THE PORT PREPAREDNESS PLAN

City of Cambridge

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CLIMATE CHANGE PREPAREDNESS & RESILIENCE

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www.cambridge.gov/ClimateChange

Cover Photo:
2018 Port Pride Day, Cambridge, MA
Source: Margaret Fuller House

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EXECUTIVE SUMMARY

Our climate is changing, bringing more severe storms, more extreme floods, and more intense heat waves. Climate change is a "risk multiplier," making the existing risks we face more likely, more common, and more severe.[1] We can no longer use past climate patterns as a guide for the future. Climate is changing our city, so we need to change, too.

Between 2015 and 2017, the City conducted a Climate Change Vulnerability Assessment (CCVA) to identify areas that are more susceptible to immediate and future risks of flooding and extreme heat. The City used the information from CCVA to embark on a Climate Change Preparedness and Resiliency (CCPR) Plan. The CCPR Plan is meant as a practical guide for the City government, its residents, businesses, institutions, and key stakeholders to implement strategies in response to climate change threats.

The City began the process of developing the Climate Change Preparedness and Resilience (CCPR) Plan with Alewife as the first pilot neighborhood plan as it had been identified to be at significant risk from climate change, is a hub of regional infrastructure and is undergoing rapid development.

The Alewife Preparedness Plan[2] and companion Handbook[3] propose resiliency strategies that provide a model for living with climate change in Alewife. Feedback on these strategies and documents is now informing the preparedness plan for the second pilot neighborhood, The Port.

WHY THE PORT?

The City chose The Port as the second study area because climate change is expected to further exacerbate future risk from flooding and extreme heat in this neighborhood, it houses populations at risk of being impacted by flooding and heat, and The Port is a mature, already-developed area representative of other neighborhoods in the City. Flooding from precipitation and heat vulnerability are imminent concerns for The Port. Both pilot plans will inform the Citywide Climate Change and Resiliency Plan to be issued by the end of 2019.

The Port neighborhood is representative of many Cambridge neighborhoods. It is a high-density residential area with a high percentage of renters (seven out of 10 residents are renters), has dense underground infrastructure, including combined sewer and stormwater pipes, and has a mix of small businesses, science buildings, and institutional uses. It is unique because of its diverse people and community, its mix of building types, and its sparse but precious ecosystem.

FRAMEWORK

In the CCPR Alewife Plan and its supporting Handbook, preparedness and resiliency strategies are organized around four categories that address different vulnerabilities: **[A] *Prepared Community* for increased social and economic resilience**; **[B] *Adapted Buildings* that house residents, businesses, and institutions; [C] *Resilient Infrastructure* that ensures continued service and/or swift recovery from extreme events**; and **[D] *Resilient Ecosystems* that integrate the built and natural environments**. The Port Plan builds upon these same categories; however, it is focused around three big ideas for change that test how specific resiliency strategies at the neighborhood, block, and community scales can make The Port more resilient. Both neighborhood plans with their different concepts will inform a more comprehensive citywide plan.

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[1] Climate Change Vulnerability Assessment, Ciy of Cambridge, http://www.cambridgema.gov/CDD/Projects/Climate/climatechangeresilianceandadaptation

[2] CPPR Alewife Preparedness Plan, City of Cambridge, http://www.cambridgema.gov/CDD/Projects/Climate/~/media/701F64FC31654DF48137CF275E38EB0F.ashx

[3] CCPR Preparedness Handbook, City of Cambridge, http://www.cambridgema.gov/CDD/Projects/Climate/~/media/905D618DAEFD4515B25D37D80239E6F9.ashx

THREE IDEAS FOR CHANGE IN THE PORT

1. **Enhanced resilient gray and green infrastructure.** This idea demonstrates how strategies and actions that combine traditional gray infrastructure improvements with opportunistic green infrastructure implementation at a neighborhood scale can increase The Port's resilience to climate change as well as improve its overall character.

2. **Super-resilient urban blocks.** This idea demonstrates how residents, institutions, and business owners in some appropriate neighborhood blocks can adopt higher levels of resiliency strategies and actions in their buildings and open spaces that would improve their immediate surroundings.

3. **Resilient People.** This idea summarizes strategies and actions that The Port neighborhood can adopt to be more connected and better prepared for climate change.

As part of the development of the plan, activities were held at community events in The Port to learn from residents about their climate change concerns and hear their experiences and recommendations for strengthening the neighborhood. These were integrated in the ideas for change. A key aspect of the recommendations is that proposed changes should not only protect lives and livelihoods at risk from climate change, but that they should also improve the well-being of the entire Port community.

IMPLEMENTING THE PORT PREPAREDNESS PLAN

Implementation of the resiliency strategies in The Port aims for a more prepared and transformed neighborhood. The key findings are as follow:

- Combined implementation of gray and green infrastructure strategies can reduce flooding impacts from future smaller and more frequent storms (e.g. storms that have a 10% change of happening every year).

- New green infrastructure in The Port could reduce the urban heat island (UHI) effect by approximately 2 degrees Fahrenheit (°F), which can reduce impact on human health and energy consumption. Resilient urban blocks could reduce local temperatures by up to 6°F.

- Implementation of resilient energy measures would not only increase buildings' preparedness but also provide energy savings of the equivalent of 3,000 to 14,000 MMBtu if at least 80% of the properties are enhanced. This translates to the annual electricity consumption of about 45 - 220 triple-decker buildings.

- The Port's vibrant social support network could be harnessed to educate and prepare the community for climate impacts.

INTRODUCTION

Our climate is changing, bringing more severe storms, more damaging floods, and more frequent and intense heat waves. Climate change is a “risk multiplier,” making the existing risks we face more likely, more common, and more severe. We can no longer use past climate patterns as a guide for the future. Climate is changing our city, so we need to change, too. While sea level rise is often discussed as a climate change impact, inland flooding and heat vulnerability are more imminent concerns for The Port. The City of Cambridge (the City) is working hard to prepare for the effects of climate change by creating greener streets, stronger homes, closer-knit communities, safer and faster commutes, and healthier residents. To get ready for change, the City is building smarter infrastructure, developing innovative tools, and launching several initiatives and programs that promote a greener environment.

Between 2015 and 2017, the City conducted a Climate Change Vulnerability Assessment (CCVA) to identify areas that are more susceptible to the immediate and future climate risks of flooding and extreme heat. The City used the findings from the CCVA to embark on a Climate Change Preparedness and Resiliency Plan (CCPR). The CCPR Plan is meant as a roadmap for the City, its residents, businesses, institutions, and key stakeholders to implement strategies in response to climate change threats (heat, flooding from precipitation, and flooding from sea level rise and storm surge).

The City began the process with a neighborhood plan for Alewife, which was studied first due to the level of flooding risk and the prospect for development. The Alewife Preparedness Plan and companion Handbook identified resiliency strategies for a new model of living with climate change in Alewife. The feedback on these strategies and documents are now informing the second pilot plan focusing on The Port. The City chose The Port as the second study area because the future risk of flooding and extreme heat is high, it houses populations at risk of being impacted by flooding and heat, and is representative of other mature, developed areas in the City. Both pilot plans will inform a Citywide Plan to be issued by the end of 2019.

WHAT IS PREPAREDNESS AND RESILIENCE?

Climate change preparedness is a state of readiness for anticipated impacts, such as extreme or repeated flooding and higher temperatures. For the city, these have been assessed for two planning horizons: 2030 and 2070. Resilience is the ability of infrastructure, residents, and the economy to withstand, adjust to, and recover from the impacts of climate change, with recovery often measured in time and cost. It follows that preparedness and resilience will both increase if risk-reduction strategies are implemented.

THE PORT PLAN IN CONTEXT

The Port is one of 13 neighborhoods in Cambridge, located in the eastern part of the city and bordered by Wellington-Harrington, Mid-Cambridge, Cambridgeport, and the Area2/MIT neighborhoods. For CCPR, The Port boundaries have been adjusted slightly to include the corresponding stormwater catchment boundaries, which are used for flood modeling to evaluate the effects of different storms **(Figure 1.0.1)**.

Covering an area of 191 acres, The Port is predominantly high-density residential with few designated open and green spaces that include Sennott Park, Green Rose Heritage Park and Clement Morgan Park. The major commercial center and transit center of The Port lies in Central Square, with the main commercial strip along Massachusetts Avenue, while smaller commercial areas exist along Prospect Street and Columbia Street at Main Street. The triangle located in the southern part of the neighborhood bounded by Massachusetts Avenue, Main Street, and Vassar Street, sometimes known as the Osborn Triangle, is a former industrial center, now home to high-tech laboratories and offices, as well as facilities for neighboring Massachusetts Institute of Technology.[4]

[4] Climate Change Preparedness & Resilience Plan, Community Development Department, City of Cambridge, http://www.cambridgema.gov/CDD/Projects/Climate/climatechangeresilianceandadaptation.aspx

The City chose The Port as the second study area because it has a high risk of future flooding and extreme heat, it houses populations at risk of being significantly impacted by flooding and heat, and it is representative of the mature, developed area in the City.

Figure 1.0.2 The Port neighborhood and The Port study area boundaries

1.0

WHY THE PORT?

1.0 WHY THE PORT?

The Port is representative of many Cambridge neighborhoods. It is a high-density residential area with a high percentage of renters (seven out of ten residents are renters), dense underground infrastructure (including sewer, combined sewer, and stormwater pipes), and a mix of small businesses, science buildings, and institutional uses. It is unique because of its diverse people and community, its mix of building types, and its sparse but precious ecosystem, including parks and urban trees.

1.1 FRAMEWORK FOR THE PLAN

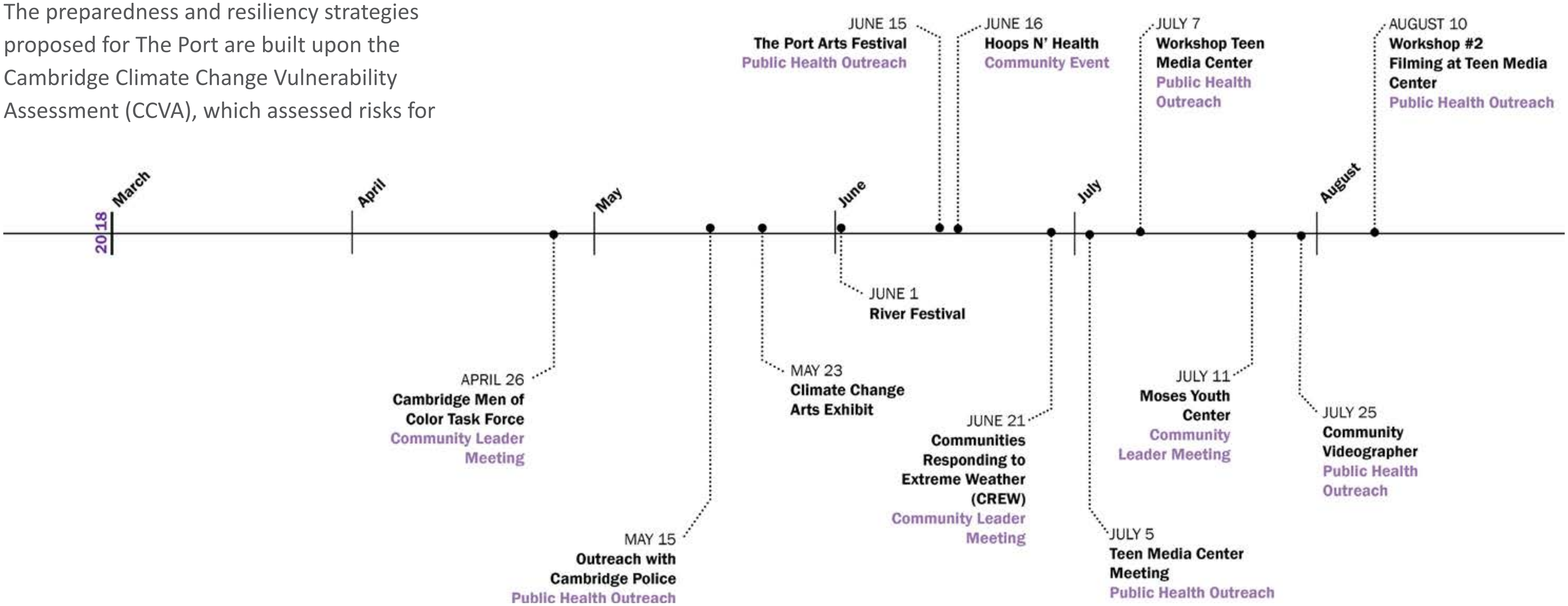
The preparedness and resiliency strategies proposed for The Port are built upon the Cambridge Climate Change Vulnerability Assessment (CCVA), which assessed risks for the City assuming no actions were taken. The Port Plan recommends three big ideas for change and associated strategies to increase the neighborhood's preparedness to projected climate change extreme events and, in the process, to enhance the well-being of the whole community.

1.1.1 PARTNERSHIP FOR CHANGE

Government action is not enough. The City of Cambridge—and the world—needs the buy-in and momentum of local communities to ensure our cities and our futures are stronger, safer, and healthier.

For these reasons, the City and The Port community leaders engaged with stakeholders and residents in defining a shared mission and developing this plan as illustrated in the project's timeline in **Figure 1.1.1**. The Port community is already a strong community that mobilizes action. A shared mission and a plan will rally and empower the community and its residents to act to address climate change impacts.

Various community-based organizations including faith-based organizations, social service providers, and youth leaders have participated in several focus groups. These stakeholders learned about



climate change projections and the potential impacts. In turn, they informed the City about the neighborhood's needs, priorities, resources, and strategic ideas. Community sessions and participation in neighborhood events have provided further opportunities to learn and share. The engagement process, which included residents and community leaders directly from the start (Spring 2018), provided for mutual learning about past, present, and potential future climate-related impacts to the neighborhood.

In concert with this effort, the Cambridge Public Health Department (CPHD) initiated a project with residents and youth in The Port. Teens in the Mayor's Summer Arts Program learned about the relationship between climate change an public health. Working with CPHD, they created a video featuring interviews with residents about these issues in the Port.[5] The video, along with a companion workshop guide, is available for local community organizations to use as they further engage residents in protecting themselves and their neighbors.

These efforts in The Port are giving a voice to the community and creating a vision for a resilient neighborhood. This is only the beginning of a call for action to create new opportunities out of the climate-related challenges that must be faced. In the process, both resiliency and equity will be advanced along with the ability to address several pressing economic, social, and health disparities that already exist in the neighborhood.

Most important, we heard that climate change impacts need to be made personal, and residents need to be empowered to act. The following is a summary of the most pressing issues for the people of The Port.

[5] Climate Change and Healh, CPHD, http://www.cambridgepublichealth.org/climate-change

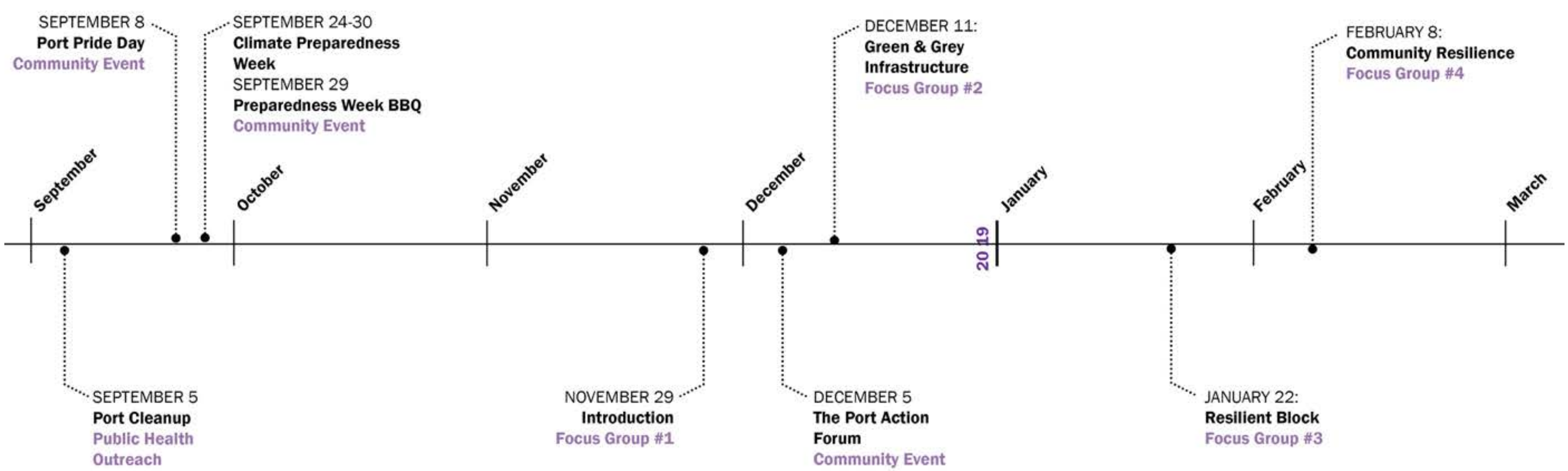


Figure 1.1.1 Timeline of stakeholder engagement process in The Port

HOW WILL CLIMATE CHANGE IMPACT MY NEIGHBOR?

FLOOD

The Margaret Fuller House daycare located in the basement is at risk of being flooded and my kids might not be able go to daycare for a few days. It will be difficult to find affordable emergency childcare or stay home from work and lose critical pay time.

My neighbors are not fluent in English and are often shy to ask for help. They are not able to access information to find where help is available.

Our place of worship is at risk of flooding. This could prevent us from reaching to our members that may also be impacted by the flood.

Our neighbors that own the small business next door can suffer property damage and loss of income.

Our neighbor that owns rental property in an area that got flooded will have to deal with property damage, and utilities in the basement that could be damaged and need to be replaced.

Flooding in our neighborhood can affect large institutions, such as MIT and Novartis. Employees will not be able to get to work. The loss of productivity will impact our community with loss of revenue.

HEAT

Some of our neighbors already use the Margaret Fuller House as a cooling center, but it is hard for their window air conditioners to cool the building during hot days. The increase in the number of hot days in the upcoming summers will make it even harder for the center to help our neighbors cool down.

Elderly neighbors, who live alone on a fixed income, might be concerned about paying for air conditioning and might be more prone to heat strokes.

Members of the community that walk or bike to work and our neighbors that work outside will be more exposed to the heat and more prone to having a heat stroke.

Community organizations that are not well equipped for heat will not be able to provide a cooling space for people in the community because of the power outages, lack of AC or poorly insulated buildings.

Our neighbor that owns a business will see increased costs with energy use to be able to keep their place of business cool.

Figure 1.1.2 Voices from The Port [Source: Interviews with the community through The Port stakeholder engagement process and CPHA video – http://www.cambridgepublichealth.org/climate-change/]

HOW WILL CLIMATE CHANGE **IMPACT ME**?

My roof, which leaks during rains, can result in mold and mildrew, which will make my children's asthma worse.

My asthma or other chronic diseases need to be closely monitored to avoid getting worse if a building has been damaged.

Most utilities, such as water, furnace, electric panels, and laundry, are usually in basements. Even minor flooding in a basement can be disruptive if it damages utilities. As an owner, replacing these utilities and redoing the basement might be cost-prohibitive.

Athletes or outdoor workers are at risk for heat stroke while exercising or working outdoors during hot days.

Heat waves impact us personally with discomfort or an increase in our electric bills.

I was born and raised here in The Port. This is a place that concerns me a lot; especially as we start thinking about climate change.

We can do this if we want to—we have to be intentional—commit to each other and accept the fact that when crisis happens we're strong enough to get through it.

We already have a community that works together. We have the creativity, the technology—now's the perfect time to bring these things together and make a big change!

1.2 A UNIQUE NEIGHBORHOOD

To develop resiliency strategies for The Port, an important first step is to understand its unique conditions. The conditions are reported here and grouped into four categories, like those identified in the CCPR Handbook, including: **[A] Prepared Community**, **[B] Adapted Buildings**, **[C] Resilient Infrastructure**, and **[D] Resilient Ecosystems**. These also align with the categories in the CCPR Handbook under which the resiliency strategies are organized. The strategies for The Port are also organized using these four categories.

1.2.1 PREPARED COMMUNITY [A]

The Port community is the most diverse group of people in the city, but the neighborhood is evolving, as shown in **Table 1.2.1** The City will need to be thoughtful in selecting an effective range of climate resiliency strategies to address this diversity and social change.

Many members of the Port community in the study area are at risk from the impacts of changing conditions in their environment, such as extreme heat or flooding, as shown in **Table 1.2.2**. Populations most at risk of being affected by flooding or extreme heat are ones with limited capacity to adapt or recover from hardship and include children under 5 years old, people over 65, people below poverty levels, and people who are isolated because they speak limited English. A higher proportion of The Port's residents are foreign-born, are children under 5, or have a lower per capita income than citywide.[6] Additionally, one out of four residents of The Port lives in public housing, and one out of four public housing residents in the city lives in The Port neighborhood.[7] Although people from this group have less capacity to adapt to climate change impacts, as a group they might be better-connected via housing or cultural networks and could also be well supported by the City's resources such as the Housing Department.

The diversity of people in The Port supports a range of community services such as schools and youth centers, religious organizations, community organizations, and public housing. These services provide important resources and connect the people of The Port. The neighborhood is home to a rich mixture of cultural heritage. The diversity of The Port also indicates that information on how to prepare for climate change should be adapted into different languages and for a variety of cultural approaches.

Table 1.2.1 Diversity in The Port neighborhood

Group	The Port (2010)	The Port (2017)	The City (2017)
White	50.5%	60.3%	66.9%
Black	27.8%	20.4%	10.8%
Hispanic	12.3%	12.4%	8.8%
Asian / Pacific Is.	11.2%	12.1%	15.8%
Mixed / Other	10.3%	6.7%	6.3%
Native	-	0.5%	0.2%

[Source: 2010 Census Data, and 2013-2017 ACS]

Table 1.2.2 Population at risk in The Port study area*

Population at Risk	Total Count	Impacted by Flooding
Children Aged 0-5	266	200
Seniors Aged 65+	359	280
Non-English Speakers	1,738	1,200
Residents Below Poverty Line	1,082	810

* The Port neighborhood area (approximately 191 acres) housed an average of 7,023 people between 2013-2017. The number of residents in The Port study area (approximately 153 acres) as considered in CCPR is approximately 4,780 because The Port study area is smaller than The Port neighborhood area. Assumptions were made for this population analysis because census tract data does not match The Port's study area boundaries. [Source: 2016 ACS data]

[6] City of Cambridge, CDD, The Port Neighborhood Profile, October 2014
[7] Cambridge Housing Authority, 2018 data

1.2.2 ADAPTED BUILDINGS [B]

The Port's diversity is also reflected in its land use and building types, which are a mix of residential, commercial, charitable, and educational or institutional, as shown in **Figure 1.2.1**. The neighborhood's residential area has multifamily homes and apartment buildings, and there are numerous commercial and mixed-used buildings along Massachusetts Avenue and Prospect Street. The citywide plan, Envision Cambridge,[8] released in May 2019, identifies growth corridors along these main commercial arteries. These growth corridors will need to develop in ways that will mitigate the effects of a changing climate, while maintaining rent and housing and financial affordability for the community.

Because of proximity to Kendall Square and MIT, the biotech sector is thriving in The Port. In **Figure 1.2.1**, this sector is included in both education/ institutional and commercial land uses. This sector has been an important part of the City as it provides jobs and revenue. But the neighborhood is experiencing a steady increase in rental rates.[10]

Four property owners are important stakeholders, as they own about half the land in The Port: **1)** the City owns parks, parking lots, and other facilities; **2)** the Cambridge Housing Authority owns several public housing developments;

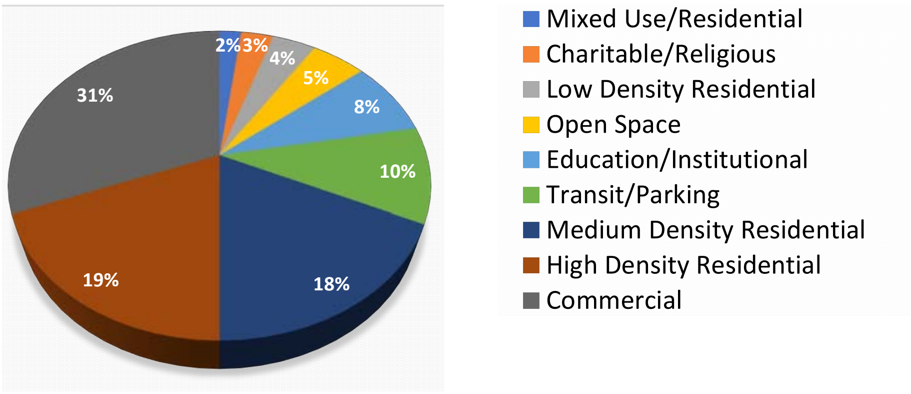


Figure 1.2.1 Land use in The Port [Source: City of Cambridge Assessing Department, 2017]

3) MIT owns multiple buildings throughout the neighborhood and in the Osborn Triangle; and **4)** Charles Stark Draper Laboratory is located in the Osborn Triangle in proximity to Kendall Square. These stakeholders represent the diverse makeup of the neighborhood, a mix of public and private institutions, with vested interests and different resources, which can contribute to The Port's sustainable and resilient growth.

1.2.3 RESILIENT INFRASTRUCTURE [C]

The density of the neighborhood translates into density of the infrastructure. The Port is well served by several infrastructure systems, including transportation, energy, and water/stormwater/ wastewater pipe infrastructure. Central Square is the commercial center of the neighborhood. It is a transportation node that connects people to the rest of Cambridge and neighboring cities, such as Somerville and Boston, through the Red Line MBTA stop and multiple bus and bike routes. The Port residents rely more on buses and bikes, and less on cars, than residents in other parts of the City.[10]

The Port houses a diversity of energy sources: an active steam distribution line, electrical transmission lines, the MIT co-generation plant, a natural gas regulating station and transmission lines, and the Novartis steam co-generation unit.

The Port's stormwater infrastructure drains to stormwater outfalls as the Charles river via Massachusetts Avenue at Memorial Drive

[8] Envision Cambridge, http://www.cambridgema.gov/~/media/Files/CDD/compplan/envisioncambridgefinalplan/envisioncambridgefinalreport.pdf
[9] City of Cambridge, Community Needs Assessment, January 2017
[10] City of Cambridge Community Development Department, The Port Neighborhood Profile - Draft, October 2018 (Note: the final report has not been published yet)

and Endicott Street. The Port's wastewater is pumped to its destination at the Deer Island Wastewater Treatment Plant. After intense rain events, combined sewer overflows occur on the Charles River through the Binney Street combined sewer outfall. The City is investing now in major stormwater infrastructure improvements to reduce flooding and continue sewer separation projects that will reduce sanitary and combined sewer overflows.

1.2.4 RESILIENT ECOSYSTEMS [D]

The ecosystem of The Port study area includes all the living organisms, such as plants, trees, and animals, interacting with each other, and with other components of the environment, including soil and climate. A healthy ecosystem is an important component of a healthy community and includes open spaces—mainly parks, pervious surfaces, and areas with trees that can provide shade. The Port study area has fewer open spaces and less tree canopy and pervious surfaces than the rest of the city.

The City's Urban Forest Master Plan has already identified The Port as a challenging area with limited planting opportunity because of its dense character.[11] A tree canopy is made up of the overlapping branches and leaves of the trees and, in Cambridge, covers about a quarter of the city during summer. The Port has experienced a decline in urban tree canopy over the last few years (a loss of about 4.2 acres, or 14%, between 2009–2018), in areas shown in **Figure 1.2.2** The tree canopy will also be under stress from climate change impacts such as droughts, extreme heat, flooding, ice storms, and high winds.

Pervious areas are areas that allow water to leach into the underlying soil. These surfaces include grass, mulched groundcover, planted areas, vegetated roofs, permeable paving as well as porches and decks erected on pier foundations that maintain the water permeability beneath. In The Port, pervious areas are a small proportion (15%) of the total neighborhood area; this affects the health of the ecosystem as trees and vegetation need healthy soil that can absorb and retain water.

The urban character of The Port, with its high density of people, buildings, and infrastructure, limits the extent of the existing green open space and tree canopy. Expanding the green open space and tree canopy under these limiting conditions will require creative solutions.

Table 1.2.3 **Existing infrastructure and ecosystems in The Port study area***

Size
153 acres in the Port study area
191 acres in the Port neighborhood
Infrastructure
6.4 miles of stormwater pipes
6.3 miles of wastewater pipes
1.6 miles of combined sewer pipes
9.4 miles of water pipes
8 miles of roadway
17.8 miles of sidewalk
2.4 miles of bike lanes
13 MBTA bus stops
Protected open space
5% versus 14% citywide
1 acre/1,000 people versus
5 acres/1,000 people citywide
Low tree canopy cover
16% compared to 25% citywide
Low percentage of pervious area
15% (City's regulations aim for 25%)

[Source: City of Cambridge, GIS data as of 2018]

[11] Cambridge Urban Forest Master Plan, Public Meeting #1, October 3, 2018

Figure 1.2.2

Tree canopy changes in The Port 2009-2018

[Source: City of Cambridge GIS Data, February 2018]

1.3 HOW WILL CLIMATE CHANGE IN THE PORT?

Our climate is changing, bringing more storms, more serious floods, and more heat waves. The City is modeling the impacts of projected flooding and heat to prepare for change. Areas in the city that are more susceptible to the immediate and future climate risks of flooding and high heat have been identified in the Climate Change Vulnerability Assessment (CCVA). One of the key findings is that The Port will experience more frequent and extreme rain events and heat waves.

1.3.1 EXTREME RAIN

The Port has experienced flooding in the past and continues to experience it during both small and large storms. This flooding is caused by the City's stormwater infrastructure's limited capacity to convey more frequent and significant storms, the regional sewer system that also has limited capacity, and the fact that The Port is in a low-lying area prone to flooding. Rain that falls on paved surfaces is collected by the City's stormwater pipes. These pipes can carry a set volume of water, which is based on the size of the pipe. During short-duration, high-intensity storms (for example, 2 inches of rain in one hour), some pipes cannot carry the additional stormwater, and this water ends up flooding our streets and houses.

Rain-driven flooding is likely to become more frequent, expansive, and deeper in The Port neighborhood with climate change. **Table 1.3.1** explains the terminology used to describe storms throughout this report. **Table 1.3.2** documents the different storms used for modeling flooding risk. The Port has experienced significant flooding in the past, such during the July 10, 2010, short-duration, high-intensity "cloud burst," which dropped 3.6 inches of rain in one hour (100- to 200-year storm). Preliminary results indicate that the area at risk of flooding from smaller, more frequent (10-year) storms is projected to nearly double in the next 50 years if no action is taken.[12]

The City is currently making major investments in stormwater infrastructure projects in The Port to reduce the flooding risks. For example, a stormwater tank is currently under construction in Parking Lot 6 (PL6), and the City has also identified another potential location in The Port for a second stormwater and sanitary tank to reduce flooding. **Figure 1.3.2** shows the projected flooding in the neighborhood during a future smaller, more frequent (2070, 10-year) storm, assuming construction of the PL6 stormwater tank and other stormwater infrastructure improvement projects that have been recently constructed or are in their final stages of design. After implementation of these projects, the flooded area of The Port will reduce by 3%, shown in **Figure 1.3.1**.[13] and in **Table 1.3.2**. This reduction in flooding will help during near future smaller, more frequent (2030, 10-year) storms, but as illustrated in the map, actions are still required to address remaining flooding, shown in blue. In addition, larger, less frequent (100-year) storms, will still cause significant flooding problems. Even after infrastructure improvements, the neighborhood remains at risk of flooding for both near-future and future larger, less frequent (100-year) storms, as shown in **Table 1.3.2**, and we will need to address these risks with additional strategies.

[12] Climate Change Vulnerability Assessment (CCVA) Report, Part 1 – (November 2015)
[13] Appendix 1 – Gray and green infrastructure analyses for The Port

Table 1.3.1 **Types of storms modeled for The Port**

Storm	Total Rain (inches)	Peak Intensity (inches/hour)	Storm referenced in the text as:
Present 10-yr[1] 24-hr	4.9	1.2	Smaller, more frequent
2030 10-yr 24-hr	5.6	1.4	Near future smaller, more frequent
2070 10-yr 24-hr	6.4	1.6	Future smaller, more frequent
Present 100-yr[2] 24-hr	8.9	2.2	Larger, less frequent
2030 100-yr 24 hr	10.2	2.5	Near future larger, less frequent
2070 100-yr 24-hr	11.7	2.9	Future larger, less frequent

Notes:
1. 10-year storm: a storm that has a 10% chance of happening every year, making the average time between storms of this size 10 years.
2. 100-year storm: a storm that has a 1% chance of happening every year, making the average time between storms of this size 100 years

The City is currently making major investments in stormwater infrastructure projects in The Port to reduce flooding risks. One of these investments is the stormwater tank under construction in Parking Lot 6, which includes a new pipe connection across Mass Ave .to allow stormwater to flow into the Charles River.

Table 1.3.2 **Flooding in The Port**

Storm	Total Flooding Volume (MG)		% Port Area Flooded		% Port Properties Flooded	
	Before Improvements	After Improvements*	Before Improvements	After Improvements*	Before Improvements	After Improvements*
Present 10-yr[1] 24-hr	2.4	1.2	8%	6%	20%	15%
2030 10-yr 24-hr	3.7	2.6	11%	10%	22%	22%
2070 10-yr 24-hr	5.6	4.7	18%	15%	40%	29%
Present 100-yr[2] 24-hr**	16.0	13.0	38%	38%	76%	81%
2030 100-yr 24 hr**	21.5	18.4	43%	43%	82%	83%
2070 100-yr 24-hr**	28.0	24.5	47%	48%	84%	86%

Notes:
* Includes the stormwater tank under construction in Parking Lot 6 and other stormwater infrastructure improvement projects that have been recently constructed or are in their final stages of design.
** 100-year storm values are calculated from the City's latest model results as of April 2019.

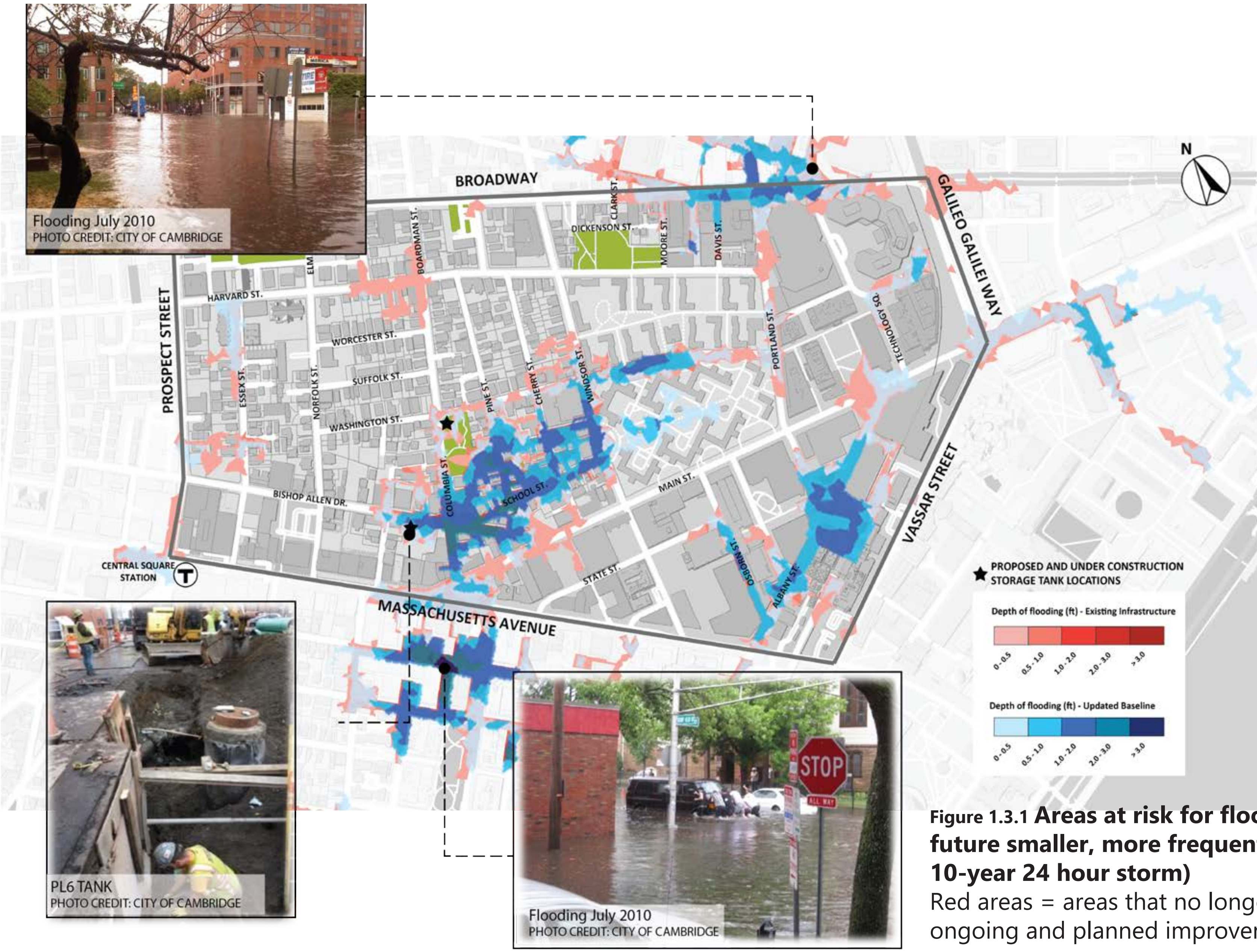


Figure 1.3.1 **Areas at risk for flooding during a future smaller, more frequent storm (2070 10-year 24 hour storm)**

Red areas = areas that no longer flood after ongoing and planned improvements

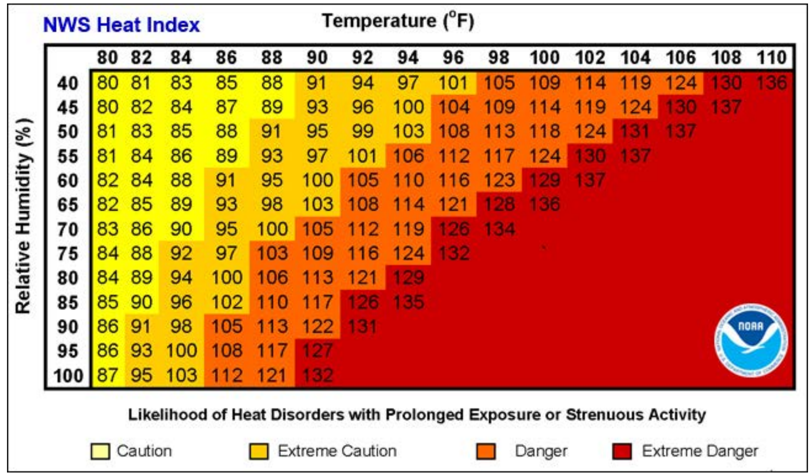
[Source: Appendix 1 – Gray and green infrastructure analyses for The Port]

1.3.2 EXTREME HEAT

Dense urban areas such as The Port have more buildings and pavement that absorb heat and are significantly warmer than rural or less developed areas. This is called the urban heat island (UHI) effect. Urban heat islands are warmer during the day and cool off less during the night. Hotter night temperatures make it harder for people to cool off and avoid heat stress. People living in The Port community will feel the effects of more extreme temperature resulting from the UHI effect.

Days of extreme heat with temperatures that reach over 90 degrees Fahrenheit (°F) are projected to triple within the next 15 years because of climate change, increasing from an average of 11 days a year today to about 31 days a year by 2030. This means that heat waves (3 days in a row over 90°F) will be more frequent and longer in duration. By 2070, Cambridge may experience about 75 days over 90°F.[14]

As temperatures become hotter, we may enter temperature ranges on the hottest days that will be dangerous to the health of The Port residents and will add stress to buildings, infrastructure, and the ecosystem, including urban trees. Ambient air temperature is the measured air temperature. Heat index, which is a combination of ambient air temperature and relative humidity, and is shown in **Figure 1.3.2**, represents the "feels like" temperature for people. This UHI effect will make the" feels like" temperature harsher and increase the likelihood of heat stress.



NWS Heat Index — Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Figure 1.3.2 **Heat index chart**
[Source: National Weather Service NWS,NOAA]

The Port, especially Central Square, was identified as a hot spot, prone to higher future outdoor air temperatures. Higher temperatures will magnify the UHI effect and make the neighborhood even hotter, as shown in **Figure 1.3.3**. The map illustrates the variability in ambient air temperature on a 90°F day. With the UHI effect, the average temperature in The Port is about 92°F with almost half (43%) of The Port experiencing temperatures above 92°F. The City is already preparing for existing and projected heat waves. Through the Urban Forest Master Plan, the City aims to curb the loss of canopy and plant more trees. The City is already encouraging white (reflective) coating on roofs or the installation of green roofs. Additionally, the City has embarked on a public education and outreach campaign to raise awareness of extreme heat impacts and provide information on heat-reduction resources.

Table 1.3.3 **Ambient air temperature distribution in The Port on a 90°F day**

Ambient Temperature (°F)	Percent of the Port Study Area
87.8 - 88.0	0%
88.1 - 90.0	16%
90.1 - 92.0	40%
92.1 - 94.0	23%
94.1 - 96.0	16%
96.1 - 100.0	4%

[14] Cambridge CCVA. https://www.cambridgema.gov/CDD/Projects/Climate/~/media/307B044E0EC5492BB92B2D8FA003ED25.ashx

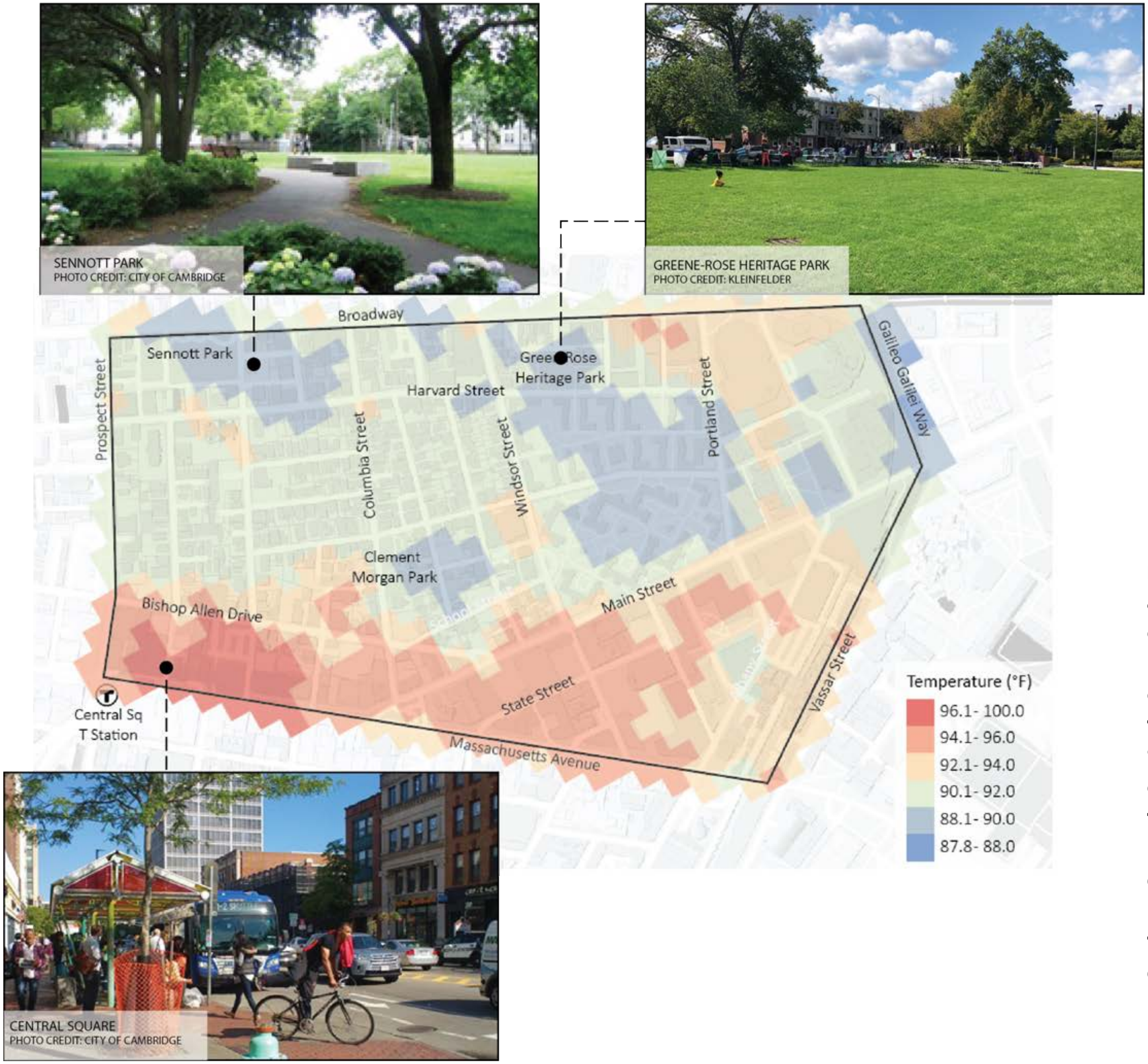


Figure 1.3.3 **An average ambient air temperature of 90°F on a day in the City means approximately 80% of The Port experiences temperatures greater than 90ºF, and almost half (43%) of The Port experiences temperatures above 92°F (days with temperatures greater than 90°F days are projected to become more frequent in the future: 31 days per year by 2030 and 3 months per year by 2070)**
[Source: Appendix 1 – Gray and green infrastructure analyses for The Port]

1.4 HOW WILL EXTREME RAIN AND HEAT IMPACT THE NEIGHBORHOOD?

Extreme rain and heat will impact public health, critical services, infrastructure, environment, and the city's economic well-being. The vulnerability assessment identified elements of The Port community that are most at risk of flooding and heat waves. In this section, key impacts on The Port are described for **[A] *Prepared Community* with increased social and economic resilience**; **[B] *Adapted Buildings* that house residents, businesses, and institutions**; **[C] *Resilient Infrastructure* that ensures continued service and/or swift recovery from extreme events**; and **[D] *Resilient Ecosystems* that integrate the built and natural environments**.

1.4.1 PREPARED COMMUNITY [A]

The Port is rich in community resources servicing its population. As illustrated in **Figure 1.4.1**, there is a density of institutions, nonprofit organizations, and meeting places that support a vibrant community. The Port's community resources, from religious organizations to healthcare and social service organizations, could be affected by flooding. Incapacitated community services may not be able to reach populations at risk, which are more isolated because of limited mobility, limited income, age, or language barriers.

> Heat stress causes more deaths in the United States than any other weather impact, including storms and hurricanes.

More frequent flooding can expose residents to contaminated outdoor and indoor floodwaters. Outdoor floodwaters and areas with sustained ponding during warmer months are perfect breeding grounds for mosquitoes and other disease-carriers. Indoor floodwaters can create unhealthy indoor conditions, such as mold and pest problems. Mold is one of the main health risks after a flooding event, especially if residential units are not properly repaired or restored after flooding damages.

For populations at risk, extreme heat impacts can cause heat strokes, hospitalization, and even death. Heat stress causes more deaths in the United States than any other weather impact, including storms and hurricanes.[15] Young children, older adults, and people with chronic respiratory and heart problems are more vulnerable to the effects of heat. Even healthy outdoor workers and people exercising must be very careful to take more breaks and drink more fluids during heat waves. Warmer indoor temperatures can reduce worker productivity. Extreme heat can cause power outages as demand for electricity stresses electricity distribution systems. Loss of power and the resulting loss of air conditioning can lead to great heat stress on health.

1.4.2 ADAPTED BUILDINGS [B]

Flooding will impact some of the neighborhood's critical assets (shown in **Figure 1.4.2**), and community resources, (shown in **Figure 1.4.1**). Buildings housing these critical assets and services are at risk. For example, the Cambridge Health Alliance building, which is a health and emergency response center, might not be operational during times of most need if flooded. Similarly, the Margaret Fuller House is a vital community resource and has a day-care center in its basement that is vulnerable to flooding.

Economic losses from a flood event and/or an area-wide power loss would be significant. Approximately 15% of The Port area and one out of three properties will be at risk from flooding from a 10-year storm in 2070.[17] Central Square and the Osborn triangle of The Port are most prone to flooding. These two areas are also the most vibrant economically; flooding could result in structural damage to buildings and loss of activity, with significant financial repercussions for the businesses, the City, and for the people who work in these areas.

[15] Centers for Disease Control and Prevention, Extreme Heat, www.cdc.gov/disasters/extremeheat

Arts & Outreach

1 Cambridge Community Art Center
2 Central Square Theater

Community Organization

3 Cambridge Community Foundation
4 Cambridge Community Outreach
5 Hildebrand Family Self-Help Center, Inc.
6 Margaret Fuller Neighborhood House

Public Health

7 Cambridge Public Health Department

Neighborhood Hub

8 Central Square Farmers Market
9 Izzy's Restaurant & Sub Shop
10 Camies Bakery and Restaurant

Place of Faith

11 Christ the King Church (Presbyterian)
12 St. Mary's Parish
13 Islamic Society of Boston
14 Pentecostal Tabernacle North Campus
15 St. Bartholomew's (Episcopalian)
16 St. Paul's AME
17 Temple Beth Shalom
18 Union Baptist Church
19 The Gospel Room
20 Christian Life Center

Public Housing

21 116 Norfolk Street
22 JFK Apartments
23 Newtowne Court
24 Washington Elms

School/ Youth Center

25 Tutoring Plus
26 Moses Youth Center
27 Fletcher Maynard Academy
28 Prospect Hill Academy
29 The Algebra Project, Inc.
30 The Henry Buckner School

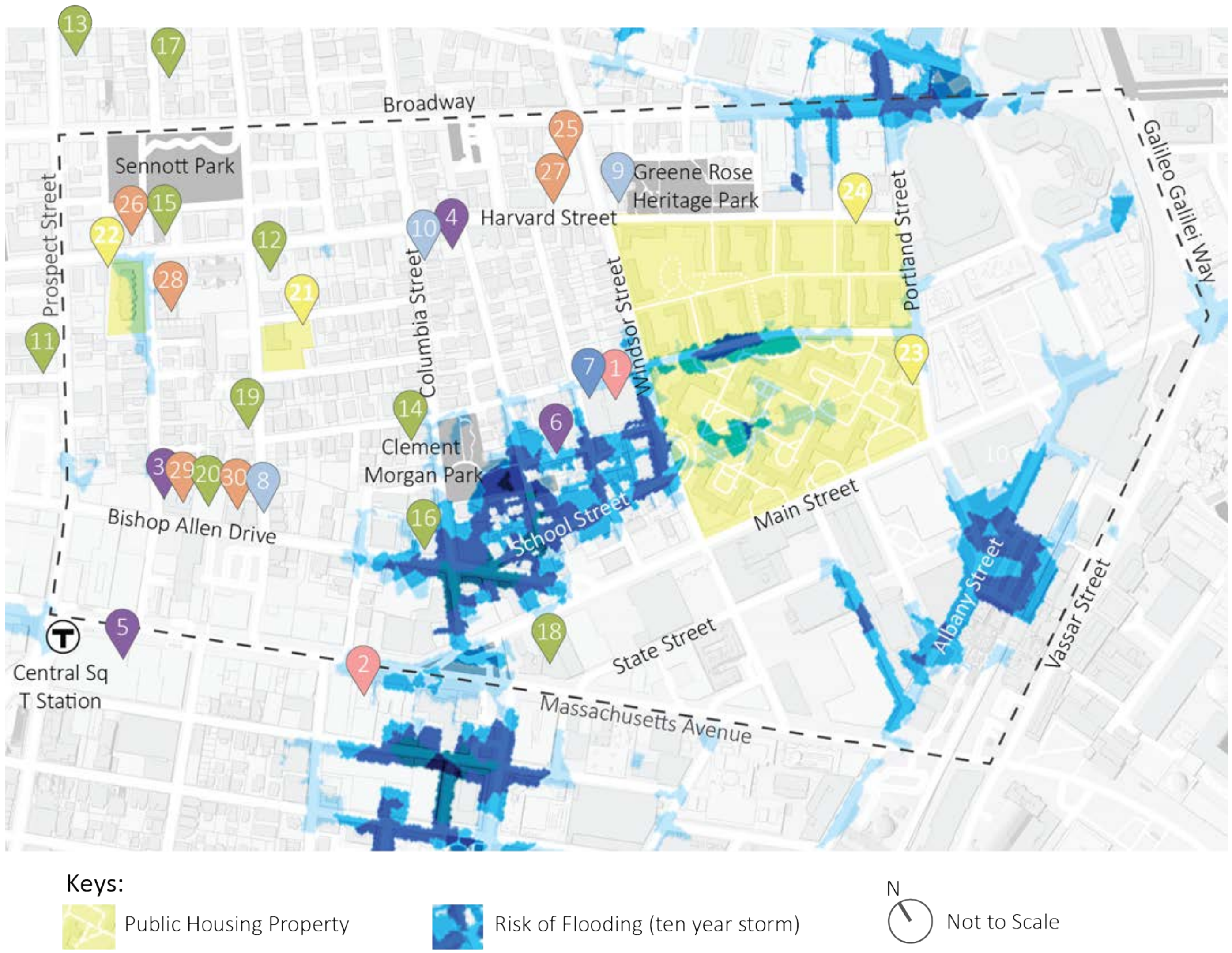


Figure 1.4.1 Community resources and impacts of flooding in The Port (10-year storm 2070 storm)
[Source: Cambridge GIS land use data (2017) with Google Map updates as of February, 2019.]

1.4.3 RESILIENT INFRASTRUCTURE [C]

Flooding can disrupt electricity and transportation infrastructure, and the drinking water, stormwater, and wastewater collection systems. Flooding of the Central Square Red Line T stop and bus transportation node will limit the mobility of people and their ability to get around.

Heat waves can affect performance of electrical infrastructure and assets. Extreme heat can affect the power supply, transformers, and power generation facilities. Diminished utility capacity may lead to rolling blackouts or outages. A significant increase in air-conditioning loads may exceed the already reduced generation capacity.

Extreme heat will be more prevalent in the Port's commercial district, along Central Square and bus and bicycle routes. This will affect working and living conditions, as well as people's ability to travel, whether by walking, bicycling, or using public transit. The cost and ability to cool homes and workplaces will also be affected.

1.4.4 ECOSYSTEM [D]

Flooding, extreme heat and drought will contribute to the loss of the existing tree canopy. Extreme rain events that result in more than 2 feet of standing water for more than 24 hours can significantly affect flood-intolerant tree species or trees in poor condition. Such event could be caused by a 100-year 2030 storm.[16] Projected warmer temperatures will have greater impact on tree species not adapted to warmer climate. Similarly, a moderate drought will affect drought intolerant tree species. Stresses brought by pests and diseases are likely to increase and might further exacerbate canopy loss. Preliminary findings from the ongoing Urban Forest Master Plan show that canopy loss in The Port from flooding, extreme heat and drought are potentially minimal but might increase as extreme weather events will gain in intensity and frequency. The City's ongoing Urban Forest Master Plan[17] is focusing on the health of the urban forest and climate change impacts and will provide strategies to maintain and enhance a healthy tree canopy.

Figure 1.4.2 Key physical and social vulnerabilities to projected climate change impacts [Source: CCVA, February 2017]

[16] Refer to the Appendix 1: Gray and green infrastructure analyses for The Port
[17] Urban Forest Masterplan, City of Cambridge, https://www.cambridgema.gov/Departments/publicworks/urbanforestmasterplan

2.0

THREE IDEAS FOR CHANGE

2.0 THREE IDEAS FOR CHANGE

The three ideas for change work at different scales to increase the resiliency of The Port. (**Figure 2.0.1**) Enhanced Gray and Green Infrastructure is best achieved at the neighborhood scale with strategies that can be applied to the stormwater system or the urban forest for the entire neighborhood. The Super-Resilient Blocks are for distinct pilot projects addressing groups of buildings and open spaces. Finally, Resilient People involves residents of The Port taking an active role in building stronger social connections and community initiatives to prepare the community for climate change.

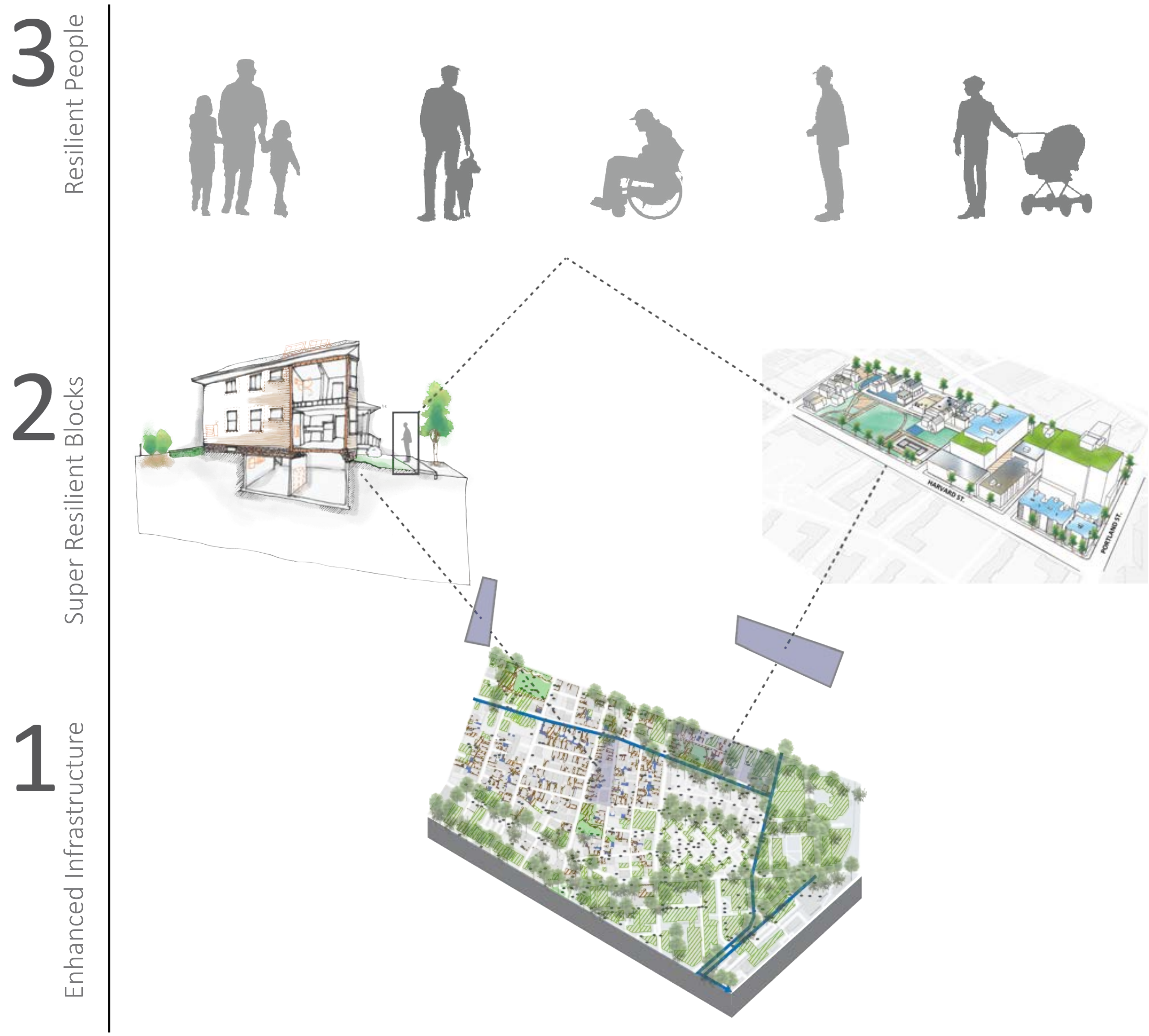


Figure 2.0.1 **Three ideas for change**

IDEAS FOR CHANGE

#1 ENHANCED RESILIENT GRAY AND GREEN INFRASTRUCTURE

2.1.1 THE IDEA

The City is committed to improving the lives and livelihood of The Port residents and businesses and is preparing the neighborhood for climate change. Knowing that climate change will increase the frequency of extreme precipitation and heat waves and place greater demand on stormwater and energy infrastructure systems, respectively, the City is looking at a range of solutions for the neighborhood to best respond to flooding risk and impacts from extreme heat.

Combined implementation of gray and green infrastructure can be effective in reducing flooding and the Urban Heat Island effect in The Port and provide additional benefits to the neighborhood, such as improving water quality, beautifying the cityscape, and reducing energy costs.

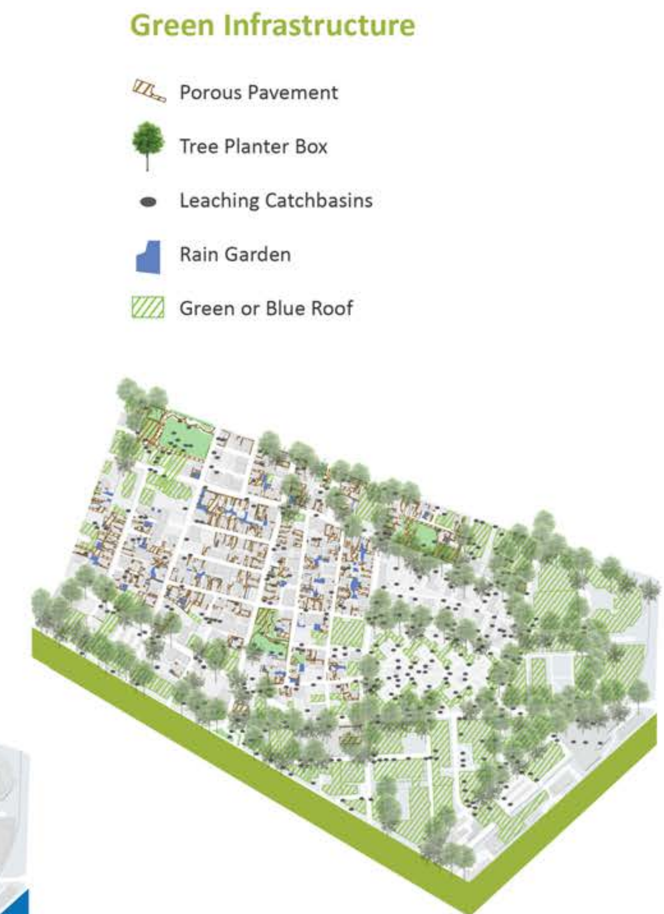
Gray infrastructure strategies for drainage systems to manage stormwater can include new pipes, pumps and/or underground storage tanks. Gray infrastructure projects mitigate flooding by holding water, such as large storage tanks, and/or by draining floodwaters away from areas as quickly as possible, such as larger pipes and pump stations. For new gray infrastructure projects, the City is adopting revised design criteria that consider climate change and are more resilient to extreme events in the future.

Green infrastructure strategies in this report constitute the natural ecosystem, such as increased tree canopy and other engineered solutions that use plants to mimic the soil ecosystem, such as bioretention basins, rain gardens, and green roofs. Flood reduction benefits from green infrastructure can vary by how they are designed and implemented. In the Port, green infrastructure has limited benefits considering site conditions such as soil types, limited available space for implementation, and density of underground infrastructure. Nevertheless, green infrastructure provides additional co-benefits, such as mitigate urban heat island (UHI) impacts, improve water quality and reduce energy demand. Innovative strategies being studied for The Port include tree box filters interconnected to nearby leaching catchbasins to retain water and reduce flooding.

Sustainable energy strategies studied for The Port will enhance energy resilience as they are designed to provide energy autonomy during extreme events. The implementation of "microgrids" and "community energy" systems can provide the additional benefit of increasing efficiency and the amount of energy supplied by renewable sources, reducing pollution and costs. **Microgrids** are local electricity networks that can operate independently from the utility grid during power outages. Like microgrids, **community energy systems** are network of distributed energy resources (DERs) such as solar PB arrays, battery storage, and combined heat and power (CHP) units also providing for a reliable energy supply to could maintain power to critical facilities during power outage.

Gray infrastructure is defined as traditional engineering systems that generally use concrete, solid plastics, or steel, implemented to manage impacts from natural hazards such as flooding.

Green infrastructure includes best management practices and/or engineering installations that mimic the natural environment. By restoring the natural ecosystem, green infrastructure can provide benefits, such as flood reduction, improve water quality, reduce urban heat island impacts and lower energy costs, creating a more livable cityscape.



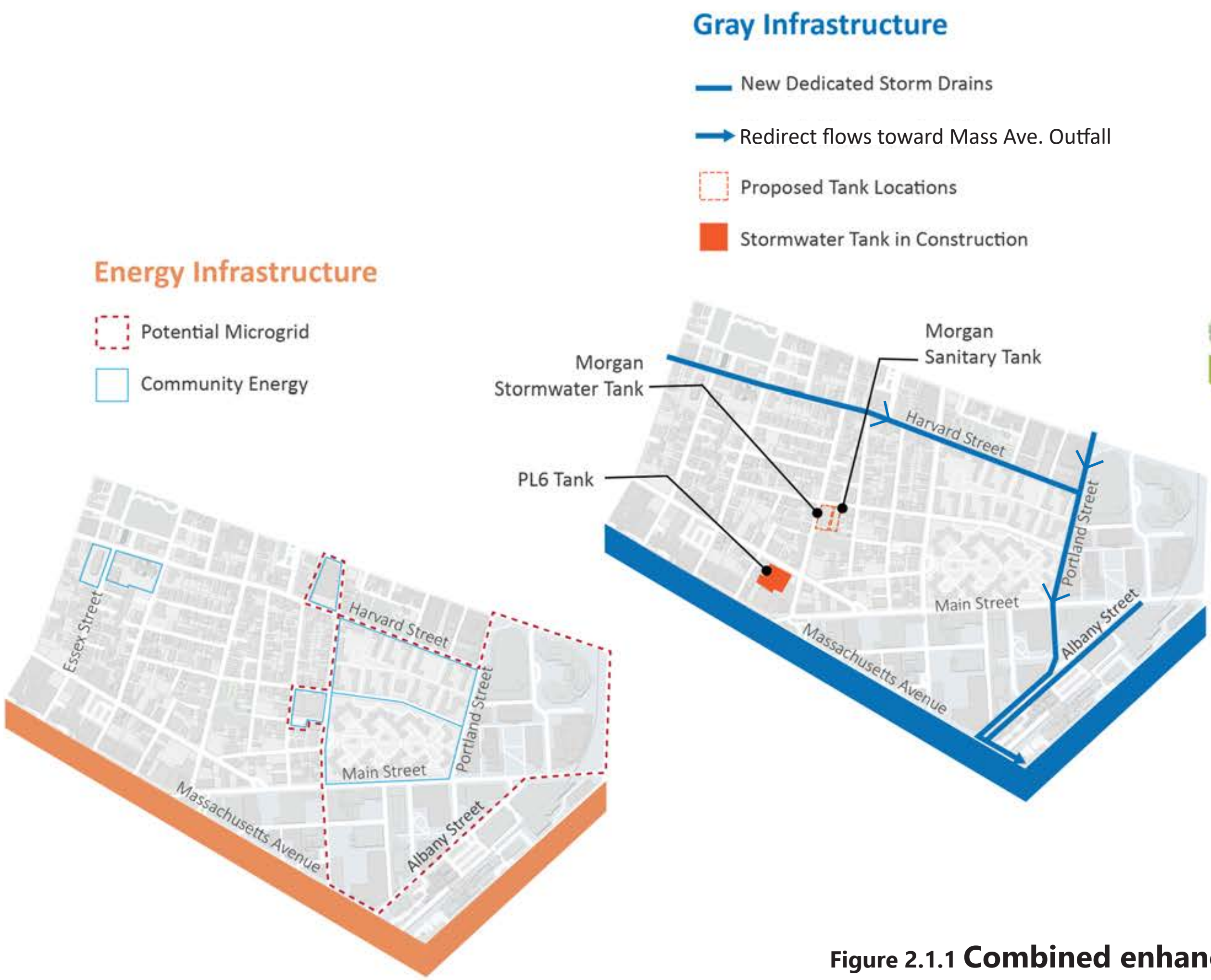


Figure 2.1.1 **Combined enhanced energy, gray, and green infrastructure**

2.1.2 WHAT WOULD BE GAINED—BENEFITS AND METRICS

- Enhanced gray and green infrastructure could significantly increase the resiliency of The Port by reducing flooding and the UHI effect and providing more energy resiliency to the neighborhood as reported in **Table 2.1.1**.
- Gray infrastructure strategies can possibly reduce flooding within The Port by **66%** for the 2070 10-year storm.
- Green infrastructure strategies, when combined with gray infrastructure strategies, can possibly reduce flooding by an **additional 11%, to an effective total of 77%** flood reduction for the 2070 10-year storm. **Section 2.1.5** further discusses the basis for these figures.
- Heavy precipitation with storms is expected to become more frequent. A present-day storm that has a 1-in-25 chance each year of dropping 6 inches of rain in 24 hours is projected to have a 1-in-10 chance by 2070. The combination of gray and green infrastructure strategies can prevent worse flooding for these size storms.
- Installing green infrastructure within the public right-of-way as opportunities arise, as well as on public and private parcels can provide benefits to mitigate the urban heat island (UHI) effect and reduce ambient air temperature. On a 92ºF-day, model results show that the average temperature within The Port is reduced by 2ºF to 90ºF, and areas with ambient temperatures over 92ºF reduces from 44% to 29%.
- Green infrastructure can also treat stormwater to improve water quality by leaching water into the ground. The total phosphorus pollutant loading from The Port that runs off to the Charles River can be reduced by 15% or more.[18]
- Solar Photovoltaic (PV) systems installed as part of a microgrid and/or community energy system in The Port could produce more than 9,000 MMBtu[19] of electricity.[20]

Table 2.1.1 Projected benefits

Maximum Benefits		Co-benefits
Reduced Heat	Up to 2°F reduction in ambient air temperature	Neighborhood beautification
Reduced Flooding	Up to 77% reduction in flooding	15% reduction in phosphorous, improves water quality
Energy Resiliency	About 9,000 MMBtu in energy savings, equivalent to the annual electricity usage of approximately 375 households	Mitigates approximately 910 metric tons CO_2e[21] in GHG emissions, equivalent to the annual GHG emissions of 45 existing triple-decker buildings

[18] Appendix 1 – Gray and green infrastructure analyses for The Port

[19] Appendix 2 – Energy resilience for The Port

[20] Consumption & Energy, U.S. Energy Information Administration, https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ma.pdf - U.S. Energy Information Administration

[21] Carbon dioxide equivalent (CO2e) is a standard unit of measure for greenhouse gas emissions that allows the quantification of various greenhouse gases as a single unit. It represents, for a given amount of greenhouse gas, the equivalent amount of carbon dioxide with the same global warming potential.

2.1.3 HOW CAN IT BE DONE?

The City of Cambridge has invested in several large-scale gray infrastructure projects in The Port neighborhood that will be completed by 2020 to improve the existing drainage system. The first phase of The Port Infrastructure Improvement Project is a $35 million investment by the City to improve drainage, sewers, streets, and sidewalks in The Port neighborhood. New underground stormwater storage tank (0.39 MG capacity) being constructed at the municipal Parking Lot 6 (PL6) located on Bishop Allen Drive will capture water during rain events and pump the water away from The Port via a storm drain on Massachusetts Avenue. This system will significantly reduce the frequency of flooding and back-ups in The Port, but the area will still be vulnerable to flooding during less frequent, larger storms.

As part of The Port Preparedness Plan, the City also evaluated additional **gray infrastructure** alternatives to reduce flooding impacts in The Port from climate change. These alternatives are high-level conceptual plans with an implementation timeframe for Year 2030 and onwards, when it is expected that the City will experience more frequent and intense storms.[22] Among the six gray infrastructure scenarios[23] that the City has evaluated, the recommended alternative leverages a combination of drainage infrastructure rehabilitation and diversion of stormwater flows with new drain pipe connections to enhance the drainage capacity in The Port, targeting flood impact areas, such as the intersection of Bishop Allen Drive and Columbia Street.

In the recommended alternative, the next phase of The Port Infrastructure Improvement Project would include construction of a 0.72 MG underground stormwater storage tank with a 10 MGD pump station and an adjacent 0.16 MG underground sanitary storage tank under the existing Clement Morgan Park. It will require completing sewer separation in The Port, and redirecting stormwater flows away from The Port

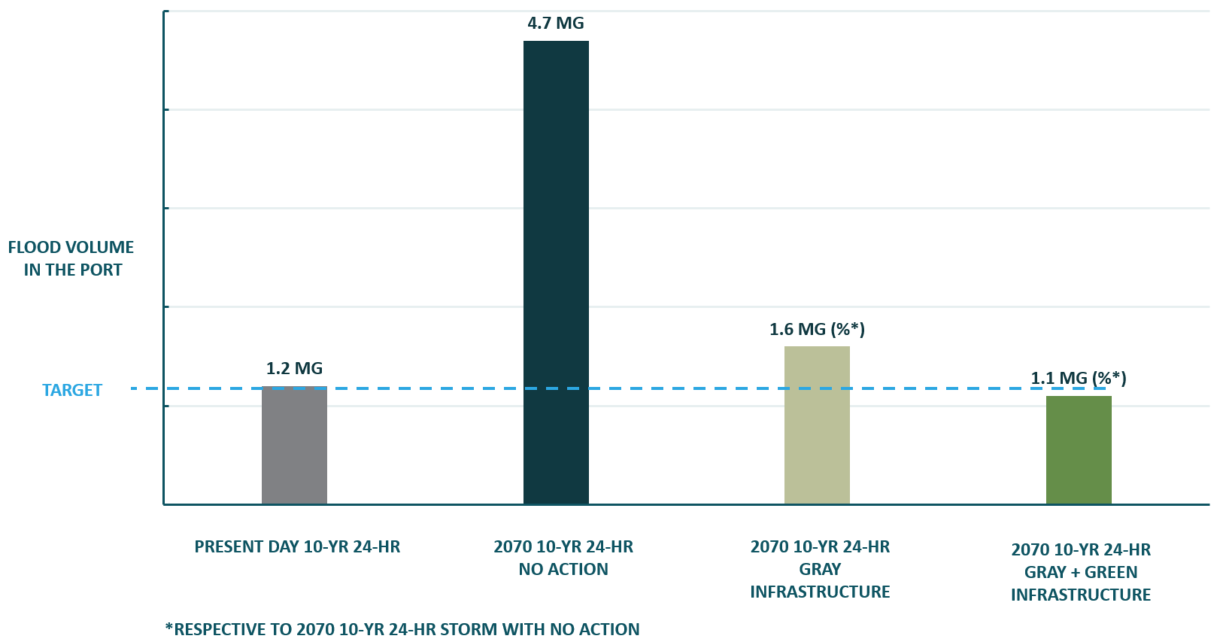


Figure 2.1.2 Flood mitigation strategies to address climate change
[Source: Kleinfelder based on Appendix 1 – Gray and green infrastructure analyses for The Port]

[22] CCVA Report Part 1 –Precipitation, https://www.cambridgema.gov/CDD/Projects/Climate/~/media/307B044E0EC5492BB92B2D8FA003ED25.ashx, Page 12
[23] Appendix 1 – Gray and green infrastructure analyses for The Port

to the South Massachusetts Avenue drain system. New underground drain pipes are also proposed on Albany Street to reduce flooding in that area. Additional details on studied alternatives are described in Appendix 1. The stormwater pump and storage tank at the Morgan Park along with the other improvements will help to carry stormwater flows quickly away from The Port neighborhood, and under an intense rainstorm where the drainage system in The Port is overwhelmed, this alternative can provide a back-up connection to carry the stormwater flows towards the Charles River outfall on Massachusetts Avenue. Nevertheless, the benefits from gray infrastructure alone are not enough to compensate for the flood impacts from climate change, as summarized by the stormwater model results shown in **Figure 2.1.2**

Figure 2.1.2 illustrates the concept that effective combination of gray and **green infrastructure** solutions can reduce flooding from smaller, more frequent 10-year storms by 2070, such that flooding under future conditions is not exacerbated compared to present-day flooding. The City's current infrastructure (that is already built or currently being built) in The Port can mostly manage the flooding from the present day 10-year (smaller, more frequent storm) and results in 1.2 million gallons (MG) flooding (represented by the first gray bar in **Figure 2.1.2**). If no further actions are taken to improve infrastructure, the flooding in The Port is likely to be 4.7 MG for the 10-year storm by 2070 (represented by the second blue bar in **Figure 2.1.2**). However, with new gray infrastructure projects (discussed further in **section 2.1.5**), flooding in The Port is likely to be only 1.6 MG (represented by the third light green bar in **Figure 2.1.2**) for the 10-year storm by 2070. Further, with an effective combination of new gray and green infrastructure projects, flooding in The Port is likely to be only 1.1 MG (represented by the fourth dark green bar in **Figure 2.1.2)** for the 10-year storm by 2070. It was also determined that green infrastructure alone is not adequate to mitigate flooding in The Port. An effective combination of gray and green infrastructure solutions can nullify the impacts of climate change for the smaller, more frequent storms in the future and increase the resiliency of the neighborhood.

Enhanced Energy Resilience could be achieved by having a **microgrid** built in the neighborhood. The area with the most potential for microgrid implementation encompasses Draper Laboratory and Alexandria's Technology Square, the Cambridge Housing Authority's Washington Elms and Newtowne Court apartment complexes, the Fletcher-Maynard Elementary School and the Cambridge Health Alliance, and MIT and Novartis facilities located between Massachusetts Avenue and Main Street (area outlined in red in **Figure 2.1.3**).[24] Draper, Alexandria, MIT, and Novartis are ideal "anchor" customers with high energy demands and a need for reliable power. Fletcher-Maynard, the Cambridge Health Alliance, and certain Housing Authority facilities connected to the microgrid could serve as shelters for residents during storm, flooding, and extreme heat events.

Community Energy Systems - An alternative and potentially complementary solution to the microgrid is the implementation of "community energy" systems. Like microgrids, community energy systems are comprised of groups of loads and distributed energy resources that function as a single entity.

They are both managed virtually and are not connected via physical infrastructure. Because of this, energy resilience is only available at the site of the generation source (e.g., at the building, rather than across all energy users), but costs are significantly less. Further, these systems allow community members to invest and reap the economic benefits of distributed generation (e.g., renters can invest in a solar PV system and receive a share of payment for energy generation). Community energy systems can serve as the first step toward traditional microgrid implementation by creating distributed energy resources and establishing a managing entity. This can help reduce the cost of microgrid construction and provide more time for any ownership, financing, and regulatory challenges to be resolved.

In The Port, ideal sites for installing community energy systems, specifically solar PV, include the City-

[24] Appendix 2 – Energy resilience for The Port

owned sites, in addition to the Housing Authority's JFK Apartments and the Prospect Hill Academy (area outlined in blue in **Figure 2.1.3**).[25] Large institutions or corporate entities could also be good candidates for implementing these systems. Solar PV and community energy storage systems installed at these facilities could sell or confer "shares" of the system to residents living within The Port area. This would both enable residents in multifamily buildings (e.g., rentals, condos, and cooperatives) to invest in and benefit from solar PV and enhance the energy resiliency of City-owned facilities. Further, these community energy systems could eventually become integrated with and provide energy to a microgrid in the area.

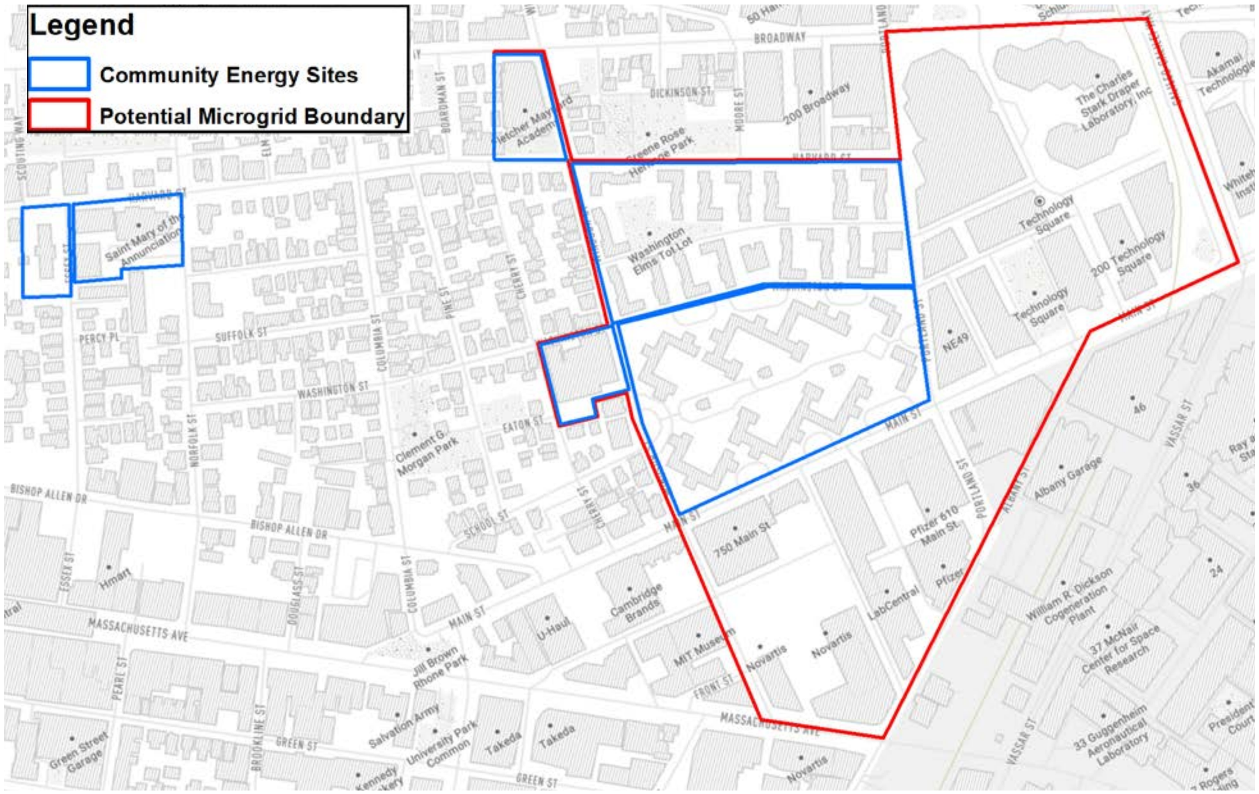


Figure 2.1.3 Potential locations to implement microgrids and community energy projects [Source: Appendix 2 – Energy resilience for The Port]

[25] Appendix 2 – Energy resilience for The Port

Microgrids can provide both energy resilience and improved energy efficiency, in addition to numerous other co-benefits. Traditionally, microgrids are defined as groups of interconnected loads (i.e., buildings or other energy consumers) and distributed energy resources (e.g., on-site solar panels or natural gas generators) that can be controlled as a single entity, much like a large building, and are able to disconnect from the central electricity grid during an outage while continuing to deliver power.

Microgrids and energy community systems are best for sites with a density of high-demand energy consumers that value reliable power, and critical facilities where increased energy resilience can be used to benefit the surrounding community, such as community facilities, hospitals, nursing homes, and pharmacies.

2.1.4 PRECEDENTS RELEVANT TO THE PORT

Like Cambridge, several cities in the United States have dense urban environments with little space left underground for larger gray infrastructure. Many have been implementing green infrastructure projects to alleviate increased flooding caused by more frequent storms, increase water quality by treating stormwater, and reduce urban heat island effect.

Green Infrastructure Incentives (Portland, OR)

In 2007, the City Council in Portland, Oregon, approved a policy to promote and incorporate the use of green street elements in public and private development. Under this policy,[26] all development funded by the City of Portland must incorporate green street facilities or 1% of their construction cost will go to a Green Street Fund. The City will assist in developing incentives and encouraging the private sector to implement green-street projects through planning, design, and funding.

Green Infrastructure Plan (Hoboken, NJ)

The U.S. Department of Housing and Urban Development funded the "Hoboken Green Infrastructure Strategic Plan"[27] as part of New Jersey's Regional Plan for Sustainable Development. The strategic plan evaluated neighborhood-wide strategies to adopt gray, green, and blue infrastructure as illustrated in **Figure 2.1.4**. The plan evaluated strategies for different districts in the Hoboken area and the Hoboken Green Infrastructure strategic plan utilizes a combination of gray, green, and blue infrastructure and identifies strategies that are comparable to our findings in this study for The Port.

Green Infrastructure Strategy Plan for the City of Hoboken

[Source: http://www.hobokennj.org/docs/communitydev/Hoboken-Green-Infrastructure-Strategic-Plan.pdf]

[26] Green Streets Policy, Portland Oregon, https://www.portlandoregon.gov/bes/article/154231
[27] Hoboken Green Infrastructure Plan, Together North Jersey, http://www.hobokennj.org/docs/communitydev/Hoboken-Green-Infrastructure-Strategic-Plan.pdf

Like many cities implementing **gray and green infrastructure**, the effectiveness of the combined approach relies greatly on cooperative efforts between the City and its stakeholders.

Heat Management Assessment (Louisville, GA)

Focusing on urban heat island, the Georgia Institute of Technology worked with the Louisville Metro Office of Sustainability in Kentucky in 2016 to develop a heat management assessment[28] for the Louisville Metro Region. The study identified cooling strategies through public policies, tree planting, cool roofing, and cool paving to manage the UHI effect. Most strategies relate to reducing impervious cover with combinations of new regulatory and economic incentives to bring land cover changes and energy efficiency outcomes.

Save the Rain (Onondaga County, NY)

Onondaga Lake was once the most polluted lake in North America. As part of the efforts to clean up the lake, the "Save the Rain" program aims to reduce combined sewer overflow (CSO) discharges by using a combination of gray and green infrastructure solutions. The program was able to reduce 95% of combined sewer overflow from a limited addition of gray infrastructure and an extensive use of green infrastructure—including rain barrels, tree pits, bioretention filter-strips, underground filtration systems, and porous pavements. The green infrastructure provided co-benefits by beautifying neighborhoods, adding open green space, reducing localized flooding and basement backups.

Parkville Microgrid (Hartford, CT)

The Parkville Microgrid project arose from the City's interest in a resilient power solution to serve critical community facilities that could act as a refuge for residents during emergencies or bad weather. The final system was designed to serve 100% of electricity requirements for Parkville Elementary School, Dwight Branch Library, Parkville Senior Center, and Charter Oak Health Center (during nonemergency operation). In the event of electrical grid outage, the system will provide 640 kW of emergency power to these locations in addition to a local fuel station and grocery store. The Parkville microgrid uses natural gas-powered fuel cells, which, although not considered a renewable source of energy, produces less emissions than gas-fired electricity generation. The microgrid was funded through a public-private partnership between the City of Hartford, the microgrid operator, Constellation, and the fuel cell provider, Bloom Energy.

Additionally, numerous state grants and incentives, including Renewable Energy Credits, were used.

Summary

As demonstrated by these examples, green infrastructure designs can complement gray infrastructure to maximize stormwater management, improve water quality, and reduce urban heat islands. Neighborhood-scale energy systems can provide resilience along with environmental and cost benefits. In addition, green infrastructure can enhance the overall character of the neighborhood and contribute to livability and wellbeing of the residents. This combination of approaches/design of infrastructure is the model the City of Cambridge is interested in pursuing further in partnership with key stakeholders.

[28] Urban Heat Management Study, Louisville, https://louisvilleky.gov/sites/default/files/advanced_planning/louisville_heat_mgt_revision_final_prelim.pdf

The approach for combining gray and green infrastructure is to maximize gray infrastructure and then to assess how much additional flooding can be captured by maximizing green infrastructure.

2.1.5 IMPLEMENTATION

The approach proposed in The Port for combining gray and green infrastructure is, first, to maximize gray infrastructure and second, to assess how much additional flooding can be captured by maximizing green infrastructure.

Maximizing gray infrastructure:

In the last few years, the City has evaluated several gray infrastructure alternatives in The Port and is constructing significant improvements in the Bishop Allen Drive area including a 0.39 MG stormwater storage tank under a municipal parking lot. The next project is the addition of a 0.72 MG stormwater storage tank and 0.16 MG sanitary storage tank under Morgan Park to maximize the use of public land for flood mitigation. Other options are under considerations and will be further studied to assess their cost-benefit as shown in **Figure 2.1.4**. These include sewer separation along Harvard Street, adding a new drainage connection on Albany Street and redirecting stormwater runoff from The Port to the Charles River outfall on Massachusetts Avenue.

The City is the lead implementer for large-scale gray infrastructure improvement projects since they are built within the City right-of-way and part of either roadway, underground, or park/open space projects that are under the purview of the Public Works Department. These projects are done in consultation with residents and key stakeholders as they are complex, and efforts need to be well coordinated to maximize positive outcome and minimize disruption for stakeholders.

Maximizing green infrastructure:

While the City takes the lead for implementation of gray infrastructure, implementation of green infrastructure requires a partnership between the City, key stakeholders, property owners, and residents. Maximizing green infrastructure requires improvement both in the public right-of-way and on abutting private properties with designs that can be adapted to different urban conditions. For example, a parcel that is covered by a large building with a flat roof might be the ideal candidate for installing a green roof while another parcel with 50% open space might be ideal for a rain garden. The key concept for green infrastructure is to capture as much stormwater as possible to replenish groundwater, and reduce, delay, and potentially treat the stormwater entering the piped infrastructure to maximize the conveyance system's carrying capacity. Most promising strategies have been identified as informed by The Port's unique conditions.

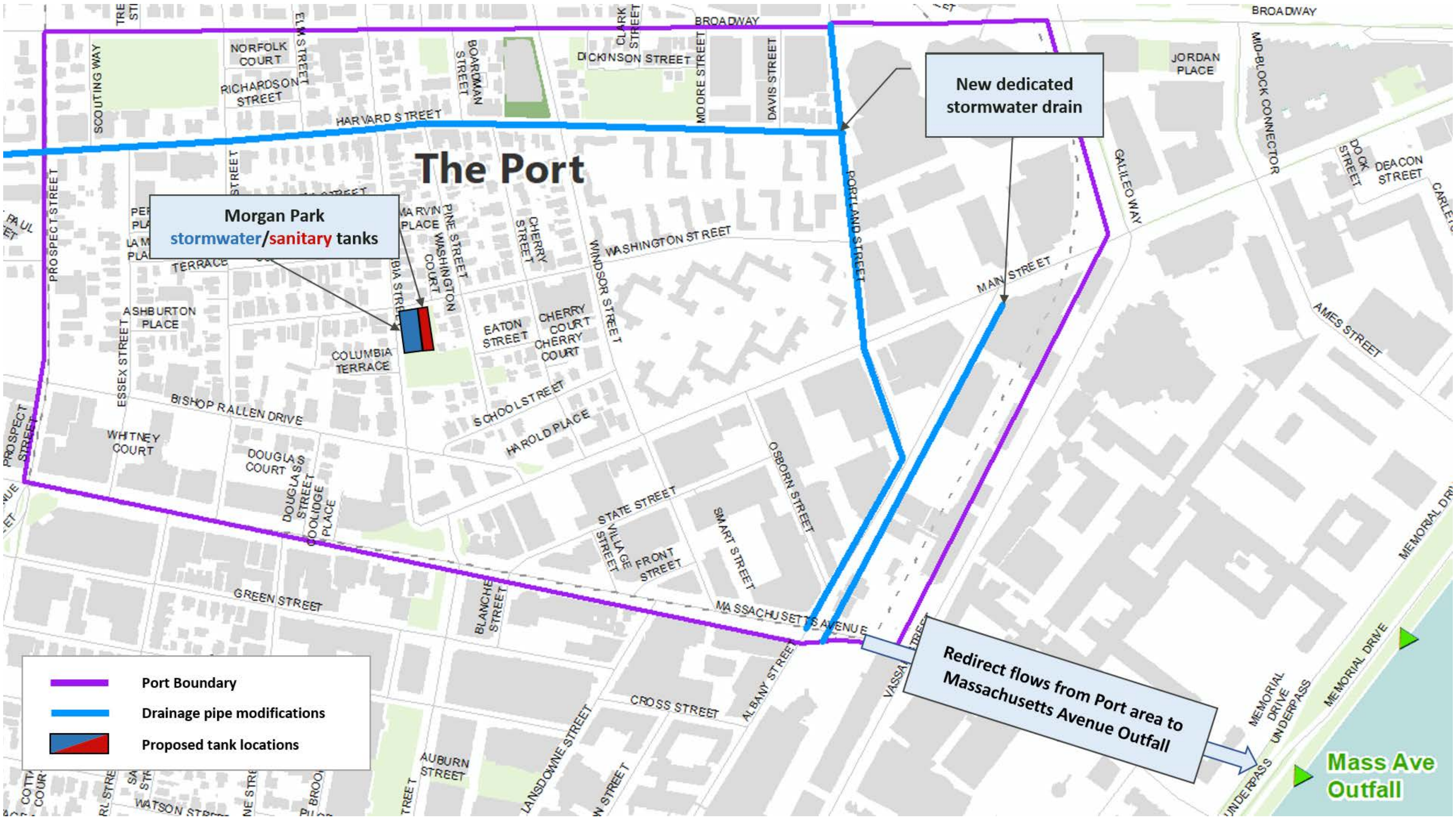


Figure 2.1.4 Overview of recommended gray infrastructure projects

Source: Kleinfelder based on Appendix 1 analysis

The performance of the recommended **gray and green infrastructure** alternative in The Port was tested using the City's stormwater model. With the proposed strategies considered in the green infrastructure alternative, it was estimated that an average 35% reduction in impervious area could be achieved, which results in an additional 11% flood volume reduction over the gray infrastructure alternative. In addition, green infrastructure can treat the stored stormwater and reduce phosphorus loading by approximately 35 pounds/year, a 15% reduction from the current phosphorus loading of 238 pounds/year[29] from The Port study area.

Considered alternitives include:

Green Roof at 23 Sidney Street University Park - Credit: Cambridge Community Development

Green roofs

Building roofs collect large amounts of stormwater and consequently contribute a significant amount of runoff that directly discharges into the street's drainage system. Green roofs are effective in intercepting the stormwater before it reaches the ground. Green roofs provide pervious area to building roofs and, therefore, reduces the overall stormwater runoff from the site.

Rain garden in Alewife neighborhood - Credit: Kleinfelder

Bioretention basin/rain garden

The Port has a high density of medium-density residential use parcels that often have small front and/or back yards. These small areas, if designed as rain gardens, can capture roof runoff and direct it into the ground instead of to impervious surfaces that send runoff to the City's piped infrastructure.

Porous pavement - Credit: University of New Hampshire

Porous pavement

Voids in porous pavements can help store surface runoff and reduce flows into the drainage system. Stored runoff volume in the voids can also seep into native soil, providing groundwater recharge.

Leaching catch basin - Credit: Massachusetts Clean Water Toolkit: http://prj.geosyntec.com/npsmanual/leachingcatchbasin.aspx

Leaching catch basins and tree box filters

The City is evaluating options for connecting leaching catch basins with tree box filters. Leaching catch basins with sumps can capture the stormwater runoff from the roadway, filter out road salt, and redirect the collected stormwater to the tree boxes. The tree boxes can have engineered soils and crushed stones as filter medias to promote groundwater infiltration. In addition to the tree box filters capturing the sidewalk runoff, the connection from the leaching catch basin to the tree box filter captures runoff from a much larger area, provides water to trees, further infiltrates stormwater into the ground, and improves the water quality of the runoff.

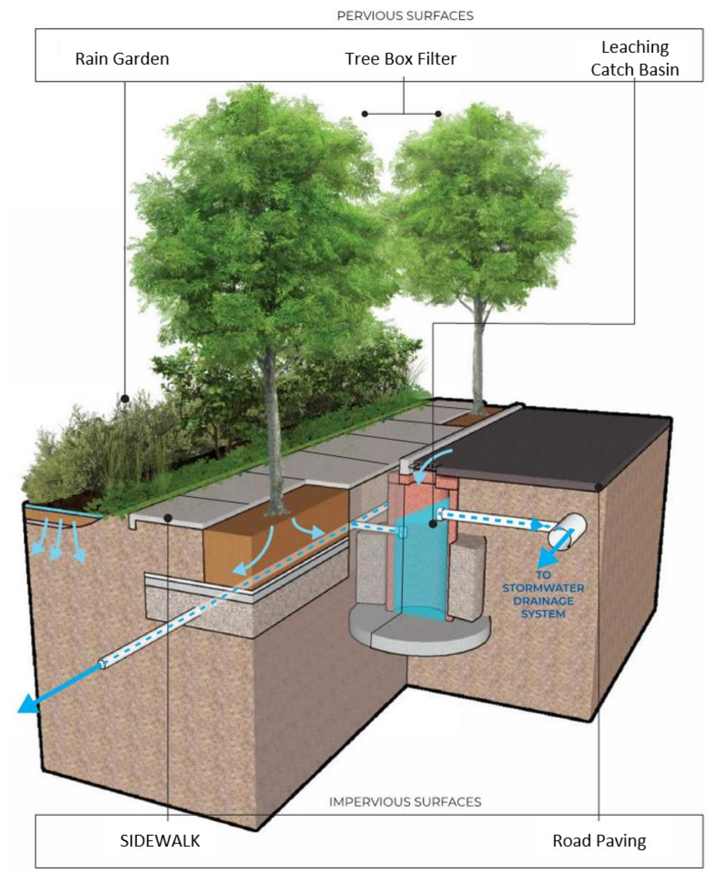


Figure 2.1.5 **Conceptual approach for connecting tree box filter are leaching catchbasins**

[Source: Kleinfelder, 2018]

[29] Appendix 1 – Gray and green infrastructure analyses for The Port

Table 2.1.2 Resilient strategies for energy, gray, and green infrastructure summarizes the range of energy, gray, and green infrastructure strategies taken from the Climate Change Preparedness & Resilience (CCPR) Handbook that are most suited for The Port as they relate to resilient buildings, infrastructure, or ecosystems. New strategies developed for The Port Preparedness Plan have also been added.

		Strategy	Tool Box /Action	Targeted Implementation	Benefits and Metrics
Green Infrastructure	B6	***Site green infrastructure***	Build rain gardens for stormwater infiltration	Approximately 70,000 square feet[30] of areas within open spaces and residential backyards need to be converted to rain gardens	Estimated 0.5 million gallons (MG) of stormwater can be stored[30]
			Use porous materials on pavements to minimize impervious surfaces	Approx. 54,000 square feet[30] of existing pavement need to be resurfaced with porous materials having a SRI ≥ 29	Estimated 0.12 MG of stormwater can be stored[30]
				65% of the residential parcels need to replace existing driveways and parking lots with porous pavement	
			Install green roofs	Building roofs spanning approximately 280,000 sq.ft[30]	Estimated 0.3 MG of stormwater can be stored[30]
				70% of the buildings need to implement green roofs. The footprint of each green roof should span approx. 30% of the entire roof, at a total approx. 280,000 square feet[30]	
	C new	***NEW:* Resilient infrastructure***	Implement leaching catchbasins	92 catch basins1 would need to be retrofitted into leaching catch basins; install lateral connections to adjacent tree box filters to capture stormwater runoff from both roadways and sidewalks.	Estimated 0.11 MG of stormwater can be stored[30]
			Connect leaching catchbasins to tree box filters		
	D1	***Resilient urban forest***	Plant trees in public right-of-way to increase tree canopy	90 new trees need to be planted in proposed tree box filters	
				312 new trees (with no tree box filters) need to be planted in public Right-Of-Way (ROW) on sidewalks wider than 8 feet	Mitigate Urban Heat Island impacts and reduce ambient temperature
Gray Infrastructure	C6	***Flood protection***	Divert stormwater flows to areas that have additional capacity	Existing stormwater flows that route to Binney St need to be diverted to Mass. Ave. drainage system; new drainage connection needs to be established on Albany St[31]	Stormwater model results predict flood reduction of 3.1 MG by 2070 (66% reduction compared to 2020 system conditions)[31]
	C7	***Combined sewer separation***	Continue sewer separation	Need to complete sewer separation along Harvard St and remove sewer-drain cross connections at common manholes[31]	
	C8	***Stormwater storage***	Evaluate feasibility of additional storage tank in strategic location(s)	A 0.72MG underground stormwater storage tank and 0.16MG underground sanitary storage tank need to be implemented at Morgan Park[31]	
Energy Infrastructure	C9	***Clean energy facility***	Conduct a feasibility study for a community energy pilot	Community energy pilot needs to be implemented in The Port area- targeting approximately 240,000 square feet of rooftop space across 23 City-owned buildings[32]	Est. 4,500 MMBtu of renewable energy (annually) equal to the electricity consumed by approx. 70 triple-deckers. Mitigates approx. 430 metric tons CO2e in GHG emissions equal to about 95 cars off the road[32]
			Establish parking photovoltaic (PV) canopies	Rooftop solar photovoltaic (PV) canopies totaling approximately 23,000 square feet need to be installed at Standard Parking and Technology Square garage[32]	Est. 1,500 MMBtu of renewable energy (annually) equal to the electricity consumed by approx. 25 triple-deckers. Mitigates approx. 150 metric tons CO2e in GHG emissions equal to about 35 cars off the road[32]
			Conduct a feasibility study for microgrids	Draper, Alexandria, MIT, and Novartis need to form partnerships to initiate a microgrid feasibility study and identify potential sites to implement microgrids[32]	Est. 3,500 MMBtu of renewable energy (annually) equal to the electricity consumed by approx. 55 triple-deckers. Mitigates approx. 330 metric tons CO^{2}e in GHG emissions equal to about 70 cars off the road[32]

2.1.6 HOW TO GET STARTED?

WHAT THE CITY CAN DO:

For gray infrastructure strategies:

- Monitor performance of ongoing drainage improvement projects that will be completed by 2020 and validate these improvements with respect to flood reduction.
- Develop conceptual design, feasibility, and costs for the recommended new gray infrastructure alternative(s).
- Identify additional gray alternatives when new redevelopment and/or public spaces become available.
- Continue to coordinate with state agencies on the City's sewer separation initiatives.

For green infrastructure in the public realm:

- Retrofit about 90 of 460 traditional catch basins in The Port into leaching catch basins to promote groundwater infiltration.
- Conduct a more detailed pilot study in parallel with the Urban Forest Master Plan to design and evaluate performance of the interconnected system of tree box filters and leaching catch basins.
- Develop implementation plans and incentives for residents to adopt green infrastructure.
- Increase the tree canopy in the public right-of-way by planting 90 new trees in proposed tree box filters and aiming to plant up to 312 trees in the public Right-Of-Way (ROW) for sidewalks wider than 8 feet.

For energy resilience:

- Convene a working group of major institutions/property owners in the area and conduct a microgrid feasibility study for The Port.
- Partner with private sector companies to implement a community energy pilot program within The Port.

[30] Appendix 1 – Gray and green infrastructure analyses for The Port (Section 3)
[31] Appendix 1 – Gray and green infrastructure analyses for The Port (Section 2.2)
[32] Appendix 2 – Energy resilience for The Port

WHAT THE COMMUNITY AND PROPERTY OWNERS CAN DO:

For gray infrastructure strategies:

- Avoid discharging fat, oil, or grease (FOG) into the sewer system; FOG can easily clog pipes and limit conveyance of stormwater flows in combined sewer areas.
- Remove any illicit connections to the stormwater drainage system (e.g. misconnected sewer lateral pipes).
- Redirect gutters that capture roof runoff or sumps that capture flooding to a pervious area on the property.

For green infrastructure in the public realm:

- Property owners should coordinate with the City for proper installation guidance of rain gardens for maximization of operation.
- Aim for 54,000 square feet of porous pavement replacing impervious surface for The Port.
  - Aim for up to 65% of the residential/private properties to convert their driveways and private parking lots to be resurfaced with porous pavement.
  - Aim for the maximization of porous surface on large parcels and open spaces.
- Aim for up to 280,000 square feet of green roof in The Port to capture direct stormwater and reduce urban heat island.
  - Aim for 70% of all existing buildings in The Port to have 30% of roof area with flat or mildly slanted roofs to install a green roof.
  - Aim for the maximization of green roofs on large projects.

For energy resilience:

- Property owners can explore opportunities to invest in microgrid or in the community energy pilot, where they would own a "share" of a solar PV system within the area and receive corresponding payments for energy it generates and sells.

IDEAS FOR CHANGE

#2 SUPER-RESILIENT URBAN BLOCKS

2.2.1 THE IDEA

The urban block presents an opportunity for innovative projects in the neighborhood to demonstrate how maximum resiliency efforts for buildings, drainage and energy systems, and ecosystems can reduce flooding and the urban heat island effect and increase energy resiliency in one defined area. The idea for change pushes resiliency strategies to the maximum implementation possible to explore how efforts in strategic locations could benefit the resiliency of the neighborhood. Two representative urban blocks in The Port (**Figure 2.2.1**) were identified to test introducing change at a faster pace by implementing super-resilient urban blocks: a residential block and a mixed-use block.

An **urban block** is the smallest area in an urban neighborhood like The Port that is surrounded by streets. It is usually divided into any number of smaller lots in private and/or public ownership but sometimes only one building or a park constitutes an entire block. An urban block supports neighbors with abutting properties and shared interests and investments in the surrounding community.

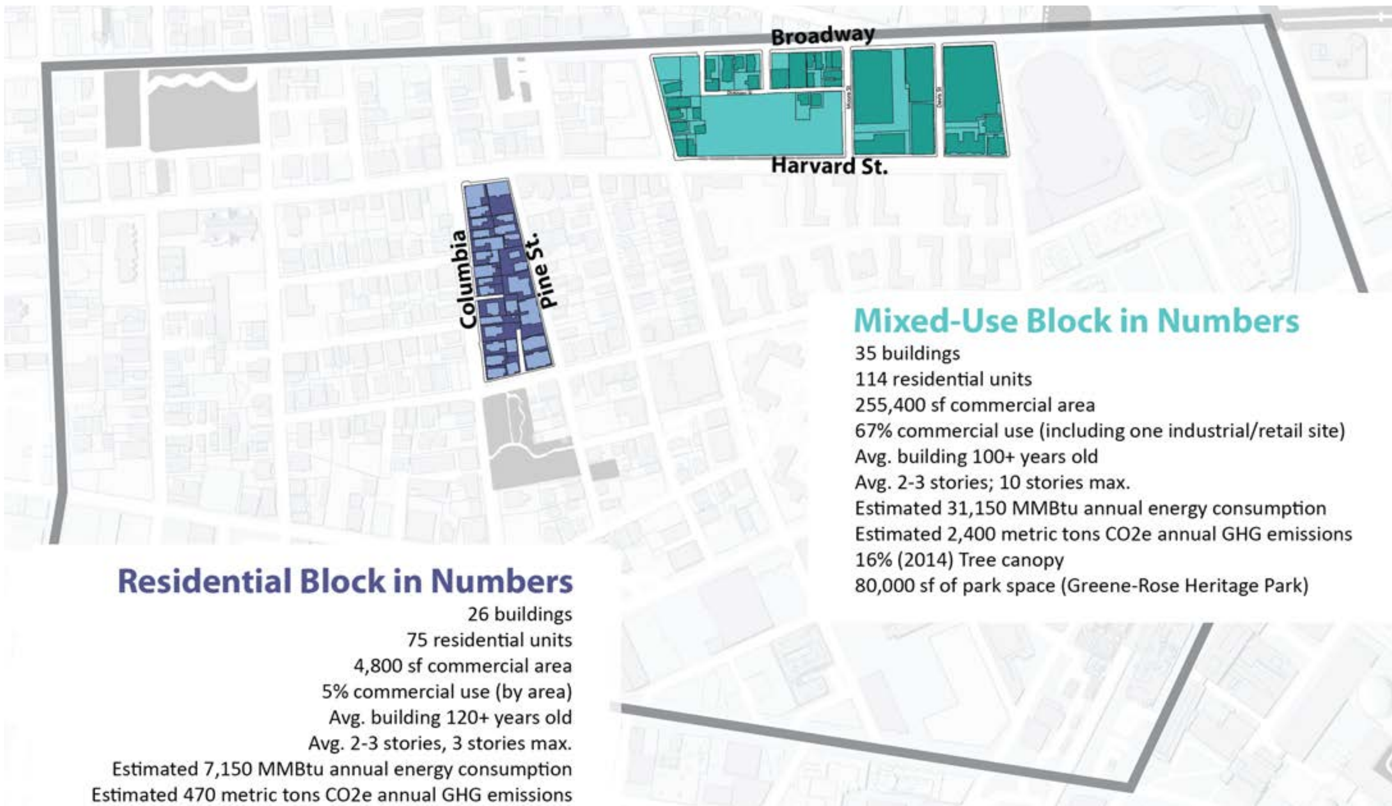


Figure 2.2.1 **Resilient block locations and baseline data**

2.2.2 WHAT WOULD BE GAINED—BENEFITS AND METRICS

A resilient urban block could demonstrate how, if each property is built to its maximum potential with respect to climate change, it can contribute greater benefits in terms of resiliency improvements to the residents of the block and citywide if combined with other properties. Benefits of maximum implementation of the resilient residential block and the mixed-use block are reported in **Tables 2.2.1** and **2.2.2**.

Table 2.2.1 Maximum projected benefits for the implementation of strategies for the residential block

Maximum Benefits		Co-benefits
Heat [33]	Up to 2 °F reduction in ambient air temperature	Neighborhood beautification
Flooding [33]	Peak flow reduced by 41% in the residential block	Stormwater quality improvement
Energy [34]	3,070-3,780 MMBtu in energy savings if 85% of the buildings in the block are improved (in terms of total area) , equivalent to the electricity usage from approximately 145 households	Mitigates approximately 200 metric tons CO_2e [35] in GHG emissions, equivalent to the annual GHG emissions of 10 existing triple-deckers

Table 2.2.2 Maximum projected benefits for the implementation of strategies for the mixed-use block

Maximum Benefits		Co-benefits
Heat [33]	Up to 6 °F reduction in ambient air temperature	Neighborhood Beautification
Flooding [33]	Peak flow reduced by 22% in the mixed use-block	Stormwater quality improvement
Energy [34]	11,320-14,430 MMBtu in energy savings if 88% of the buildings in the block (in terms of total area), equivalent to the electricity usage from approximately 545 households	Mitigates approximately 700 metric tons CO_2e [35] in GHG emissions, equivalent to the annual GHG emissions of 35 existing triple-deckers

[33] Appendix 1 – Gray and green infrastructure analyses for The Port
[34] Appendix 2 – Energy resilience for The Port
[35] Carbon dioxide equivalent (CO2e) is a standard unit of measure for greenhouse gas emissions that allows the quantification of various greenhouse gases as a single unit. It represents, for a given amount of greenhouse gas, the equivalent amount of carbon dioxide with the same global warming potential.

For the block to be super-resilient means future improvements will be designed and perform such that the block can accommodate and recover from projected climate change conditions.

2.2.3 HOW CAN IT BE DONE?

For the block to be super-resilient means future improvements will be designed and perform such that the block can accommodate and recover from projected climate change conditions. This includes all elements comprising the urban environment and the relationship shared between those elements: buildings (including roofs, windows, building envelope, basement), pavement, landscape, and infrastructure. While specific strategies for enhancing resiliency could differ based on the block's composition of residential, commercial, and institutional properties, the process for mobilizing and moving toward implementation is similar.

The **Residential Block** was chosen to represent a typical block in The Port, as most of the buildings are residential, with two to three dwelling units. The residential block confined by Columbia, Harvard, Pine, and Washington Streets presents challenges considering its limited open space, small lot sizes, and high private property ownership. There are, however, opportunities for increased energy resiliency and implementation of green infrastructure at the parcel level to contribute to stormwater management and reduce urban heat island while enhancing the quality of living by "greening" the block.

To assess the range of possible strategies, actions are identified for new or recently renovated buildings or existing buildings that need to be retrofitted. These actions inform the best approach for resiliency improvements to a representative building in the residential block as shown in **Figure 2.2.2**.

***Actions for retrofitting buildings:** Of the 26 buildings in the Residential Block, actionable improvements can be implemented throughout to make meaningful progress toward resiliency.*

- Roofs make up 51% of the total area in the Residential. If 20 of the 26 buildings could upgrade their roofs to white or green roofs, a meaningful reduction in urban heat island can be achieved.
- Most of the buildings in the Residential Block were built before 1900. Buildings from this era have little to no insulation at the foundation, walls, and ceilings. **Upgrading building envelopes** in the 20 buildings built before 1900 could reduce energy consumption for the block by up to half of what is currently consumed. This assumes the buildings were not previously upgraded.
- **Solar photovoltaic (PV)** systems added to building roofs improve the ability to stay safe ("passive survivability") if the building is cutoff from the electricity grid and connected to an energy storage system. Solar PV can be installed on any roof with moderate to good solar access and structural strength.
- Almost all existing buildings have **utilities** (water heater, furnace, etc.) in the basement. To be more resilient to flooding, raise utilities above design flood elevation if the property is already experiencing flooding or vulnerable to flooding in the future.
- Check the Cambridge FloodViewer to help understand the risk of flooding to your property and how to protect against it.

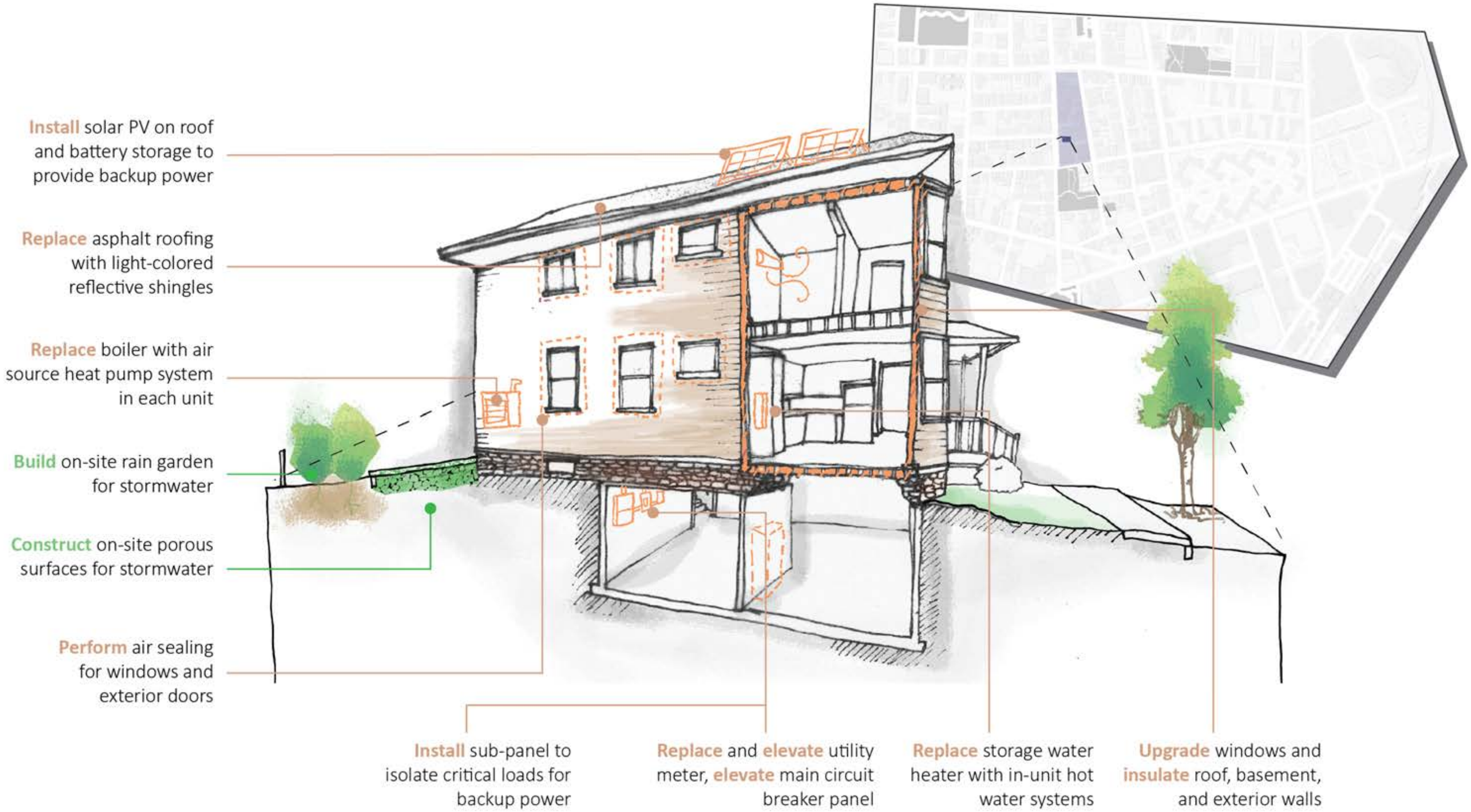


Figure 2.2.2 Representative building and site strategies and actions in the residential block

Build/protect to refers to the resiliency measures taken to provide protection to a critical elevation, thus **minimizing damage.**

Actions for new buildings or complete renovation: ***New development or extensive renovation provides opportunities for meeting higher standards allowed by new technology and for integrating resilient design to address flooding and heat.***

- **Build/protect to the 2070 10-year flood elevation** from precipitation or sea level rise/storm surge, whichever is higher, and recover from the **2070 100-year flood elevation from precipitation or sea level rise/storm surge,** whichever is higher.[36] Check the Cambridge FloodViewer to help understand the risk of flooding to your property and how to protect against it.
- Design buildings using the American Society of Civil Engineers (ASCE) 24-14 **Flood Resistant Design and Construction** as a reference when a site is below the 2070 100-yr flood elevation.
- Locate **utilities**, such as the electrical shutoff to the building, and residential units above the determined flood elevation.
- Design buildings with passive **strategies**, including building orientation, high-performance building envelope (e.g., R-20 minimum wall insulation and R-40 minimum roof insulation, U-0.3 maximum glazing), shading, natural ventilation, and white or green roofs, and limit air leakage (less than or equal to 3 ACH at 50 pascals); other references for high-performing buildings include Passive House Institute US Certification and LEED Pilot Credit for Resiliency.

Recover from refers to the resiliency measures taken to provide protection to a critical elevation, thus **expediting recovery.**

Actions for site resiliency: ***Whether a building retrofit or new construction, site improvements provide opportunities for increased resiliency to adapt to increased flooding and/or extreme heat. The Residential Block has 49% non-building space: yards, patios, sidewalks, driveways, and midblock alleyways. This space presents opportunities for improvements.***

- Replace existing conventional pavement with porous pavement or pavers; 18,000 square feet (38% of existing site space) replaced could improve localized flooding impacts. Porous pavement or pavers with a solar reflectivity index (SRI) of at least 29 will reduce urban heat island effect.[37] Ideal conditions for this improvement are patios and driveways.
- Approximately 1,500 square feet within the Residential Block is suitable for conversion into a rain garden. That is equivalent to about 25 properties in the block installing a 60-square-foot **rain garden** in each of their parcels.
- Connect the roof gutter to a **pervious or storage/detention area** on the property (such as rain gardens or rain barrels) rather than discharging to an impervious area such as a driveway or the street.
- Maintain mature **trees** in private and public property. Plant new trees where possible to shade buildings.
- The City can replace existing catch basins with **leaching catch basins** to capture street stormwater runoff. To maximize storage, make lateral connections to tree box filters.

A resilient urban block could demonstrate how, if each property is built to its maximum potential with respect to clim-ate change, it can contribute greater benefits in terms of resiliency improvements to the residents of the block and citywide if combined with other properties.

The **Mixed-Use Block** selected to test the feasibility of the approach is bounded by Windsor Street, Broadway, Portland, and Harvard Streets as shown in **Figure 2.2.1**. It includes a mix of commercial office, industrial, retail, smaller 1-3 unit residential, and higher-density multifamily residential buildings.

The Mixed-Use Block presents opportunities for change and urban enhancement through the various types of properties it includes. Larger commercial and industrial lots tend to be built out to the lot lines, so the solutions must be geared more toward the building rather than the site. Small businesses and residential lots offer more space for site-level improvements, as well as building improvements similarly made in the residential block. City-owned property, such as Greene Rose Heritage park, is favorable for more strategic infrastructural improvements that can have additional community benefits.

To assess the range of possible strategies, actions are identified for new and recently renovated buildings and for existing buildings and those needing retrofits to inform the best approach for resiliency improvements as shown in **Figure 2.2.3**.

***Actions for retrofitting buildings:** Of the 35 buildings in the mixed-use block, actionable improvements can be implemented throughout to make meaningful progress toward resiliency.*

- Roofs make up 48% of the total area in the Mixed-Use Block. If 3 larger buildings could upgrade their roofs (approximately 25,000 square feet combined) to white/blue roofs, holding up to 0.7 inches of rain, they can detain up to 1,460 cubic feet (10,900 gallons) of stormwater during the peak of an extreme rainstorm. White/blue roofs can also reduce the urban heat island effect. If another 10,200 square feet of roof space are upgraded to include green roofs, further stormwater and urban heat island reduction can be achieved.
- **Solar PV systems** added to building roofs improve the ability to stay safe ("passive survivability") if the building is cutoff from the electricity grid and connected to an energy storage system. Solar PV can be installed on any roof with moderate to good solar access and structural strength.
- Almost all existing buildings have **utilities** (water heater, furnace, etc.) in the basement. To be more resilient to flooding, raise utilities above design flood elevation if property is vulnerable to flooding in the future. At least 4 buildings in the mixed-use block have finished basement-level residential living space.
- Check the Cambridge FloodViewer to help understand the risk of flooding to your property and how to protect against it.

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[36] FloodViewer, City of Cambridge https://www.cambridgema.gov/Services/FloodMap
[37] USGBC Heat Island Reduction Credit- https://www.usgbc.org/credits/ss7

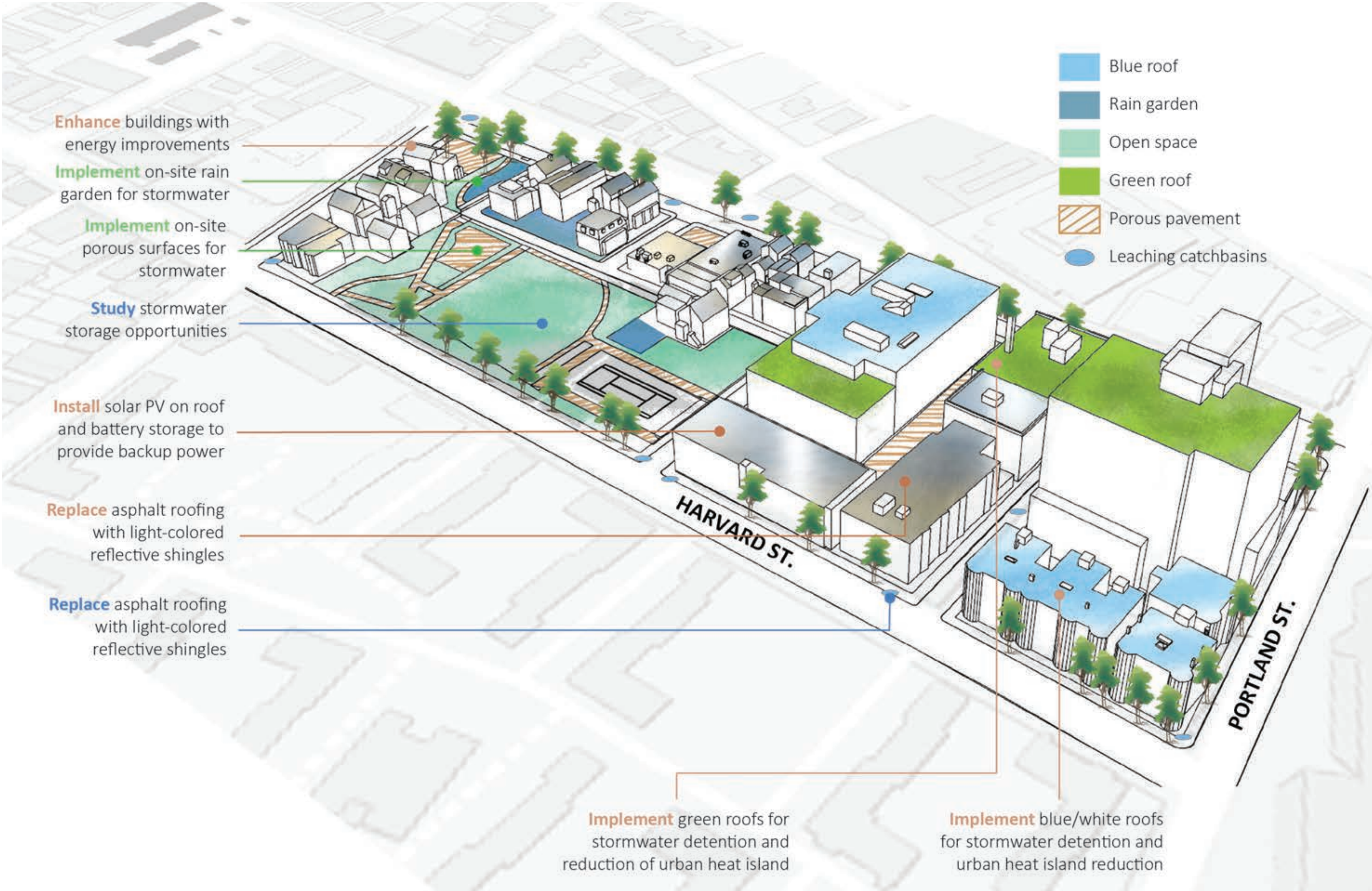


Figure 2.2.3 **Representative building and site strategies and actions in the mixed-use block**

Actions for new buildings or complete renovation: ***New development or extensive renovation provides opportunities for meeting higher standards allowed by new technology and for integrating resilient design to address flooding and heat.***

- If 25,000 square feet of roofs in the mixed-use block were to be **completely renovated or newly constructed** as white/blue roofs holding up to 4.5 inches of rain, it would be possible to detain up to 9,400 cubic feet (70,100 gallons) of stormwater during the peak of an extreme rainstorm. White/blue roofs can also reduce the urban heat island effect. Including additional green roofs would further reduce both stormwater runoff and urban heat island effect.

- **Build/protect to the 2070 10-year flood elevation** from precipitation or sea level rise/storm surge, whichever is higher, and recover to the 2070 100-year flood elevation from precipitation or sea level rise/storm surge, whichever is higher. Check the Cambridge FloodViewer to help understand the risk of flooding to your property and how to protect against it.[38]

- Design buildings using the American Society of Civil Engineers (ASCE) 24-14 **Flood Resistant Design and Construction** as a reference when site is below the 2070 100-year flood elevation.

- Locate **utilities**, such as the electrical shutoff to the building, and residential units above the determined flood elevation.

- Design buildings with **passive strategies** including building orientation, high-performance building envelope (e.g., R-20 minimum wall insulation and R-40 minimum roof insulation, U-0.3 maximum glazing), shading, natural ventilation, and white or green roofs, and limit air leakage (less than or equal to 3 ACH at 50 pascals). Other references for high-performing buildings include Passive House Institute US Certification and LEED Pilot Credit for Resiliency.

Actions for site resiliency: ***Whether a building retrofit or a new construction, site improvements provide opportunities for increased resiliency to adapt to increased precipitation and/or extreme heat. The Mixed-Use Block has 52% nonbuilding space: park space, yards, patios, sidewalks, driveways, and midblock alleyways. This space presents opportunities for improvements.***

- Replace existing conventional pavement with porous pavement or pavers; 28,000 square feet replaced could improve localized flooding impacts. Porous pavement or pavers with a solar reflectivity index (SRI) of at least 29 will reduce urban heat island effect.[39] Ideal conditions for this improvement are in small commercial parking lots and park pedestrian pathways.

- Approximately 3,000 square feet of existing landscaped area within Greene Rose Heritage Park and adjacent residential properties are suitable for conversion into a rain **garden**.

- Greene Rose Heritage park presents an opportunity for stormwater storage. The park currently has an underground 500 gallons infiltration tank, which could be upgraded to either a storage tank or storage feature within the park.

- The City can replace six existing catch basins with **leaching catch basins** to capture street stormwater runoff. To maximize storage, make lateral connections to tree box filters.

[38] FloodViewer City of Cambridge https://www.cambridgema.gov/Services/FloodMap
[39] USGBC Heat Island Reduction Credit- https://www.usgbc.org/credits/ss7

2.2.4 PRECEDENTS RELEVANT TO THE PORT

Our approach draws on efforts from other innovative communities and programs within the City of Cambridge that provide evidence for concentrated efforts of maximum implementation using the site and block-scale approach.

Concord Highlands (Cambridge, MA)

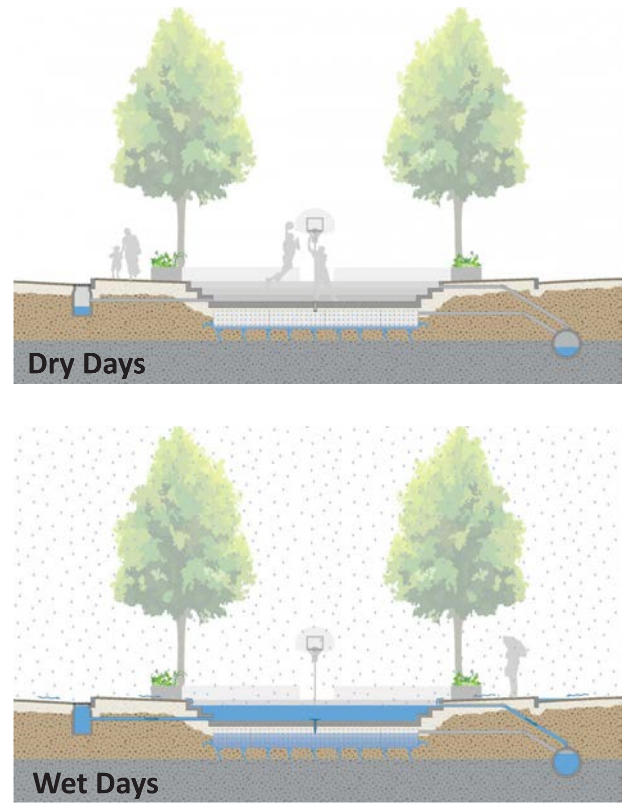
In the Alewife neighborhood, the Concord Cambridge Highlands Project by nonprofit Homeowners Rehab, Inc. was developed on a repurposed site to address the need for low-income housing in the city. The project received funding from the City of Cambridge, the Massachusetts Housing Finance Agency, the Massachusetts Department of Housing and Community Development (DHCD), and TD Bank.[40] The new building, located across the street from Fresh Pond Reservation Park features 98 affordable units, a community room, rooftop terrace, and front and rear recreational areas. While unplanned initially, an effort to build and operate more sustainably led to the building being able to meet Passive House level performance (indoor temperatures that can stay within 55-85° F for 4 days passively). Added resilient design features include that all units were located above the 2070 design flood elevation, with mechanical equipment on the roof. This project serves as a model for new and retrofit residential development to show what resiliency design decisions could be achieved for building in the Port.

Benthemsquare (Rotterdam, NL)

In the Netherlands, Benthemsquare is an urban square designed to improve open space and store stormwater, or a "water square." Using a highly involved level of stakeholder participation and input, the water square exemplifies placemaking, creating space for social events and everyday leisure. The storage of stormwater is utilized as a feature of the design including a waterfall or "waterwall." When wet, it serves as an education element on stormwater storage and the environment; when dry, it is used as a recreational space for basketball and volleyball. This example focuses on opportunities provided by open space, which could be applicable to park space in the resilient mixed-use block and other open space in Cambridge.[41]

The Cambridge Multi-Family Energy Pilot (Cambridge, MA)

The City of Cambridge and Eversource together



Example of how a water square is used in urban design. Credit: Atelier Groenblauw[13]

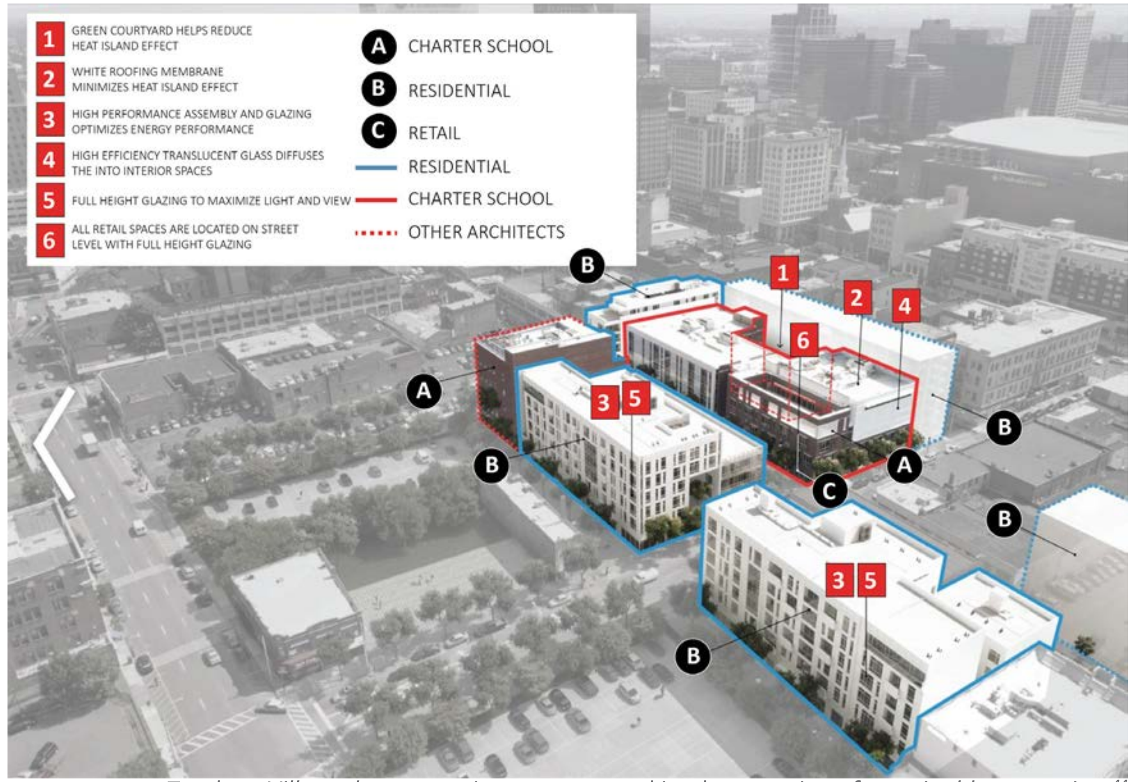
launched a multifamily energy pilot program to help apartment and condo buildings save energy. The program offers whole-building energy assessments, free solar assessments, and free retrofit advisory services. In the first year, 1,300 households participated in the program.[42] One

[40] New housing development will provide affordable homes in Cambridge, The Huntongton News, https:////huntnewsnu.com/55378/city-pulse/new-housing-development-will-provide-affordable-homes-in-cambridge/
[41] Water Square Benthemplein, De Urbanisten, https:/ /www.urbanisten.nl/wp/?portfolio=waterplein-benthemplein

9-unit market-rate building owned by an offsite landlord in the Port is engaged in the program, but no buildings in either of the resilient blocks have enrolled in the program at the time of publication of this document.

Teachers Village (Newark, NJ)

There are examples of neighborhoods that organize and join efforts to meet higher standards to be more sustainable and resilient. Teachers Village is a sustainable neighborhood development project including new construction and retrofits that incorporate green infrastructure and energy conservation into a mixed-use neighborhood. The project will be certified as LEED Neighborhood Development, an example of an accreditation that employs improved performance of buildings, which are monitored over time, maximizes open space, and prioritizes pedestrian connectivity to transit, jobs, and amenities within the neighborhood or block. The model program provides a precedent for concentrated implementation of resiliency and sustainability measures at the block and neighborhood scale.[43] This example demonstrates concentrated implementation at a smaller scale than the neighborhood or block.



Teachers Village demonstrating concentrated implementation of sustainable strategies. [44]

The resilient block's approach draws on efforts from other innovative communities and programs within the City of Cambridge that provide evidence for concentrated efforts of maximum implementation using the site and block-scale approach.

[42] The Cambridge Multi-Family Energy Pilot, Cambridge Energy Alliance, https://cambridgeenergyalliance.org/current-efficiency-promotions

[43] Teachers Village, USGBC, https://www.usgbc.org/projects/teachers-village

[44] Richard Meier & Partners' Teachers Village Looks to Revitalize Downtown Newark Through Education , Arch Daily https://www.archdaily.com/805441/richard-meier-and-partners-teachers-village-looks-to-revitalize-downtown-newark-through-education

2.2.5 IMPLEMENTATION

Implementing strategies to reduce the risk of urban heat island and flooding could mean that urban blocks will feel cooler during a heatwave and owners/renters will receive lower utility bills and experience less flooding. It can also lead to enhanced quality of living with open space and green infrastructure that contribute to a more resilient urban context. There are several initiatives in Cambridge and Massachusetts supporting resilient development. **Tables 2.2.3**, **2.2.4, and 2.2.5** present a summary of the strategies with specific actions, how these can be implemented, expected results, and what type of partnership/program can be leveraged to implement each strategy.

Table 2.2.3 Strategies for all resilient blocks

		Strategy	Tool Box /Action	Targeted Implementation	Benefits and Metrics
Resilient Urban Blocks	B New	***Adapted planning for resilient urban blocks***	Convene two resilient block task force groups	Implementation plans need to be devloped for each resilient blocks (residential & mixed use)	Model for more resilient blocks citywide
	B5	***Building management for flood & heat protection***	Educate residents and land owners on flood vulnerability	Maximized use of the FloodViewer and access to the Cambridge Public Health Department resources on climate change preparedness	Informed building owners and renters reducing vulnerability to climate change impact
	B7	***Adapted zoning, policies & regulations***	Identify the potential & study the effectiveness of special incentives zones	Zoning changes need to be integrated with resiliency incentives	Faster pace for implementation of resiliency measures

Table 2.2.4 Strategies for a resilient residential block

		Strategy	Tool Box /Action	Targeted Implementation	Benefits and Metrics
Residential Urban Block	B4	***Heat protection for existing buildings***	Retrofit buildings with white roofs	17 buildings roofs need to be retrofited with asphalt shingle or membrane covering, spanning approximately 25,000 square feet[46]	For a typical building, white roofs would result in an estimated 8% reduction in annual energy consumed for cooling, and a 1% reduction in overall building GHG emissions.
			Retrofit buildings with green roofs	3 typical flat roof buildings need to install green roofs spanning approximately 2,300 square feet[46]	Estimated 2,250 gallons (approx. 300 cubic feet) of stormwater can be stored on-site
	B6	***Site green infrastructure***	Use porous materials on pavements to minimize impervious surfaces	Approximately 18,000 square feet[46] of existing pavement would need to be resurfaced with porous materials having a solar reflective index ≥ 29	Estimated 7,500 gallons (approx. 1,000 cubic feet) of stormwater can be stored on-site
			Build rain gardens to promote stormwater infiltration	Approximately 1,500 square feet4 of areas within residential yards need to be converted to rain gardens, equivalent to about 60 square feet per parcel in this residential block	Estimated 11,200 gallons (approx. 1,500 cubic feet) of stormwater can be stored on-site
	B New	***NEW: Resiliency of building scale energy***	Install solar PV panels to increase renewable energy production	Solar Photovoltaic (PV) systems need to be installed on building roofs with moderate to good solar access, battery storage sized to provide sufficient backup power for critical loads	Two days of back-up power for critical loads, where installed. Renewable energy production would offset 4% of annual energy consumption and 5% of GHG emissions[45]
			Renovate century-old buildings to increase energy efficiency	23 residential buildings constructed before 1920 enhanced with more efficient building envelopes and high-efficiency electric heating, cooling, and hot water systems[45]	Enhancements would result in an estimated 50-60% reduction in annual energy consumption, and a 40-50% reduction in total GHG emission[45]
	D1	***Resilient urban forest***	Maintain and improve urban tree canopy	Maintain existing trees and new trees need to be planted where possible	Estimated 0.12°F decrease in ambient air temperature for every 1% increase in canopy; neighborhood beautification [47]

Table 2.2.5 **Strategies for a resilient mixed-use block**

		Strategy	*Tool Box /Action*	*Targeted Implementation*	*Benefits and Metrics*
Mixed-Use Urban Block	*B1 /2*	***Flood/heat protection for new buildings***	Design new buildings with white/ blue roofs	3 new building need to install blue roofs spanning approximately 25,000 square feet[46] with 4.5 inches of stormwater detained	Estimated 70,100 gallons (approx. 9,400 cubic feet) of stormwater can be stored on-site
			Retrofit existing buildings with white/blue roofs	3 building roofs need to be retrofiited with blue roofs spanning approximately 25,000 square feet[46] with 0.7 inches of stormwater detained	Estimated 10,900 gallons (approx. 1,460 cubic feet) of stormwater stored on-site
			Design new buildings with green roofs	About 7 medium-sized building roofs need to install green roofs spanning approximately 10,200 square feet[46]	Estimated 7,500 gallons (approx. 1,000 cubic feet) of stormwater can be stored on-site
	B6	***Site green infrastructure***	Build rain gardens to promote stormwater infiltration	Approximately 3,000 square feet[46] of areas within open spaces and residential backyards need to be converted to rain gardens	Estimated 20,900 gallons (approx. 2,800 cubic feet) of stormwater can be stored on-site
			Use porous materials on pavements to minimize impervious surfaces	Approximately 28,000 square feet[46] of existing pavement need to be resurfaced with porous materials having a solar reflective index ≥ 29	Estimated 12,700 gallons (approx. 1,700 cubic feet) of stormwater can be stored on-site
	B New	***NEW: Resiliency of building scale energy***	Install solar PV panels to increase renewable energy production	Solar photovoltaic (PV) systems need to be installed on building roofs with moderate to good solar access, batter storage sized to provide sufficient backup power for critical loads	Two days of back-up power for critical loads, where installed in residential buildings of that selected block. For a typical residential buildings in that block, renewable energy would offset 4-12% of annual energy consumption and 5-8% of GHG emissions.[45]
	C6	***Sub neighborhood scale flood protection***	Install leaching catchbasins to capture stormwater runoff from roadways	6 catchbasins need to be retrofitted into leaching catch basins, and install lateral connections to adjacent tree box filters	Estimated 3,700 gallons (approx. 500 cubic feet) of stormwater can be stored
			Connect leaching catchbasins to tree box filters to maximize stormwater runoff capture from both sidewalks and roadways	16 interconnecting tree box filters need to be installed, 6 of them laterally connected to adjacent leaching catch basins	Estimated 7,500 gallons (approx. 1,000 cubic feet) of stormwater can be stored
	C8	***Stormwater storage***	Evaluate stormwater storage designs in Greene Rose Heritage Park	Existing underground infiltration tank at the Rose-Heritage Park upgraded to collect stormwater flows from Broadway to capture flood volumes at the intersection of Broadway and Hampshire Street	Estimated up to 1.5 million gallons (MG) of stormwater can be stored
	D1	***Resilient urban forest***	Mature trees in private and public property	Maintain existing trees and new trees need to be planted where possible	Estimated 0.12°F decrease in ambient air temperature for every 1% increase in canopy; neighborhood beautification [47]

45 Appendix 2 – Energy resilience for The Port
46 Appendix 1 – Gray and green infrastructure analyses for The Port (Refer to Figure 32)
47 Based on the 2009 tree canopy data

2.2.6 HOW TO GET STARTED?

WHAT THE CITY CAN DO:

The City is already acting by adopting policies and programs that support the implementation of resilient buildings. Concurrently with the *Climate Change Preparedness & Resilience (CCPR) Plan*, the City is developing an *Urban Forest Master Plan* to guide the development of the urban forest into the future and has the *Net Zero Action Plan* for buildings to advance the goal of Cambridge becoming a net zero community. To facilitate opportunistic implementation of resiliency strategies identified for the two resilient blocks, the City could:

Convene two resilient block task force groups under the guidance of the City to focus on developing an implementation plan that could be a model Citywide. Initiatives for the groups could be:

Step 1: Plan a study for each block

- Inventory properties within the blocks resulting in the identification of parcels ideal for improvements, develop detailed assessments of the identified possible strategies, and confirm feasibility of proposed implementation.
- Work with the City to identify funding mechanisms to support implementation strategies.
- Work with stakeholders to gain buy-in for a pilot project, educate on benefits of implemented strategies such as energy improvements, and work with existing programs to overcome challenges to implementation.
- Develop property-specific checklists for owners documenting informational and financial resources available to facilitate property modifications, with changes linked to benefits.
- Develop Resilient Block Pilot Program to guide projects and work with the City to identify existing incentives for private properties.

Step 2: Design and project development

- Facilitate project design and advise on best practices.
- Consider developing contractor best practices information sessions.

Step 3. Implement and monitor

- As projects are designed and constructed, monitor progress and celebrate milestone achievements.

Study the possibility of creating targeted special incentive zones for the resilient urban blocks. For example:

- One option could be for the Resilient Block Pilot Program to use the LEED Neighborhood Development standard as a model for additional resilient blocks throughout the city to aid in tracking improvements towards resiliency.
- As the City is reviewing zoning recommendations proposed by Envision,[48] assess how resilient block could be facilitated for new development and existing properties for implementation of resiliency measures.

Stormwater storage at Greene Rose Heritage Park:

- Analyze potential stormwater storage options at Greene Rose Heritage Park and evaluate best options for design.
- Proceed with the selected design option(s) at Greene Rose Heritage Park, based on the findings from analysis of stormwater storage options at the Park.

[48] The City's comprehensive master plan guiding growth, sustainability achievement, and community-based planning (http://envision.cambridgema.gov/)

What property owners and renters can do:

The Port requires a strong partnership between the City and the neighborhood community in preparing for climate change. Different actions can be taken by stakeholders based on whether they are renters, owners, or part of advocacy groups. With the City's support, different stakeholders can test options for early implementation.

Actions for building owners

- Plan to leverage regular building maintenance or repairs to implement resilient upgrades. For example, roof replacements on buildings occur every 25 to 30 years. Incorporate a white roof into the routine replacement to help mitigate urban heat island and improve energy costs for the building during summer months.
- Reduce the use of basement space to non-critical storage by relocating electrical panels and main shutoff above grade level and eliminating residential living space vulnerable to flooding. If unable to move critical systems and/or living space, take measures to dry-floodproof the perimeter of the building.
- Pursue building envelope improvements, such as adding insulation to exterior walls and replacing windows with more efficient models.
- Work with condo associations or building management companies for multi-owner/renter properties to implement building-wide envelope improvements, upgrade existing mechanical systems with high-efficiency electric systems, and install solar PV and storage systems, potentially using revenue from energy generation to finance those improvements.
- Plant a rain garden.
- Replace driveways with porous asphalt or porous pavers.
- At a high level of assessment, there is minimal opportunity for planting trees. If opportunity exists, owners should plant trees on property.
- Install solar PV on roofs of buildings to improve energy resiliency.
- Take advantage of free energy audits and energy efficiency incentives from Eversource and the state.

Actions for renters

- Take actions such as hanging insulated curtains over windows to prevent heat from escaping in the winter.
- Understand vulnerability to flooding and how to protect persons and personal items from being damaged by using the City's Flood Viewer[49] and resources from the Cambridge Public Health Department.[50]
- Plant and help care for trees on the property.
- Work with condo associations or building management companies for multi-owner/renter properties to implement building-wide envelope improvements, upgrade existing mechanical systems with high-efficiency electric systems, and install solar PV and storage systems, potentially using revenue from energy generation to finance those improvements. Take advantage of free energy audits and incentives from Eversource and the state.
- Advocate for building owners/management companies/neighbors to pursue resiliency upgrades.

[49] FloodViewer, City of Cambridge, https://www.cambridgema.gov/Services/FloodMap
[50] Emergency Preparedness, CDPH, http://www.cambridgepublichealth.org/services/emergency-preparedness/

IDEAS FOR CHANGE

#3 RESILIENT PEOPLE

2.3.1 THE IDEA

A resilient community of people and organizations in The Port supports actions that tackle climate change and brings residents closer to their neighbors. Building a resilient community means that everyone will feel connected and supported to respond to change. A resilient community has "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events."[51]

For The Port neighborhood to be resilient, residents and community organizations will need to rely upon one another. The aim of a resilient network is to connect people and organizations of the Port so that they have resources to withstand climate-related events and to thrive. It is important to make people resilient by strengthening their individual preparedness as well as their bonds of mutual support. The rich array of community-based organizations in the Port also needs to prepare itself for extreme heat and possible flooding and to better connect resources. A resilient network connects people (our neighbors) and organizations (from business associations to medical providers to places of worship or socializing) so that we have resources to withstand climate-related events and to thrive.

2.3.2 WHAT WOULD BE GAINED—BENEFITS AND METRICS

The physical and social resiliency of a community are equally important to prevent natural hazards from turning into large-scale disasters.[52] Social bonds that connect residents are an important element in advancing the resiliency needed to prepare communities that may face a disaster.[53] Several forms of social connections have been found to be valuable. Three forms that may be particularly useful to The Port neighborhood:

1. **Social support networks:** A connection among community social service organizations, institutions, and residents to one another can help make sure that all residents have access to support in times of need. This includes access to health and social services as well as support offered by caring neighbors.
2. **Social participation:** Building stronger relationships that provide friendship and company ensures people are not isolated. This includes seniors, children, those who are differently abled, and the homeless. Isolation can increase risks due to a disaster, while knowing and connecting with neighbors can be vital.
3. **Community engagement in collective actions:** Taking actions together for positive change that benefits one another draws people together, develops a stronger sense of community, and can help residents handle difficult situations. Volunteering may increase trust while strengthening mutual support networks and a culture of service. Engaging residents as volunteers in climate-related actions offers many benefits. Acting on climate change has been shown to improve peoples' ability to stay positive and rebound after climate-related events (increasing their sense of self-efficacy rather than hopelessness).[54] It is important that residents have opportunities to advocate for, and work toward, their own vision of a resilient community. Applying the leadership of those who will be most affected by climate change leads to more just, appropriate strategies that can improve neighborhoods now and into the future.[55]

2.3.3 HOW CAN IT BE DONE?

For The Port community to be resilient in times of crisis, we need a strong community that offers supports, fosters human connections, engages residents to be active on a regular basis, and presents opportunities to volunteer and contribute to climate resiliency. Such a strong community can arise "organically" but to be of best use in times of crisis, it is important for efforts to be deliberate in identifying connections for meeting critical needs while building upon the full range of assets that exist among residents and organizations in the community. Actionable improvements could be to:

- Increase the number of households in The Port that are registered in the Smart 911 and CodeRED programs. Smart911 provides for a secure online database where users can register their phone number and create a profile to share critical information with dispatchers when they call 911. CodeRED is an emergency notification system for members of the Cambridge community to subscribe to an emergency notification managed by the City. The current rate of participation in CodeRed is approximately 50% for The Port.
- Document the number of business owners reaching out to CDD to learn about the Preparedness Resources for Businesses and set a target to increase that number within the next year and eventually engage all small businesses to the degree possible.
- Document the number of seniors living alone and develop an outreach program for each senior to have a "neighbor who knows them" and will check on them, alert medical professional/community leaders during emergencies such as heat waves and extreme flooding.
- Conduct climate education workshops facilitated by community members in community gathering places. Set a goal to reach a specific number of residents per year.
- Have a minimum of the anchor organizations already identified in The Port bolster their resiliency and their ability to support residents. One could be developed to serve as a resiliency hub based on the concept described in the CCPR Handbook.
- Add metrics to the City's biannual survey that are most meaningful and valuable to The Port community to establish a resiliency baseline and indicator of progress for a Prepared Community.

The City of Cambridge is working for all members of the City to have access to information about climate change to prevent and prepare for the impacts while increasing equity. ***Equity*** means addressing the reasons behind why inequalities in health, livelihoods, or living conditions exist. Strengthening neighborhoods that are at high risk of climate-related impacts and that have a history of inequity is essential. The Port is one such neighborhood.

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[51] National Research Council (NRC), Disaster Resilience: A National Imperative. 2012

[52] Adger WN. Social-Ecological Resilience to Coastal Disasters. Science (80-). 2005;309: 1036–1039.

[53] Townshend, I., Awosoga, O., Kulig, J. et al. Nat Hazards (2015) 76: 913.

[54] Vinson T (2004) Community adversity and resilience: the distribution of social disadvantage in Victoria and New 637 South Wales and the mediating role of social cohesion. Report submitted to the Ignatius Centre, Jesuit 638 Social Services, University of New South Wales. http://acl.arts.usyd.edu.au/jss/index.html Accessed 27 Jul 639 2013 as cited by Townsend, et al.

[55] Yuen, et al., Urban Sustainability Directors Network, Guide to Equitable, Community-Driven Climate Preparedness Planning 2017. Accessed 28 January 2019 https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness-_high_res.pdf

To create a **resilient community** in The Port, services and connections need to be adapted to be accessible to all.

As illustrated in **Figure 2.3.1**, equity is different than equality. In the bottom left image, it is assumed that everyone will benefit from the same supports. They are being treated equally. In the top image, individuals are given different supports to make it possible for them to have equal access to the game. They are being treated equitably. In the bottom right image, all three can see the game without any supports or accommodations because the *cause of the inequity* was addressed. The systemic barrier has been removed.

To create a resilient community in The Port, services and connections need to be adapted to be accessible to all; for example, adjusting for age, economic conditions, English proficiency, access to social media and having the time to attend information sessions about the expected impacts of climate change. Building resilience also means beginning to tackle the root causes of social, structural, and economic inequities (e.g., poverty, discrimination, lack of access to education, jobs, and healthcare). Addressing these systemic inequities has the co-benefit of reducing vulnerability to the impacts of climate change while enhancing social cohesion, health, wellbeing, and community resilience.

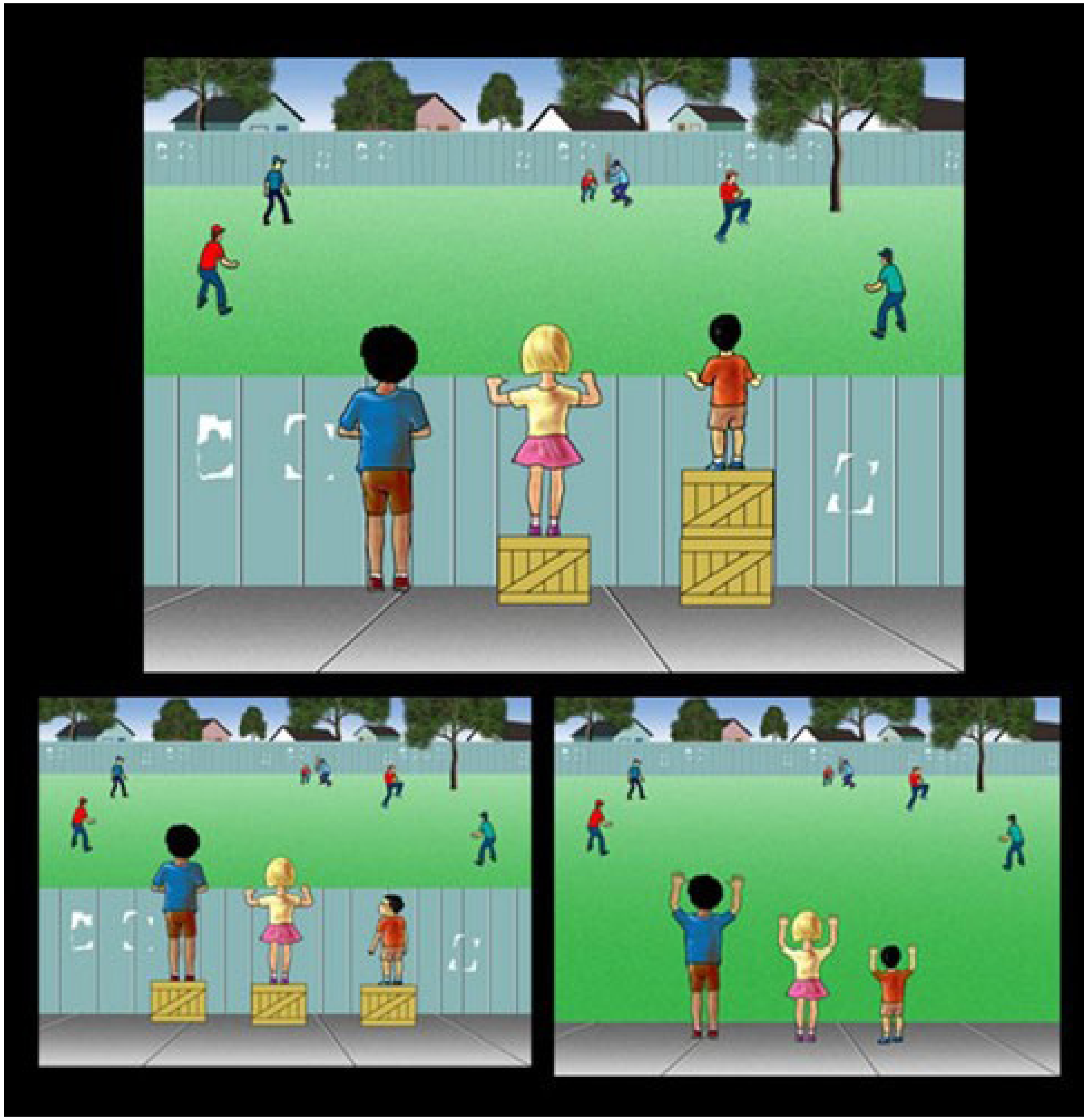

Figure 2.3.1 **Equity versus equality**

[Source: Internet competition for best representation for equity vs. equality. Anonymous.]

2.3.4 PRECEDENTS RELEVANT TO THE PORT

Our approach draws on efforts of communities across the country to advance climate equity.

Greenovate Boston Leaders, for example, is a program by the City of Boston which sets a goal for underserved communities to have access to greater resources and to benefit from increased collaboration within and across neighborhoods. It provides training to members of the community to become "leaders" for outreach to increase awareness and understanding of climate change. In addition, Climate Ready Boston planning efforts have required consultants to team with established community organizations to connect environmental justice communities with "information about, and access to, the resources that they need to improve their communities and strengthen their resilience."[56] Because such communities often have lacked access to resources, Greenovate sets the stage for funding opportunities that can create a pipeline for community investments toward resiliency.

Chicago Strategic Plan and Chicago Community Trust recognized the potential for strengthening neighborhoods by directing resources that strengthen and link community organizations and residents. A community-led strategic planning process resulted in a mandate to address the fundamental issue of inequity. The plan[57] includes:

- Helping to remove the underlying barriers, whether regulatory, cultural, or financial, that too often impede both individual and community progress.
- Focusing on equitable development: ensuring that every neighborhood and everyone can benefit from economic transformation, especially low-income residents, communities of color, immigrants and others at risk of being left behind, even as parts of the City thrive.
- Ensuring that as neighborhoods improve existing residents can stay—and are not displaced in the process. This requires not only the conscious use of investments to create both connections to economic and ownership opportunities, but also community planning where residents have seats at tables when decisions are made that shape their neighborhoods and lives.
- In concert, the Chicago Community Trust (Trust)[58] has announced a new five-year strategic plan that includes offering funding to "anchor organizations" in the City. To realize its vision for metropolitan Chicago, which includes helping the region become the most philanthropic in the country, the Trust will focus its future grantmaking on initiatives that inspire philanthropy in all its forms, engage residents to work with one another for the common good, and lead change aimed at solving pressing issues. The Trust provides general operating grants ("GO Grants") to organizations that address chronic needs in the community and streamline its grantmaking process to reduce the administrative burden on nonprofits pursuing grants. The Trust provides a model of philanthropy based on supporting "anchor organizations" to contribute to a common cause. This approach could be applicable for engaging the established community resources in The Port to focus on climate change.

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56 Resilient Boston: An Equitable and Connected City, City of Boston, July 2017. https://www.boston.gov/departments/resilience-and-racial-equity, accessed 2/13/2019
57 http://www.lisc.org/media/filer_public/a1/7e/a17e31db-bd18-415e-9c68-61be90d1956d/122817_chicago_strategic_plan_2017.pdf
58 Founded in 1915, the Chicago Community Trust and Affiliates (Trust) was established by local business leaders to support the residents of Chicago with grants to arts, social service, education, and community organizations.

The Port has a vibrant social support structure with more than 30 not-for-profit organizations established in 0.2 square mile neighborhood with a community of approximately 5,000 people.

Falmouth community engagement model offers a good local model for community engagement as part of its outreach resiliency program. Residents were interviewed by JSI Research & Training Institute at the food pantry to identify a range of needs and ideas on how best to address resiliency. Recommendations ranged from gardening, including climate-resilient plants, to crafts activities for seniors during hot days to support for homeless youth living in cars.[59]

The Margaret Fuller House in The Port also provides a good local model for what is needed to help establish a resilient community by working with community organizations. It is a multiservice center that offers childcare, computer access, a library, public space on hot days, and a food pantry among other resources for residents.

The Margaret Fuller House regularly connects residents to their neighbors and to community organizations. The house works with the City and networks such as the Men's Health Taskforce to hold community fairs and festivals, including Port Pride Day. These activities enable neighbors to meet one another. In the last year, residents learned about climate issues and shared their experiences and ideas for strengthening their neighborhood. To help in such outreach, the director, staff, and resident clients worked with the Cambridge Public Health Department to create and share videos about climate change and public health that help inform and prepare The Port community.

Youth art project at Margaret Fuller House. Credit: http://www.margaretfullerhouse.org

[59] Working Towards Coastal Resilience for Underserved/Hard to Reach Community Members on Cape Cod, Waquoit Bay National Estuarine Research Reserve and JSI Research & Training Institute, September 2018.

2.3.5 IMPLEMENTATION

The Port has a vibrant social support structure with more than 30 not-for-profit organizations and resources established in a 0.2 square mile neighborhood with a community of approximately 5,000 people. These resources, identified in **Table 2.3.1**, have already created a strong network of people in The Port that plays an active role in connecting others, providing services or education, and fostering volunteer opportunities. This network of organizations needs to remain informed and be further educated about the impacts of climate change and resilient measures to be able to help the Port community to become more resilient.

1. **Social and support networks** that focus on climate resiliency by taking actions to:

- **Support organizations that are regularly relied upon for social services** will need to be prepared to address the challenges of climate change. They **need to be linked so that they can efficiently share resources and meet various needs** across The Port. Anchor organizations need adequate resources to fulfill these functions. A resiliency hub of connected organizations can strengthen community networks while working daily to increase preparedness among residents and businesses through education, training, planning, and implementation of resilience and sustainability measures.
- Make sure that **people have access to services or spaces** that are, by design, **resilient to flooding or extreme heat**. Identifying which of The Port's existing organizations would be best suited to become a resource during extreme events and could support a resiliency hub is an important first step. Identified organizations need to enhance their facility to be prepared for flooding and extreme heat. Vulnerabilities to extreme heat and flood have been identified in **Figure 2.3.2**.

Table 2.3.1 Community Resources at risk and strategies for preparedness to flooding and heat

#	*Organizations at Risk of Flooding*	*Possible Preparedness Actions for Flooding**	*Organizations at Risk for Extreme Heat*	*Possible Preparedness Actions for Heat**
1	Cambridge Community Art Center	Use flood resilient construction materials [B3.4]	For all, possible surges in energy demand and loss in tree canopy.	Maximize natural ventilation [B4.1]
2	Central Square Theater	Elevate or protect utilities [B3.3]		Install back-up solar energy or ductless heat pumps to improve efficiency and A/C capacity. [B4.2]
6	Margaret Fuller House	Relocate electrical panel and main shutoff above grade level [B3.5]		
7	Cambridge Public Health Department			
		Have a maintenance plan and emergency plan for maintaining basic services for flood events [B5.1]		Replace windows with low emissivity** (Low-E) that emits low levels of radiant heat. [B4.4]
16	St. Paul's Ame			
22	JFK Apartment	Implement onsite store/retain/delay strategies for stormwater [B6.1]		Provide increased tree & vegetative cover to help buffer heat [B5.6]
23	Newtowne Court			

* Actions detailed in Strategies B3-B6 of the CCPR Preparedness Handbook https://www.cambridgema.gov/~/media/Files/CDD/Climate/CCPR/ccprpreparednesshandbook_cambridge.pdf

** "Low-E" literally means low emissivity, which in turn means a surface that emits low-level of radiant heat. All surfaces reflect, absorb, and transmit heat. So, a Low-Ecoating reduces the amount of that heat transfer. When talking about replacement windows the term Low-E really applies to the glass being used.

Possible strategies for increasing resiliency have been identified for preventing flooding damage and heat resiliency. It is assumed that most facilities in The Port, as in the rest of Cambridge, are not well equipped to deal with the projected increase in extreme heat events with insulation in old buildings not maximized, ventilation and cooling not updated to be energy efficient and limited access to A/C. Possible strategies to better prepare the facilities for heat identified in **Table 2.3.1** are taken from the *Cambridge Climate Change Preparedness and Resilience Handbook* developed for Alewife.[60]

[60] CPPR Alewife Preparedness Plan, City of Cambridge, http://www.cambridgema.gov/CDD/Projects/Climate/~/media/701F64FC31654DF48137CF275E38EB0F.ashx

2. **Social participation** is about building relationships that provide friendship and company, ensuring people are not isolated. Social participation is already part of The Port daily life, so this is about being deliberate about who is being reached and how often. To be effective, the following is needed from the City and key stakeholders:

- Work with well-connected community-based organizations to identify and draw together residents who may be most at risk. Healthcare and social service organizations, businesses and unions, youth and adult educational organizations, and advocacy organizations should be identified to serve as anchor organizations.
- Serve the range of residents of all ages and of all languages, culture, and circumstances to:
  - ✓ Pre-identify people who are at risk and/or who may be isolated during flooding and extreme heat and reach to them to start a discussion on how best to be prepared. By understanding which residents need special support before extreme heat or flooding event, special engagement accommodations can be anticipated by emergency services, supporting organizations and family or neighbors.
  - ✓ Work with vulnerable populations and their providers to identify best approaches for preparedness. These include seniors, young children, those who have health or mental health conditions, are homeless, and/or who need support with substance use.

Figure 2.3.2 **Port Community Organizations at Risk of flooding for the 10-year storm by 2070**

[Source: Cambridge GIS land use data (2017) with Google Map updates as of 02, 2019]

- ✓ Inform those who, while they may be healthy, may have greater exposures to heat or flood waters, such as outdoor workers and athletes (via workplaces, schools, and sport clubs).

- Update directories of organizations and the services they offer. Work closely to understand the challenges they may be facing in offering their programming. Help leverage support that strengthens and sustains their vital community programs.

- Offer accessible information tailored to The Port's different communities.

  - ✓ Provide information tailored to language and culture.

  - ✓ Expand upon current activities of community organizations from shared meals and activities at the Senior Center to community and service activities at faith-based organizations.

  - ✓ Learn what activities and services residents need and their ideas on how best to implement.

3. **Community engagement** in actions to encourage volunteering, which draws people together to work for the benefit of others. Ways to involve residents and organizations of The Port in climate actions could be to:

- Support community conversations with local government agencies to further discussion on resilient housing, businesses, and adaptable transportation.

- Provide participatory budgeting that can direct resources to The Port that help sustain a resilient community.

- Increase community participation in education and outreach, from school projects that inform students and their families to creating engaging educational materials and events on climate change impacts.

- Achieve greater participation in existing community programs to encourage stronger networks. For example:

  - ✓ Organize a block party.

  - ✓ Start a telephone tree.

- Use the City's "Resident Opinion Survey"[61] to define the metrics that are most meaningful and valuable to The Port community to establish a resiliency baseline for A Prepared Community.

Resilient Port table at Hoops N' Health, Summer 2018. Credit: Kleinfelder

[61] 2018 City of Cambridge Resident Survey https://www.cambridgema.gov/news/2018/09/2018residentsurvey

Table 2.3.2 **Strategies for resilient people**

		Strategy	Tool Box /Action	Targeted Implementation	Benefits and Metrics
Resilient People	**A1**	***Neighborhood resilience hub***	Support community organizations to establish neighborhood hubs to foster social resilience and emergency preparedness	Identify which of the existing Port's organizations would be best suited to become a "resiliency hub"	Increase the number of households registered to Smart 911
	A3	***Support systems for vulnerable populations***	Reach out to populations at risk to validate communications, and resiliency-building strategies	Residents most at risk of flooding or extreme heat need to be identified to help prepare for extreme conditions	Increase participation to CodeRed
			Educate populations at risk, employers, providers, and in-home caregivers of medically vulnerable populations about heat and flooding risks and to recognize danger signs	Collaborate with well-connected community-based organizations to identify and draw together residents who may be most at risk.	
				Inform those who, while they may be healthy, may have greater exposures to heat or flood waters, such as outdoor workers and athletes	
			Develop a database of facilities and locations with concentrations of population at risk of flooding and/ or heat to assist with response activity	Link support organizations so that they can efficiently share resources and meet various needs across The Port	
			Offer accessible information tailored to The Port's different communities	Information need to be translated to language and culture tailored to The Port's diverse communities	
	A5	***Business and organizational preparedness***	Support businesses and community organizations to establish a resilience and emergency preparedness plan	Emergency planning and business operations need to facilitate the inclusion of resiliency to climate change needs	Enhance number of businesses informed about information/ toolkits available to support a resiliency plan
	A6	***Critical community facilities resilience***	Provide for continuity of operations during extreme events	Support community discussions to inform local policies from resilient housing to resilient businesses to adaptable transportation resilient to climate change impacts	I Increase the number of household registered to Smart 911
			Maintain a resilient transportation and transit infrastructure to ensure mobility and evacuation routes		
	A9	***Stronger social network***	Compile resource listings and design culturally and linguistically appropriate educational and outreach materials with tailored messages	Community participation in education and outreach need to develop engaging educational materials and events about climate change impacts	
			Engage in activities to build social connections among residents to foster neighborhood cohesion and resilience	Greater participation from existing community needs to be achieved in programs that encourage stronger networks	Provide for people above 65 and living alone to have a "buddy"; organize a block party; start a telephone tree
			Establish a baseline for the metrics/milestones defining a resilient community	Metrics need to be defined using the biannual City survey to establish a resiliency baseline for a Prepared Community	

[62] E.P.A.C. (Emergency Preparedness and Coordination), Cambridge Fire Department, https://www.cambridgema.gov/cfd/firedeptdivisions/EPAC
[63] Hurricane Evacuation Zones,MEMA, https://www.mass.gov/service-details/hurricane-evacuation-zones

2.3.6 HOW TO GET STARTED?

WHAT THE CITY CAN DO:

As previously stated, to get started will require a partnership between the City and its people. **The City has programs in place to connect people to organizations and services such as the following:**

- The City has created a ***Comprehensive Emergency Preparedness Plan*** [62] that focuses on emergency planning, including extreme events and ***Evacuation Plan*** developed with regional partners for evacuation routes during hurricanes.[63]
- The Cambridge Public Health Department, the City's Police Department, Human Services Department, Peace Commission, and the Cambridge Public Schools established the **Cambridge Community Response Network (CCRN)**. Facilitated by the Public Health Department, the CCRN helps residents, students, and workers identify the various tools and resources needed to build resiliency and better recover from a traumatic episode.[64]
- **CodeRED** is an emergency notification system that allows the City to send emergency notifications to subscribers via email, text, and phone calls.[65]
- **Smart911** is a secure online database where users can register their phone number and create a profile that will be visible to dispatchers when they call 911. This information can help emergency responders save your life and the lives of others by ensuring a quicker and more adequate response for your specific needs.[66]
- The City's combined **Emergency Communications and 911 Center** (ECC) manages the coordinated dispatch of police, fire, emergency medical service (EMS), and other resources.

In developing this preparedness plan, the City learned that many residents of The Port are not aware of these plans and services. Many residents and community leaders have said that they are not aware of the plans for how the City will respond during major flooding and heat events. Consequently, the City has started to prepare materials on climate change to be shared throughout the community. This includes:

- Fact sheets on climate change.
- Videos tailored to educate on climate change impacts in The Port.
- Outreach that is being conducted at events, such as during the annual **Climate Preparedness Week** held the third week of September.

These present opportunities for residents and the City to learn from one another and for local strategies to be further improved as advanced by residents. **The City is looking at means to identify additional opportunities to:**

- Work with community organizations in The Port to identify who would benefit from an upgrade to enhance their resiliency to flooding and extreme heat and help them identify the best approaches for becoming more resilient.
- Continue the process of identifying community members who will need a helping hand and enlisting leaders and community organizations best positioned to disseminate knowledge and to connect to people in need.
- Work with the leaders of community organizations to spread knowledge on how climate change can affect The Port community and how to access available resources to adapt.
- Encourage residents to join existing programs—for example, joining the volunteer Medical Reserve Corps that can assist during extreme events.
- Establish a baseline by understanding how The Port community is resilient. For example, include questions on indicators for neighborhood resiliency in the City's biannual survey, and ask if people are part of a volunteer association or if they hold neighborhood events.
- Support those who are homeless during extreme events working with the Cambridge Multi-Service Center (MSC) that focuses on homeless and near-homeless individuals and families.

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[64] Cambridge Community Response Network, https://www.cambridgema.gov/Departments/peacecommission/CCRN
[65] Code Red, https://www.cambridgema.gov/iwantto/signupforcodered
[66] Smart 911, https://www.cambridgema.gov/Services/smart911

What The Port community can do:

Take practical steps to be prepared for extreme heat and flooding

- Review the Cambridge Public Health Department Heat and Flooding fact sheets available on the department's website.[67]
- Contact the Cambridge Public Health Department Environmental Health program for advice on ensuring a healthy home at 617-665-3838.
- Get to know your neighbors and learn who may need help in an emergency.
- Join in one of the many existing programs:
  - ✓ Take advantage of Meet Your Neighbors Days that are held annually by the City. Port Pride Day, usually in early September, and other community fairs and festivals are opportunities to meet neighbors and celebrate The Port.
  - ✓ Volunteer to be part of the fabric of the neighborhood. You can go to your local community organizations and find opportunities and sign up on sites such as Many Helping Hands 365.[68]
  - ✓ Get trained and join the volunteer Medical Reserve Corps that can assist during events that threaten public health[69]
- Be a part of the climate change community by becoming active in the many local climate change organizations in Cambridge.
  - ✓ Contribute to grassroots organizations such as Communities Responding to Extreme Weather (CREW), which regularly host workshops to inform and involve residents at sites such as the local library.
  - ✓ Tell your story as your life experience might provide cues on how to overcome adversity or reach out to your community.
  - ✓ Be an active member of your community—for example, by making a phone tree or holding a block party event.

BUSINESSES CAN CONTRIBUTE TO COMMUNITY PREPAREDNESS BY:

- Learning how to maintain business continuity during extreme events. The City's Community Development Department is developing business continuity toolkits for small- and medium-sized businesses that include measures and available resources for preparedness to extreme events.[70]
- Understanding the limitations their business may have if it were flooded or if it is too hot outside.
- Talking to vendors about how they are prepared for climate change.

RESIDENTS CAN CONTRIBUTE TO COMMUNITY PREPAREDNESS BY:

- Using low- or no-cost ways to prevent mold, mildew, and pests. Ideas and support for those with children who have asthma are available at the Cambridge Public Health Department Healthy Homes Program.[71]
- Being involved in education and outreach, from school projects that inform students and their families to creating engaging educational materials and events on climate change impacts.
- Contributing to an existing community program to reduce the local impacts of climate change. For example:
  - ✓ Tree planting to help remove greenhouse gases and lessen urban heat islands.
  - ✓ Community gardening to grow heat-and pest-resilient vegetables to use and share.
- Joining any community group just to be part of the community.

[67] Climate Change, CDPH, www.cambridgepublichealth.gov/climatechange
[68] Many Helping Hands 365, https://www.manyhelpinghands365.org/
[69] Medical Reserve Corps of Massachusetts, http://www.mamedicalreservecorps.org/
[70] Preparedness Resources for Businesses , CDD, https://www.cambridgema.gov/CDD/econdev/smallbusinessassistance/emergencypreparednessforbusinesses
[71] Cambridge-Somerville Healthy Homes, CPHD, http://www.cambridgepublichealth.org/services/childrens-health/healthy-homes

What The Port community can do:

[Photo Credit: Margaret Fuller House]

[Photo Credit: Margaret Fuller House]

[Photo Credit: Kleinfelder]

Figure 2.3.3 Community Engagement

3.0 IMPLEMENTATION

3.0 IMPLEMENTING THE PORT PREPAREDNESS PLAN

Achieving climate change preparedness and resiliency in The Port is possible by fostering a strong partnership among the stakeholders, including the City, community leaders, business owners, institutions, and residents of The Port. Strategies and actions that enable The Port community to remain safe, function normally, and avoid major damage during extreme events and/or recover rapidly to normal operations afterward will help achieve resiliency.

These strategies have been assessed for their efficacy to reduce impacts of both extreme heat and flooding from extreme precipitation. The impact of the actions in reducing greenhouse gas (GHG) emissions is also evaluated, since these can be instrumental in climate change mitigation and in the long term can reduce the scale of projected impacts. Although some climate change impacts are inevitable—and The Port community needs to be prepared and resilient—it is equally important to slow down and/or reduce the cause of climate change by mitigating GHG emissions.

Proposed actions for The Port vary in their stage of development or resources required for implementation. Some are discrete suggestions that can be undertaken as pilot projects, others are policies that could be tested, while others might require more extensive feasibility studies.

Many strategies and actions for The Port are aligned with other City partnerships and programs related to ongoing initiatives and priorities as they contribute to shared goals for energy efficiency, the greening of the City, or regional actions for climate preparedness. These have been identified and include:

- ***Net Zero Action Plan:*** A 25-year plan that addresses both new and existing buildings and includes target dates for reduction of GHG emissions from buildings.
- ***Multifamily Energy Pilot:*** A program that provides no-cost energy efficiency assessments and solar assessments and retrofit incentives to owners of multifamily buildings in the City.
- ***Municipal Vulnerability Preparedness (MVP) Action Grant:*** The City has received an action grant from the Executive Office of Energy and Environmental Affairs (EOEEA) as part of the State's MVP Program.
- ***Urban Forest Master Plan:*** A strategic plan to evaluate, maintain, and expand the urban forest canopy while being more resilient to climate change.
- ***Envision Cambridge:*** The City's comprehensive plan guiding growth, sustainability achievement, and community-based planning.

3.1 PATHWAY TOWARD CLIMATE PREPAREDNESS FOR THE PORT

The pathway toward climate preparedness is summarized by reporting how the proposed strategies and actions affect extreme heat and flooding from extreme precipitation. Their efficacy to reduce greenhouse gas (GHG) emission is also assessed.

The ideas for change are supported by different resiliency strategies and actions that are at different stages of development:

- ***Study:*** Different actions will require further study to determine their feasibility, such as analysis for the proposed gray infrastructure strategies to reduce projected flooding.
- ***Pilot or programs:*** Other actions might be better suited for pilot projects, such as testing the efficiency of innovative design for tree pits.
- ***Policies or guidelines:*** Some actions might be implemented as policies, such as encouraging more green roofs or white roofs.

Table 3.1.1 Implementation pathway by climate change impact

			STRATEGY	ACTION	STUDY	PILOT/PROGRAM	POLICY/GUIDELINES	FLOOD	HEAT	GHG
GREEN & GREY INFRASTRUCTURE	GREEN	B6	Site Green Infrastructure	Build rain gardens to promote stormwater infiltration	○	○	●	■	■	□
				Use porous pavement to minimize impervious surfaces	○	○	●	■	■	□
				Install green roofs	○	○	●	■	■	□
		C New	New Resilient Infrastructure	Install leaching catchbasins	○	●	○	■	□	□
				Connect leaching catch basins to tree box filters	○	●	○	■	■	□
		D1	Resilient Urban Forest	Plant trees along public right-of-way to increase tree canopy	○	●	○	■	■	□
	GRAY	C6	Flood Protection	Divert stormwater flows to areas that have capacity	●	○	○	■	□	□
		C7	Combined Sewer Separation	Continue sewer separation	○	●	○	■	□	□
		C8	Stormwater Storage	Evaluate feasibility of additional storage tank(s)	●	○	○	■	□	□
	ENERGY	C9	Clean Energy Facility	Conduct a community energy pilot project	○	●	○	■	■	■
				Establish parking photovoltaic (PV) canopies	○	●	○	■	■	■
				Establish microgrid feasibility study	●	○	○	■	■	■
BOTH RESILIENT BLOCKS		B New	Adapted planning for resilient urban blocks	Convene two resilient block task force groups	●	○	○	■	■	■
		B5	Building management for flood & heat protection	Educate residents and land owners on flood vulnerability	○	●	○	■	■	□
		B7	Adapted zoning, policies & regulations	Study the possibility of special incentives zones	●	○	○	■	■	■

			STRATEGY	ACTION	STUDY	PILOT/PROGRAM	POLICY/GUIDELINES	FLOOD	HEAT	GHG
RESILIENT URBAN BLOCKS	RESIDENTIAL	B4	Flood/Heat Protection for New Buildings	Retrofit buildings with white roofs	○	○	●	□	■	□
				Retrofit buildings with green roofs	○	○	●	■	■	□
		B6	Site Green Infrastructure	Use porous pavements to minimize impervious surfaces	○	○	●	■	■	□
				Build rain gardens to promote stormwater infiltration	○	○	●	■	■	□
		B New	Building Energy Resiliency	Install solar PV panels to increase renewable energy production	○	○	●	■	■	■
				Renovate century-old buildings to increase energy efficiency	●	○	○	■	■	■
		D1	Resilient Urban Forest	Maintain and improve urban tree canopy	●	○	○	□	■	□
	MIXED-USE	B1/2	Flood/Heat Protection for New Buildings	Design new buildings with white/blue roofs	○	○	●	■	■	□
				Retrofit existing buildings with white/blue roofs	○	○	●	■	■	□
				Design new buildings with green roofs	○	○	●	■	■	□
		B6	Site Green Infrastructure	Build rain gardens to promote stormwater infiltration	○	○	●	■	■	□
				Use porous pavements to minimize impervious surfaces	○	○	●	■	■	□
		B New	Building Energy Resiliency	Install solar PV panels to increase renewable energy production	○	●	○	■	■	■
		C New	New Resilient Infrastructure	Install leaching catch basins	○	●	○	■	□	□
				Connect leaching catch basins to tree box filters	○	●	○	■	■	□
		C8	Stormwater Storage	Evaluate stormwater storage design in Greene Rose Heritage Park	●	○	○	■	□	□
		D1	Resilient Urban Forest	Maintain mature trees on private and public property	○	●	○	□	■	□
PREPARED COMMUNITY		A1	Neighborhood Resilience	Support organizations to establish neighborhood hubs	○	○	●	■	■	□
		A3	Support Systems for Vulnerable Populations	Reach out to people at risk to validate communications	○	○	●	■	■	□
				Educate populations about heat and flooding risks	○	●	○	■	■	□
				Develop a database of facilities at risk of flooding/heat	●	○	○	■	■	□
				Offer accessible information	●	○	○	■	■	□
		A5	Business & Org Preparedness	Support organizations to establish preparedness plan	○	●	○	■	■	□
		A6	Critical Community Facilities Resilience	Provide continuity of operations during extreme events	●	○	○	■	■	□
				Maintain resilient transit infrastructure	●	○	○	■	■	□
		A9	Stronger Social Network	Compile resource listings with tailored messages	●	○	○	■	■	□
				Engage in activities to build social connections	○	●	○	■	■	□
				Establish baseline metrics defining a resilient community	●	○	○	■	■	□

3.2 TIMELINE FOR PREPAREDNESS AND RESILIENCY ACTIONS IN THE PORT

The Plan for a creating climate resiliency in The Port establishes a framework for documenting and reporting progress. The timeline for implementation provides a scalable workplan identifying the priority actions that need to be taken in the short-term, next steps documented in mid-term, and actions that can be conducted in the long-term. Each step is actionable, and it will be important along the journey to celebrate successes and milestones of achievements.

The implementation timeline shows which actions should be started in the near future and identify ones that will require more time. Progress for the three ideas for change and supporting strategies will be tracked, and actions will be evaluated over time to assess if they are providing the expected benefits. The timeline will also provide an opportunity to adapt to evolving climate change science and add actions informed by technological developments, policy changes, and evolving community priorities.

Table 3.2.1 Timeline for implementation

			STRATEGY	ACTION	0-5 YEARS	5-10 YEARS	10+ YEARS
GREEN & GREY INFRASTRUCTURE	GREEN	B6	Site Green Infrastructure	Build rain gardens to promote stormwater infiltration	■	■	■
				Use porous pavement to minimize impervious surfaces	■	■	■
				Install green roofs	■	■	■
		C New	New Resilient Infrastructure	Install leaching catchbasins		■	
				Connect leaching catch basins to tree box filters		■	
		D1	Resilient Urban Forest	Plant trees along public right-of-way to increase tree canopy	■	■	■
	GRAY	C6	Flood Protection	Divert stormwater flows to areas that have capacity		■	
		C7	Combined Sewer Separation	Continue sewer separation	■	■	■
		C8	Stormwater Storage	Evaluate feasibility of additional storage tank(s)	■		
		C9	Clean Energy Facility	Conduct a community energy pilot project		■	
				Establish parking photovoltaic (PV) canopies		■	
				Establish microgrid feasibility study	■	■	
BOTH RESILIENT	BLOCKS	B New	Adapted planning for resilient urban blocks	Convene two resilient block task force groups	■		
		B5	Building management for flood & heat protection	Educate residents and land owners on flood vulnerability	■	■	■
		B7	Adapted zoning, policies & regulations	Study the possibility of special incentives zones	■		

			STRATEGY	ACTION	0-5 YEARS	5-10 YEARS	10+ YEARS
RESILIENT URBAN BLOCKS	RESIDENTIAL	B4	Flood/Heat Protection for New Buildings	Retrofit buildings with white roofs	■	■	■
				Retrofit buildings with green roofs	■	■	■
		B6	Site Green Infrastructure	Use porous pavements to minimize impervious surfaces	■	■	■
				Build rain gardens to promote stormwater infiltration	■	■	■
		B New	Building Energy Resiliency	Install solar PV panels to increase renewable energy production	■	■	■
				Renovate century-old buildings to increase energy efficiency		■	
		D1	Resilient Urban Forest	Maintain and improve urban tree canopy	■	■	■
	MIXED-USE	B1/2	Flood/Heat Protection for New Buildings	Design new buildings with white/blue roofs	■	■	■
				Retrofit existing buildings with white/blue roofs	■	■	■
				Design new buildings with green roofs	■	■	■
		B6	Site Green Infrastructure	Build rain gardens to promote stormwater infiltration	■	■	■
				Use porous pavements to minimize impervious surfaces	■	■	■
		B New	Building Energy Resiliency	Install solar PV panels to increase renewable energy production		■	
		C New	New Resilient Infrastructure	Install leaching catch basins		■	
				Connect leaching catch basins to tree box filters		■	
		C8	Stormwater Storage	Evaluate stormwater storage design in Greene Rose Heritage Park	■	■	
		D1	Resilient Urban Forest	Maintain mature trees on private and public property	■	■	■
PREPARED COMMUNITY		A1	Neighborhood Resilience	Support organizations to establish neighborhood hubs	■	■	■
		A3	Support Systems for Vulnerable Populations	Reach out to people at risk to validate communications	■	■	■
				Educate populations about heat and flooding risks	■	■	■
				Develop a database of facilities at risk of flooding/heat		■	
				Offer accessible information	■		
		A5	Business & Org Preparedness	Support organizations to establish preparedness plan	■	■	■
		A6	Critical Community Facilities Resilience	Provide continuity of operations during extreme events	■		
				Maintain resilient transit infrastructure	■		
		A9	Stronger Social Network	Compile resource listings with tailored messages	■		
				Engage in activities to build social connections	■		
				Establish baseline metrics defining a resilient community	■	■	■

The goal of **stakeholder engagement** is to empower The Port community to take actions to address climate change by defining a shared mission that can raise and rally the neighborhood.

NEXT STEPS

COMPLETION OF THE CITYWIDE PLAN

The **Port Preparedness Plan** is the second pilot plan informing the City's comprehensive **Citywide Climate Change Preparedness and Resiliency (CCPR) Plan**. Next steps will include further evaluating the proposed ideas for change developed for The Port and the strategies for Alewife and test their feasibility citywide for a more resilient Cambridge. New strategies and actions developed for The Port will also be included in the final version of the CCPR Handbook, to be reissued with the Citywide CCPR Plan by the end of 2019.

Selected actions in The Port could also be tested in pilot projects so the community gets a jump start and is better prepared for climate change impacts.

As was the case in the development of the Climate Change Vulnerability Assessment (CCVA), it is recognized that the resiliency strategies herein are based on climate change scenarios developed for Cambridge that are drawn from the best available science but involve ranges of uncertainty. These strategies will need to be revisited periodically to ensure community preparedness plans continue to reflect updated projections specific to local climate change.

STAKEHOLDER ENGAGEMENT

It is crucial to underscore the importance of incorporating stakeholder input in preparedness planning and in developing and implementing resiliency strategies. The stakeholder engagement process that has been established as part of the CCPR Plan supports this purpose. Cambridge's residents, business associations, and regional and local organizations have provided input in defining vision, framework, and strategies. To make progress on fostering greater community resiliency, a program to continue and maintain engagement is needed.

READER NOTES

PRODUCED IN COLLABORATION WITH

Kleinfelder, Lead Consultant

BuroHappold Engineering for Energy Resilience

JSI Research & Training Institute, Inc. (JSI), for Public Health

Stantec, for Water Modeling

www.cambridge.gov/ClimateChange