Hampton Heat Resilience Plan

PLAC 5863 : Climate Adaptation Planning

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Photo Source: City of Hampton

Executive Summary

The following document provides an analysis and a series of recommendations relating to the issue of extreme heat impacts caused by anthropogenic climate change. The study area for this work was the neighborhoods of Downtown and Phoebus within the city of Hampton, VA. First established by European settlers in 1607, the city has continually evolved to address the changing needs of its residents. In December of 2017, the city of Hampton continued this evolution by publishing a climate resiliency plan titled "Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency." Since then, the city's Resilient Hampton team has worked to ameliorate issues of sea level rise and flooding within the city. Other climatic impacts, such as extreme heat, however, have not yet been addressed by the city. This study on Hampton's Heat Resilience Plan serves to address that gap in knowledge and provide a starting point for future work in addressing extreme heat, particularly as the impacts of extreme heat manifest in low-income and otherwise vulnerable communities within the city.

Extreme heat has varied definitions, depending on locality, but is primarily defined by several (at least 2-3) days of high heat over 90 degrees Fahrenheit. This can cause numerous physical impacts, including buckling roads and igniting powerlines, but also is of concern due to its potential deadly impacts for individuals. According to the Center for Climate Change and Health, extreme heat causes more deaths than any other natural disaster, resulting in more than 7,100 individuals dying in the United States between 1999 and 2010. These impacts are exacerbated by urban heat island, or the phenomenon in which more developed urban areas experience higher surface temperatures than surrounding suburban and rural areas.

The impacts of extreme heat are not felt equally across a community. Low-income communities, elderly residents, children, and those with pre-existing medical conditions have been identified by the Center for Disease Control as the populations most vulnerable to extreme-heat-related medical emergencies. These outcomes are also informed by the locations of these communities within a city, which is in turn informed by the history of injustice, displacement, and disinvestment in the city, including the practice of redlining. This document provides a definition for who is most vulnerable to heat-related impacts in Hampton, as well as provides a spatial analysis of where these vulnerable communities are located within the Downtown and Phoebus neighborhoods.

This document also recommends several adaptive strategies to best support the residents in Hampton with alleviating heat-related impacts. These recommendations include formalizing the network of cooling centers within the city; creating and implementing educational outreach strategies about the dangers of extreme heat and what opportunities are available to stay cool within the city; and long-range implementation strategies such as cool roof initiatives, increasing access to affordable and shaded public transportation, and increasing tree canopy coverage within the city.

The authors of this document hope that the following analysis and recommendations can provide the Resilient Hampton team a solid foundation upon which to build a Heat Resilience Plan for the city that not only addresses the potential health-related impacts of extreme heat generally, but also works to address these issues in a way that centers equity.

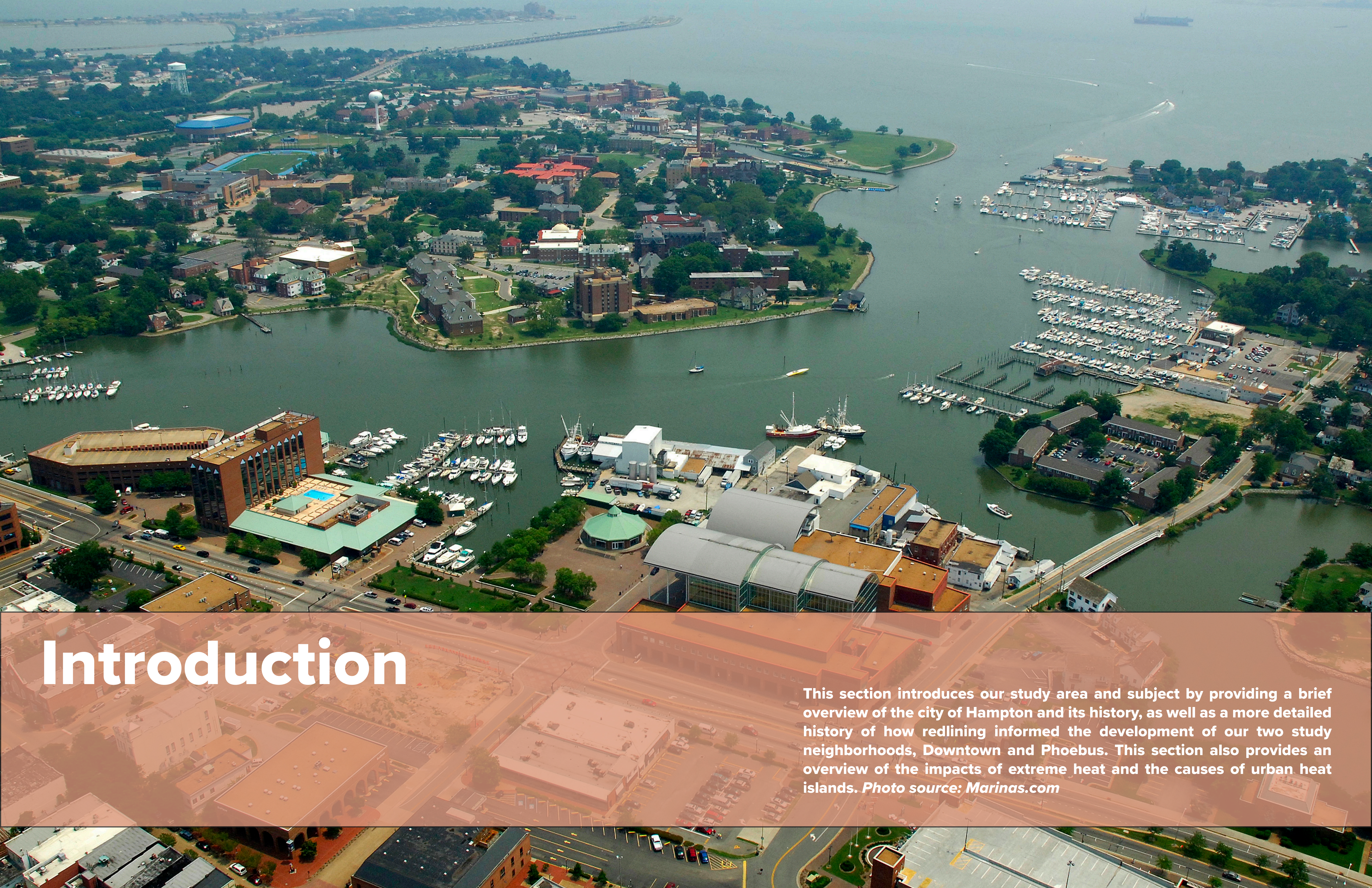
Acknowledgements

First, thank you to Carolyn Heaps (Resiliency Officer for the City of Hampton) for her support in helping create clear guidelines for our work, providing access to Hampton's data, and allowing us to help pave new paths for Hampton's climate adaptation planning.

We would also like to thank Professor Bev Wilson for his persistence in offering GIS assistance and hunting down difficult to obtain data; for continuing to provide important insights and constructive critiques for our project; and for teaching this course.

This course would not be complete without our fellowclassmates in PLAC 5863: Climate Adaptation Planning (Fall 2021). We thank you for engaging in important discussions about the complexities of climate change and how we as planners work to address these complexities.

Finally, we would like to thank the authors of the following planning documents: Virginia Coastal Resilience Master Plan: Phase 1 (Virginia Department of Conservation and Recreation); Beat the Heat Hunting Park: Community Heat Relief Plan (City of Philadelphia, Sustainability Office); Virginia Beach Sea Level Wise Adaptation Strategy (City of Virginia Beach, Sea Level Rise team); and Living with Water Hampton: A Holistic Approach to Addressing Sea Level Rise and Resiliency (City of Hampton, Resilient Hampton team). These plans informed the content of our work and provided design inspiration for this document.



Introduction

This section introduces our study area and subject by providing a brief overview of the city of Hampton and its history, as well as a more detailed history of how redlining informed the development of our two study neighborhoods, Downtown and Phoebus. This section also provides an overview of the impacts of extreme heat and the causes of urban heat islands. *Photo source: Marinas.com*

Who, What, Where? Hampton 101

The city of Hampton, VA is an independent city located within the Hampton Roads Planning District. Nearby cities include Newport News to the west, as well as Norfolk, Portsmouth, and Virginia Beach to the south of the Hampton Roads channel.

In 2019, the total population for the city was estimated to be **137, 148**, making it the 8th most populous city in the state of Virginia.

The city is divided into several neighborhood districts, including Aberdeen Gardens, Buckroe Beach, Downtown, Fox Hill, Northhampton, Newmarket, Phoebus, and Wythe. Based on the structure of the Resilient Hampton team's work on water planning for the city at the neighborhood level, the authors of this study focused their attention on two neighborhoods: Phoebus and Downtown.

Based on estimates of the population of Census Tracts that intersect with these two neighborhoods, the total population of both neighborhoods in 2019 was **35, 649** residents, or **25.26%** of the total population of the city.

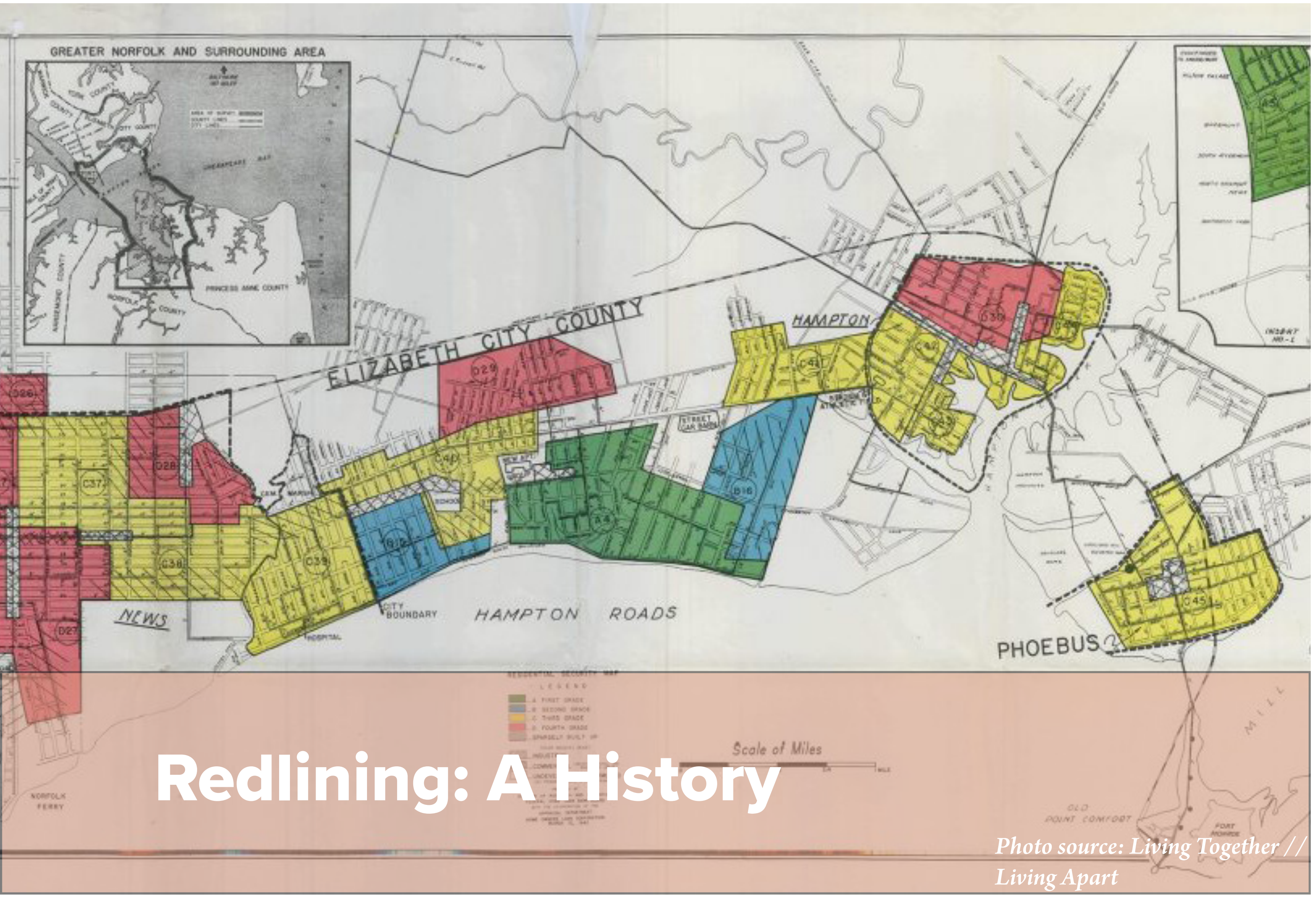
Of those 137, 148 residents:

51, 202 identify as White (**37.33%** of the population)
67, 915 identify as Black or African American (**49.52%** of the total population)
10, 355 identify as two or more races (**7.55%** of the total population)
7, 676 residents (**5.60%** of the total population) identify as native or indigenous (identified as "American Indian" by the United States Census Bureau), Asian, or other.

"A City of Firsts"

As the city of Hampton writes of its history, "Hampton is a city of firsts." The home for thousands of years to the Kecoughtan people, once part of the Powhatan Confederacy of tribes, the earliest English settlers arrived in the Hampton Roads region in 1607. There, the English, lead by Captain John Smith, built Fort Algernon, which would later become the site of Fort Monroe.
In 1619, Hampton would also become the site upon which the first enslaved Africans would arrive to the American continent. Almost 150 years later, in May of 1861, three enslaved men arrived to Fort Monroe to demand protection by the Union army against enslavement. The army granted this request, thereby identifying Fort Monroe as a place of refuge for eventually thousands of enslaved individuals. By the 20th century, the city of Hampton also became an early site of great importance to America's journey to space: NASA's Langley Research Center was established in the city during World War I, due to Hampton's proximity to Washington D.C. and later become the site where the first astronauts, who traveled aboard the Mercury, were trained. Today, the city is home to some of the descendants of the earliest English settlers and first enslaved Africans, as well as numerous other individuals. Many of the city's neighborhoods are also classified as historic districts, including Downtown and Phoebus.

IMAGE RIGHT: "Arrival and Debarkment of U.S. Forces at Hampton Ruins, near Fort Monroe" (1862, Edward Sachse). This print illustrates the arrival of Union forces arriving to Hampton. Confederate soldiers burned the city after realizing they would not be able to hold it. ***Photo source: Smithsonian Museum of American History***



Redlining: A History

Photo source: Living Together // Living Apart

Introduction

The racial demographics of the city of Hampton have been informed by several factors, dating back to the city's early settlement. One of the most consequential determinants of racial demographics throughout the United States, was the practice by the United States government and real estate practitioners of scoring neighborhood's vitality. This process is known colloquially as redlining. The history of redlining in Hampton began in the 1930s. Neighborhoods were classified into four categories, A, B, C, and D, which A and B are classified as the most attractive for refinancing, and C and D as not worth reinvesting. Each classification was assigned a color, and red was designated for D neighborhoods, hence the name. In our study area, Phoebus and Downtown Hampton were identified primarily as "C" and "D" neighborhoods.

Phoebus

In a redlining document from 1939, Phoebus was classified as a Level C neighborhood. The document set shell fisheries odors, lighting, the conditions of housing, transportation, and even "limited shade trees" as criteria to classify the neighborhood as less attractive. Back then, 30% of the population in Phoebus were African Americans.

Downtown Hampton

The redlining map separated downtown into four parts. Three of them were Level C (C42, C43, C44), and one of them was Level D (D30). Like Phoebus, these are considered as less attractive due to the housing conditions and odors. The income level of the three areas back then was relatively low compared to other so-called "Level A and B" Neighborhoods.

Level D, Downtown (*left*)

In the 1930s, the "D" area in Downtown had the lowest income group and the population was 100% African Americans. The occupation was primarily fisheries workers, and the income level was $1000 per year. In the redlining document, the neighborhood was classified as "least attractive" for reinvestment due to housing conditions, access to transportation, odor, etc., and it even wrote "houses are in poor conditions and do not evidence pride of home ownership"— Area description, circa 1939 (Hampton History Museum, image courtesy of Mapping Inequality Project).

Level C, Phoebus (*right*)

"Phoebus is a typical country town of about 3,000 [people]. The terrain is level and about 75% improved. Economic activity is primarily dependent on Langley Field and Fort Monroe...Mallory Street and County road are principal thoroughfares, although traffic is not hazardous. Few other streets are hard surfaced and all are poorly lighted. Some pride of home ownership evident in good maintenance of property, but there are few shade trees and no part of the town has residential charm or appeal. Shell fisheries are located along the waterfront, giving rise to obnoxious odors, especially in damp weather...Adequate transportation by bus and street car. New construction is scattered, the surrounding area sparsely settled and largely devoted to farming. The Chesapeake and Ohio Railroad tracks bisect the town north and south. General age and obsolescence preclude a desirable classification." — Area Description, circa 1939 (Hampton History Museum, image courtesy of Mapping Inequality Project)

Extreme Heat and Urban Heat Islands

Why is Extreme Heat a Concern?

The growing occurrences of extreme heat events and heat waves due to climate change have increasingly become a major topic of concern in recent years. While the average temperature continues to increase at a moderate pace, climate change has caused more frequent extreme weather events, particularly extreme heat.

Definitions of extreme heat vary across localities and geographies but describes extreme heat as "a long period (2 to 3 days) of high heat and humidity with temperatures above 90 degrees [Fahrenheit]."

There are many impacts of extreme heat seen in every aspect of our everyday lives. In urban environments, a greater risk of impacts such as buckling roads and highways, as well as bursting water lines and igniting power lines, are common due to thermal expansion. Extremely high heat can also bring concerns of droughts, which can in turn increase the risk of other hazards such as fire and landslides. This is due to dry land soaking up less water, which in turn increases surface runoff. If an intense rainstorm were to occur during a period of drought, the risk of flash flooding increases dramatically.

For the city of Hampton, the greatest concerns of extreme heat are likely not environmental impacts, although these should be noted, but the human physiological impacts of extreme heat events. When people are exposed to extreme heat, they can suffer from potentially deadly illnesses, such as heat exhaustion and heat stroke. According to the CDC, extreme heat can also contribute to deaths from heart attacks, strokes, and other forms of cardiovascular disease, on top of respiratory disorders. Due to these impacts, the Center for Climate Change and Health has identified that extreme heat causes more deaths than any other type of natural disaster, even though most heat-related deaths are preventable through outreach and intervention.

Between 1999 and 2010, more than 7,100 people died from heat-related illness in the U.S. This is an average of 618 deaths per year. Extreme heat affects various populations differently, and elderly and young populations, people with underlying conditions, and minority groups that live in hotter areas of the city can be disproportionately impacted. Areas with low tree canopy coverage and a high percentage of impervious surfaces, such as parking lots are particularly vulnerable. These areas are often where the residences of low-income communities are located.

What is an Urban Heat Island?

An urban Heat Island is phenomenon experienced in metropolitan areas wherein the most central parts of the city are much warmer than the rural areas surrounding it. This phenomenon is caused by heat that is created through energy generation by vehicles, people, impervious surfaces, and buildings. Additionally, reduced natural landscapes in urban areas contribute to the lack of natural cooling through vegetation and water cycles, and thus increases temperatures in cities. Building materials seen in urban areas such as asphalt, steel, and brick are often very dark colors, which absorbs more light energy and converts it into heat. Buildings with insulation capture and store heat and release during the night, which can have serious health implications for urban residents during heat waves. Impervious surfaces don't allow absorption of water, which inhibits the cycle of infiltration and evaporation from ground surfaces, increasing heat in urban environments.

Depending on the intensity and distribution of activities and development, various areas of the city can have different surface temperatures. In a study conducted by scholars Susanne Benz and Jennifer Burney in 2021, both of whom work for the UCSD School of Global Policy and Strategy, the authors analyzed surface temperature measurements in 1,056 large counties in the United States and found that communities with high poverty and high non-white residents can be up to 7 degrees warmer during the summer compared to the wealthiest areas. This often results, as the authors and other scholars have identified, from lack of tree canopy in lower-income neighborhoods, more buildings, and to a lesser extent, higher population density.

What does this mean for Hampton?

There is strong evidence that the city of Hampton has urban heat islands resulting from historical redlining. The population of Black residents in both Phoebus, particularly the southern part of the neighborhood, and Downtown are larer than the city's average, which is 45.52% (pg. 8): 58.4% of the population in south Phoebus and 69.3% of the population in Downtown Hampton identify as Black, according to the 2019 American Community Survey.

In the case of Hampton, the map of urban heat (below) shows high temperatures in the Downtown area and South Phoebus, which both have high impervious surface coverage and low tree canopy compared to the surrounding neighborhoods. In our analysis of land surface temperatures for our study area, we found that Census tract 113, which encompasses much of the Phoebus neighborhood, appears to have the greatest land surface temperatures in the area.

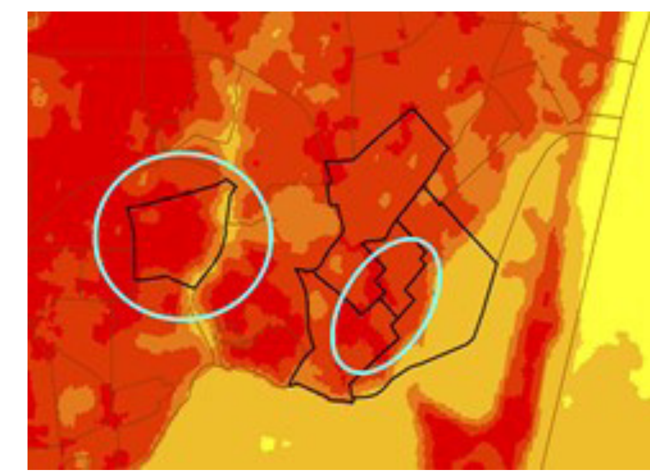


IMAGE ABOVE: Land surface temperature data from the USGS Landstat in 2020. Block groups in the study have been idenitifed by blue circles. These areas have higher overall surface temperatures than other neighborhoods in the city.

Vulnerability and Community Partner Assessment

This section defines vulnerability and risk in the context of this study, provides a geospatial analysis of several factors that inform extreme heat vulnerability, and introduces the existing and potential community and institutional partners that may be able to assist in implementing the strategies recommended in this study. *Photo Source: Daily Press*

Defining Vulnerability & Risk

Given the equity focus of this study, the authors focused our attention on a measure of vulnerability and risk that directly relates to an understanding of the intersectionality of social experiences and inequities. This understanding of vulnerability is often called social vulnerability in vulnerability and climate adaptation scholarship. As defined by the CDC in their Social Vulnerability Index, social vulnerability encompasses "a number of factors, including poverty, lack of access to transportation, and crowded housing" which may "weaken a community's ability to prevent human suffering and financial loss in a disaster." (CDC/ATSDR Social Vulnerability Index). Our definition for this study of vulnerability is situated within this framework and is as is defined as follows:

VULNERABILITY:
The process through which residents within the neighborhoods of Downtown Hampton and Phoebus become susceptible to heat-related medical emergencies or other negative impacts due to extreme heat. In other words, those most vulnerable are residents most susceptible to these impacts. In Hampton, this may include individuals living in poverty, without access to a household vehicle, and those living without health insurance. Given that younger and older individuals are often more susceptible to extreme heat impacts, those under 5 and over 65 are also considered most vulnerable in this work.

Risk is closely related to vulnerability and is described as follows:

RISK:
The likelihood that negative heat impacts will occur. This means, for example, that the more vulnerable populations identified above will likely experience a greater risk than those who are less vulnerable.

Vulnerability Assessment Methodology

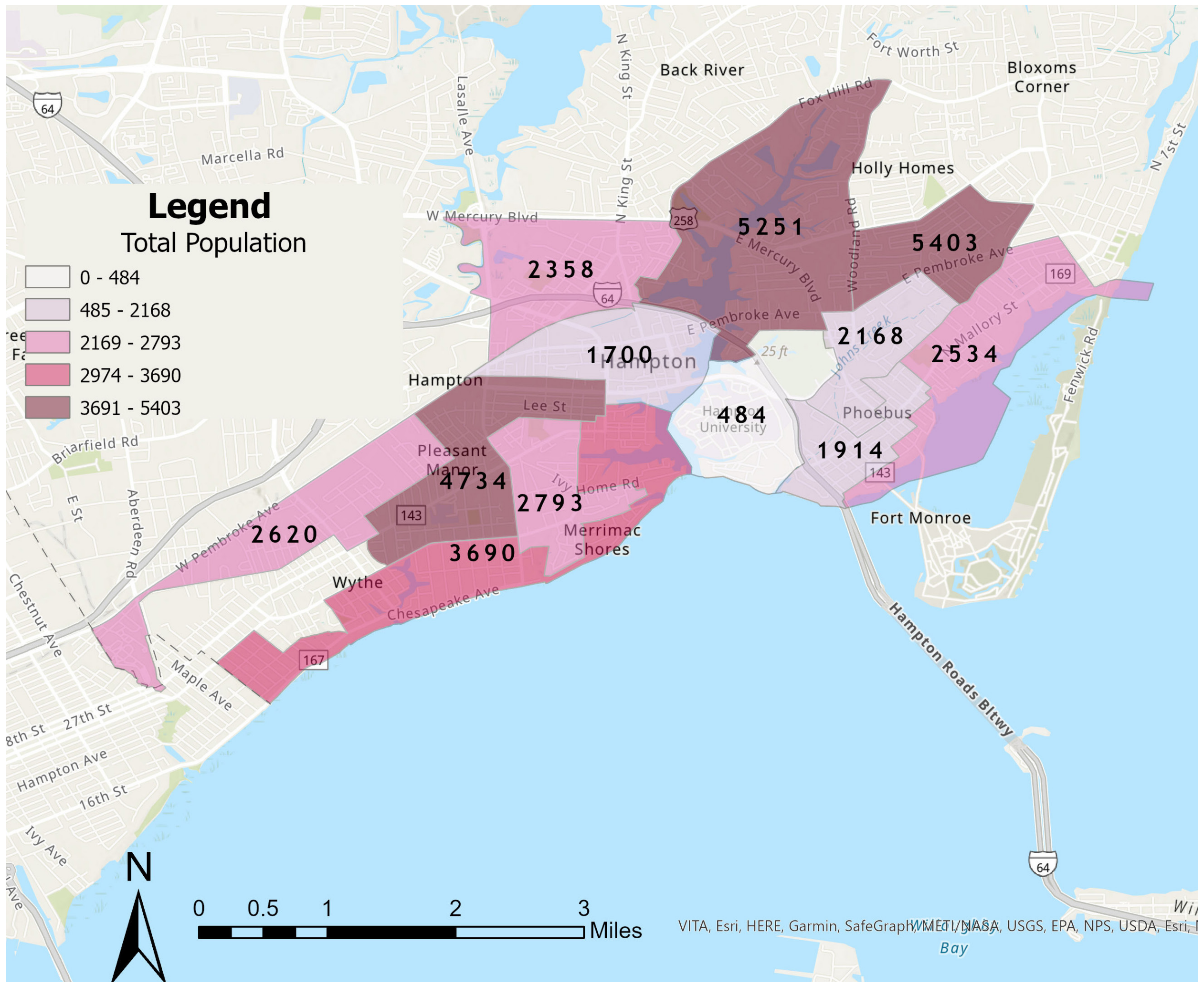
To examine how vulnerability manifests in our study area, the authors conducted a geospatial analysis of several social demographic factors using ArcGIS Pro. This process began by downloading Census tracts for the state of Virginia from the Census Bureau, as well as a shapefile of the City of Hampton's Master Plan neighborhood zones, which included information regarding the geographic location of Phoebus and Downtown Hampton.

Using the Select by Location feature of ArcGIS, the Census tracts that intersected with these neighborhood zones were identified as the study area for analysis. These included Census tracts 106.01 and 106.02, 108-10.02, 112-16, and 118-19. For a more complete and site-specific analysis, the authors recommend the city of Hampton creates shapefile boundaries for the neighborhood districts of the city for optimal analysis.

After the Census tracts within the study area were identified, demographic data, such as the population living below the federal poverty line and the population without a vehicle for their household, were downloaded from the Census Bureau. These data were collected during the 2019 American Community Survey (ACS). It should be noted that household vehicle availability is estimated on a 5-year basis by the ACS. To collect data on the population living without health insurance, data from the CDC Places Project was downloaded. This project, using modeling completed in 2018, publish yearly estimates for the number of individuals living without health insurance, in addition to several other health indicators, for every Census tract within the United States.

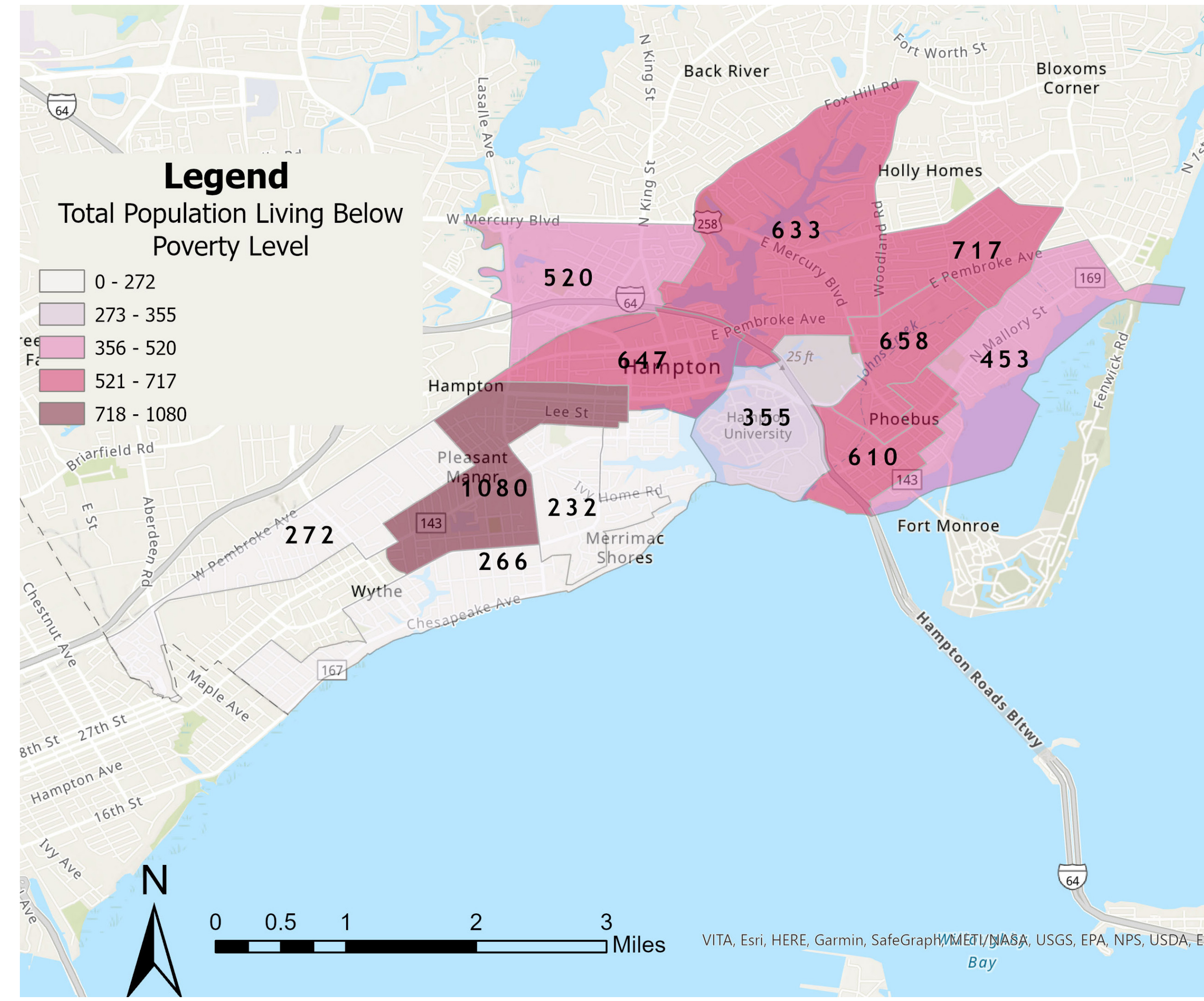
After collection, the demographic data were joined to the Census tract information and visualized in the maps following this page (pgs. 17-20). Raw counts provide a measure of the population on a scale that is relevant to the overall scope of the projcet, whereas percentages may in fact, serve to make the scale less apparent.

Total population in study area



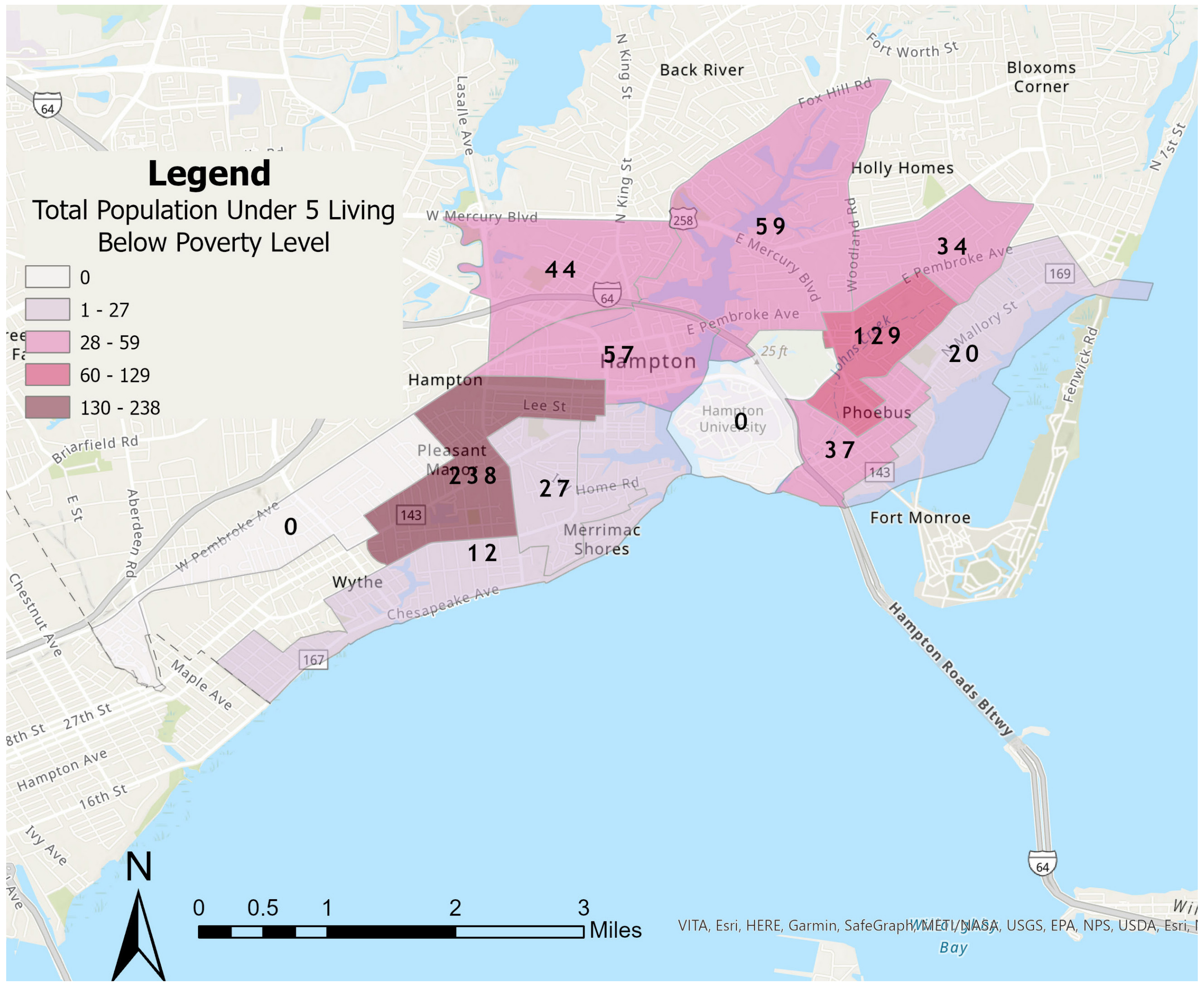
This map indicates the total population, according to the 2019 American Community Survey, of each Census tract used for this vulnerability analysis. It is included in this document to contextualize the data of the maps following it. Data was obtained from the City of Hampton Open Data Portal and from the Census Bureau. This map was created by Jenni Rogan on December 4, 2021.

Total population living in poverty



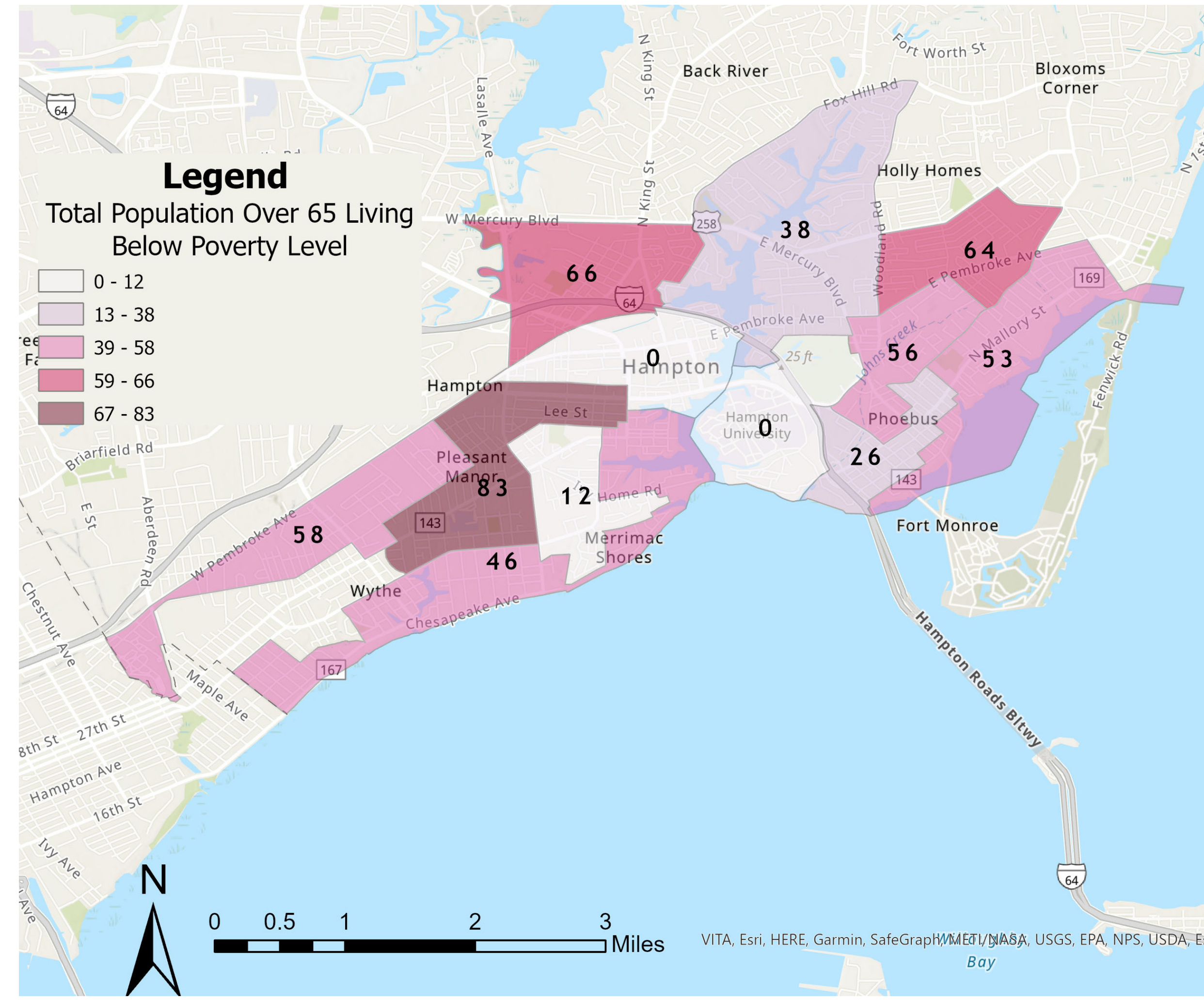
These data are relevant as they provide a general analog for vulnerable populations, as well as provide insight into who may struggle most with affording to run air conditioning within their residence. The EPA and the CDC have both recognized that those over the age of 65, along with outdoor workers, those with pre-existing medical conditions, young children and pregnant women, and people experiencing homelessness as particularly of concern for heat-related health impacts. Data was obtained from the City of Hampton Open Data Portal and from the Census Bureau. This map was created by Jenni Rogan on December 4, 2021.

Total population living in poverty under the age of 5, 2019



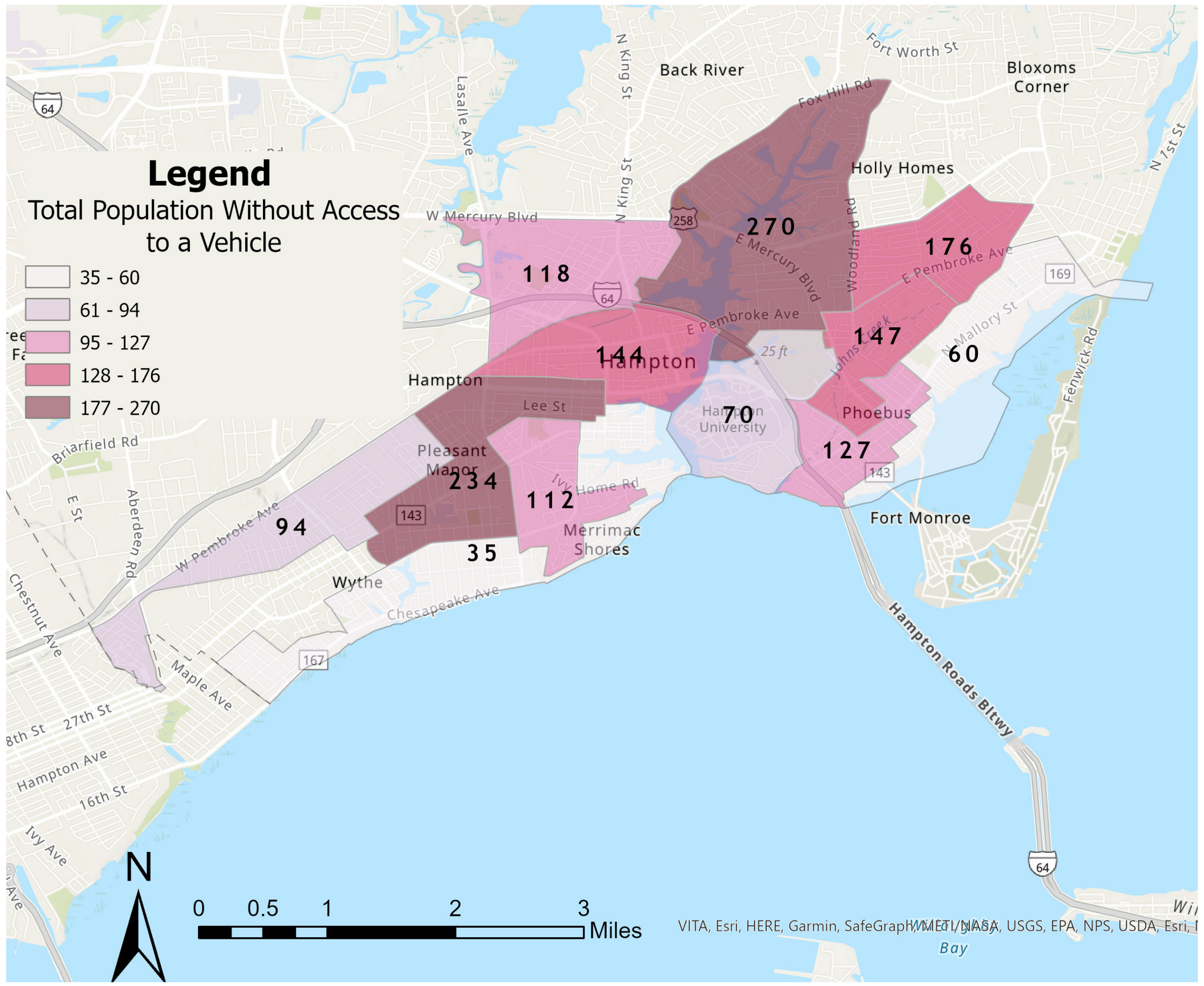
These data are relevant in that they indicate where vulnerable family units with young children reside within the study area. Health concerns related to extreme heat are of particular concern for young children due to their developing immune systems. Young children living in poverty may also be more vulnerable to other medical conditions, such as asthma, which contribute to overall vulnerability to heat-related impacts. Data was obtained from the City of Hampton Open Data Portal and from the Census Bureau. This map was created by Jenni Rogan on December 4, 2021.

Total population living in poverty over the age of 65, 2019



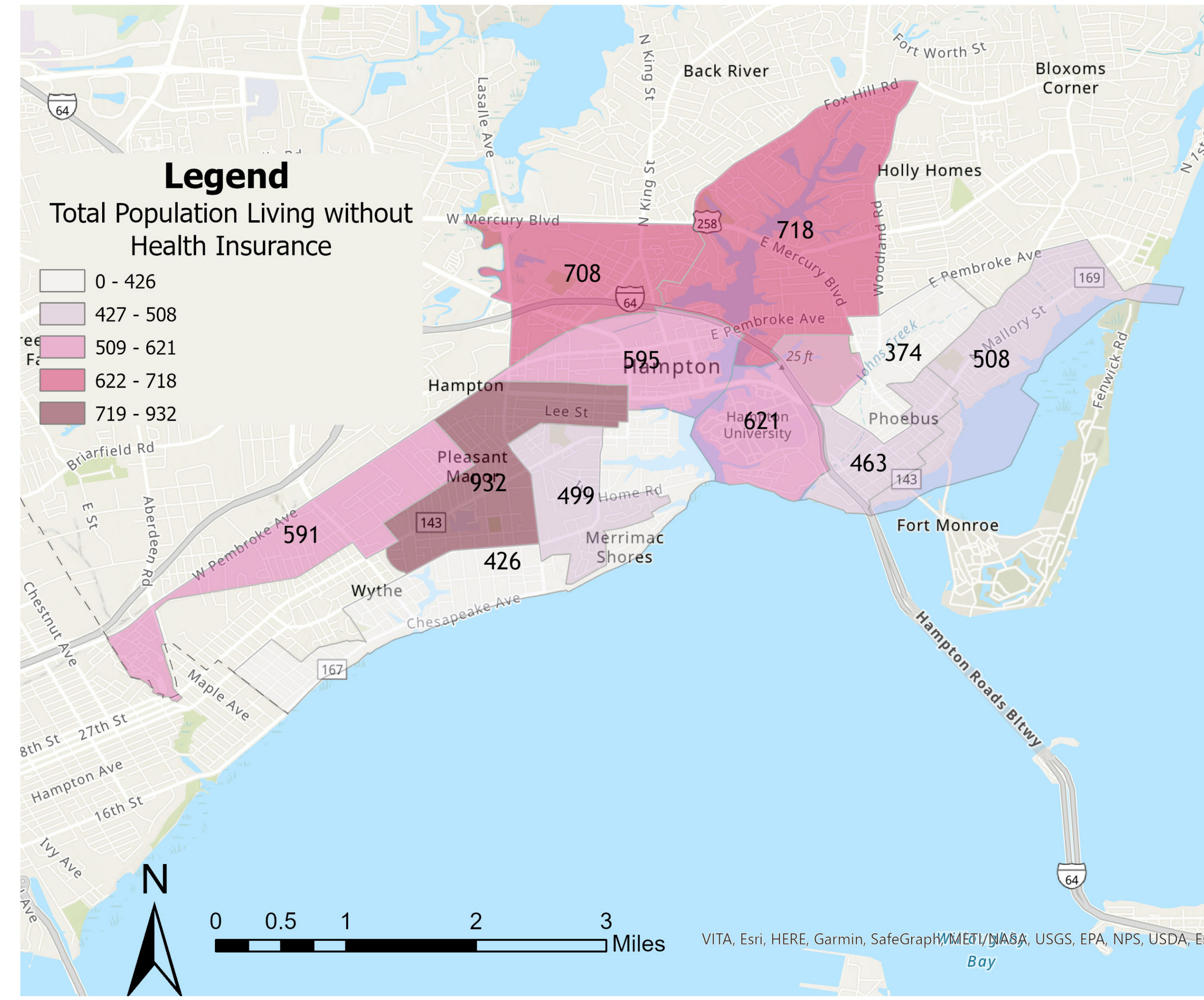
These data are relevant as they provide insight into the locations of elderly residents within the study area. Elderly residents within a community are particularly vulnerable to negative health impacts due to extreme heat due to higher frequency of pre-existing medical conditions and to the fact that elderly residents are more likely to live in isolation. Community support networks that check in on elderly residents have been identified as crucial to reducing the number of heat-related deaths in individuals over the age of 65. Data was obtained from the City of Hampton Open Data Portal and from the Census Bureau. This map was created by Jenni Rogan on December 4, 2021.

Total population without access to a household vehicle, 2019



These data are relevant for understanding where they may be issues of accessibility in visiting cooling centers or other cooling strategies during heat emergencies. Further analysis is needed to determine how these patterns intersect with public transportation access within the city of Hampton. This map was created by Jenni Rogan on December 4, 2021. Data was obtained from the City of Hampton Open Data Portal and from the Census Bureau.

Total population living without health insurance, 2020



These data are relevant as they give insight into issues of access relating to seeking treatment for heat-related medical emergencies. Those living without health insurance also may be predisposed to other medical conditions, such as cardiovascular diseases, that also contribute to an individual's vulnerability to needing medical attention during a heat emergency. This map was created by Jenni Rogan on December 4, 2021. Data was obtained from the City of Hampton Open Data Portal and from the PLACES Project 2020 Dataset.

Community and Institutional Partner Analysis

Photo source: Downtown Hampton Child Development Center

The city of Hampton has several existing partnerships with both institutions of higher learning and non-profit organizations that the authors believe can provide the foundation for implementing the findings and recommendations of this report. The following subsection elaborates on the community and institutional partners that have been identified and provides a brief example of the ways in which these partners can assist Hampton in implementing the strategies addressed in the next section of this report.

HELP: Hampton Roads Ecumenical Lodgings and Provisions

HELP is a faith-based organization that works to help low-income and unhoused individuals when they are in crisis. This can include offering emergency housing, providing food through their food pantry, and offering medical care through the organization's network of clinics. During previous heat emergencies in the city, HELP has also worked with the city to spread the word about the locations of emergency cooling centers in the past. In implementation, the authors believe HELP can continue to provide support through education and outreach to vulnerable populations, given the relationships the organization has with community members.

Downtown Hampton Development Partnership:

Downtown Hampton is the non-profit organization that manages the Business Improvement District for the neighborhood. In this work, the organization utilizes the funds it receives to enhance the physical beauty, commercial vitality, and distinguished character of Downtown Hampton. The authors believe this organization could help guide some of the larger-scale implementation strategies in its work regarding the commercial vitality and physical beauty of the area.

Institutions of Higher Learning: Hampton University, Christopher Newport University, and the University of Virginia

Hampton University is a private, HBCU located in Downtown Hampton. Christopher Newport University, located in Newport News, also has an established research partnership with the city of Hampton. One such professor at the institution whose work is situated within the scope of this study is John Finn, who currently holds the position as department chair for the geography department and whose work is focused on the continued social and environmental impacts of racial segregation, including the practice of redlining. The University of Virginia, while not local to the Hampton Roads area, also has a working relationship with the city through networking and alumni connections. All three post-secondary institutions can provide critical support in implementing strategies and additional research, given their resources. The two local institutions can also provide support through community engagement opportunities.

City-Run Community Hubs:

The authors believe that both the library and community center network of Hampton also serve as community partners for the implementation of this study. Several community and neighborhood centers are located within our study area, including the Little England Cultural Center, the new Mary Jackson Neighborhood Center, and the North Phoebus Community Center. Libraries in the study area include the main Hampton Public Library and the Phoebus Branch. Given the role these services have in engaging and educating the community, we believe it will be a natural step to incorporate them into helping to engage and educate the community regarding extreme heat concerns and the accompanying adaptive measures. The Hampton City School system may also be able to provide a supportive role in implementing these strategies, particularly education.

Our Adaptive Strategy Recommendations

This section outlines the adaptive strategies and next steps the authors of this study most recommend for further work on addressing extreme heat in Hampton. This section also includes a discussion of funding source recommendations to financially assist with the implementation of these strategies. ***Photo Source: City of Hampton***

Formalized Network of Cooling Centers

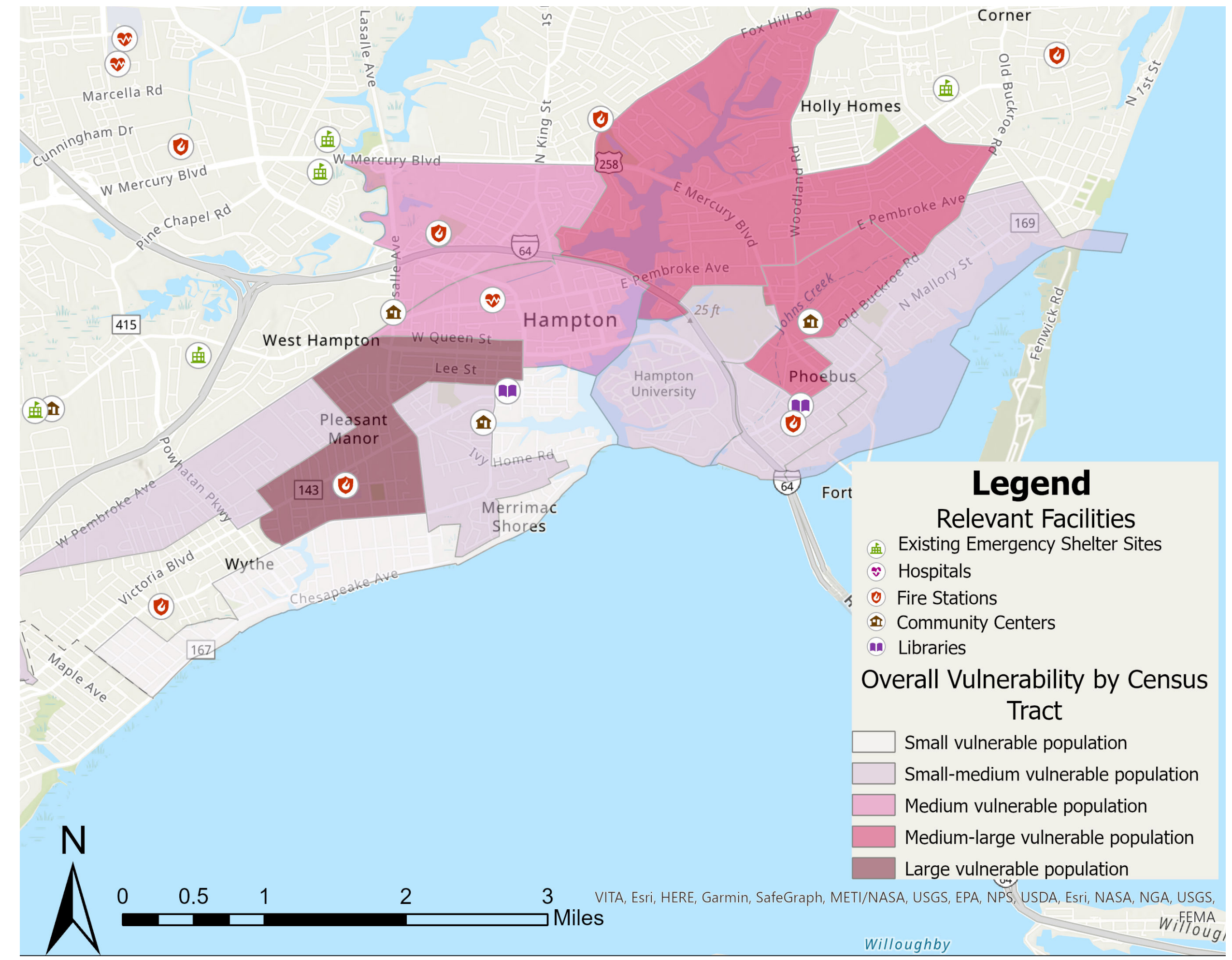
As shown in our analysis, our study area includes at least 6400 individuals who have been identified as vulnerable to extreme heat impacts. For many residents, including those who are experiencing homelessness, these impacts may be exacerbated by financial constraints, which may mean that residents either do not have central air conditioning in their home or may not feel financially capable of running their air conditioning during times of extreme heat. For residents unable to afford to maintain an air-conditioned residence, public air-conditioned spaces are critical to ensuring that all residents are cool and, more importantly, safe. These spaces are called cooling centers.

Our first recommendation for the City of Hampton is to formalize the cooling center network of the city. In our analysis and research, we determined that the city does not currently maintain a list of specific cooling centers. While the city does have resources that can be provided to the public during heat emergencies, the authors of this study believe have a permanent list and making resources available outside of periods when extreme heat is forecast will not only better prepare residents in such an event, but also encourage the city to continually update these resources as needed.

When extreme heat is forecasted, the city of Hampton currently notifies residents of cooling centers that are often located within "libraries, community centers, and participating houses of worship and day centers that are staffed by volunteer organizations such as HELP, Inc." (City of Hampton Emergency Management Team). These spaces were similarly identified by the authors of this work and visualized on the following page (pg. 28). The authors of this study additionally identified public safety venues such as fire stations and some public schools (determined to be emergency shelters by the City of Hampton) as potential options for cooling centers. Given the potential need for medical care if a heat emergency is not properly prepared for, hospitals and other medical care facilities were also included in the accompanying map for this recommendation.

It should be noted, as well, that the location, particularly with regards to public transit and walkability, of cooling centers is crucial to ensuring that residents stay safe, as determined by Andrew M. Fraser and colleagues in a study published 2017 on cooling center accessibility in the Phoenix and Los Angeles area. Once the City of Hampton formalizes the locations of its cooling centers, as well as conducts a community survey regarding air conditioning accessibility and affordability (discussed more on page 30), further analysis on the accessibility of cooling centers can be completed. The work on the locations of vulnerable populations in this study may act as a first step towards in this direction.

Existing and Potential Cooling Center Network, 2020



The locations of existing emergency shelters, including police stations and certain public schools; fire stations; community centers; and libraries were collected to create a spatial visualization of the potential network of cooling centers in Hampton. Hospitals were also mapped to determine the accessibility of hospitals to the study neighborhoods. Census tracts were determined to have a small, medium, or large vulnerable population based on the number of individuals living in poverty, without access to a vehicle, and without health insurance. Data was obtained from the City of Hampton Open Data Portal, the Census' American Community Survey, and the CDC Places Project. This map was created by Jenni Rogan on December 6, 2021 for PLAC 5863: Climate Adaptation Planning.

Education and Outreach

Many of the analyses and recommendations outlined in this report were informed by the City of Philadelphia's Beat the Heat Hunting Park plan, a community-centered heat relief plan for a neighborhood within the city of Philadelphia that—like our study area—has experienced the lasting consequences of redlining and a history of disinvestment from the city. The educational outreach strategies outlined in this sub-section particularly draw on this plan and we encourage the City of Hampton Resilient Hampton team to explore the Beat the Heat plan, if they have not done so previously, when continuing to engage in this work.

The first educational outreach strategy we recommend is to engage the community through surveys or community meetings about extreme heat to determine the starting level of knowledge. This survey may include questions regarding community member's experience with heat in their community, their knowledge level about the dangers of extreme heat and how to avoid negative health impacts, and their interest level about implementing the long-range adaptive strategies discussed later in this section (pgs. 31-33). These early meetings or surveys may coordinate well with some of the recommended data collection projects, discussed on the following page (pg. 30).

Depending on the results of the survey, the authors recommend integrating programming that aims to educate community members about missing gaps in knowledge. These programs could take numerous forms, ranging from paper documents to information booths at a block party, to a city-sponsored fair like the Hunting Park's Environmental Wellness Fair & Tree Giveaway.

IMAGE LEFT: Volunteers from the Tree Tenders group posing after a tree planting in the Philadelphia Hunting Park neighborhood in 2019. This effort was conducted as part of the Hunting Park Heat Relief Plan. ***Photo source: City of Philadelphia***

Community-Sourced Data Collection Projects

The authors of this study determined two community-driven data collection projects that we recommend the city of Hampton implements and manages. These projects will serve two, complementary purposes: 1. They will provide the city with additional data needed to best implement an equity-driven approach to extreme heat adaptation and 2. They can work to help inform the community about the dangers of extreme heat and how the city hopes to address those concerns.

Central A-C Accessibility Project

The first community-driven data collection project would be to distribute a survey regarding resident's abilities to access and afford central air conditioning within their home. While the tax accessor's office for the city does have data on the presence or absence of central air conditioning within most buildings within our study area, this data is currently not scalable, nor does it address the environmental justice concerns of affordability. By creating a way in which community members can share this information, the city can gain a better sense of areas of greatest need for education regarding utility assistance programs (such as LIHEAP, which is discussed in more depth on page 34), as well as where new cooling centers may be most needed.

Urban Heat Island Mapping

Although imagery from the USGS regarding land surface temperatures does exist, and was used for this study, the authors believe that involving community members in data collection efforts regarding urban heat island impacts and land surface temperature will not only provide an important educational opportunity, but also enhance these data by speaking to the lived experience of residents.

NOTE:
Urban heat island mapping is currently being undertaken by NOAA through their National Integrated Heat Health Information System and CAPA Strategies program and applications to be part of the 2022 campaign are open as of the time of this writing (December 11, 2021). Applications close at **5 PM Eastern time on January 14, 2022**. More information can be found here: https://nihhis.cpo.noaa.gov/Urban-Heat-Islands/Mapping-Campaigns.

Long Range Implementation Stategies: Overview

Photo source: Wikipedia

The following pages provide evidence for several adaptation suggestions that have been noted in the literature as common, yet effective strategies for mitigating urban heat effects (Keith et al. 2020). These strategies include incorporating cool, reflective roofs in building practices; increasing the number of protective shelters along bus routes; and increasing tree canopy and vegetative cover.

Given the scale and scope of these strategies, the authors believe that community partners such as the Downtown Hampton Development Partnership may be able to assist in coordinating the implementation of these strategies. Additionally, city-wide cooperation, perhaps in the form of policy proposals, may be necessary for these strategies to be most successful.

It should also be noted that, due to the limited scope of this study, the authors did not complete an in-depth analysis of the effectiveness and optimal locations for these strategies within Hampton. Nevertheless, we hope the following subsection can provide insight into the possibilities for more expansive, city-wide heat mitigation initiatives.

Cool Roofs, Public Transportation, and Policy Proposals

Cool Roofs

A cool roof, which primarily can be achieved through painting a roof with white or reflective paint, or through the building materials used, is designed to reflect more energy than a conventional roof. This keeps the interior of the building cooler, thereby reducing energy bills and helping alleviate the need for air conditioning within the building. Cool roofs may also work to insulate buildings in the winter, thereby providing heating assistance in addition to cooling. Compared to the normal roofs, cool roofs can reflect sixty percent more sunlight, which can help keep the home and neighborhood cooler (Berkeley Lab).

For the residents of Downtown Hampton and Phoebus, we have identified the following benefits when implementing cool roofs: reduced gas (depending on heat source) and electric, increased roof longevity, and potential opportunities for government rebates upon installation. We encourage the City of Hampton to install more cool roofs for neighborhoods with extreme heat island effects when funding is available. The Downtown Hampton Development Partnership may be able to offer assistance in this work, or perhaps incentivize this practice within the Downtown Business district.

Public Transportation

Increasing access to cool and accessible public transportation in extreme heat can reduce the carbon emissions caused by private cars, thus reducing the urban heat island effects. More specifically, there can also be more bus shelters, more free public transportation during extreme heat, and more electric buses to reduce carbon emission and provide more equal opportunities for people without cars to get around Hampton during extreme heat.

Policy Proposals

As the important role that policy makers play in solving environmental issues, we suggest the policy makers in Hampton take heat vulnerability into consideration when they make policy decisions in land use planning, tree planting, public space investment, and transportation planning. It is important for them to be aware of the issue of increasing climate change, do more research, review city policies, work with communities for co-production of heat mitigation knowledge, and outreach to potential fundings to reduce urban heat island effects and social inequality.

Increased Tree Canopy

Another effective strategy in mitigating urban heat island is the use of tree canopy. Trees decrease urban temperatures through direct shading and evaporative cooling. The EPA mentions that "shaded surfaces, for example, may be 20–45°F (11–25°C) cooler than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2–9°F (1–5°C)."

Urban tree canopy also has other benefits. A major benefit is reduced energy use. A summertime energy-use study in which eight 6-m-tall and eight 2.4-m-tall trees were planted around one house and then moved to another house showed that shading by these trees decreased summertime energy demand by as much as 30%. This could especially help low-income neighborhoods that already have high energy burdens.

Urban tree canopy also improves air quality and lower greenhouse gas emissions. It provides habitat, helps protect the health of waterways and removes fine particles from the air to improve air quality. There are many studies that show the positive health impacts of urban tree canopy as well.

The spatial pattern of tree canopy has a large impact on heat mitigation. Big patches with more core area are generally better for heat mitigation than scattered, isolated trees. However, more concentrated forest comes at the cost of less direct shading of buildings, which requires distribution of trees.

Hampton should consider the use of different spatial patterns when planting trees depending on the existing urban fabric, the needs and the purpose of the trees being planted. For instance, Downtown Hampton may want more scattered trees in order for them to provide direct shading for the buildings, whereas a neighborhood in Phoebus may prefer to plant a large patch of trees in hopes to decrease the temperature of the overall neighborhood.

Funding Source Recommendations

In order to make our recommendations more achievable, we have included a list of potential funding sources to which the city of Hampton could apply. It should be noted the following funding opportunities are reward either on a rolling basis or are likely to have future application cycles.

Several of the funding opportunities identified are at the city-wide scale. These include grants such as the Climate-Ready States and Cities Initiative (CRSCI) program, which helps localities identify likely climate impacts in their communities, and their most at-risk populations and locations. The program also helps grant recipients develop and implement health adaptation plans and address gaps in critical public health functions and services. The FEMA Hazard Mitigation Grant Program (HMGP) provides funding to state, local, tribal and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. The NOAA Environmental Literacy Program helps assist in increasing community resilience to extreme weather & climate change.

There are also several funding opportunities available to low-income individuals through federally funded programs. These include the Virginia Weatherization program, which provides financial assistance in helping individuals installment more energy conserving measures within their residences. This program is administered through a number of organizations, and the primary provider for this program for the city of Hampton is project: HOMES, a non-profit based in Richmond that specializes in affordable housing access. LiHEAP, or the Low Income Home Energy Assistance program, also helps low-income individuals with affording home energy bills related to heating and cooling, as well as with weatherization measures.

A table with this information, as well as links to websites where more information can be found about each of these funding opportunities can be found on page 39 of this document.

Conclusions and Appendices

This section concludes our study by discussing the limitations of this work, as well as next steps. Relevant sources, as well as a table detailing information regarding funding sources, are also provided. *Photo source: MAA*

Conclusions

This study provides an analysis and a series of recommendations relating to the issue of extreme heat, which is caused by anthropogenic climate change. Our study area included the neighborhoods of Downtown and Phoebus within the city of Hampton, VA. This document began with relevant background information on the history of the City of Hampton, particularly in relation to its history of redlining in the Downtown and Phoebus neighborhoods, its scar of disinvestments in housing and infrastructure, as well as an overview on extreme heat and its impacts.

The study then continued by providing a definition for vulnerability and risk in the context of this work and conducted geospatial analysis to identify where the most vulnerable communities, in terms of heat-related impacts, reside within the defined study area. Once vulnerable communities were identified, the authors of this study provided several recommendations for how to best address issues of extreme heat in ways that center those most vulnerable to its impacts. The study also provided an overview of relevant funding sources that may financially assist in the implementation of these recommendations.

This study is not without limitations, however. Due to the work of this document occurring within the timeframe of an academic course, time and resources both limited the extent of analysis. Had the authors had more time, we would have been interested in more thoroughly examining the intersection of the surface temperature mapping and the location of vulnerable populations. Additionally, the authors would have been interested in conducting further site-specific analysis of our recommendation, although this proved challenging due to data limitations. Finally, the authors would have been interested in providing further analysis on the accessibility of air conditioning, although we hope our recommendation for further data collection on this topic may serve as a basis for this future work.

Even with these limitations in mind, the authors hope this report will provide a solid foundation for future work on extreme heat resilience within the city of Hampton, and we thank the city of Hampton for providing us with this important opportunity to help pave the way for heat adaptation planning in Hampton.

Appendix A: Recommended Reading

Benz, S. A., & Burney, J. A. (2021). Widespread Race and Class Disparities in Surface Urban Heat Extremes Across the United States. Earth's Future, 9(7), e2021EF002016. https://doi.org/10.1029/2021EF002016

CDC/ATSDR's Social Vulnerability Index (SVI). (2020). https://www.atsdr.cdc.gov/placeandhealth/svi/index.html

Finn, J. (2021). Redlining: Environmental Justice [StoryMap]. Living Together / Living Apart. https://www.livingtogetherlivingapart.com/redlining-environmental-justice

Fraser, A. M., Chester, M. V., Eisenman, D., Hondula, D. M., Pincetl, S. S., English, P., & Bondank, E. (2017). Household accessibility to heat refuges: Residential air conditioning, public cooled space, and walkability. Environment and Planning B: Urban Analytics and City Science, 44(6), 1036–1055. https://doi.org/10.1177/0265813516657342

Keith, L., Meerow, S., & Wagner, T. (2019). Planning for Extreme Heat: A Review. Journal of Extreme Events, 06(03n04), 2050003. https://doi.org/10.1142/S2345737620500037

Nelson, R. (n.d.). Mapping Inequality [Richmond University]. Mapping Inequality. Retrieved December 12, 2021, from https://dsl.richmond.edu/panorama/redlining/

Poletto, C. (2021, November 10). How 'Cool Roofs' Can Help Fight Climate Change. The New York Times. https://www.nytimes.com/2021/11/10/realestate/cool-roofs-climate-change-nyc.html

Solecki, W., Rosenzweig, C., Blake, R., de Sherbinin, A., Matte, T., Moshary, F., Rosenzweig, B., Arend, M., Gaffin, S., Bou-Zeid, E., Rule, K., Sweeny, G., & Dessy, W. (2015). New York City Panel on Climate Change 2015 Report Chapter 6: Indicators and Monitoring: NPCC 2015 Report Chapter 6. Annals of the New York Academy of Sciences, 1336(1), 89–106. https://doi.org/10.1111/nyas.12587

US EPA, O. (2016, July 1). Climate Change Indicators: Heat-Related Deaths [Reports and Assessments]. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths

*It should be noted, in the event this document becomes publicly distributed, that any individuals portrayed in these photographs have not consented to being represented in this document, although all photographs displayed here are publicly available. Additionally, all credit of photographs belongs to the original source, cited with photo.

Appendix B: Funding Source Table

Grant Name	Provider	Website	Who Would Apply
Cimate-Ready States and Cities Iniatitive	CDC	https://www.atsdr.cdc.gov/placeandhealth/share/onemap_heat-crsci/extreme_heat_home. html	The City of Hampton
Virginia Weatherization Assistance Program	Department of Energy (Project:HOMES in Richmond is also a partner)	https://www.benefits.gov/bene-fit/2090	Individuals
Low Income Home Energy Assistance Program (LIHEAP)	Department of Health and Human Services	https://www.acf.hhs.gov/ocs/low-income-home-energy-assis- tance-program-liheap	Individuals
FEMA Hazard Mitigation Grant Program (HMGP)	FEMA	https://www.fema.gov/grants/mitigation/hazard-mitigation	The City of Hampton
NOAA Environmental Literacy Program	NOAA	https://www.noaa.gov/office-education/elp	The City of Hampton

Note:
My contribution to this project are the following sections:
Executive Summary
Redlining: A History
Part of Vulnerability Assessment
Adaptive Strategy Recommendations