement process and ensure that approvals were granted at every step without problems or delays. The project's sustainability and climate resilience measures helped the building received approvals in the fastest time the city allows.

## Mitigating Risks

Resilient design and construction strategies for the project include the following:

- \* Constructing a new building that is nine inches higher than the original building, thus providing better protection against sea surge and floods
- \* Locating the electrical room on the first floor, well above the floodplain
- \* Installing the emergency generator on the roof, with enough fuel on site in a secured location to support fire, life, and safety operations for up to four days
- \* Placing the main entrance to the building on the facade opposite the water to prevent the greatest loss in case of a flood, and limiting entrances to two on the waterfront side, reinforced with special waterproofing to keep the interior dry

- \* Protecting the at-grade and harbor-facing retail space against surges and flooding with an 18-inch curb wall and sandbags
- \* Selecting planters, hardscape, exterior railings, and plants—generally hardy native ones accustomed to coastal sites—that are able to withstand immersion in salt water

“We incorporated these features into our design and budget from the beginning, so our sustainability and resiliency strategies cost a minimal amount, if anything, over the original building budget,” notes Molly Bordonaro, a partner at Gerding Edlen. “We asked our landscape architect to design the surrounding area with seawater-resistant vegetation and also plantings that were positive for

**“We saved money by getting the building out of the storm surge's way, so it's a win-win.”**

—Patrick Wilde

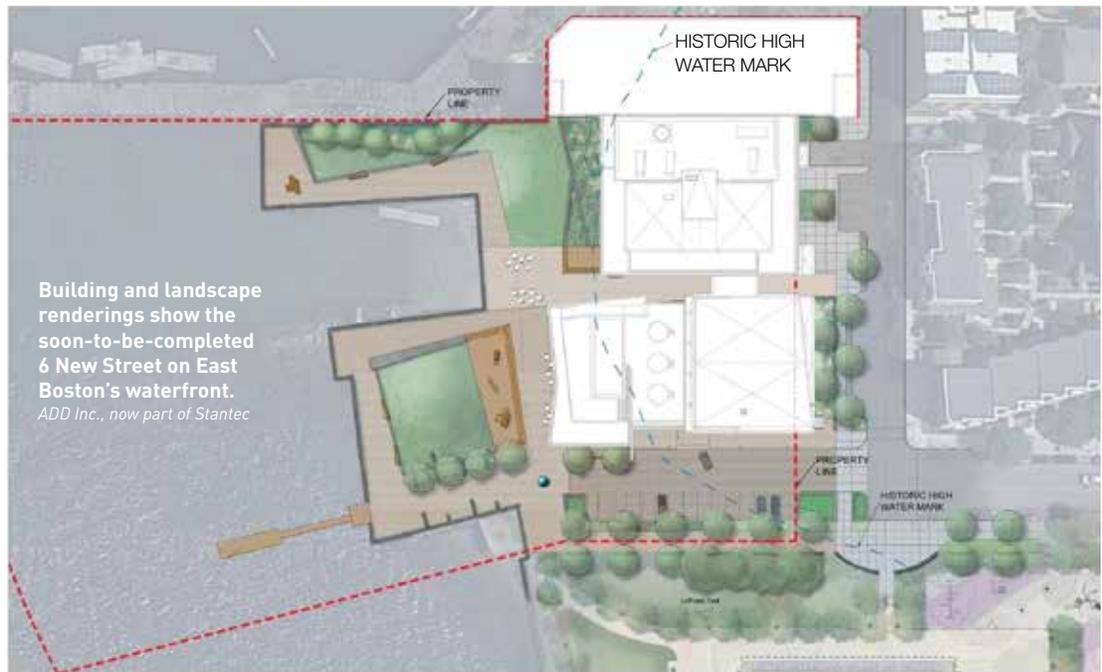
possible runoff into the Boston Harbor. We also looked for unique plantings in large pots that could serve to protect the building against water during a storm surge. All this was done within the original landscape budget.”

Site soil from digging foundations for the new building was used to raise the grade, thereby saving trucking costs. “We saved money by getting the building out of the storm surge's way, so it's a win-win,” says Wilde. “We didn't sit down and do payback analysis around a specific set of items,” he adds. “We looked at these as ‘the right way to build the building,’ having a building that ‘would stand the test of time,’ and ‘what makes the most sense.’”

## Creating Value

Resilience strategies can save money on construction, insurance premiums, insurance deductibles, and by expediting the entitlement process so the building can be finished and leased sooner, says Bordonaro. Not having to build a basement to house the electrical room and emergency generator saved the project money; the required waterproofing, given the shallow depth of the water table, would have been difficult and costly to install.

Insurance premiums were lowered by reducing exposure to storm surge by locating power



equipment above the 500-year-flood elevation and providing physical protection against floods, she says. Gerding Edlen's insurance underwriter, Affiliated FM, estimated the resilience strategies could reduce the potential flood-loss expectancy from \$10 million to \$1 million, which equates to a significant premium drop. A building without the features that 6 New Street incorporated would pay annual premiums that were ten times higher for flood insurance. Thus, the resilient design is creating real savings for 6 New Street's ongoing operating budget.

Another money-saving strategy was conducting a cladding study to ensure that exterior wall material could withstand winds of up to 100 miles per hour. In Boston, a developer can design to prescribed code values or engage a consultant to provide a wind analysis. For 6 New Street, a consultant provided a more precise analysis, specific to the site, which drove engineering values down and allowed the use of a lighter-gauge steel at lower construction costs. In light of its exposure, a building of this value could incur tens of millions of dollars in wind-loss damages for compromised window or roof systems that allowed storm water into interiors, thereby requiring significant downtime before the property could be lived in again. Gerding Edlen analyzed wind-loss expectancies on the basis of actual exposure and building design. The result was a potential wind-loss expectancy

of only several million dollars, which meant an additional savings in insurance premiums for the building.

The developers are also betting that resilient design and construction will reduce the costs of repairing storm or sea-rise damages, as well as costs of annual maintenance. They estimate an annual energy cost savings of 24 percent, or nearly \$150,000, especially from the cogeneration of heat and power. The building's cogeneration turbine will be installed in a mechanical penthouse secured from storm surge threats, thus adding not just to the building's energy efficiency, but also to its resiliency.

Bordonaro says 6 New Street's resiliency is attractive for branding and image. She says properties that Gerding Edlen has developed and sold in Boston and other cities have been sought after by institutional buyers because of their sustainability, lower operating and maintenance costs, and "build-to-last" resiliency, which has translated into top-of-the-market sales pricing per unit. Sustainability and climate resilience measures (as well as location and design) also get credit for outperforming the market in increased rent per square foot, faster leasing, higher renewal rates, and improved occupancy. The developers expect 6 New Street to be open in December 2016. Preleasing premiums range from 2 percent to 18 percent higher per square foot for studios and two-bedroom apartments than comparable properties in the Boston market.

# Arverne by the Sea

Queens, New York

## AFTER SUPERSTORM SANDY ROARED OVER THE ROCKAWAY PENINSULA

of Queens, New York, in October 2012, Arverne by the Sea emerged with minimal water and wind damage and no fire damage, unlike most neighboring areas along Rockaway Beach. While the region suffered much devastation, the 120-acre master-planned and mixed-use community, located between the Arverne transit station and the Atlantic Ocean, survived intact and recovered quickly because of a number of resilience measures that were included in the project's planning, design, and construction.

Exterior courtyards provide a shared common space for the residences, with storm drainage below.

*Arverne by the Sea LLC*

### Project data

#### PROJECT TYPE

Residential, mixed use, transit-oriented development

#### DEVELOPMENT TEAM

The Benjamin Companies; The Beechwood Organization; EE&K Architects, a Perkins Eastman Company; Meltzer/Costa and Associates; Wohl & O'Mara LLP; C.A.C. Industries Inc.

#### PROJECT SIZE

120 acres

#### PROJECT COST

\$1 billion

#### RESILIENCE FEATURES

Fortified dunes, streets angled against storm winds, grade raised out of floodplain, enhanced stormwater drainage, highly weather-resistant siding, buried utilities, hurricane-resistant windows

#### RESILIENCE INVESTMENTS

\$100 million

#### RESILIENCE RETURNS

10 to 15 percent



In 2000, joint-venture developers the Beechwood Organization of Jericho, New York, and the Benjamin Companies of Garden City, New York, had conceived Arverne by the Sea in response to a request for proposals issued by the New York City Department of Housing Preservation and Development intended to provide high-quality housing, services, and community amenities in areas of urban blight. While preparing an environmental impact statement for the project in 2003, the two developers studied rising sea levels and hurricanes. Michael Dubb, Beechwood founding principal, had experienced Hurricane Andrew in Florida in 1992

## **Arverne has withstood a substantial test of resilience against hurricanes and sea surge, and its ability to recover quickly has helped the overall market in the Rockaways.**

and reminded his partners they had to be prepared for significant storms and sea surges, given they were building on the coast in the potential path of hurricanes.

“That’s primarily why we raised the grade and implemented the stormwater management system,” says Gerard Ronski, the attorney and project executive for Arverne. “We certainly went beyond what was required.”

When Superstorm Sandy hit, about half of the community was built, with a Stop & Shop supermarket and nearly 1,000 residential units completed. Elements such as retail and restaurant spaces, a YMCA and community center, transit plaza, and parks were still under construction. The project, due to be completed in 2017, will encompass 2,296 residential units in several building types, including multifamily condominium buildings and two- and three-level townhouse buildings with two to five attached units.

The Arverne developers returned to the site in the early hours after the hurricane to discover that the resilience measures they had put in place, such as raising the buildings out of the floodplain, had protected the majority of the community from destruction. In fact, Arverne became a regional hub and disaster response center for the peninsula in Sandy’s aftermath.

## **Mitigating Risks**

Arverne’s first line of defense against storm surge and flooding was the wide beach and dunes—which act as nature’s barriers on islands like the Rockaways—and the Rockaway boardwalk, which ran along the beachfront. As a first order of business, the developers and the city fortified the dunes along the entire oceanfront of the property. Behind the boardwalk and dunes, a new roadway provided storm and flood protection, including a large below-grade stormwater drainage system.

To add to the natural and built defenses along the waterfront, the developers trucked in more than a half-million cubic yards of tested fill dirt to raise most of the site three feet to nine feet above the 100-year floodplain. The streets were set at angles from the beach to reduce the wind’s impact on homes during storms. Utilities, such as electrical, were installed underground. The electrical infrastructure included accessible waterproof transformers. Storm drains were placed in front yards and backyards and connected to an underground drainage system that included on-site retention and large storm drains on each property and beneath the streets.

Homes were designed to be weather resistant. Foundations had deep wooden pilings and poured reinforced concrete slabs, with homes raised at least three feet above the street level. Double-glazed, low-emissivity, pressure-resistant windows were installed. Steel framing was added to the exterior walls, which were clad with durable fiber-cement HardiePlank lap siding, and wind-resistant shingles were installed on the roof. The developers also used highly durable exterior sealants around window frames to prevent water infiltration and high-quality DuPont Tyvek HomeWrap to withstand the elements. In the new sections of Arverne, the developers are now using the lessons they learned from Sandy to build homes even tighter and higher above the floodplain.

The community lost power during the hurricane, “but because we put our electric underground, and in a waterproof vault, we got our power back faster than anyone,” notes Ronski. “We were the only area on the peninsula with power for a week and a half following the storm, and the Stop & Shop was the only supermarket on the peninsula open for six months.” Arverne became the hub of recovery activity on the peninsula; the developers opened the



transit center but delayed occupancy by retail tenants for a year to allow the city to use the space for a 5,500-square-foot emergency-response center.

## Creating Value

As a public/private partnership, the Arverne developers were required to purchase the land from the city and build new public infrastructure, but they invested more than required in both infrastructure and other elements that provided resiliency—an estimated \$100 million, or 10 percent to 15 percent of the overall project development cost, says Romski. The fiber-cement siding, for example, cost 20 percent to 25 percent more than typical vinyl siding. The partners think the investments in durable, high-quality construction helped the project withstand damage from Sandy, enhanced the community's reputation, and have led to higher-than-market rental and for-sale prices.

Resiliency measures helped avoid significant damage to units under construction, the cost of which likely would have outstripped the value covered by the project's construction risk policy. Most homeowners are also saving the cost of flood

insurance premiums because the Arverne homes have been built at a higher grade, avoiding the flood insurance requirement.

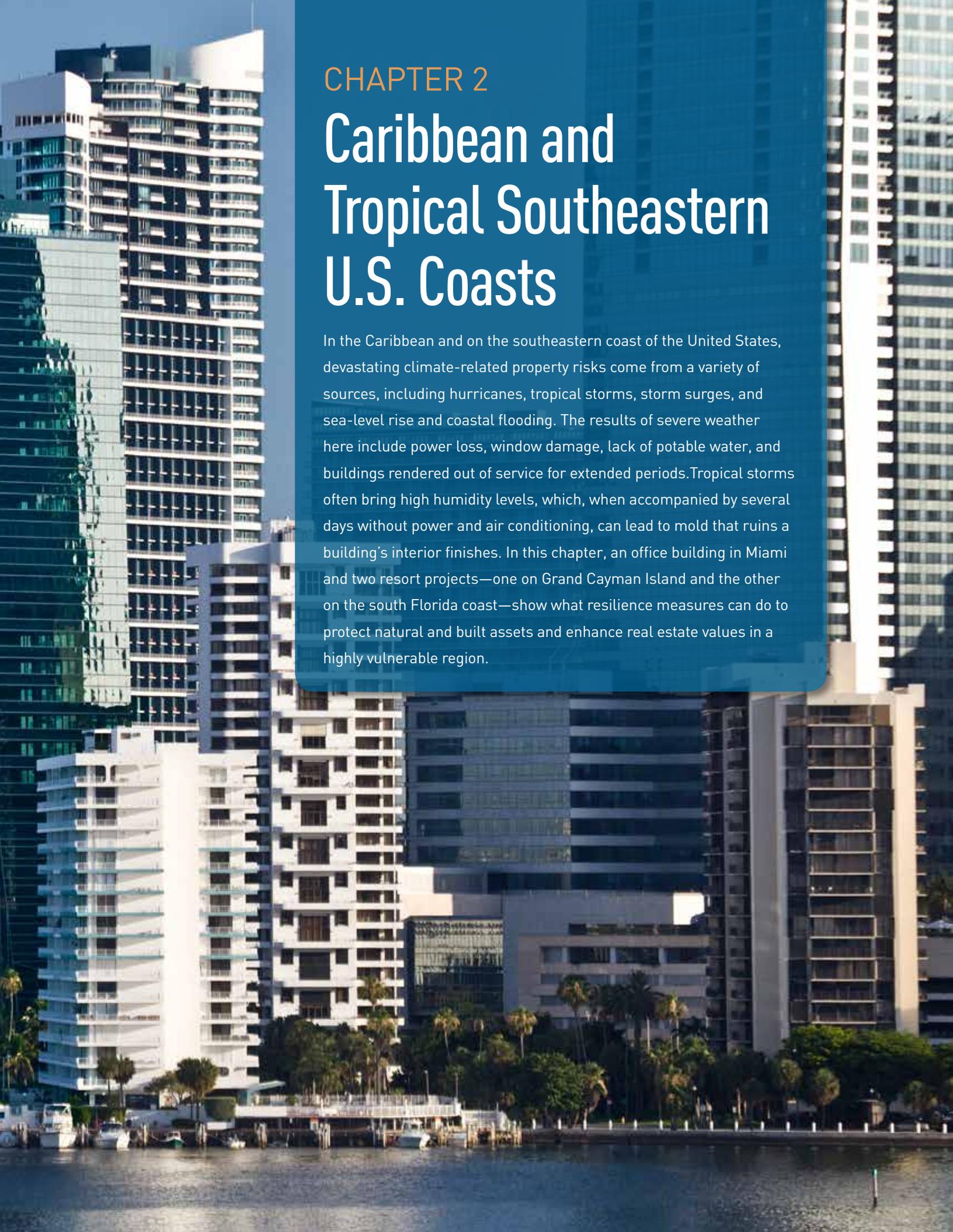
An unforeseen benefit of resilience efforts was an improved company brand and new business. Following Sandy, the city and the Federal Emergency Management Agency asked the developers to help get homeowners in other places on the peninsula back in their houses quickly through its Rapid Repairs program. As a homebuilder that survived Sandy, "We knew for our brand and for our community, we needed to get the community back on track," says Romski. The developers have also become the redevelopment contractor for the borough of Queens under the NYC Build It Back program, which will build homes to replace homes that were destroyed or substantially damaged by Sandy to new more resilient standards.

Arverne has withstood a substantial test of resilience against hurricanes and sea surge, and its ability to recover quickly has helped the overall market in the Rockaways. Besides the resilience features, says Romski, "it is really a testament of successful urban redevelopment. We're very proud of it."

**Arverne by the Sea site plan.**  
Arverne by the Sea LLC

1450 Brickell Avenue (center) is located in downtown  
Miami's financial district.  
*Robin Hill*





## CHAPTER 2

# Caribbean and Tropical Southeastern U.S. Coasts

In the Caribbean and on the southeastern coast of the United States, devastating climate-related property risks come from a variety of sources, including hurricanes, tropical storms, storm surges, and sea-level rise and coastal flooding. The results of severe weather here include power loss, window damage, lack of potable water, and buildings rendered out of service for extended periods. Tropical storms often bring high humidity levels, which, when accompanied by several days without power and air conditioning, can lead to mold that ruins a building's interior finishes. In this chapter, an office building in Miami and two resort projects—one on Grand Cayman Island and the other on the south Florida coast—show what resilience measures can do to protect natural and built assets and enhance real estate values in a highly vulnerable region.

# 1450 Brickell

Miami, Florida

## Project data

### PROJECT TYPE

Commercial, mixed-use, Class A office tower

### OWNER

1450 Brickell LLC

### DEVELOPMENT TEAM

Rilea Group, Nichols Brosch Wurst Wolfe & Associates Inc. (NBWW), Blanca Commercial Real Estate, Coastal Construction Group

### PROJECT SIZE

586,000 square feet

### PROJECT COST

\$250 million

### RESILIENCE FEATURES

High impact-resistant windows and framing, backup generator for emergency power, ground floor elevated above flood level

### RESILIENCE INVESTMENTS

Approximately \$15 million

### RESILIENCE RETURNS

\$1 million annual electricity savings, more-competitive insurance bids, marketing advantage, faster lease-up

**LOCATED AT THE SOUTHERN GATEWAY** to downtown Miami's Brickell financial district, 1450 Brickell is a 35-story, 586,000-square-foot Class A office tower that features panoramic views of the city and Biscayne Bay one block away. It was Miami's first LEED Gold-certified private office building and is one of the city's most resilient. The office tower was designed with impact-resistant glass windows that can withstand the force of large projectiles as well as winds approaching 300 miles per hour, an important building defense in this hurricane-prone site. When it was completed in 2010, 1450 Brickell incorporated the strongest curtain wall window system of any commercial building in the nation.

The building's ground floor includes a raised lobby on the left, retail space and loading docks on the right, the breezeway through the middle, and the auto entrance drive with access to the parking garage near the top of the plan.

NBWW



In 2005, Alan Ojeda, the founder and CEO of Rilea Group, began planning 1450 as the second phase of a two-acre mixed-use project on Brickell Avenue, Miami's Wall Street. (The first phase was the 36-story One Broadway apartment building. The project also includes a parking garage with 1,200 spaces, located in the lower floors of the office building, and an adjacent 12-story parking structure, which has a rooftop terrace). The 2005 commercial real estate market in Miami was in transition as a result of overbuilding and heavy damage along Brickell Avenue from Hurricane Wilma. Many high-rise buildings lost windows, suffered extensive damage, and were out of commission for an extended period.

The Miami-Dade code for commercial buildings required that the first 30 vertical feet of a building have large-missile impact-resistant glass to withstand high winds and impacts from flying debris; above 30 feet, glass had to resist small-missile impacts. But the damage from Hurricane Wilma convinced Ojeda that the code was not adequate. Ojeda recalled that when he surveyed the area after the storm, the streets were littered with glass from windows as high as the 25th floor that had exploded or imploded. The developer, who had been planning the office building with a glass curtain wall, determined that hurricane-resistant glass needed to be even stronger and, if it was required to protect the first 30 vertical feet of a high-rise building, "why not do it for the other 500 feet?"

## Mitigating Risks

Completed in 2010, the \$250 million building is constructed with a poured-in-place reinforced concrete structural system that uses post-tensioned one-way slabs and beams. The entrance, lobby, and elevator corridors are elevated eight feet above grade to reflect the slope of the site, which is higher on the north side, and to raise the lobby base above the floodplain to avoid the impacts of flooding during hurricanes. The ground level also includes a breezeway, two retail banks, and spaces for two restaurants; one restaurant is at street level within the floodplain, but it includes a system of glass panels that can be put in place for protection during storms.

Ojeda worked with a veteran team of architects and consultants—including Nichols Brosch Wurst Wolfe & Associates Inc., architects; the Blanca



Commercial Real Estate leasing team; and Coastal Construction Group as general contractor—to research impact-resistant glass and structural framing systems and to redesign the building to withstand the extra weight of heavier, more resilient glass and framing. The curtain wall consists of tempered blue glass that is nine-sixteenths of an inch thick, laminated, and constructed of layers that can resist extreme heat and impacts. The curtain wall was strengthened with heavy bolts, thick aluminum framing, and silicon to hold the glass in place.

“We spent nine months looking at glass, not only considering impact-resistant qualities but also the color and the overall quality,” says Ojeda. Wind-tunnel tests ensured the glass could withstand a Category 5 hurricane, in which winds can exceed 157 miles per hour, without experiencing major breaches to the building’s exterior. Ojeda requested glass with essentially twice that resistance; the more resilient glass and stronger framing added roughly \$13 million to the building’s cost.

## The tandem sustainability and resilience efforts increased the construction cost by 6 to 8 percent but have been “recouped several-fold.”

Another risk following hurricanes is large-scale power outages. The building has a second backup generator that exceeds code requirements, able to run the air-conditioning and lighting systems and to provide electrical power for tenants during power outages. The backup system includes a 2,200-kilowatt emergency power generator and a 2,000-kilowatt standby power generator, capable of supplying about 50 percent of the power for air conditioning during a recovery period. The electrical vault is a “throw-over” vault with two primary feeds; if one feed loses power, the vault automatically switches to the other primary feed for continuous power.

### Creating Value

Ojeda estimates that the tandem sustainability and resilience efforts increased the construction cost by 6 to 8 percent, but that these costs have been “recouped several-fold.”

Spending the extra money to install high-impact resistant windows for the entire height of the building, especially during a financial crisis, was a risky undertaking: Ojeda believed it was a wise strategy for the long run. Beyond the protection the glass will provide during a severe storm, the gamble has paid off already in more competitive insurance bids and lower operating expenses. The window glass, for example, deflects heat better and has reduced the need for air conditioning, which in Miami consumes about 60 percent of a building’s electricity. Ojeda estimates that the glass and other measures have contributed to annual electricity cost savings of about \$1 million.



The Brickell Avenue entrance lobby is raised several feet above the street level and the floodplain.

1450 Brickell, Miami, Florida

The building’s resilience became a key marketing point, ensuring tenants that the building would continue to operate when other buildings might be out of service. Many of 1450’s 67 tenants—including J.P. Morgan Chase & Company, American Express, the H.J. Heinz Company, and Bank of New York Mellon—are based in or do business in different time zones, and the concept of continuity of operations is essential to them. Ojeda said resilience, especially the provision of the second backup generator to maintain operations, provided an edge in being able to fully lease the building by 2013, compared with the 40 percent lease-up rates of two comparable commercial properties that came to market at the same time.

The tandem sustainability and resilience investments were beneficial in several other ways: the strength of the glass and its ability to separate heat from light lowered the building’s energy intensity and was critical to earning LEED Gold certification. The building’s LEED Gold certification and resilience measures, among other factors, were assets that drew high-profile tenants who shared the developer’s commitment to sustainability. Finally, and perhaps most important, says Ojeda, building for both sustainability and resilience “is the right thing to do” to try to reduce global warming and to mitigate the effects of increasingly intense hurricanes and sea-level rise.

# Ritz-Carlton, Grand Cayman

Grand Cayman, Cayman Islands

IN 2012, FIVE MILE CAPITAL PARTNERS LLC purchased the Ritz-Carlton, Grand Cayman, a luxury resort property with an eight-story, 365-room hotel on 144 acres of Grand Cayman Island, at the foreclosure sale. The property stretches from Seven Mile Beach to the North Sound on the island's west coast.

The view from an oceanfront room at the Ritz-Carlton, Grand Cayman.

**Project data**

**PROJECT TYPE**  
Hospitality, resort

**DEVELOPMENT TEAM**  
OBM International, Applied  
Technology & Management Inc.,  
Phoenix Construction

**PROJECT SIZE**  
144 acres

**PROJECT COST**  
\$25 million spent of total \$50  
million planned for upgrades,  
new amenities

**RESILIENCE FEATURES**  
Upgraded generator with  
cogeneration of heat and power,  
flood control measures, restored  
mangroves

**RESILIENCE INVESTMENTS**  
\$3.5 million, including estimated  
future expense for mangrove  
restoration

**RESILIENCE RETURNS**  
\$300,000 annual energy savings,  
protection against storm damages  
to property, enhanced property  
value, marketing advantage





Five Mile Capital Partners, a private equity firm based in Stamford, Connecticut, set out to upgrade the facilities, make operations more efficient, and develop new amenities. What made the firm’s plan exceptional was the additional goal of restoring a natural area and reducing the planned development footprint to increase the asset’s value and to protect the Caribbean island’s coastline.

Five Mile knew the resort was vulnerable to hurricanes and tropical storms and all the destruction that could accompany them. During Hurricane Ivan, which struck the island in 2004, the hotel, then under construction by the previous owner, was inundated with 16 feet of standing water and incurred damages related to high winds, water, and humidity. After Hurricane Ivan, the owner filed \$180 million in insurance claims, about a third of which was for damages to interior finishes. Storm-related construction delays pushed out the hotel opening by a year and a half, meaning significant lost revenues.

The coastline of the property along the North Sound, although mostly undeveloped and sheltered by a buffer of mangrove trees, also suffered hurricane damage. As part of the hurricane cleanup effort, the previous owner cleared mangrove vegetation along with other storm debris and installed

a rock berm that impeded ocean water flow, which caused damage to eight acres of mangroves. Mangroves provide habitat for marine wildlife and birds, so their loss negatively affects the local ecosystem. By buffering wave action, preventing erosion, and absorbing floodwaters, mangroves can also play an important role in protecting waterfront property during tropical storms; but in this case, the existing mangrove buffer was not wide enough.

Five Mile had been one of several secured mortgage lenders for the property, and when the previous owner defaulted, the firm took control of the hotel through a recapitalization. Upon taking title, the firm had a repriced, attractive basis in the property and saw an opportunity for a new approach to create value and make the Ritz-Carlton a top resort in the Caribbean, if not the world. Five Mile wanted to optimize the hotel operations and make strategic capital investments in recreation amenities, such as a marina. Since 2013, Five Mile’s upgrades have included a multimillion-dollar children’s water park, meeting spaces, common areas, retail shops, restaurants, tennis courts, an expanded gym, and completely renovated guestrooms.

## Mitigating Risks

Five Mile also has introduced numerous resilience measures: a hurricane preparation plan is in place, informed by lessons learned from Hurricane Ivan. Strategies include barricading parts of the hotel during an intense storm, installing a concrete wall around the generator to prevent stormwater from flooding the diesel tank, and adding removable flood protection walls to cover lower-level doors during storms.

The resort also modified the existing emergency generator and hotel switch gear to provide power during and after a storm, mainly for elevators. To ensure that the hotel could be pressurized and dehumidified during a sustained power loss, the emergency power system was enhanced to accommodate the chillers, cooling towers, outside air-conditioning units, and pumping systems. With the new excess capacity, the generator now runs six hours every day. Capturing and reusing waste heat from generating electricity enables the hotel to meet 80 percent of its heating requirements as well.

A key resilience strategy focused on the mangrove buffer, which emerged as an opportunity for creating value for the property in several ways. The mangroves will be restored to support new recreation opportunities in an environmentally sensitive way and as part of a storm protection system. A Five Mile team, including OBM International planners and architects, worked with U.S.-based Applied Technology & Management Inc. (ATM) to develop this vision. ATM's environmental and marina consultants and coastal engineers assessed the mangrove conditions, documented baseline environmental data, and proposed an environmental restoration plan that supported the mangrove as an amenity. Five Mile also worked with Jean-Michel Cousteau's Ambassadors of the Environment to identify ways to enhance environmental and educational programs on site, such as boardwalk access, viewing platforms, and kayak trails.

The mangrove analysis supported a new plan for developing for-sale luxury units on the property. The previous owner had applied for development authorization to remove what was left of the mangroves and to build 350 condominiums on the site. Five Mile's approach focuses on quality over quantity by reducing to 90 the number of new for-sale units and by restoring the eight acres of mangroves as a natural amenity that will benefit

the island and its inhabitants as well as the resort guests and owners.

The Cayman Islands Department of Environment has encouraged the new approach as a coastal development best-practice model for mangrove protection and restoration. The Grand Cayman government is pleased that Five Mile wants to enhance critical natural infrastructure that supports the island's environment and local economy. In turn, Five Mile welcomes its relationship as a partner with the government. Authorization for the comprehensive development proposal is anticipated by the close of 2015.

## Creating Value

Since 2012, Five Mile has completed \$25 million in improvements and resilience measures and has committed to spending an additional \$25 million. Approximately 10 percent of the investment has been directed to resilience strategies, including hotel barricades, a concrete wall around the

**“We’re at the cutting edge of what property owners should be thinking about in terms of reducing carbon footprint, being environmentally sensitive, and accommodating the community.”**

—Jim Glasgow

generator, the expanded on-site generator, and removable flood protection walls. The Ritz now generates more than \$100 million in revenues, which represents a significant portion of the local economy (the resort employs 800 people, one-third of whom are local residents). Five Mile believes that recent resilience efforts have helped enhance the value of the property, now estimated at more than \$500 million.

Energy savings are helping the bottom line. In a region where utilities cost between four and seven times what they cost on the U.S. mainland, the upgrade of the on-site generator—coupled with cogeneration of heat and energy, produced at 32 cents per kilowatt hour—saves \$300,000 annually in electric costs. The ability of the on-site generator to operate the hotel air conditioning for 30 days to pressurize the building is critical for protecting

**Shoreline protection and habitat creation will be similar to that in Martin County, Florida's Twin Rivers Park (seen here). Stones will create a bulkhead for shoreline protection while mangroves will be propagated to create habitat and defend against erosion.**

*Applied Technology & Management Inc.*



interior finishes against high humidity conditions, especially after a storm, which helps the resort avoid costly future damages.

Long-term asset value was a motivating factor for resilience efforts. Risk assessment and insurance professionals have said the enhanced storm protection system, including restored mangroves, could lower insurance premiums. Five Mile believes that this natural feature and associated amenities will enhance the price and velocity of sales when residential units come to market.

"We take the long view," says Jim Glasgow, managing partner of Five Mile Capital. Although the return on investment for the mangrove restoration and improved storm protection may be hard to calculate, the project offers much ancil-

lary value, including tasteful natural landscapes, recreational amenities authentic to the destination, and a unique platform for ecotourism education programs. "There is no doubt in our minds that it will make our property that much more attractive from a marketing perspective, for both hotel guests and property owners."

Yet another reason for resilience efforts: Being stewards of the land "is the right thing to do," says Glasgow. "We're at the cutting edge of what property owners should be thinking about in terms of reducing carbon footprint, being environmentally sensitive, and accommodating the community. We feel these efforts and profitability are not mutually exclusive—they will be selling-point amenities to customers."

# South Florida Resort

A WORLD-CLASS RESORT IN SOUTH FLORIDA that is being redeveloped by an institutional investor is showing how investments that address climate change risks can also benefit the bottom line with more effective marketing, better financing terms, and lower insurance premiums and energy bills. Key components of this resort's resilience process have been multiple strategies to prevent damage from risks such as strong winds and storm surges, as well as a disaster recovery plan that allows the resort to recover quickly after an event.

### Project data

**PROJECT TYPE**  
Resort and conference center

**OWNER**  
Institutional investor

**PROJECT COST**  
Many millions of dollars

**RESILIENCE FEATURES**  
Relocation of electrical infrastructure above storm-surge level, hurricane-resistant windows and doors, on-site backup power (generators, diesel fuel tank), on-site water desalination wells, water storage tank

**RESILIENCE RETURNS**  
Insurable value boosted by 50 percent; \$685,000 annual savings on insurance, energy, and water; more-competitive conference business



The fortification of the cooling towers on the property was accomplished with a steel enclosure, protecting the machinery from wind and storm-surge debris.



Five emergency generators are strategically placed for rapid installation in case of power failures.

The owner is halfway through a major redevelopment that has focused on upgrades, amenities, and a transition to a resort that includes state-of-the-art meeting facilities. In the early planning stages, the redevelopment took a turn toward resilience when the owner became aware that the property, valued at more than \$500 million, was vulnerable to climate change, especially increasingly intense hurricanes and tropical storm surges.

**“We thought it would be prudent to protect the property from incurring substantial storm damage that would take over a year to recover from.”**

—Project manager

“It became clear to us that, with an asset of this value, it would be very unfortunate if we had a major storm event and lost power and water service to the property,” says the owner’s project manager. After hurricanes, for example, water intrusions and high humidity can cause mold outbreaks within days, and if the air conditioning is not working, all the building finishes could be ruined. If the entire region is hit, rebuilding timelines could be complicated by competition for resources. “We thought it would be prudent to protect the property from incurring substantial storm damage that would take over a year to recover from.”

## Mitigating Risks

The resort is designed to withstand a Category 3 hurricane, during which a storm surge could reach an elevation of 16 feet. Whereas the property’s lowest occupied level is at an elevation of 20 feet, the building’s critical infrastructure systems, including the electrical service and central energy plant, were at an elevation of nine feet, making these systems vulnerable. The owner decided to raise the electrical service and to install hurricane-resistant windows, and then the owner kept adding to the list. “Once we started thinking about this, it became very clear that the various aspects of protecting the building were all interrelated,” notes the project manager.

Over the past decade, resilience strategies for the resort have included the following:

- \* Development of a disaster-recovery plan that provides step-by-step procedures for preparing the site for a storm and for restoring services afterward
- \* Installation of hurricane-rated windows and doors throughout the property, with large-missile impact-resistant glass on levels up to 30 feet and small-missile impact-resistant glass on levels above 30 feet
- \* Relocation of the property’s electrical infrastructure to an elevation of 20 feet, well above storm-surge elevation, to protect critical electrical components—switchgears, transformers, and electrical panels. (The new equipment elevation is well above the code requirement of 12.5 feet.)
- \* Construction of two new electrical service switchgear buildings with generator “quick connects” located above storm-surge elevations
- \* Procurement of five emergency generators with a capacity of 2,000 kilowatts that are strategically placed after an event to provide electrical service
- \* Installation of a 20,000-gallon underground diesel fuel tank to run the emergency generators for up to ten days
- \* Fortification of the central energy plant to provide cooling after a hurricane
- \* Fortification of the property cooling towers with a steel enclosure to protect from wind and storm-surge debris
- \* Installation of a piping system between the two central energy plants to maintain cooling under adverse conditions

- \* Installation of wells for a desalination unit and a 15,000-gallon underground water storage tank for the cooling tower water makeups that also could provide potable water

## Creating Value

The owner estimates that its resilience investments boosted the insurable value of the property by 50 percent. The resilience investments have improved the resort's branding and image, which has been important in the competitive high-end Florida convention business. "Many groups make their plans one to two years in advance, and this resilience gives them the confidence that the facility will be online and available even if there had been a hurricane six months before," says the project manager.

Resilience measures lowered annual insurance premiums by an estimated \$500,000, offering a significant reduction in annual operating expenses. They also have led to immediate energy savings: the impact-resistant windows are energy-efficient low-E rated and are saving approximately \$110,000 per year and mitigating the resort's contribution to global warming. The use of the on-site wells for irrigation reduces the use of city water and saves \$75,000 per year.

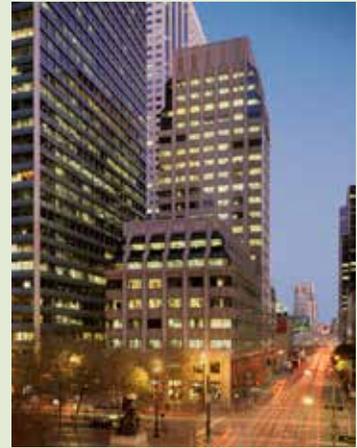
Resilience strategies have enabled the property to maintain a competitive advantage by reducing the likelihood of building damage, shortening the duration of recovery, and adapting the site to a variety of conditions that would keep the resort operating. The owners also believe they have enhanced access to competitive financing and favorable terms.

"What we've done is more like what institutions like hospitals and government agencies do for emergency response," says the project manager. "This is a long-term hold for us, and this asset will stand out because of the resilience put into it."

## Building Occupancy Resumption Program

### 455 Market Street San Francisco, California

Following natural disasters such as a large earthquake, one factor in reopening buildings is the potential backlog in conducting inspections to ensure buildings are safe to re-enter. Inspection delays can lead to costly closures of businesses and displacement of residents.



The LEED Gold-certified office building 455 Market Street is in the heart of San Francisco's financial district. The owner of the property, a fund advised by UBS Global Asset Management, has participated in the Building Occupancy Resumption Program (BORP) since 2009. BORP is an award-winning program developed to shorten the period after disasters for buildings to resume normal operations.

The program allows San Francisco building owners to arrange post-disaster building inspections by precertified licensed structural and civil engineers or architects with special training in emergency structural inspection. The inspectors are deputized by the city and county of San Francisco's Department of Building Inspection (DBI) to conduct emergency inspections and to determine a building's legal occupancy status (red, yellow, or green) soon after a disaster. Hospitals typically have priority inspections, and BORP-certified buildings are next. If a building is tagged green, operations can resume quickly.

The 455 Market Street owners and its property manager, Cushman & Wakefield, engaged Tuan & Robinson Structural Engineers at a one-time fee of \$13,500 that covered the initial inspection and any postevent inspection. The engineers are required to respond within eight hours of a disaster. Tuan & Robinson reinspects the building every two years and recertifies the BORP with the DBI for approximately \$300.

The 455 building ownership has contracts with its elevator and fire, life, and safety vendors to inspect the building promptly following a disaster. 455 Market Street's insurance company, FM Global, also sends an engineer to inspect the building and its documentation approximately every two years to make recommended upgrades for loss prevention and building safety and stability, such as installing bracing for piping. One additional benefit of the BORP is that earthquake insurance costs can be reduced by the shorter expected period of rent loss following an earthquake.

The program was developed by the city and county of San Francisco's DBI, with the cooperation of the Structural Engineers Association of Northern California and the San Francisco chapters of the Building Owners and Managers Association and the American Institute of Architects.



## CHAPTER 3

# South-Central and Western United States

Climate change impacts are being felt acutely in the south-central and western United States, from historic floods in Tennessee to persistent multiyear droughts in Texas, Arizona, and California. Some areas within this broad expanse experience great weather extremes, from high heat, strong winds, and severe drought to intense rainfall and flash floods. In this chapter, four projects, one in each of these states, demonstrate how buildings and landscapes can survive and thrive with resilient planning, design, and development strategies. These diverse adaptation strategies—some following nature’s example to cool buildings and collect stormwater for irrigation and others using the latest technology and materials to conserve water and energy and prevent flooding—are providing models for emerging best practices to protect property use and value as climate change advances.

**The University of Arizona’s ENR2 building in Tucson.**  
*Timmerman Photography*

# Gaylord Opryland/Grand Ole Opry

## Nashville, Tennessee

### Project data

**PROJECT TYPE**  
Hospitality, entertainment

**DEVELOPMENT TEAM**  
Ryman Hospitality Properties Inc.

**PROJECT SIZE**  
100,000-square-foot Grand Ole Opry House, 4 million-square-foot Opryland Resort and Convention Center, 100-acre-plus site

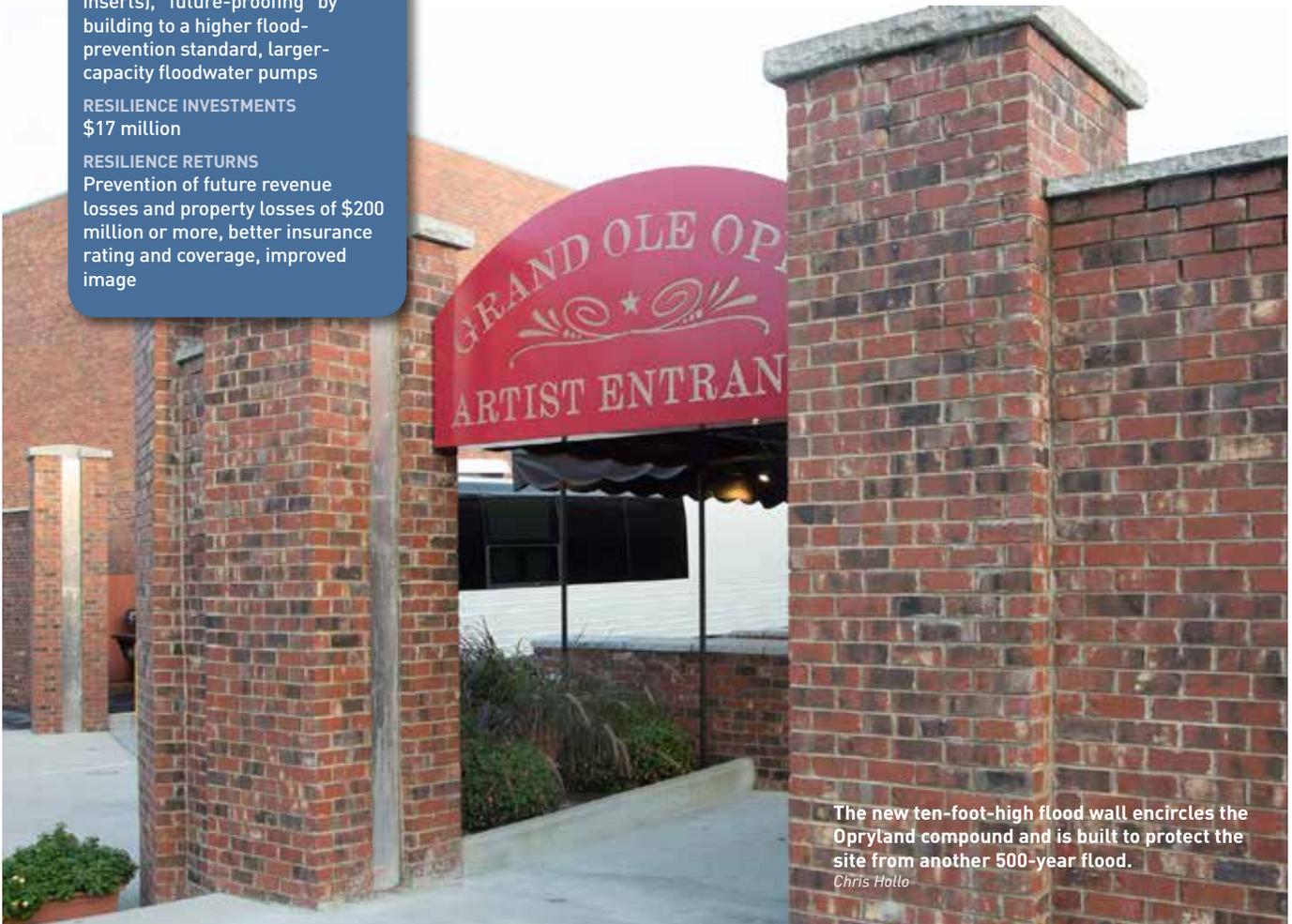
**PROJECT COST**  
Not available

**RESILIENCE FEATURES**  
Flood barriers (wall and movable inserts), "future-proofing" by building to a higher flood-prevention standard, larger-capacity floodwater pumps

**RESILIENCE INVESTMENTS**  
\$17 million

**RESILIENCE RETURNS**  
Prevention of future revenue losses and property losses of \$200 million or more, better insurance rating and coverage, improved image

IN MAY 2010, A "1,000-YEAR RAIN EVENT" pummeled Nashville, Tennessee. More than 13 inches fell in two days, causing the Cumberland River to rise to the elevation of a 400-year flood and overtop a flood protection system. The flood caused nine deaths, destroyed or damaged thousands of homes, and caused more than \$2 billion in damages in the city. Floodwaters inundated the historic Grand Ole Opry House, 800,000 square feet of the 4 million-square-foot Gaylord Opryland Resort and Convention Center, and most of the back-office facilities owned by Ryman Hospitality Properties Inc., which was then operating under the name of Gaylord Entertainment Company.



The new ten-foot-high flood wall encircles the Opryland compound and is built to protect the site from another 500-year flood.

*Chris Hallo*



**An aerial view of flooding at the Grand Ole Opry House.**  
*The Tennessean*

The performance stage of the Grand Ole Opry, the world-renowned country music venue, was covered with four feet of floodwater. At Gaylord Opryland, electrical switch rooms the size of small gymnasiums, all technology and communications infrastructure, miles of electrical wiring, and most of the facilities' enormous kitchens and food storage areas were destroyed by the flood. Between the Opry House and the hotel and convention center, damages totaled more than \$200 million. Flood remediation and refurbishment of the facilities took five months for the Opry House and six months for the resort and convention center.

During recovery, the company continued to pay employee wages for six weeks after the flood and also provided three months of health care coverage to the more than 1,800 employees who were temporarily laid off during the rebuilding. The out-of-service period for the Opryland properties, one of Nashville's largest employers, had a huge impact on the local economy, negatively affecting suppliers, outsourcing companies, cleaning crews, transportation providers, and city revenues (the company at the time generated more than 20 percent of the city's hotel taxes).

## Mitigating Risks

In 2012, Ryman Hospitality Properties completed construction on a combined \$17 million perimeter flood protection system around the hotel and the Opry House, to protect the 100-plus-acre site from another monumental flood. The large floodwall, which stands 10 feet tall in some places, is built of

brick and concrete; the barrier system is completed with aluminum planks stored on the property that groundskeepers can install quickly to stop water from coming through pedestrian and vehicle gates. The new wall was built on top of a previous flood protection system constructed to a 100-year-event standard following a 1975 flood. The owners reached out to the public to help alleviate fears that the floodwall could adversely affect surrounding properties.

Ryman Hospitality Properties built to the 500-year standard after the 2010 flood because of "the enormity of the damage and the fact it was so far-reaching," says Bennett Westbrook, senior vice president of investments, design, and construction for Ryman Hospitality Properties Inc. "The idea of going through that again was unimaginable." By exceeding the customary 100-year-flood protection level, they also "future-proofed" the property against changing federal flood regulations and increasing risks related to climate change.

Ryman Hospitality Properties was the first U.S. company to install the flood barrier technology manufactured by EKO Flood USA LLC, using a flood protection system that has been proven effective in Europe for more than 20 years. The floodwall now offers better protection for two backup emergency generators, which are capable of powering facilities for five days. The property owners also increased the floodwater pumping capacity in the protected area from 50,000 gallons per minute to 125,000 gallons per minute to remove a greater volume of rainwater in the event of a flood.

Facility damages stemming from the 2010 floods.  
*The Tennessean*



## Creating Value

Westbrook says spending \$17 million on the two flood protection systems was “an easy call” considering the alternatives that another devastating flood could entail, such as massive property damages, business interruption, human toll, and implications to the company’s investors if the re-

**Westbrook says spending \$17 million on the two flood protection systems was “an easy call,” considering the alternatives that another devastating flood could entail.**

built facilities were not adequately protected. Such resilience measures also were a wise investment, he says, given the value of the assets—it would cost an estimated \$2.5 billion to rebuild the Gaylord Opryland Resort and Convention Center and \$100 million to replace the Grand Ole Opry House.

The new flood protection wall and EKO flood system helped Ryman Hospitality Properties meet the requirements of the property insurer, FM

Global, to qualify for insurance rating advantages and better coverage for roughly the same premium Ryman paid before building the wall.

Although the owners’ financial commitment to employees resulted in very low turnover and saved significant costs in training new employees, Ryman Hospitality Properties believed that future-proofing the building against a similar expenditure was a wise move.

The Grand Ole Opry facilities represent “a lot of assets, a lot of expensive capital, and a tremendous amount of investment,” says Westbrook. He says the variety of measures Ryman Hospitality Properties has taken—building the floodwall, acting swiftly to fix damages, taking care of employees, and enhancing the public spaces during recovery construction—all have improved public relations, marketing, and the bottom line for the property.

From this more positive perspective, Westbrook adds, the resilience process allowed for investments in the property that would not have been possible before the flood: “We took the opportunity to do extensive renovations during the dark period, which would have been far too disruptive to do had the hotel and Opry House been operational with customers in house.”

# The Residences at La Cantera

San Antonio, Texas

**IN SAN ANTONIO, TEXAS**, resilience means being able to prepare for, recover from, and adapt to drought. So when USAA Real Estate Company, San Antonio, and the Cambridge Development Group, Dallas, were planning a resort-style destination town center at La Cantera, a master-planned community on land owned by USAA, they committed to developing a project that conserved and recycled water. “Drought in San Antonio is a way of life, and addressing that within the building design made total sense to us,” says Hailey Ghalib, managing director of the USAA Realty Company and national director of its multifamily development program.

**The Residences at La Cantera.**

*USAA Real Estate Company, Mark Humphrey’s Studio, and LRK*

**Project data**

**PROJECT TYPE**  
Residential, mixed use

**OWNER**  
USAA Real Estate Company,  
Cambridge Development Group

**DEVELOPMENT TEAM**  
Looney Ricks Kiss, J. Robert  
Anderson Landscape Architecture,  
Jordan Foster Construction

**PROJECT SIZE**  
150-acre master-planned  
community, 425,697-square-foot  
multifamily and mixed-use building

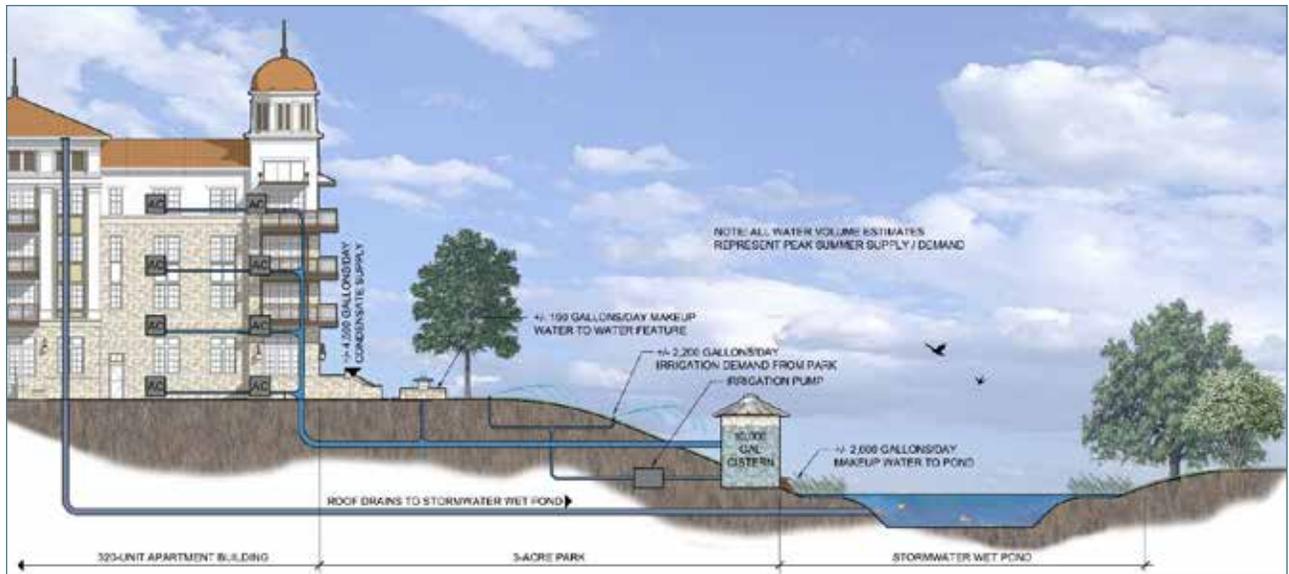
**PROJECT COST**  
\$47 million

**RESILIENCE FEATURES**  
Water conservation and recycling,  
cistern to capture stormwater  
runoff and condensate, native and  
drought-tolerant landscape

**RESILIENCE INVESTMENTS**  
Not available

**RESILIENCE RETURNS**  
Protection of \$1.4 million park,  
rental premiums, enhanced asset  
value of \$500,000, \$8,840 in  
annual water savings, marketing  
advantages





**A rendering of the water conservation efforts at the Residences at La Cantera.**

*USAA Real Estate Company, Mark Humphrey's Studio, and LRK*

Completed in 2014, the \$47 million Residences at La Cantera is a four-story, 425,697-square-foot multifamily building with 323 apartments and 3,700 square feet of retail space. Located next to the Shops at La Cantera and the La Cantera Hill Country Resort, the Residences include amenities such as a clubhouse, cyber café, fitness center, resort-style pool, and Jacuzzi. The 150-acre master-planned community is being developed with 1 million square feet of Class A offices, upscale shops, restaurants, and lifestyle amenities and will be connected by a pedestrian greenway, a network of urban parks and natural areas, and a hike and bike trail.

USAA Real Estate Company and the Cambridge Development Group sought to provide an attractive resort landscape while respecting the need to conserve water. San Antonio periodically has instituted water-use restrictions in response to drought. During La Cantera planning in 2011 and 2012, Texas experienced one of its worst droughts ever, which it recovered from only in 2015 with excessive rains that briefly helped restore water levels. Just months later, San Antonio had water restrictions back in place, limiting the use of irrigation systems and water features.

### Mitigating Risks

USAA worked with Looney Ricks Kiss, an architecture firm based in Memphis, Tennessee; Austin-based landscape architect J. Robert Anderson; and Dallas-based Jordan Foster Construction.

With this team, USAA focused on resilient design and construction strategies for the building, which meets Texas Green certification standards. The developers' planning and design choices have had the most effect on water conservation. They installed Energy Star-certified dishwashers and high-performance kitchen faucets and shower heads and located water heaters close to fixtures in most units, thus reducing the amount of water wasted while the resident waits for hot water.

The developers also addressed drought through the design of the landscape and its focal point, a 1.5-acre park that features an urban plaza, great lawn, adventure playground, pond, and picnic areas shaded by preserved live oak trees. They installed native and other drought-tolerant plants and mulched landscape beds at least four inches deep to retain moisture from irrigation. They constructed a 10,000-gallon cistern next to the wet pond to store rooftop stormwater runoff and condensate from air conditioning equipment, which are piped from the buildings; this recycled water is then used to irrigate the park and renew the pond.

The developers have begun focusing more on resilience metrics. For example, the cistern, which was sized to hold enough water to irrigate the park daily, was retrofitted to monitor water levels and the amount of water being added daily. Thus, they know that watering requirements range from 1,000 gallons a day to 4,000 gallons a day. Because the cistern collects up to 4,500 gallons a day (when all the units are filled) and is constantly being refilled, the owners know they can meet irrigation needs.

## Creating Value

Protecting the value of the amenities of the park and the plantings—even under drought conditions—was key to USAA’s decision making. “Part of the motivation was being a responsible corporate citizen and ensuring that the landscaping and public park would be irrigated with limited use of potable water,” says Ghalib. The park alone cost \$1.4 million to build and would cost at least \$425,000 to replace if damaged by drought. The value of the park translates to rent premiums for park views of between \$35 and \$50 a month per apartment, or \$25,560 of additional annual revenue, resulting in about \$500,000 in added asset value.

Resilience savings so far include lower maintenance costs and an immediate beneficial effect on operating income. As Ghalib says: “We saw the cost efficiencies in cutting back on the water bills and being able to maintain the park through drought conditions and water restrictions by capturing water that otherwise gets wasted.” The landscaping for the park requires between 30,000 gallons of water a month in winter and 118,700 gallons of water a month during the summer—a total annual water requirement of 878,400 gallons. On the basis of San Antonio Water Service’s 2015 water rates, water charges would total approximately \$3,840 annually. Additional fees, including a service availability fee

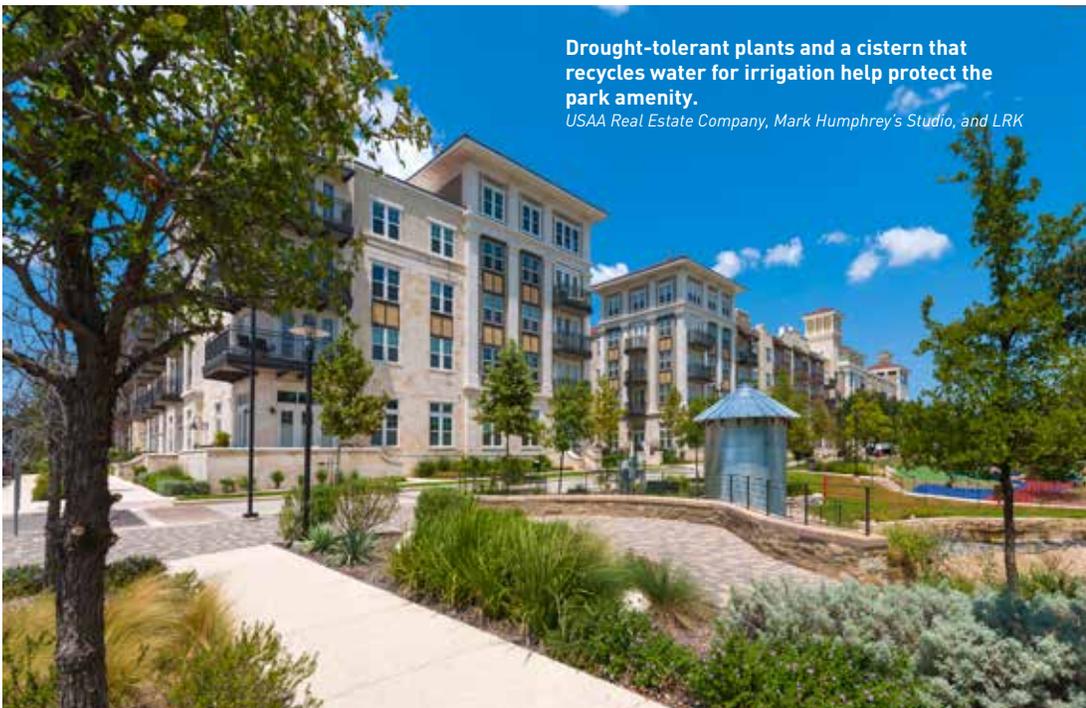
and a stormwater fee, would add \$5,000 a year to the water bill. The Residences consequently save an estimated \$8,840 in annual water charges by using the air-conditioning condensate and stormwater collection system to irrigate the landscape.

**“Drought in San Antonio is a way of life, and addressing that within the building design made total sense to us.”**

—Hailey Ghalib

The water recycling system also has marketing advantages, says Ghalib. “Whenever we tell tenants, residents, and visitors about the water reclamation, people receive it really well. It is definitely a distinguishing feature.”

USAA’s resilience efforts for the Residences at La Cantera are part of a company commitment to “build every asset as if we are going to own it long term,” says Ghalib. “With this one, we’re making sure every decision about materials and equipment makes sense for us and anyone else.”



**Drought-tolerant plants and a cistern that recycles water for irrigation help protect the park amenity.**

*USAA Real Estate Company, Mark Humphrey's Studio, and LRK*

# ENR2

## Tucson, Arizona

### Project data

**PROJECT TYPE**  
Institutional, academic

**OWNER**  
University of Arizona

**DEVELOPMENT TEAM**  
GLHN Architects & Engineers,  
Richärd+Bauer, Hensel Phelps  
Construction Company, Turner  
Structural Engineering, McGann &  
Associates

**PROJECT SIZE**  
150,954 square feet for research,  
administration, and instruction

**PROJECT COST**  
\$75 million

**RESILIENCE FEATURES**  
Passive energy systems, building  
orientation, courtyard design,  
mechanical systems elevated above  
floodplain, backup power and  
on-site generators, water  
harvesting, green infrastructure

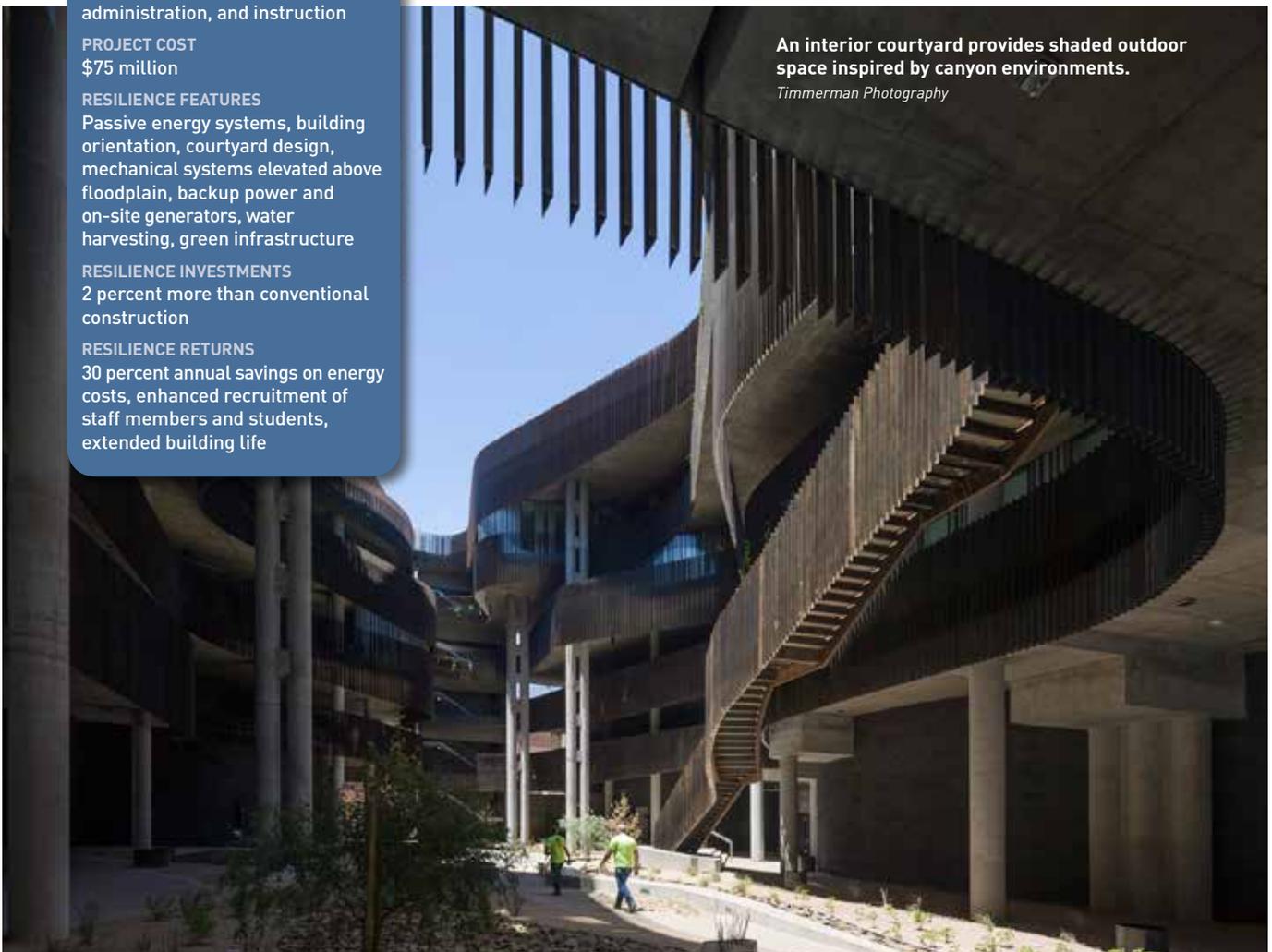
**RESILIENCE INVESTMENTS**  
2 percent more than conventional  
construction

**RESILIENCE RETURNS**  
30 percent annual savings on energy  
costs, enhanced recruitment of  
staff members and students,  
extended building life

**IN THE DESERT SOUTHWEST**—a region beginning to feel the effects of climate change more acutely than many others—weather extremes may include less frequent but more intense rainfall, as well as flash floods, hard freezes, extreme heat, high winds, and long droughts. ENR2, a new five-story, 150,954-square-foot research, administration, and instruction building on the University of Arizona campus in Tucson, responds to these risks, thus creating an ecofriendly environment that saves energy and water and evokes the canyons and mesas of the Sonoran Desert. Resilience efforts are already paying off.

**An interior courtyard provides shaded outdoor space inspired by canyon environments.**

*Timmerman Photography*



Designed by GLHN Architects and Engineers in Tucson and Richärd+Bauer architects in Phoenix and built by Hensel Phelps Construction Company, the \$75 million building integrates innovative solutions to architecture for a desert environment, with many sustainable components that minimize the use of energy and water while protecting the structure from the effects of extreme weather. Slated for LEED Platinum certification, the building's key resiliency features are its passive energy systems, building orientation, and courtyard design.

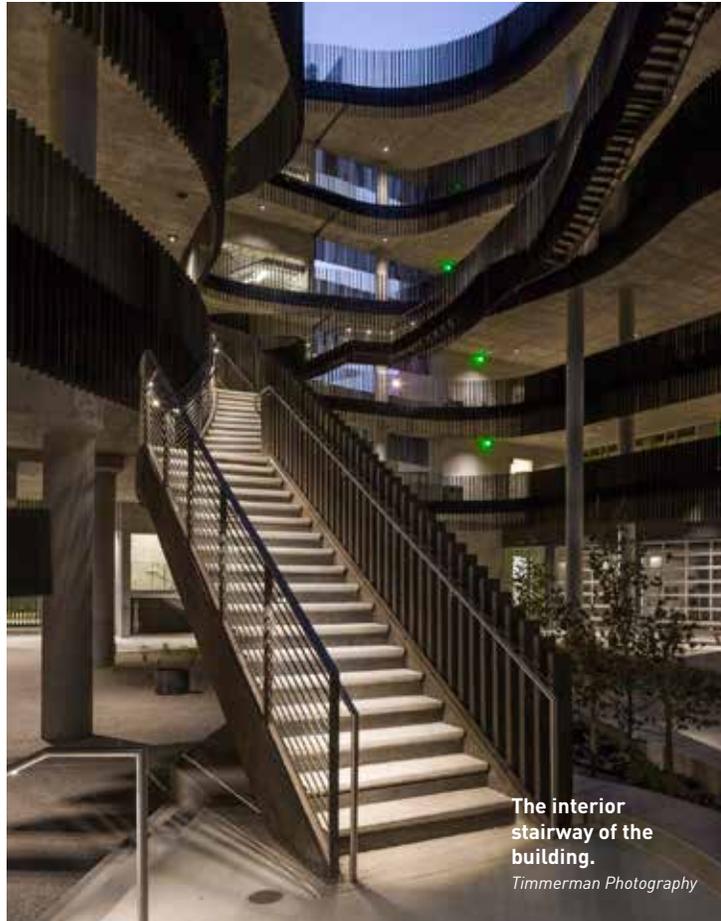
Completed in July 2015, ENR2 was designed to further interdisciplinary research in earth and environmental sciences, natural resources, and math and related sciences. The building includes faculty offices, conference space, research and work space, and instructional dry laboratories. A 600-seat auditorium and a coffee café meet the needs of a growing student population.

The building serves as a living model of evolving ideas about environmental sustainability and resilience—especially appropriate considering that the lead tenant is the Institute of the Environment, which conducts research on effective adaptation and mitigation factors related to climate change. “We also house the university's environmental groups, so this building had to be the most environmentally responsible building on campus,” says May Carr, senior architect in the university's planning, design, and construction department and project manager for the building.

## Mitigating Risks

Resilience measures for the building included fortifying the exterior to address high winds, sun and monsoon rain exposure, and summer temperatures that can reach more than 110 degrees Fahrenheit. Many of the important features of the building are passive systems and design strategies that require little if any assistance from renewable energy sources. These passive strategies include configuring the building around a central courtyard that integrates exterior circulation and interaction space and reduces the interior's need for air conditioning by about 30 percent.

The building minimizes the impacts of summer heat with the building mass, which is constructed of poured-in-place concrete, and has shading and strategically reduced openings. Vertical metal fins and overhangs shade the building on the south facade. In the courtyard, garden terraces and



The interior stairway of the building.  
*Timmerman Photography*

balconies form overhangs that create comfortable shaded microclimates for year-round outdoor meetings and socializing. These building features also evoke a desert slot canyon atmosphere with curvilinear lines, light, and shadows.

“The way we are protecting the building is through shading,” says Carr. “Our harshest exposures are on the east and west sides, and those have limited openings with a lot of building mass.” The building was designed to perform well and consistently at a comfortable temperature of 74 degrees Fahrenheit to save on energy costs and provide resilience, given the likelihood of increasing hot spells. The dedicated outdoor air system combined with overhead induction coils known as “active” chilled beams provide the primary heating, ventilation, and air conditioning for perimeter office spaces on floors two through five. The interior open-office spaces rely on an underfloor low-velocity air displacement system, which costs less to install and operate. On the courtyard balconies and terraces, large fans help circulate cooler air,



The building exterior is covered in a “blind” that filters direct sunlight.

Timmerman  
Photography

and plants temper the building through evapotranspiration. Heat gain and energy costs on the building have been greatly reduced, compared to other campus buildings.

“We are looking to see how the building responds to higher heat and longer heat events, and how increasing drought conditions are going to affect how the building works,” says Carr. “If the grid goes down and it’s 110 degrees outside, opening all the doors will not help cool the interior significantly.” Although so far, she says, even when it is very hot, “the courtyard space has been doing what we wanted it to do.”

Drought-prone areas like Tucson also face the risk of flooding, as less frequent but more intense rainfall runs off sun-hardened ground. Although the university does not build in the floodplain, the risks of storm-related flooding and power outages still exist. ENR2 resilience strategies included elevating the mechanical equipment above the 100-year-flood plain and providing backup power and on-site generators to allow the building to continue to be used even during a power outage.

The building also addresses drought risks with water harvesting and green infrastructure featuring native and drought-tolerant plants. When it rains, the water free-falls to the courtyard, drips through balcony and terrace planters, and flows into catch basins before being collected in the 52,000-gallon holding and filtration tank installed underground. Landscaped beds are irrigated with the stored stormwater runoff, captured building condensate, and reclaimed water. “There is always recognition of the presence of water, but it is being done in a way that acknowledges our desert environment,” notes Carr.

## Creating Value

“We are looking to maximize the longevity and efficiency of our buildings,” says Pete Dourlein, associate vice president for the university’s planning, design, and construction department. “As an institution, our goal is to build 50- to 100-year-life buildings.”

Even with the latest energy-systems technology and high-quality materials, the cost of building ENR2 was comparable to other university buildings, he says. Separating the building with a central courtyard cost more than constructing a solid block building because of more exterior surface area, but the advantages included reducing heat, solar gain, and the amount of interior space that needed to be cooled. Greater exposure to natural light and views also has been proven to boost people’s productivity.

**“The way we are protecting the building is through shading.”**

—May Carr

Energy-efficient features such as chilled beams and underfloor electrical distribution systems cost an estimated 2 percent more than conventional construction features to install. Projections show the building’s energy-saving features alone will save 30 percent on energy costs compared to conventional buildings.

Early responses indicate the building is boosting the university’s and departments’ images, a benefit in recruiting staff members and students. “Some of the faculty and researchers are already talking it up with their colleagues across the country and creating a buzz about this phenomenal new environment they are going to work and collaborate in,” says Dourlein. “Our assets are our people. That is what the space is for, even if we may not be able to put a price to that.”

# KB Home Double ZeroHouse

Lancaster, California

**IN THE DAWN CREEK NEIGHBORHOOD** of Lancaster, California, 60 miles north of Los Angeles, KB Home, one of the nation's largest home builders, is addressing the climate risks of drought, extreme heat, and water availability with the construction of "double-zero" single-family homes—double zero because they use zero energy and zero fresh water for irrigation. A model for the future, the double-zero home is designed and constructed to produce within a year as much energy as it uses through technology such as photovoltaic (PV) solar panels and enough water to irrigate the landscape through an on-site graywater recycling system.

## Project data

### PROJECT TYPE

Single-family residential

### DEVELOPER

KB Home

### SIZE

1,773–3,206 square feet per home

### PROJECT COST

High \$200,000s and up

### RESILIENCE FEATURES

Graywater recycling, highly efficient appliances, energy management system, drought-tolerant landscaping, solar panels

### RESILIENCE INVESTMENTS

\$48,000 per home

### RESILIENCE RETURNS

\$300 to \$3,000 in energy costs and 100,000 gallons of water saved annually, enhanced drought tolerance



**A model KB Home Double ZeroHouse.**  
*Applied Photography*

The homes feature solar panels and water conservation tools like the Nexus eWater system.

*Applied Photography*



In California, where years of historic drought have led to stringent water restrictions and where future water shortages are more likely, markets have started to focus more on water use. KB Home has been “looking at ways to be more water efficient over the long term to increase resilience,” says

## By lowering energy and water use, KB Home’s Double ZeroHouse addresses anticipated climate risks while reducing a home’s impact on the environment.

Thomas DiPrima, president of urban operations for the company’s Los Angeles Ventura division. “How do we make water go further, how do we reduce the cost of water, and how do we make homes where the landscape fits the local conditions?”

Another factor in KB Home’s double-zero approach is that in 2006 California passed AB32, one of the world’s most progressive laws to address climate change. The law requires the state to reduce carbon emissions from energy and other uses to 1990 levels by 2020 by increasing energy efficiency in buildings, expanding the use of renewable energy technology, and reducing waste, among other strategies.

### Mitigating Risks

By lowering energy and water use, KB Home’s Double ZeroHouse addresses anticipated climate risks while reducing a home’s impact on the environment. A graywater recycling system is expected to recapture and reuse between 40,000

and 70,000 gallons of water annually for a household of four. The system by Nexus eWater collects and cleans drainwater from showers, bathroom sinks, and washing machines for subterranean yard irrigation. The Dawn Creek home also features cutting-edge water-conserving technologies, offering homebuyers a WaterSense®-labeled home with advanced plumbing, drought-tolerant landscaping, and smart irrigation. The dishwasher uses 33 percent less water than other highly efficient dishwashers by reusing water from the final rinse cycle for the pre-rinse cycle of the next load. WaterSense®-labeled bathroom faucets, toilets, and showerheads and a motion-sensing kitchen faucet help save more water.

With all of its water-efficient elements, the home is estimated to conserve up to 100,000 gallons of water annually for a household of four or more when compared to a typical resale home; for landscaping, the home is estimated to reduce water use by approximately 70 percent compared to the resale home. A real-time meter allows homeowners to track water use. “If we have the ability to daily or weekly look at our water use, we have the ability to change our habits,” says DiPrima, who would like to see meters that would inform consumers of costs as well as amount of water used.

The Double ZeroHouse has been certified by the U.S. Department of Energy (DOE) for meeting all of the energy efficiency requirements of the DOE Zero Energy Ready Home program (see facing page). To be certified, a home must meet the energy and durability requirements of Energy Star Certified Homes Version 3, the insulation requirements of the 2012 International Energy Conservation Code (IECC), and the indoor air-quality and water-saving

requirements of the U.S. Environmental Protection Agency’s Indoor airPLUS and WaterSense programs. The home must have PV solar panels installed or have the conduit and electric panel space in place for them.

Ranging in size from 1,773 to 3,206 square feet, the Double-ZeroHouse homes employ a range of systems and features to reduce the homes’ energy use. All feature a built-in home energy-management system that allows homeowners to track energy use remotely from a smartphone or tablet. The system can be expanded with optional upgrades such as smart thermostats, lighting controls, and Internet-connected door locks. Smart appliances can be programmed to run energy-intensive tasks at off-peak hours. Electric vehicle charging stations are another optional upgrade. The homes are super insulated with advanced framing techniques and materials. A high-efficiency tankless hot-water heater also supplies heat for the home, and all of the lighting is LED based. “We don’t install LED lights in a home only because they save energy,” says DiPrima. “We look at other factors, such as longer-term maintenance and lower cost. LED bulbs may last the life of the home.”

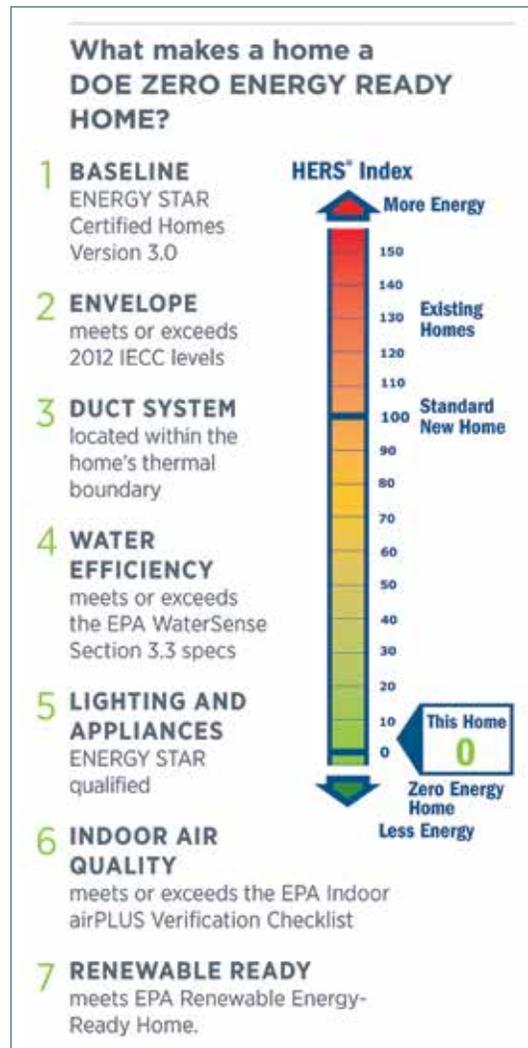
## Creating Value

Dawn Creek home prices range from the high \$200,000s, depending on design. KB Home estimates it costs an additional \$48,000 over conventional design and construction for appliances and water-heating and cooling systems that support resilience, not including discounts and energy-tax incentives. Projected annual energy savings compared to a home built to the 2009 IECC standards are \$2,698 with PV panels and \$361 without, so savings can quickly offset the extra construction costs, which are financed over the life of a mortgage. DiPrima says KB Home has been able to reduce the cost of a net-zero home by developing more efficient technologies and working with trade partners to improve installation methods, and KB is looking for more cost efficiencies. “By cutting costs, we are putting buyers back in the market,” says DiPrima, adding that homeowners are more likely to stay in their homes when they have fewer surprises and know what energy costs will be.

Consumers have shown interest in net-zero homes, he says, although the four- to five-year timeline needed to recoup investment after tax credits and incentives has deterred buyers who are

unsure how long they will stay in a home. Financing structures could be doing more to drive demand: mortgage lenders now require a home to be finished and certified before a “green loan” is approved, DiPrima says, and solar production does not always appear to be adequately valued by many appraisers, even though it greatly reduces energy costs.

The Double ZeroHouse has received significant local, national, and international media coverage—at an estimated advertising value of more than \$7.1 million—in addition to interest from municipalities, nonprofit organizations, and the general public. If adopted throughout KB’s portfolio, the influence of the Double ZeroHouse would be significant. In 2013, KB Home delivered 2,179 homes in its West Coast region, which includes all of drought-prone California.



Source:U.S. Department of Energy.







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