The seawall at Battery Park City, Manhattan.

NYC Economic Development Corporation

GOAL 8

Identify and pursue strategies to increase the city's resilience to climate change and sea level rise.

GOAL 8

INCREASE CLIMATE RESILIENCE

New York's shoreline has been dramatically altered over the centuries. From the moment the Dutch arrived in Nieuw Amsterdam, piers, wharves, docks, and bulkheads have been built. And landmass itself has been added, through the process of fill. While such modifications to the landscape have radically changed the shoreline ecology, they've also given rise to the region's economic engine and enabled more than eight—and soon nine—million people to inhabit the city. New York's ability to support a large population and substantial employment in a small area is one of its greatest contributions to the environment, resulting in per-capita carbon emissions that are one-third the national average and allowing the preservation of open space and natural resources elsewhere. In recent years substantial improvements to water quality and marine ecology have been made, even as the population of New York has continued to grow.

Now human activity is altering the waterfront in a new way. Climate change resulting from global greenhouse-gas emissions is expected to cause sea levels to rise, which will further transform our shoreline. The New York City Panel on Climate Change projects that by the 2050s, sea levels could be 12 inches higher than they are today or, in the event of rapid melting of land-based polar ice, as much as 29 inches higher than today. By the 2080s, increases of up to 23 to 55 inches are projected. And as the sea level rises, the risks from severe storms and flooding that New York has always faced as a coastal city exposed to the ocean are expected to increase, too.

New York is already taking steps to address climate change. The City is working to reduce its contribution to climate change through the *PlaNYC* goal of reducing greenhouse-gas emissions 30 percent by 2030. Adaptations to our environment to increase the city's ability to withstand and recover quickly from weather-related events, or its climate resilience, are also being contemplated and made.

Building climate resilience requires recognition of the character of New York City's coastal areas as well as the risks they face. For instance, most portions of New York stand several feet or more above sea level, and therefore face different challenges from, say, New Orleans or the cities of the Netherlands, substantial portions of which are below sea level. In those cities, floodwaters do not naturally recede after a storm, exacerbating the potential for damage and disruption, as seen with Hurricane Katrina in New Orleans in 2005. Then, too, New York City's potential for flooding comes primarily from coastal waters, as opposed to the river flooding that cities such as London must address. For New York City, both temporary inundation from higher sea levels and damage from storm surges must be considered. The impacts of flooding and wave action may make sense to address separately or in combination, depending on circumstances.

Building resilience to coastal storms and flooding anticipated in the future does not lend itself to quick or simple solutions. Strategies that have historically been used to divide water from land will not make sense with climate change and sea level rise. To simply bulkhead the entire waterfront would not adequately address risks, would become increasingly costly, and would have negative ecological consequences for our waterways and coastal areas. To abandon dense coastal neighborhoods would have enormous costs as well. A balanced approach to increasing climate resilience will require case-by-case analysis, drawing on a toolkit of strategies that the public and private sectors can consider and apply to address vulnerabilities. In deciding among a range of practical alternatives, it will be important to consider the costs and benefits of each option, as well as opportunities to address multiple goals. Any strategy must recognize the ecological benefits of wetlands, shallows, and intertidal zones, along with other public priorities such as waterfront access and economic development.

Because certain risks are unavoidable, a resilience strategy should not seek to eliminate all risks. Instead, the city must identify and manage risks; take steps to minimize danger to lives and damage from flooding and storms; and limit disruptions from storm events and the recovery time after such events. Implementing a resilience strategy will require actions not only by government, utilities, and other public entities, but also by private property owners, businesses, and communities. In some instances, more restrictive government regulations may facilitate increased resilience, while in others regulatory or other impediments may need to be modified to allow citizens and government the latitude to implement adaptation strategies.

Building resilience will be an ongoing process extending beyond the time frame of *Vision 2020*. Nevertheless, it is important to take action today. Since the most pronounced impacts for New York City are not projected to begin until mid-century, there is an opportunity for planning, with periodic re-evaluation of risks and strategies as climate science evolves and provides greater clarity on changing conditions.

"Sea level rise is unequivocal. It's happening. The only question is by how much. Construction around the waterfront and bay has to allow for unpredictable change. We can't just build a big wall and forget about it."

—Guy Nordenson, structural engineer and principal, Guy Nordenson and Associates

IMPLICATIONS OF CLIMATE CHANGE

Climate change and rising sea level clearly have important ramifications for New York City, where there are nearly half a million people and almost 300,000 jobs within the Federal Emergency Management Agency (FEMA) 1- and 0.2-percent-annual-chance flood zones (see "Flood Risk in New York City," page 109). Climate change raises important considerations for all five functional categories of the waterfront identified in *Vision 2020*.

The Natural Waterfront

The specific effects of climate change on a particular natural shoreline are not easily identified. The shoreline is constantly subject to a range of forces and events, some induced by human activity and some not. For instance, erosion and siltation patterns vary throughout the harbor estuary. The rise in sea level and increased frequency and magnitude of coastal storms will likely cause more frequent coastal flooding and inundation of coastal wetlands as well as erosion of beaches, dunes, and bluffs. They may also result in accretion and siltation in other areas. Alterations in the landscape, along with increases in temperature and changes to precipitation patterns, will affect the many plant and animal species that inhabit New York's diverse coastal ecosystems.

The Public Waterfront

Today nearly half of the coastline is parkland or publicly accessible areas. In addition to providing valuable and productive habitat, these parks and public areas are treasured places for recreation and relaxation. Beaches and other naturalized shorelines provide access for surfing, swimming, kayaking, and other water sports. Waterfront greenways are hugely popular for recreation and transportation. All these spaces are valuable resources that enhance the city's livability and the health of its population.

Coastal storms and temporary or more frequent inundation of low-lying areas could result in damage to or loss of parks, esplanades, piers, plazas, beaches, boat launches, and other facilities. These events are expected to accelerate the erosion of unstabilized shorelines and the degradation of bulkheads (vertical retaining structures of timber, steel, or reinforced concrete, used for shore protection) and piers.

Riverside Park South on the Hudson River, Manhattan.

Approaches to Climate Change

There are two broad ways to address climate change. One is mitigation, which involves actions to limit further contributions to climate change. The continued growth of New York City itself is a mitigation strategy for climate change, enabling a large population to live in dense settlements in which per-capita carbon emissions are one-third of the national average. The City's mitigation efforts revolve around *PlaNYC* initiatives to achieve a 30 percent reduction in greenhouse-gas emissions by 2030.

The other general approach to climate change is adaptation, and it entails making preparations for the effects of climate change that are already inevitable. *Vision 2020* focuses on adaptation strategies for our waterfront and waterways to build climate resilience in response to existing and projected climate hazards.

The Redeveloping Waterfront

A substantial portion of the coast today is occupied by residential and commercial buildings that will be subject to the same risks from flooding and coastal storms as other waterfront uses are. Today several policies are used to manage these risks for new buildings, including flood insurance, zoning and building codes, and design of structural features such as ground floors raised above flood elevation. Existing buildings, though eligible for flood insurance, are of course generally more difficult to elevate or floodproof.

The Working Waterfront

Much of the city's critical infrastructure is located on the waterfront, including a wide range of transportation facilities—subway tunnels, rail yards, highways, streets, airports, heliports, bridges, vehicular tunnels, piers, and slips—as well as the power plants, sewer and wastewater treatment facilities, and waste transfer stations that keep the city running. Also on the waterfront are the city's marine cargo ports and maritime enterprises such as tugboat and barge operators, ship repair facilities, cruise terminals, and a variety of other industrial and commercial businesses. Flooding and storm surges pose potential risks of structural damage, interruption of services and operations, and property loss. Hazardous materials improperly stored in vulnerable areas could be subject to leakage, which could affect adjacent neighborhoods. Sea walls, bulkheads, and other shoreline structures are likely to experience more damage from additional wave action and sea level rise, requiring more frequent repairs and maintenance. The effects of climate change may pose navigational issues, too, such as accelerated silting of channels necessitating more frequent dredging. Higher temperatures will cause bridges to sag slightly more, and this, coupled with rising sea levels, will result in lowered bridge clearance for ships, with implications for port activity in the city and region.

The Blue Network

Rising sea levels and increased storm activity will likely bring stronger wave action and choppier waters within the Harbor, potentially leading to greater damage along the shoreline. Recreational boating, waterborne transportation, and other water activities will also be affected. These activities will experience changes in our waterways on a gradual but daily basis, and their facilities and operations may need to be adapted. Public education about the waterfront and waterways presents an opportunity to communicate more widely the importance of both mitigation and adaptation (see "Approaches to Climate Change," above).

RESILIENCE PLANNING CURRENTLY UNDER WAY

Steps are already being taken to improve New York City's climate resilience. These include emergency preparedness planning, efforts to improve data on climate risks, and the exploration of strategies to prepare for the effects of climate change.

Emergency Preparedness Planning

An important part of climate resilience is the ability to respond to and recover from adverse events. New York already orchestrates responses to weather-related events. Maintaining and improving the city's ability to bounce back from storms is crucial to building climate resilience.

The New York City Office of Emergency Management (OEM) maintains plans to deal with specific events. These plans include the *Citywide Debris Management Plan*, *Power Disruption Plan*, *Flash Flood Emergency Plan,* and *Coastal Storm Plan* (see Figure 1). These plans could be used to respond to events related to climate change. In 2009 OEM produced the City's first *Natural Hazard Mitigation Plan*, which is required by the Federal Emergency Management Agency for the city to be eligible for certain federal disaster mitigation funds.

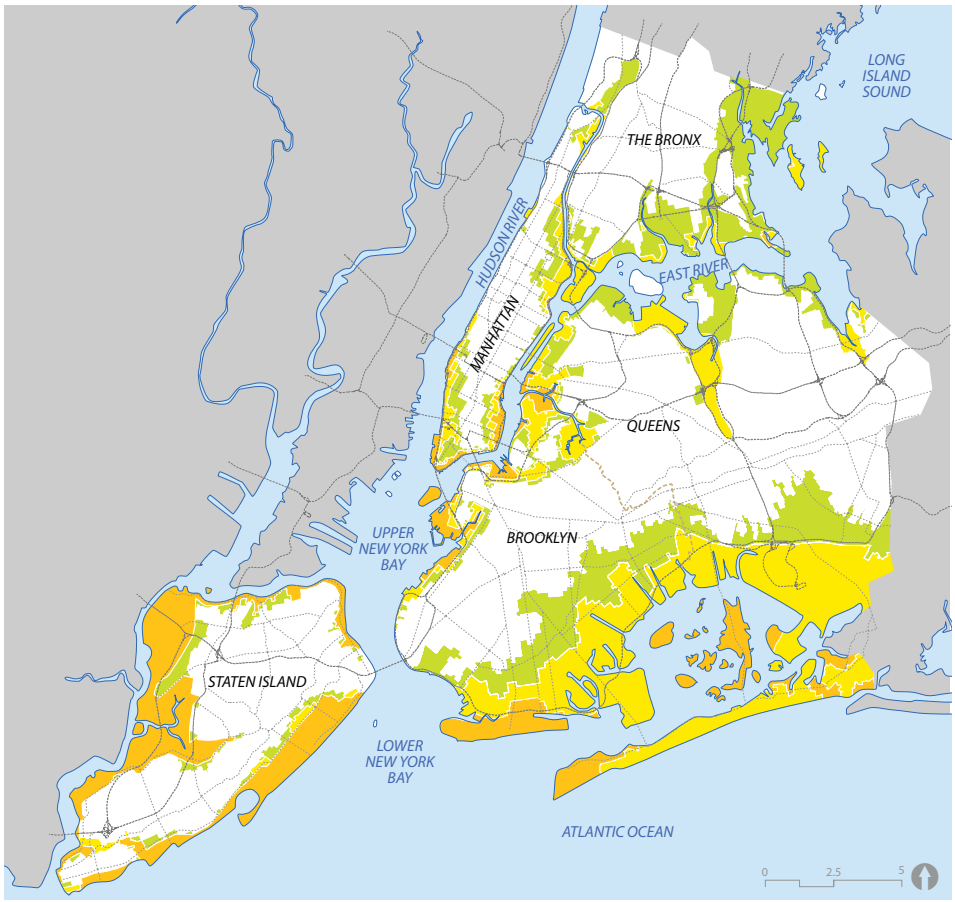
Communities can increase their resilience by building preparedness among local residents and institutions. One of OEM's roles is educating New Yorkers about preparing for emergencies. Its Ready New York community-outreach program educates city residents about hazards such as coastal storms and flooding, and encourages the public to prepare for emergencies.

Improving Data on Climate Risks

A number of coastal cities worldwide have initiated efforts to plan for long-term climate resilience, including London, Rotterdam, Sydney, and San Francisco. New York City is a pioneer in this emerging field. *PlaNYC*, released in 2007, recognized the importance of adapting to a changing climate, and contained a set of initiatives to begin the formulation of adaptation activities. As a critical first step, Mayor Bloomberg convened the New York City Panel on Climate Change (NPCC), a group comprised of scientists who study climate change and its impacts as well as legal, insurance, and risk-management experts. In 2009 the NPCC released *Climate Risk Information*, which outlined a set of climate-change projections for New York City and described potential risks to critical infrastructure. (These projections have been adopted by the State of New York in its planning activities for climate change and sea level rise.) In 2010 the NPCC issued *Climate Change Adaptation in New York City: Building a Risk Management Response,* which presented an iterative, risk-management approach to climate-resilience planning for both the public and private sectors that involves near-term actions and periodic re-evaluation of long-term risks and strategies.

Another *PlaNYC* initiative was to convene the New York City Climate Change Adaptation Task Force to assess the vulnerabilities of the city's critical infrastructure. The Task Force, consisting of city, state, federal, and private infrastructure operators and regulators, used NPCC's projections to identify more than 100 types of infrastructure that climate change could affect, including water, energy, transportation, and communications. The Task Force explored strategies to reduce risk and increase resilience.

Building resilience in coastal communities requires an understanding of which areas are likely to be vulnerable to flooding and storm surge. Until recently, the data available on the elevation of land and buildings in the coast was insufficient for making an accurate assessment, with a margin of error of several feet. The City has acquired more accurate LiDAR (light detection and ranging) elevation data, which will have a substantially smaller margin of error and make improved risk assessment possible.



NYC Office of Emergency Management

Figure 1: New York City Hurricane Evacuation Zones from the *Coastal Storm Plan*

Zone A: Encompasses all areas that will be inundated with storm surge in a Category 1 hurricane and all areas abutting the Atlantic coast, regardless of inundation. Faces the highest risk of life-threatening tidal inundation. The immediate beach areas in this zone are also vulnerable to destructive surf and coastal erosion.

Zone B: Encompasses all Category 2 inundation areas. These areas are at risk from damaging inland storm surge, but not from destructive surf.

Zone C: Encompasses all Category 3 and 4 inundation areas. These areas, though farthest from the pounding coastal surf, are still at risk.

STRATEGIES TO BUILD RESILIENCE

There are a variety of adaptation strategies that can be applied to build resilience, and these strategies can generally be divided into three general categories: retreat, accommodation, and protection. These categories are not mutually exclusive alternatives, but represent a range of possible solutions that can be applied where warranted. Potential strategies to build resilience include physical measures and policies at a variety of scales—for individual buildings, larger sites, and broader waterfront reaches—as well as other non-physical policies such as flood insurance.

NYC Office of Emergency Management

Post-storm flooding in Brooklyn.

Flood Risk in New York City

The Federal Emergency Management Agency (FEMA) establishes official geographical boundaries for areas that face different levels of flood risk. These boundaries, which are shown on FEMA's Flood Insurance Rate Maps, are used for administering the National Flood Insurance Program, and are also referenced in other regulations such as building codes. FEMA has designated the 1-percent-annual-chance flood zone, also known as the 1-in-100-year flood zone, as the area that has a 1 percent chance every year of experiencing a flood. In New York City, there are more than 215,000 people living within the FEMA 1-percent-annual-chance flood zone, and there are also more than 185,000 jobs. Farther inland, in the 0.2-percent-annual-chance flood zone, also known as the 1-in-500-year flood zone, the area where FEMA deems there to be a 0.2 percent chance each year of a flood, there are more than 475,000 people and more than 290,000 jobs.

Retreat

Retreat is the practice of prohibiting, restricting, and/or removing development in or from the most vulnerable coastal areas to minimize hazards and environmental impacts. Retreat strategies include rolling easements, land purchases, and setback requirements. These strategies can reduce harm to ecosystems and provide a margin of safety by keeping homes and businesses from areas susceptible to flooding. However, such measures can have dramatic effects on property owners and communities, and have been explored mostly as a potential adaptive strategy for undeveloped areas, areas of low-density development, or open uses such as farming or habitat conservation. Retreat has also been adopted following severely damaging floods. It has never, however, been applied preemptively in an area as densely developed as New York City.

Retreat may be a viable strategy in less-developed portions of New York, such as in natural areas or open spaces, where it is compatible with other goals. For instance, it may be possible to allow wetlands to migrate inland in important natural areas to maintain species habitat and moderate the impact of storm surges.

However, it is unlikely that retreat from previously developed areas would be practical. In New York City, retreat from the shoreline, considered as a broad strategy, would not only be expensive to implement, but it would also have a wide range of other costs: It could displace residents and neighborhood institutions, disrupt transportation and business activity, and impede the city's achievement of its *PlaNYC* goals for sustainable, dense development to accommodate a growing population. The city's vast infrastructure—including transit and sewer systems—cannot be moved to higher ground. Waterfront land that is not built out but is used for public open space also serves an important role in supporting New York City's population.

Accommodation

A variety of actions can be employed to minimize damage from flooding and storm surges without completely shielding a facility or site. One example is requiring floodproofing for portions of buildings located below projected flood elevation in flood-prone areas. The lower levels of buildings can be designed to withstand controlled flooding, using breakaway walls, waterproof materials and sealants, or vents to allow floodwaters to advance and recede without causing structural damage. Buildings or other facilities can be designed with critical systems and equipment elevated above the projected flood level.

Existing building-code regulations, consistent with federal standards, require the floodproofing of all buildings located within the Federal Emergency Management Agency (FEMA) 1-percent-annual-chance flood zone. This entails measures such as raising habitable spaces and critical building systems above the FEMA base flood elevation. FEMA's National Flood Insurance Program encourages additional measures for safety by allowing substantial discounts to flood insurance premiums for buildings that exceed floodproofing standards by one or two feet in elevation, called "freeboard." However, zoning height limits are typically measured from the FEMA base flood elevation, which can discourage or prevent an owner from adding freeboard. Elevation is a solution most easily applied to new buildings; its application to existing buildings can be complicated and expensive. Because floodproof construction can limit active uses at street level, the freeboard elevation of buildings requires special attention to the quality of the streetscape.

Accommodation measures can go beyond individual buildings to the scale of a site. It is possible to configure streets and open spaces

to accommodate controlled flooding, designing such areas with salt water-tolerant plant species and elevated structures that can survive temporary inundation.

Although floodproofing and other accommodation measures can add costs to construction or rehabilitation of buildings and sites, they generally require less initial investment than flood barriers or levees, and carry less risk of potential large-scale failure. They can be implemented on a smaller scale, by private or public entities, and in an incremental manner. However, because of the many parties that may be involved, sites within a given area may have different levels of protection.

Protection

Protection strategies involve the deployment of structures that protect a building or the shoreline from erosion, prevent flooding and inundation, or reduce wave and tidal action. These strategies often are applied at the building or site scale, though they could also be used to protect an entire neighborhood or reach. Examples include:

- **Retractable water-tight gates or barriers** to protect windows or other building openings can be employed to shield a single structure.
- **Seawalls, bulkheads, or revetments** are essentially walls that are commonly built at the edge of an individual parcel of land as shoreline infrastructure. The maintenance of these types of structures is already a continuous process requiring funding and periodic issuance of permits for maintenance or repair work. In the future, these needs will likely grow. Increased wear and tear on waterfront infrastructure will require more frequent maintenance and replacement of bulkheads, seawalls, and stabilized shorelines. These "hard" bulkheaded edges result in scouring of the channel in front of the wall and limit potential for habitat near the shoreline.
- **"Soft edges,"** or graduated edges, can be created where possible. The benefits of soft edges include the reduction of speed and force of tidal action and waves, thereby limiting erosion and damage; accommodation of shifting water levels; reduced long-term maintenance costs; and increased intertidal zone (the area that is sometimes underwater, depending on tides), which can provide enhanced habitat.
- **Raising the elevation of land** can restore eroded beaches, and the establishment of dunes can prevent the recurrence of beach erosion. Elevating low-lying development sites and streets through the addition of fill can reduce their vulnerability.
- **Dikes and levees** are raised embankments designed to prevent flooding, and **floodgates or storm-surge barriers** are gates used to restrict the flow of waves and floodwaters. These structures can provide substantial protection from floodwaters for a larger area but also bear a range of costs, can alter ecological functions, and still may be overtopped by a flood or storm surge exceeding their designed capacity.
- **Breakwaters, groins, and jetties** are structures located off shore or extending outward from the shore that are intended not to wall out floodwaters but to reduce the impact of waves, limiting erosion and potential damage. While they can disrupt tidal patterns, they can also provide habitat.
- **Restored or constructed wetlands, beaches, barrier islands, and reefs** can function as dynamic storm barriers that both protect and serve ecological functions.

"Soft edges" deployed at Brooklyn Bridge Park are part of the site's stormwater management system. The constructed wetland also dissipates wakes and provides habitat.

Other Resilience Considerations

While not an adaptation mechanism in and of itself, insurance is a tool for managing risk and encouraging strategies of retreat, accommodation, or protection where appropriate. When informed by accurate information on risk, insurance can make riskier developments more costly and less risky developments comparatively less expensive. For example, reduced premiums are available through the National Flood Insurance Program for buildings that incorporate freeboard.

Current FEMA flood maps do not necessarily reflect current flood risks, however, and can be updated based on newly available high-resolution elevation data. In addition, sea-level-rise projections indicate that in the future a broader geography will be subject to coastal flooding. Representatives of the insurance industry participated as members of the New York City Panel on Climate Change and should continue to be engaged in future efforts to align industry practices with climate-resilience goals.

Climate risks do not, of course, end at New York City's borders. Other coastal communities in the region face similar challenges. In addition, some adaptation strategies for New York City, particularly those that affect waterways or entire reaches of the shoreline, may raise regional issues that require coordination with other jurisdictions. Communicating and sharing knowledge with other governments in the region, including through partnerships like the New York-Connecticut Sustainable Communities Consortium (recipient of a grant from the U.S. Department of Housing and Urban Development), can facilitate resilience planning throughout the region.

Architecture Research Office

Rendering from *On the Water: Palisade Bay* of potential storm surge barrier islands in Upper New York Harbor.

Research and Innovation

The challenges of climate change lead us to re-examine traditional approaches to coastal management and to seek new, creative solutions to supplement the range of available adaptation strategies. The *On The Water: Palisade Bay* project by Guy Nordenson, Catherine Seavitt, and Adam Yarinsky, which considered potential interventions to attenuate storm surge in Upper New York Harbor, was an important step in exploring alternative approaches. The subsequent "Rising Currents: Projects for New York's Waterfront" exhibition at the Museum of Modern Art further illustrated potential strategies.

Clearly, more information will be needed. This includes the creation of a comprehensive inventory of adaptation strategies—including innovative strategies—with possible applicability to New York City. It will be important to establish partnerships among practitioners of many disciplines—including planning, engineering, design, marine biology, and ecology—to develop and test new coastal interventions that have the potential to promote a safe city and sound ecology within a changing environment. Studies that provide information on the benefits and drawbacks of emerging strategies will be helpful as part of this effort. Pilot projects that gather empirical data on the effectiveness and ecological value of alternative strategies will also be valuable.

Integrating Resilience into Planning

Everyone from government to homeowners to insurance companies will need to consider the implications of climate change and sea level rise and make decisions about resilience strategies. It will be important to integrate resilience considerations into planning on a continuing basis. This will provide opportunities for ongoing adaptation. For instance, much of the city's waterfront infrastructure—such as bulkheads, docks, roads, and bridges—will need to be rebuilt or renovated as a matter of course before the most pronounced effects of sea level rise are expected to be felt. Incorporating consideration of climate-change projections into the design specifications for such structures and into long-term capital plans will ensure that flood risks and sea level rise are taken into account when new facilities are built, and existing ones upgraded.

Whether it's piloting inventive solutions or simply replacing existing bulkheads, the maintenance and improvement of the waterfront will require a predictable process for the review and issuance of permits for in-water construction (for further discussion see section of *Vision 2020* on government oversight, beginning on page 96). Establishing guidelines and standards for the design of waterfront infrastructure can facilitate the protection of development areas while minimizing ecological damage and maximizing ecological benefits.

EVALUATION OF STRATEGIES

With a waterfront as big and as diverse as New York's, there can be no one-size-fits-all solution for climate change. It is important to identify a range of potential strategies to increase the city's resilience. In very limited, less-developed portions of the city, controlled retreat from coastal land may be an option; in others, accommodation strategies may be sufficient; and in yet others, enhanced protection of shorelines will be necessary. In all these cases, decisions about shoreline management must consider the full range of costs and benefits and take into account both ecological and economic development goals. Opportunities to leverage other resources or provide co-benefits—such as augmenting a berm alongside a highway that could also serve as a levee—should be considered.

Evaluating these strategies is challenging. There is inherent unpredictability in storm events and the risks they present, as well as some uncertainty in climate projections. In addition, it is difficult to predict future changes that may result from storm events, or from erosion and accretion of shorelines, or the secondary effects of such changes. There are also many unknowns about the possible effects of many of the strategies mentioned above. In the future, scientific modeling, empirical research, and pilot projects can yield better information. Improved scientific understanding will be important in the evaluation of potential adaptive strategies.

There are, however, actions that can be explored now to build resilience. These include allowances and potential requirements for more stringent flood protection of buildings in flood-vulnerable areas; updating FEMA flood maps to accurately reflect current topography; the periodic updating of emergency-response plans; improvements to the coastal permitting processes necessary to undertake adaptation; and public education about climate-related risks and opportunities to address them.

Measures to increase the city's resilience must consider a number of goals, including economic development, public access, and ecological health. Strategies should be promoted that produce co-benefits or advance other desirable ends. Building resilience can be an impetus for transforming the waterfront in ways that can make the city not only more climate-resilient, but also more healthy, prosperous, and livable.

Increase Climate Resilience: Strategies and Projects

Though the most severe effects of climate change are not expected to be felt by 2020, this plan considers steps to take within the next 10 years to prepare for rising sea levels and more intense storm activity associated with climate change.

Building on efforts already under way, the City will pursue the following set of strategies to develop a better understanding of future risks and identify means to reduce these risks. The City will work with communities, scientists, and policymakers to further research into physical risk-reduction measures and evaluate the effectiveness of these measures to increase New York's resilience. In addition, the City will continue to examine regulations and programs currently in place to reduce flood damage—such as the building code, insurance, and emergency preparedness planning—and explore how to strengthen these tools to meet future climate risks. The City will also continue to engage communities in resilience planning, furthering local efforts by providing information and education.

Vision 2020's 10-year strategies are complemented by the *New York City Waterfront Action Agenda*, a set of projects chosen for their ability to catalyze investment in waterfront enhancement. The City commits to initiating these projects over the next three years and will be tracking progress on an ongoing basis. For each project, the lead agency and implementation year are noted.

Together, these strategies and projects lay out a comprehensive vision for the waterfront and waterways and a plan of action to achieve that vision.

1. Conduct a citywide strategic planning process for climate resilience.

VISION 2020 STRATEGIES

- This process would include outreach to a range of stakeholders; highlight efforts to assess the risks, costs, and potential solutions for building climate resilience; and outline an ongoing, dynamic, risk-based planning process that can take advantage of new information and projections as they become available.

ACTION AGENDA PROJECTS

- Establish a strategic planning process for climate resilience by updating *PlaNYC*. (Mayor's Office, 2011)

2. Develop a better understanding of the city's vulnerability to flooding and storm surge and examine a range of physical strategies to increase the city's resilience.

VISION 2020 STRATEGIES

- Identify resources to promote scientific research and micro- and macro-scale modeling of flood and storm surge risks and potential interventions to inform decisions about coastal management.
- Promote pilot projects to test potential strategies and evaluate their effectiveness in providing coastal protection as well as their beneficial and detrimental effects on aquatic life.
- Create an inventory of adaptation strategies with potential applicability for New York City and evaluate strategies based on a full range of costs and benefits. Options to be considered include the potential strategies identified in this plan as well as additional innovative strategies to be identified through engagement with practitioners.

ACTION AGENDA PROJECTS

- Study best practices for increasing climate resilience to flooding and storm surge. (DCP, 2012)

3. Explore regulatory and policy changes to improve resilience of new and existing buildings to coastal flooding and storm surges.

VISION 2020 STRATEGIES

- Consider changes to the Zoning Resolution to remove disincentives to enhanced flood protection of buildings through freeboard.
- Consider modifications to construction codes to require freeboard for a wider range of buildings.
- Incorporate consideration of projections for climate change and sea level rise into the design standards for infrastructure in waterfront areas.

ACTION AGENDA PROJECTS

- Study urban design implications of enhanced flood protection, and explore zoning and building code changes to promote freeboard. (DCP, 2012)

4. Work with the Federal Emergency Management Agency (FEMA) and the insurance industry to encourage the consideration of more accurate data on current and future risks of flooding and storm surges.

VISION 2020 STRATEGIES

- Explore measures to promote flood protection in areas that may become subject to flooding based on climate projections.

ACTION AGENDA PROJECTS

- Partner with FEMA to update FEMA Flood Insurance Rate Maps to more accurately reflect current flood risks. (Mayor's Office, 2012)

5. Assist with local resiliency planning.

VISION 2020 STRATEGIES

- Provide training to residents in emergency preparedness and response in order to further community engagement.
- Educate residents and businesses about property protection, infrastructure technology, and public/private partnerships.

ACTION AGENDA PROJECTS

- Support coastal communities' efforts to undertake local resilience planning, and improve the dissemination of publicly-available data on the locations of hazardous material storage. (Mayor's Office, 2012)

6. Integrate climate change projections into NYC's emergency planning and preparedness efforts.

VISION 2020 STRATEGIES

- Work with appropriate city, state, federal agencies and stakeholders to incorporate the potential effects of climate change into NYC's *Natural Hazard Mitigation Plan*.
- Analyze future flood and storm surge risks for NYC's *Coastal Storm Plan*.
- Assess how climate change and sea-level rise models may affect critical facilities.

ACTION AGENDA PROJECTS

- Revise NYC's *Natural Hazard Mitigation Plan* to reflect new information—for instance, updated Sea, Lake and Overland Surges from Hurricanes (SLOSH) data—as well as regulatory and policy changes. (OEM, 2013+)
- Revise NYC Coastal Storm Evacuation Zone maps based on updated SLOSH data to identify vulnerable populations. (OEM, 2013)