Chapter 5

Strategies and Actions

Disaster Preparedness and Planning Project Vision:

Baltimore will be a city whose daily activities reflect a commitment shared by government, business, and citizens to reduce or eliminate impacts from current and future natural hazards.

Disaster Preparedness and Planning Project Goals:

GOAL 1: Protect the health, safety and welfare of Baltimore City residents and visitors

GOAL 2: Prevent damage to structures, infrastructure, and critical facilities

GOAL 3: Build resilience and disaster prevention and planning into all programs, policies, and infrastructure (public and private)

GOAL 4: Enhance the City of Baltimore's adaptive capacity and build institutional structures that can cope with future conditions that are beyond past experience

GOAL 5: Promote hazard mitigation and climate adaptation awareness and education throughout the City of Baltimore

GOAL 6: Become a Community Rating System (CRS) classified community

Current Climate Initiatives

Recognizing the potential risks associated with projected changes in climate, the City of Baltimore has already begun to establish initiatives to reduce our impact on the environment and increase resiliency to hazardous events. Many of these programs are reviewed in Baltimore's Sustainability Plan and its subsequent Annual Reports, and include efforts to increase natural features within the City, improve self-sufficiency, increase efficiency, and reduce greenhouse gas (GHG) emissions. Some key programs are highlighted below.

- Stormwater Utility and Clean Water Baltimore Program: The City of Baltimore, as mandated by the State of Maryland in April 2012, must raise funds to support a comprehensive stormwater management program. Stormwater remediation projects will reduce the impacts of flooding hazards.

- Urban Tree Canopy Initiatives: With a number of forestry and "green" organizations and agencies, Baltimore is pursuing its goal of increasing the Urban Tree Canopy to 40% by 2037. DP3 recognizes the potential for trees and other natural features to mitigate damage from hazard events.

Tree Baltimore Campaign

- Baltimore Food Policy Initiative: The Baltimore Food Policy Initiative (BFPI) is an inter-governmental collaboration aimed to increase access to healthy and affordable foods in Baltimore's food deserts. Ensuring adequate supply of healthy food will reduce negative health impacts during hazard events.

- Green Building Standards: Baltimore Green Building Standards for commercial and multi-family buildings over 10,000 square feet aims to increase the efficiency and reduce the environmental impact of all new or extensively modified structures. Many of the DP3 actions below recommend enhancing or incorporating these standards into disaster planning efforts.

- Climate Action Plan: Baltimore's Climate Action Plan (CAP) was established to reduce Baltimore's greenhouse gas (GHG) emissions through a range of strategies targeted at reducing the amount of fossil fuel needed for everyday living. Its recommendations are critical steps to preventing additional climate impacts.

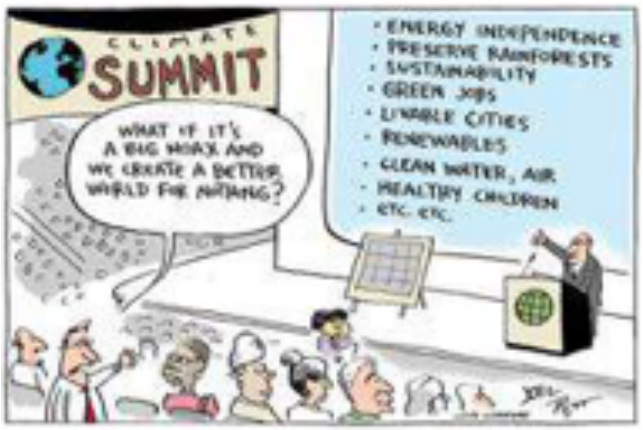
- Growing Green Initiative: The Growing Green Initiative (GGi) is an effort to promote the transformation of vacant land into green spaces that will provide economic, social, and environmental benefits to our neighborhoods. Growing Green is an umbrella for all of the "Grow Baltimore" greening efforts that address the re-use of vacant land, including Vacants to Value, Homegrown Baltimore, Clean Water Baltimore, and Power in Dirt. GGi provides a strategic approach for both short-term and long-term reuse of vacant land that combines blight elimination, tree planting, urban agriculture, and stormwater management to help mitigate the negative impacts of vacant properties and set the stage for future redevelopment opportunities.

- Energy Office: The Baltimore Energy Division strives to increase the energy efficiency, comfort, safety, healthy and durability of buildings throughout the City by upgrading and retrofitting them.

While this list is by no means exhaustive, it is indeed illustrative of some of the key efforts underway in Baltimore. Additionally, many of these initiatives and programs will be incorporated in the actions described in this chapter.

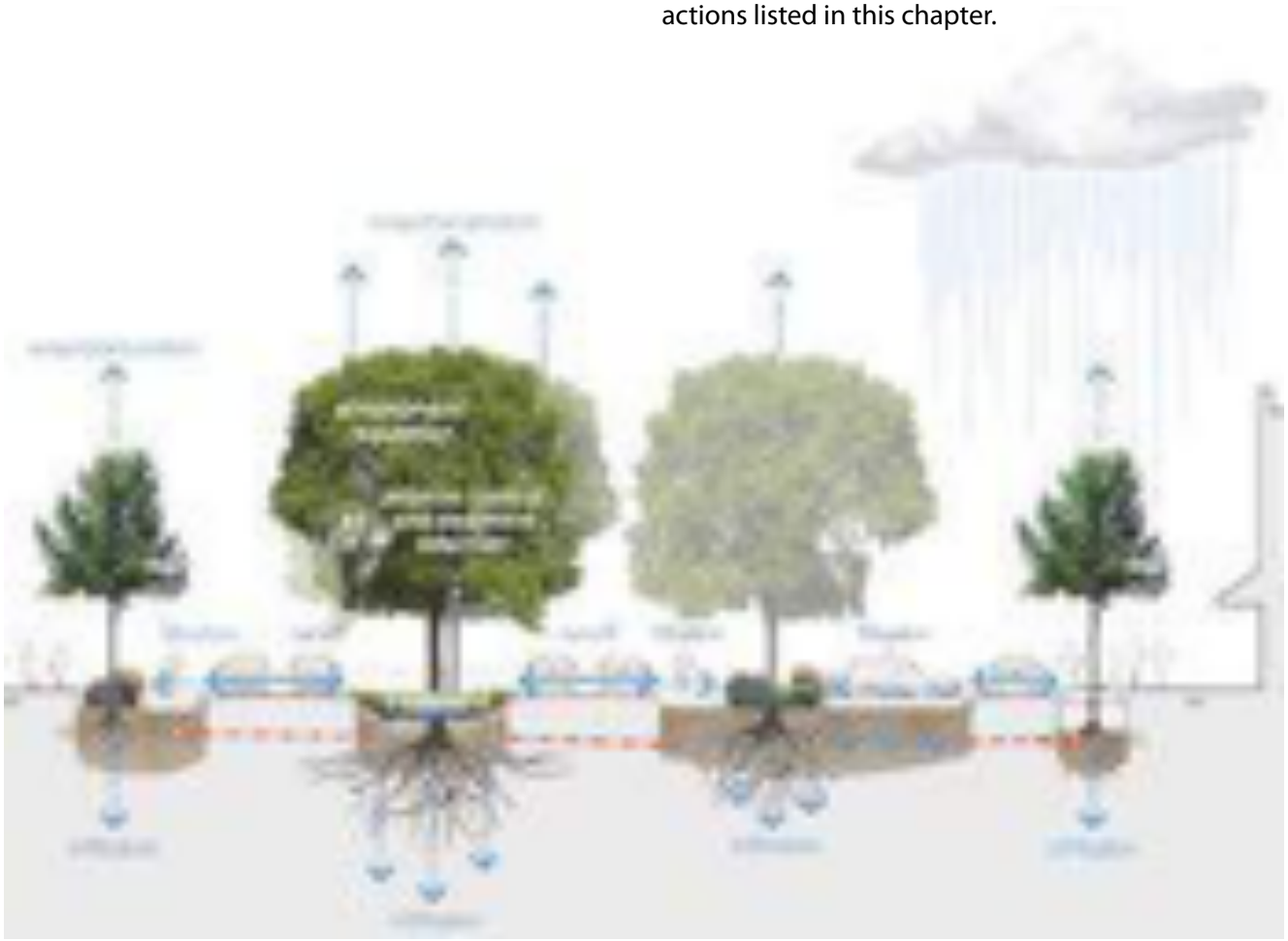
No Regret Actions

While there is significant evidence of a changing climate and the potential to reduce those changes through human activities, many continue to debate climate change. The image right, by cartoonist Joel Pett, makes a valid statement. The cartoon depicts a scene from a hypothetical climate summit where a speaker appears to be demonstrating the added benefits of reducing our impact on the climate, to which one audience member stands up and questions, "What if it's a big hoax and we create a better world for nothing?"



Would that really be so terrible? "No Regrets" actions are actions that will provide benefit and cause no harm regardless of whether or not climate change happens. The "No Regrets" approach to decision-making is a strong precautionary approach to prevent risk to health, safety, and the environment. It is important to prioritize these actions as they focus on enhancing, strengthening, and protecting Baltimore's residents and assets; either way, the City of Baltimore will benefit.

For example, fixing leaking water pipes and maintaining drainage channels are two very smart and cost-effective investments that will benefit the City even in the absence of climate change. Climate-proofing new buildings increases toughness and can save energy, both of which are smart "No Regret" actions. The City will evaluate financial, technological, informational, and legal constraints as part of implementation of all the strategies and actions listed in this chapter.



Low Impact Development Cross-Section

Source: LID Design Manual

Low Impact Development Cross-Section

Source: LID Design Manual

Urban Sectors

The strategies put forth in this plan are grouped according to corresponding urban sectors—infrastructure, buildings, natural systems, and public services. In the hazard mitigation and adaptation process, each sector plays an important role as they are understood to be significantly impacted by the consequences of hazard events and a changing climate. While impacts may vary, most urban systems are vulnerable to more than one hazard. Sorting the action plan by sector, rather than by individual hazard, allows for strategies to address multiple vulnerabilities simultaneously.

Furthermore, the DP3 plan is expected to be reviewed by a diverse range of agencies, businesses, industries, or other individuals. Depending on the viewer, one sector may be more relevant than another. For example, the owner of a gas station will be more concerned with the infrastructure section, and will be interested to learn how infrastructure systems are most vulnerable, as well as what can be done to increase the resiliency of their property. The sector organization recognizes the far-reaching scope of this plan and presents a more readily understandable and flexible framework. In this way, the DP3 plan becomes a resource and reference tool.

One of the most pressing challenges facing states and municipalities today is the quality and capacity of built public infrastructure—the water systems distribution and treatment, schools and municipal buildings, transit systems, and other core assets upon which we all depend. The links between well-functioning infrastructure and economic growth are well documented. Inadequate or failing public infrastructure disproportionately hurts low-income people. As we saw in New Orleans after Hurricane Katrina, and in New York and New Jersey after Superstorm Sandy, low-income communities are often located in the flood-prone sections of cities, resulting in prolonged health issues associated with mold and moisture after flooding. The 1995 Chicago heat wave resulted in 750 deaths, most of which were elderly low-income residents who could not afford air-conditioning were afraid to open windows for fear of crime. However, as NOAA has stated, "heat is the number one weather-related killer in the United States." In fact, NOAA's National Weather Service statistical data revealed "heat causes more fatalities per year than floods, lightning, tornadoes, and hurricanes combined."[1] In New York City, when public transportation failed, transit-dependent low-income residents could not get to work and, because they were not salaried, could not earn wages to support their families. In Baltimore, many residents might face the same risks if the City does not sustain a system of efficient, reliable infrastructure.

Baltimore City

Climate change should be a key consideration in the development and maintenance of existing or future infrastructure. Already, infrastructure in Baltimore has been proven vulnerable to unpredictable, extreme weather events. Extreme heat, for instance, leads to the buckling of roads, melting asphalt, and warped railroad tracks. In July 2012, a heat wave led to train tracks and pavement buckling in the Baltimore region and a US Airways jet stuck in melted pavement at Baltimore Airport.[2] Additionally, heat, accompanied with the concentrated use of air conditioning, may overheat and overwhelm electrical supplies, leading to a significant power outage. In a hazard event, this increased electric cooling demand may be combined with reduced energy supply reliability, which can result in rolling brown-outs or black-outs. Similarly, a flooding event could submerge underground power generators, rendering them useless. Other hazards may contribute to inoperative public transportation, severed utility or communication lines, overflowing sewer systems and the inundation of waste management facilities, and much more. Additionally, extreme events threaten linkage infrastructures such as bridges, roads, pipelines, and transmission networks. Different forms of infrastructure are vulnerable to climate change in distinct ways and to varying degrees, depending on their state of development, resilience, and adaptability. Furthermore, infrastructure may face an immediate physical impact, or the damage may be more indirect.

Baltimore's existing infrastructure was built for the City's past conditions. However, current weather is already presenting a challenge, and a changing climate will increase the City's infrastructure vulnerabilities. Climate change could have significant implications for infrastructure. While infrastructural elements are sensitive to the climate existing at the time of their construction, due to their generally long operational lifetimes, infrastructural elements are also sensitive to climate variations over the decades of their use. For example, a substantial proportion of infrastructure built in the next five years, will still be in use long after 2030. Therefore, increasing infrastructure's resilience to the impacts of climate change is a top priority.

To increase the resilience of both new and existing infrastructure, we must be prepared to mitigate and adapt to the impacts of climate change. Preparing infrastructure for these changes will not only minimize Baltimore's risk and vulnerability, it will also maximize potential opportunities. Baltimore's infrastructure, which is an interconnected network of highly valuable assets, enables the City to grow and prosper. By proactively mitigating and adapting to climate change, Baltimore will advance its goals of reducing carbon emissions and becoming a sustainable city. This, in turn, will enhance the City's overall competitiveness, increase its resilience, and open the door to robust social, economic, and environmental growth. The proposed strategies which relate to this sector will help Baltimore establish an infrastructure network that is able to endure or adapt to the impacts of climate change.

Source: Ken Stanek

Buildings

Baltimore's buildings, some of which have been significant features in their communities for decades or even centuries, add vibrant charm to the City. Baltimore City has an extensive and diverse collection of buildings. These structures are homes, cultural institutions, offices, schools and universities, historic landmarks, critical facilities, community establishments, and places of worship.

In the past, Baltimore's building stock has been subject to weather-related risks. In particular, flooding associated with extreme precipitation events has caused a great deal of damage (for a description of historical occurrences, see the Flooding Hazard Profile). During extreme events, buildings may be destroyed —entirely or in part — or rendered unstable due to the impacts from storm surges and flooding waters. A changing climate is likely to intensify this impact. For instance, storm surge, when combined with projected sea level rise, will pose a greater threat to Baltimore's existing coastal building stock. Additional hazards, including earthquakes, may further weaken a building's structural integrity.

Resilience of Baltimore's building stock is particularly important considering that many structures serve as refuge for City residents during severe storms and other extreme weather events. Similarly, critical emergency facilities — hospitals, fire stations, police stations, government buildings, and the like — perform essential functions during these events and increase the City's capacity to respond to, and alleviate, the impacts of a hazard. The strategies within this plan aim to protect buildings from current and future climate risks by increasing their resiliency. Additionally, the recommended actions intended to mitigate climate change impacts from buildings — which, alongside the energy needed to operate them, produce considerably high greenhouse gas emissions — by improving energy and resource conservation.

Baltimore City Rowhouses

Source: ApartmentTherapy.com

Natural Systems

Although natural systems will indeed suffer adverse consequences as a result of climate change (and environmental health should therefore be given particular attention), this plan embraces nature for its potential as a hazard mitigation and climate adaptation tool. In many cases, natural features are capable of offsetting greenhouse gases, as well as alleviating the severity of weather events, effectively reducing long-term risks from climate change and hazards. On the other hand, if not properly maintained, natural elements such as trees and streams may themselves become a danger during an extreme weather event.

As Baltimore attempts to reduce greenhouse gas emissions and curb the effects of climate change on the City, natural systems are increasingly seen as a mitigation strategy. Trees and vegetation are valuable for their ability to absorb carbon dioxide and transform it into oxygen. This process, known as carbon sequestration, reduces greenhouse gases in our atmosphere and mitigates the extent of changes in our climate future. At the same time, this process reduces the probability of respiratory health problems during days with extreme heat. Additionally, the same trees can help to cool the City (and its water habitats), reducing the impact of the urban heat island effect.

Although trees and natural systems provide extensive benefits in an urban setting, it is important to recognize that these same systems could become a risk during a hazard event if not properly maintained. In heavy winds, trees may lose limbs or be uprooted entirely. Alternatively, a warming climate may welcome new pests or invasive species which may devastate native species of the local ecosystem. Likewise, streams without a natural buffer can become dangerous channels of flooding water during heavy precipitation events. Proper maintenance of Baltimore's natural systems will be necessary to ensure that benefits are maximized while risks are reduced. Planting dense vegetation along riparian corridors, for instance, creates a buffer from intensely flowing waters during flood events.

In addition to protecting the health and safety of Baltimore's residents, natural elements, should also be maintained for their own health. Without a strong and robust urban forest, we cannot expect to receive the same invaluable air quality improvement services. In addition to a loss of ecosystem services, the damage or destruction of trees is accompanied by other challenging consequences, including removal and replacement costs, and the considerable amount of time needed for a replacement tree to reach their full potential and value. According to the US Forest Service, a mature tree with a trunk 10 times larger than a small tree produces 60-70 times the amount ecological services.[3]

Recognizing the potential of a changing climate, Baltimore must ensure that tree and plant species will be capable of tolerating both current and future climate conditions. Priority should be given to species with high adaptive capacity, and which are therefore more likely to survive temperature increases in the future. The National Wildlife Federation recommends using a set of questions, first developed by Chicago, to guide tree and plant selections.4 Additionally, trees must be cared for and maintained. Baltimore City Forestry requires two full years of maintenance for all newly planted trees. Young tree maintenance includes mulching, watering, weeding, straightening, removing stakes, and removing root sprouts. Recently, the Forestry division improved their guidelines for tree planting and maintenance in order to promote a consistent process to nurture young trees throughout Baltimore. These actions help increase the survival rates of young trees, ensuring healthy development of Baltimore's entire urban tree canopy.

Lastly, urban biodiversity contributes to the health of the entire ecosystem. In a regional study, conducted at the University of Delaware, native and alien plant species of the Mid-Atlantic region were evaluated for their ability to support insect biodiversity. The results (the database is available for download online) can be used to determine which plants should be encouraged and which should be avoided.5

The strategies proposed in this plan aim to identify how and where nature may be managed to the City's benefit, and what actions must be taken to eliminate all avoidable risks associated with neglected natural systems.

Public Services

A major role of this plan is to expand Baltimore's preparedness for future hazards. Without a strategy for conveying information about the risks and vulnerabilities associated with these hazards, its message will fall on deaf ears. Therefore, strategies relating to public health and human services are concerned with distributing information, building resources, improving communication, and establishing response plans.

Efforts that will have the greatest capacity to mitigate climate change are often prompted by modifications to the other sectors listed above. However, without interest from the general population, or an understanding that will spark that interest, those changes are unlikely to occur. For this reason, Baltimore must encourage behavioral and other changes that will reduce greenhouse gas generation. At the same time, the City must pursue education and outreach efforts that will raise hazard awareness among residents, business owners, employees, institutions, and others. Furthermore, hazard mitigation efforts should be incorporated into all future planning documents, and across all City agencies.

Additionally, strategies should be in place that will prevent or limit health risks — including disease outbreak, physical exhaustion, and respiratory conditions, to name a few — that are triggered by extreme events. Furthermore, it will be necessary that the City build its emergency preparedness. This will require, for example, coordination between local government, NGOs, and private entities which shall establish procedures that will be employed during hazard events. Community involvement today will ensure that all of Baltimore's population is prepared, well-informed about the risks and procedures, and able to safely respond to early warnings.

Baltimore City Energy Challenge

After reviewing risks and vulnerabilities associated with natural hazards in Baltimore, the DP3 process developed a comprehensive list of strategies and actions in order to ensure the City's ability to adapt and mitigate the potential impacts. The following section includes sets of strategies for each sector. Individual actions associated with each strategy are included, as is information regarding intent, benefit, and stakeholders, as well as some additional details. Some actions are followed by the italicized letters O, S, M, or L in parentheses. These indicate the possible timeframe (ongoing, short, medium, long), which will be discussed further in Chapter 6 . Finally, the list below defines acronyms for the agencies and organizations noted as possible stakeholders.

BCFD Baltimore City Fire Department

BCHD Baltimore City Health Department

BCPD Baltimore City Police Department

BCPSS Baltimore City Public School System

BCRP Baltimore City Department of Recreation and Parks

BDC Baltimore Development Corporation

BDW Baltimore Development Workgroup

BGE Baltimore Gas and Electric

BOS Baltimore Office of Sustainability

CHAP Commission for Historic and Architectural Preservation

CoS Commission on Sustainability

CRS Community Rating System

CSX CSX Corporation

DES Department of Environmental Services

DGS Department of General Services

DHCD Department of Housing and Community Development

DHMH Maryland Department of Health and Mental Hygiene

DOP Department of Planning

DOT Department of Transportation

DPH Department of Public Health

DPW Department of Public Works

FEMA Federal Emergency Management Agency

FHWA Federal Highway Administration

MCC Maryland Conservation Corps

MDE Maryland Department of the Environment

MDH2E Maryland Hospitals for a Healthy Environment

MDNR Maryland Department of Natural Resources

MDTA Maryland Transportation Authority

MEMA Maryland Emergency Management Agency

MOEM Mayor's Office of Emergency Management

MON Mayor's Office of Neighborhoods

MOIT Mayor's Office of Information Technology

MTA Maryland Transit Administration

NAHB National Association of Home Builders

NFIP National Flood Insurance Program

NGO Non-governmental Organization

PSC Public Service Commission

SHA Maryland State Highway Administration

USACE U.S. Army Corps of Engineers

Hazard Mitigation and Climate Adaptation Strategies & Actions

The Strategies and Actions found in Chapter 5 define the programs, policies, and projects that the city will undertake to accomplish its resiliency goals.

STRUCTURE

Strategies are divided into sectors and sub-sectors throughout Chapter 5. Sectors are divided into four colors: aqua (infrastructure), orange (buildings), green (natural systems), and purple (public services). Sub-sectors are indicated in bold at the top of the page.

Strategy Name
The first two letters refer to the Sector Area (IN, BL, NS or PS) and the number refers to the order of the strategy.

Strategy Description
The description of measures provides important background information describing the city's current activities to put the measure in context, some rationale and policy direction. Additionally, some descriptions provide detailed guidance that will be used in program implementation.

Actions
Actions identify specific steps that the city can take to implement each measure.

Action Description
The background of each action and reason for the action are described in more detail below the action headers.

Implementation Guidelines Table
The tables identify responsible departments for each action (See left for the acronym table that defines the department acronyms), stakeholders, the alignment of the strategy with the DP3 goals, and connections .

Time Frame Symbol

- Short-term (1-2 years) — Measures that can help jump-start DP3 implementation within the first 1-3 years.
- Mid-term (3-5 years) — Measures that may be best for implementing within the first 3-5 years following kick-off of the DP3.
- Long-term (6+ years) — Measures that may be most feasible for implementation closer to 2020 and that can lay the groundwork for improvements beyond 2020.
- Ongoing — Measures that may be immediately implemented and/or can be continually implemented.

Source: JWPhotos_ (Flickr)








Infrastructure




BALTIMORE HARBOR TUNNEL


13FELLS POINT

ENERGY

IN-1 Protect and enhance the resiliency and redundancy of electricity system

The City's electricity supply and power grid system ensures that Baltimore's residents are not left without power in a hazard event. Most importantly, critical facilities that perform emergency response activities throughout the duration of a hazard event need reliable power supplies. Forward thinking actions facilitate Continuity of Operations Plan (COOP) during hazard events and prevent power outages of any significant scale. Beyond strengthening existing systems, increasing system redundancy is a vital measure for protecting critical infrastructure from power outages. The City will explore options for creating a redundant electrical infrastructure, including coordinated efforts with Federal programs to enhance grid resiliency, including the August 2013 Economic Benefits of Increasing Electrical Grid Resilience to Weather Outages report, authored by the President's Council of Economic Advisers and the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, with assistance from the White House Office of Science and Technology. This strategy intends to protect and support resilient energy systems, addressing power supply through both adaptation and mitigation actions. This strategy is relevant for all hazards, with particular actions targeting impacts from predicted relative sea level rise.

1. Work with the Maryland Public Service Commission (PSC) to minimize power outages from the local electric utility during extreme weather events by identifying and protecting critical energy facilities and located within the City (S)

   It is essential to harden existing infrastructure to strengthen the City's energy networks. Transmission and distribution infrastructure such as substations need to be hardened to withstand current and future impacts from hazards. BGE is filing a plan with the MD Public Service Commission (PSC) in August, 2013 which will address this issue . BGE will work with the City of Baltimore to monitor the outcome of the PSC's Derecho and MD Grid Resiliency Task Force, which is also working to address these issues. This will help reduce the likelihood of failure and ensure that service may be restored more efficiently if failures do occur.

2. Evaluate the City of Baltimore utility distribution system, and identify "underground utility districts" using BGE's May 2013 short term reliability improvement plan (S)

   Failure of key nodes in the energy distribution system can have widespread impacts on the City's energy systems, with significant repercussions for people, businesses, and communities. In May of 2013, BGE filed a short term reliability improvement plan with the PSC as a result of the Derecho Order. This plan addresses selective undergrounding throughout BGE's service area. BGE will work with the City of Baltimore to use this plan as a guide and work with the PSC to leverage potential opportunities.

   As system components are placed underground, the City will work with BGE to ensure transformers and switches are water-resistant and, where appropriate, able to withstand saltwater inundation in order to increase resiliency of the distribution system.

3. Support BGE's collaboration with the Maryland Public Service Commission to implement various smart grid solutions that will provide the City with real-time access to data during events (S)

   After an extreme weather event, the first task of any utility is to identify the location and extent of damage. Utilities usually rely on customer reports of power outages, together with on-site inspections by crews. Gathering information in this way, though, takes time and can be delayed by problems on the ground, such as impassable roads. BGE is collaborating with local Emergency Operation Centers to provide near real-time data during major weather events that result in widespread power outages. Additionally, a PSC staff working group was developed as a result of the Derecho Order to address the issue of information sharing among utilities and Emergency Management Agencies. BGE will work with the PSC to leverage potential opportunities.

4. Identify, harden, and water seal critical infrastructure relative to electrical, heating, and ventilation hardware within the flood plain

   Facilities in flood-prone areas rely on mechanical systems that may be vulnerable to inundation. Damage to these systems can result in extended facility closures and costly repairs. The City should initiate a process for flood-proofing all mechanical, electrical, heating, and ventilation systems that are located within the 100-year floodplain.

5. Increase resiliency in our energy generation system by encouraging the development of decentralized power generation and developing fuel flexibility capabilities

   The City will work with BGE and the PSC to ensure continuous power supply throughout hazard events by increasing the resiliency of energy generation systems. Hardening power supply networks, establishing back-up generation systems, and considering alternative power generation systems can help to ensure continuity of power supply throughout hazard events

6. Develop a comprehensive maintenance and training program for City employees at facilities with backup generators to ensure proper placement, hook-up and function during hazard events

   Even with generators on-hand, facilities may still experience difficulties if those generators are located in areas that are flooded or if providers failed to secure fuel in advance. Additionally, it is not unheard of for a backup generator to fail, and they are not an absolute reliable reserve. Failure may be the result of extended periods without operation, or possibly because the workers tasked with managing their use in an emergency event are not adequately prepared to do so. BGE will work with the City of Baltimore to develop a process for insuring it can accurately determine when service has been restored to customers with multiple supply lines.

7. Install external generator hookups for critical City facilities that depend on mobile generators for backup power

   It is important to maintain a fleet of mobile generators that can be deployed on short notice. However, facilities must be prepared to accept this as a power source. City government should invest in equipment that can allow City facilities to connect to backup generators quickly in the event of a power loss.

8. Partner with the Public Service Commission and the local electric utility to evaluate protecting power and utility lines from all hazards

   During storms, high winds and downed trees threaten overhead electric poles, transformers, wires, and cables. At times, rerouting lines underground may be warranted, depending on the number of customers impacted and cost involved, but this is not always a cost-effective alternative. Street trees pose a risk to utility lines and other infrastructure, and a straightforward solution requires proper evaluation and maintenance of these features. At the same time, other options should be secured. While it is impossible to protect utility lines from "all" hazards, BGE will work with the PSC to evaluate potential steps that could be taken to better insulate the electric delivery system from hazards.

9. Determine low-laying substation vulnerability and outline options for adaptation and mitigation (S)

   Power substations are vital features of the City's power distribution network. Some, however, are low-laying facilities with high vulnerability in storm surges and flooding events. Through involvement with the MD Public Service Commission–sponsored Grid Resiliency Task Force, BGE and the City of Baltimore will investigate "hardening" the electric delivery system to better withstand extreme weather events.

10. Evaluate and protect low laying infrastructure - switching vaults, conduit and transformers

    Through involvement with the MD Public Service Commission-sponsored Grid Resiliency Task Force, BGE and the City of Baltimore will evaluate measures for protecting the electric delivery system and creating a redundant and resilient conduit infrastructure.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCRP (Forestry), BGE, Building Owners, DGS, DOT, DPW, Exelon, PSC, Utility customers, Veolia, Wheelabrator
Alignment with Goals	Goals 2 and 3
Connection with Existing Efforts	 Building Standards and Zoning Codes; CAP; ESF-12; MDNR
Timeframe	

IN-2 Increase energy conservation efforts

While Baltimore intends to accommodate rising energy demand by increasing the available energy supply, a more effective —and far less expensive—strategy is to manage energy demand. This strategy increases the adaptive capacity of the City's power supply through adaptation and mitigation actions by reducing the demand for, and consumption of, energy resources. It is relevant for all hazards, for managing energy supplies and preventing service disruptions.

1. Increase energy efficiency across all sectors through education, efficiency retrofits, and building management systems.

   Increased energy efficiency saves building owners money and reduces carbon emissions. It is a primary tool for mitigating potential future climate change but can also reduce the impact from future outages. For instance, during an extreme heat event, efficient structures can remain at a comfortable temperature for longer. In 2012, the City of Baltimore developed the Climate Action Plan (CAP) to reduce Baltimore's greenhouse gas (GHG) emissions through a range of strategies targeted at reducing the amount of fossil fuel needed for everyday living. This includes strategies to increase the energy efficiency of buildings. The strategies and actions recommended in this plan support and supplement what has already been outlined by the CAP.

2. Encourage critical facilities and institutions to connect to existing cogeneration systems, or develop new cogeneration systems (S-L)

   While many critical facilities do have generators in place, power may still need to be cut for several hours due to threats from hazards. Baltimore should enhance the reliability of critical facilities by installing cogeneration equipment while hardening electrical assets at the same time. Cogeneration can produce electric power to keep critical facilities online during power outages or during peak summer load periods.

3. Continue the City's electricity demand-response program during peak usage or pre-blackout periods (M)

   The City will continue and increase support for the electricity demand-response (DR) program to control and decrease in-city peak demand.

Mayor, Community Energy Savers Grant *Source: Baltimore City*

IMPLEMENTATION GUIDELINES	
Lead Agency	
Stakeholders	BGE, Building owners, City Delegates, DOP, DPW, Energy Office, PSC
Alignment with Goals	Goal 4
Connection with Existing Efforts	CAP; ESF-12
Timeframe	

IN-3 Ensure backup power generation for critical facilities and identified key infrastructure during power outages

During a power outage, it is essential that critical facilities have backup power supplies in-place. Hospitals, nursing homes, and adult care facilities rely on extensive equipment and utility services to diagnose, treat, and care for patients. These facilities, in addition to police and fire stations, and wastewater treatment plants, tend to already have backup generation installed. However, generators will sometimes fail or may be placed in high risk areas. This builds recommended resilience and disaster prevention and planning into infrastructural and energy systems through mitigation and adaptation actions. It ensures that critical and key facilities maintain continuous power supply.

1. Investigate off-grid, on-site renewable energy systems, generators, and technologies for critical facilities to ensure redundancy of energy systems (M)

   To reduce the impact of power loss on critical facilities, increased on-site electricity generation and the use of renewable energy supplies should be investigated as means to improve the ability of critical facilities to operate reliably during disruptions to the electrical grid.

2. Seek funding to purchase and install generators for all city building designated as critical to agency functions (S)

   In order to reduce blackouts, which impact emergency response times, Baltimore must ensure reliable emergency response with a consistent power supply.

3. Develop Combined Heat and Power (CHP) co-generation plants at identified critical facilities

   Even with backup generators, critical facilities could still experience power outages. The City encourages developing a cogeneration system that will generate electricity sufficient to meet base electrical demand at critical facilities and recover heat for other building processes.

4. Evaluate and ensure backup power generation is available to healthcare facilities (nursing homes, critical care facilities, hospitals, etc.)

   Hospital and other healthcare facilities tend to already have backup generation installed. However, generators will sometimes fail or may be placed in high risk areas. It is important to ensure that backup power generation supplies are present and functioning properly at vital healthcare facilities.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BGE, DGS, DHMH, DOP, DOT, DPW, MOEM
Alignment with Goals	Goal 3
Connection with Existing Efforts	CAP; ESF-7; ESF-8; ESF-12
Timeframe	

Generator Installation at Mercy Hospital *Source: Curtis Engine*

LIQUID FUELS

Liquid fuels include the gasoline and diesel fuel necessary to transport people, goods, equipment and supplies into, out of and throughout Baltimore City. Fuel is used to run city buses, taxis, personal motor vehicles, planes and the large ships that bring goods into and out of the harbor. Beyond transportation, liquid fuels are used for a variety of other needs including heating water and homes and enabling backup generators to function. It is essential to evaluate the vulnerability of our liquid fuel system to the impacts of natural hazards in order to strengthen the supply chain and increase redundancy.

IN-4 Protect and manage compressed liquefied natural gas sites and (city) fueling stations before and during hazard events

Fuel supply infrastructure is vulnerable to extreme weather events. Natural and man-made disasters can cause disruptions in the supply of liquid fuels due to storm surge and flooding, storm- and heat-related power outages, or other events. Hardening of fuel assets, facilities, and stations would decrease disruptions and allow for faster restoration of operations. These efforts will reduce the likelihood of fuel shortages during hazard events. The City will provide damage prevention and adaptive capacity of stormwater and liquid fuel cells systems, particularly from flooding and sea level rise, through both adaptation and mitigation actions and address stormwater systems and liquid fuel cells facilities and sites.

1. Work with BGE to ensure existing preparedness plans for Spring Gardens liquefied natural gas site incorporate its vulnerability to present and predicted flooding, storm surge and sea level rise

   The Spring Gardens liquefied natural gas site is located within a densely populated area of south Baltimore northeast of the I-95 and I-395 intersection. The 72 acre facility, on the Middle Branch of the Patapsco River, has been in use by BGE since 1855. Although the site consists of a 100-foot riparian buffer zone and created wetlands, BGE should evaluate the potential to secure the Spring Gardens compressed-liquefied natural gas site against major hazards and reduce potential damage from a hazard event so as to protect the adjacent communities.

2. Adopt building code that requires anchoring of 50 gallon storage tanks or larger

   As the primary function of a storage tank is to store liquid substances, the failure of a storage tank can have several undesirable effects. Tanks in low-laying areas are vulnerable to the long-term impacts of sea-level rise and the associated impacts from potential storm surge. Additionally, tanks are vulnerable to both high wind events and high heat.

   The Maryland Department of the Environment (MDE) Oil Control Program regulates above ground storage tanks and ensures they are in compliance with State and federal regulations. It is essential to have standards in place for assessing tank integrity and ensuring tanks are stable against high winds and other hazard impacts. The City will work with MDE to support design specifications for securing fuel tanks to meet the necessary legal, safety, and resiliency standards.

BGE Spring Garden Facilities in Baltimore City

Source: Maps.Google.Com

3. Support the Maryland Public Service Commission's effort to accelerate replacement of aging natural gas infrastructure which will harden the system against flooding

In response to legislation signed into law by Governor Martin O'Malley, on August 2, 2013 BGE filed a plan with the PSC to accelerate the modernization of its natural gas distribution system to enhance safety and reliability. BGE's plan proposes to increase the rate of replacement of outdated system materials such as pipes with new modern equipment. Under the plan, 21 percent of BGE's existing natural gas system has been identified for replacement which accounts for nearly 73 percent of all gas leak repairs. The City will work with utilities, regulators, and gas pipeline operators to harden the natural gas system and control equipment against flooding.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BGE, DGS, DOP, DOT, DPW, Veolia
Alignment with Goals	Goals 2 and 4
Connection with Existing Efforts	ESF-3; ESF-10
Timeframe	

An Oil tank spills following severe storms and flooding in Colorado; September 2013 *Source: The Denver Post,Andy Cross*

IN-5 Evaluate and improve resiliency of liquid fuels infrastructure

Hazard events can place considerable stress on liquid fuel supplies. In order to improve the resiliency of energy systems, and ensure that City systems receive adequate power supply, it will be important to address liquid fuel cell infrastructure and mitigate disruptions and loss of power caused by hazard events. The City will work with utilities, the PSC, stakeholders and the State to develop and build upon existing strategies that will harden refineries, pipelines and terminals essential to sustaining liquid fuel supplies.

1. Design and implement a generator program that assists private gas stations in securing backup generators, especially those stations along major evacuation routes

   Gas stations are vulnerable to power outages during extreme weather events, which prevent continued fuel distribution. It is critical for the City to work with the State to ensure that private fueling stations along critical evacuation routes have access to generators to aide in efficient evacuation and response during a disaster.

2. Increase and ensure fuel availability during distribution disruptions

   After major hazard events, restoration of the fuel supply is often slow due to fuel shortages and lack of surplus. Work with various agencies to introduce regulatory measures for use in the event of fuel shortage to allow supply-demand imbalances in the system to be mitigated.

3. Ensure fuel for generators and delivery priority is given to critical facilities and emergency responders

   During and after hazard events, fuel resources may have limited capacity, resulting in long lines and gas stations and other challenges. In order to respond quickly to hazard events, vehicles and personnel essential to emergency response must have access to fuel. In extreme hazard priority should be given to emergency responders that rely on this service to continue to address the impacts from hazards.

New Jersey Gas Station after Sandy *Daniel Goodman / Business Insider*

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCPD, DES, DOT, DPW, MOEM
Alignment with Goals	Goal 2
Connection with Existing Efforts	N/A
Timeframe	

Oil Storage Tanks at Oil Facilities in Baltimore's Harbor

Source: Microsoft Corporation, Bing Maps

COMMUNICATIONS

IN-6 Evaluate and improve resiliency of communication systems that are in place for sudden extreme weather events

Storm surge, heavy precipitation and high winds all pose a major threat to the power grid upon which communication systems rely on. Communication systems include phone, internet and television- all of which are used to provide information and connect people before, during and after a hazard event. These systems are made up of an intricate web of cables, towers and equipment- including distribution and switching centers- that all people rely on in some capacity. In Baltimore, major power outages may result in significant disruption to business and personal communications, especially in areas where copper and coaxial cables have not been upgraded to fiber cables which are more resilient to water damage.

Communication systems play an essential role in everyday life, but are even more critical during hazard events. These systems connect emergency responders to individuals in need of their assistance, allow citizens to check in with their families and friends, provide healthcare facilities access to essential information, and assist emergency response workers in providing aide. It is vital to protect the health and welfare of residents by building resilience and disaster prevention and planning, related to all natural hazards, into communication systems; additionally, this strategy furthers Baltimore's goal to establish itself as a Community Rating System (CRS) classified community to reduce flood insurance rates.

Presently, much of Baltimore City's communications equipment is located in basements and on rooftops making it susceptible to hazards. The City will investigate vulnerabilities in current telecommunication systems and develop measures to promote redundant and resilient communications infrastructure.

1. Utilize new technologies such as fiber optics, external hook-ups, and mobile generators to improve resiliency (M)

   Fiber optic cable is the newest and most resilient type of cable, being both fully water-resistant and able to carry all types of service. The transition from traditional wire-line phone service to phone service via fiber optic cable or Internet (VoIP) should be explored in more depth.

2. Build redundancy into all public and inter-agency warning and communication systems (S)

   An effective and fast warning system is critical for conveying the threat of hazards to Baltimore's residents. Warning and communication system failure should absolutely be avoided. Establishing a resiliency program to ensure that redundancy is built into the communication system should be pursued.

3. Identify best practices for the installation and management of flood proofing of all communications infrastructure at risk of water damage (S)

   Communications and electrical equipment located in basements are extremely vulnerable to the impacts of extreme precipitation and storm surge events. Much of the existing copper cable network is not designed to sit in stormwater or corrosive salt water for long periods of time. Developing flood protection standards for new buildings while strengthening programs that encourage renovations to existing buildings ensures the adequate protection of the telecommunications equipment housed within buildings. It is essential to raise generators and switchgear, replace old copper wires, and install backup generators for all buildings, but especially so in critical facilities that are essential to maintaining City operations.

4. Implement additional nurse triage phone lines and community health centers to reduce medical surge on hospitals (S)

   In the aftermath of a disaster, it is important that Baltimore's residents are able to communicate with loved ones, but more so that they may speak to their doctors for guidance on needed medical care. Enhancing nurse triage communication may include alternative solutions such as backup phone systems, Voice over Internet Protocol (VoIP) technologies that provide off-site phone lines, or pre-disaster planning to inform residents of available emergency contact numbers.

5. Evaluate and improve early warning systems for hazard events (S)

   Early warning systems allow people to prepare for potential risks and take additional caution in their daily routines. The City should evaluate the effectiveness of existing early warning systems and identify opportunities to improve them.

6. Ensure continued operation of city governments various computer mainframes for email, control systems, and internet service by having stand-by batteries for each with a capacity sufficient for backup generation to operate (S)

   During a hazard event, communication systems may be disrupted. Residents, however, rely upon these communication systems to receive timely and clear information about hazards and the risks associated with them. It is important to ensure continuity of government communication systems with redundant power supplies.

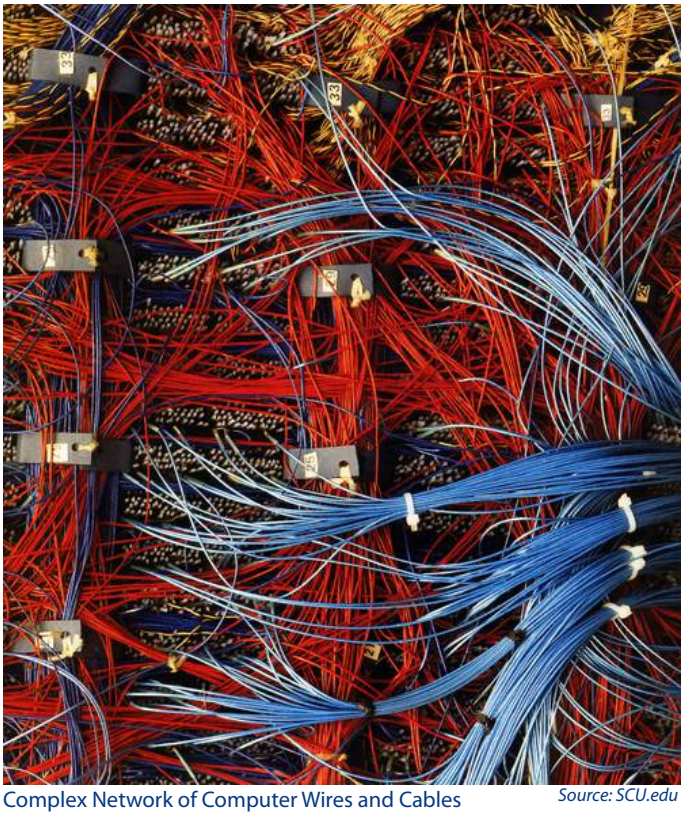
7. Identify shared communication technology for emergency responders and government agencies to ensure continued and coordinated communication during emergency events (S)

   Shared communication technology systems are outlets that enable multiple users to simultaneously share the communication channel. This may include email and other instant messaging technologies, groupware, forums, or other platforms. This technology facilitates local, cross-system coordination of on-going communication between critical entities during emergency events through a connected network of key partners, facilitating efficient response efforts.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCPD, BCFD, BGE, DHMH, DOP, DOT, Energy Office, FCC, JIS, MOIT, Private Entities, PSC
Alignment with Goals	Goals 1, 3, and 6
Connection with Existing Efforts	CAP; COOP; CRS; MD DNR; ESF-2; ESF-3; ESF-8; ESF-12
Timeframe	

Telecom Infrastructure Installation *Source: CityandStateNY.com*


Computer Ethernet Cables *Source: FreedomForumDiversity.org*


Complex Network of Computer Wires and Cables *Source: SCU.edu*

TRANSPORTATION

IN-7 Integrate climate change into transportation design, building and maintenance

Baltimore's transportation system is made up of 2000 miles of roadway, seven miles of interstate highway, and 298 bridges and culverts, in addition to light rail, subway, bus, train, and boat systems. Much of the interstate system, roadways and rail lines fall within the City's floodplain. Low-laying areas such as Fells Point have the potential to be easily inundated by heavy precipitation events and high tides. Impacts from hazards and climate change will affect the construction, maintenance, and operations of many of the City's transportation systems.

Baltimore's roadways and transportation networks are vulnerable to climate change threats and natural hazards in a number of ways, including surface flooding, wave action from storm surges, and asphalt damage due to heat waves. To mitigate the impact of these threats on streets and other infrastructure, Baltimore will integrate climate resiliency features into future design, construction, reconstruction, and maintenance projects.

This strategy addresses the potential impact of all natural hazards on transportation systems particularly to bridges, but also to other transportation and infrastructure projects — through both adaptation and mitigation actions.

1. Determine the coastal storm vulnerability and complete an exposure assessment of City transportation assets (S)

   Bridges are key connection points and generally more vulnerable than other elements of the transportation system. Flooding and earthquakes pose serious risks to the structural stability of bridges, which are vital links for conveying emergency response vehicles and for facilitating the movement of citizens as they seek safety.

2. Improve stormwater management, operations and maintenance for stream flooding that erodes away bridge supports (O)

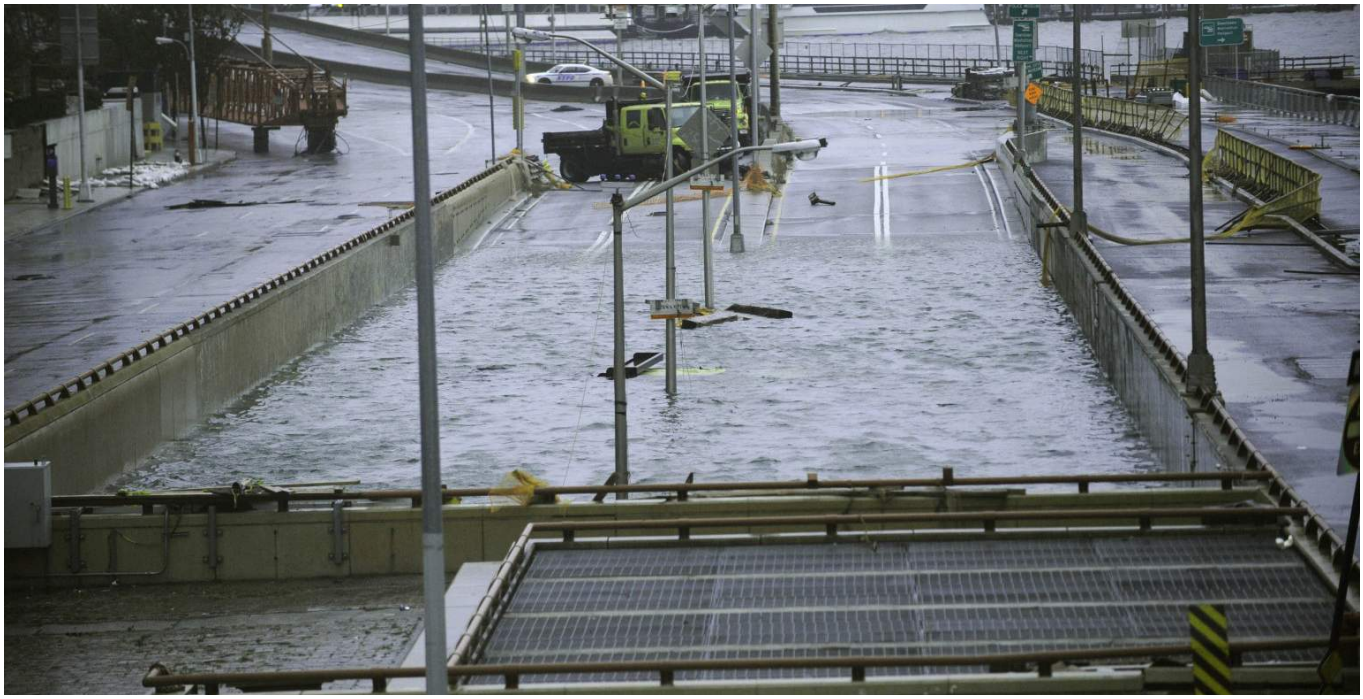
   Bridge supports are weakened by the erosion of the underlying streambed. Strengthening these supports will prevent further damage to bridges, and increase bridge resiliency during flood and storm events.

3. Incorporate compliance with earthquake standards to withstand a magnitude eight earthquake for all new, improved and rebuilt bridges (M)

   Manage the cost of structural improvements to bridges by coordinating with scheduled construction so as to proactively prepare for a potential increase in the intensity of seismic events.

Hurricane Able Flooding, 1952 *Source: Baltimore Sun*

Hurricane Able Flooding, 1952 *Source: Dick Stacks*



Storm surge from Hurricane Sandy floods tunnels and roadways throughout lower Manhattan *Source: Huffington Post*

4. Design bridges expansion joints for longer periods of high heat and develop a more robust inspection and maintenance process (S)

   Expansion points can warp and weaken during high heat events, rendering bridges inoperable and disrupting daily mobility. Increasing the capacity to withstand heat with prevent future bridge closures.

5. Research utilizing existing and new rating systems for all new infrastructure and road projects (M)

   A number of third-party rating systems already exist that provide frameworks for evaluating current conditions of the City's infrastructure. For example, to further supplement the Envista Program already in use, the Envision™ Rating system would allow the City to rate the benefits of potential projects. Similarly, the Greenroads Rating System could certify sustainable transportation infrastructure projects. These and other resources can guide the City's evaluation, maintenance, and upgrades of existing infrastructure to determine vulnerabilities as well as opportunities for improvement.

6. Identify, investigate, and incorporate Best Management Practices as they relate to transportation design, construction and maintenance (M)

   Explore alternative design practices to better prepare the transportation to withstand hazard events.

7. Require that backup solar powered street lights and signals be integrated along evacuation routes and high traffic areas (M)

   Hazard events may disrupt power supply to street light and signal systems. Along evacuation routes, these systems must remain operational. It is crucial to require the integration of backup solar power systems to ensure continuous power supply.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOT
Stakeholders	CSX, DOT, DPW, MTA, Private Contractors
Alignment with Goals	Goal 2
Connection with Existing Efforts	CAP; ESF-1; ESF-3
Timeframe	

IN-8 Identify additional alternative routes and modes for effective transport and evacuation efforts during emergency situations

Much of Baltimore's ability to respond effectively to a disaster is vulnerable to disruption and damage of critical transportation facilities. Road closures may impair the delivery of emergency services or supplies of food, fuel, and medicine. Similarly, inoperable transportation networks prevent efficient evacuation and may require more time to restore, thus limiting non-transportation infrastructure and economic activity.

Protect the health, safety, and welfare of Baltimore City Residents through improved emergency capacity of transportation systems by building resiliency, particularly to flooding hazards. This would identify existing evacuation routes and their vulnerability, establish a program to maintain specific emergency routes, and educate the public about the dangers of driving through flooded roadways.

1. Evaluate existing systems and develop a comprehensive evacuation plan (S)

   The safe evacuation of Baltimore's residents depends on a comprehensive and well-maintained network of routes. Improper care for these key routes can restrict their capacity to handle significant traffic, and a thorough plan for maintenance should be established.

2. Coordinate evacuation plans with regional partners (S-M)

   Ensuring that evacuation plans are coordinated with the surrounding jurisdictions will make certain that evacuation routes are continuous and safe.

3. Develop and prioritize clearance of specified transportation routes for delivery of emergency response supplies (S)

   The proper and continued maintenance of key routes will ensure that emergency response supplies will not encounter any problems.

4. Educate the public on the dangers of driving through flooded roads (S)

   Even in moderately low precipitation events, roadways may become flooded. To drivers, it's not always clear what the underlying surface conditions may be. Educating the public about the dangers of driving into sections of flooded roads will reduce instances of drivers and cars getting stuck in dangerous conditions.

Baltimore, 1950

Source: Hemmings..com

Flooding on the Jones Falls Expressway *Source: BaltimoreSun*

5. Make available a network of dedicated pedestrian and bicycle transportation routes leading into and throughout the City (O)

As well as contributing to healthier, greener and more livable neighborhoods, walking and/or cycling provide redundancy in the transportation system in the event of an emergency or storm event, when public transit may be temporarily disrupted or vehicular access may be more difficult (for example due to debris caused by a storm in the road blocking vehicular access). A systematic evaluation of "best and safest routes" should be performed to ensure a network is available and maintained for existing conditions as well as extreme event conditions. Incorporate current and best practices for pedestrian and cycling in existing and future transportation systems (i.e. dedicated bike lanes, signage and striping, cycling-to-public transport connections, etc.).

6. Identify and collaborate with bicycle groups and repair shops to assist in emergency response and accommodate alternate transportation needs (S)

During hazard events, roadways and other transportation networks may be impaired or unusable, leaving residents stranded or confined to a limited area. Bicycles offer an alternative mode for mobility during such an event, facilitating access for emergency responders and providing a means for residents to evacuate or meet other needs.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCHD, DOP, DOT, MOEM
Alignment with Goals	Goal 1
Connection with Existing Efforts	CAP; ESF-1; ESF-11
Timeframe	

IN-9 Alter transportation systems in flood-prone areas in order to effectively manage stormwater

Flooding can cause considerable damage to transportation systems. To prevent this damage and build resiliency of transportation systems, particularly highways, roads, and tunnels, to flooding hazards, the City will consider both adaptation and mitigation actions that may be taken. This will prevent vulnerability to flooding, including the consideration of stormwater management programs for their potential to reduce the significance of flooding.

1. Prioritize infrastructure upgrades for roads identified at risk of flooding through the use of elevation data and Sea, Lake and Overland Surges from Hurricanes (SLOSH) model results (L)

   Sea, Lake and Overland Surges from Hurricanes (SLOSH) modeling can help identify where the City can make improvements to reduce risks associated with flooding and storm surges. Additionally, improvements can be coordinated with scheduled replacement of road infrastructure, particularly in areas that frequently suffer damage due to flooding.

Managing Stormwate with "Green Infrastructure" *Source: NRDC*

2. Raise streets in identified flood prone areas as they are redeveloped (L)

   Streets in flood-prone areas are likely to require constant maintenance and upgrades. It is essential to explore raising roads to reduce impact of flooding.

3. Encourage development of Green Streets in flood prone areas and throughout the City (S-O)

   Reducing impervious surfaces and capturing rainwater, Green Streets have the capacity to absorb heavy precipitation, rather the rush it into the stormwater drain system.

4. Encourage use of permeable pavement in non-critical areas – low-use roadways, sidewalks, parking lots and alleys where soils permit proper drainage (M)

   Impervious surfaces absorb and radiate heat, as well as prevent rainwater from entering the groundwater supply. Permeable pavement, on the other hand, reduces flooding and can contribute to a reduced urban heat island effect.

5. Add pumps or other mitigation alternatives to streets as they are redeveloped (if needed) (L)

   Streets in flood-prone areas can become inundated in heavy rain events. Pumps and alternative measures can ensure that water can be quickly removed from the roadway, allowing for maintained accessibility.

6. Assess need for new culvert capacity and identify where upgrades are needed (L)

   Baltimore's stormwater system is dated and, in some places, in poor condition. Many of the features, such as culverts, were not designed to handle the current levels of precipitation, let alone projected increases in precipitation. Addressing where key vulnerabilities exist and identifying the potential for upgrades will increase the system's ability to handle future hazard events and reduce flooding.

7. Conduct an in-depth analysis of the impacts of drain fields that feed the harbor (M-L)

   Water quality in the Inner Harbor can be enhanced by reducing flooding upstream. To do this, an in-depth analysis of the drain fields that feed into the Harbor should be conducted.

8. Expand and reinforce existing stormwater education programs (L)

   Educate property owners about various ways to capture rainwater, as well as about the importance of doing so and the benefits of the stormwater utility and DPW Clean Water Baltimore program.

9. Design and implement floodgates and barriers in transportation tunnels (L)

   Tunnels are vulnerable to flooding from storm surge and heavy downpours. Floodgates, which prevent water from flowing backwards and into tunnels, can be a cost-effective strategy for reducing water infiltration and damage to these vital connections in the transportation network.

10. Encourage Federal and State Government to design and install floodgates and barriers at vulnerable transportation tunnels (L)

    Floodgates allow stormwater to flow out of waterways while preventing backflow at the same time. They provide protection against flooding. The City should work with the Federal Government to prepare for installation.

11. Upgrade existing floodgate hardware and mechanisms to control rise rate of water into all city tunnels (L)

    Existing and new floodgate systems should be able to withstand intense water rise rates, and upgrades should be considered where necessary.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOT
Stakeholders	Amtrak, BCRP, CSX, Developers, DOT, DPW, FHWA, MDTA, MON, NGOs
Alignment with Goals	Goals and 3
Connection with Existing Efforts	CAP; ESF-1; ESF-3; ESF-11; MD DNR
Timeframe	

Blue Water Baltimore's Blue Alley Project

Source: Blue Water Baltimore

IN-10 Ensure structural stability of all transportation tunnels to reduce impact from seismic activity

Tunnels are vulnerable to the impacts of seismic activity, which could damage structural integrity. Damage or failure at one of the City's tunnels would significantly disrupt the regional transportation network. The City will investigate a number of structural resiliency strategies for reducing the vulnerability of tunnels to seismic hazard events. Use both mitigation and adaptation actions to reinforce structural resiliency.

1. Repair cracks and leaks in all tunnels to reduce impact of seismic activity (M)

   Cracks and leaks create significant vulnerabilities through the weakening of tunnel facilities. Addressing these weaknesses will increase the ability of tunnels to withstand future seismic activity, and prevents further damage.

2. Follow Federal, State and Local criteria for the stabilization of Historic transportation tunnels (e.g. Howard Street) (L)

   Howard Street, an older, historic tunnel in Baltimore, is considered to be more vulnerable to hazards than other transportation tunnels. It is important to explore and pursue a combination of Federal, State, and Local funds for stabilizing this asset.

3. Install a seismically resistant fire standpipe, air monitoring, and automatic valve system in all tunnels to provide a fully automated and monitored fire suppression system (L)

   Decrease damage from fire events in underground tunnels that might occur as a result of seismic activity.

IMPLEMENTATION GUIDELINES	
Lead Agency	CSX, Amtrak, MTA
Stakeholders	Amtrak, CSX, DOT, DPW, FHWA, MDTA, MOEM, MTA
Alignment with Goals	Goal 2
Connection with Existing Efforts	CAP; ESF-1; ESF-4; ESF-10
Timeframe	

Baltimore Harbor Tunnel *Source: MDTA*

IN-11 Evaluate changes to road maintenance and construction materials based on anticipated changes in climate

Recognizing future conditions, current transportation systems may require renovation or modification. In order to prevent damage to highways and roads from extreme heat events or other hazardous conditions, road construction projects should use both adaptation and mitigation actions to address potential damage to roadway surfaces.

1. Implement a repaving strategy that reduces heat-related damage to asphalt and incorporates maintenance and operations that extend the life of the road surface

   Flooding and extreme heat, as well as seismic activity and the impact of other natural hazards, can cause significant damage to Baltimore's roadways. It is essential to prepare a reconstruction strategy to repair damaged surfaces, and include resiliency measures to reduce future damage. This will extend the life of the road surface.

2. Develop a reconstruction and repair strategy that reduces damage to concrete and incorporates better maintenance and operations

   To ensure that no vulnerability is left unaddressed, it will be important to establish a procedure for identifying and coordinating reconstruction and repair of transportation systems.

3. Develop deicing strategies and materials that are effective in extreme cold temperatures and prolonged events to stabilize roadway and bridge surfaces

   During severe winter storms, roadways and bridge surfaces may become covered in a layer of ice. To address these dangerous conditions, it is important to identify a strategy for removing this ice and ensuring safe driving conditions.

4. Design pavement sections and materials that withstand longer periods of extreme heat events

   Extreme heat can warp or cause other damage to pavement and roadway surfaces. To reduce damage during high heat events, it will be important incorporate resilient design and materials into transportation projects.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOT
Stakeholders	DOT, SHA
Alignment with Goals	Goal 2
Connection with Existing Efforts	CAP; ESF-1
Timeframe	

The Jones Falls Expressway (I-83) *Source:Wikimedia*

WATERFRONT

IN-12 Enhance the resiliency of the City's waterfront to better adapt to impacts from hazard events and climate change

Baltimore's waterfront properties are vulnerable to the impacts of coastal storms and other natural hazards. The majority of Baltimore's waterfront consists of bulkheads which are structures typically made of stone or concrete that hold shorelines in place. Adaptation and mitigation actions will increase resiliency and reduce damage .

1. Raise bulkhead height along shoreline areas most at risk (L)

   Increasing coastal edge elevations — through bulkheads, revetments, tide gates, or other shoreline structures — will harden exposed shorelines and prevent the risk of regular flooding. Raising bulkheads at select sites citywide can mitigate the effects of relative sea level rise . Throughout this process, it will be important to consider the aesthetic and functional impacts of any bulkhead changes on surrounding communities.

2. Utilize vegetation and stone to stabilize and armor unprotected shorelines (S)

   Natural features can protect adjacent communities from the impacts of coastal hazards. It is important to study the cost-effectiveness of new waterfront design guidelines that will encourage open spaces and natural areas, and to determine where and how to best utilize natural features to direct and store excess floodwaters .

3. Encourage the development of integrated flood protection systems that use structural (engineering) and non-structural (wetlands) measures (L)

   Multiple areas of Baltimore are at risk of flooding during extreme weather events. Some of these areas are home to critical facilities and dense population. It is important to encourage the installation of integrated flood protection systems in targeted areas. Protection should be designed to have minimal impact on surrounding community fabric during non-storm conditions.

4. Review and enhance coastal area design guidelines to better mitigate the impacts of flooding (L)

   Coastal hazards expose facilities near waterfront areas. New guidelines should be incorporated so as to best protect the people and property adjacent to waterways and mitigate the effects of flooding.

5. Enhance and strengthen waterfront zoning and permitting (L)

   Existing zoning and permitting requirements should be reviewed, and where appropriate, be amended and strengthened to improve the design and resiliency of new and existing buildings. Resiliency measures should be incorporated into this framework to better protect properties from flood-risks.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOT
Stakeholders	BDC, Development Community, DGS, DHCD, DOP, DOT, MDE, MDNR, MOEM
Alignment with Goals	Goal 4
Connection with Existing Efforts	N/A
Timeframe	

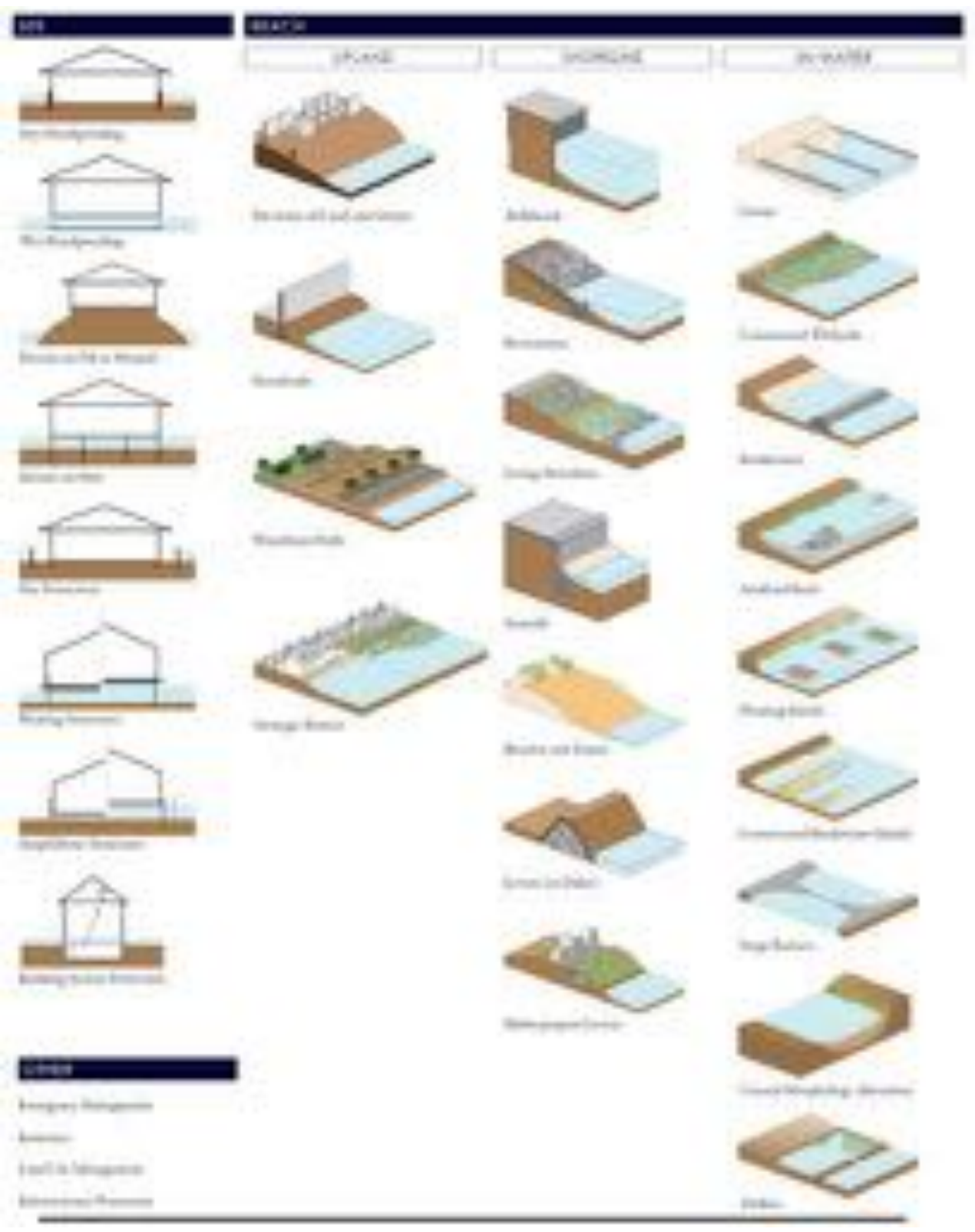


Figure 5–1 "Inventory of Adaptive Strategies," showing a variety of coastline adaptation technologies

The image above was produced by the New York City Department of City Planning in the Coastal Climate Resilience report, *Urban Waterfront Adaptive Strategies*. (The City of New York, 2013: 6).

WASTEWATER

IN-13 Increase the resilience of all wastewater systems and protect them from current and projected extreme weather events

A number of wastewater treatment assets are at risk of flooding or other damage from extreme weather events. To minimize disruptions to these systems, efforts must be implemented to protect vulnerable wastewater systems and facilities from current and projected extreme weather events.

Water and wastewater utilities will pursue implementation of resiliency projects at these facilities in conjunction with scheduled repairs and planned capital improvement projects, and as is deemed appropriate based on level of risk, historical flooding, and potential community impacts, among other criteria.

1. Ensure all water and wastewater pumping stations have off-grid, on-site energy sources and/or reliable backup power sources by increasing the number of backups and pulling electricity from different grids (L)

   Pumping stations are necessary for conveying stormwater and wastewater away from Baltimore's communities. They are, however, often vulnerable to storm surges and heavy downpours. These stations should be retrofitted with consideration of increased resiliency measures, and redundant energy systems should be installed to ensure continued operation.

2. Evaluate the sewer system to identify and develop key areas for prevention of raw sewage overflows (L)

   In heavy storm events, excessive precipitation may inundate wastewater treatment facilities. For over a decade, the City has been under a federal and State enforcement action to improve its aging wastewater infrastructure. In light of future increased intensity of storm events, this work is especially important. There are several things the City must do to prevent sanitary sewer overflows.

   This includes:

   - Cleaning and maintaining sewer pipes
   - Reducing the opportunity for stormwater infiltration and inflow into the sanitary sewer
   - Educating citizens and enforcing City Code provisions related to keeping fats, oils, and grease (which clump and clog pipes) out of the sanitary sewer
   - Maintaining a root control program to keep tree roots from damaging sewer pipes
   - Increasing and upgrading the capacity of the sanitary sewer system.

   Preventing sewage overflows is more feasible and better for the ecosystem than disinfecting them after the fact. That said, appropriate clean-up measures must be taken when overflows do occur. The City will work with utilities to identify key vulnerabilities and implement a system to ensure the disinfection of raw sewage prior to any potential overflow event that cannot be avoided.

3. Develop and adopt increased level of protection for construction, redevelopment, and design of all water and wastewater facilities that incorporate future climate projections (L)

   Adopt an increased level of protection for design and construction of all wastewater facilities based on the latest FEMA maps and modified to reflect future relative sea level rise projections.

4. Retrofit and harden low-laying pumping stations and treatment plants in flood hazard areas (L)

   Baltimore's pumping stations are necessary to convey wastewater and stormwater out of communities. However, their location, often in low-lying areas, increases their vulnerability to storm surge and flooding. These pumping stations should be retrofitted for resiliency with measures including raised or flood-proofed critical equipment, constructing barriers, or implementing redundancy measures to avoid failure of these critical treatment systems.

5. Ensure effective operations and security for wastewater treatment plants if facilities are overwhelmed by hazard event (L)

   It is essential to ensure proper treatment of waste and reduce contamination from raw sewage overflow. This will minimize the potential health and disease impacts caused by raw sewage if full treatment is not possible.

6. Establish the capability of wastewater treatment plants to function during large storm events and establish protocols for storms that overwhelm the system (L)

   Current protocols allow Back River and Patapsco Wastewater Treatment Plants to function effectively even when experiencing very high flow volumes. The limits of the current protocols should be determined and, if necessary, establish protocols for larger storms in the future.

7. Increase stormwater recharge areas and quantity management to prevent flooding from overflows (L)

   The City of Baltimore does not have a Combined Sewer System (CSO), however water can enter the system through illegal connections, flooding along sewer corridors and other channels. Enhancing stormwater infrastructure should be encouraged to reduce the amount of water entering wastewater treatment facilities. This can be attained in two ways: 1) By capturing and holding stormwater on-site, through vegetation, cisterns and rain barrels, prevents water from overwhelming drainage systems; 2) Through designing pipes and the entire system to withstand greater volumes from larger storm events. Sewerage system improvements should include resiliency planning in the design phase.

8. Conduct an assessment of the City's current water system to identify age, condition of infrastructure, capacity, weaknesses and areas for priority upgrades (L)

   Upgrading water treatment systems should take into account the potential for future impacts. Identifying vulnerabilities and increasing the protection of critical equipment will prevent future damage to these supply systems. Damage to the water systems as a result of hazard events could contaminate drinking water supplies. At the same time, waste water systems must be able to handle increased volumes and treat water supplies prior to release.

9. Conduct and utilize a detailed risk assessment to determine vulnerability of the sewage treatment plant to prevent overflows from extreme storm events

   It is important to evaluate the sewage treatment plant weaknesses and determine where improvements are most needed to increase the capacity and prevent overflows from extreme storm events.

10. Determine the elevation of sewage treatment buildings, tank construction details, and if the plant is at risk of back flow, for improvements to withstand coastal storm events

    Certain building characteristics can alter the vulnerability of a sewage treatment plant. By determining the conditions at the City's various facilities, information regarding the need for key upgrades may be revealed.

11. Retrofit wastewater treatment facility and methane gas storage system to withstand seismic activity to protect against earthquakes. Design facility to exceed current building codes

    Increasing standards beyond the previous maximum impact will proactively plan for worst case scenarios and prevent future impacts, as well as the future need for additional improvements.

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	DOP, DPW, Energy Office, MOEM
Alignment with Goals	Goal 3
Connection with Existing Efforts	 CAP; COOP; ESF-3; ESF-12
Timeframe	

IN-14 Integrate resiliency, redundancy, and structural stability into the City's drinking water system to ensure safe and reliable water storage and distribution

Protect the health of residents through enhanced resiliency, redundancy, and structural stability of the City's drinking and water supply systems, including dam facilities and infrastructure systems, from all natural hazards. Use both mitigation and adaptation actions.

1. Repair leaks and improve connection from all City reservoirs and the Susquehanna River (S-L)

   The City recognizes that every single drop of clean water is precious. This is particularly true when water supplies are low. It is essential to implement appropriate repairs to City drinking water system infrastructure. These repairs will enhance the reliability of the Baltimore's water supply and maintain flexibility during normal operations, as well as during periods of a depleted supply, or when water quality is affected by heavy rain or heat waves.

2. Provide water conservation education, and continue to protect our watersheds to assist in maintaining water quality (S)

   To avoid the impact of future dry periods or droughts, efforts to educate citizens and property owners about water conservation techniques and to encourage the use of grey water systems as water conservation and landscape maintenance can prevent excessive water use and will conserve drinking supplies. Additionally, efforts must be made to protect our watersheds by supporting and implementing the Reservoir Watershed Management Agreement. The City should work with the surrounding Counties to identify improvements that will maintain water quality, as well as key efforts to prevent future impacts to the water quality during hazard events.

3. Ensure dam emergency plans account for impacts of climate change (M)

   Damage or failure at a City dam facility can cause significant damage. While emergency plans consider methods for preventing failure or reducing impact of damage, they should consider projected changes in climate.

4. Identify and document post damage responsibilities in memorandums of understanding as addendums to the Reservoir Watershed Management Agreement (S)

   The City should ensure that dams will not fail in the future due to more frequent and intense precipitation events by identifying and documenting post-damage responsibilities into planning documents and Reservoir Watershed Management Agreements.

5. Review dam capacity, load and failure points and review them against 1,000 year and 10,000 year precipitation events (M)

   It is necessary to evaluate dam conditions and determine each facility's potential to withstand excessive precipitation caused by 1,000- and 10,000-year events.

6. Conduct a study to determine seismic design standards and seismic resiliency of drinking water distribution system (tunnels, piping, clean water pump stations, dams, shafts, and tanks) (M)

   Underground drinking water distribution systems are vulnerable to seismic activity. Failure of, or damage to, certain facilities or systems may have significant impact on drinking water sources, including contamination. It will be critical to identify vulnerabilities from utilities or other facilities by working with the utility to explore methods for risk reduction and increasing the resiliency of the distribution system.

7. Increase stormwater recharge areas and quantity management in watersheds feeding the reservoirs (S)

   Many drinking water supplies rely on groundwater systems, which must remain healthy and continue to offer high quantities of water. Diverting rainwater away from infrastructure and back into the ground recharges the reservoir systems efficiently prevents pollution from entering the

water supply. Ensuring that rainwater remains on-site, where it falls, will increase groundwater recharge.

8. Evaluate the impacts of sediment loading on reservoir capacity (S)

During rain events, sediment is carried downstream and often settles at the bed of water reservoirs. Without removal, sediment builds up and reduces the capacity for reservoirs to store water, limiting drinking water supplies. These impacts need to be more clearly understood so that the utility may identify methods for addressing sediment build-up and increasing the ability of reservoirs to store drinking water.

9. Manage watershed forests to provide maximum benefits for water quality and to maintain resiliency during extreme weather events (S)

The quality of drinking water systems should be maintained every day. Trees have the capacity to absorb and filter rainwater. Additionally, when properly maintained, trees can reduce wind intensity. Caring for watershed forests will enhance the benefits provided by trees, and better protect drinking water quality. It will be important to prioritize and encourage an increase of forest cover within reservoir watersheds and targeted areas, and encourage forest management practices to strengthen the health and capacity of forest systems to protect drinking water quality.

It is important that this strategy should be done in coordination with maintaining recreational uses and educating recreational user groups.

10. Adopt new policies on salt application to prevent high salinization on drinking water supplies (M)

While salting roadways allows for use during heavy winter storm events, the process has a negative impact on the environment and our water ways. As such, it degrades the quality of drinking water supplies upon which we rely.

11. Establish a structured Firming Program to maintain adequate storage and water quality in the source-water reservoirs during drought conditions

The City should investigate the potential of a water "firming program" that will reduce water depletions by protecting and increasing supplies. Water supply "firming" secures supplemental sources or reserves in order to increase the reliability of current the capacity during periods of limited or reduced supplies. To conserve water during droughts and water shortage periods, it is important for the City to establish its authoritative power to implement water conservation measures as needed during emergency events. Additionally, it will be important for the City to consider alternative methods for conserving water resources and distributing supplies during emergency events.

12. Maintain appropriate agreements with Susquehanna River Basin Commission (SRBC) and the Exelon Power Company to ensure adequate water withdraws from the Susquehanna River during drought emergency

During a hazard event, the Susquehanna may be an insufficient supply of drinking water. It will be important to explore and identify alternatives for emergency water supply sources and to consider and evaluate the potential for citywide requirements regarding water conservation, including enforcement measures and procedures, to ensure that adequate water is available during low-supply periods and that adequate supplies are available for emergency use.

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	BCHD, BCRP, DHCD, DHMH, DOP, DOT, DPW, MCC, MDE, Regional Watershed Groups, Reservoir Watershed Management Committee, SHA, Water Utility
Alignment with Goals	Goals 1, 2, and 6
Connection with Existing Efforts	 CAP; CRS; ESF-3; ESF-5; ESF-8; ESF-10
Timeframe	

IN-15 Conduct an assessment that evaluates and improves all pipes' ability to withstand extreme heat and cold

Much of Baltimore's water system is dated and in need of upgrades. It is important to build extreme weather resilience and disaster prevention into water and wastewater systems by using both adaptation and mitigation actions. Additionally, structural and infrastructural upgrades must be made to reduce loss of water supply from the distribution system.

Baltimore Water Pipe *Source: BaltimoreSun*

1. **Replace old and malfunctioning pipes with new pipes or retrofit existing pipes with new lining**

   Pipes that have already begun experiencing problems, or older pipes which are more vulnerable to the impacts of hazards, should be upgraded using the best available technology.

2. **Evaluate and utilize new technology that allows for greater flexibility in pipes as they are replaced**

   It is essential to prepare for future changes in hazard events and proactively upgrade pipe systems to prevent cracking and bursting.

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	DOT, DPW, Water and Wastewater Utilities
Alignment with Goals	Goal 3
Connection with Existing Efforts	CAP; CRS; MD DNR; ESF-3; ESF-4
Timeframe	

STORMWATER

IN-16 Enhance and expand stormwater infrastructure and systems

Future changes in precipitation frequency and intensity may require reconsideration of the design of existing stormwater infrastructure systems.

Increase resiliency and disaster prevention measures related to stormwater systems by enhancing drainage systems in stream corridors and improving and repairing stormwater conveyance popes and outfalls.

1. Implement the requirements of Baltimore's MS4 (separate stormwater and sewer system) permit (S)

   The City of Baltimore operates under a Municipal Separate Stormwater and Sewer System (MS4) permit, which protects water-quality and requires that Baltimore prevents pollution as much as possible. It is critical that the requirements of these permits are fully met.

2. Prioritize storm drain upgrades and replacement in areas with reoccurring flooding (S)

   While proximity to a floodplain or floodway can increase vulnerability to flooding, certain measures can reduce this vulnerability. Inadequate or older pipes, which cannot accommodate the excessive amounts of stormwater, should be upgraded so as to handle extreme rainfall and storm surge events.

3. Install backflow-prevention devices or other appropriate technology along waterfront to reduce flood risk (M-L)

   Backflow-prevention devices are used to ensure that water does not flow back through drainage infrastructure. Through the installation of backflow-prevention devices, the City can improve the performance of the drainage network and prevent risk of flooding impact along the waterfront.

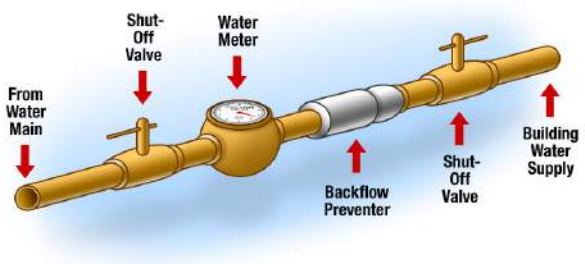
4. Preserve and protect natural drainage corridors (S)

   It is important to utilize natural drainage corridors and green infrastructure to capture more stormwater runoff and enhance the ability of the existing infrastructure to cope with environmental changes.

5. Review and revise storm drain design on a continuous basis, to accommodate projected changes in intense rainfall (O)

   The City's storm drains will require continual revision to incorporate new and projected changes in intense rainfall. This will ensure that the storm drains maintain adequate capacity.

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	Community Groups, DOT, DPW, MOEM, MDNR, NGOs, Private Developers, Stormwater Utility
Alignment with Goals	Goals 1, 3, and 6
Connection with Existing Efforts	CRS; MD DNR
Timeframe	



Backflow Preventer

Source: DemarPlumbingNYC

IN-17 Modify urban landscaping requirements and increase permeable surfaces to reduce stormwater runoff

Landscaping increases resilience and disaster prevention of stormwater systems related to flooding. Allow for more opportunities for rainwater to be absorbed by the ground and increase vegetative surfaces while reducing impervious surfaces.

1. Support existing stormwater requirements and continue to evaluate and improve Best Management Practices (M)

   Conventional stormwater management can at times be an inefficient process and cannot, or should not, be relied upon to handle intense rainfall. The City has incorporated Environmental Site Design strategies into stormwater management regulations as an element of MS4 permits in order to increase the ability to accommodate heavy rainfalls; recognizing that the Maryland Department of the Environment (MDE) establishes minimum stormwater management requirements; the Department of Public Works will coordinate its efforts with MDE.

2. Encourage urban landscaping requirements and permeable surfaces into community managed open spaces (S)

   As more communities are encouraged to adopt vacant land, utilize the Growing Green Initiative and the Green Pattern Book to educate residents, non-profits, and faith-based organizations on practices that reduce impermeable surfaces and use landscaping and trees to capture on-site rainwater. It will be important to recognize site history and soil health.

3. Utilize water conservation elements such as green roofs, rain gardens, cisterns, and bioswales on residential, commercial, industrial, and City-owned properties to capture stormwater (S-M)

   Water conservation measures lessen rainwater's load on infrastructure, and rainwater capture strategies will collect rainwater reserves for using during low-precipitation periods. The City's natural systems and features are important to capture and treat rainwater where it falls. Green roofs, rain gardens, and bioswales (small ditches that retain water during heavy rainfalls) are supplemental techniques for increasing natural elements for the purpose of capturing and treating rainwater, allowing for groundwater recharge.

4. Encourage permeable paving on low-use pathways (M)

   It is important to maximize permeable surfaces through the use of permeable paving, landscaping techniques and under drain systems. Permeable pavement should be considered in the areas of the City without class D soils. In those areas, a reduction in impervious surfaces will increase the capacity of Baltimore's land to absorb rainwater, while reducing the demand on the stormwater system.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BDC, BCRP, BDW, Citizens, DHCD, DOP, DOT, DPW, NGOs, Private Developers
Alignment with Goals	Goal 3
Connection with Existing Efforts	 CAP; ESF-3; MD DNR
Timeframe	

IN-18 Evaluate and support DPW's stream maintenance program

Increase resiliency and disaster prevention measures to protect stormwater systems from flooding and sea level rise hazards. Utilize both adaptation and mitigation measures to improve natural stream systems.

1. Review and improve status of standing maintenance requirements (O)

   A poorly maintained stream can become a liability, whereas a properly maintained stream system can effectively reduce the likelihood and impacts of flooding. It is crucial to review existing stream maintenance requirements to identify where adjustments can be made.

2. Ensure adequate funding is in place to support stream maintenance (O)

   Streams help to manage stormwater runoff, but these systems are sometimes degraded. It is important to explore various City, State, and Federal agencies to identify funding resources to ensure that stream systems are properly maintained.

3. Identify opportunities where stream restoration efforts will off-set maintenance costs (O)

   Key stream features, when maintained or improved, can have significant cost-savings benefits. Identifying where stream restoration will off-set other maintenance costs.

4. Identify interdependencies and benefits of stream maintenance with other transportation programs (O)

   The City should demonstrate that transportation projects have the potential prevent damage as well as even to improve the health of stream systems. Potential benefits of interdependencies with stream maintenance programs should be investigated and identified, in addition to specific challenges.

5. Clear streams on a regular basis, prioritize dredging the stream beds, and increase inspection and cleaning of culverts and storm drains to prevent flooding (O)

   Key areas should be regularly maintained to increase the capacity of the stream system to handle heavy downpours and reduce any potential damage.

Stoney Run in Roland Park *Source: RolandPark.org*

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	DOT, DOP, MDE, MDNR, MOEM, USACE
Alignment with Goals	Goals 2, 3, and 6
Connection with Existing Efforts	CRS; ESF-3
Timeframe	

IN-19 Support and increase coordination and information sharing across jurisdictions to better enable mitigation of cross-border impacts on the regions watersheds (e.g., understanding flood conditions upstream in the County)

Enhance adaptive capacity of the City by coordinating stormwater management efforts with surrounding jurisdictions to reduce flooding and improve water quality. Utilize both adaptation and mitigation actions.

1. Partner with local counties to evaluate major tributaries in all watersheds to determine best management practices for capturing run-off and slowly releasing it (stormwater quantity management) (O)

   Cross-jurisdictional efforts to address rainfall across the region recognize the extensive range of watershed systems and can effectively manage and prepare hydrological systems for future hazard events. This is a major action in the City's Sustainability Plan and the City-County Watershed Agreement.

2. Encourage information sharing within the Chesapeake Bay community to assist in developing best management practices

   As part of the Chesapeake Bay Watershed, Baltimore hydrological system is a critical national asset. By communicating with agencies and jurisdictions of the greater Chesapeake Bay community, the City can determine best management practices and identify priority improvements.

Baltimore Rain Garden *Source: BlueWaterBaltimore*

Baltimore Trash Cleanup *Source: BlueWaterBaltimore*

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	BCRP, County Governments, DOP, DPW, MCC, MDNR, NGOs, Stormwater Utility
Alignment with Goals	Goal 4
Connection with Existing Efforts	MD DNR
Timeframe	

Pierce's Park, Stormwater Park *Source: Flickr.com*

SOLID WASTE

IN-20 Reevaluate and support a comprehensive debris management plan for hazard events

Build resilience and disaster prevention into solid waste and stormwater systems through adaptation and mitigation actions.

1. Investigate best practices for managing and disposing of downed trees, yard waste, building debris, as well as additional household garbage (S)

   Loose debris can become dangerous during hazard events, clogging storm drains or causing private property damage. After a hazard event, this debris can overwhelm City services and require extensive cleanup efforts. It is crucial to investigate alternative strategies for managing and disposing of post-hazard debris and waste.

2. Expand and integrate existing programs to reduce or intercept debris before it gets into the streams and harbor (M)

   Trash and debris on streets will slowly move into stormdrains which convey this waste into the harbor, at which point it has infiltrated a major waterway of the Chesapeake Bay Watershed. Once in the harbor, trash and debris are difficult to recover, and can have negative impacts on businesses and industries adjacent to the Harbor. By collecting this trash and debris before it enters storm drains, the City can avoid the costly process of cleaning the Harbor.

3. Develop and promote solid waste management actions for citizens to implement before a hazard event (S)

   Proactive management will prevent the impacts during a hazard event and reduce the need to recover afterward. To address potential exposure of the solid waste network, Baltimore should harden its waste collection and disposal facilities to ensure continued waste collection and disposal throughout future events, as well as minimize any impacts that might result from flooding of facilities that store solid waste.

Baltimore Jones Falls Trash Wheel *Source: healthyharborbaltimore*

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	Planning, MOEM, R&P, MOEM, BGE, NGOs
Alignment with Goals	Goal 3
Connection with Existing Efforts	CAP; ESF-3
Timeframe	

POLICY AND GOVERNMENT DECISION-MAKING

IN-21 Encourage the integration of climate change and natural hazards into private and State planning documents, systems, operations, and maintenance

Increase overall resiliency and disaster prevention efforts in private and statewide planning documents, systems, operations, and maintenance. Consider transportation systems, emergency response actions, and air quality measures.

1. Incorporate consideration of hazards and climate adaptation efforts into all plans, systems, operations, and maintenance (M)

   It is important to continually review climate change and hazard information to be incorporated into all City plans, operations, and maintenance frameworks to ensure citywide preparedness.

2. Ensure Red Line planning incorporates adaptation strategies (S)

   As a major project, the Red Line must consider the long-term impacts of future hazards and incorporate adaptation strategies into project development. Current Red Line design is building to a Flood Protection Elevation of 11-feet (NAVD88). The 100-yr (tidal) flood is approximately 5-feet (NAVD88) and Isabel was a 500-year event at 7-feet (NAVD88). The proposed design elevation at 11-feet is 6 feet above Base Flood Elevation (BFE).

3. Ensure hazard scenarios, utilized in vulnerability assessments, are at a minimum 25% greater in intensity and impact than historical record events to date (O)

   Recognizing the increasing frequency and intensity of hazard events, it is important to plan for events that will be more dangerous than previous experiences.

4. Develop guidelines for hospital, health care facilities and other institutional entities (e.g. Universities) (O)

   Hospitals can become more efficient in their ability to respond to hazard events by developing and adopting clear guidelines for actions during emergencies.

5. Partner with regional air quality institutions to integrate air quality measures and messaging into City climate change policy efforts (O)

   The City should work with major institutions to minimize and mitigate the risk of air quality problems, by addressing major air quality concerns into climate change policy initiatives. Additionally, a framework for communicating about air quality concerns should be developed.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	MOEM, DOT, Health Care Community, Hospitals, MD2HE, MEMA, MTA, MOEM, SHA
Alignment with Goals	Goal 3
Connection with Existing Efforts	 CAP; ESF-1; MD DNR
Timeframe	

IN-22 Develop City policy which requires new city government capital improvement projects to incorporate hazard mitigation principles

Enhance Baltimore's adaptive capacity through policy improvements that cost effectively incorporate mitigation actions into ongoing construction and physical maintenance projects.

1. Discourage new public projects in hazard-prone areas such as floodplains or the coastal high hazard areas

   It is understandable to forgive existing construction that has taken place within flood-prone areas. However, knowing the dangers, and the costs associated with flooding impacts, development within flood-prone areas should be minimized to only include facilities that can only function if placed in high risk areas.

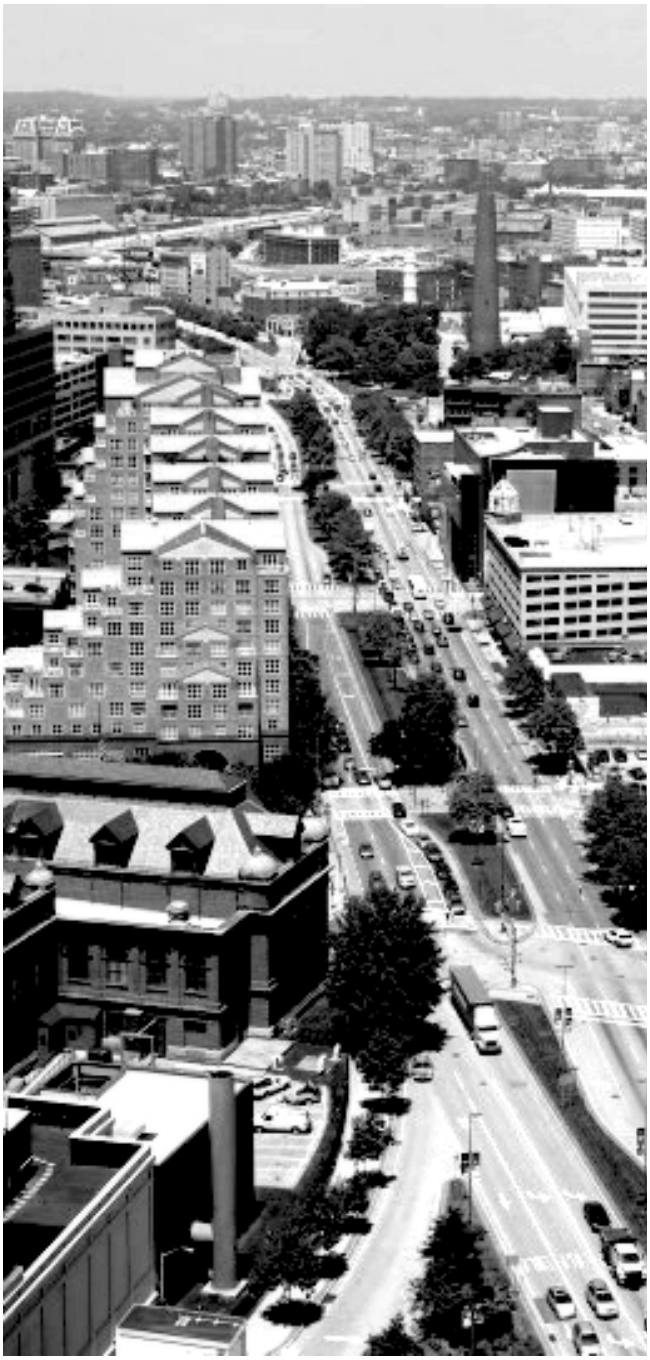
2. Utilize hazard mitigation design requirements that exceed minimum standards for critical facilities

   Planning ahead, the City should prepare for the worst so as to increase resiliency, particularly of critical facilities. Expecting hazards that are more intense than previously experienced, the City cannot risk using low standards.

3. Use comprehensive infrastructure assessments to identify infrastructure in need of replacement and prioritize funding for those projects

   It is important to prioritize key improvement projects to be sure that the most vulnerable infrastructure assets are strengthened first.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BCHD, BCRP, DGS, DOP, DOT, DPW, Energy Office, MOEM
Alignment with Goals	Goal 4
Connection with Existing Efforts	ESF-3; ESF-5
Timeframe	



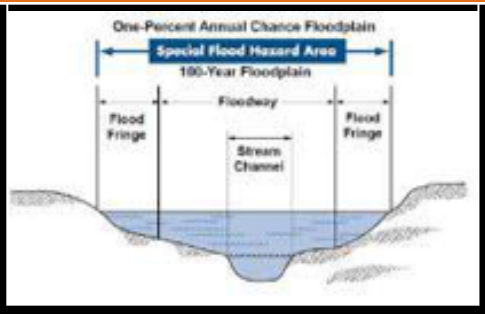






Buildings




One-Percent Annual Chance Floodplain
Special Flood Hazard Area
100-Year Floodplain
Floodway
Flood Fringe
Flood Fringe
Stream Channel

CITY CODES AND DESIGN GUIDELINES

BL-1 Develop and implement hazard protections for critical facilities including hospitals, fire stations, police stations, hazardous material storage sites, etc.

Prevent structural damage from all natural hazards to critical facilities through adaptation and mitigation actions. Strengthen existing building codes and land use regulations, focusing on efforts to enhance the resiliency of energy systems and reduce vulnerability from flooding .

1. Conduct educational outreach for city-owned, residential, commercial, and industrial buildings about proper storage and disposal of hazardous materials and heating oil (S)

   Prevent additional health and safety risks by educating about the requirements regarding proper care and storage of hazardous materials, which are vulnerable during hazard events and could increase the risks associated with hazard impacts.

2. Require hazardous materials stored in city-owned, residential, commercial, and industrial buildings within the floodplain to be elevated a minimum of three feet above the freeboard (M)

   Hazardous materials that are exposed to flood water can become a significant danger. It is crucial to review methods for increasing hazardous material protection within the floodplain by requiring higher elevations, considering potential standards for retrofitting existing systems.

3. Require new critical facilities to be designed with redundant operating systems (L)

   To improve the resiliency of any new critical facility, it is important to amend Building Codes to require a higher level of protection and critical systems redundancy.

4. Require pre-wiring for generators at all facilities designated critical to agency operations and hazard response (M)

   Critical facilities allow for proper emergency response during hazard events. It is important to consider new regulations to pre-wire certain facilities to accept generators to ensure that critical facilities have redundant power supplies.

5. Develop stricter flood regulations for critical facilities (M)

   While all floodplain regulations should be updated to accommodate climate change, this is especially true for critical facilities which provide emergency response services. Stricter regulations should be required for these critical facilities.

6. Develop partnership with private fueling stations to provide backup generators in exchange for a commitment to fueling emergency response vehicles during a hazard event

   Emergency personnel must be able to respond quickly, providing continuous fueling to vehicles that are critical for emergency response. By partnering with private fueling stations, the City can ensure that these facilities remain in operation during a hazard event so as to permit fueling of emergency response vehicles.

7. Ensure storage of and access to fuel for generators in critical facilities

   Redundant power systems require adequate resources. Critical facilities should not be without adequate supply of fuel to power generators during hazard events.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BGE, DGS, DOP, DPW, Hospitals, Material Storage Sites
Alignment with Goals	Goals 2, 5, and 6
Connection with Existing Efforts	 CRS; ESF-3; ESF-5; ESF-10
Timeframe	

Floods + Buildings | Glossary of Terms

Actual Cash Value (ACV)	The cost to replace an insured item of property at the time of loss, less the value of physical depreciation.
Base Flood	The flood having a 1% chance of being equaled or exceeded in any given year.
Base Flood Elevation (BFE)	The elevation shown on the Flood Insurance Rate Map (FIRM) for Zones AE, AH, A1-A30, AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO, V1-V30, and VE that indicates the water surface elevation resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.
Breakaway wall	A wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building or supporting foundation system.
Elevated Building	A building that has no basement and has its lowest elevated floor raised above the ground level by foundation walls, shear walls, posts, piers, pilings, or columns. Solid foundation perimeter walls are not an acceptable means of elevating buildings in V and VE zones.
Enclosure	That portion of an elevated building below the lowest elevated floor that is either partially or fully shut-in by rigid walls.
Lowest Floor	The lowest floor of the lowest enclosed area (including a basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area, is not considered a building's lowest floor provided that such enclosure is not built so as to render the structure in violation of requirements..
National Flood Insurance Program (NFIP)	A federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.
Post-FIRM Building	A building for which construction or substantial improvement occurred after December 31, 1974, or on or after the effective date of an initial Flood Insurance Rate Map (FIRM), whichever is later.
Pre-FIRM Building	A building for which construction or substantial improvement occurred on or before December 31, 1974, or before the effective date of an initial Flood Insurance Rate Map (FIRM).
Replacement Cost Value (RCV)	The cost to replace property with the same kind of material and construction without deduction for depreciation.
Special Flood Hazard Area (SFHA)	A FEMA-identified high-risk flood area where flood insurance is mandatory for properties. An area having special flood, mudflow, or flood-related erosion hazards, and shown on a Flood Hazard Boundary Map or a Flood Insurance Rate Map as Zone A, AO, A1-A30, AE, A99, AH, AR, AR/A, AR/AE, AR/AH, AR/AO, AR/A1-A30, V1-V30, VE, or V.
Wave Height Adjustment	A measurement that is added to the base flood elevation for V Zones shown on the Flood Insurance Rate Map published prior to 1981. For coastal communities, the base flood elevation shown on Flood Insurance Rate Maps published prior to 1981 are still-water elevations, which include only the effects of tide and storm surge, and not the height of wind-generated waves.

BL-2 Enhance City building codes that regulate building within a floodplain or near the waterfront

Baltimore Building Codes should be amended to help protect building systems and enable continued building operation in a flooding event. It is essential to identify ways to facilitate the voluntary construction of new, more resilient building stock and to encourage voluntary retrofits of existing vulnerable buildings over time. Build the City's resilience to flooding and sea level rise hazards through enhanced building codes and regulations in flood-prone areas. Use both adaptation and mitigation actions to increase disaster prevention measures.

1. Design new projects to be resilient to a mid-century sea level rise projection and adaptable to longer-term impacts

   In order to reduce future flooding impacts and the need to possibly relocate facilities due to sea level rise, projects should be required to be resilient to a mid-century sea level rise projection.

2. Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet as buildings are redeveloped and renovated (S)

   The City should prepare for increased flooding events and future sea level rise and incorporate resiliency to coastal hazards into building design through building code requirements. In early 2012, Governor O'Malley released an executive order on Climate Change and "Coast Smart" Construction that requires all State agencies to consider and evaluate coastal hazards in development and construction projects in order to avoid or reduce impacts. In June 2013, to expand the scientific research, Gov. O'Malley and the Maryland Climate Change Commission released the Updating Maryland's Sea-Level Rise Projections report.

3. Continue to regulate to the existing tidal floodplain delineation as adopted 2 February, 2012 (S)

   While using the existing tidal floodplain delineation, exceptions cannot be made. Current regulations will remain in place and should be seen as strict requirements. The current floodplain delineation captured the impact of Isabel. The proposed tidal floodplain delineation reflected that Isabel was a 500-year event. Current regulations, including the one-foot freeboard requirement, will remain in place for the current floodplain delineation and should be seen as a reasonable requirement.

4. Incorporate outfall elevation regulations (S-M)

   It is important to incorporate outfall pipe elevation regulations into the maintenance and improvement of water infrastructure to increase the system's capacity to handle excessive flows and higher tides.

Flooding at the Jones Falls, Mt. Washington *Source: Flickr.com*

Flooding at the Jones Falls, Mt. Washington *Source: Flickr.com*

5. Develop Construction Best Practices for development within floodplains (S)

   Even with tighter regulations of development within floodplains, construction practices, if not suitable, can leave a building vulnerable to flood hazards. It is essential to ensure proper design through the development of Construction Best Practices guidelines.

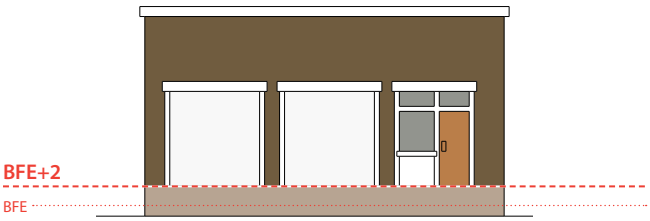
6. Train all code enforcement and building inspectors about flood proofing techniques and the local floodplain ordinance (M)

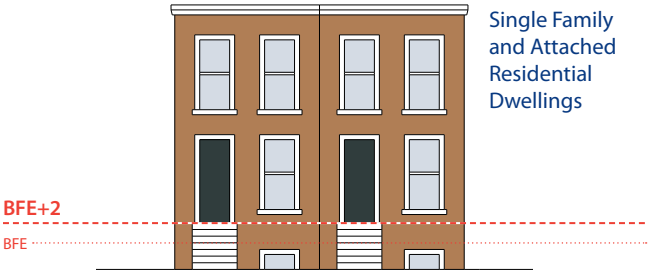
   Code enforcement workers and building inspectors should be prepared to look for vulnerabilities in buildings within the floodplain so as to identify key upgrades for preventing future damage.

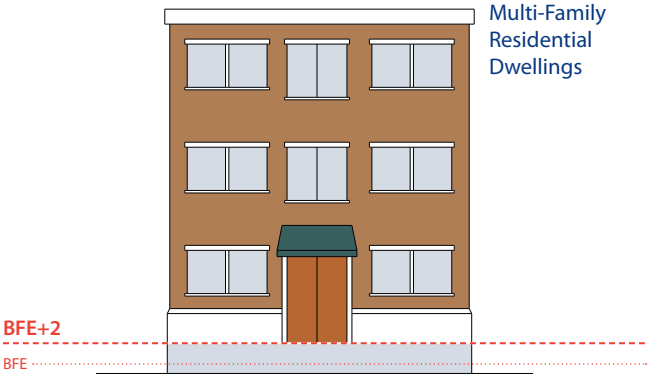
7. Encourage green roof installations to include vegetated and reflective technologies for all new commercial, industrial, multifamily, and city-owned development (M)

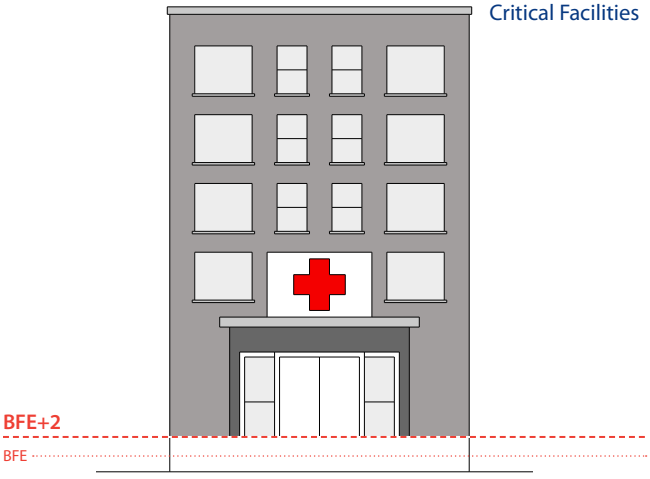
   Vegetated roofs provide energy savings benefits, reduce the urban heat island effect, and increase rainwater capture. Where feasible, the use of vegetated or reflective roofs for new commercial, industrial, multi-family, and city-owned developments should be implemented.

IMPLEMENTATION GUIDELINES	
Lead Agency	Department of Planning
Stakeholders	Baltimore County, BDW, DHCD, DOP, DPW, MDE, Utilities
Alignment with Goals	Goals 3 and 6
Connection with Existing Efforts	CAP; CRS; ESF-3; ESF-5; ESF-12
Timeframe	









BL-3 Strengthen City zoning, floodplain and construction codes to integrate anticipated changes in climate

Increase the resilience of Baltimore's buildings and properties to all hazards by addressing land use and stormwater and floodwater management systems. City codes and standards must continue to develop and incorporate climate risks to both protect existing buildings and strengthen new and substantially improved buildings. Utilize both adaptation and mitigation actions to improve building codes and regulations will increase the resiliency of Baltimore's building stock.

1. Review zoning code and strengthen language (where necessary) in order to better protect citizens and increase resiliency in buildings (M)

   City planning, design, and land use are all important aspects of resiliency to flooding hazards. It is important to review existing codes to assure that residents and buildings are adequately protected. Citywide zoning code changes can provide flexibility. Baltimore has recently undergone a comprehensive zoning code rewrite, to which DP3 strategies and actions will be reviewed.

2. Review and amend existing building and floodplain regulations to require more flood resistant new and existing structures when located in the floodplain (M,O)

   New construction and renovation projects should increase resiliency to flooding hazards. It is important to review and amend existing codes, where necessary, to require the use of flood resiliency strategies.

3. Utilize open space category in zoning code to protect sensitive areas (e.g. stormwater sites, steep slopes, floodways, etc.) (M)

   Recognizing the mitigation potential of natural systems and features, identify opportunities to utilize key properties to protect vital landscapes and incorporate the open space land use designation to do so.

4. Review and increase Flood Protection Elevation (Base Flood Elevation + Freeboard) standards to the highest available State, Federal or local elevation level (S)

   It is essential to plan ahead and prepare for more frequent and intense flooding events. Accordingly, Flood Protection Elevation should be set to a higher standard. This is done by requiring Freeboard (an additional vertical height requirement) on top of the Base Flood Elevation when designing, planning and regulating within the floodplain.

5. Evaluate and update stormwater management regulations to avoid increases in downstream flooding (S)

   Measures taken upstream and reduce negative impacts downstream during hazard events. The City should identify priority improvement projects and update stormwater management regulations, where appropriate, to avoid downstream flooding.

6. Adopt design requirements that include wet and dry flood proofing techniques (S)

   The City will review for adoption, whole or in part, the ASCE 24-05 *Flood Resistant Design and Construction*. ASCE 24 establishes the minimum requirements and expected performance for the design and construction of buildings and structures in flood hazard areas. It is not a restatement of all the NFIP regulations, but offers additional specificity, some additional requirements, and some limitations. Buildings designed according to ASCE 24 are better able to resist flood loads and flood damage than those structures meeting the NFIP minimum requirements. It is important to adjust requirement to modify building design standards and increase the use of flood-proofing techniques to reduce building damage from storm events.

7. Review and consider adoption of the International Green Construction code (S,O)

   It is critical to ensure the flexibility to adopt the Green Construction code by establishing several levels of compliance, starting with the core provisions of the code, and then offering "jurisdictional requirement" options that can be customized for individual projects.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BDC, City Government, Community Groups, DHCD, DGS, DPW, NAHB, NGOs, MDE, Private developers, Private land owners
Alignment with Goals	Goals 3, 4, and 6
Connection with Existing Efforts	 CAP; CRS; ESF-3; ESF-5
Timeframe	

BL-4 Update a list of flood prone and repetitive loss buildings to consider for acquisition

In some cases it is too expensive or physically impossible for building owners to elevate or flood-proof their property. Where properties suffer from repetitive losses due to flooding, it is important to consider ways to increase their resiliency through physical improvements, or purchase and remove them from the floodplain by demolishing them. Acquisition of flood prone properties requires collaboration between many city agencies, residents and property owners in the area which is often difficult; it is also an expensive option. The City will focus its efforts on updating the list of flood prone and repetitive loss properties which will help prioritize and guide mitigation funding and future acquisitions.

1. Continue to acquire property (including repetitive loss properties) in the special flood hazard areas where feasible and appropriate (O)

   Where possible, acquire properties within flood-prone areas to prevent repetitive damage to private property.

2. Prioritize Hazard Mitigation Assistance funding for mitigation of repetitive loss properties and severe repetitive loss properties (O)

   In order to reduce the frequency of damage from flooding, it is important to identify key properties for mitigation efforts.

3. Develop a creative financing program for flood resiliency in industrial buildings

   It is crucial to explore alternative financing sources for projects in industrial buildings to encourage pursuit of flood resiliency measures.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	DHCD, DOP, MEMA, MDE, Office of Real Estate
Alignment with Goals	Goals 2 and 6
Connection with Existing Efforts	 CRS; ESF-3; ESF-5
Timeframe	

STRUCTURAL

BL-5 Improve wind resiliency of new and existing structures

Scientific projections suggest an overall increase in the frequency of the most intense storm events that are accompanied by wind hazards. Current Building Code requirements should take into consideration this projected increase. Recognizing that older buildings that predate modern standards are particularly vulnerable, efforts should address renovations to both new and existing structures. The City will review existing building codes and identify where wind-resistance specifications must be made for both façade elements and rooftop structures and equipment.

1. Review local building codes to determine if revisions are needed to improve the structures ability to withstand greater wind velocities and storm impacts (S)

   To address the uncertainty of future wind events, and to improve Baltimore's approach to protecting buildings from wind risks, consider revisions to existing codes where greater wind velocities or storm impacts are possible. Taking a precautionary measure, Baltimore will amend Building Code to clarify current wind-resistance specifications, so as to increase Baltimore's extreme weather resiliency through structural improvements. The City will use both adaptation and mitigation actions to prepare for future high wind and storm events.

2. Retrofit emergency shelter windows to withstand winds associated with coastal storm events (L)

   To increase the resiliency of the City's emergency shelters, which protect residents during hazard events, buildings should be retrofitted to upgrade windows so as to withstand higher wind speeds.

IMPLEMENTATION GUIDELINES	
Lead Agency	DHCD
Stakeholders	BDC, Commercial Building Owners, DGS, DOP, MDE, MOEM, Private Developers
Alignment with Goals	Goal 2
Connection with Existing Efforts	ESF-3; ESF-6
Timeframe	

Wind Damage in Baltimore City *Source: Kim Haris*

Damage from a 2010 Earthquake in Chile *Source: Inhabitat*

BL-6 Evaluate various seismic design enhancements using prototypical Baltimore City building types

In 2011, Baltimore experienced a magnitude 5.8 earthquake, originating in Virginia. Due to this event, it is essential to increase Baltimore's resiliency to earthquakes and other seismic events.

1. Determine engineering effectiveness and cost-benefit of various earthquake mitigation measures using computer modeling

It is important to utilize computer software to identify the potential risks association with seismic activity, and determine the effectiveness and cost-benefit of structural mitigation measures.

IMPLEMENTATION GUIDELINES	
Lead Agency	DGS
Stakeholders	BDC, Commercial Building Owners, DGS, DOP, MDE, MOEM, Private Developers
Alignment with Goals	Goal 2
Connection with Existing Efforts	ESF-3
Timeframe	

BL-7 Retrofit existing buildings in the designated Flood Area to increase resiliency

It is critical to improve flood damage prevention measures by increasing structural resiliency through mitigation actions such as retrofits and upgrades. To accomplish this, engineering alternatives will be studied, where assets cannot be moved, and measures will be developed that identify how to best increase structural resiliency within the designated Flood Areas.

1. Target and encourage flood resiliency retrofits for buildings in the designated Flood Area

   Larger buildings have higher risk for impacting a greater number of people, and should therefore be encouraged to implement resiliency retrofit measures, including the relocation of critical mechanical and operation equipment, structural reinforcement, building to a higher than otherwise required base flood elevation, or other strategies. It should be noted that all new work must meet floodplain development requirements. Also, if the cumulative structural improvements (i.e. over a 10 year period) exceed 50% of the structures value (not including land), then the whole structure would need to be brought up to floodplain code.

   Explore and develop a creative financing program for residential and commercial properties to assist with retrofitting buildings. This may require evaluation of FEMA's Public Assistance Policy 9525.1 Post-Disaster Property Tax Reassessment which may assist in reducing financial burdens on commercial property owners who suffer significant structural damage and are faced with major costs of repair.

2. Prioritize retrofitting and increasing resiliency of Public Housing units in the designated Flood Area and other high risk areas

   It is important to evaluate and prioritize resiliency investments for Public Housing developments to incorporate new flood resiliency measures and ensure protection of vulnerable populations. The Housing Authority of Baltimore City (HABC) serves nearly 20,000 residents with an inventory of nearly 11,000 units. Residents include seniors, low-income households, working class and other vulnerable populations. Due to their initial placement, many Public Housing buildings, both public and private, are particularly vulnerable to natural hazards and require resiliency upgrades. Upgrading buildings electrical and mechanical equipment and flood-proofing essential systems are just some of the methods necessary to increase resiliency and protect residents.

3. Educate building owners within the floodplain to ensure that all electrical, mechanical, and key building systems are above the base flood elevation and meet existing codes

   There are approximately 5,968 buildings located in the City's regulated 100-Year and 500-Year floodplains. Working with building owners and developers, the City will identify methods to reduce damage to utilities caused by flooding through behavioral and operational changes. An educational program should illustrate strategies for preventing flooding impacts—which may include relocating compressors to roofs or off of the ground, or properly storing materials above the flood protection elevation.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BDC, DHCD, DPW, Federal and State Partners, MCC, MON, NGOs, MOEM
Alignment with Goals	Goal 2, 3, and 6
Connection with Existing Efforts	N/A
Timeframe	

National Flood Insurance Program (NFIP)

"Flooding is America's most common natural disaster. Yet it's not covered by most homeowners insurance."

Unfortunately, many home and business owners do not find out until it is too late that their homeowners and business multiperil policies do not cover flooding.

The National Flood Insurance Program (NFIP) was created by Congress in 1968 to help provide a means for property owners to financially protect themselves against the risks of flooding. Baltimore City, as a participating community, agrees to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding. Almost everyone in a participating NFIP community can buy flood insurance.[1]

The NFIP offers flooding insurance to both homeowners and business owners. The insurance system is based on the principle of risk-based premiums: those with greater risk (i.e., those more likely to suffer damage and require a claims payment from an insurance provider) should pay higher premiums than those with less risk. Thus, an owner of a property in an area prone to floods and hurricanes should pay more for insurance than the owner of a property in an area with less risk. The reason insurance providers must charge risk-based rates is that these rates are necessary for providers to remain financially solvent and have sufficient resources to pay policyholder claims in the event of losses.

How does NFIP define "flooding"?

Covered flooding is defined by NFIP as a general and temporary condition during which the surface of normally dry land is partially or completely inundated. Two properties in the area or two or more acres must be affected. Flooding can be caused by:

- Overflow of inland or tidal waters, or
- Unusual and rapid accumulation or runoff of surface waters from any source, such as heavy rainfall, or
- Mudflow, i.e., a river of liquid and flowing mud on the surfaces of normally dry land areas, or
- Collapse or subsidence of land along the shore of a lake or other body of water, resulting from erosion or the effect of waves, or water currents exceeding normal, cyclical levels.

FEMA emphasizes the threat of flooding, noting that property owners may still be at risk despite being located far from a water source. In fact, FEMA explains that an average of 25-30 percent of flood insurance claims come from low-to-moderate risk areas.

Further Reading:

FEMA provides a host of additional resources about NFIP on their website. For more information, refer to their Publications.

1 FloodSmart.gov

Biggert-Waters Flood Insurance Reform Act

In 2012, Congress passed and the President signed the Biggert-Waters Flood Insurance Reform Act of 2012. The law extended the NFIP for five years, and calls on FEMA and other agencies to make a number of changes to the way in which the NFIP operates. To strengthen the NFIP financially, Section 100205 of the new law requires FEMA to begin charging rates that reflect true flood risk; artificially low rates and deep subsidies are no longer sustainable. Beginning October 2013, premiums for pre-FIRM business properties, severe repetitive loss properties (1–4 residences), and properties on which claims payments exceed fair market value will increase by 25% annually until they reflect the full-risk rate. Routine rate revisions will also include a 5% assessment to build a catastrophic reserve fund. Phasing-out of both grandfathering and the Preferred Risk Eligibility Extension will begin in 2014 and rates are anticipated to rise 20% per year over a 5-year period until they reach full risk rates.

This is a huge change and many property owners in Baltimore City will be affected by the new law. Property owners who face increased premiums should discuss options such as verifying the accuracy of the rate determination, increasing the deductible, or retrofitting to or rebuilding at a higher elevation. The City of Baltimore will also work to become a CRS community which will lower premiums for policy holders.

NON-STRUCTURAL

BL-8 Improve resource conservation practices in all City owned buildings

Increase resiliency of City Government buildings by increasing efficiency of internal energy systems, and increased measures for energy conservation. Energy use reduction is important for regional energy supply protection during extreme heat events and other high energy demand situations.

1. Install energy-efficient and low-water-use equipment during renovations in all City-owned buildings (M)

   By reducing energy demand and increasing water conservation measures, buildings are better suited to avoid or reduce impacts associated with hazard events. City-owned facilities should incorporate energy efficient and low-water-use equipment into scheduled renovation projects.

2. Support energy efficiency, weatherization and renewable energy generation as part of Baltimore City schools ten-year plan (S)

   Providing emergency shelter during hazard events, and serving as key community facilities throughout the year, school facilities will require additional measures to increase resiliency and prevent damage. To mitigate climate change and reduce energy demand, while at the same time increasing a building's capacity to withstand hazard events, energy efficiency, weatherization, and renewable energy generation should be incorporated into the Baltimore City School System's ten-year plan.

3. Update Baltimore green building standards by offering multiple compliance paths for new and substantially renovated construction

   Baltimore should provide an example and model for green building within the City and set a precedent that will encourage more green building projects, thus increasing resource efficiency.

IMPLEMENTATION GUIDELINES	
Lead Agency	DGS
Stakeholders	MOEM, BCPSS, DCHD, DGS, DOP
Alignment with Goals	Goal 3
Connection with Existing Efforts	CAP; CHAP
Timeframe	

BL-9 Conduct educational outreach to increase resource conservation practices in private buildings

Increase hazard mitigation awareness through resource conservation educational materials and programs for the general public and businesses. Include information about utilities, water use, energy savings programs, hazardous materials, and electricity demand.

1. Conduct educational outreach and provide information about savings related to reduced water use (S)

   Conserving water resources reduces reliance on the City's systems during low supply events. The City encourages additional educational outreach efforts to convey the importance and benefits of water conservation measures.

2. Educate and provide resources and information about utility rebate programs

   To encourage energy efficiency, water conservation, and weatherization efforts, it is important to develop an educational program into existing communication efforts.

3. Provide energy efficiency education to include information on conserving electrical power. Emphasize reductions during summer peak demand hours (S)

   Reducing energy demand could lessen the burden on the power supply system during high heat events. It is important to build upon existing educational programs that provide information regarding energy efficiency and conservation, such as the Baltimore Energy Challenge (BEC).

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BCPSS, BGE, BOS, DOP, Exelon, MON, NGOs, MOEM
Alignment with Goals	Goal 5
Connection with Existing Efforts	CAP; ESF-5; ESF-11
Timeframe	

BL-10 Use HAZUS-MH computer modeling to determine losses generated by coastal storms

Protect the health, wellness, and safety of Baltimore residents by evaluating mitigation practices as the results speak to potential losses generated by coastal storms and extreme wind, flood and earthquake events through the use of computer modeling technology. Determine possible mitigation measures, and identify adaptation responses.

1. Utilize engineering studies and cost-benefit analyses to identify additional mitigation needs and actions

   Through the use of engineering studies and cost-benefit analyses, the City will consider and identify where additional steps may be taken to mitigate the impacts of hazard events.

2. Evaluate various building design enhancements to reduce losses generated by earthquakes, floods, and storm surge

   Considering the potential future impacts of natural hazards, more efficient building design techniques will be evaluated and encouraged. Update seismic engineering requirements to current national standards. Take into account soil and foundation underpinning. Require seismic detailing and inspections to ensure compliance. Perform seismic study of existing tall buildings. Retrofit buildings to exceed new building code seismic provisions.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	DHCD,FEMA, MEMA, MOEM, NOAA
Alignment with Goals	Goal 1
Connection with Existing Efforts	ESF-3
Timeframe	









Natural Systems














URBAN PARKS AND FORESTS

NS-1 Utilize green corridors and parks to help protect surrounding communities from the impacts of hazard events

Leverage natural features to protect the health, wellness, and safety of Baltimore residents. Regard natural elements such as stream corridors and trees for their capacity to mitigate the impacts of hazard events. This strategy is primarily focused on mitigation actions, but recognizes that increased natural capacity can positively influence climate adaptation efforts.

1. Evaluate green corridors and parks for possible improvements for floodplain management (M)

   Baltimore will seek to protect parks and increase the capacity of its park system to absorb floodwaters (from storm surge and heavy precipitation) through tree plantings, stormwater management and stream restoration.

2. Increase the resiliency of park facilities and buildings

   Though park facilities and buildings may not provide an emergency service, they are nonetheless vital amenities for the communities they serve. Baltimore will work to protect these facilities from the impacts of climate change and to enable them to quickly re-open when impacts do occur.

IMPLEMENTATION GUIDELINES	
Lead Agency	BCRP
Stakeholders	DOP, Community Groups, DPW, NGO's
Alignment with Goals	Goals 1 and 6
Connection with Existing Efforts	CAP; CRS; MD DNR
Timeframe	

Patterson Park

Source:: Jay Moore

NS-2 Increase and enhance the resilience and health of Baltimore's urban forest

Baltimore's urban forests and trees offer countless environmental benefits, but are vulnerable to climate change-related impacts and hazards, including storm surge, wind, and changes in average temperatures. Increasing Baltimore's tree canopy will improve stormwater management, increase air quality and reduce impacts from the urban heat island.

1. Anticipate the impacts of future changes in temperature and weather on the urban forest by developing a comprehensive list of plant and tree species known to have a broad range of environmental tolerances (S)

   With changing climate trends, much of today's landscape may not be able to withstand future temperatures, rainfall patterns, or other conditions. Landscaping and habitat conservation efforts must consider plant species that are appropriate for today's climate, as well as able to withstand future conditions to prevent widespread loss of vegetation. It will be important to refer to Baltimore City Recreation and Parks' comprehensive list of appropriate tree species for street tree plantings.

2. Establish and routinely update a comprehensive tree inventory to anticipate insect and forest structural impacts of climate change (S)

   It is essential to maintain an ongoing inventory of trees to be used to identify significant impacts and areas in need of restoration.

3. Establish a comprehensive maintenance program that includes pruning for sound structure and the removal of hazardous limbs and trees. First focus on areas where vulnerable infrastructure is nearby such as energy supply and roads (M)

   Baltimore will establish a comprehensive tree maintenance program and modify standard tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events.

4. Continually adjust and modify planting details and specifications to assure the health and longevity of trees (S)

   Utilizing the tree inventory, identify locations to assist with tree growth and reducing the high rate of tree mortality and failure during storms.

5. Increase the urban tree canopy and target areas with urban heat island impacts (O)

   Trees are recognized for their ability to provide significant air quality and cooling benefits. It is important to assure that planting efforts increase tree canopy coverage in targeted areas to reduce the impact of extreme heat events.

Baltimore Forests *Source: BaltimoreSun*

IMPLEMENTATION GUIDELINES	
Lead Agency	BCRP (Forestry)
Stakeholders	USFS, BGE, Community Groups, DOP, DOT, DPW, MDNR, NGOs
Alignment with Goals	Goal 1
Connection with Existing Efforts	CAP; MD DNR
Timeframe	

NS-3 Create an interconnected network of green spaces to support biodiversity and watershed based water quality management

Enhance Baltimore's adaptive capacity through the establishment of an interconnected system of green spaces and natural features which increase biodiversity and reduce stormwater runoff. Actions focus on using vacant properties to create new green spaces and linking these to existing parks, stream valleys, and public lands.

1. Utilize the Growing Green Initiative (GGi) to increase green spaces in areas where there is available vacant land in order to reduce the heat island effect (O)

   In areas that are vulnerable to heat-related hazards, the increase in green spaces is desirable. The Growing green Initiative can serve as a tool for communities, non-profits, and public agencies to reduce impervious surfaces by establishing new gardens, forests, green stormwater infrastructure, and parks.

2. Convert vacant land and row houses into meaningful and connected open space (O)

   Baltimore's distressed neighborhoods often have large amounts of vacant properties but lack parks and green spaces. The opportunity to create green stormwater facilities, parks, and other types of community green spaces should be used as criteria for targeting whole block blight demolition and re-using of vacant lots for community benefit and to help link residents to adjacent parks and open spaces.

3. Complete a habitat analysis and plan for the City

   The City should promote and encourage habitat preservation and restoration throughout the City and explore options for creating an interconnected network of green patched and corridors. This will require an analysis of existing conditions and the development of a plan and supporting strategies and policy recommendations to enhance the quality, biodiversity and connectivity of Baltimore's green spaces and habitat patches.

4. Create a strategic plan that identifies areas of focus for tree planting, stormwater management, and forest preservation

   It is important to explore more and larger green infrastructure programs to absorb stormwater, mitigate local flooding, decrease urban heat island effects, increase pedestrian and traffic safety, and beautify neighborhoods. This includes expanding the use of green infrastructure at appropriate locations in City streets to improve water quality in combined sewer areas.

5. Certify Baltimore as a Community Wildlife Habitat through the National Wildlife Foundation (NWF)

   A Certified Community Wildlife Habitat, a certification offered by the National Wildlife Foundation (NWF), provides habitat opportunities throughout the community- in yards, on school grounds, in community gardens and in parks and other public spaces. Baltimore will become certified by certifying yards, parks and schools through NWF and educating residents about sustainable gardening practices.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BCRP, BDC, Community Groups, DHCD, DOP, DPW, Federal Agencies, MDNR, NGOs, State Agencies
Alignment with Goals	Goal 4
Connection with Existing Efforts	 CAP; MD DNR
Timeframe	

NS-4 Expand, protect and restore riparian areas in the city

Baltimore will pursue cost-effective methods for using stream valleys and associated natural features to protect adjacent land and communities from the impacts of flooding hazards. Utilize adaptation and mitigation actions to address the capacity of riparian buffers.

1. Conduct regular maintenance of stream restoration projects and stormwater quality facilities

   Stream systems can serve to buffer the impacts of severe weather events. Proactively maintaining these systems will increase the capacity to withstand significant precipitation levels.

2. Evaluate current regulations regarding stream buffers and floodplains and modify them (if appropriate) to assure they adequately protect perennial stream corridors

   Baltimore will restore freshwater streams and restore or construct wetland systems to manage stormwater runoff and reduce the impacts of extreme weather events. Riparian buffer planting protect stream edges and provide a safe edge during flood events. Some areas of the City are more likely to experience increased flooding impacts. As the floodplain is expected to rise and expand, more land must be dedicated to establishing and restoring natural stream buffers.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BCRP, DOP, DPW
Alignment with Goals	Goal 1
Connection with Existing Efforts	MD DNR
Timeframe	∞

Example of a Stream Restoration Effort

Source: DHEC.co.za

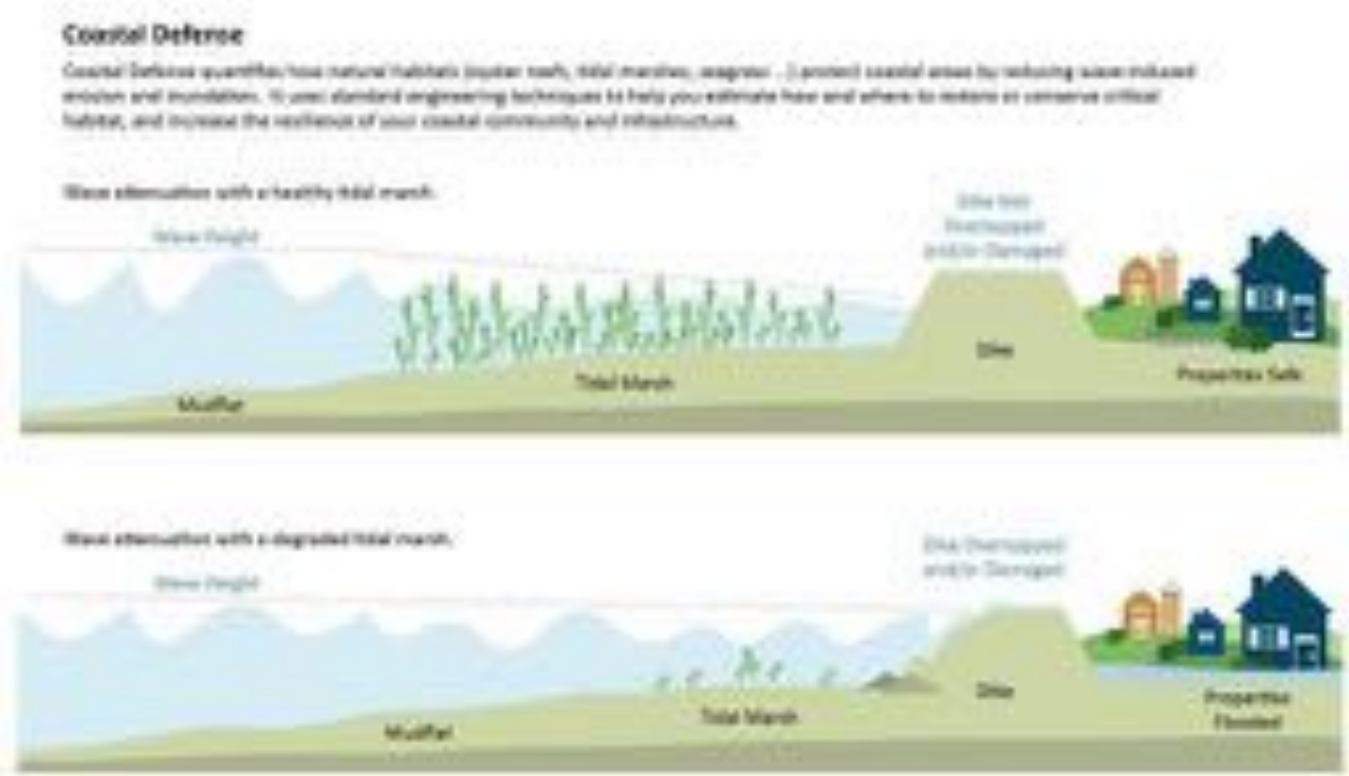


Diagram showing potential for coastline defense with natural elements

Source: CoastalResilience.org

Stream restoration efforts stabilize natural buffers

Source: CBF.org

NS-5 Preserve and create new coastal buffer efforts and support creating more wetlands and soft shoreline along coastal areas

Enhance ecological buffers along coastal areas to increase floodwater management and resiliency to flooding and sea level rise. Protect the health, safety, and welfare of Baltimore's residents with both adaptation and mitigation efforts.

1. Integrate natural buffer requirements, such as wetlands and soft shorelines, into new development or redevelopment (S)

   Explore innovative coastal protection techniques, such as soft infrastructure investments, for flood and wave risk reduction. Likewise, wetlands can act as natural buffers that protect upland communities by retaining some water and absorbing wave strength during storm conditions.

2. Complete stream restoration projects in Baltimore City and County stream valleys that lead into the coastal wetlands so as to increase habitat and reduce sedimentation (L)

   Efforts to protect stream systems upstream will prevent damage downstream and maintain a healthy hydrological system. This will require cooperation with Baltimore County and other jurisdictions outside of Baltimore.

3. Identify and evaluate areas in the Critical Area buffer to prioritize ecological buffer restoration efforts

   Key areas are in need of additional or immediate improvements, and prioritized restoration efforts will increase the stream system's resiliency. It is critical to ensure the flexibility to adopt the Green Construction code by establishing several levels of compliance, starting with the core provisions of the code, and then offering "jurisdictional requirement" options that can be customized for individual projects.

Source: ChicagoWilderness.org

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BCRP, BDC, DOP, DPW, NGOs, State Agencies, Waterfront Partnership
Alignment with Goals	Goals 1 and 6
Connection with Existing Efforts	CRS; MD DNR
Timeframe	

The natural systems sub-committee recognizes that enhancing and improving the resilience of Baltimore's water supply is an essential natural systems element. This is reviewed in the infrastructure section under IN-14.

WATER SUPPLY AND MANAGEMENT

NS-6 Require the City's drought management plan to account for changes in climate

Enhance the adaptive capacity of the City's Water Supply with increased drought preparedness. This strategy is primarily focused on mitigation actions. The Maryland Department of the Environment, through the Maryland Statewide Water Conservation Advisory Committee, released the Statewide Drought Monitoring and Response Plan in 2000 to outline methods for monitoring, as well as steps to respond to, drought conditions. In this plan, the City of Baltimore rests within the Central Region for drought monitoring and response. The Susquehanna River Basin Drought Coordination Plan, also produced in 2000, includes Baltimore City within the lower basin area. This plan notes that the U.S. Army Corps of Engineers has developed drought management plans for each reservoir project in the Susquehanna River Basin. It will be important that these and other drought management plans are updated to reflect the most recent conditions and vulnerabilities.

1. Map drought risks and water availability via climate change scenarios

   The City should identify future risks and vulnerabilities of the water supply system to better understand the risks association with drought and climate change-related hazards.

2. Update drought management plans to recognize changing conditions (S)

   Projected changes in future conditions should be incorporated into drought management plans to prevent future impacts.

IMPLEMENTATION GUIDELINES	
Lead Agency	DPW
Stakeholders	BCHD, Water Utility
Alignment with Goals	Goal 4
Connection with Existing Efforts	CAP
Timeframe	

NS-7 Integrate climate change and natural hazards planning into small watershed action plans (SWAPs)

The City will integrate climate change and hazard mitigation into Small Watershed Action Plans (SWAPs) to protect water quality and quantity. Increase the adaptive capacity of the City's stormwater and floodwater management system. Use adaptation and mitigation actions.

1. Review existing watershed management plans and identify future actions to address climate impacts

   The City will enhance efforts to protect its watersheds and review opportunities to revise existing management plans to implement watershed protection efforts that address potential future impacts associated with climate change.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	DOP, DPW, NGO's
Alignment with Goals	Goal 4
Connection with Existing Efforts	CRS; MD DNR
Timeframe	

NS-8 Conduct detailed ongoing analysis of climate information, trends in storm events and hydrology to support policy changes responding to climate change

Use detailed analysis of accurate data to support flood policies to protect the health, safety, and welfare or Baltimore's residents from changes in sea level rise. This strategy is primarily concerned with adaptation measures Baltimore must use to update all City planning and emergency preparedness efforts.

1. Expand the use of climate information (e.g. seasonal forecasts) in water resources planning and management (S)

   The City must recognize the environmental and climatological conditions that impact water resources and incorporate the information into resource planning and management to better understand and prepare for hazard impacts.

2. Research and actively monitor trends in storm events, stream flow and other conditions affecting hydrology and water (O)

   As scientists expect conditions to change over the coming century, the City intends to respond effectively to hazard events. To do so, the City will seek to identify and utilize appropriate tools for monitoring trends in storm events and environmental conditions.

3. Update flood maps to reflect changing risk associated with climate change (S)

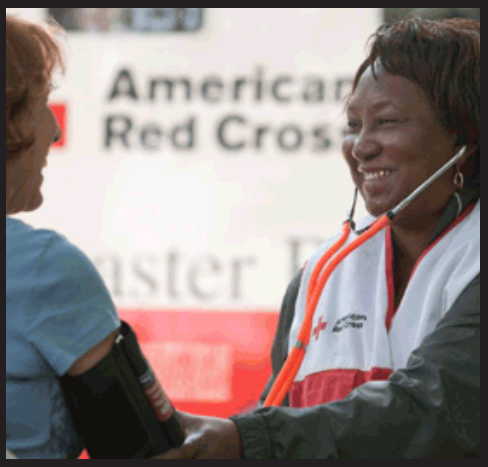
   Flood maps should be updated regularly to reflect changing risks associated with climate change. The City will work with FEMA to revise existing flood maps to recognizing existing and future risks from flooding.

4. Continuously improve and enhance flood vulnerability data (O)

   Flood vulnerability data is constantly evolving. The City should continue to take steps to improve and enhance this data and incorporate new information into citywide efforts to reduce impacts associated with flooding.

The Jones Falls through Mt. Washington, Flooded (above) and showing Average Conditions (below)

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BDC, FEMA, MDE, MDNR, MEMA, NGOs, State Agencies, Waterfront Partnership
Alignment with Goals	Goals 1 and 6
Connection with Existing Efforts	CRS; MD DNR
Timeframe	







Public Services













EMERGENCY PREPAREDNESS AND RESPONSE

PS-1 Strengthen emergency preparedness coordination between local government, NGOs, and private entities by updates to the City Emergency Operations Plan (EOP) and related Emergency Support Functions (ESF)

Increase Baltimore's adaptive capacity by coordinating communication and interaction between various entities using both adaptation and mitigation actions to address all natural hazards.

1. Identify and develop a common database that all city government agencies and departments should utilize for hazard information, preparedness and response (S)

   A single, comprehensive database that provides hazard information should be accessible by all government agencies and departments. It is important to explore the potential use of this resource.

2. Ensure consistency and integration with existing and future response plans within and between agencies (O)

   Efficient and effective emergency response will require cooperation and dependability across government agencies and existing plans should be reviewed for inconsistencies. Develop proper, adequate and consistent training that is specific, practical and readily accessible to operational personnel, supervisors, and commanders. Agencies should review annually the City's Emergency Operation Plan to identify ways to integrate new resources and/or changing responsibilities.

3. Continue to identify and improve coordination with Key Partners including private sector, State partners, Federal partners, community, universities and industry leaders through Local Emergency Planning Committee (O)

   During a hazard event, communication and coordination between the City and other key partners will ensure that response efforts and easily implemented. It is essential to identify where existing communication should be established or improved.

4. Coordinate outreach efforts of the Mayor's Office of Emergency Management, Mayor's Office of Neighborhood and Constituent Services and Baltimore City Health Department to leverage messages related to all-hazards emergency preparedness (M)

   During a hazard event, and immediately after, communication among agencies and with residents should provide reliable information. To improve the flow of accurate and reliable information, the City will use existing interagency working groups to develop standardized communications protocols for use during hazard events, to ensure that critical messages regarding hazard emergency preparedness is conveyed.

5. Develop strong working relationships with local experts to provide technical assistance to refine and improve city government emergency preparation

   Using technical assistance and recommendations from local experts, the City will be able to enhance emergency preparation.

6. Review and improve specific response plans contained in the EOP and related ESFs that relate to extreme weather events (snow, heat, flood, wind, electrical outages, and other hazard events)

   The purpose of this Emergency Operations Plan (EOP) is to define the actions to be taken by Baltimore City government, State and Federal agencies, and other non-governmental organizations in the event of an emergency. In order to effectively respond to any natural hazard emergency situation in Baltimore City, this plan recommends reviewing existing response plans, identifying gaps, and improving response efforts. This will require a coordinated effort among all participants and stakeholders .

Baltimore City Fire Boats *Source: capecodfd.com*

7. Ensure equipment purchases and communication systems are compatible across agencies and jurisdictions (O)

   During a hazard event, there is limited time to react to serious impacts. By ensuring that equipment and systems are consistent across agencies, the City can quickly respond to and address any mechanical or electrical needs.

8. Encourage all animal rescue and care shelters to further develop their internal plans for animal's health and safety during and after a hazard event

   Fear for animal safety often prevents individuals from appropriately reacting to hazard warnings. Additionally, animal shelters, which contain large numbers of animals, may not be adequately prepared to react during and after a hazard event. It is important to encourage all shelters to prepare for hazard events and establish an internal hazard response plan.

9. Ensure all animal rescue and care shelters located within the floodplain are provided the support to apply for and obtain funds to relocate

   Animal shelters within floodplains are more vulnerable. It is important to work with key partners to identify resources and support that will help these facilities relocate or flood proof.

10. Develop and implement a case study of hospital-based practices that foster community resilience to climate change

    Develop pilot projects to assist hospitals in incorporating community resiliency into existing operations. The multi prong approach would consider hospital specific actions as they relate to the treatment of vulnerable patient populations, IRS-mandated community benefit, environmental sustainability, and emergency preparedness.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCHD, BCPD, Community Groups, County Governments, DOP, DHMH, Humane Society, MOEM, MOIT, MON, PSC
Alignment with Goals	Goal 4
Connection with Existing Efforts	CAP; MD DNR
Timeframe	∞

PS-2 Develop a Hazard Awareness Program

Increase hazard awareness with the creation of an ongoing outreach program. Consider both adaptation and mitigation actions to increase Baltimore preparedness for all hazard events.

1. Create a standardized early warning system for members of the public (S)

   In order for Baltimore's residents to prepare and quickly respond during a hazard event, a clear, easily understandable and standardized early warning system is needed for notifying the public of potential hazards.

2. Evaluate and improve community health center strategies for communicating with patients during an emergency

   As a part of emergency response efforts, health centers should be prepared to communicate with patients during an emergency. It is critical to evaluate the competency of these systems and identify opportunities to enhance these strategies.

3. Educate citizens about the existing early warning systems and actions they should take when alarms sound

   Prior to a hazard event, Baltimore's residents should be aware of the early warning system already in place. Knowing how it works, through what outlets they can receive warning information, and the information that various terminology or messages may convey will ensure that residents can understand emergency information and will be prepared to quickly respond.

4. Prepare and integrate occupational health and safety messages and instructions for first responders (O)

   Integrating hazard safety into occupational health and safety messages helps to ensure worker protection and publicly conveys hazard preparedness messages through a public interface.

5. Hold climate specific seminars, in partnership with MDH2E and MHA, for hospital emergency and sustainability managers

   Hospital facilities are critical facilities that will be under considerable pressure during and after a hazard event. It is important to prepare educational programs to instruct hospital emergency and sustainability managers about their responsibilities during hazards, as well as what actions should be taken.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCHD, DHMH, DOP, MDH2E, MEMA, MOEM
Alignment with Goals	Goals 1 and 5
Connection with Existing Efforts	 CAP; ESF-11
Timeframe	

PS-3 Designate community leaders and organizations that can assist and provide support during hazard events

Leverage community resources and empower individuals to increase efforts to protect Baltimore residents from all natural hazards. This strategy is concerned with measures for climate adaptation and emergency preparedness.

1. Prior to a hazard event, identify lead contacts serving vulnerable populations and coordinate actions to maximize safety and information sharing (O)

   So as to guarantee the proper dissemination of emergency and early warning information, the City should identify key points of contact who can convey safety information prior to, during, and after a hazard event.

2. Develop a community group coordination plan and implementation guide (M)

   To assist community representatives with the task of conveying hazard information, the City should develop a community group coordination plan and implementation guide.

3. Identify and evaluate plans already in place and work to improve utilization of community based leaders to assist in preparedness and response (L)

   It is important to consider how existing plans may be leveraged to establish community-based preparedness and response programs.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCHD, BCPD, Community Groups, DOP, HABC, Hospitals, MOEM, MON
Alignment with Goals	Goal 1
Connection with Existing Efforts	CAP; MD DNR
Timeframe	∞

MOEM Preparation Meeting

PS-4 Integrate climate change and natural hazards planning into all City and community plans

In the past, climate adaptation and resiliency have not been significant considerations when prioritizing city projects. The City encourages interagency and cross-jurisdictional partnerships to ensure that resiliency is a factor. Likewise, Baltimore advocates for similar changes in the planning and evaluation of major projects and plans.

It is important to incorporate resiliency and disaster prevention in all City and community plans to address all natural hazards. Incorporate climate adaptation measures into City policy.

1. Develop guidelines to include proactive resilience planning into plan development process

   Incorporate resiliency efforts into plan development and establish a framework which can guide agencies through this process.

2. Incorporate language that strengthens the ability of city government officials to enforce rules and restrictions that support public health, safety and welfare related to hazard events and conditions (M)

   When incorporating hazard planning into existing programs and plans, language should be used which will present government officials with the power to enforce rules and regulations that support public health, safety, and welfare.

3. Partner with Maryland Department of Health and Mental Hygiene or other pertinent entity to develop institutional checklist and materials for health care specific resilience plans

   Better prepare hospitals for future hazards and increase capacity and ability to respond to hazard events.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCHD, BCPD, DHCD, DOP, MOEM, State/Fed. Agencies
Alignment with Goals	Goal 3
Connection with Existing Efforts	 CAP; MD DNR
Timeframe	

PS-5 Better equip emergency workers for natural hazards

Increase Baltimore's adaptive capacity by preparing emergency workers for hazards associated with disease outbreaks. This strategy focuses on adaptation measures and emergency preparedness.

1. Research and identify personal protective equipment (PPE) needs based on specific hazards (O)

   It is important to investigate how first responders can be better prepared and equipped to respond to a variety of potential hazards.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCFD, BCPD, MOEM
Alignment with Goals	Goal 4
Connection with Existing Efforts	 CAP
Timeframe	

Integrating DP3 with Existing Efforts | THIRA and COOP

Hazard Mitigation and Climate Adaptation planning are not the only tools used to identify hazards and vulnerabilities prior to emergency planning. Other similar efforts include the Emergency Operations Plan, Threat and Hazard Identification and Risk Assessment, Continuity of Government, and the Continuity of Operations Plan. Findings and outcomes, through the DP3 process, will be used in informing these other processes. The Threat and Hazard Identification and Risk Assessment (THIRA) is one such example. THIRA is a FEMA tool designed to help jurisdictions understand the threats and hazards they face. Threats considered under THIRA include natural hazards but also technological hazards (e.g. airplane crash, power failure, train derailment, etc.) and human-caused incident(s) resulting from intentional actions (e.g. civil disturbance, school violence, terrorist acts, etc.). In completing the risk assessment, THIRA matches impacts with hazards and defines these impacts within 'core capabilities' (i.e. resources to address the impact). Impacts include displaced households, fatalities, injuries/illnesses, direct economic impacts, indirect economic impacts from supply chain system disruption, and disruption to infrastructure are some but not all of the impacts considered.

Preparing for response, Baltimore identifies resources/capabilities and defines the response. This process results in understanding existing capabilities and capacities to know what might need to be supplemented, improved, or sustained. For example, hurricanes are an annual hazard for Baltimore City. The context used for the THIRA is a storm that makes landfall in the Baltimore region as a category 2 hurricane. The impact includes 80% of the region without power, damage to critical infrastructure, localized looting, etc. Within the core capability of Mass Care, we expect to shelter 7,500 people throughout the region, and 20% of that population has an access or functional need. The corresponding capability assessment will show us if we can achieve that target and what gaps, if any, need to be addressed if there is a shortfall.

While several core capabilities of THIRA fall under the mission area of mitigation, the main focus of the THIRA is on disaster response. The DP3, on the other hand, is a much deeper look into reducing and eliminating long-term risks from natural hazards. The THIRA also includes threats, which is a term for terrorism or manmade disaster, while the DP3 only includes natural hazards in its scope. Taken together, the THIRA and DP3 cover natural and manmade disasters that could befall Baltimore City and identify strategies and resources necessary to reduce our vulnerability to any disaster.

COOP – Ready to Respond

Continuity of Operations (COOP) planning is necessary to ensure essential functions of government can take place in a catastrophic disaster. COOP plans are agency-specific and identify personnel and resources necessary to maintain operations essential to its mission. For example, the Baltimore City Fire Department must be able to respond to and suppress fires even if it is not fully staffed or firehouses are destroyed. COOP plans must include, at a minimum: key personnel, essential functions, and a backup facility.

DP3 strengthens COOP plans by identifying long-term hazards and the possible extent of the impacts (e.g. maps, data, risk assessment). COOP planning typically only looks at existing structures and essential functions. COOP planning, when paired with DP3, helps agencies self-identify vulnerabilities (to natural hazards) with both primary sites as well as backup facilities. By integrating these processes, the impacts of natural hazards are more clearly defined. In doing so, COOP plans are reinforced and steps to mitigate hazard events in the future may be better prioritized. Furthermore, linkages with additional hazard mitigation tools (EOP, COG, THIRA, etc.) can continue to build the City's resiliency.

HEALTH

PS-6 Anticipate and address potential disease outbreaks caused by extreme weather events and changing climatic conditions

Increase adaptive capacity and prepare for potential disease outbreaks as a result of extreme weather events. This strategy is concerned with adaptation measures and emergency preparedness.

1. Support studies of heat and flood related vector borne diseases in the Baltimore the region based on changing temperature and moisture (O)

   Prevent injury or loss of life due to disease outbreaks through the exploration of studies regarding heat and flood related impacts.

2. Evaluate existing programs that detect disease outbreaks to determine their flexibility to respond to new conditions

   As conditions change, the City is likely to encounter new diseases which may be created by the conditions during or after hazard events. It is essential to evaluate existing programs and surveillance methodologies to determine their capacity to detect and respond to new and changing conditions.

IMPLEMENTATION GUIDELINES	
Lead Agency	BCHD
Stakeholders	BCHD, CDC, DHMH, MDNR, MEMA, MH2E, MOEM, State Agencies
Alignment with Goals	Goal 4
Connection with Existing Efforts	CAP; MD DNR
Timeframe	∞

PS-7 Protect Baltimore residents from the effects of hazard events and plan for more frequent hazard instances

Protect the health and safety of Baltimore's residents by preparing for more frequent hazard instances related to extreme heat. This action addresses both adaptation and mitigation measures, and is concerned with emergency preparedness.

1. Re-evaluate and update existing heat alerts, advisories, and updates to healthcare and emergency service providers (S)

   It is important to re-evaluate and update hazard alerts so as to ensure adequate communication. This will reduce the health impacts caused by high heat events.

2. Ensure that residents and visitors have access and transportation to cooling centers during extreme heat events (O)

   During high heat events, residents should have access to cooling centers or similar options. It is important to explore key gaps in these assets in order to reduce health impacts.

Source: www.wbaltv.com

3. Evaluate code red plans to ensure all agencies adequately protect their own workers (S)

   By evaluating code red plans, the City can promote first responder readiness and general safety at cooling centers which may require additional security measures.

4. Consider extending hours for public wading pools during extreme heat events (M)

   Residents should have access to cooling center or similar facilities during extreme heat events. In some places, these facilities have limited hours. An investigation of facilities is necessary to consider ways to extend hours of operation during extreme heat events.

5. Include information about Code Red in the event permitting process, and incorporate language that allows BCHD to cancel outdoor events

   Through the Code Red system, citizens are better informed about the dangers of high heat days. Time spent outside during extreme heat events can be decreased through better information.

6. Work with Regional, State and Local partners to improve air quality and reduce respiratory illnesses

   Air quality improvement must be a regional goal, as activities in one area can significantly impact the surrounding air. It is important to communicate and partner with surrounding jurisdictions, as well as with Regional, State, and other Local partners to identify key actions for improving air quality and reducing cases of respiratory illnesses.

7. Create and implement programs to manage combined health impacts of heat and air pollution

   Poor air quality is made worse with high temperatures. This means that the negative health impacts, such as respiratory illnesses, will become a greater problem. It is critical to establish a program that will identify and address the combined health impacts of extreme heat and poor air quality hazards to implement strategies that will reduce the associated risks and hazards.

BALTIMORE CITY COOLING CENTERS

Centers open 9am–7pm on weekdays, 11am–7pm on weekends.

Northern Community Action Center
5225 York Road | (410) 396-6084

Southern Community Action Center
606 Cherry Hill Road | (410) 545-0900

Northwest Community Action Center
3939 Reisterstown Road | (443) 984-1384

Southeastern Community Action Center
3411 Bank Street | (410) 545-6510

Eastern Community Action Center
1400 E. Federal Street | (410)396-9468

The following SENIOR CENTERS are open during a Code Red Heat Alert from 9am–7pm on weekdays only.

Waxter Center for Senior Citizens
1000 Cathedral Street | (410) 396-1324

Oliver Center
1700 Gay Street | (410) 396-4861

Sandtown-Winchester Senior Center
1601 N. Baker Street | (410) 396-7724

Hatton Center
2825 Fait Avenue | (410) 396-9025

John Booth
229 1/2 S. Eaton Street | (410) 396-9202

Zeta Center
4501 Reisterstown Rd. | (410) 396-3535

Additional cooling centers may be opened during an extended heat event. Please call 311 before leaving home for the latest cooling center hours and information.

IMPLEMENTATION GUIDELINES

Lead Agency	MOEM
Stakeholders	BCHD, BCRP, Community Groups, DHMH, Licenses and Permitting, MDE, MOEM, Transportation partners
Alignment with Goals	Goal 1
Connection with Existing Efforts	CAP
Timeframe	∞

EDUCATION AND OUTREACH

PS-8 Conduct climate, resiliency, and emergency planning education and outreach

Increase hazard awareness related to all natural hazards through education and outreach. Consider emergency preparedness enhancements through hazard response education and risk communication. Use both adaptation and mitigation actions.

1. Incorporate environmental health and climate change into curriculum at schools, universities and health care facilities

   Incorporating environmental health and climate change information into curriculums encourages people to become stewards of the environment and motivates them to make a change.

2. Educate communities on how city agencies respond to hazard events, their role in an event, and how agencies work together (O)

   It is important to ensure that residents know who to call for what issue during a hazard, reducing response times.

3. Educate and train community groups to participate in responding to hazards (O)

   Communicate with the public to ensure that communities are better prepared for disaster situations. Include disaster preparation and response steps from FEMA/CDC in outreach efforts conducted with community leaders.

4. Generate a comprehensive community-specific all hazards outreach campaign (S)

   Increase general educational outreach programs to educate communities. This will engage residents and prepare them for climate change, reducing future impacts from a hazard.

5. Develop and communicate a simplified process for Baltimore residents to follow after a hazard event (S)

   The City should establish an easy to remember method for obtaining up-to-date information about emergency conditions (e.g. Code Red) and any available resources, such as cooling centers. This should include information regarding climate change impacts, how residents may be impacted, and recommended protective measures.

6. Create curriculum for hospitals to teach communities about climate change as part of hospital community benefits programs (M)

   Climate change curriculums at hospitals can educate residents about opportunities to prepare for climate change and hazard events (educating about future conditions, where to get information, how to stay safe, whether to seek shelter or evacuate, etc.).

7. Utilize existing preparedness messaging to include information on universal precautions to insect-borne and other infectious diseases (S)

   Preparedness messaging should be utilized to increase citizen awareness of hazards and the potential increase of infectious diseases in the area. As a result, this effort could change resident behavior.

IMPLEMENTATION GUIDELINES	
Lead Agency	MOEM
Stakeholders	BCHD, DNR, DOP, DPW, DHMH, MH2E, MOEM, MOIT, MON, Hospitals
Alignment with Goals	Goal 5
Connection with Existing Efforts	 CAP; MD DNR
Timeframe	

Baltimore City Emergency Training *Source: Baltimore City*

Baltimore Energy Challenge

Emergency Dispatcher in Baltimore

Red Cross Food

Red Cross Baltimore *Source: Facebook.com*

PS-9 Improve awareness and education about the importance of flood insurance and preparation for Baltimore citizens

Insurance plays a significant role in providing citizens and businesses with financial protection against impacts from natural hazards. In order for insurance to be most effective, consumers must be aware of their risks and must clearly understand the coverage provided by their insurance policies, incorporating what the policies may include or exclude.

Additionally, both insurance providers and policy holders should be aware of the extensive efforts that Baltimore is taking to minimize damage from flooding hazards through the efforts outlined in this report. Increasing the overall awareness and understanding of flood insurance, risks associated with flooding, and the City's efforts to address and mitigate flooding impacts will foster a more robust insurance market that serves to benefit all participants.

1. Create an educational program centered on flood hazards, coastal construction practices and evacuation procedures (S)

   It is critically important that owners of properties within the floodplain understand their obligations. The City will launch a consumer education campaign to convey this information. Communication channels may include MTA advertisements, radio spots, news blasts, and social media, among other options.

2. Encourage owners of properties to purchase flood insurance and improve policyholder awareness at time of sale or renewal (O)

   Issues of consumer awareness and education should be addressed at the points of sale and renewal, and throughout the life of an insurance contract.

3. Inform property owners who have paid off their mortgage that flood insurance is still necessary (S)

   Property owners and homeowners should be aware that their standard homeowners' policies generally do not provide flood coverage.

4. Identify programs and grants that assist citizens in purchasing flood insurance and making flood proofing changes (M)

   Efforts to update and remap Baltimore's floodplain will likely result in significant changes in flood insurance premiums, which many residents, especially the City's most vulnerable populations, will not be able to afford. Methods which will help individuals afford risk-based premiums under the NFIP should be explored. Flexible pricing options, such as a higher deductible, can encourage more residents to purchase flood insurance. (See the Summary of the NFIP October 2013 Premium Rate and Rule Changes).

Flooding in Baltimore *Source: Baltimore Sun/Glenn Fawcett*

Flooding in Fells Point

5. Develop an annual newsletter to inform and remind owners of property in the floodplain about flood insurance and flood proofing activities they should undertake (S, O)

   An annual newsletter that informs and reminds owners of property within the floodplain about flood insurance and flood proofing measures will ensure that property owners aware and informed about the hazards they may face and how they can take action to prevent damage.

6. Provide information on how to file for reimbursement for impacts of hazards (S, O)

   Citizens impacted by a flood event need assistance navigating the formal process of reimbursement. Assist members of the public in understanding what is available to them and how to file — when individual assistance is made available by FEMA, a disaster recovery center (DRC) is established that provides this help.

7. Require a flood disclosure form, and educational information as part of lease agreements for commercial and residential properties (S)

   It is important to proactively communicate with property owners and renters about the risks associated with flooding, which can decrease impacts from flooding and the loss of property during hazardous events.

8. Develop floodplain awareness information for rental tenants and ensure distribution as tenants change

   Since rental tenants are generally more transient than property owners, it is important that the City increase awareness programs regarding floodplain conditions to this population. Changing tenants should be provided with resources and information regarding their property and risks associated with flooding.

IMPLEMENTATION GUIDELINES	
Lead Agency	FEMA/MEMA
Stakeholders	Community Groups, DHCD, DHMH, DOP, FEMA, MEMA, MOEM, MON, NFIP, NGOs, MOEM
Alignment with Goals	Goals 1, 5, and 6
Connection with Existing Efforts	CAP; CRS
Timeframe	∞

FOOD SYSTEM

PS-10 Increase Baltimore's Food Security

To grow the capacity of the food system to withstand direct and indirect risks associated with climate change and natural hazards, Baltimore will work with local and regional partners to study the local food system for potential vulnerabilities and produce a long-term plan for protecting the resiliency of the regional food system. In collaboration with partners, the City will identify what our current food system looks like, where our food comes from, and our food needs. This will lead to identifying vulnerabilities and utilization of scenario modeling to increase food system resiliency.

This process will involve data collection and analysis, proactive planning, and transportation system considerations all of which are necessary to increase the adaptive capacity of the Baltimore food system.

1. Develop a food security plan for Baltimore

Climate change, extreme weather and economic volatility threaten and increase the vulnerability of the global food system. Changes in rainfall patterns and increases in more extreme weather are expected to affect food production and distribution. These changes are also expected to increase the number of pests and diseases that both crops and livestock are susceptible to. This could destabilize our current farming and food systems. A food security plan helps increase production of, access to, and consistency of, healthy food options for Baltimore's residents. It also evaluates food storage, food distribution, location of food banks and pantries, accessibility, and backup energy considerations for stores, among other issues.

2. Increase land under cultivation for commercial urban agriculture

Increased local food cultivation has many benefits beyond increasing the amount of food available. Increasing the amount of land used for commercial agriculture would also reduce stormwater runoff, reduce the impervious surface area within the City, reduce the urban heat island effect, and would boost the City's self-sufficiency and capacity to support residents in a hazard event. Although the amount and type of food currently grown in the Baltimore region is insufficient to wholly support residents in a food crisis, increasing opportunities for urban agriculture would help offset food needs and demand during and after a hazard event.

Real Food Farm Mobile Farmers Market *Source: Inhabitat*

Baltimore Farmers Market *Source: BaltimoreSun*

3. Link Jessup and regional/local food producers to local distributors

   Building adaptive capacity of our food system and surrounding agricultural community is essential to becoming more resilient to climate change. This requires identifying where our food comes from, how that source may be impacted by climate change, how that food gets to the city, and the current capacity and abilities of Jessup. Once these elements are identified, it is essential to determine vulnerabilities in the food system, identify additional aggregator needs, and develop strategies for reducing vulnerability. It also requires evaluating new technology and developing a "climate-smart" food system which could include creation of additional regional or local aggregator (if necessary). Linking assets such as food producers, food banks, and retailers to local residents can help reduce food availability issues and can connect local communities with one another, building social capital.

4. Incorporate Baltimore's food policy initiative into planning efforts

   Baltimore's food policy initiative focuses on integrating food issues into all planning processes. This includes consideration of food deserts, food access and opportunities to expand local food options.

5. Double the size and number of food producing community gardens by 2025

   The current food policy goal is to increase access to fresh foods and grow more food locally so as to increase self-sufficiency. This requires consideration of all land being utilized for food production as well as the number of people with the skills to grow food. Baltimore City will work with local and regional partners to collect relevant land use data and increase the amount of land being utilized for food production within the City.

IMPLEMENTATION GUIDELINES	
Lead Agency	DOP
Stakeholders	BOS, DOP, MDA, Urban Farms and Community Gardens (P&P and CGRN)
Alignment with Goals	Goal 1
Connection with Existing Efforts	MD DNR
Timeframe	

On September 30, 2013, the City of Baltimore released the draft of its urban agriculture policy plan for public comment. "Homegrown Baltimore: Grow Local" documents the history, benefits, and types of urban agriculture in Baltimore; lays out current local urban agriculture efforts and the policies that affect them; and identifies challenges and provides recommendations for creating a more robust urban agriculture sector for the city. All types of food production, from backyard gardening to commercial farming, are considered. See the draft: http://www.baltimoresustainability.org/homegrown-baltimore-grow-local