A Natural Infrastructure Resiliency Plan *for the City of* HAMPTON

Prepared for the City of Hampton by the
Green Infrastructure Center Inc.

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Green Infrastructure Center

By the Green Infrastructure Center Inc.

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Participants in the Community Steering Committee workshops included city residents, as well as representatives from Wetlands Watch, the Chesapeake Bay Foundation, Hampton University, Fort Monroe Authority, Hampton City Schools, Virginia Tech Cooperative Extension, Hampton Extension Master Gardeners and Tree Stewards, James River Association, and the Hampton Roads Planning District Commission (HRPDC).

Participants in the local stakeholder meetings included representatives from:

- Fort Monroe Authority
- Fort Monroe National Monument, National Park Service
- NASA Langley Research Center
- Hampton University
- Langley Air Force Base (JBLE-Langley)
- HRPDC
- VT Cooperative Extension
- Old Dominion University Institute for Coastal Adaptation and Resilience (ODU ICAR)

City of Hampton staff participants in the project included representatives from:

- Community Development:
  - — Resilience Division
  - — Housing and Neighborhood Services Division
  - — Planning and Zoning Division
- Parks, Recreation, and Leisure Services
- Public Works Department - Engineering
- City Attorney's Office
- Clean City Commission
- Information Technology Department- GIS

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Photo by City of Hampton

Creating a Citywide Natural Infrastructure Plan *(continued)*

Executive Summary

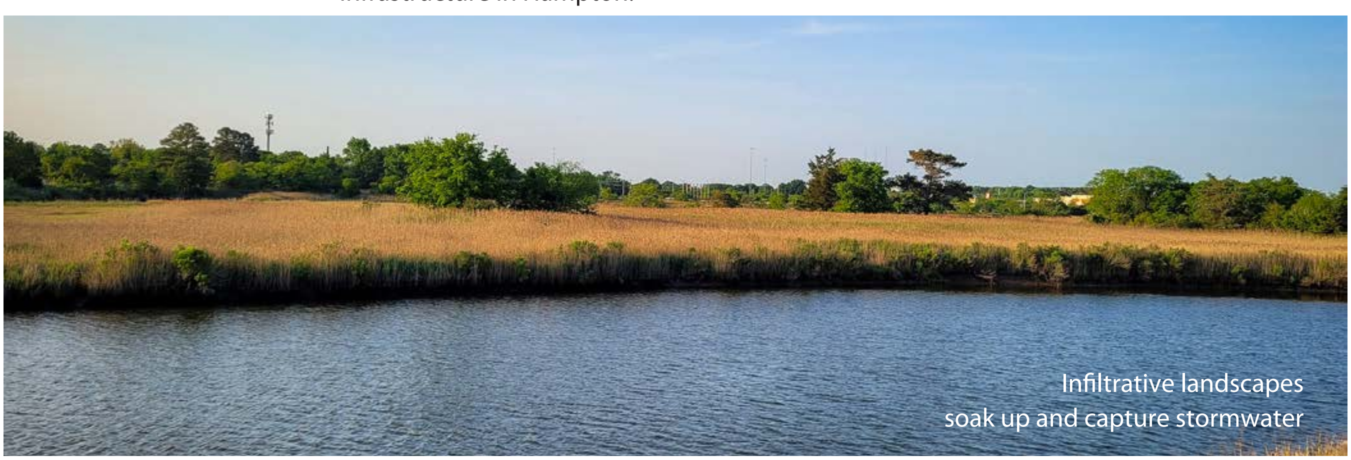
Natural Infrastructure includes all the interconnected natural systems in a landscape, such as intact forests, trees, wetlands, dune systems, parks and rivers.

This ***Natural Infrastructure Resilience Plan*** complements and expands upon the ongoing work of the city of Hampton's Resilient Hampton Initiative by helping the city to achieve the goal of becoming a resilient coastal city. This plan provides strategies for the management, protection, and restoration of natural infrastructure in Hampton. Natural Infrastructure (NI) includes all the interconnected natural systems in a landscape, such as intact forests, trees, wetlands, dune systems, parks and rivers that provide clean water, clean air, food, urban cooling, nature based recreation, and stormwater infiltration. These landscapes also provide critical habitat for wildlife, such as mammals, birds, and amphibians. Planning to conserve or restore NI ensures that communities can be vibrant, healthy, and resilient.

This plan builds resiliency through Natural Infrastructure by identifying areas of significant tree canopy, wetlands, and marshes that should be protected. In addition, the plan maps opportunities to plant new vegetation (trees, shrubs, perennials, grasses etc.) to create:

- Infiltrative landscapes that soak up and capture stormwater
- Adaptive landscapes that buffer from storms and adapt to rising seas
- Cooling landscapes that mitigate heat
- Cleansing landscapes that filter pollution
- Equitable landscapes that address unequal distributions of NI and its benefits
- Connective landscapes that provide access to open space to increase wildlife movement and human health

This plan is not an entirely new approach. It is an outgrowth and continuation of the City's Living With Water approach. Living With Water, adopted as a City Council strategic priority, reframes the challenges of a changing climate, such as recurrent flooding and rising sea levels, as opportunities to live and thrive with water. The Resilient Hampton Initiative works to integrate water and flood risk mitigation into a safe, sustainable future that celebrates and maximizes the benefits of the city's water assets. This plan supports this ongoing work by planning for the management, protection, and restoration of natural infrastructure in Hampton.



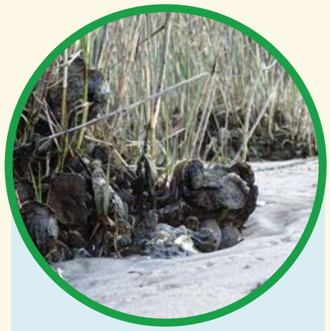
Infiltrative landscapes soak up and capture stormwater

The Benefits of Natural Infrastructure

There are different types of natural infrastructure providing multiple benefits to the coastal city of Hampton including:

Tidal & Forested Wetlands

- Slow and absorb the energy of waves
- Filter and clean floodwaters
- Provide fisheries, food and jobs
- Provide habitat
- Sequester and store carbon



Oyster & Coral Reefs

- Slow storm surge
- Provide food for people, birds and crustaceans
- Filter and clean water
- Provide habitat such as nurseries for young fish

Sand Dunes

- Buffer waves as a first line of defense
- Provide habitat for wildlife, birds and insects

Living Shorelines

- Slow waves and reduce erosion
- Protect property
- Filter stormwater
- Provide habitat
- Allow for adaptation and marsh migration

Urban Trees and Forests

- Reduce runoff and absorb floodwaters
- Shade and cool homes and businesses
- Provide clean air and water
- Reduce urban temperatures
- Sequester and store carbon

Open Space and Parks

- Store floodwaters and recharge aquifers
- Increase nearby property values
- Reduce urban temperatures
- Provide habitat for people, wildlife, birds and insects
- Provide human access to nature and fitness

Green Streets

- Capture and clean stormwater
- Beautify travel ways and encourage economic development
- Provide pedestrian-friendly walkways and connectivity
- Reduce urban temperatures

Nearly 500 acres of city parkland is expected to be inundated or impacted by sea level rise during the next 20 years.

This ***Natural Infrastructure Resilience Plan*** was created by through a partnership between the Green Infrastructure Center Inc. (GIC) and the City of Hampton's Resilience Division. It is the culmination of a two-year effort to map and plan for Hampton's natural infrastructure. Many community partners, City departments, and members of the public contributed ideas to create strategies in this plan. A City Staff Advisory Committee and a Community Steering Committee provided input during committee meetings. Two public open-house workshops and several online surveys provided additional opportunities for public input. The project team consulted with key city partners and large landholders, including NASA Langley Research Center (NASA LaRC), the Fort Monroe Authority (FMA), the National Park Service (NPS), Hampton University, and Joint Base Langley Eustis – Langley (JBLE-Langley). Ideas provided by these groups informed the strategies in this plan.

To help the city manage its natural infrastructure, an assessment was conducted to determine its extent and condition. This assessment included an analysis of city land cover (tree canopy, water, and impervious surfaces), the connectivity of city trails and parks, and the locations of large patches of intact open spaces, marshes and shorelines. In addition, analyses of natural infrastructure risks and opportunities were completed to guide planning and decision making.

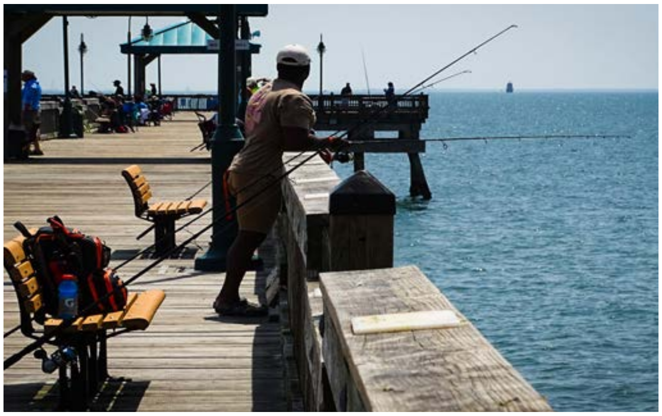
Key Findings

- **Hampton's current urban tree canopy is 32%. City Council has set a goal to increase canopy to 33%. This will require the City to plant 3,580 more trees at a rate of 358 trees annually to reach the goal within 10 years on city-owned lands. Additional voluntary tree planting will also be needed on private properties to archive the goal. This additional canopy will help the city absorb and clean more stormwater and reduce flooding.**

- **Of the city's 170 miles of shoreline, 43 miles are currently hardened; of those, 25 miles have potential to be naturalized thereby protecting properties from erosive wave-action, and improving habitats for people and wildlife.**

- **There are 151 acres of 100-foot wide stream buffers, 87 acres of 100-foot wide tidal water body buffers, and 189 acres of 100-foot wide additional future coastal buffers (after 1.5 ft of sea level rise) that are available for planting trees and vegetation to both buffer against flooding and storms and filter runoff to protect surface waters.**

- **Hampton has 2,656 acres of parkland. Water access within these parks includes 4 fishing piers, 4 beaches, 4 public boat ramps, and 7 kayak launches. However, some of these waterfront recreational amenities are vulnerable to sea level rise. Over the next 20 years, nearly 500 acres of parkland are projected to be inundated or impacted by sea level rise.**

Public beaches and fishing piers such as these at Buckroe Beach are valued waterfront recreation assets.

Existing city goals, programs, policies, and codes were reviewed to guide the strategic planning process. Opportunities for tree planting, habitat restoration, living shorelines, enhancing walkability, and access to parks, trails, and water were mapped and evaluated to determine where new trails, green streets, or other key linkages are needed. The plan's vision, goals, and implementation strategies are summarized below.

Vision for a Green, Healthy, Resilient City

The vision guiding this plan has woven together the three essential components of any successful implementation of a natural infrastructure plan: ***land, water,*** and ***people***

LAND VISION

Hampton's natural and constructed green infrastructure benefits the community through integrated flood mitigation, thriving habitats, and climate resiliency.

WATER VISION

Hampton has restored shoreline habitats, wetlands, and riparian buffers that improve water quality, buffer from storm surge, and adapt to sea level rise.

PEOPLE VISION

Hampton's citizens are informed, engaged, and empowered to create a healthy, equitable, vibrant, and resilient city.

Goals Summary

Implementation strategies were developed from the three vision elements and the goals are summarized here. Detailed actions, responsible parties, timeframes, and costs are included in the implementation section on pages 54-68.

Land Goal 1: Utilize an urban forestry program to manage the City's trees to provide habitat, stormwater infiltration, urban cooling, and recreation.

Strategy 1.1: Hire an urban forester to oversee all tree care, maintenance, and planting on City properties, as well as provide outreach and education to the public.

Strategy 1.2: Participate in the Arbor Day Foundation's Tree City USA program.

Strategy 1.3: Create a plan to achieve a tree canopy cover of 33% over 10 years.

Strategy 1.4: Target tree plantings to increase tree canopy in vulnerable communities and in areas with the highest impact on stormwater retention.

Strategy 1.5: Promote large tree conservation through a heritage tree program developed with community partners.

Strategy 1.6: Promote incentives for tree planting by citizens and businesses.

Land Goal 2: Increase and maintain natural green infrastructure to build climate resilience and support native habitats.

Strategy 2.1: Protect high-quality habitat cores and connect them with green corridors.

Strategy 2.2: Incentivize property owners to use conservation landscaping best practices, including the use of native plants.

S**trategy 2.3:** Create areas of native habitat at parks and schools to reduce mowing and application of herbicides and pesticides to increase habitat and stormwater infiltration.

Strategy 2.4: Revise the City Code, Zoning Ordinance, Landscape Guidelines, and Design Standards to support conservation and use of natural infrastructure.

Strategy 2.5: Protect and restore the habitat of rare, threatened, and endangered (RTE) species to improve the City's Community Rating Scale.

Land Goal 3: Install and maintain constructed green infrastructure to slow and store stormwater where natural infrastructure practices are less suitable.

Strategy 3.1: Use publicly-owned properties as pilot and demonstration sites for constructed green infrastructure.

Strategy 3.2: Retrofit publicly-owned property using constructed green infrastructure to slow and store water and buffer and adapt to rising tides.

Strategy 3.3: Encourage the use of constructed green infrastructure by developers to slow and store stormwater.

Strategy 3.4: Establish a volunteer stewardship program to assist with maintenance of green infrastructure.

Strategy 3.5 Increase City staff and contractors' understanding of how to maintain constructed green infrastructure.

Water Goal 4: Protect and restore natural shorelines and wetland habitats to ensure the longevity of ecosystem services as tides rise and climate changes.

Strategy 4.1: Expand programs to engage private property owners in adapting to inundation from sea level rise and shoreline erosion.

Strategy 4.2: Pilot nature-based solutions on public property as demonstration projects, prioritizing locations that support wetland migration.

Strategy 4.3: Restore vegetated riparian buffers to enhance water quality, prevent erosion, and support wetlands migration.

Water Goal 5: Enhance water quality and provide flood mitigation through natural infrastructure.

Strategy 5.1: Daylight streams and creeks to provide habitat and store water.

Strategy 5.2: Plant buffers along streams, creeks, and ditches to filter and slow stormwater.

Strategy 5.3: Acquire and restore flood-prone and environmentally-sensitive properties to increase the landscape's natural water storage capacity and restore the functionality of natural floodplains.

Strategy 5.4: Establish a pilot program to implement conservation landscaping practices and resilient design strategies on acquired flood-prone properties to maximize community benefits.

For additional details on strategy implementation, see pages 54-68.

People Goal 6: Expand community awareness and understanding of resilience projects through effective marketing and outreach.

Strategy 6.1: Utilize the Resilient Hampton Engagement and Outreach Plan to promote the benefits of natural infrastructure.

Strategy 6.2: Create an online dashboard to map resiliency and sustainability projects across the city.

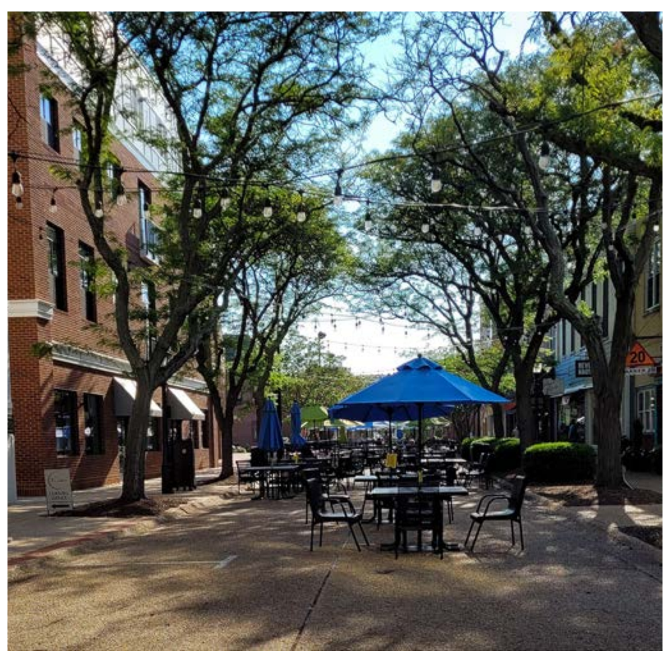
Strategy 6.3: Curate interpretive and educational signage at all public-facing resiliency project sites to educate the public about the function and benefit of resiliency projects.

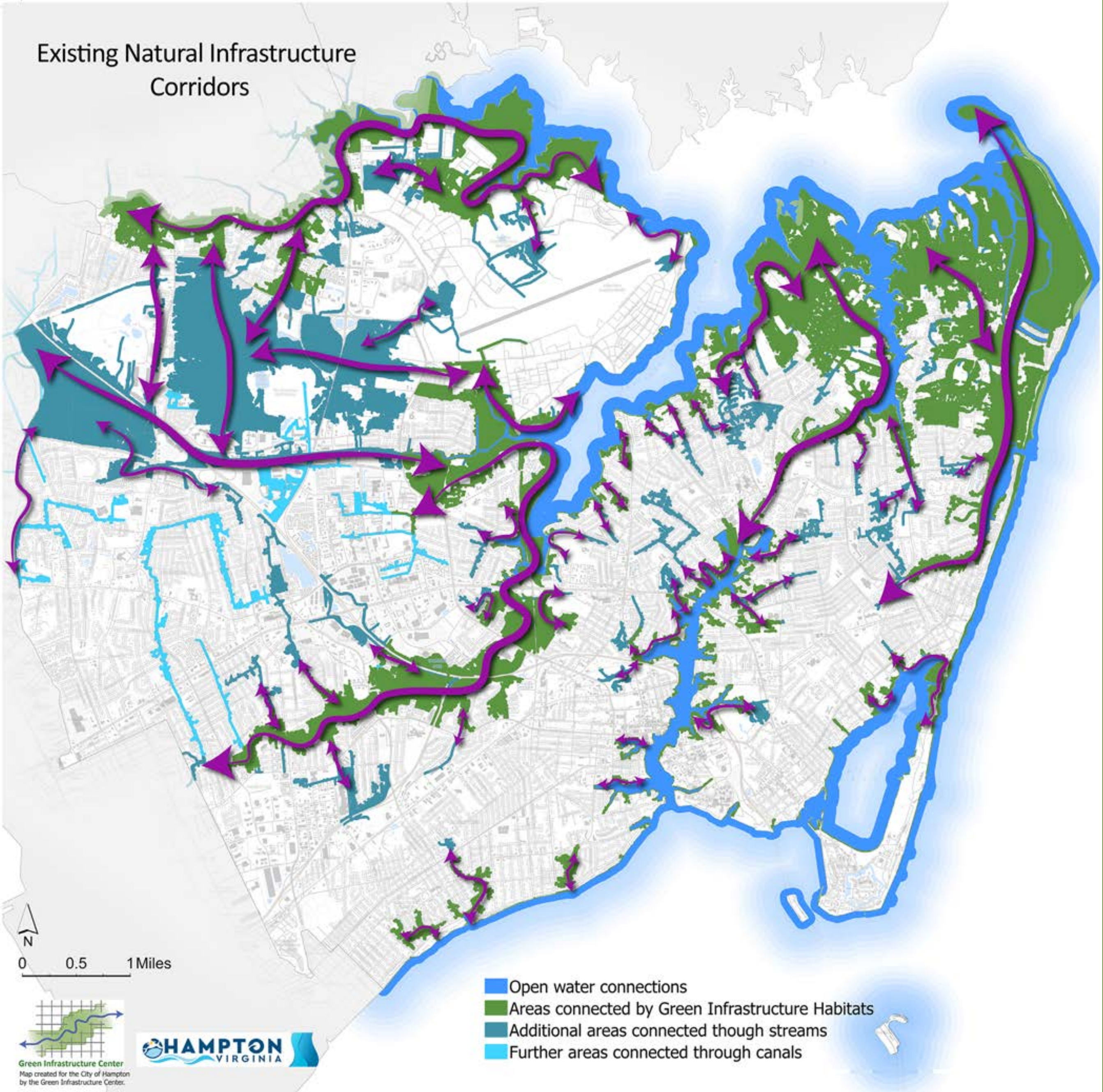
People Goal 7: Support healthy communities through equitable access to green spaces and natural assets.

Strategy 7.1: Utilize such natural infrastructure projects as community gardens and food forests to address food insecurities and food deserts.

Strategy 7.2: Target street greening to soak up stormwater, improve aesthetic values, increase safety, and provide more opportunities for alternative transportation.

Strategy 7.3: Identify opportunities to increase or enhance equitable access to natural assets, with a focus on disadvantaged communities.





Map 1. Existing Natural Infrastructure Corridors

This map depicts Hampton's existing habitat network and connectivity based on natural land and water features. Greater connectivity leads to more resilient ecosystems because species can move, breed, and repopulate areas disturbed by storms. People also benefit because many of these pathways provide trails or scenic vistas that support community well-being.

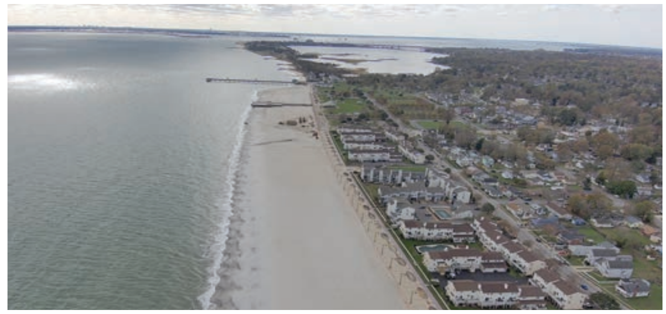
Map 2. Future Connectivity Opportunities

This map shows opportunities for future connections. Some connections are purely for wildlife, birds, or pollinators as they cross private lands, while others increase walkability and wellness opportunities for city residents by adding pedestrian or bicycle pathways.

Introduction & Purpose

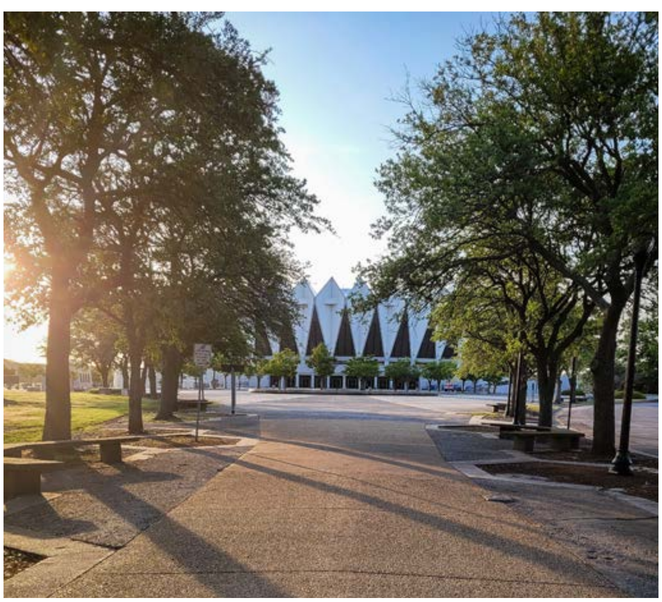
Hampton – Past, Present, and Future

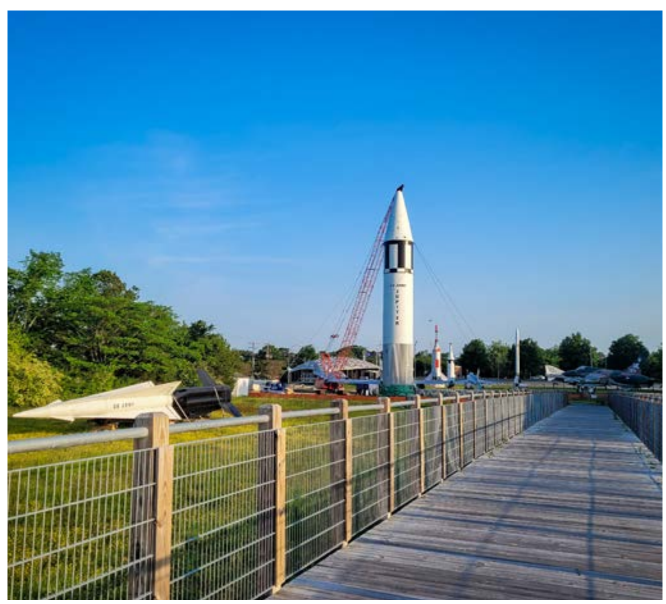
The City of Hampton is a coastal community located in the southeast corner of the Commonwealth of Virginia, at the mouth of the Chesapeake Bay. The first inhabitants of present-day Hampton were Algonquian Native Americans, who established the Kecoughtan settlement in between the Hampton River and Chesapeake Bay. In 1610, English colonists seized this village and established their own town, calling it Hampton. Considered the oldest continuously-occupied English settlement in the United States, the modern history of Hampton traces back to the earliest explorers who came to this country from England. Spanning four centuries, Hampton's history provides a legacy of national and international significance, including pivotal events in the creation and evolution of the country. Hampton has shaped the history of commerce and national defense, slavery and emancipation, free education in America, human exploration and modern space flight.



Buckroe Beach is a sandy ¾ mile beach on the Chesapeake Bay.

The City of Hampton – its people, landscape, and functions – has continually adapted to the circumstances of its location at the very eastern edge of the North American continent. Preparing for the next century requires further adaptation as the City charts a new course of living with the many challenges of a rapidly changing climate - particularly increasing sea levels, coastal storms, and urban heat. By protecting and expanding its natural assets, Hampton can the reduce negative impacts of a changing climate to create a more resilient future for all residents. Implementing the strategies in this plan, along with the current and future policies, projects, and programs of the City's Resilient Hampton Initiative, will support Hampton in its on-going mission to live and thrive with water and adapt to the impacts of climate change.





The popular Waterwalk trail passes by at the Hampton Coliseum (left) and winds along New Market Creek to Air Power Park (right) where an outdoor display of aircraft and spacecraft celebrate Hampton's role in early space exploration and aircraft testing.

Resilience Planning in Hampton

This Natural Infrastructure Resilience Plan is an outgrowth of the Resilient Hampton Initiative. Resilient Hampton focuses on the challenges of recurrent flooding and rising sea levels in the community. In 2015, the “Dutch Dialogues” - a gathering of visionary experts exploring the future of Hampton Roads region in the face of climate change - served as a catalyst for the City of Hampton to pursue building its coastal resilience. Hampton adopted the “living with water” approach, explored during the Dutch Dialogues, as a framework for coastal resilience. Rather than fighting water intrusion, Hampton will create a safe, sustainable future that maximizes the benefits of “living with water.” The living with water approach integrates flood risk mitigation, engineering, spatial planning, urban design, environmental goals, community amenities, and economic development. Instead of figuring out how to "engineer" water away, the city now allows water to be an integral part of the community.

RESILIENT HAMPTON

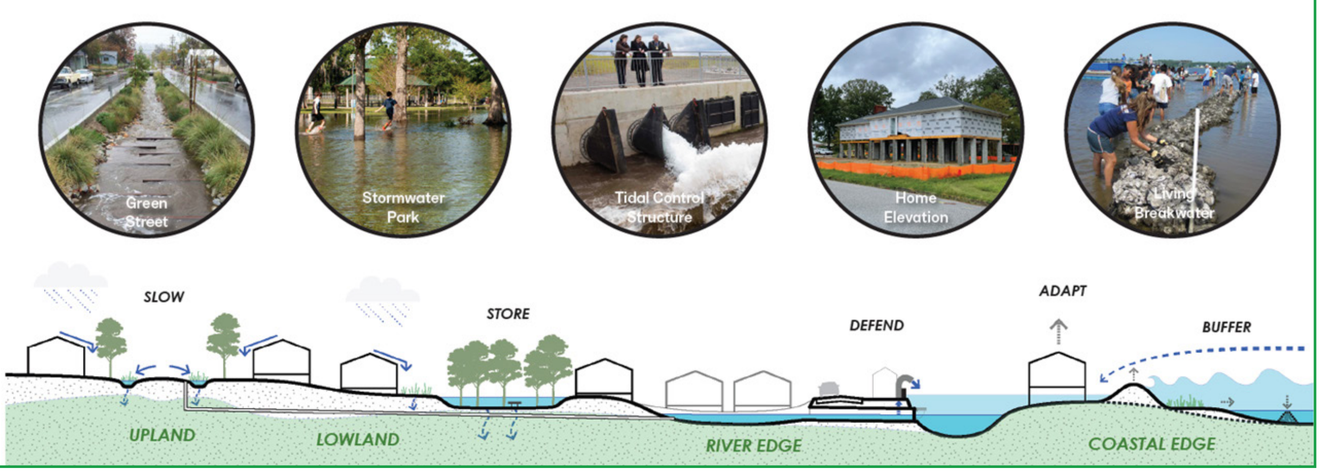
Resilient Hampton embraces an asset- and place- based approach to resilience. The following guiding principles were developed to inform decision making:

- **Create Value-Driven Solutions**
- **Reinforce Assets**
- **Layer Public Benefits**
- **Strengthen Partnerships**
- **Use Good Data**
- **Share Knowledge & Resources**

This Resilient Hampton Initiative has since led efforts to create the citywide Living with Water Hampton Plan in 2017, which serves as Phase I of a multi-year strategy. Phase II of this work is currently underway through the completion of neighborhood-scale and watershed-level community resilience plans and the implementation of projects and programs identified in those plans. The City has completed the Newmarket Creek Pilot Project Area Water Plan (2021) and the Downtown Hampton, Phoebus, and Buckroe Water Plan (2023). The City is moving into its next Water Plan area – Fox Hill, Grandview, and Harris Creek.

The Resilient Hampton Initiative embraces design strategies to promote resilience, such as slowing and storing stormwater, and adapting, defending, and buffering against rising water and storm surges to live safely and sustainably with water. As part of its planning and design strategy, the Resilient Hampton Team engages with the community, empowering community

RESILIENCE DESIGN STRATEGIES

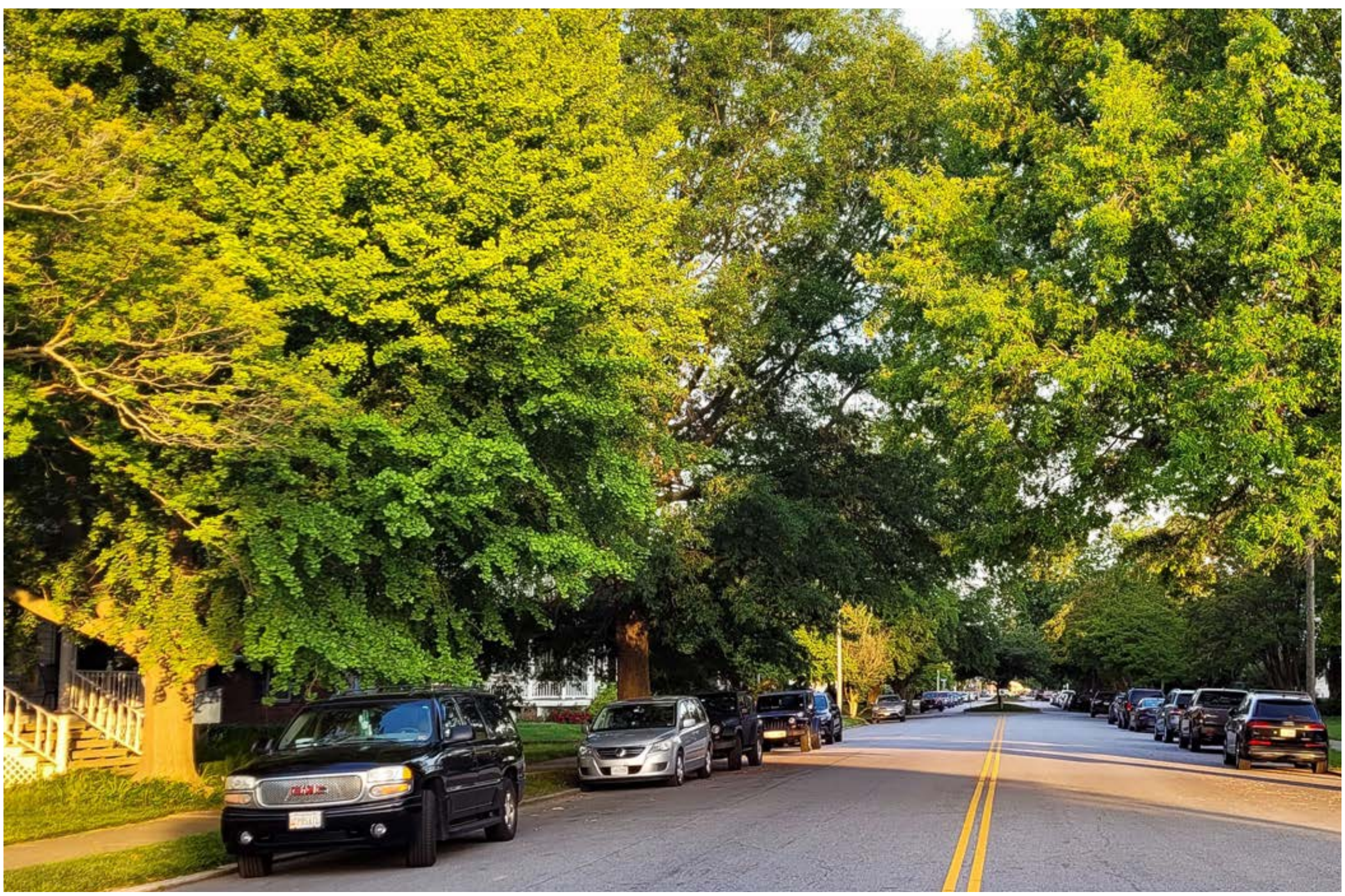


members to implement resilient design strategies in their neighborhoods by taking such actions as rain garden installations, creating living shorelines, and planting trees. In short, utilizing natural infrastructure is a key component of this work.

Natural infrastructure provides multiple benefits and compliments and expands on the work of the Resilient Hampton Initiative. Natural infrastructure can be used to relieve pressure on the stormwater system by creating more infiltrative landscapes to slow and store stormwater. This can be done by planting vegetation, such as trees and shrubs, to absorb and evapotranspire water and increasing infiltration by converting impervious surfaces to pervious. In developed areas where planting trees is less suitable, storage and infiltration can be added through such constructed green infrastructure practices as permeable pavers, green roofs, and cisterns.

Adding back living shorelines is another key "natural infrastructure" strategy. Living (planted, natural) shorelines buffer against storms, while allowing pathways for marsh migration. Another strategy is to unbury (daylight) piped creeks. Known as creek daylighting, resurfacing buried creeks re-expands the floodplains of those creeks to better capture and disperse floodwaters by spreading and slowing water flow to reduce erosion and increase groundwater recharge. Adding back natural sinuosity (meanders) also slows down water flow, and improves habitat, water quality and scenic beauty.

These approaches are examples of using natural infrastructure to increase resilience, since naturalized landscapes can adapt to climate change. This plan increases the use of natural infrastructure to expand the city's resilience opportunities. Implementing this plan will create a healthier, cooler, and more connected and equitable city.



Many Hampton streets have large, old street trees that capture stormwater, provide shaded sidewalks, and add beauty to neighborhoods. It is important to plant the next generation of trees to maintain these benefits as older trees are lost.

Project Background and Purpose

Hampton is surrounded by water, and vulnerable to flooding from rainfall, rising seas, and storm surges. Indeed, the Hampton Roads area is considered the second most threatened landscape in the U.S. to sea level rise impacts because its land is also subsiding. As a result, flooding has already become a major concern for residents and businesses, especially for those communities that lack the resources to adapt to changing conditions or to relocate. These flooding events vary from simple nuisances – flooded yards and street puddles – affecting everyday life, to more severe events that threaten lives, property, and commerce. These severe events often consist of downed trees and power lines, roads blocked with debris, streets turned into fast-flowing streams, and high-water surges that threaten the long-term integrity of buildings, all of which disproportionately impact the city's most vulnerable populations.

Vulnerable communities are even more at risk because of increasing flood insurance rates, repetitive property losses, and lack of safe routes to employment and critical services, such as communications and reliable power. This plan recognizes the challenges of stormwater management created by urbanization, increased impervious cover, and reduced natural infiltration, all of which exacerbate flooding, even during small rain events.

Photo Credit City of Hampton

Sunny day flooded street

Tree at Fort Monroe

The following pages contain new data, models, and strategies to guide the City of Hampton's coastal resilience efforts in the face of increasing flooding and a changing climate. This ***Natural Infrastructure Resilience Plan*** also details specific goals and strategies for using natural infrastructure to decrease community flooding, expand access to green space, reduce pollution, and mitigate urban heat. It has examined both the extent and the connectivity of the city's natural infrastructure network (Map 1, page 10) and evaluated risks to this network from such phenomena as flooding and sea level rise.

A future connectivity map (Map 2, page11) shows where and how to create a more connected and resilient landscape in Hampton. The more the landscape is connected, the more it will be able to cope with extreme events and the more resilient it will be. If species are harmed in one area, interconnections and corridors can help new members of those species reach and repopulate the damaged landscape. Similarly, if trails or access to green spaces for recreation are lost because of sea level rise or repeated storms, providing additional access to other green spaces will allow people new and multiple options to enjoy the outdoors. By planting trees and creating more green infrastructure, such as bioswales, permeable surfaces and green rooftops, and absorbing more rainfall within the soil and vegetation, flooding of stormwater pipes and streets will be reduced. Protecting and restoring natural ("green") infrastructure, especially the planting of trees, can also moderate increasing urban temperatures and significantly lessen urban air pollution and stormwater runoff.

Image at left shows an example city's gray infrastructure, including buildings and roads. Classified high-resolution satellite imagery (*at right*) adds city green infrastructure data layer (trees and other vegetation). The green infrastructure provides cleaner air, water, energy savings and natural beauty. A resilient city must manage both its gray and green infrastructure.

Protecting and expanding the city's natural infrastructure – trees, meadows, streams, ditches, wetlands and shorelines – helps buffer the city from storms, absorbs and reduces standing water and flooding, and supports wildlife and people.

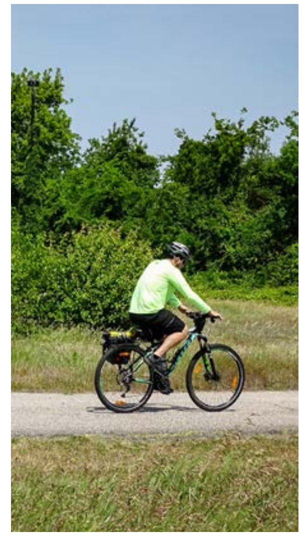
NI contributes to resiliency by helping the city adapt more readily to threats such as pests and diseases, and to other disturbances, and protecting people, wildlife, birds and other creatures from a wide range of impacts. For example, if climate change causes more extreme storm events, better buffering along coastlines may be needed. NI such as living shorelines or forested buffers along rivers can help to lessen impacts from wind and withstand erosion from wave action. They can also provide more protected areas for such wildlife as shore birds, oyster banks and shallow marsh nurseries for fish, shrimp, crabs and amphibians. Peoples' homes and properties are also better protected when buffers are provided.

As the future will likely include hotter days – and more of them – planting shade trees today is a hedge against future heat impacts. A shaded sidewalk can feel up to 12 degrees cooler and trees can protect outdoor workers, as well as people recreating or walking to work, school, home or social places. Tree canopy cover should be robust and include trees of different age spans. Even in well-treed neighborhoods, older trees may fail as they age, and unless new trees are planted today, there will not be shade in the future.

Last, but far from least, stormwater should be absorbed and infiltrated into the ground, to lessen flooding impacts on city streets, businesses and homes. By providing more places to infiltrate water and more trees to soak up that water, the city's landscape can function more like a sponge. As a result, the city has embarked on a watershed planning process to evaluate engineering and restoration needs for four city watersheds – the James River, South Back River, Chesapeake Bay, and Hampton Roads Harbor. This plan and its data will help the city utilize its natural assets to achieve those watershed strategies as well. Adoption of this plan will ensure that the city is utilizing all avenues to create healthier ditches, streams and bays.

Creating a Citywide Natural Infrastructure Plan

To plan for NI, an assessment of the City's landcover was conducted by resource types such as: urban forest, which is made up of the city's trees; waters, including drainage ditches, streams, wetlands, and bays; meadows; dunes; and other natural landcover. The plan also looks at NI by uses, such as parks, pathways and trails; boat launches; community gardens; or other uses of NI that benefit people. Maps created for the plan identify large intact natural areas supporting the city, as well as, additional areas that can be planted with trees, living shorelines, or meadows or connected via trails or green streets to create a resilient, connected, healthy city. These maps were a key component of the planning process undertaken with the City and community.

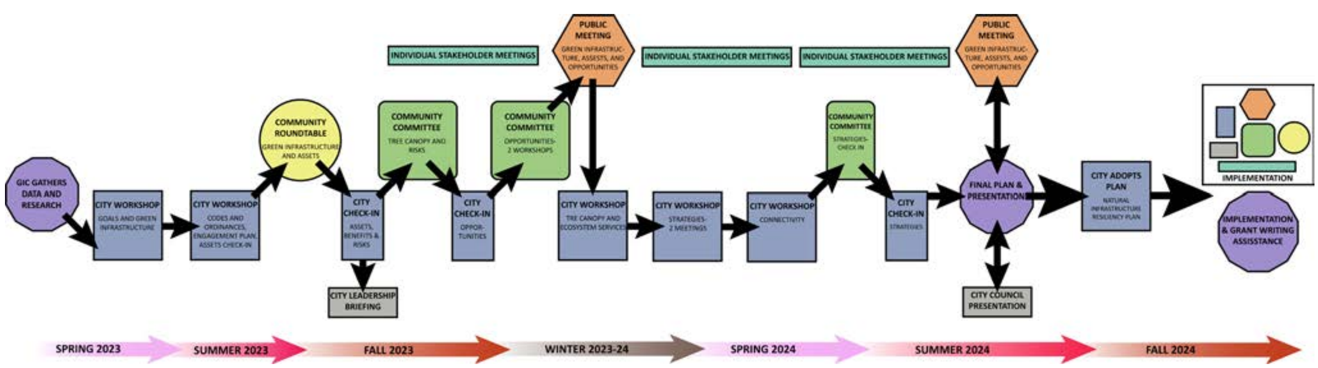


Access to walking and biking trails improves community health.

Planning Process

This plan culminates a two-year planning process undertaken with the City of Hampton. The Hampton Resilience Division and the GIC partnered to lead a City Staff Advisory Committee and Community Steering Committee through a 6-Step Green Infrastructure Planning Process from winter 2023 through spring 2024. During that time, City staff and GIC staff also met individually with stakeholders about efforts to protect and restore natural infrastructure on their properties. In addition, informational posters, surveys, and open houses were provided for the public to learn about the project and offer feedback. In parallel, City leadership was briefed though memos and presentations.

Workplan Diagram



The Resilience Division and the GIC worked with a City Staff Advisory Committee, Community Steering Committee, and the public for two years on the mapping and strategies that inform this plan. This work included 14 workshops, 2 open houses, poster displays in libraries and community centers, online and paper surveys, stakeholder outreach meetings, and presentations to the City Council.

6-Step Green Infrastructure Planning Process

1. Set Your Goals – What does your community value?

2. Review Data – What do we know or need to know, to map identified values?

3. Map Your Community's Ecological and Cultural Assets – Based on the goals established in Step 1 and data from Step 2.

4. Assess Risk – What assets are most at risk and what could be lost, if no action were taken?

5. Rank Assets and Determine Opportunities–Based on those assets and risks you have identified, which ones should be restored or improved?

6. Implement Opportunities – Include natural asset maps in both daily and long-range planning (park planning, comp plans, zoning, tourism, and economic development, etc.)

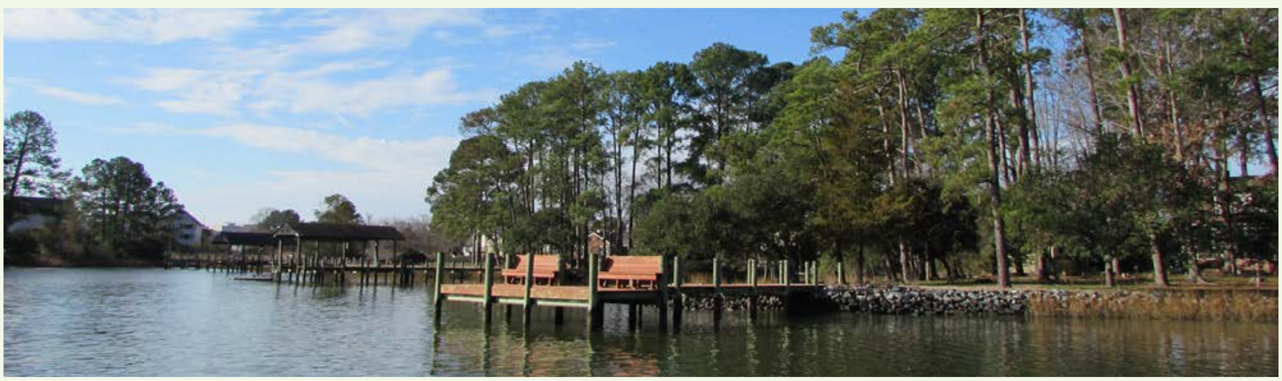


photo credit City of Hampton

The GIC worked with the City to understand its goals and to create and compile necessary GIS data. To map and evaluate the city's natural infrastructure, the GIC created a landcover map using imagery from the National Aerial Imagery Project (NAIP). This NAIP imagery is updated using aircraft surveys every 2-4 years by the US Department of Agriculture during the growing season when vegetation is most easily identified. These data include infrared bands (reflected light) that can be classified to determine land cover types, trees, shrubs, grass, bare soil, and impervious surfaces. This land cover classification was used to determine the city's tree canopy, distinguish pervious and impervious surfaces, and to identify other features.

Maps beginning on page 23 show the results of this analysis and the current natural infrastructure network map. Once the natural infrastructure network was mapped, themed overlays were created on this network that documented those recreation, culture and water assets supported by natural infrastructure (see maps in Appendix B). Next, risk assessment maps were created to illustrate the risks that flooding, storms, sea level rise, development and pollution pose to the natural infrastructure in Hampton (see maps in Appendix B).

Following the risk assessment, opportunities were identified for restoring natural infrastructure using such strategies as tree planting to mitigate heat and soak up the most stormwater, naturalize shoreline buffers, and planting other native landscapes to filter pollution and provide habitat (see maps pages 23-52). These maps aided strategy discussions with the Community Steering Committee and City Staff Advisory Committee.

City Staff Advisory Committee

The City Staff Advisory Committee, led by staff from the Resilience Division, was comprised of representatives from the Community Development Department, Public Works Engineering, Parks, Recreation, and Leisure Services (PRLS), the Clean City Commission, Information Technology – GIS, and the City Attorney's Office. Committee members attended workshops and check-ins throughout the planning process and assisted with roundtables, Community Steering Committee meetings, and public open houses. It reviewed the maps and data, community input, and City goals and worked on strategies to restore and protect natural infrastructure and plan for future connectivity in Hampton.

Community Steering Committee

A Community Steering Committee composed of Hampton citizens, non-profit partners, and institutional representatives met throughout Fall of 2023 and Spring of 2024 to guide and advise the project team on identifying strategies to protect and enhance natural infrastructure. In addition to Hampton citizens, this Committee included representatives from Wetlands Watch, the Chesapeake Bay Foundation, Hampton City Schools, Master Gardeners, Tree Stewards, Virginia Cooperative Extension, Fort Monroe Authority, Hampton University, and Old Dominion University.

The Community Steering Committee worked collaboratively to identify opportunities to expand and protect NI in Hampton.

Key Stakeholders

The Resilience Division and GIC met with key partners and stakeholders to discuss how they were currently protecting and restoring natural infrastructure and recommendations for a more resilient city. Hampton includes several large landholder institutions committed to working with the city on resilience and natural infrastructure- Fort Monroe Authority, National Park Service, Hampton University, NASA Langley Research Center, and Joint Base Langley-Eustis – Langley. Read more about efforts undertaken by these stakeholders in the Implementation section starting on page 69.

Public Engagement

Community input and feedback are foundational to Resilient Hampton's planning approach. In addition to the planning work undertaken with the City Staff Advisory Committee and Community Steering Committee, this planning process included opportunities for public learning, engagement, and feedback. In January 2024, informational posters and surveys were placed in the four branches of the Hampton Library – Main, Willow Oaks, Phoebus, and North Hampton. These informational stations provided the community an alternative, low-tech way for residents to engage in the planning process.

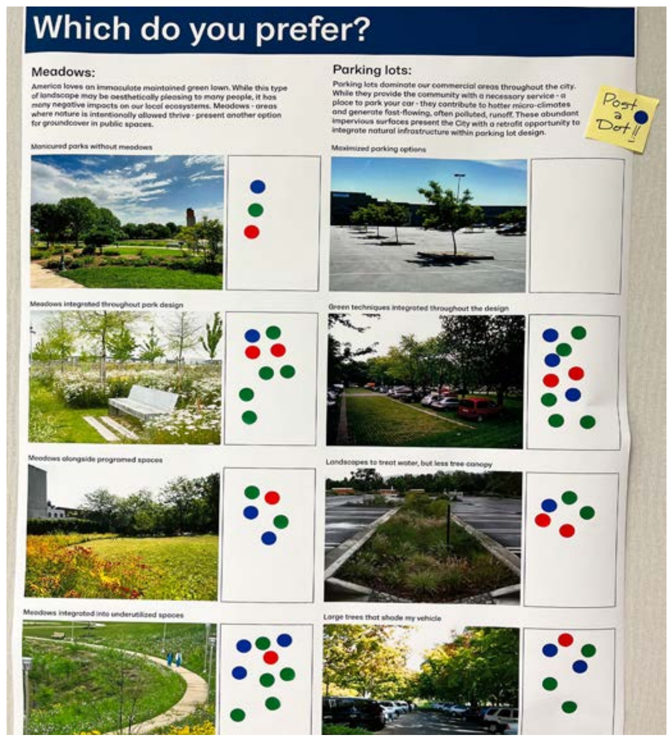
A February 2024 open house included a presentation introducing the project and comment stations for topics of natural assets, flooding locations, visual preferences, and perceived barriers to tree planting. Opportunities to comment were open through the end of the Spring. The final open house held in May 2024 was a drop-in event with several opportunities for feedback and discussion with City and GIC staff.

In addition to the in-person engagement opportunities outlined above, the Resilience Division utilized the City's social media platforms and e-newsletters – including the Resilient Hampton Newsletter – to share educational information and digital surveys to provide feedback to the project team. Information was also shared with existing neighborhood networks through the Hampton Neighborhood Commission.

Following is a summary of community input, and a full suite of comments can be found in Appendix D.

Summary of Community Findings

More than 100 people commented through two public meetings, an online survey, and paper surveys at libraries and community centers. Feedback from each of the 10 neighborhood districts was received, with the strongest showing from the neighborhood districts of Greater Wythe and Fox Hill. Input indicates that Hampton residents value natural areas both for human and wildlife use, want more shaded walkable streets and desire greater access to nature trails. A summary of key questions and examples of answers are found on the following page.



The public open houses included a mix of information sharing, discussion, and opportunities for feedback.

Survey Questions and Most Frequent Answers

Which of these assets do you want to see more of in your community?

1. Native habitat for birds and pollinators
2. Walkable streets shaded by trees
3. Nature trails

What are the places you and your family want to be able to walk to?

1. Neighborhood parks
2. Nature trails
3. Commercial districts

Favorite natural assets identified in the community survey

- **Grundland Creek and the surrounding marsh is a beautiful, living wetland.** It's full of ospreys, bald eagles, herons, deer, foxes, raccoons, woodpeckers, and the occasional coyote. Plus, all the marsh plants, crabs, snails, and oysters. It is essentially undeveloped and I hope it stays that way. It gives you a glimpse of what this whole area must have looked like before it was settled, like a little Garden of Eden.
- **The Matteson trail.** Perfect mix of sun and shade and perfect distance with the flexibility of taking a 3-mile trail and making it into 2, 6 or 9 miles, etc.
- **The beginning of the Waterwalk Trail by the Space Park is wondrously beautiful**. On a foggy, frosty morning, there can't be a prettier place in Hampton than the river and marshes there. I love to walk there and watch it change through the seasons. Plus, the wooden walkway is much easier on my joints than pavement. Thank you for building that!
- **Sandy Bottom**. We love the playground, trees, nature trails, and lakes. It is the closest and most accessible natural area near us.

Flooding locations identified in the community survey

- **Little Back River and Fox Hill Rd** The streets tend to flood in the areas surrounding my neighborhood on both sides. If you're patient and wait, the water recedes relatively quickly after a storm passes, but can be difficult for emergency vehicles or those who don't have the option to stay home. Flooding in my neighborhood is worse than it was when I moved in 12 years ago.
- **5th Street at Long Creek**. It is often impassable due to sunny day flooding, and predictably underwater anytime there is a storm, especially with strong east winds and/or at high tide.

More than 100 people commented through two public meetings, an online survey, and paper surveys at libraries and community centers.

Sandy Bottom Nature Park is a 456-acre environmental education and wildlife facility. There is a nature center, lakes, trails, and a playground.

Natural Infrastructure Mapping

Natural Infrastructure Network

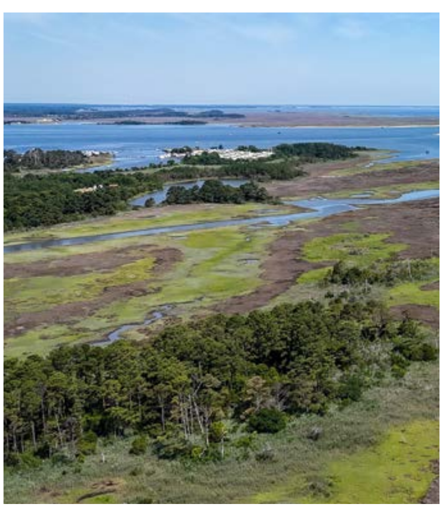
Landcover data were created by classifying National Agricultural Imagery Project (NAIP) 2023 aerial imagery of Hampton into nine land cover classes (types). Natural features analyzed included bays, wetlands, tree canopy, dunes, etc. This was the first step in mapping the city's natural infrastructure. (For details on this process see Appendix C.) Knowing the types of land cover, including impervious surfaces such as: roads, buildings, and parking lots, or pervious; such as trees, grass, or water, allows for analysis of their location and abundance. For example, how much tree canopy does the city have and where is it located? Where is it lacking?

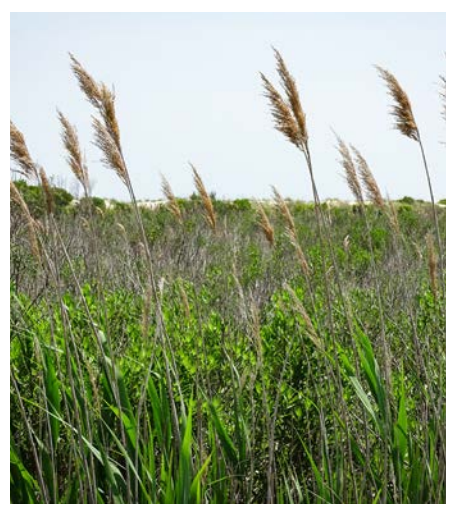
Significant areas of intact vegetation comprising a minimum of 100 acres of habitat are called habitat cores. These habitat cores are large enough to support a multitude of native species. They are surrounded by edge habitat where some impacts may occur, such as from invasive species or disturbance by housing developments.

Habitat corridors and smaller patches of habitat link these cores into a connected network and allow species to migrate. Corridors provide pathways for animals, pollinators, and people to move across the landscape. Connected landscapes are more resilient because it is easier for species to reach and repopulate habitats following a disturbance such as a hurricane or nor'easter. This project identified key Natural Infrastructure Corridors that help form the habitat network (see Natural Infrastructure Corridors Map, page 23). These corridors represent potential wildlife movement based on connectivity provided by water and the natural infrastructure network. Those corridors that traverse public lands can also be used by people.

Natural landcover was divided into four classes, with core habitats serving as the largest areas of unfragmented habitat, devolving to smaller areas such as habitat patches and fragments (see Natural Infrastructure Network Map page 24). Of the 10,130 acres of natural infrastructure (trees, and other vegetation, water, and wetlands) within Hampton, about 41% is protected. Areas large and intact enough to constitute a core habitat encompass 2,329 acres, of which 61% are protected in some way. Protecting the remaining core habitat and habitat patch acreage, as well as restoring connectivity to these features by creating new corridors will benefit wildlife, community health, and resilience since connected landscapes allow displaced species to reach and repopulate areas affected by disturbance more easily.

Photo by City of Hampton



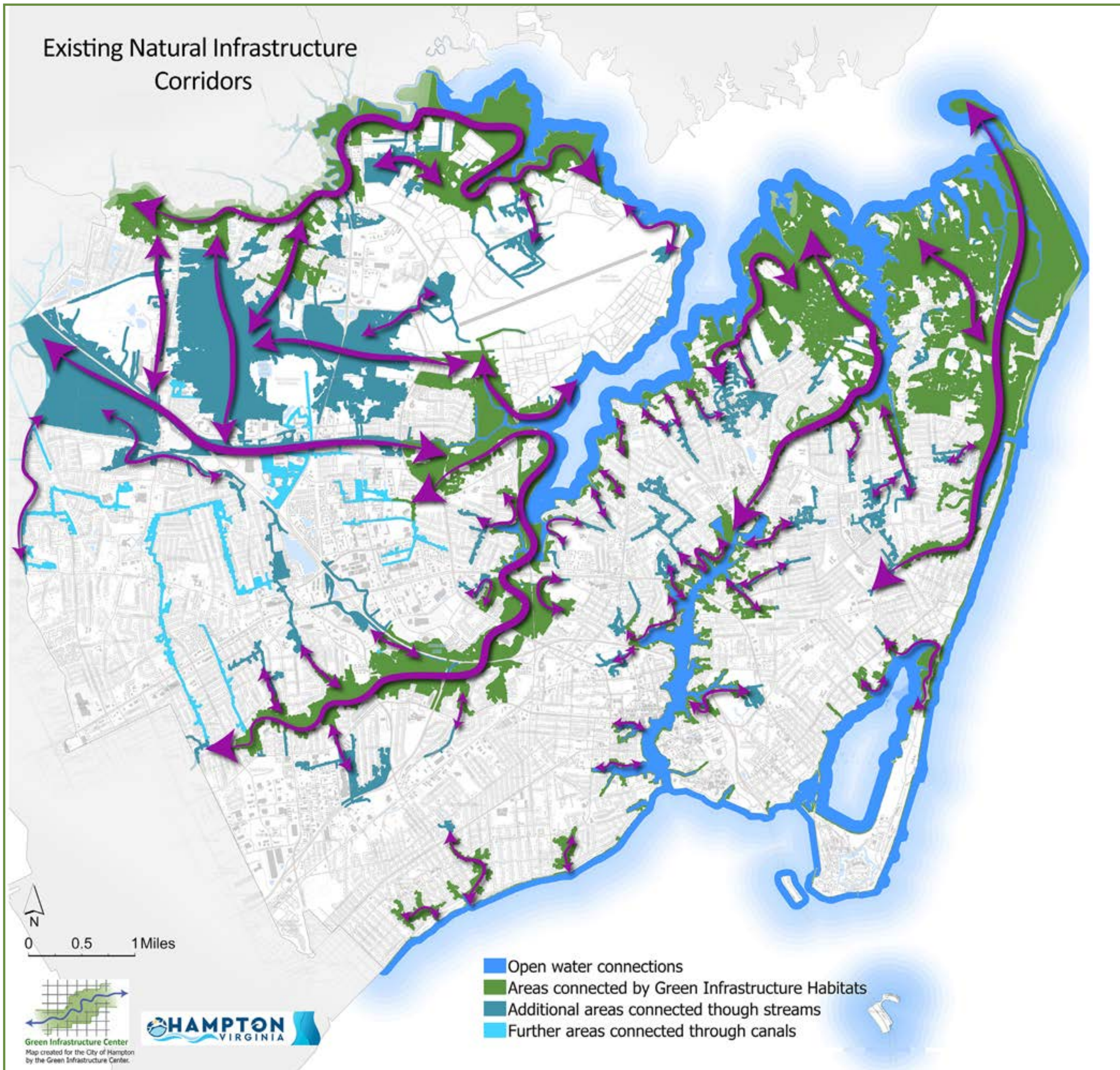


Grandview Nature Preserve is more than 475-acres of core habitat of salt marsh, tidal creek, sand dunes and beachfront.

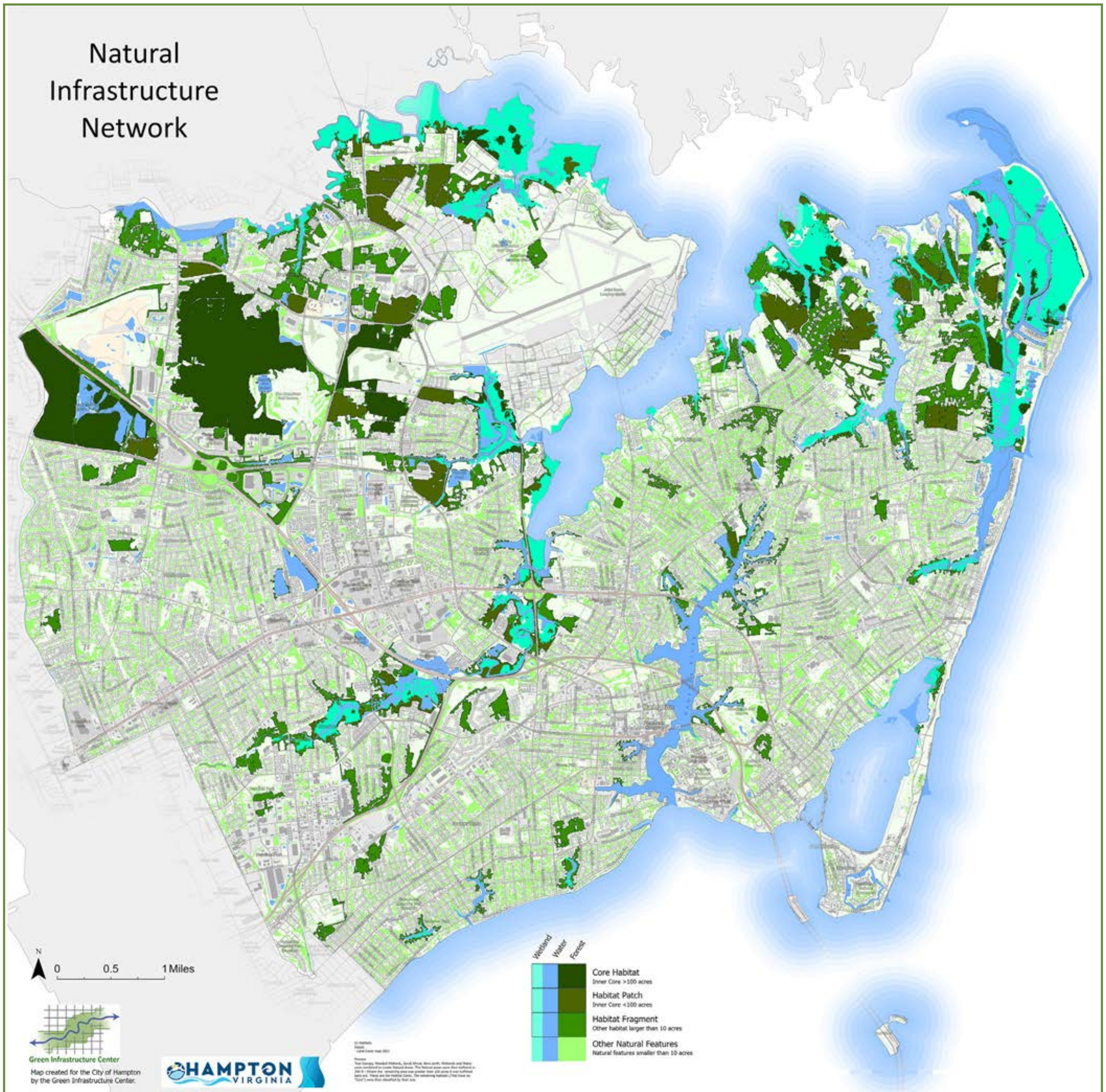
The city can use these maps of natural infrastructure features and connectivity corridors to determine key landscapes to protect or restore and to guide planning decisions, such as where to locate future trails, portions of parcels that should remain as open space, or places to add more natural infrastructure, such a living shorelines and wetland restoration.

Natural Infrastructure Network Features	Total Acres	Percentage Protected*
Core Habitat	2,329	61%
Habitat Patch	1,392	48%
Habitat Fragment	2,718	48%
Other Natural Features	3,690	20%
TOTAL NI Features	10,130	41%

*Protections include city parks, federal parks, Chesapeake Bay Preservation Act Resource Protection Areas.



Map 1. Wildlife move through the natural infrastructure network along habitat corridors.



Map 3. Natural Infrastructure Network

This Natural Infrastructure Network map includes large intact habitat cores in Grandview Nature Preserve and Sandy Bottom Nature Park, smaller habitat patches, and urban street trees.

Tree Canopy Analysis

Trees comprise a significant portion of Hampton's natural infrastructure. They provide many social benefits from beautifying neighborhoods and increasing home values to reducing stress, but these trees also serve a role as "natural infrastructure" by capturing and cleansing stormwater, providing shade, and cooling the city, reducing air pollution, and creating connected walkable streets, trails, and parks. Each year, many trees are lost to development, old age, disease, pests, and storms, among other reasons. With these losses, the benefits and services trees provide are also lost.

The current tree canopy in the city is 32%. The City has set a goal to increase its tree canopy by 1%, to reach 33% in the next 10 years. This will require the City to focus on protecting existing trees and to plant at least 358 new trees per year over the next 10 years. The City's planting goal assumes 20% of the land is City-owned and still requires significant private sector tree planting on the remaining 80% of the land, which is privately owned. The City is working with stakeholders (see stakeholder section pages 69-77) to meet planting goals. Further analysis of the tree canopy and natural infrastructure, as well as approaches to using these maps and data to create cleaner, more infiltrative, cooler, more equitable, adaptive, and connective landscapes are discussed in the following sections.

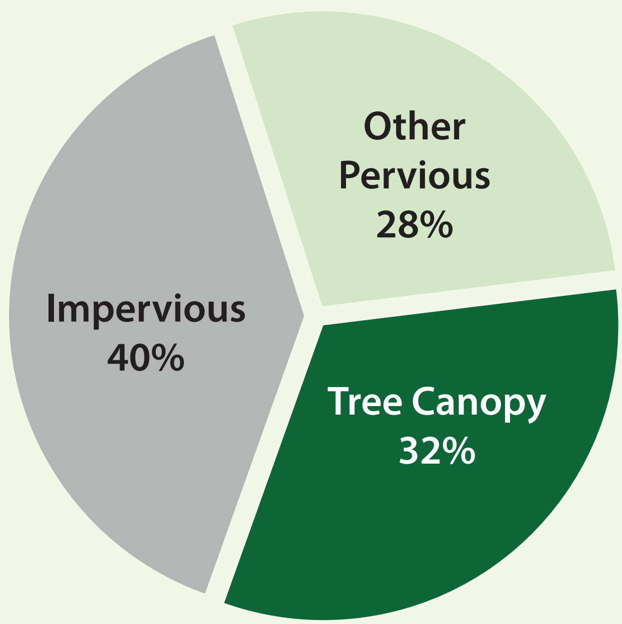
Hampton Citywide Tree Canopy Snapshot

32%	Tree Canopy Coverage Percent
9,005	Acres Tree Canopy Coverage
7%	Potential Planting Area (PPA) Percent
1,905	Acres of Potential Planting Area (PPA)
44%	Potential Tree Canopy

There is space to plant:

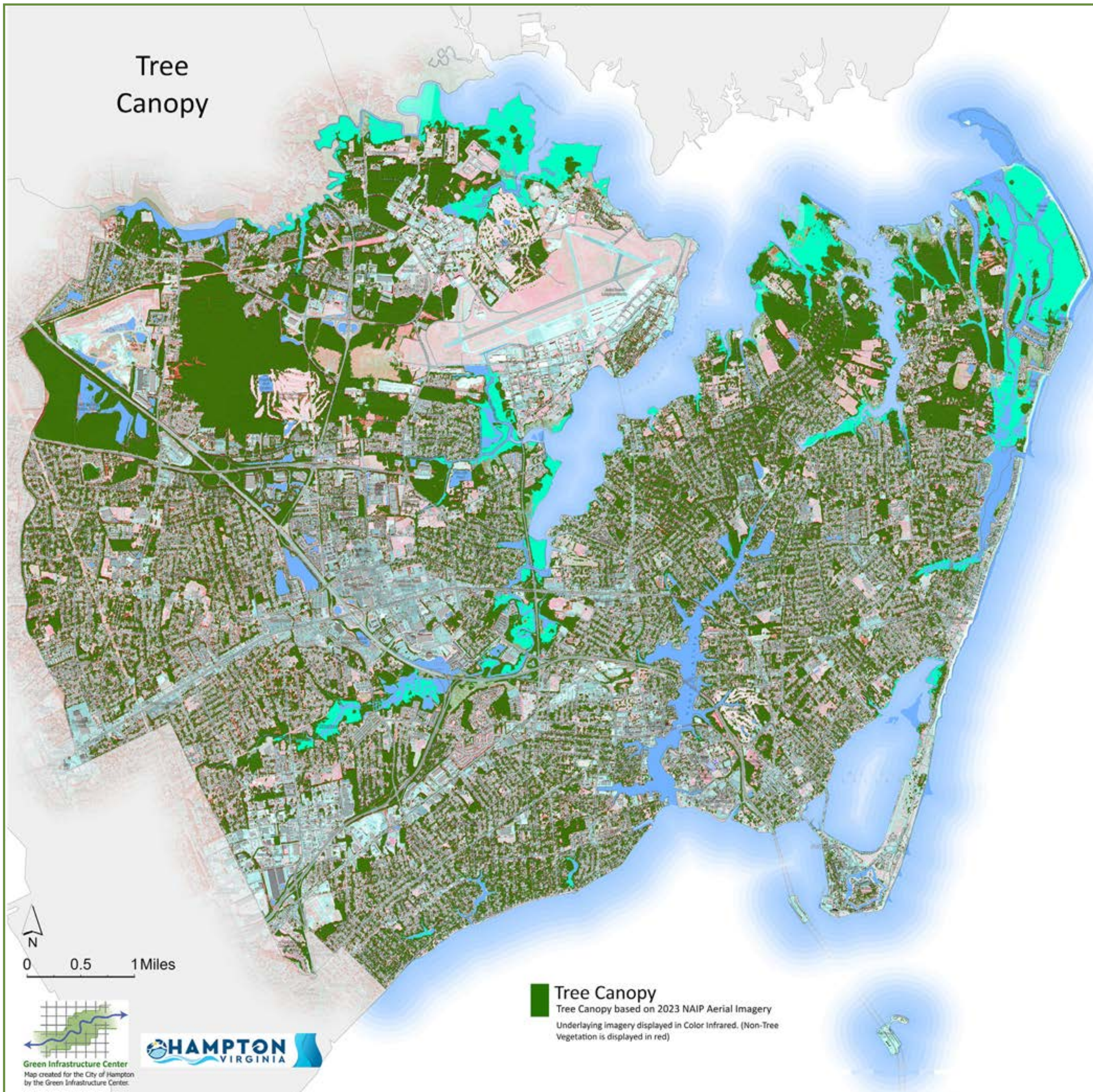
- 72,715 Small trees
- 82,159 Large trees
- 154,874 TOTAL TREES

Hampton Tree Canopy



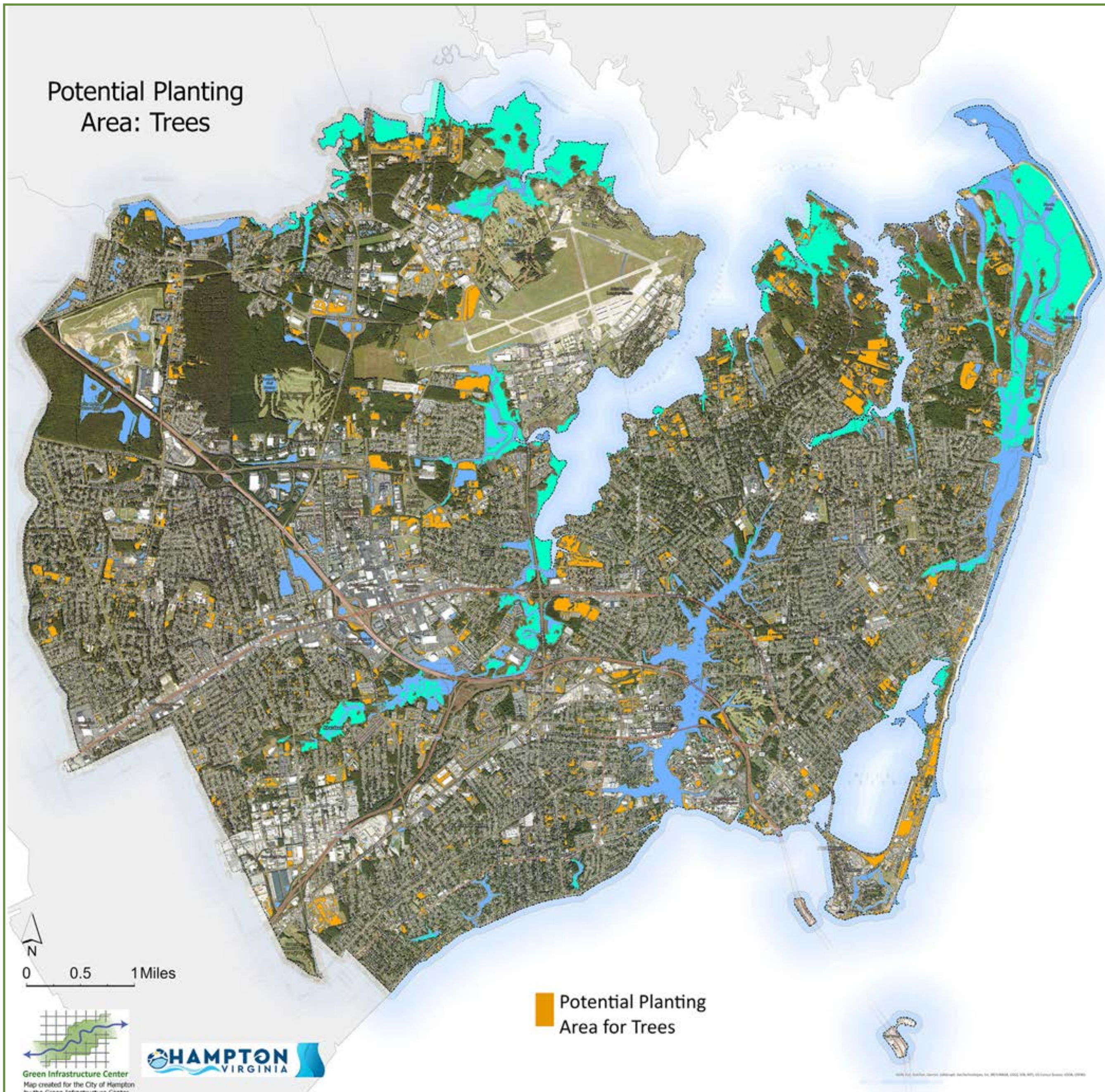
Citywide forest cover is 32%.

Other pervious landcover includes turf, bare earth, and scrub-shrub.



Map 4. Tree Canopy

The existing tree canopy in Hampton comprises 32% of the city's land cover.



Map 5. Potential Planting Area for Trees

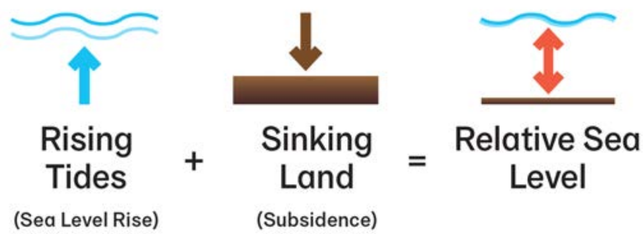
The potential planting area (PPA) for trees in Hampton is 1,905 acres or 7% of the city's land cover. These potential planting areas are on city, federal, and private land. The City has set a goal of increasing tree canopy by 1% over 10 years. It will take all landowners working together to reach this goal.

Risks to Natural Infrastructure

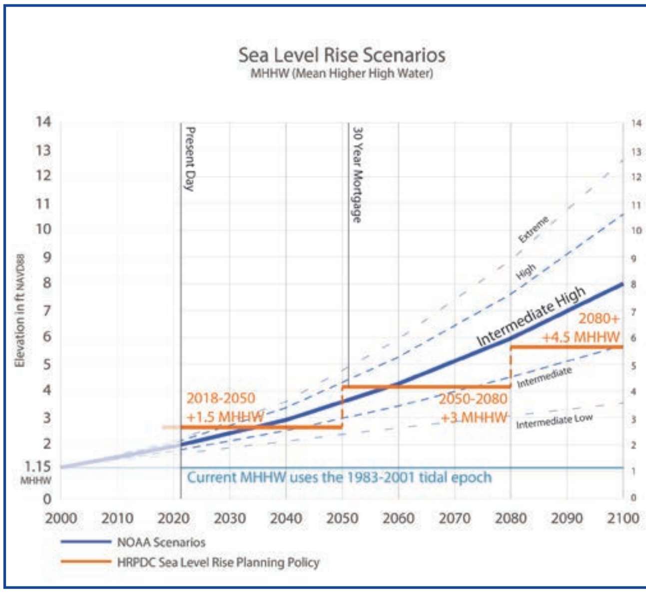
Natural Infrastructure in Hampton is facing multiple risks. These risks include sea level rise, storms, tidal and stormwater flooding, development pressures, and pollution.

Sea Level Rise

With climate change, sea levels are projected to rise in the ocean, bay, and rivers surrounding Hampton. Relative sea level rise in the region is expected to be one of the highest rates in the country due to the impacts of subsidence and rising tides. As we plan for the protection and restoration of natural infrastructure, it is important to consider the future impact of sea level rise. The planning horizon chosen for this plan is to the year 2040, to coincide with Hampton's 2040 Community Plan.



The sea level rise planning scenario chosen for evaluating risks and determining opportunities in this plan is 1.5 ft of sea level rise above the current MHHW (Mean Higher High Water, the average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch). This is the planning recommendation for near-term decisions (2018-2050) adopted by the Hampton Roads Planning District Commission and the City of Hampton. This recommendation is based on the Virginia Institute of Marine Science (VIMS) modeling and National Oceanic and Atmospheric Administration's (NOAA) 2017 intermediate high curve for projected sea level change at Sewell's Point, Virginia (see graphic above, right). Using 1.5 ft of sea level rise, potential tree planting areas that would be inundated in this scenario were eliminated from the plan. Instead, living shorelines or salt-tolerant native plantings are recommended in these landscapes (see Sea Level Rise Risk Map Appendix B).



Impacts to Hampton from 1.5' of Sea Level Rise (SLR)

"Impacted" means inundated by 1.5' of sea level rise (SLR) or disconnected low-lying areas likely to pond and remain wet.

- **39 miles of hardened shoreline**
- **508 acres or 19% of park land**
- **311 acres of city-wide tree canopy**
- **1,087 acres of wetland**
- **68 acres of pervious open space**

Photo by City of Hampton

Storms

Storms are increasing in frequency and intensity with climate change. Tree canopy is the Natural Infrastructure at the highest risk of storm damage in Hampton and the Storm Risk Map (Appendix B) depicts risks to the tree canopy based on the NOAA Maximum envelope for high water for a Category 3 Hurricane. During a Category 3 Hurricane, all tree canopy in the city is at risk from high winds, and 83% of the tree canopy is at risk from storm surge. High winds and flooding can cause tree damage, tree failure, and drive saltwater intrusion. As the City protects and restores natural infrastructure, the city also can undertake storm planning for the urban forest to protect it from storms. Tree risk assessment and proactive tree care can reduce storm damage, as well as City liability risk.

Tree assessments and proactive care reduce future storm-related damage to trees.

Flooding

Community flooding has been increasing with rising tides, rising sea levels, and increased storm frequency and intensity. Limiting impervious surfaces and maintaining or restoring NI improves floodplain function and capacity and protects upland areas from flooding.

The existing tree canopy in the mapped floodplain (see Flood Risk Map Appendix B) is providing flood mitigation benefits, while existing pervious surfaces offer opportunities for additional tree or shrub planting to filter pollutants and soak up stormwater. Removing any excess impervious surfaces and daylighting streams (returning them to the surface) can further restore floodplain functions.

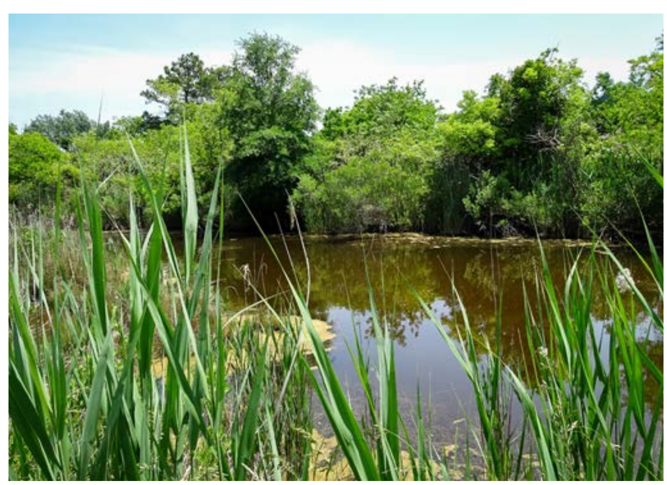
City Land Cover Within FEMA's Special Flood Hazard Areas:

100-year floodplain (7,949 acres)

- 39% tree canopy coverage.
- 29% impervious surface coverage.
- 32% other pervious coverage.

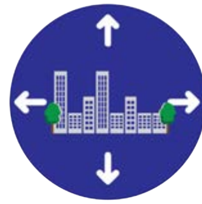
In the 500-year floodplain (3,174 acres)

- 29% tree canopy coverage.
- 43% impervious surface coverage.
- 28% other pervious coverage.



Polluted Runoff and Impaired Land

Dense development patterns concentrate paved surfaces and lead to polluted runoff, while past land uses such as gas stations or chemical storage, can leave a legacy of impaired lands. Hampton, with its past and present industrial and military land uses, is no exception. There are brownfield sites throughout the city, as well as impaired streams, rivers, and estuaries (see Impaired Land and Water Map Appendix B). Pollution impacts the health of people, ecosystems, and wildlife. While pollution poses risks to NI, protecting, and restoring NI is a key strategy for reducing pollution. Additionally, new NI can also be strategically planted to mitigate some of the impacts of this pollution. Tree roots and many types of plants can capture and break down pollutants.



Development Pressures

One of the biggest threats to loss of NI in the urban environment is from development (see Development Risk Map Appendix B). Hampton must balance the economic benefits of development with the loss of ecosystem services when this natural infrastructure is removed. As part of this project, GIC reviewed the City's development codes and suggested modifications and practices for working with developers to protect more NI on development sites. Protecting NI through new parkland or conservation easements is also an effective means of limiting the loss of NI to development.

photo credit City of Hampton

Natural Infrastructure Opportunities

With an understanding of the extent and condition of existing Natural Infrastructure (NI) and an assessment of the risks to this NI, an analysis of opportunities was conducted based on 6 landscape typologies that support important ecosystem services in a changing climate:

- Infiltrative landscapes to capture stormwater
- Cleansing landscapes to filter pollution
- Cooling landscapes to mitigate urban heat
- Equitable landscapes to address unequal distribution of natural infrastructure
- Adaptive landscapes to increase resilience to rising tides, storm surges and seas
- Connective landscapes to increase wildlife movement, human access and system resilience

The following sections detail these opportunities and the maps created for each typology.

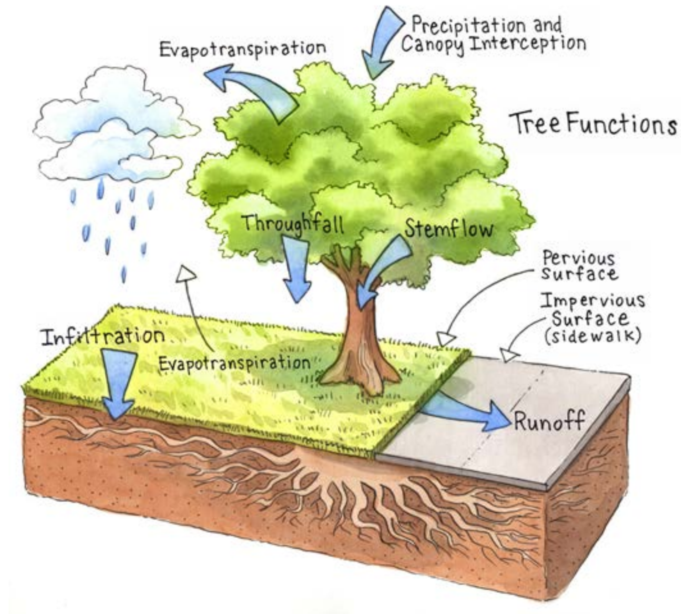
Infiltrative and Cleansing Landscapes

Stormwater

Trees provide natural flood mitigation and stormwater filtration at a fraction of the cost of engineered systems. As forested land is converted to impervious surfaces, runoff increases. Excess stormwater runoff can cause temperature spikes in receiving waters, increased pollution of surface and ground waters, and greater potential for flooding. Trees also reduce nitrogen, phosphorus, and sediment runoff by cleaning rainfall and stormwater of these pollutants. Increased loads of nutrients can reduce oxygen in surface water, causing harm to fish and other aquatic life.

A robust tree canopy reduces the amount of pollutants that reach drainage ditches, streams, rivers, and the bay. The average annual precipitation in Hampton is 47 inches, much of which becomes stormwater, carrying pollutants from the land into surface water.

Large, paved areas contribute significant volumes of this runoff. During a one-inch rainfall event, a one-acre paved area, such as a mall parking lot, will release 27,000 gallons of runoff compared to an acre of forest, where only 750 gallons of water run off. While stormwater ponds and other traditional best management practices (BMPs) are designed to mimic rainfall release by detaining and filtering runoff, they do not fully replicate pre-development hydrology. The greatest number of community benefits are achieved when traditional BMPs are partnered with nature-based solutions. Both practices are needed to create a resilient city.



In addition, older parts of Hampton were developed prior to current stormwater regulations and thus lack stormwater management practices that are required for new developments. This is why not all runoff is captured or treated before it flows to open waterways. Since trees filter stormwater and reduce overall flows, planting or conserving trees is a natural way to mitigate stormwater, especially in areas that lack engineered systems. Thus, each tree plays an important role in stormwater management.

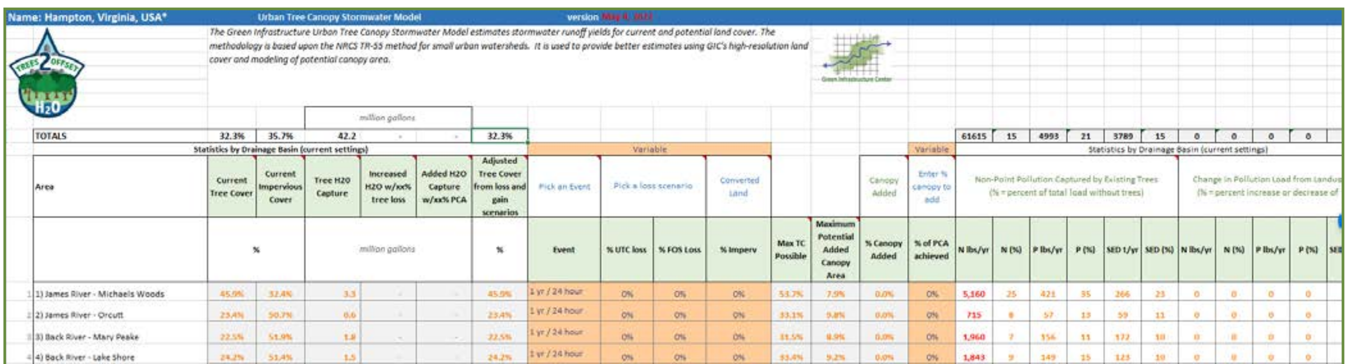
Based on the GIC's review of multiple studies of tree canopy rainfall interception, a typical street tree's crown can intercept between 760 gallons to 4,000 gallons of water per tree per year, depending on its species and age. During a 1-year/24-hour rainfall event (2.94 inches) in Hampton, the trees take up 42.2 million gallons of runoff, or about 64 Olympic swimming pools of water.

In Hampton, during a one year/24-hour rainfall event (2.94 inches) the trees take up **42.2 million gallons of runoff**, or about

64 Olympic size swimming pools worth of water!

The best land cover for capturing stormwater is the urban forest. The GIC evaluated stormwater runoff and uptake by the city's tree canopy using GIC's Trees and Stormwater Calculator (TSW) Tool. The TSW tool estimates the capture of precipitation by tree canopies and the resulting reductions in runoff yield. It considers the interaction of land cover and soil hydrologic conditions. It can also be used to run 'what-if' scenarios, specifically losses of tree canopy from development or storms and resultant added stormwater runoff or increases in stormwater capture from adding more tree canopy. Trees intercept, take up and slow the rate of stormwater runoff. Canopy interception varies from 100 percent at the beginning of a rainfall event to about three percent at maximum rain intensity. Trees take up more water early on during storm events and less water as storm events proceed and the ground becomes saturated (Xiao et al., 2000). Many forestry scientists, as well as civil engineers, recognize that trees have important stormwater benefits (Kuehler 2017, 2016).

The Trees and Stormwater Maps (pages 33 and 34) analyze tree canopy and underlying soils to determine the best locations for protecting existing trees and planting new trees to capture stormwater.



Name: Hampton, Virginia, USA*　　Urban Tree Canopy Stormwater Model　　version

The Green Infrastructure Urban Tree Canopy Stormwater Model estimates stormwater runoff yields for current and potential land cover. The methodology is based upon the NRCS TR-55 method for small urban watersheds. It is used to provide better estimates using GIC's high-resolution land cover and modeling of potential canopy area.

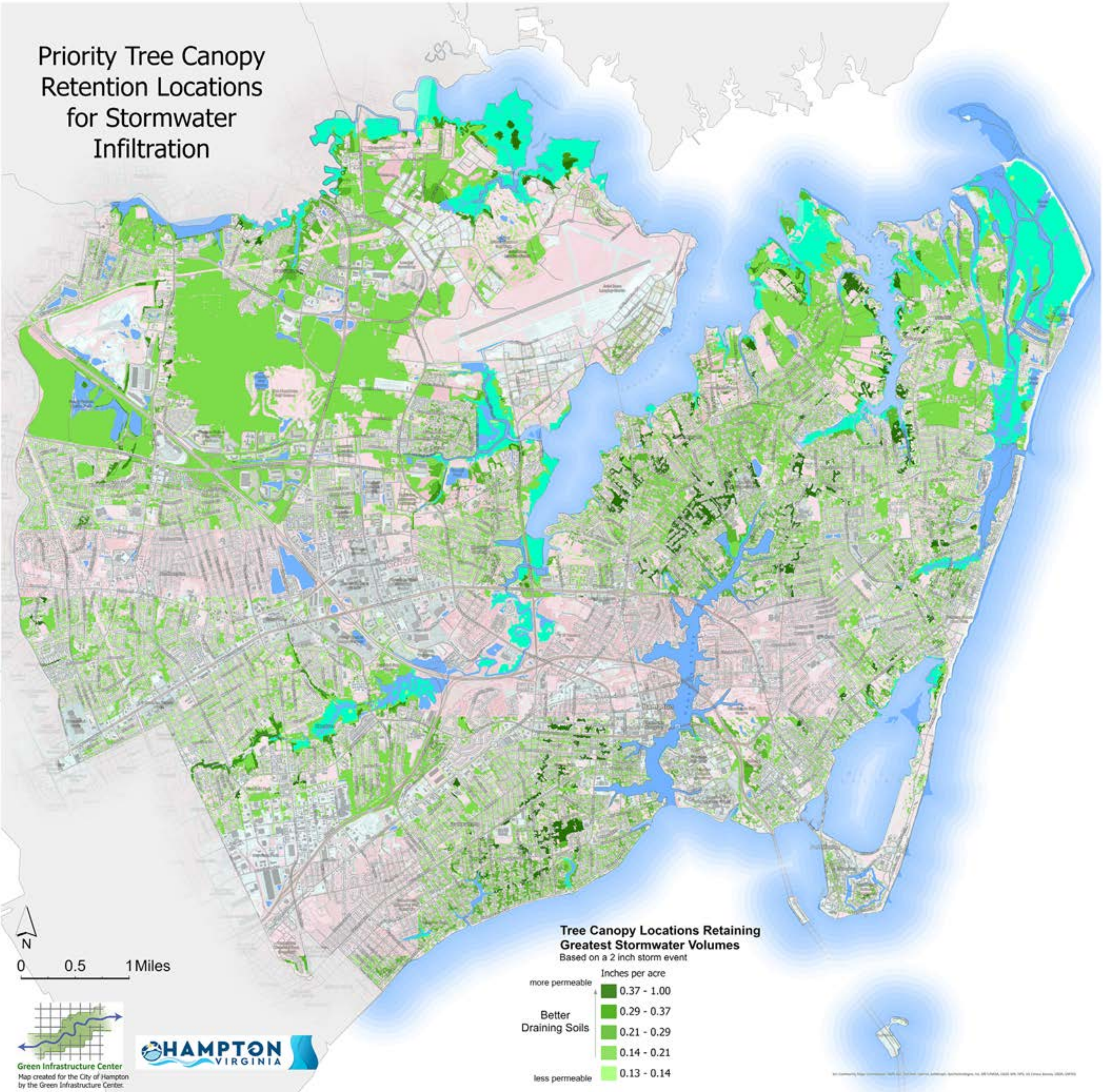
Statistics by Drainage Basin (current settings)

Area	Current Tree Cover (%)	Current Impervious Cover (%)	Tree H20 Capture (million gallons)	Increased H2O w/xx% tree loss (million gallons)	Added H2O Capture w/xx% PCA (million gallons)	Adjusted Tree Cover from loss and gain scenarios (%)	Event (Pick an Event)	% UTC loss (Pick a loss scenario)	% FOS Loss (Pick a loss scenario)	% Imperv (Converted Land)	Max TC Possible	Maximum Potential Added Canopy Area	% Canopy Added (Canopy Added)	% of PCA achieved (Enter % canopy to add)
TOTALS	32.3%	35.7%	42.2	-	-	32.3%								
1) James River - Michaels Woods	45.9%	32.4%	3.3	-	-	45.9%	1 yr / 24 hour	0%	0%	0%	53.7%	7.9%	0.0%	0%
2) James River - Orcutt	23.4%	50.7%	0.6	-	-	23.4%	1 yr / 24 hour	0%	0%	0%	33.1%	9.8%	0.0%	0%
3) Back River - Mary Peake	22.5%	51.9%	1.8	-	-	22.5%	1 yr / 24 hour	0%	0%	0%	31.5%	8.9%	0.0%	0%
4) Back River - Lake Shore	24.2%	51.4%	1.5	-	-	24.2%	1 yr / 24 hour	0%	0%	0%	33.4%	9.2%	0.0%	0%
5) Back River - Briarfield	26.0%	52.4%	1.4	-	-	26.0%	1 yr / 24 hour	0%	0%	0%	35.3%	9.3%	0.0%	0%

Statistics by Drainage Basin (current settings)

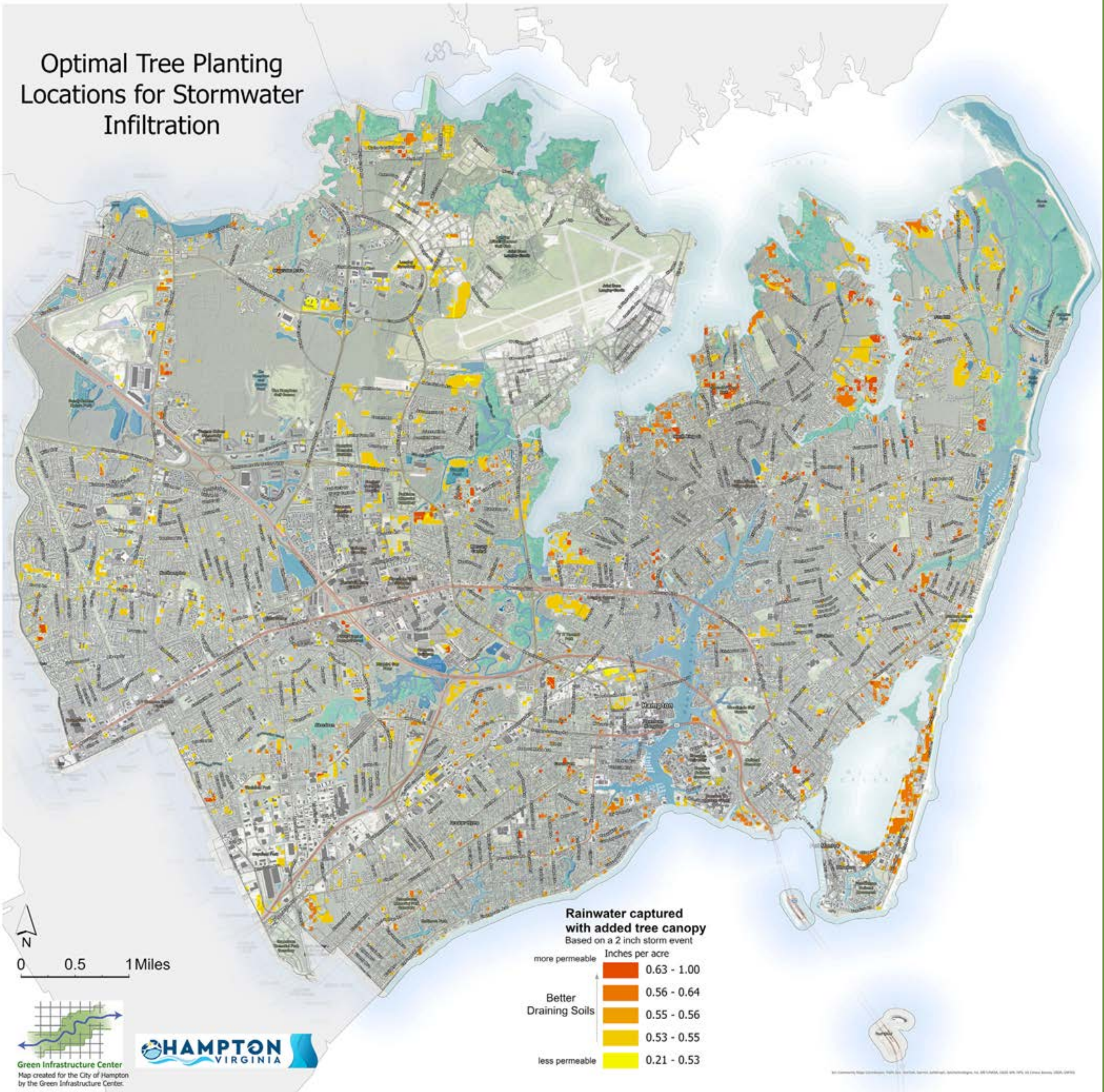
Area	Non-Point Pollution Captured by Existing Trees (% = percent of total load without trees): N lbs/yr	N (%)	P lbs/yr	P (%)	SED t/yr	SED (%)	Change in Pollution Load from Landus[e] (% = percent increase or decrease of: N lbs/yr	N (%)	P lbs/yr	P (%)
TOTALS	61615	15	4993	21	3789	15	0	0	0	0
1) James River - Michaels Woods	5,160	25	421	35	266	23	0	0	0	0
2) James River - Orcutt	715	8	57	13	59	11	0	0	0	0
3) Back River - Mary Peake	1,960	7	156	11	172	10	0	0	0	0
4) Back River - Lake Shore	1,843	9	149	15	123	10	0	0	0	0
5) Back River - Briarfield	1,895	11	154	17	116	11	0	0	0	0

The Trees to Offset Stormwater Tool (TSW) allows the city to see the water uptake by existing canopy and model impacts of tree canopy changes by watershed.



Map 6. Priority Tree Canopy Retention Locations for Stormwater Infiltration

This map identifies existing mature tree canopy that is in the best location (in dark green) for retaining stormwater on-site.



Map 7. Optimal Tree Planting Locations for Stormwater Infiltration

This map identifies the best areas to plant trees to maximize stormwater capture.

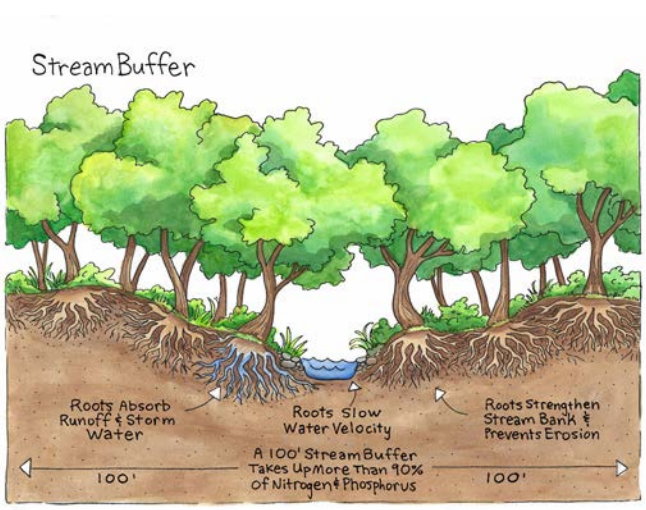
Pollution Mitigation

Trees and other vegetation filter pollution from air and stormwater and mitigate or contain soil pollution. To reduce pollution, the City can plan for cleansing landscapes by strategic planting of trees and plants to filter particulate matter from the air or water and remediate or contain soil pollution. (See Pollution Mitigation Map, page 37.)

As tree cover is lost and impervious areas expand, excessive stormwater runoff results in pollutants, such as oil, metals, lawn chemicals (e.g., fertilizer and herbicides), pet waste, trash, and other contaminants flowing into surface waters. Trees help capture and filter that urban runoff. According to the GIC's stormwater model, during a 1-year/24-hour rainfall event (2.94 inches) in Hampton the trees capture:

- 61,615 lbs./year of nitrogen
- 4,993 lbs./year of phosphorus
- 3,789 tons/year of sediment

These three pollutants above are the main pollutants of concern in the Chesapeake Bay and are addressed through Total Maximum Daily Load (TMDL) Action Plans. Nitrogen and phosphorus are plant nutrients that can cause harmful algal blooms, while sediment can clog fish gills, smother aquatic life, and necessitate additional dredging of canals and waterways. Algal blooms can



Planting trees and/or leaving unmown strips along drainage ditches such as this one on Shell St. can lead to a reduction in stormwater pollutants reaching the Chesapeake Bay.

reduce oxygen levels, further harming fish and other aquatic life. These pollutants can be targeted by planting trees and other vegetation along streams and drainage ditches, as well as along roads and adjacent to large impervious surfaces, such as parking lots. The Pollution Mitigation Map identifies existing turf open space that can be planted:

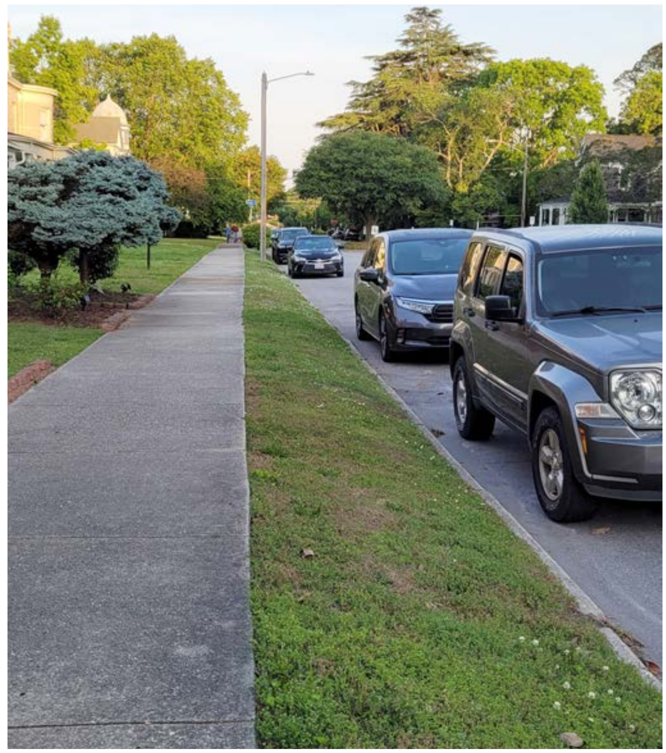
- Within 100 ft of a stream or canal.
- Within 200 ft or a road or impervious surface.
- Within 100 ft of a stream or canal and within 200 ft of a road or impervious surface.

All of these locations have the potential to address stormwater pollution with strategic vegetation planting to filter pollutants from stormwater running off of roads and parking lots and into streams and canals.

Air quality pollution removal values were calculated by applying the multipliers used by i-Tree models to the city's tree canopy. I-Tree is a peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefit assessment tools. It provides standard pollution removal values per acre for various air pollutants. The i-Tree model values for urban areas were used to derive the annual pollution removal numbers for Hampton below.

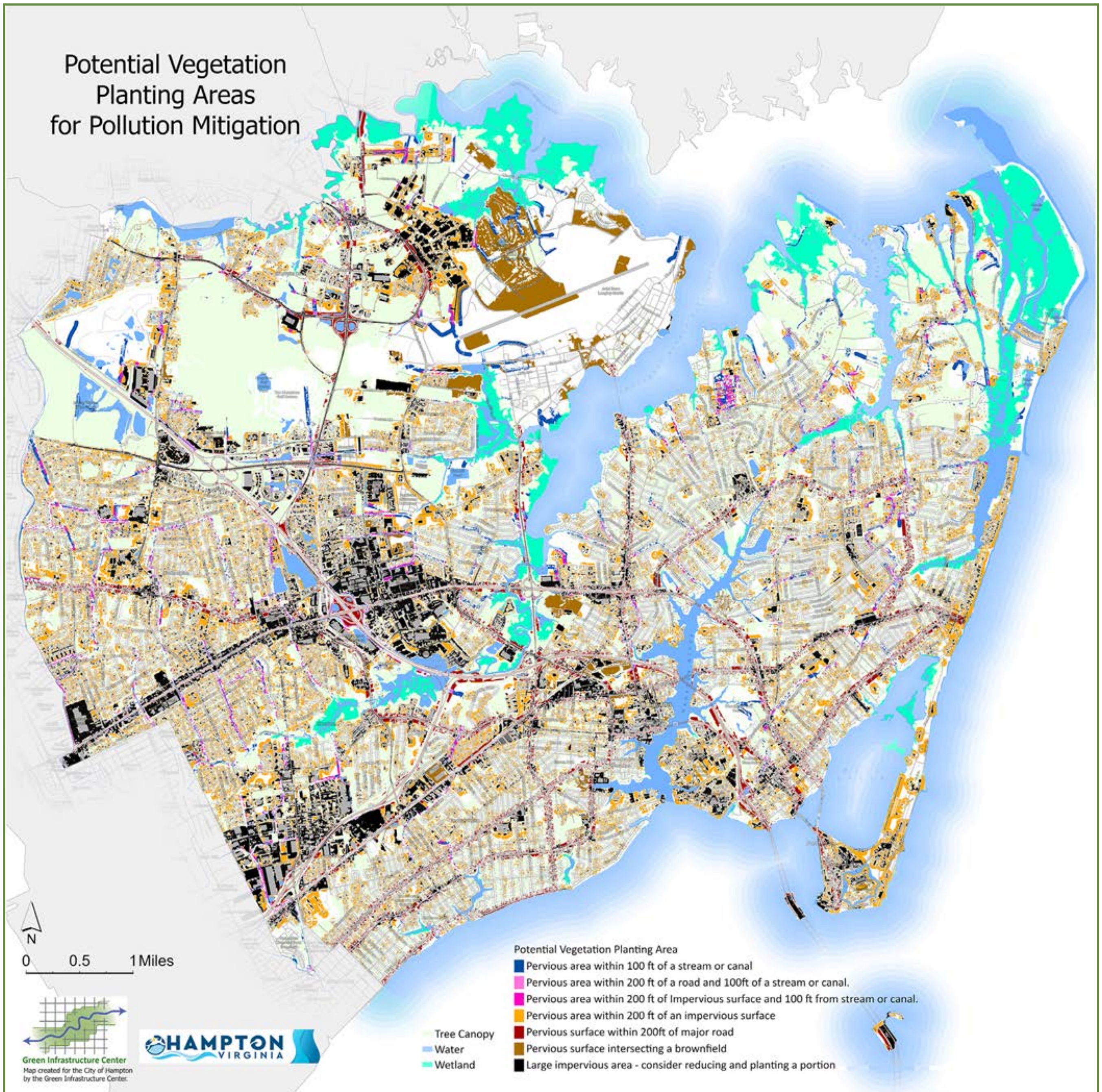
Carbon monoxide (CO), and carbon dioxide (CO_2) contribute to global climate change. Ground-level ozone (O_3), nitrogen dioxide (NO_2),sulfur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) are airborne pollutants and respiratory irritants that negatively impact human health. Trees filter and clean such particles from the air. As a result, people in well-treed neighborhoods suffer less from respiratory illnesses, such as asthma (Rao et al, 2014). This means that investments in canopy at the neighborhood scale can increase the health of residents. Additionally, locating trees along streets or adjacent to high-traffic roads (pervious surfaces within 200 ft. of a major road on the Pollution Mitigation Map) can provide buffers against air pollution from vehicles.

Locating trees along streets or adjacent to high-traffic roads can provide buffers against air pollution from vehicles.



Pounds of air pollution and greenhouse gases removed annually by all trees in Hampton							
CO (carbon monoxide)	**NO_2** (nitrogen dioxide)	**O_3** (ozone)	**PM_{10}*** (particulate matter 10 microns)	**$PM_{2.5}$** (particulate matter 2.5 microns)	**SO_2** (sulphur dioxide)	**CO_2seq** (carbon dioxide sequestered) in lbs	**CO_2stored** ** (carbon dioxide stored in lbs)
720	**11,436**	**188,745**	**30,347**	**6,844**	**340,309**	**50,608**	**1,495,010**

*PM = Particulate matter
**CO_2 stored is not an annual rate but a total amount of carbon stored.



Map 8. Potential Vegetation Planting Areas for Pollution Mitigation

This map identifies pervious open space that can be planted to potentially mitigate stormwater pollution, air pollution, or soil pollution by planting trees and other vegetation in proximity to the pollution source, such as along roads, or between the source and water bodies.

Cooling and Equitable Landscapes

Urban heat is a growing concern- extreme heat is increasing in Virginia as the climate changes. In Hampton, the number of days above 100˚F is projected to rise from the historic average of 9 days per year to 40 by the year 2040. The city's experience of extreme heat is exacerbated by the large number of impervious surfaces and lack of tree canopy. This phenomenon is known as urban heat island effect.

Multiple studies have found significant cooling (2-7 degrees Fahrenheit) and energy savings from having shade trees in cities.

Days Per Year of Extreme Heat			
Where we are now	Where we are currently headed		If bold action is taken
Historically 1971-2000 average	Midcentury 2036-2065 average	Late Century 2070-2099 average	Extreme heat limited to
9 days per year	40 days per year	71 days per year	30 days per year

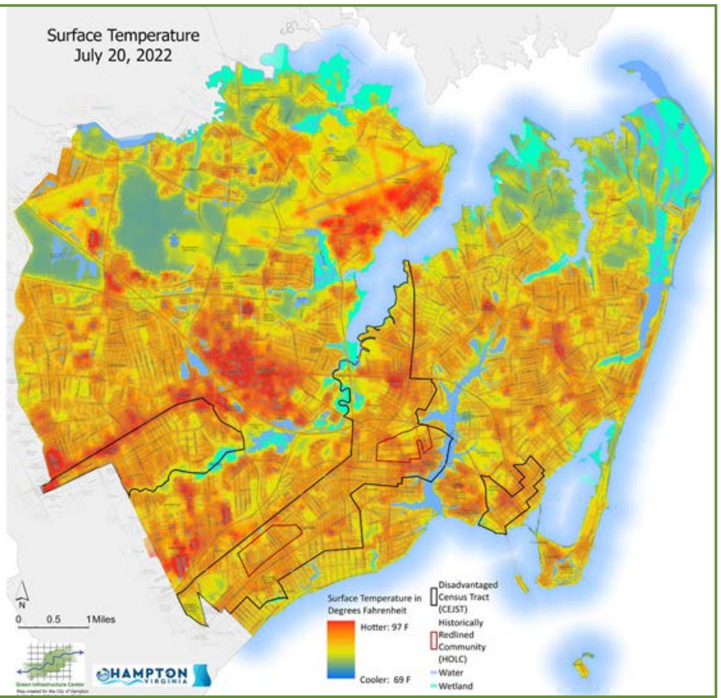
Union of Concerned Scientists. 2019, Killer Heat Interactive Tool.
In this table "bold action" refers to reductions in greenhouse gases through energy conservation. It does not consider the effects of planting more trees.
https://www.ucsusa.org/resources/killer-heat-interactive-tool

The negative impacts of extreme heat are pervasive in Hampton, particularly for vulnerable communities. Excessive heat can lead to physical heat stress, which especially affects infants and children up to four years of age, those 65+ years of age and older, those with underlying medical issues, and those on certain medications (Centers for Disease Control 2020). Vegetation and tree canopy reduce urban heat island effect, thereby creating a cooler landscape for Hampton's citizens. Tree cover shades streets, sidewalks, parking lots, and homes, making urban locations cooler and more pleasant for walking or biking. Multiple studies have found significant cooling (2-7 degrees Fahrenheit) and energy savings from having shade trees in cities (McPherson, et al., 1997).

To reduce city temperatures, the City will utilize trees and vegetation to cool the landscape. This project evaluated inequities in the distribution of tree canopy and opportunities to correct them through tree canopy data, surface temperature data and U.S. Census data showing race and income statistics. The following map illustrates prioritized tree planting areas in the city to mitigate urban heat and advance equity.

Map 9.
Surface Temperatures Hampton, VA
July 30, 2022

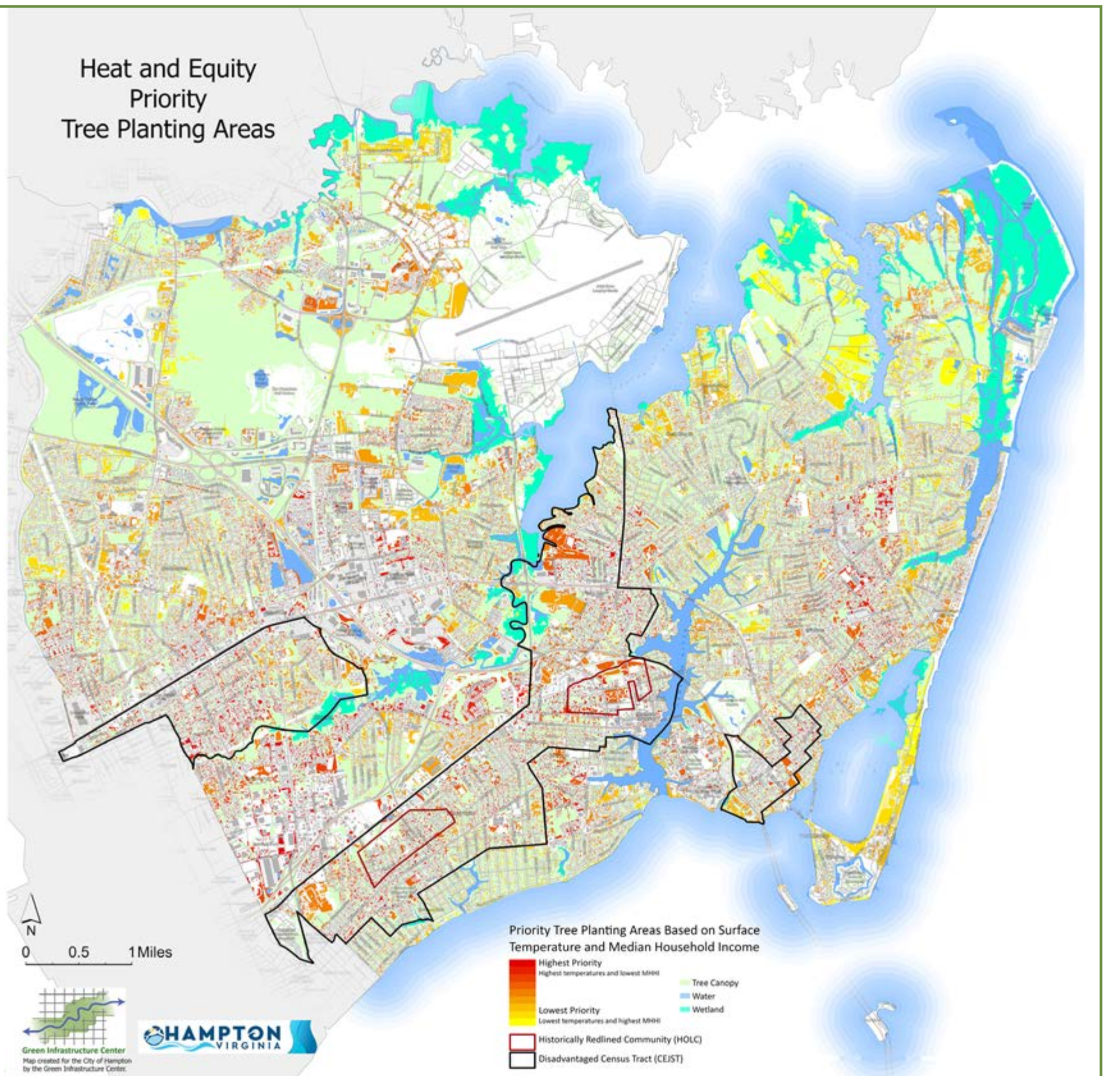
The surface temperature map captures the hottest to coolest places in the city on a typical summer day.



In Hampton, the number of days above 100˚F is projected to rise from the historic average of 9 days per year to 40 days per year by the year 2040.

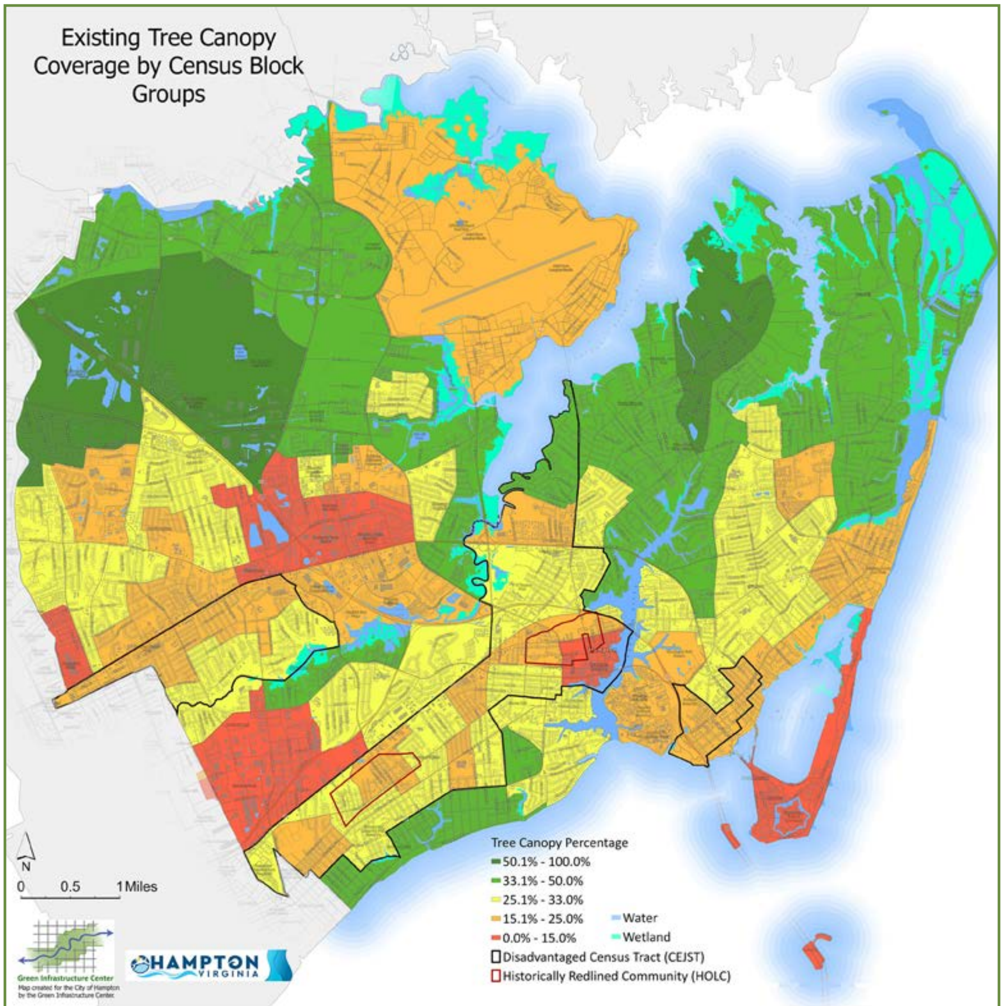
Map 10.
Heat and Equity Priotiy Tree Planting Areas

The heat and equity map uses surface temperature data and median household income data to prioritize potential tree planting areas.



What is redlining?

Redlining is the discriminatory practice of denying services (typically financial, such as home loans) to residents of certain areas based on their race or ethnicity. Under fair lending laws, these factors cannot be used for making lending or underwriting decisions. However, this still happens today both to renters and buyers. Years of this practice led to segregated neighborhoods where minority persons could not get loans or be shown housing in white neighborhoods. Disinvestment in these redlined communities over many decades led to some areas having fewer parks, trees, and outdoor amenities, such as trails or access to the water.



Map 11. Existing Tree Canopy Coverage by Census Block Groups

This map illustrates the percent tree canopy cover by Census Block Group. The red outlines are those Hampton neighborhoods that were redlined by the Homeowners Loan Corporation. Black outlines indicate neighborhoods identified as disadvantaged by the federal Climate and Economic Justice Screening Tool (CEJST). Within these boundaries, identifying locations for new tree planting, native habitat planting, parks, and trails will provide opportunities to create a healthier, more equitable city.

Hampton has many open spaces where trees may be planted to reduce urban heating.

Adaptive Landscapes

In response to climate change, Hampton is planning for adaptive landscapes to buffer against storms and to respond to rising sea levels. Retaining trees and forests along its coasts will provide a wind break and help evaporate and reduce standing water. While there are opportunities for planting new trees in locations for future coastal buffers, open spaces affected by sea level rise and storm surge are often more appropriately planted with salt-tolerant native wetland or upland grasses, perennials, or shrubs.

Living Shorelines

A living shoreline is a natural infrastructure technique that utilizes plants and other natural materials, such as sand and rocks, to stabilize shores on such protected coastal waterways as bays, estuaries, and rivers. Living shorelines filter sediments and pollutants from the water, buffer against storms and floods, reduce erosion, provide habitat, and play an important role in mitigating climate change through carbon sequestration. They often cost less than and reduce wave action better than hardened shorelines (during moderate storms).

Living shorelines encompass a wide range of shoreline treatments, from vegetation only, which is appropriate in low wave-energy environments, to vegetation planted with edging, sills, oyster reefs, and offshore breakwaters, depending on the level of wave action. In high wave-energy settings, hardened shoreline structures may be the best option, but these treatments should be used sparingly because they prevent marsh migration and may create seaward erosion. In areas where bulkheads and rock revetments are necessary, they can be designed to include plants that will provide habitat.

Twenty-five miles of the city's hardened shoreline could be naturalized.

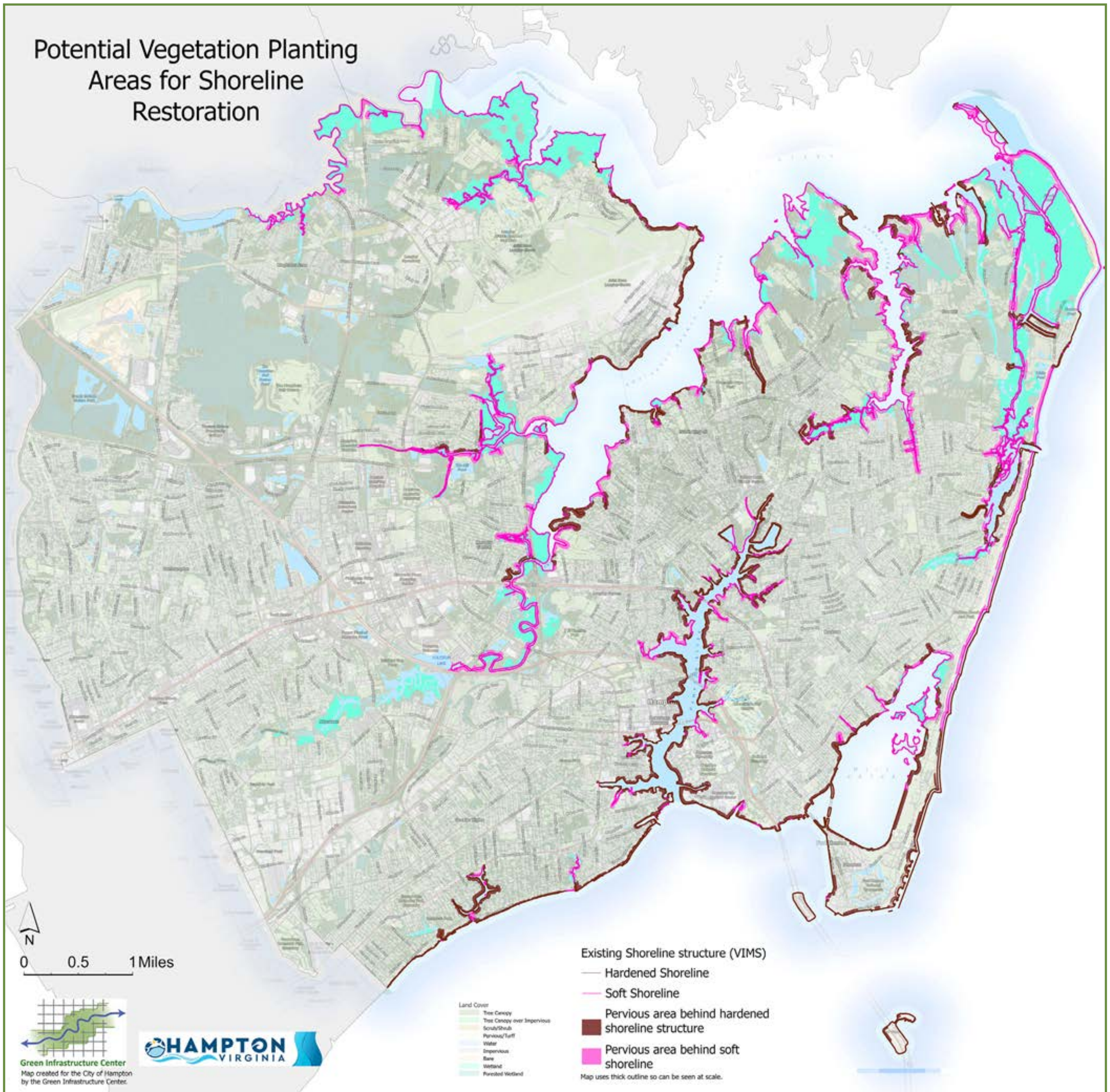
This shoreline restoration project used a combination of living shorelines and rocks to ensure the habitat is protected from strong wave actions.

The Shoreline Restoration Map on page 42 identifies pervious open space adjacent to hardened and softened shorelines that can be planted with salt-tolerant living shoreline species. Of the city's 170 miles of shoreline, 43 miles are currently hardened; of those, 25 miles could be naturalized as either marsh or marsh with sill according to the VIMS Shoreline Management Model, thereby reducing erosion, protecting property from wave-action, and improving habitats for people and wildlife.

Marsh Migration

Tidal marshes are coastal freshwater and saltwater wetlands identified by plant communities of grasses and rushes. These wetlands provide many ecosystem services, such as protecting the shoreline from wave action and storm surges, decreasing saltwater intrusion into drinking water sources, filtering pollutants from entering the bay and ocean, and sequestering carbon to mitigate the impacts of climate change. They also provide habitats for birds, fish, crustaceans, and other wildlife.

Shoreline development, including buildings, roads, bulkheads, and seawalls, threaten Hampton's tidal marshes. Rising sea levels add a new, significant threat. Marshes will move inland to higher ground as sea levels rise. This is known as marsh migration and is the movement of tidal marshes into upland areas caused by rising sea levels, while former marshes transition to

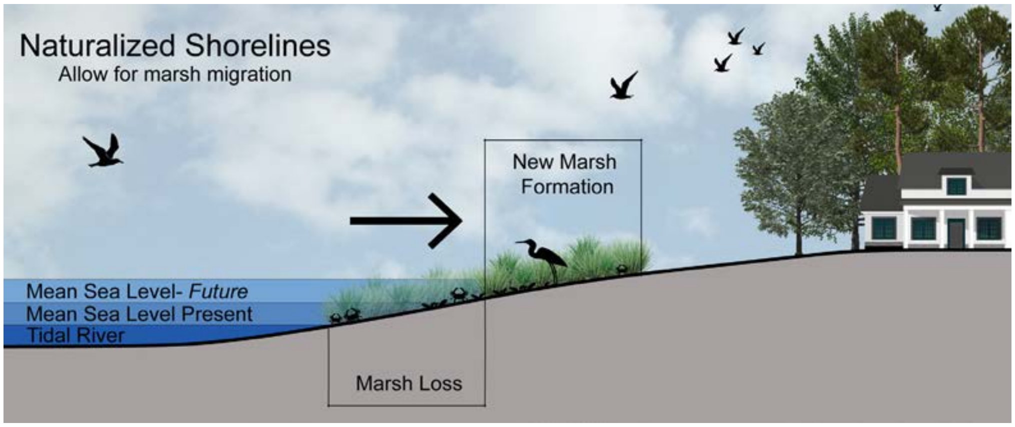


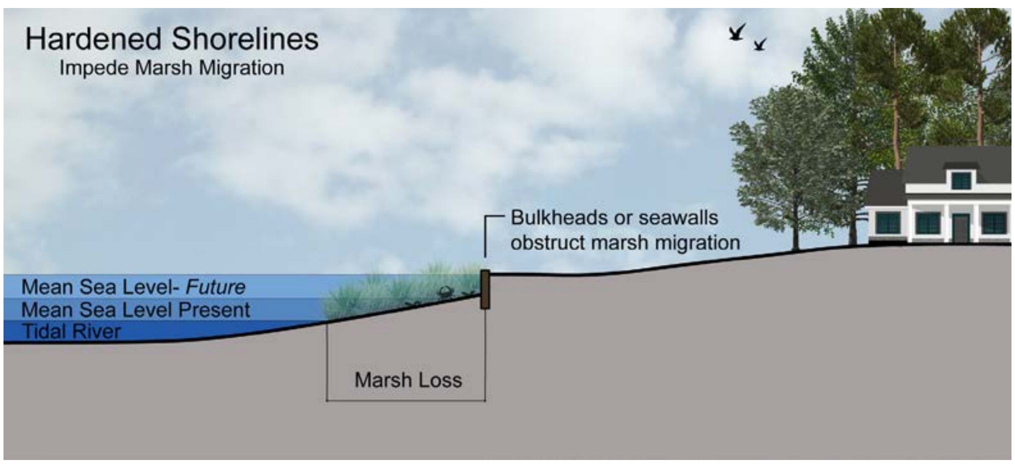
Map 12. Potential Vegetation Planting Areas for Shoreline Restoration

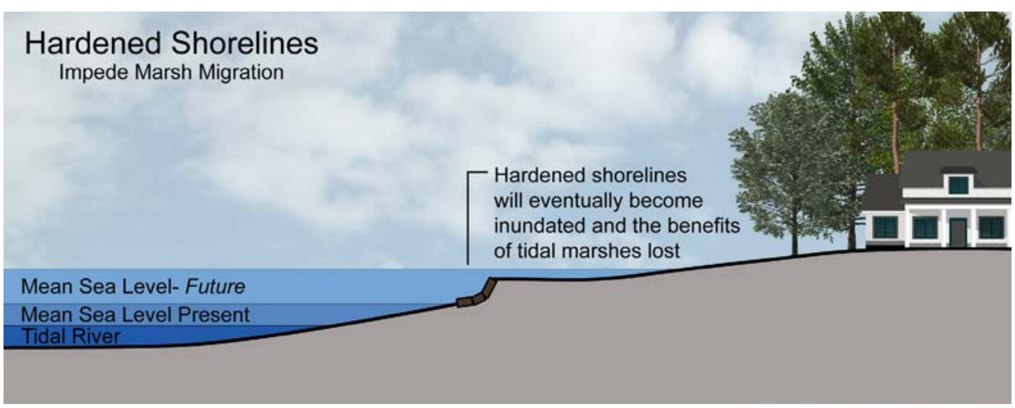
This map illustrates shoreline conditions – hardened or soft – along all shorelines in Hampton, based on VIMS data. In addition, using the land cover map, pervious open space along shorelines has been identified, indicating where shoreline restoration plantings can occur.

open deep-water habitat. In undeveloped, natural areas, storm surges and saltwater intrusion kill existing plant communities, such as lowland forests (causing ghost forests). As water levels rise, marsh plants to move in. This “marsh migration” often involves the accretion of sediment, which keeps the marsh above rising sea levels. However, in some cases, if the elevation is not conducive (too steep, too rocky, or it has impediments such as walls or bulkheads) or if seas rise too rapidly, accretion may not occur quickly enough for plant migration.

Man-made barriers to marsh migration, such as bulkheads, roads, parking lots and buildings can prevent the formation of new marsh.







◀ Naturalized or living shorelines with upland open space will offer pathways for marshes to migrate as sea levels rise. Hardened shorelines and paved surfaces will impede the upland migration of marshes. As sea levels continue to rise, bulkheads and sea walls will become inundated and these formerly hardened shorelines will lose the marshes that buffer against storms, provide habitat, and clean stormwater.

In cities and developed areas, man-made barriers to marsh migration can prevent the formation of new marsh. In many of these situations, human intervention may be necessary to ensure successful marsh migration. Proactively removing any barriers to marsh migration in suitable locations ahead of time, will facilitate a smoother transition for people and aquatic life. Marsh migration is important for aquatic life because shallow marshes support a multitude of species not found in deep water habitats. Shallow marshes also serve as nurseries for young fish, crabs and other shellfish.

When storm surges deposit water behind bulk heads or other barriers, standing water remaining can cause isolated wetland formation over time making these areas unsuitable for human dwellings. Areas subject to frequent flood damages may be declared repetitive loss properties and become eligible for other assistance. For more see text box below.

The maps on pages 45 and 46 show potential marsh migration areas as sea levels rise, first, by 1.5 feet, and then by 3 feet. The Potential for Unimpeded Marsh Migration Map indicates the potential for marsh migration if it was unimpeded by existing land cover (trees and sand dunes) or development (roads, parking lots and buildings). The Current Open Space Available for Marsh Migration Map shows potential marsh migration areas limited to existing open space. Maintaining and protecting these open spaces now will allow wetlands the space to migrate and survive into the future and continue to provide ecosystem services to the city.

In addition, there may be areas where development will need to retreat from rising seas to allow for wetland migration. Identifying ways to physically alter the

What is a repetitive loss property, as defined by FEMA, and what are the options?

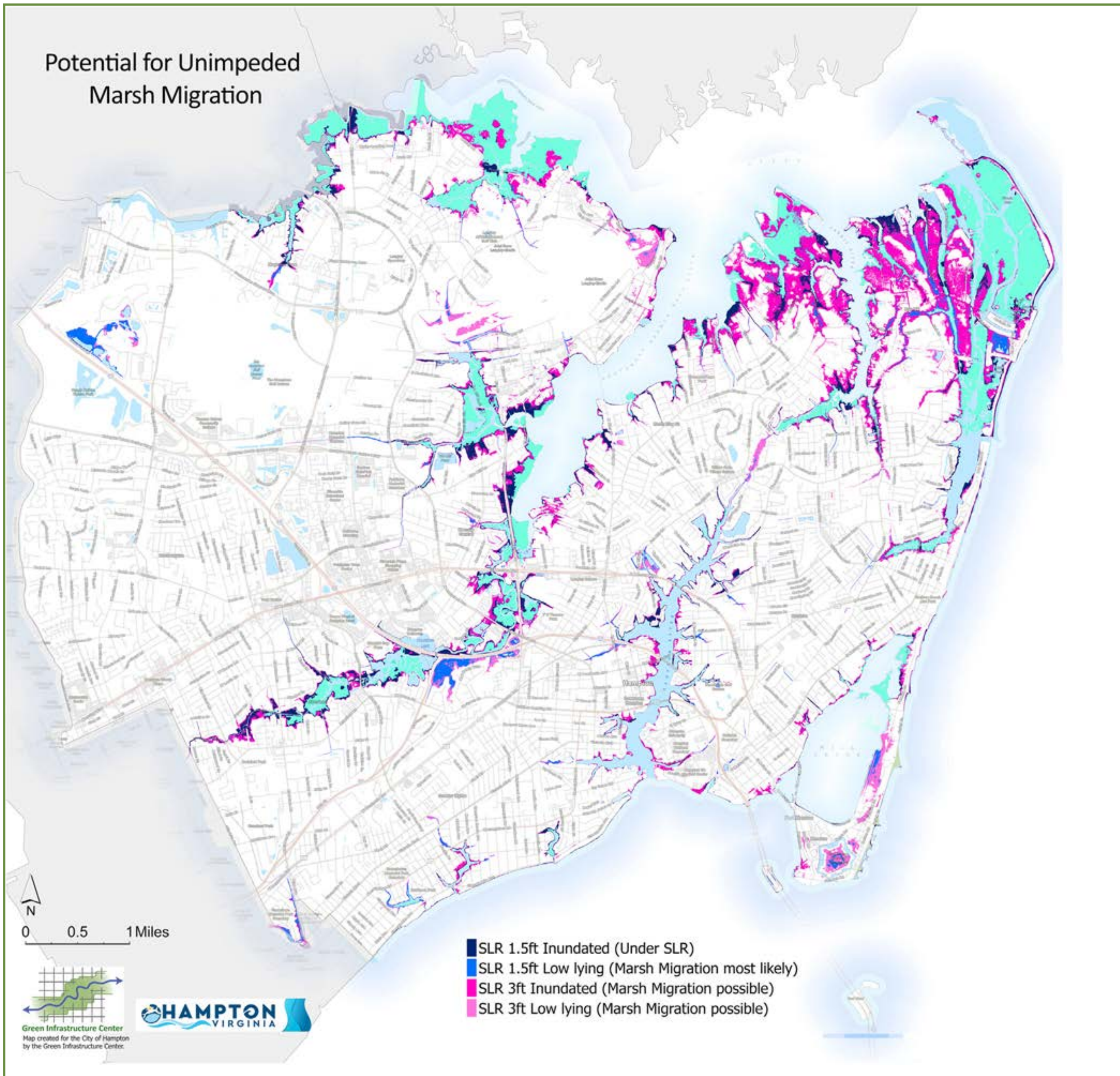
The Federal Emergency Management Agency (FEMA) manages floodplain regulations in the U.S., as well as disaster response and recovery programs. The Community Rating System (CRS) reflects the level of risk for a community. Lower risk ratings from the agency show that a community has become safer and can also result in reduced insurance premiums for landowners.

In contrast, for CRS purposes, a repetitive loss property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period since 1978 (the year at which consistent claims data collection began). Therefore, a building with paid NFIP claims of more than $1,000 in 1979 and again in 1985 is considered a repetitive loss property and will be treated as such until that building's flood problem is mitigated. On the other hand, a building with paid NFIP claims of more than $1,000 in 1994 and again in 2013 would not be a repetitive loss property. Severe repetitive loss (SRL) properties are another class of repetitive loss. These properties, defined under the 2004 Flood Insurance Reform Act, are those buildings that either have four or more claims of $5,000 or more, or have at least two claims that cumulatively exceed the building's value. Hampton has been awarded more than $11 million dollars over the past five years from the federal and state governments to help homeowners elevate homes that have seen repeated flooding and are expected to see more in the future.

When the City intends to apply to FEMA, it mails letters to flood-prone areas, inviting homeowners to respond; and then uses FEMA's Benefit to Cost Analysis (BCA) tool to determine if properties are eligible. For eligible properties, the City considers many factors, including level of risk (as measured by BCA score), proximity to flood sources, repetitive loss/severe repetitive loss status, how complementary it is to existing City plans and priorities, and the ability to group homes in the same area, etc. The process takes many years to complete and is entirely voluntary. For those properties that are impractical to elevate, or would be cut off by permanent inundation, land may be acquired and allowed to transition to more suitable uses, such as an eventual wetland park or habitat.

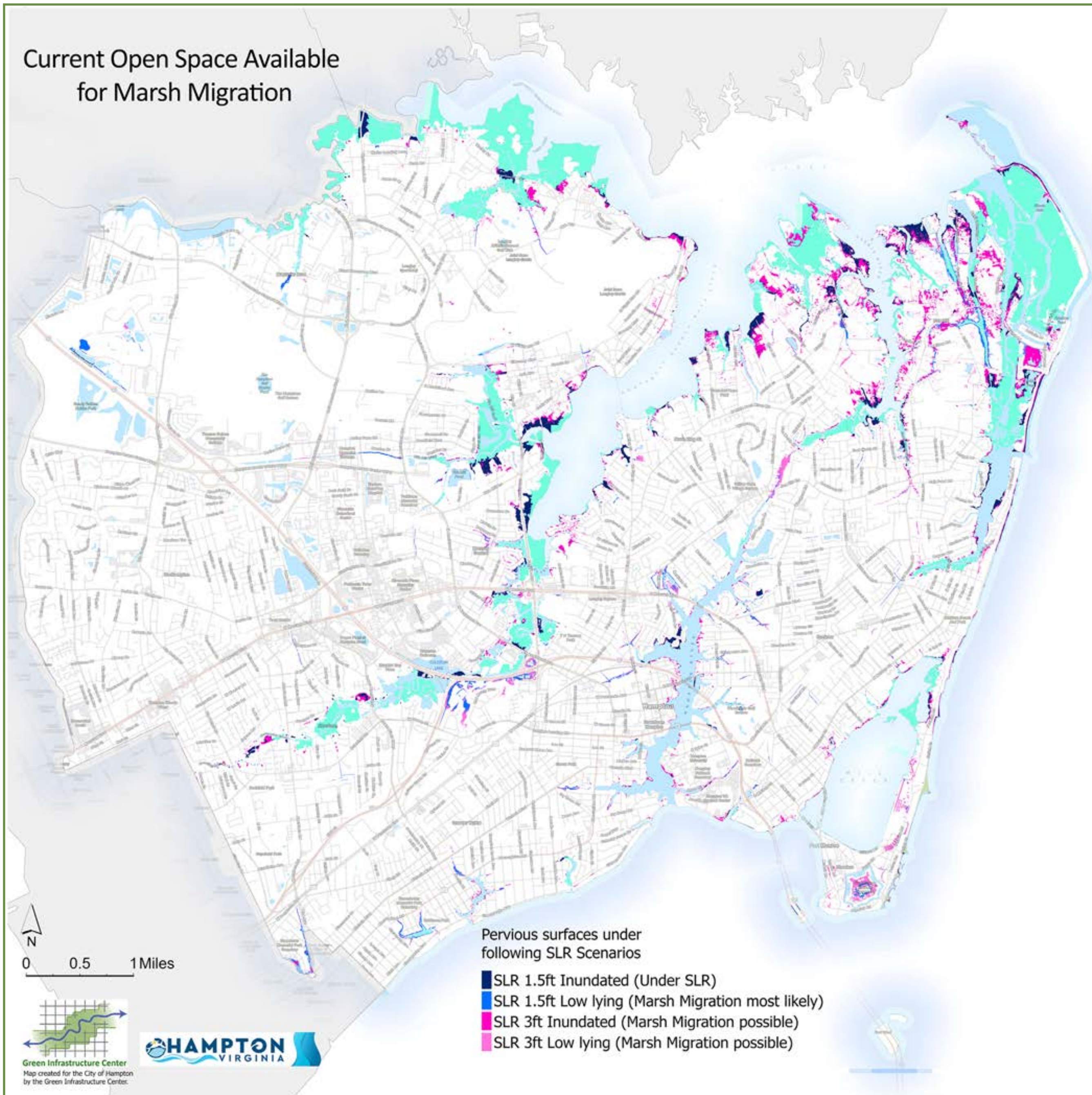
landscape as seas rise (such as removing bulkheads and parking lots and replacing road sections with bridges) to accommodate marsh migration will become important strategies for maintaining these wetland ecosystems. Using these maps, the city can identify marsh migration corridors and devise strategies for accommodating future marsh movement. On city land, strategies may include keeping open areas free from development and where barriers exist, planning for relocation or retreat.

Planning for marsh migration on private land will require education, outreach, and innovative ideas. Planting living shorelines with upland buffer plantings today could provide space for future migration. Additionally, providing incentives for conservation easements on private land with marsh migration potential could provide space for future wetlands, while reducing the tax burden on lands that can no longer be developed.



Map 13. Potential for Unimpeded Marsh Migration

This map illustrates the potential for marsh migration as sea levels rise from 1.5 feet to 3 feet if it was unimpeded by existing land cover (trees and sand dunes) or development (roads, parking lots and buildings).



Map 14. Current Open Space Available for Marsh Migration

This map shows potential marsh migration areas in existing open space as sea levels rise from 1.5 feet to 3 feet.

Connective Landscapes

Hampton is planning for connective landscapes to allow for wildlife movement and survival, to provide human access to nature, and to create more resilient natural systems. Connectivity ties into many of the other landscape typologies since more connected systems are more resilient and better able to infiltrate, cleanse, cool, and adapt. For example, research shows that the more connected green spaces are to one another, the greater temperature reduction benefits they provide (Hirschfeld 2024).

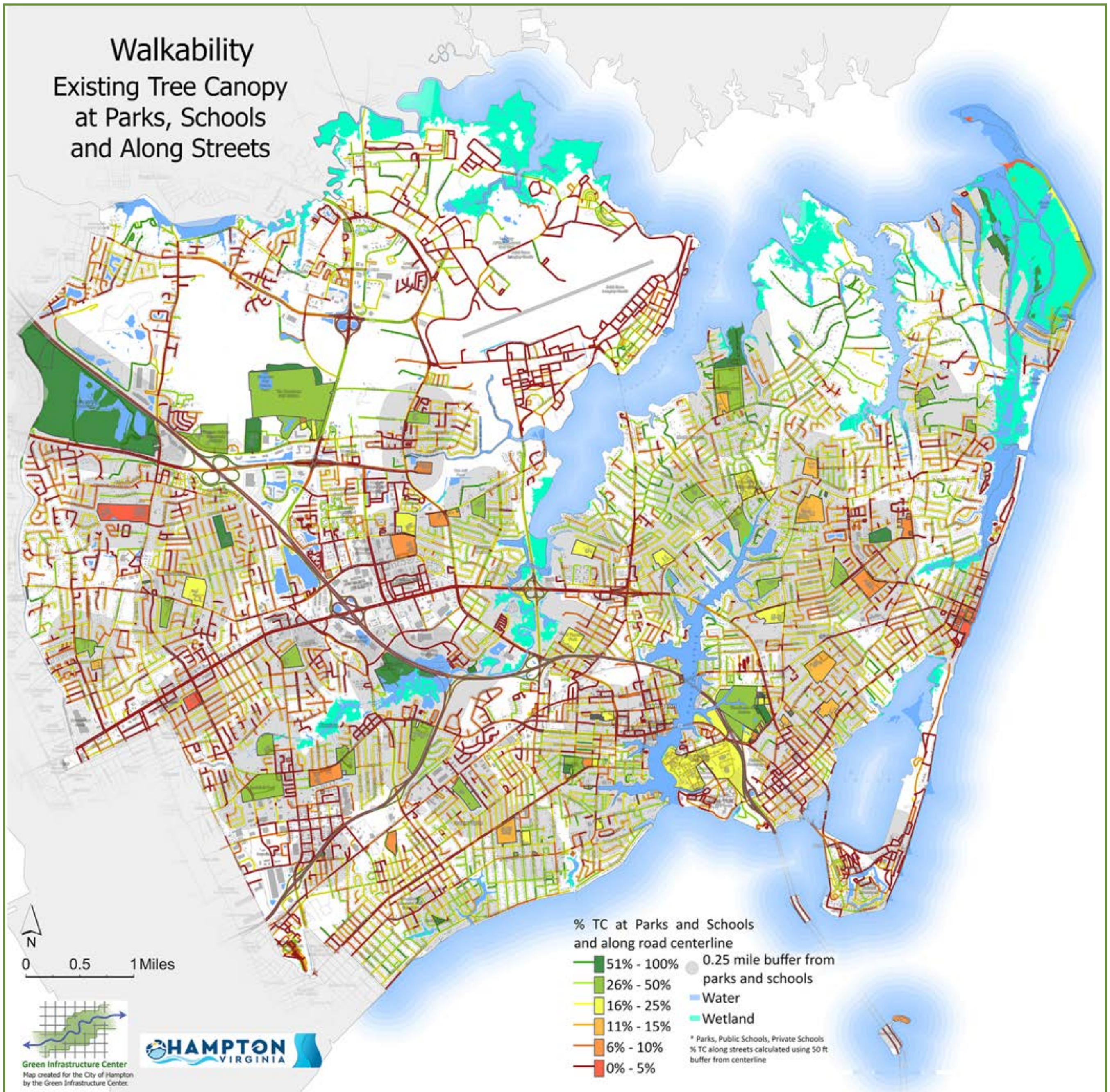
> **Wildlife, birds, pollinators, and amphibians benefit from connected landscapes by having more areas to migrate, forage, and thrive. People benefit from enhanced access to green space through visual beauty, trails and parks, and water access too. Multiple studies have linked physical and mental well-being to green space access. (Firehock 2015.)**

Planting Native Habitats

While increasing tree canopy is a primary goal of this Natural Infrastructure Resilience Plan, wildlife benefits are maximized when trees are planted as part of a complex woodland habitat. However, not every location is suitable for tree planting. For instance, there are height restrictions under powerlines and tree roots must not intrude into the surface on capped landfills or archaeologically-sensitive areas. Sometimes an iconic or historic view must be maintained and trees may not be planted or at least planted so as to allow some openings to see through. Open spaces maintained as mown turf can provide more benefits if planted to create a native meadow or shrubland habitat. Planting woodlands, shrublands, and meadows together will provide habitat and connectivity for a greater diversity of species to thrive.

The Habitat Restoration Map on page 52 identifies potential opportunities for converting pervious open space into habitat. There are some locations where woodland, shrubland and meadow can be introduced, and other locations where a variety of restrictions mean that only shrubland and meadow are appropriate landcovers.

Photo by City of Hampton



Map 15. Walkability: Existing Tree Canopy at Parks, Schools and Along Streets

This map shows which streets, parks, and schools have the most canopy (dark green) and which have the least (red). The percentage tree canopy along streets depicts the extent of shade covering city streets. The percentage value represented is the percentage of tree cover within the 50 ft. area for that road segment. Additionally, the gray areas are ¼ mile areas from schools and parks. To facilitate walkability to these amenities, streets lacking good coverage within these areas should be prioritized for tree plantings.

Maintaining a native meadow or shrubland requires less fossil fuel resources than the typical mowing and fertilizing of turf grasses. However, this requires a shift in management techniques that may necessitate education and training. Successful planting begins with proper design and installation. For a successful native habitat planting of meadows, shrublands, or woodlands, hiring a design professional with experience in ecological planting and design is important. The designer begins with a comprehensive site analysis that considers soils, sun and shade, moisture, and microclimates on a site. Instead of amending the soil, an ecological design professional will identify the best native plant community to mimic based on site conditions and aesthetic choices. By selecting plants adapted to the conditions of the site that support the intended plant community, long-term watering and maintenance needs can be reduced.

Meadow's installations have increased in recent years, but often suffer from bad press because of substandard design and installation. For a successful installation, work with a professional ecological designer who will:

- Consider the soil, water, sun, and microclimates on the site
- Design with native plant communities
- Not amend soils
- Not till or disturb the soil
- Seed by hand or with a no-till seeder

Dynamic Meadows

Landscapes are dynamic and continuously changing. A well-designed meadow planting is intended to change over time. The plant mix should include emergent species that will dominate in the first year, while the longer-lived perennials will take several years to establish and flower. Without intervention, a meadow in Hampton will continue to undergo succession to become a shrubland, and ultimately a woodland. To maintain a meadow planting of herbaceous plants, the meadow must be mowed annually to cut back woody plant growth.

Meadow composition will change over time, with the early years dominated by short-lived emergent species, such as black-eyed susan (upper left), while over time longer-lived perennial species will become established, such as coneflower (left). Meadow plantings should contain at least 40% grasses (above).

Urban Rewilding: Bringing nature and native species back into cities

Rewilding is a term first used in Europe, that has rapidly spread across the world. Rewilding Europe[1] explains that “It’s about letting nature take care of itself, enabling natural processes to shape land and sea, repair damaged ecosystems and restore degraded landscapes.” Rewilding efforts use deliberate land management techniques to restore original habitats and actively work to reintroduce lost species. In London, England, where hundreds of projects are in progress, small local sites are purchased and returned to nature, often by voluntary groups, and the wider community is encouraged to plant wildflowers and erect bird tables in their back gardens. Such micro projects are linked to larger city parks and bodies of water, to create a network of habitats that, taken together, restore nature and natural processes in cities for the benefit of both humans and wildlife. Here in Virginia, many groups have adopted patches of land to return them to native landscapes, such as wetlands, and they monitor the return of native shorebirds and mammals.

Urban rewilding emphasizes habitat, connectivity, and human coexistence with nature and wildlife. At the city scale, every piece of green space has the potential to support wildlife and connect people to nature. Urban rewilding seeks to maximize habitat and connectivity in those green spaces. While Hampton cannot support larger carnivores, such as the Red Wolf that once roamed the landscape, there can be ample habitat provided for smaller species, such as the southern flying squirrel, muskrats, river otters, or smaller amphibians, such as salamanders and green frogs, and especially birds. Providing adequate habitat for these species helps ensure they can live in harmony with people.

For a complete list of such native species, see the city’s Wildlife Management Plan prepared for Sandy Bottom Nature Preserve. https://hampton.gov/DocumentCenter/View/710/Appendix-I---Wildlife-Species-in-Hampton?bidId=

Wildlife bridges can be used in rural areas for large mammals to cross roads without conflicts.
In cities, smaller mammals and amphibians can benefit from wildlife tunnels under roads.

[1] https://rewildingeurope.com/what-is-rewilding/

Ways to rewild include:

- Manage parks and green spaces for wildlife:

  —Reduce mowing and use of pesticides on city property.

  —Designate wild areas in parks of all scales.

  —Create a system of interconnected corridors along which wildlife can move.

- Identify specific areas for the introduction of specific species, to act as their core habitat, from which they can spread into neighboring areas. Some species will require only a small 'home base', while other will require a larger area. Examples include osprey stands.

- Utilize areas of large urban parks to manage them to support some wild populations.

- Consider protective fenced-off areas for some species, to prevent human disturbance and allow a species to establish itself. Later, once species establish, these fences can be removed.

- Encourage local neighborhoods to 'adopt' a species; encourage young people to get involved with their reintroduction and protection.

- Manage small urban green spaces for multiple, generalist species.

- Transform abandoned lots and roadsides into native meadows; plant with flower species that encourage specific insects.

- No space is too small – it is the entire, citywide connectivity that is important, so the more pockets of wildness the better.

Install and encourage buildings with living roofs and living walls.

- Backyard habitat is critical – teach homeowners how to create native habitat in their yards, to include leaving edges as wild gardens, putting up bird boxes, lowering the size of fences, planting natives as hedges, etc.

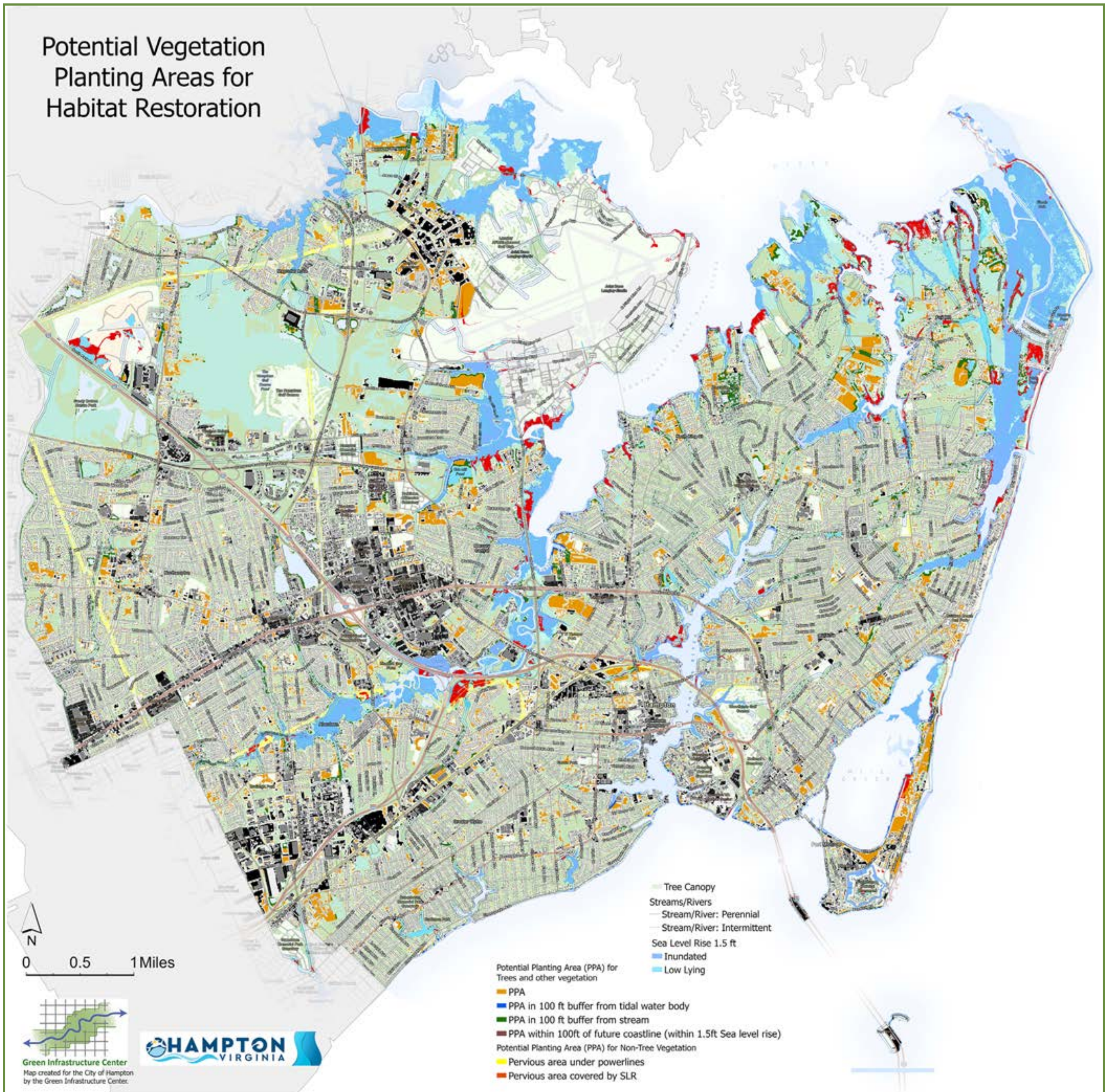
- Create stormwater parks, including ponds, which benefit people and wildlife.

- Install and encourage buildings with living roofs and living walls.

- Create green corridors for wildlife and people – green streets, animal crossings, allow habitat in utility corridors, and create more greenway/trail connections.

- Plant native habitat along living shorelines, in meadows, and as shrubland and woodlands, as part of an interconnected system that will attract diverse wildlife.
  See Planting Native Habitat on page 47 and Living Shorelines on page 41.

Newly planted living shoreline establishment.



Map 16. Potential Vegetation Planting Areas for Habitat Restoration

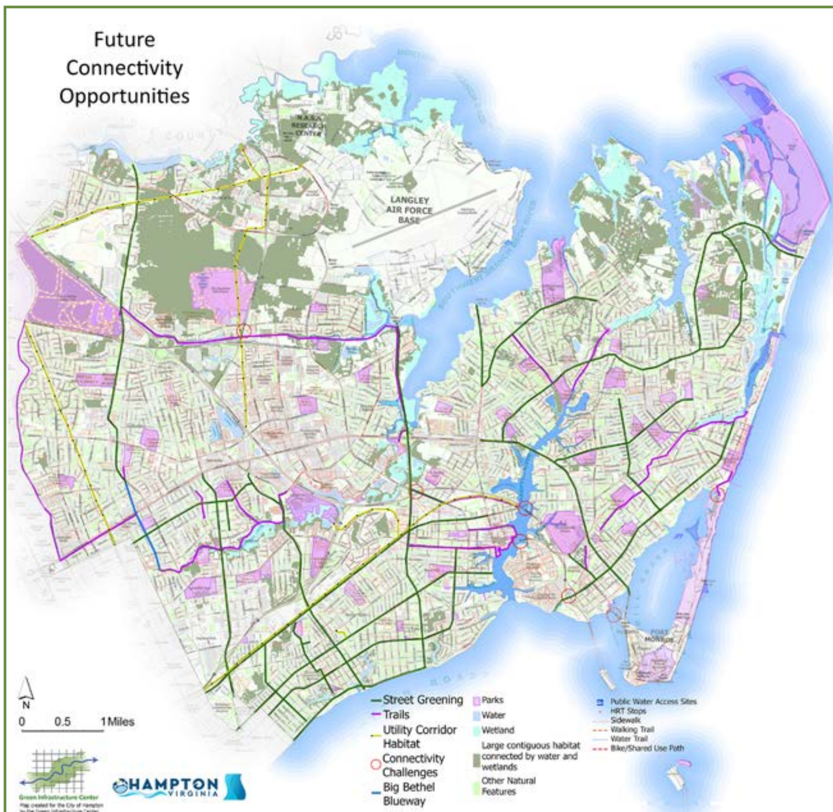
This map identifies pervious open space that can be planted with trees and other native vegetation to restore habitats and connectivity across the city.

Future Connectivity

A synthesis of the mapping, analysis, and strategy work is reflected in the map, below, of future connectivity opportunities. This map presents options for making Hampton more connected for wildlife, pollinators, and people at the citywide scale. The City Staff Advisory Committee assisted with suggestions to "create greener" connections (see green lines). Street greening approaches range from implementing complete green streets to targeting tree planting campaigns at private property owners along a street that lacks space in the right-of-way (ROW). The map identifies several new trails for increased connectivity (purple lines) and access to natural areas.

Some trails are proposed to connect with existing trails to create a large circuit, while others involve creek daylighting (unburying a creek) projects to increase resilience and habitat connectivity. Additionally, the map identifies large utility corridors that could facilitate pollinator or wildlife movement and connectivity (yellow lines) through native shrubland or meadow plantings. This would require working with Dominion Energy and the easement owners along utility lines. Demonstration projects could be completed first on city-owned land and then spread to interested private landholders.

Finally, the map identifies areas in the city with connectivity challenges posed by bridges and highways (red circles). This infrastructure will be difficult to change, so connectivity through these areas will require creative solutions. In one location, a closed pedestrian tunnel could be renovated and reopened, in another location, pedestrian connectivity may require a water taxi. These are areas in which the City and its partners can work towards connectivity solutions.



Map 2. Future Connectivity Opportunities

This map should be included in the daily and long-range planning by City staff to guide decisions, from new park locations and parcel development to transportation planning, which will align with this plan for a connected, green city.

You can view this map full size on page 11.

Note: Pages 54 - 68 contain an **Implementation Action Plan**

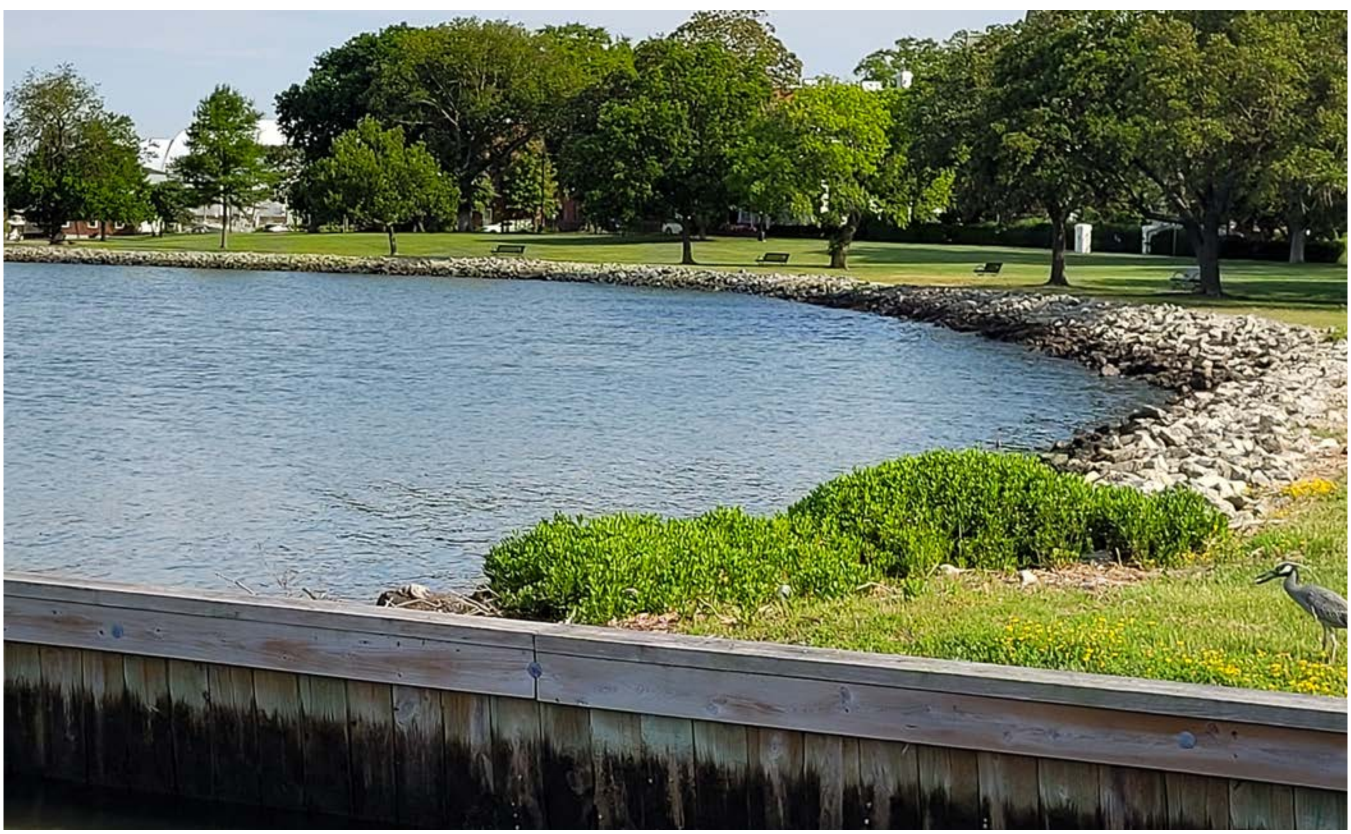
These pages can be found at the link below for reference.

https://hampton.gov/4119/Natural-Infrastructure-Resiliency-Plan

Stakeholders and Partnerships

The City of Hampton cannot create a resilient, green city alone. To be effective, this work will take robust partnerships with local stakeholders, organizations, and the public. The City has a strong set of partners that will be crucial for continued success. These include such stakeholders as the NASA Research Center, Langley Air Force Base, Fort Monroe Authority, National Park Service and Hampton University as well as such partners as Hampton City Schools, Wetlands Watch, the James River Association, the Chesapeake Bay Foundation, Hampton Master Gardeners and Tree Stewards, and the Virginia Cooperative Extension. These stakeholders and partners have expressed interest in carrying forward ideas from the planning process, such as growing native trees at Bluebird Gap Farm, working with City schools on living shoreline projects, providing training and education, and more. As the City moves forward with implementing this plan, it will be important to involve these partners and stakeholders in the process. The GIC has recommended developing a Natural Infrastructure Plan Task Force with City staff, partners, and stakeholders to monitor progress on the plan and adapt it as needed.

As the City moves forward with implementing this plan, it will be important to involve partners and stakeholders in the process.



NASA Langley Research Center

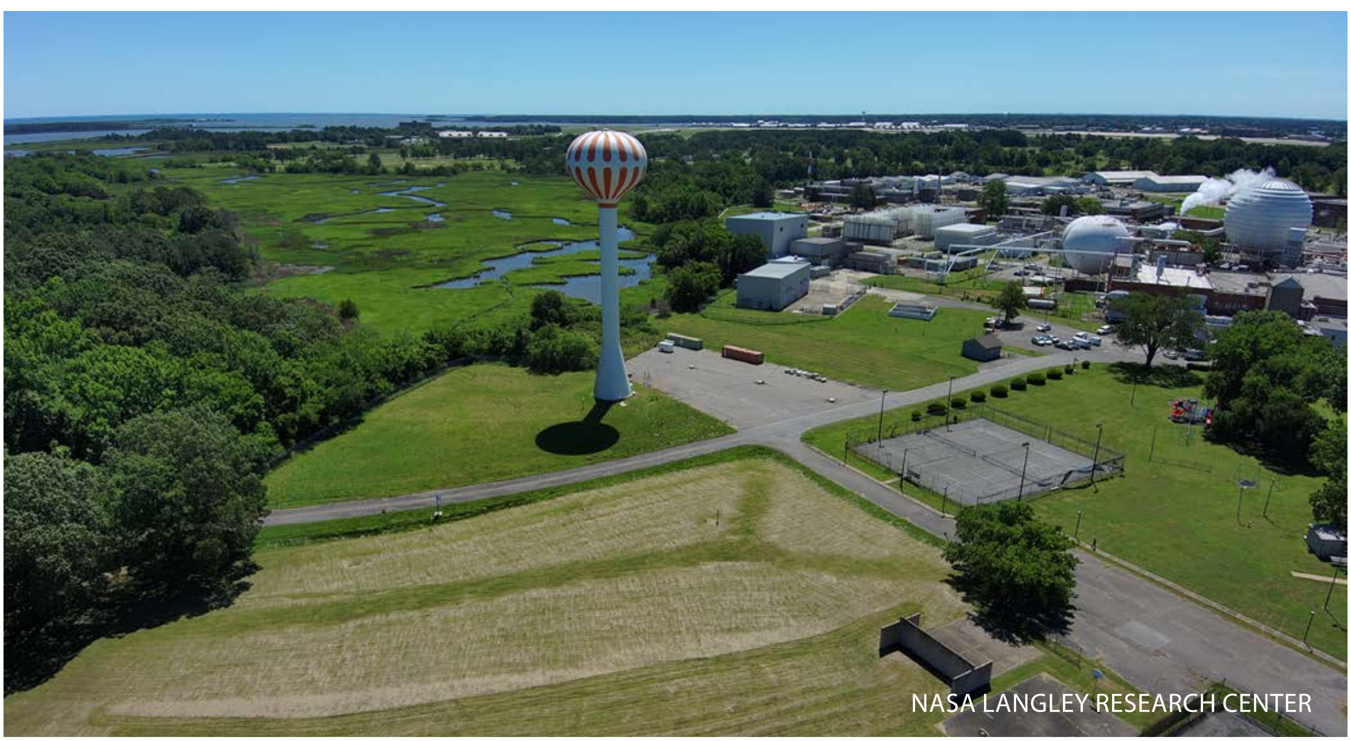
The Center Operations Directorate (COD) at the NASA Langley Research Center (Center) focuses on the campus's natural resources, along with managing stormwater to reduce or mitigate flooding. As a coastal facility, it faces risks from flooding because of sea level rise and storm surge. Its investments in resiliency planning are well underway to meet the impact of climate change. Efforts include mapping and modeling for storm surge and sea level rise and using these data to plan for storm response, as well as retreating from areas subject to rising sea levels. The Center is also actively monitoring land subsidence and sharing these data with Hampton Roads stakeholders.

NASA Langley Research Center's resiliency approach uses natural and constructed green infrastructure on its campus, with the goal of improving the health of the Back River and Chesapeake Bay. The first strategy is to protect existing wetlands and forests, which cover more than a third of its site. Then, as buildings are removed as part of a plan to retreat from rising sea levels, restoration and reforestation are being implemented on these former building sites that lie on the edge of existing forest and wetlands. To date, five acres have been reforested, with more acreage in line for restoration.

To reduce stormwater challenges, the Center has avoided increasing its footprint, with a requirement that new construction should not increase the overall square footage of the built landscape. Any new buildings must also be constructed to have a base flood elevation above projected sea level rise.

On developed areas of the campus, constructed green infrastructure is being used to capture and treat stormwater runoff. Today, there are 32 stormwater best management practices on the campus, including permeable paving, a green roof, rain gardens, and bioretention cells. The Center also requires the use of native plant species, prohibits the use of irrigation structures or fertilizers, and stipulates that any tree that has to be removed is replaced at a suitable location.

The GIC identified potential planting area for trees (PPA) on the campus, however much of the landscape is reserved for future buildings or has underground utility lines, which



NASA LANGLEY RESEARCH CENTER

There are 32 stormwater best management practices on the campus including permeable paving, a green roof, rain gardens, and bioretention cells.

prohibit tree planting. The GIC discussed the possibility of planting non-tree native habitat in these areas, such as meadow or coastal shrub planting that will provide habitat and stormwater benefits, will not conflict with utilities, and can be removed when new development occurs. NASA has already converted about two acres to meadow and will continue to explore additional opportunities.

As a research institution, NASA Langley Research Center is open to sharing those methods, practices, and lessons it has learned with the city and other stakeholders in Hampton and will be a tremendous resource as resiliency work continues across the city.

NASA Langley Research Center Campus

About 40% of the 764-acre NASA Langley Campus is currently covered by trees, wooded wetlands, and marshes. The Center has installed 32 Green Infrastructure Stormwater BMP facilities on the campus and has been a Tree City USA facility since 2010.

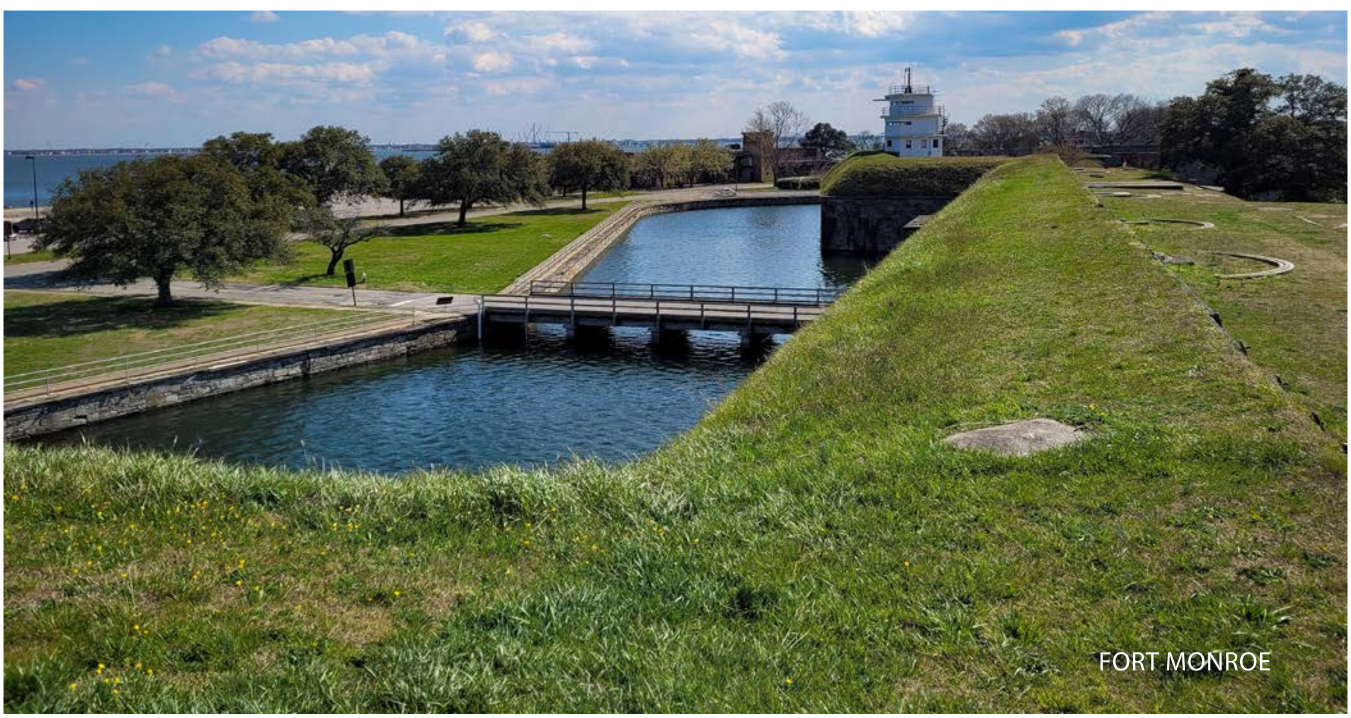
Fort Monroe Authority and the National Park Service

Fort Monroe is a 561-acre peninsula within the municipal boundary of the City of Hampton. The entirety of Fort Monroe, otherwise known as Old Point Comfort, is designated as a National Historic Landmark District (NHL). Land ownership is divided between federal lands owned by the National Park Service (NPS), US Army, and US Coast Guard, and Commonwealth of Virginia state-owned land. Aside from the Army and Coast Guard parcels, the property is managed by the Fort Monroe Authority (FMA) and the National Park Service (NPS). The FMA serves as a stewardship partner, undertaking maintenance, management, and planning to preserve and reuse this historic property and provides assistance to the NPS through a Cooperative Management Agreement (CMA).

As a coastal facility, the lands making up Fort Monroe are within a Special Flood Hazard Area (SFHA) and are subject to a 1% annual chance of flooding. The fort is exposed to such flooding from hurricanes and other severe storms, which can produce high-water events.

The peninsula on which the Fort is situated is surrounded by Hampton Roads Harbor to the south, the Chesapeake Bay to the east, and Mill Creek to the west. The northern end of the property connects to Buckroe Beach via a narrow isthmus. The northwestern approach to the Fort Monroe peninsula passes through the formerly incorporated town of Phoebus, which is now part of the City of Hampton. They are connected by the East Mellen Street and East Mercury Boulevard bridges. Additionally, the historic stone fort, which is within the Fort Monroe National Monument, lies within and is surrounded by a tidally influenced wet ditch or moat.

Typically, flood events arise from tropical storms, hurricanes, and nor'easters, resulting in high-intensity rainfall, high tides, high winds, and storm surges. During such events, the coastal defenses around the fort are overtopped and the existing stormwater infrastructure experiences back-flooding because of high tidal tailwater elevations. Storm surge is identified as the major contributor to highwater and/or flooding events, while flooding events from rainfall are typically minor and masked by storm surge.[1]


FORT MONROE

[1] Fort Monroe Authority Resilience Plan, April 2024

The Algernourne Oak is located within the historic fort and is believed to be over 500 years old. The tree has witnessed many historic events such as the establishment of Fort Monroe and the Civil War.

In addition to a resiliency plan, a master plan was developed for the area in 2013. This master plan was intended to facilitate redevelopment in a mixed-use approach utilizing adaptive reuse, new construction, and open space, in order to fulfill the Commonwealth's mission to protect the landscape while providing both public access to the historic resources and recreational opportunities, and also facilitating enhanced stewardship of natural resources.

Natural Infrastructure on the peninsula consists of trees, wetlands, shrubs, and beach. Many of the trees are large and impressive.

The FMA is conducting a grant-funded tree inventory within the inner fort and plans to apply for funds to inventory trees across the remainder of the property. The tree inventory will inform a management and maintenance plan for those trees. While there are some open areas available for new trees on the peninsula, new tree planting is limited by strict standards governing excavations that could disturb or destroy historic designations and archaeological resources.

Fort Monroe History

1609: Site identified by English settlers and called Pointe Comfort by Captain John Smith.

1619: "20 and odd" Africans were brought to the Virginia colony by the English privateer White Lion, which had seized them from a Portuguese slave ship, thus marking the first arrival of enslaved Africans and the beginning of slavery in the English colonies of North America.

1819-1834: Fort constructed to protect the US from naval attacks.

1861-1895: During the Civil War, the fort remained under Union control and became known as the "Freedom's Fortress" and was a refuge for escaped slaves. Following the war's end, the fort held the former president of the confederacy Jefferson Davis captive for two years.

1914-1918: Fort Monroe was active in preparing and maintaining coastal defenses. Once the US entered the World War in 1917, the fort became a troop training and mobilization center.

1939-1945: During World War II, Fort Monroe was a key installation for the U.S. Army, and played a crucial role in coastal defense and military operations.

1973: During the Cold War, Fort Monroe became the headquarters for the U.S. Army's Training and Doctrine Command.

2011 onward: Fort Monroe was decommissioned in 2011, after which President Obama designated it as a National Monument, ensuring its preservation and opening it to the public.

Around the North Gate area, new trees will be incorporated into proposed infill development, while large shade trees will be strategically located, whenever possible, in such redevelopment projects as the reuse of buildings, improvements to parking lots, the relocation of utilities, streetscape redesign, and new designs for parks and open spaces. In areas where trees or woody vegetation are not possible, the FMA will determine whether new native meadows or wetland habitats could be installed instead.

Fort Monroe's master plan advocates a living shoreline along Mill Creek from the entrance of the fort to the community center. The multi-use Trail757 (formerly known as the Birthplace of America Trail) will parallel this living shoreline and provide seven miles of multi-use trails on the peninsula, which will connect to a larger trail network that stretches throughout the city of Hampton and connects it to the entire region. The FMA plans to replace the damaged kayak launch on Mill Creek and hopes to collaborate with the City of Hampton on living shorelines and other resiliency projects.

The US Army's parcel of land is on the north end of the peninsula and is currently undergoing a remediation and monitoring process to remove contaminants from past military uses. Once these processes are complete, the NPS will take over ownership of the land, opening up more access opportunities. Once the land has been transferred to the NPS, the City of Hampton hopes to collaborate with the NPS on a trail connecting Buckroe Beach boardwalk to Fort Monroe.

Joint Base Langley-Eustis

Joint Base Langley-Eustis (JBLE) – Langley is an active military base located on 3,152 acres within the City of Hampton. JBLE – Langley is committed to working with the City on natural infrastructure and resiliency projects.

The base includes an active airfield, buildings, facilities, and housing units, as well as forests, wetlands, and living shorelines. The northern area of the main base drains into the Northwest Branch of the Back River, while its southern drainage enters into the Southwest Branch of the Back River.

JBLE – Langley has an Integrated Natural Resources Management Plan to guide its site management. The mission of the base has impacted the quantity and quality of its natural resources and current plans must balance the demands of an active military base and flight field with the benefits of strategically protecting and restoring natural infrastructure.

The USAir Force Bird Air Strike Hazard (BASH) program maintains a wildlife exclusion zone around the airfield to prevent wildlife-aircraft accidents. The exclusion zone is achieved through fencing, reducing groundcover vegetation, and removing such habitats as wetlands that could attract birds.

Despite the need to restrict wildlife uses in some areas, opportunities for restoring or protecting natural infrastructure have been identified and implemented. The base has gained Tree City USA status, holds remarkable tree tours, and has surveyed their trees, including an annual hazardous tree inventory. Shoreline restoration projects have been constructed on 10,861 linear feet of shoreline along the Back River and its Southwest Branch. Additionally, JBLE – Langley partnered with the Chesapeake Bay Foundation and Booker Elementary School to construct an oyster reef restoration project in the Back River near the JBLE – Langley Marina.

The base is currently exploring opportunities for additional living shorelines to provide improved resilience to sea level rise, storms, and erosion, as well as improved aesthetics and water quality. Invasive species are managed to better encourage native habitat for pollinators and wildlife.

JBLE – Langley supports outdoor recreation by maintaining such trails as the Langley Nature Trail. As an older facility, the base also has some legacy contaminated areas and these are addressed through an Environmental Restoration Program that includes site monitoring.

Hampton University

Hampton University is an important city stakeholder and historic institution. This private, historically black university traces its origins to the Civil War when enslaved persons who had escaped bondage by sheltering at Fort Monroe were educated, from 1861 onwards, under the now famous "Emancipation Oak." The oak offered shelter to the first students but achieved its true fame when it became the first site where the Emancipation Proclamation freeing America's enslaved persons was first read. In 1863, a "school for Negro children" was founded there by General Butler, followed in 1889 by the Whittier School, to teach students at the Hampton Normal School, until in 1872, it became the Hampton Normal and Agricultural Institute. It continued in various iterations, with a focus on trades-based education, and also served to educate captive Native Americans freed following the end of the Red River War in the 1870s. Renamed the Hampton Institute, the college later expanded its course offerings and majors to become today's Hampton University.[1]

While the riverfront campus offers stunning views and access to resources for students, such as for those studying marine science, the location also puts the campus at risk

HAMPTON UNIVERSITY

Hampton University Campus

- **314** acres of land
- **20%** of the land area is Tree Canopy Cover
- **50%** of the land area is Impervious Surfaces
- **17 Acres** of land is potential planting area (PPA) for trees

[1] https://home.hamptonu.edu/about/history/

HAMPTON UNIVERSITY

The Emancipation Oak is an historic live oak tree on Hampton University's campus where, in 1861, Mary Peake led the first classes for formerly enslaved students and in 1863 was the site of the first southern reading of the Emancipation Proclamation.

from sea level rise and increased flooding. The university is now exploring resilience strategies to adapt to a changing climate, including the incorporation of additional natural infrastructure such as trees, living shorelines, and native plants into its campus. A group of multidisciplinary faculty and staff recently formed a "green team" to work toward a sustainable and resilient campus. Hampton University will collaborate and partner with the City of Hampton as it moves forward with implementation of this natural infrastructure plan. The University sent a letter to the city to officially endorse this plan and a pledge to participate. An excerpt from the letter is provided at right.

At Hampton University, we recognize the significance of building resilient communities, particularly in the face of environmental challenges and climate change impacts. As an institution deeply rooted in our community, we understand the importance of safeguarding our natural resources, enhancing infrastructure resilience, and promoting environmental justice.

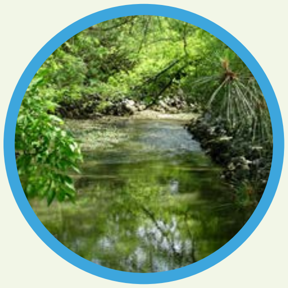
The City of Hampton's Natural Infrastructure Resiliency Plan aligns with our university's commitment to environmental sustainability, community engagement, and social equity. This plan presents a vital opportunity to address our community's ecological vulnerabilities and foster long-term resilience.

—Darrell K. Williams
President Hampton University

Multi-Functional Landscapes for People and Water

Multi-purpose green stormwater facilities for play, for art, and for nature too!

Multi-functional stormwater spaces are the new way to think about stormwater management.



In this plan, nature as infrastructure is a key focus. Stormwater is often thought of as a waste product that needs to be managed through a structure or facility that takes up space. Traditional stormwater facilities, such as stormwater ponds, whether wet or dry, often take up usable open space, which could've been used for parks, paths, or even buildings. In addition, such facilities are often fenced off limits to people, to prevent trespass or harm. However, in developed landscapes, this means sacrificing good open spaces and even making them less attractive. But it does not have to.

Multi-functional stormwater spaces are the new way to think about stormwater management. Following are some examples of how constructed stormwater spaces can become multi-purpose for play, for respite, for habitat and for stormwater treatment. It is not usually raining all day, every day, so stormwater facilities should be able to be purposed for sunny day uses too. Following are examples that Hampton can consider as it redevelops and tackles more stormwater management needs.

Stormwater Playgrounds

Recessed areas can be used for playsets when they are not holding water. Children should be brought indoors during storms anyway. Once the playground dries out, play can resume. These are recessed play areas that serve as dry stormwater ponds with play equipment within them.

Stormwater Parks

These are large parks with stormwater ponds or wetlands incorporated as part of the interpretive experience. For example: Puget Sound Stormwater Park visit: https://www.psrc.org/media/6285

Pervious Astroturf/Underground Tanks

While artificial play fields have some drawbacks, including being hotter for athletic play, when they are employed, why not also design them as stormwater catchment systems. Schools across the country, including the University of Virginia, have created underground sand filtration systems to capture and clean stormwater. The field itself does not become compacted because it is not made of soil, so water continues to filter through no matter how much it is used. An even better solution is to put catchment tanks beneath a natural playfield. At UVA, beneath the new track infield is a subsurface 187,025-gallon cistern that collects rainwater, mitigating stormwater runoff while also providing a source of water that can be used for irrigating the field above.

Nature Parks

Nature can also become part of the discovery and fun for children and adults using stormwater parks. In Baltimore, MD, developers did not want to sacrifice valuable land for stormwater basins and they wanted to treat both volume and quality so they created a delightful discovery landscape for people to enjoy. This unique feature makes the business

Rodney Cook Sr. Park in Atlanta reduces flooding by capturing and storing up to 10 million gallons of stormwater while simultaneously creating a vibrant community destination.

area family friendly too and a welcome respite for stressed office workers to boot. Prices Park in Baltimore is worth the visit: https://inhabitat.com/pierces-park-combines-art-play-and-stormwater-management-into-a-stunning-urban-oasis-in-baltimore/pierces-park-by-mahan-rykiel-25/

Permeable Playing Fields

Spaces we use for recreation, such as basketball or even pickleball courts, can be constructed to be permeable. This means that they will not freeze and crack in winter or have standing water after a rainstorm, allowing play to resume immediately. In New York City, where space is at a premium, many play fields are now permeable and there are many firms that can provide permeable surfaces courts. For example, this green playground in New York will also capture 655,000 gallons of stormwater annually, and create a drier space for children to resume play.
For more see: https://citylimits.org/2023/01/27/an-overlooked-climate-solution-greener-playgrounds/

Adaptive Re-Use

In Atlanta, Georgia, a neighborhood suffering from stormwater problems and a lack of accessible open space was able to receive both through the design of Rodney Cook Sr. Park, which is a "16-acre dual-purpose park and watershed management system that alleviates flooding by capturing and storing up to 10 million gallons of stormwater while simultaneously creating a vibrant community destination." For the full story: https://ezine.nrpa.org/nrpa/ParksRecreationMagazine/april-2022/index.php#/p/14

Finally, note that many of these stormwater structures can be played in or on when it is not raining. In Greenleaf Park in Charlottesville, Virginia, this grant-funded bioswale ended up being a favorite spot for toddler play, even though it was not designed for that use initially, it does invite kids in. It also has an interpretive sign designed by the elementary school showing how Mr. Dirty Raindrop gets clean.

For a guide with case studies to stormwater playground design see: https://www.mapc.org/wp-content/uploads/2018/07/FINAL.Designing-Parks-and-Playgrounds-as-Green-Infrastructure.Chelsea.6.29.18.pdf

In Greenleaf Park, Charlottesville, young children are drawn to this bioswale area for play and exploration.

Conclusion

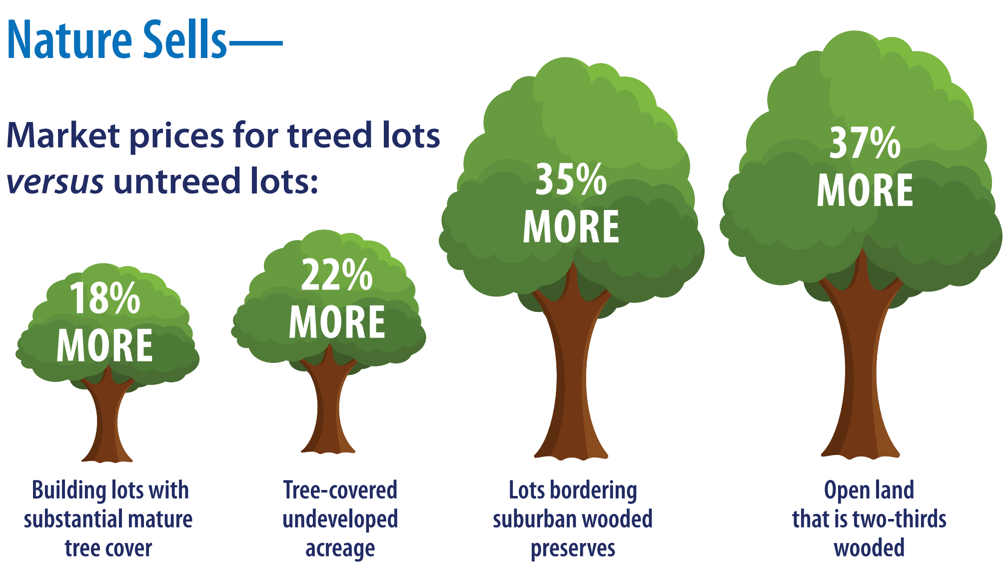
Resiliency is a journey requiring constant adaptation. Implementing this plan ensures that the city will harness all its infrastructure – both constructed and natural – to adapt to a changing climate, while also building a more livable, resilient, and prosperous city.

For every dollar invested in climate resiliency, a city can save at least $4 in other costs.

Investing in its natural infrastructure is a wise investment for the City. FEMA estimates that, for every dollar invested in climate resiliency, a city can save at least $4 in other costs. Accordingly, investments in green infrastructure will, over the long term, pay Hampton back too. For example, adding street trees will not only provide natural beauty, but will reduce utility bills and wear and tear on asphalt. Indeed, people tend to shop longer and pay more per item in tree-lined shopping districts, thereby increasing sales and sales-tax revenue, while treed lots in residential areas bring higher property values, also resulting in greater tax revenues for the City, as well as higher resale values for residents (Wolf, 2007).

Even non-property holders benefit from more treed green infrastructure by saving money on air conditioning. The US EPA has published multiple studies documenting the costs saved in energy from planting trees and has shown that electricity demand for air conditioning decreases 1-9% for each 2°F decrease in temperature. Multiple studies have found significant cooling (2-7° F) and energy savings from shade trees in cities (McPherson, et al., 1997).

- Developments that include green space or natural areas sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing community green space (Benedict and McMahon, 2006).
- 57% of voters are more likely to purchase a home near green space, while 50% would pay 10% more for a home located near a park or other protected area (National Association of Realtors).
- Trees on developed lots add to property assessments, adding about 18% more in real estate value. (Wolf, 2007) (See nature sells graphic.)



Source: Kathleen Wolf, 2007, *City Trees and Property Values.*

Having more natural areas also makes Hampton healthier. Trees absorb volatile organic compounds and particulate matter from the air, improving air quality, and thereby reducing rates of asthma. Trees also clean the air of ground level ozone (O_3), a key air pollutant. Even at the neighborhood level, trees reduce pollutants. Well-treed neighborhoods suffer less respiratory illnesses, such as asthma (Rao, et al., 2014). Thus, trees may improve respiratory health, making people less likely to suffer ill effects from asthma, or complications from flu or corona virus. This also provides savings in lower medical costs.

Adapting landscape design to work with water and welcome it in will allow the city to thrive as it faces a continually changing climate. Utilizing the power of existing vegetation to absorb and transpire water is a more effective approach than trying to manage water only through pipes and underground structures. Reducing stormwater volume and capturing water before it enters the system is also more effective, both in the short-term and long-term. Using adaptive and natural barriers to sea level rise, such as living shorelines and forest buffers, provides habitat, damage protection, and cleaner water for fisheries and people.

The city needs a multipronged solution to become more resilient:

- engineered solutions, such as cisterns, tanks, and drainage pipes
- natural green infrastructure, such as trees and marshes to capture, absorb, and filter water; and
- constructed green infrastructure which combines engineering techniques with natural materials, such as treed bioswales or green rooftops.

By taking a comprehensive and considered approach, Hampton is now using the most strategic tools to create its vision as an adaptive, resilient, and thriving city.

Implementation of this plan is envisioned to take 20 years, but the resiliency journey is unending. This plan will need to be reviewed annually to determine its progress and may be modified as new ideas or circumstances change. The

The plan will need to be adapted as circumstances, personnel, and the environment change. Tracking the plan's progress regularly over time will ensure that intended outcomes are achieved.

plan should also be used to justify necessary expenditures for resiliency projects, grant proposals, and staffing to ensure that every opportunity to reimagine and restore Hampton's landscape is leveraged.

This plan is a living document that is not intended to be shelved, but rather to be integrated into staff work plans, annual budgets, grant proposals and partnerships with outside agencies. An implementation committee will meet at least bi-annually to document the plan's progress and adapt its strategies as needed. New grant opportunities may allow some items to be completed faster and more robustly.

In summary, no city can do this work alone. It will take the considered effort of every staff person, appointed and elected officials, community groups, regional planning agencies, state and federal agencies, businesses, and citizens to realize this plan's vision. The city welcomes everyone on this resiliency journey. To learn more about how to engage or to follow the status of this plan please visit: https://hampton.gov/3459/Resiliency

Appendix A: Funding Opportunities

FEMA offers grants for planning and construction of flood and stormwater infrastructure.

Grants from FEMA

Building Resilient Infrastructure and Communities FEMA Grant: Planning and construction grants for flood and stormwater infrastructure. Very competitive. https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

FEMA Flood Mitigation Assistance Grant Program
https://www.fema.gov/grants/mitigation/flood-mitigation-assistance

Hazard Mitigation Grant Program FEMA

FEMA's hazard mitigation assistance provides funding for eligible mitigation measures that reduce disaster losses. https://www.fema.gov/grants/mitigation

Disaster Planning FEMA Pre-disaster mitigation grants: The Pre-Disaster Mitigation (PDM) grant program provides funds to state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters. https://www.fema.gov/grants/mitigation/pre-disaster

Infrastructure

Clean Water State Revolving Fund (CWSRF)EPA: The CWSRF program is a federal-state partnership that provides low-cost financing to communities for a wide range of water quality infrastructure projects, including municipal wastewater facilities, nonpoint source pollution control, decentralized wastewater treatment systems, stormwater runoff mitigation, green infrastructure, estuary protection, and water reuse. https://www.epa.gov/cwsrf

National Fish and Wildlife Foundation Grants: The foundation provides matching grants for a variety of habitat and green stormwater projects. Check frequently to learn about opportunities in Virginia. Here is an example: https://www.nfwf.org/programs/national-coastal-resilience-fund/national-coastal-resilience-fund-2024-request-proposals. Search on: https://www.nfwf.org/programs

Environmental Education

EPA Environmental Education Grants: The EPA provides grants that support environmental education. https://www.epa.gov/education

NOAA Chesapeake Bay-Watershed Education and Training Program: Encourages capacity building and partnership development for environmental education programs throughout the entire Chesapeake Bay watershed. https://www.fisheries.noaa.gov/grant/noaa-chesapeake-bay-watershed-education-and-training-program

Five Star and Urban Waters Restoration Grant Program: Focuses on the stewardship and restoration of coastal, wetland and riparian ecosystems across the country https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program

Tree Planting Projects

Dominion Energy Charitable Foundation: grants to protect natural resources and help make efficient use of energy, such as planting shade trees or greening school projects: https://www.dominionenergy.com/our-company/customers-and-community/charitable-foundation

Arbor Day Foundation Community Tree Planting Grants: Funds to plant trees in disadvantages communities. https://www.arborday.org/programs/community-roots/

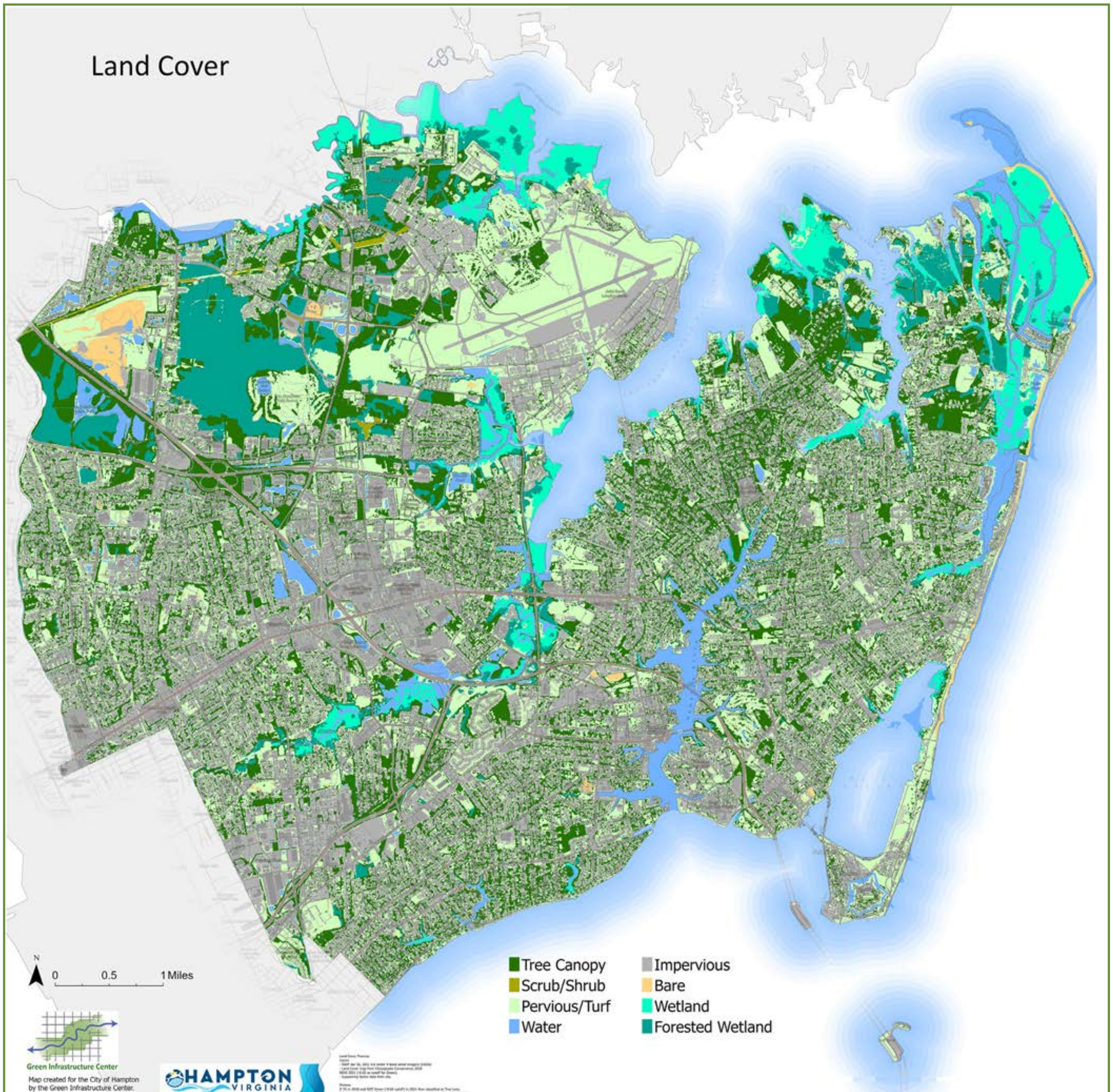
Virginia Department of Forestry Grant Programs: The Virginia Trees for Clean Water Grant Program funds tree planting efforts and public education on trees. Recommended funding ranges from $1,000- $50,000 on a reimbursement basis and grant funding can be applied to private contractors, supplies, trees, site preparation, and maintenance expenses as well. Similarly, the **Urban and Community Forest Grant Program** encourages citizen involvement in urban forestry projects. Funds are also available for staff positions such as arborists. https://dof.virginia.gov/urban-community-forestry/urban-forestry-community-assistance/

Living Shorelines: **The James River Living Shoreline Cost Share Program** is administered by the James River Association and is available to homeowners whose property is within in the James River watershed. https://www.jamesrivershorelines.org/apply.html

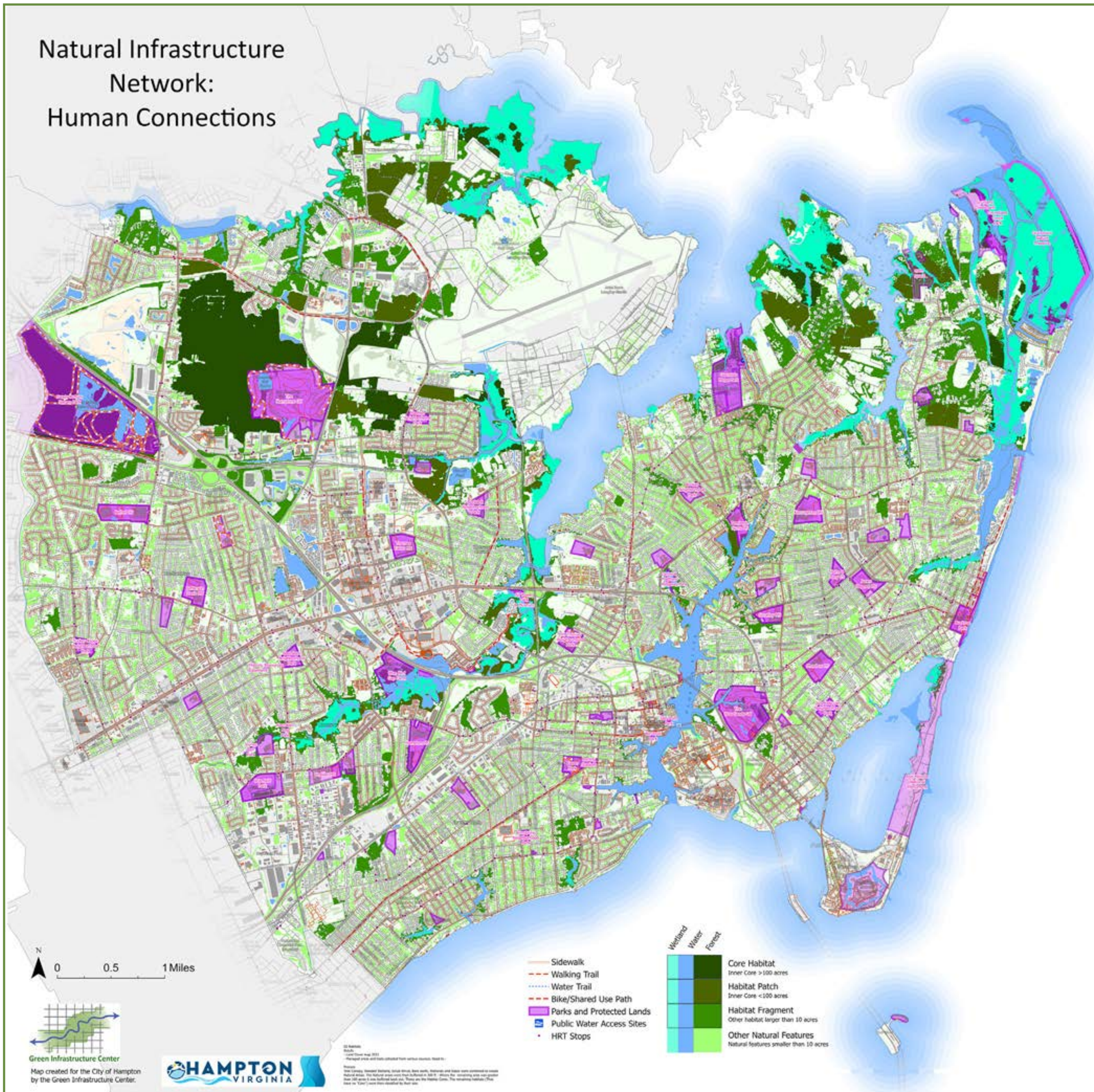
The Virginia Trees for Clean Water Grant Program funds tree planting efforts and public education on trees

Appendix B: Additional Maps

Additional maps created for this project and referenced in this report are included here.

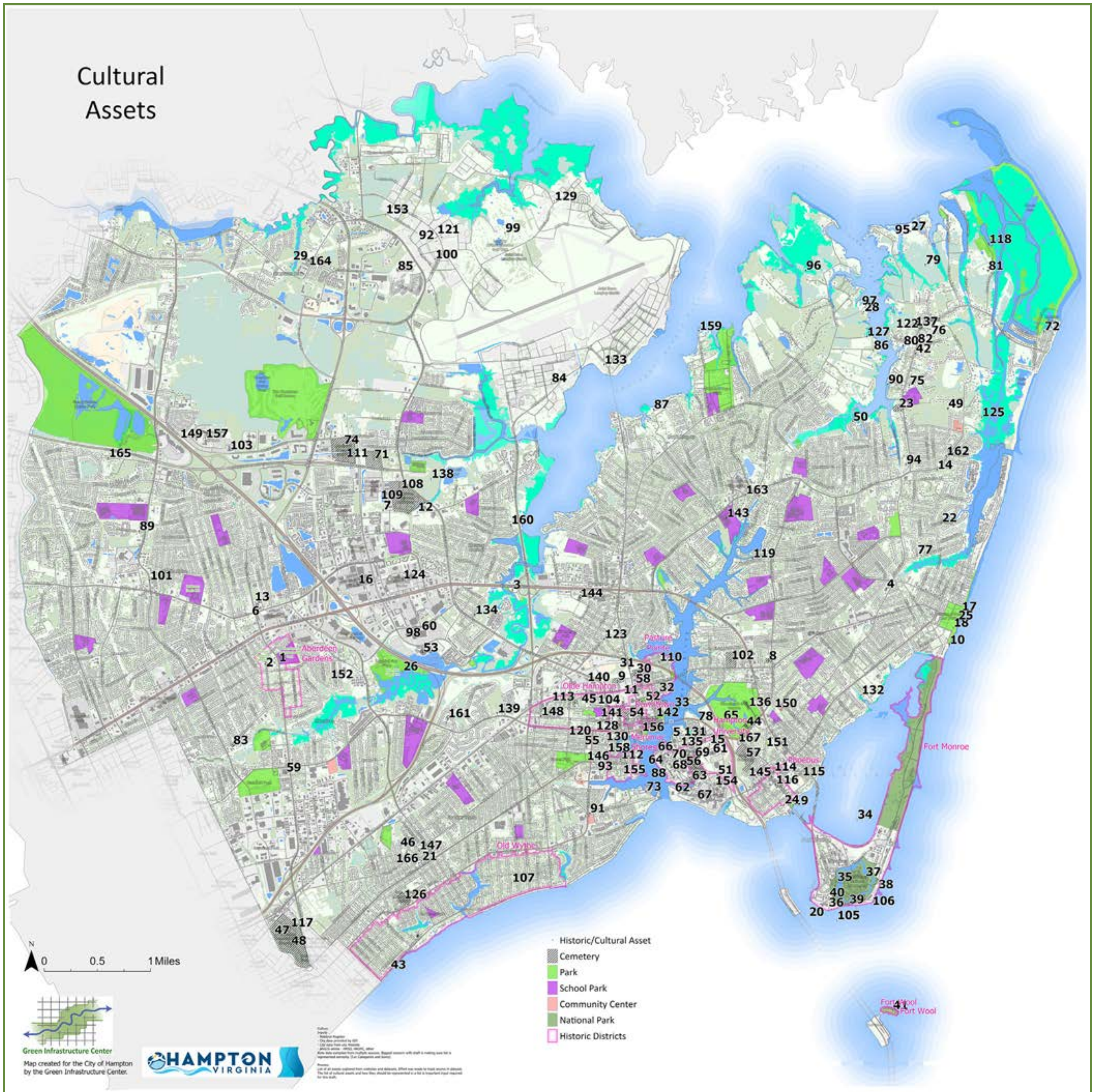


This landcover map was created with 2021 aerial imagery and updated with 2023 aerial imagery.
This map and data inform many of the other maps created in this project.



This map overlays Hampton's human connections such as trails and bus stops on the natural infrastructure network map.

Appendix B: Additional Maps



This map overlays Hampton's cultural assets on the natural infrastructure network map.
The black-numbered recreation assets on this map are listed on the following 3 pages.

Cultural Assets Sites

#	Name	Site Category
1	Aberdeen Gardens Historic District	Historic District
2	Aberdeen Gardens Historic Museum*	Cultural Historical Significant Place
3	Air Power Park Museum	Museum
4	Antioch Baptist Church*	Church
5	Armstrong/Slater Gallery	Museum
6	Ascent College	Higher Education
7	Ballard Cemetery	Cemetery
8	Barnes Cemetery	Cemetery
9	Bassett Cemetery	Cemetery
10	Bay Shore Beach at James T. Wilson Fishing Pier*	Cultural Historical Significant Place
11	Bethel A.M.E. Church Cemetery	Cemetery
12	Bethel AME Church*	Cemetery
13	Bethel College	Higher Education
14	Bloxom - Copeland Cemetery	Cemetery
15	Booker T. Washington Memorial Garden & Statue*	Cultural Historical Significant Place
16	Bryant & Stratton College	Higher Education
17	Buckroe Beach	Cultural Historical Significant Place
18	Buckroe Beach Carousel	Cultural Historical Significant Place
19	Camp Hamilton*	Cultural Historical Significant Place
20	Chamberlin Hotel	Building
21	Chesterfield Site	Cultural Historical Significant Place
22	Children's Museum Of Hampton	Museum
23	Clark Cemetery	Cemetery
24	Clark, Reuben, House	Building
25	Confederate Cemetery	Cemetery
26	Davis Cemetery	Cemetery
27	Douglas Smith Cemetery	Cemetery
28	Drummond Cemetery	Cemetery
29	Ebenezer Cemetery	Cemetery
30	Elmerton Cemetery	Cemetery
31	Elmerton Cemetery/Mary Peake Gravesite*	Cemetery
32	First Baptist Church*	Church
33	First Methodist Cemetery	Cemetery
34	Fort Monroe	Historic District
35	Fort Monroe Chapel Of The Centurion	Building
36	Fort Monroe Museum	Museum
37	Fort Monroe Quarters 1	Building
38	Fort Monroe Quarters 17	Building
39	Fort Monroe Stone Fort	Building
40	Fort Monroe Visitor and Education Center*	Cultural Historical Significant Place
41	Fort Wool	Historic District
42	Fox Hill Historical Society	Museum
43	Garden City Cultural And	Museum
44	Good Samaritan Cemetery	Cemetery
45	Grand Contraband Camp*	Cultural Historical Significant Place
46	Greenbriar Elementary School*	Cultural Historical Significant Place
47	Greenlawn & Pleasant Shade Cemeteries*	Cemetery
48	Greenlawn Cemetery	Cemetery
49	Guy Cemetery	Cemetery
50	Hamilton Cemetery	Cemetery
51	Hampton University Cemetery 2	Cemetery
52	Hampton City Hall	Cultural Historical Significant Place
53	Hampton Coliseum	Building
54	Hampton Downtown Historic District	Historic District
55	Hampton History Museum*	Museum
56	Hampton Institute	Historic District

*African-American Heritage Sites

Cultural Sites *(continued)*

#	Name	Site Category
57	Hampton National Cemetery	Cemetery
58	Hampton National Guard Armory	Building
59	Hampton Post Office	Post Office
60	Hampton Roads Convention Center	Cultural Historical Significant Place
61	Hampton University	Higher Education
62	Hampton University Academy Building (1881)*	Building
63	Hampton University Cemetery	Cemetery
64	Hampton University Cleveland Hall (1874)*	Building
65	Hampton University Emancipation Oak*	Cultural Historical Significant Place
66	Hampton University History Museum*	Museum
67	Hampton University Mansion House (1828)*	Building
68	Hampton University Memorial Church (1886)*	Church
69	Hampton University Museum	Museum
70	Hampton University Wigwam Building (1878)*	Building
71	Hampton Veterans Memorial Gardens	Cemetery
72	Hawkins Cemetery	Cemetery
73	Herbert House	Building
74	Hot. Mem Gardens Cemetery	Cemetery
75	Hubbard Cemetery	Cemetery
76	Jack Routten Cemetery	Cemetery
77	James Topping Cemetery	Cemetery
78	John Biggers Murals*	Cultural Historical Significant Place
79	John Smith Cemetery	Cemetery
80	John Topping Cemetery	Cemetery
81	Johnson Cemetery	Cemetery
82	Joseph Routten Cemetery	Cemetery
83	Joynes Rd Cemetery?	Cemetery
84	Langley AFB Post Office	Post Office
85	Langley Speedway	Cultural Historical Significant Place
86	Latimer - Hickman Cemetery	Cemetery
87	Lattimer Cemetery	Cemetery
88	Legacy Park*	Cultural Historical Significant Place
89	Lewelling-Moore Cemetery	Cemetery
90	Lewis Cemetery	Cemetery
91	Little England Chapel*	Church
92	Lunar Landing Research Facility	Cultural Historical Significant Place
93	Main Library	Library
94	Mallory Cemetery	Cemetery
95	Mason Cemetery	Cemetery
96	Mears Cemetery	Cemetery
97	Messick Cemetery	Cemetery
98	MLK Hampton Heroes Plaza*	Cultural Historical Significant Place
99	Nasa Langley Research Center (Larch) Historic District	Historic District
100	NASA Variable Density Tunnel	Building
101	Northampton Branch	Library
102	Oakland Cemetery	Cemetery
103	Old Dominion University-Peninsula Center	Higher Education
104	Old Hampton Post Office	Post Office
105	Old Point Comfort*	Cultural Historical Significant Place
106	Old Point Comfort Lighthouse	Building
107	Old Wythe Historic District	Historic District
108	Parklawn Cemetery	Cemetery
109	Parklawn Memorial	Cemetery
110	Pasture Point Historic District	Historic District
111	Peninsula Chapel Mausoleum	Cemetery

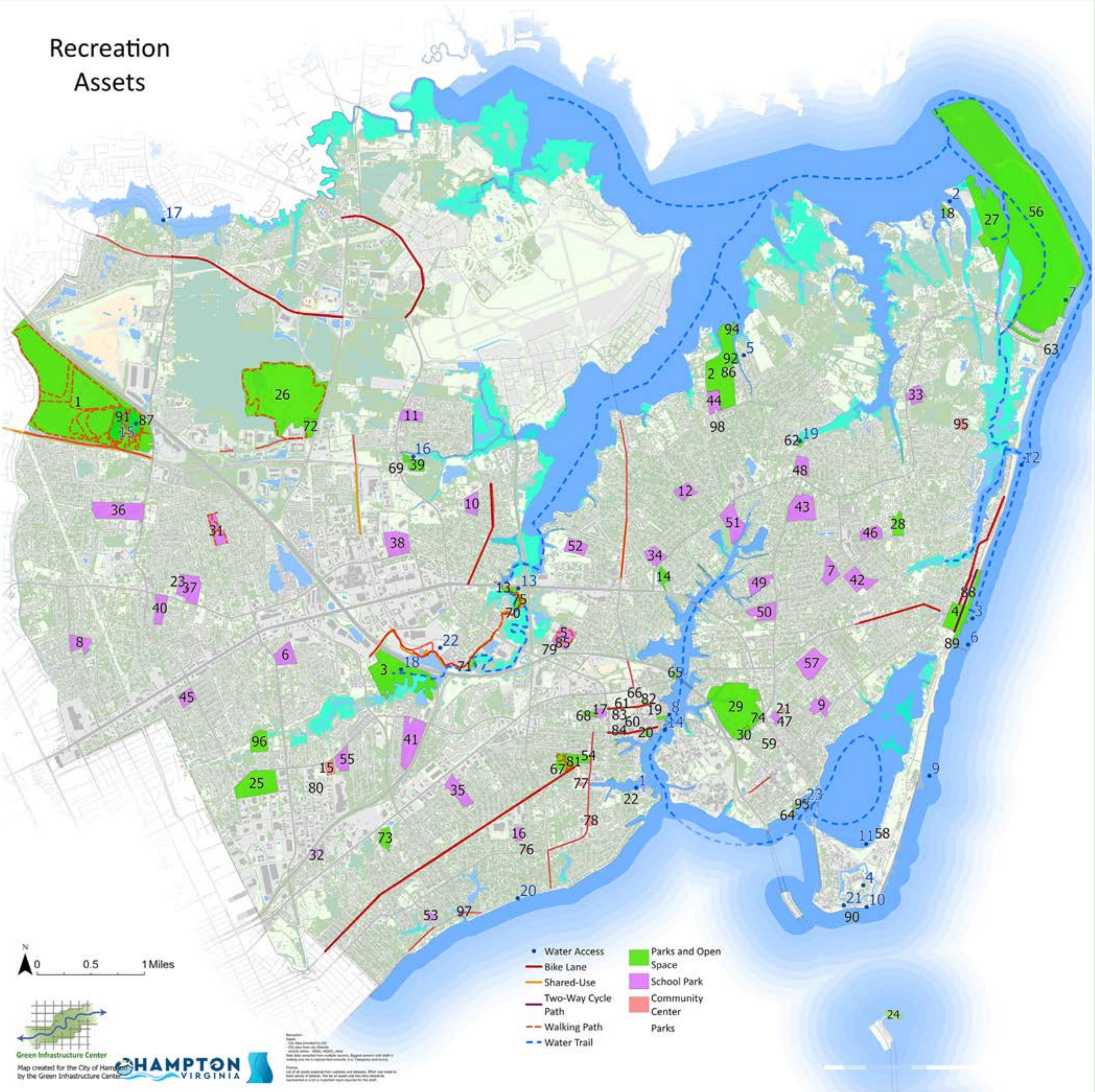
*African-American Heritage Sites

Cultural Sites *(continued)*

#	Name	Site Category
112	Peninsula Museums Forum	Museum
113	Phillips Cemetery	Cemetery
114	Phoebus Branch	Library
115	Phoebus Historic District	Historic District
116	Phoebus Post Office	Post Office
117	Pleasant Shade Cemetery	Cemetery
118	Poole Cemetery	Cemetery
119	Poor House Farm Cemetery	Cemetery
120	Queen Street Baptist Church*	Church
121	Rendezvous Docking Simulator	Cultural Historical Significant Place
122	Richard Routten Cemetery	Cemetery
123	Rip Rap Road And Quash Street*	Cultural Historical Significant Place
124	Riverdale Post Office	Post Office
125	Robert Topping Cemetery	Cemetery
126	Rosenbaum Memorial Park	Cemetery
127	Rountree Cemetery	Cemetery
128	Ruppert Sargent Building*	Building
129	Saint Leo University-Langley	Higher Education
130	Scott House	Building
131	Second Church of Elizabeth City Parish Cemetery	Cemetery
132	Shelton Cemetery	Cemetery
133	Sherwood Cemetery	Cemetery
134	Sinclair/Johnson Cemetery	Cemetery
135	Site Of Dixie Hospital*	Cultural Historical Significant Place
136	Smith Cemetery	Cemetery
137	Spencer Routten Cemetery	Cemetery
138	Sportsplex Lrsn_7001644 Cemetery	Cemetery
139	St. Cyprian's Episcopal Church*	Church
140	St. John's Church	Building
141	St. John's Epis. Church Cemetery	Cemetery
142	St. John's Episcopal Church*	Church
143	Store Cemetery	Cemetery
144	Tenants Lodge Cemetery	Cemetery
145	The American Theater	Cultural Historical Significant Place
146	The Charles Taylor Visual Arts Center	Museum
147	The Virginia School for The Deaf, Blind and Multi-Disabled*	Cultural Historical Significant Place
148	Third Elizabeth City County Parish Church Cemetery	Cemetery
149	Thomas Nelson Community	Higher Education
150	Thornton Cemetery	Cemetery
151	Trusty, William H., House *	Building
152	Tucker Family Cemetery*	Cemetery
153	Vaughan Family Cemetery	Cemetery
154	Veterans National Cemetery	Cemetery
155	Victoria Boulevard Historic District	Historic District
156	Virginia Air & Space Center*	Museum
157	Virginia Peninsula Community College	Higher Education
158	Virginia School Of Hair Design	Higher Education
159	Wallace - Tennis Cemetery	Cemetery
160	Watts Cemetery	Cemetery
161	West Cemetery	Cemetery
162	William Bean Cemetery	Cemetery
163	Willow Oaks Branch	Library
164	Winder Garrett	Cemetery
165	Wood Cemetery	Cemetery
166	Wythe Post Office	Post Office
167	Zion Baptist Church*	Church

*African-American Heritage Sites

Appendix B: Additional Maps



This map overlays Hampton's recreation assets on the natural infrastructure network map.
The black-numbered recreation assets on this map are listed on the following page.
The blue-numbered water access recreation assets on this map are listed on page 92.

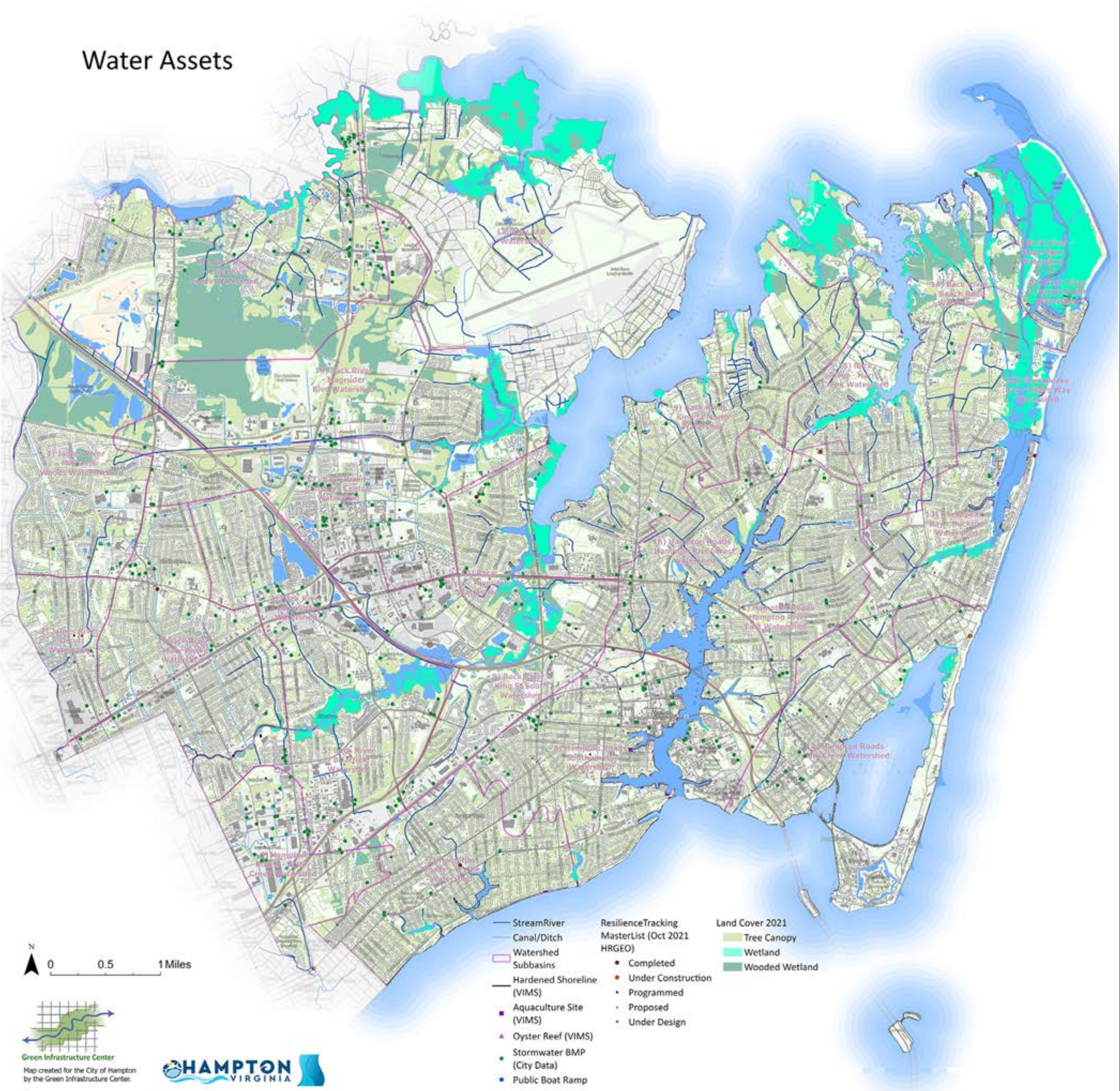
Recreation Sites

#	Name	#	Name
1	Sandy Bottom Nature Park	50	Spratley Middle School
2	Gosnell's Hope Park	51	Syms Middle School
3	Bluebird Gap Farm	52	Tyler Elementary School
4	Buckroe Beach & Park	53	Robinson Park
5	YH Thomas Neighborhood Park	54	Darling Stadium
6	Aberdeen Elementary School	55	Hampton Adult Learning Ctr
7	Cary Elementary School	56	Grandview Nature Preserve
8	Tucker - Capps Elementary School	57	Phoebus High School
9	Jane Bryan Elementary School	58	Fort Monroe CC
10	Burbank Elementary School	59	Fulton St Park
11	Machen Elementary School	60	Hampton History Museum
12	Booker Elementary School	61	Old Hampton Networking Center
13	Air Power Park	62	Sam Houston Park
14	Ridgway Park	63	Beach Rd Park
15	West Hampton CC	64	Phoebus Waterfront Park
16	Armstrong Elementary School	65	River St Park
17	Old Hampton Park	66	Honor Park
18	Dandy Point Boat Ramp	67	James M Eason Memorial
19	Mill Point Park	68	Grant Circle Park
20	Carousel Park	69	Armistead Pointe Park Pond
21	North Phoebus CC	70	Waterwalk at Central Park Trail
22	Sunset Boat Ramp	71	Greenman Property
23	Northampton CC	72	Hampton Aquatics Center
24	Fort Wool	73	War Memorial Stadium
25	Briarfield Park	74	Woodlands Skate Park
26	Hamptons Golf Course	75	Air Power Park
27	Grundland Creek Park	76	Hampton Senior Center
28	Hampton Soccer Park	77	Therapeutic Center
29	Woodlands Golf Course	78	Little England Cultural Center
30	Hampton Tennis Center	79	YH Thomas CC
31	Kraft Elementary School	80	Mingee Dr. Maintenance Office
32	50th St Park	81	Darling Stadium Office
33	Asbury Elementary School	82	Parks Administration
34	Barron Elementary School	83	Old Hampton Networking Center
35	Bassette Elementary School	84	Hampton History Museum
36	Bethel High School	85	Hampton Clean City Commission
37	Tarrant Middle School	86	Gosnold's Hope Park Landscaping
38	Eaton Middle School	87	Sandy Bottom Nature Ranger Station
39	Boo Williams Basketball Complex	88	Life Guard Office
40	Forrest Elementary School	89	Jim Wilson Fishing Pier
41	Hampton High School	90	Engineers Pier
42	Jones Middle School	91	Sandy Bottom Nature Park Lake
43	Kecoughtan High School	92	Gosnold's Hope Boat Ramp
44	Langley Elementary School	93	Phoebus Dinghy Dock
45	Mallory Elementary School	94	Gosnold's Hope Park BMX Track
46	Merrimack Elementary School	95	Fox Hill Neighborhood Center
47	Moton Elementary School	96	Former Tarrant Elementary School
48	Phillips Elementary School	97	Indian River Park
49	Smith Elementary School	98	Friendship Island Park

Appendix B: Additional Maps

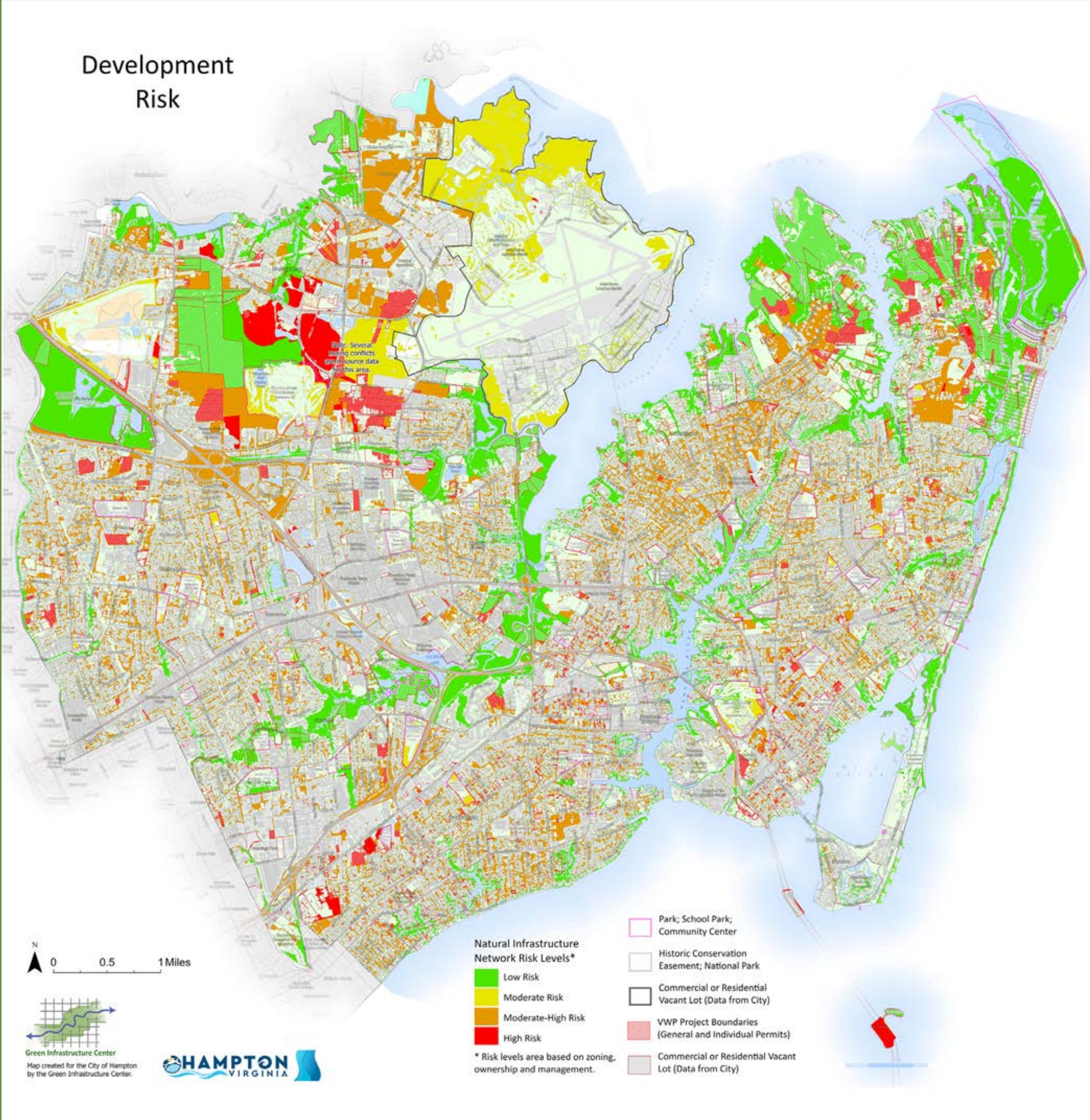
Water Access Sites

#	Name	Boat Ramp	Kayah Launch	Fishing Pier	Swim Beach
1	Sunset Creek Boat Ramp	■			
2	Dandy Point/Fox Hill Landing	■			
3	Buckroe Beach Park		■		■
4	Fort Monroe National Monument				
5	Gosnold's Hope Park	■	■		
6	James T. Wilson Fishing Pier			■	
7	Grandview Nature Preserve/Factory Point				■
8	Mill Point Park		■		
9	Outlook Beach				■
10	Engineer Wharf Fishing Pier			■	
11	Fort Monroe Launch		■		
12	Salt Ponds Beach				■
13	Air Power Park		■		
14	The Docks at Downtown Hampton	■			
15	Sandy Bottom Nature Park		■	■	
16	Armistead Pointe Park				
17	Bethel FAM Camp LAFB	■	■	■	
18	Bluebird Gap Farm		■		
19	Fort Worth Overlook				
20	Chesapeake Avenue - Hampton Roads Harbor Overlook				
21	Continental Park				
22	Waterwalk at Central Park				
23	Mill Creek Dock		■		

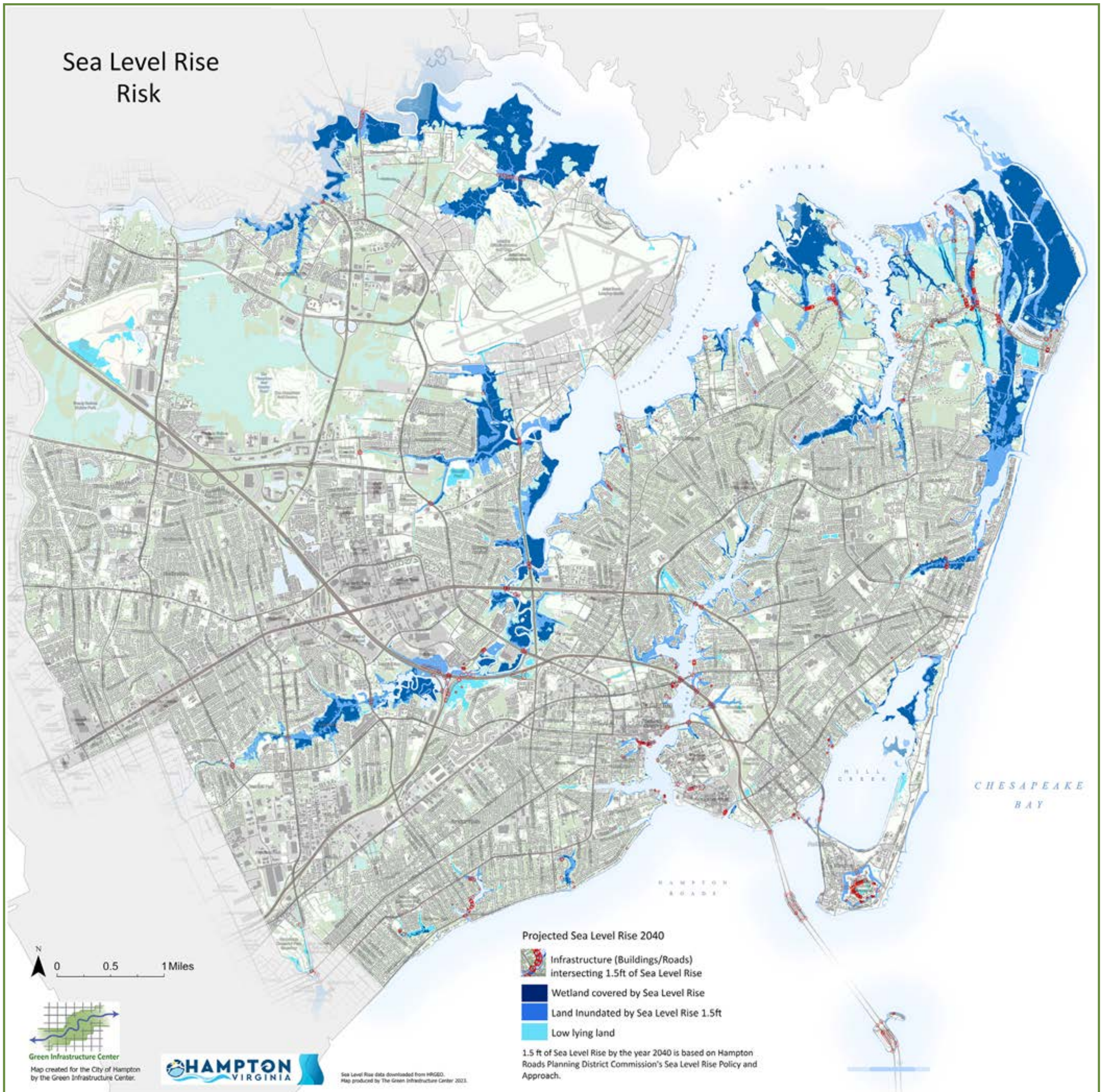


This map overlays Hampton’s water assets on the natural infrastructure network map.

Appendix B: Additional Maps

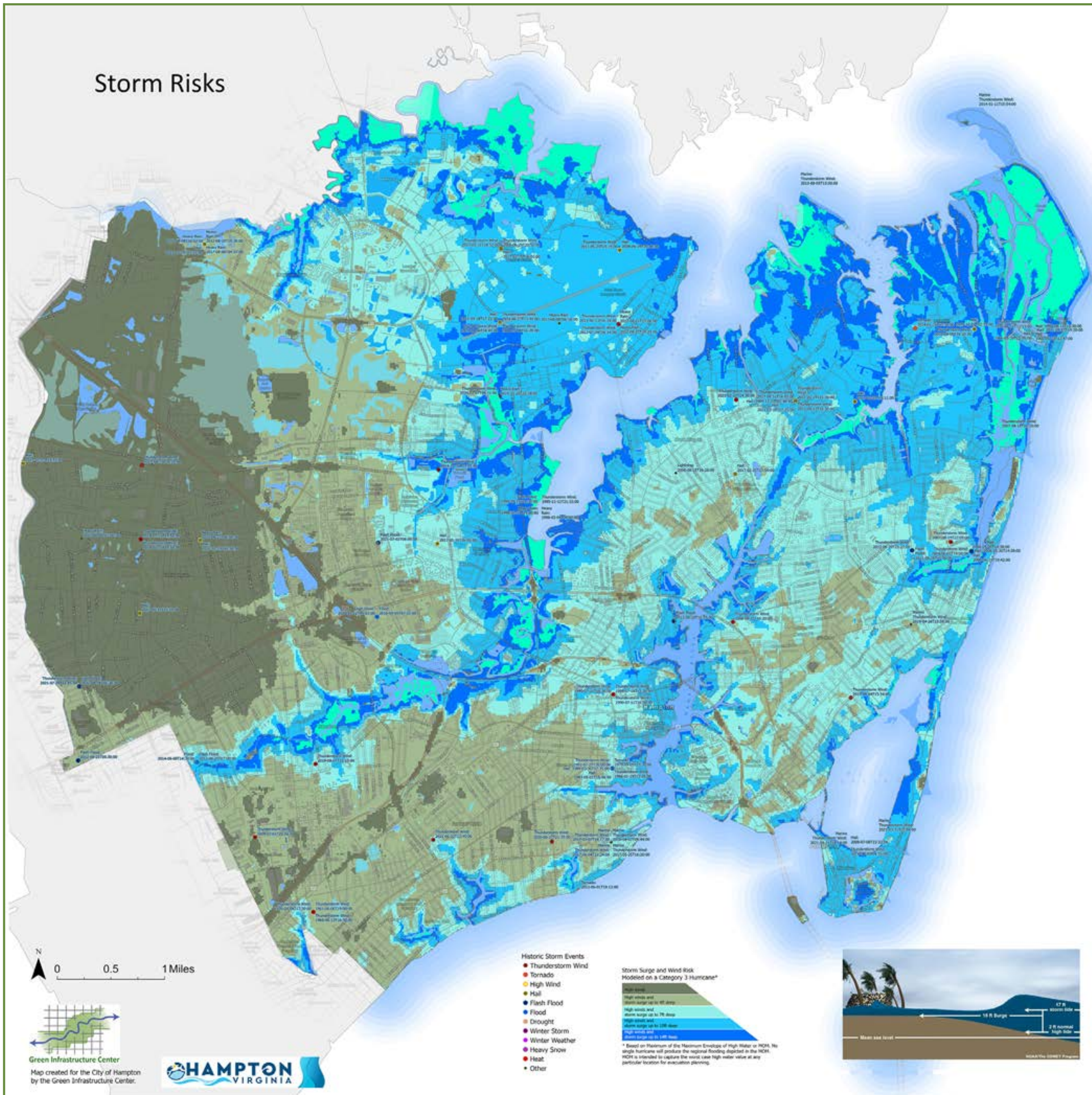


This map analyzes the development risk to Hampton's natural infrastructure.
Green is the NI at the lowest risk and red is the NI at the highest risk of development.

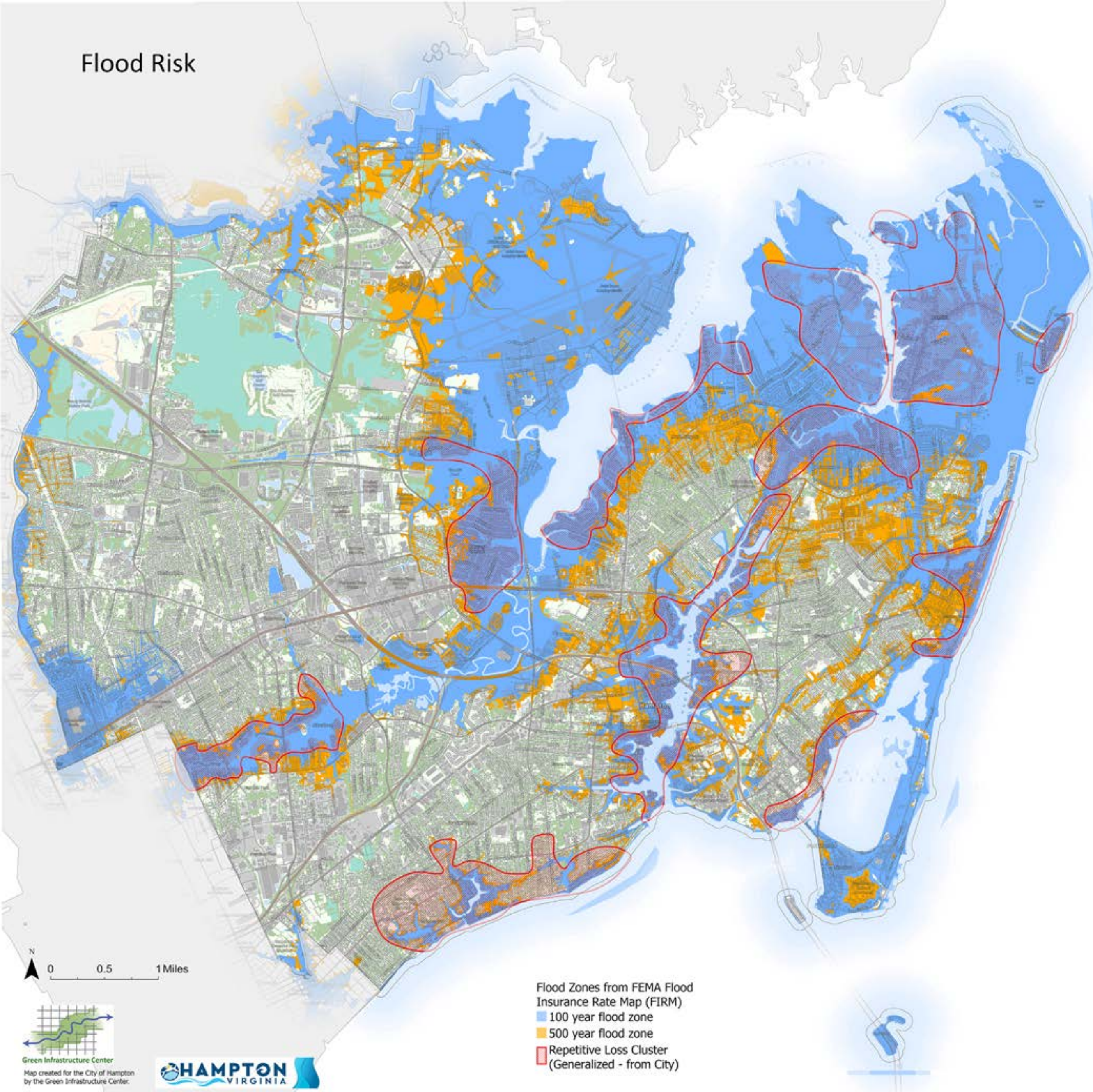


This map analyzes the risk of sea level rise to the year 2040, or 1.5 ft., to Hampton's natural infrastructure. The potential impacts include land and wetland inundated by 1.5 ft as well structures impacted by this level of inundation. In addition, low lying lands likely to experience ponding are also identified.

Appendix B: Additional Maps

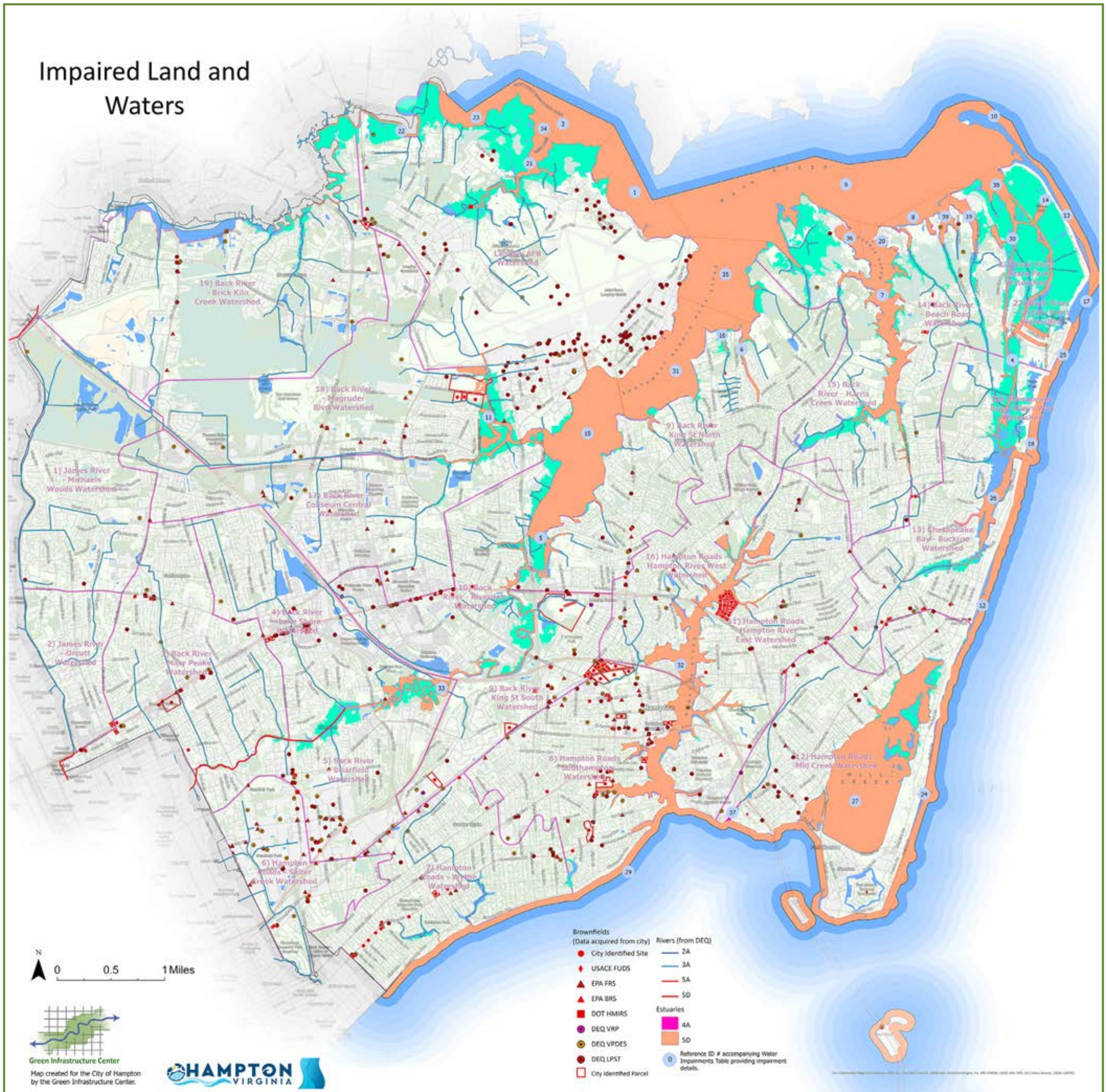


This map analyzes the risk a Category 3 Hurricane poses to Hampton's natural infrastructure. These impacts range from high wind risk to high winds and 14 ft storm surge risk. This map illustrates the Maximum of the Maximum high water for all areas of the city (see Appendix C for more details).

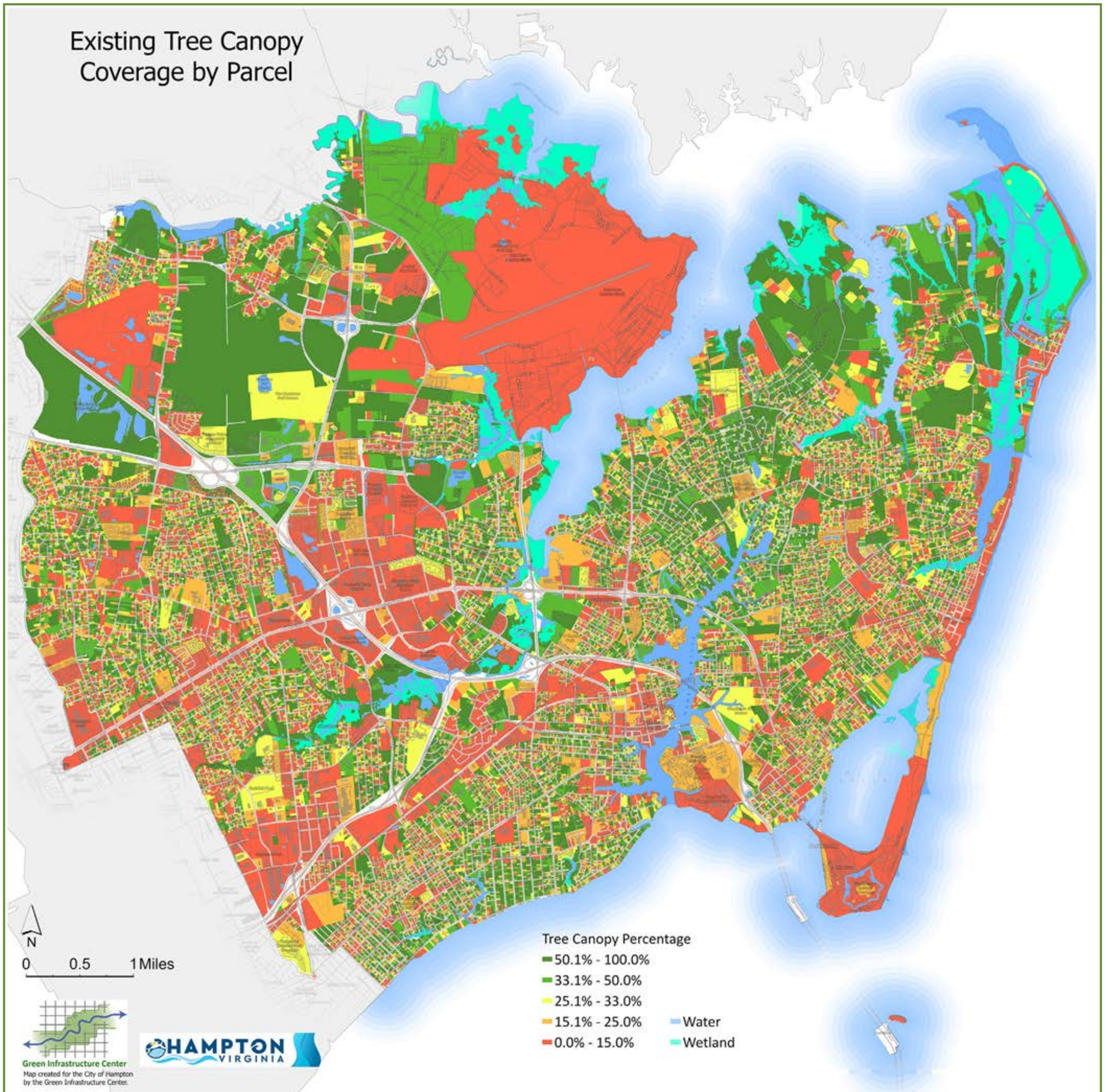


This map illustrates the flood risk facing Hampton's natural infrastructure with the 100-year and 500-year flood zones and repetitive loss clusters.

Appendix B: Additional Maps



This map illustrates pollution challenges facing Hampton's natural infrastructure.
Brownfields and impaired waters are indicated.



This map analyzes the tree canopy in each parcel across the city. These data can help the city identify parcels with significant tree canopy to protect and parcels with ample PPA to plant new trees.

Appendix C: Technical Appendix

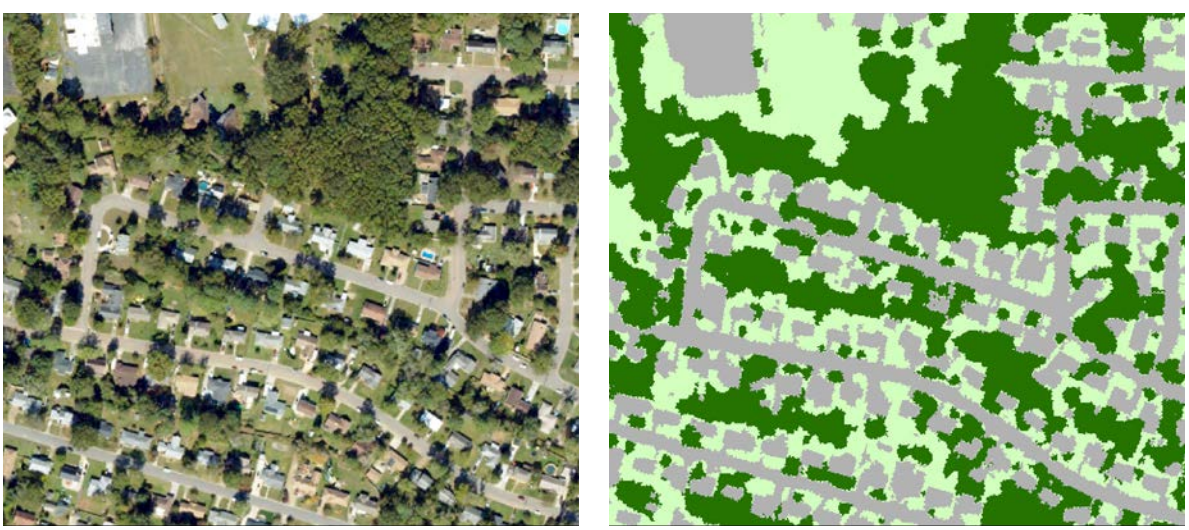
Land Cover Analysis Method

This section provides technical documentation for the methodology used to classify land for the city. Land cover classifications are an affordable method for using aerial or satellite images to obtain information about large geographic areas. Algorithms are trained to recognize various types of land cover based on color and shape. In this process, the pixels in the raw image are converted to one of several types of pre-selected land cover types. In this way, the raw data (the images) are turned into information about land cover types of interest, e.g., what is pavement, what is vegetation. This land cover information can be used to understand land use; for example: What is the tree canopy percentage in a specific neighborhood?

Method

Satellite imagery from the National Agricultural Imagery Program (NAIP) distributed by the USDA Farm Service Agency was classified to determine the types and extent of different land covers in Hampton.

1. Canopy maps were created using the NAIP imagery captured in 2021 and then updated when 2023 NAIP imagery was made available in 2024. Current LiDAR data was not available at the time of classification, so the ArcGIS extension Feature Analyst was used to identify and then update the tree canopy. Feature Analyst employs machine learning for feature classification, and in this case used data from a previous land cover classification created by the Chesapeake Bay Conservancy in 2018 to classify current imagery.
2. Once we had an accurate canopy classification, we proceeded with obtaining the remaining land cover classes:
   a) Tree Canopy over impervious are canopy features that overlapped Impervious surfaces primarily created from existing data such as buffered road centerlines.
   b) Wetlands were based on NWI Wetlands dataset and refined using remote sensing and local knowledge.
   c) Wooded wetlands were also based on the NWI wetlands and refined using the tree canopy data produced in step 1.
   d) Turf/Pervious are features identified as “green” or typically above 0 in NDVI but were not identified as canopy by Feature Analyst.
   e) Impervious surface data from Kimley-Horn and other city sources were used to compile the impervious surfaces layer. These vector datasets were used both for mapping Tree Canopy over impervious surfaces and as training data to pick up missing impervious features.
   f) Bare earth is sometimes confused with Impervious surfaces, but typically has a NDVI closer to 0.



NAIP aerial imagery from 2023 and Landcover image classification.

Natural Infrastructure Network Methods

GIC created a model for an urban natural infrastructure network based on the land cover classification. The natural infrastructure network maps identify natural infrastructure features by size and intactness and overlay the network with human connections and existing connectivity corridors.

Natural Infrastructure Network

Inputs

- Land Cover 2023 NAIP

Analysis

- The first step identifies natural areas, such as forests, wetlands, water bodies, and dunes. These features come from the land cover classifications: tree canopy, forested wetland, scrub-shrub, bare earth, wetlands, and water.
- These natural areas were combined to create a binary natural/non- natural layer which was then buffered in 300 ft. Where the remaining interior core was larger than 100 acres the natural areas were buffered back out and classified as habitat cores.
- Natural areas with an interior core less than 100 acres were classified as habitat patches and natural areas larger than 10 acres were classified as habitat fragments. The remaining natural features less than 10 acres were classified as other natural features.

Natural Infrastructure Network: Human Connections

Inputs

- Land Cover 2023 NAIP
- Natural Infrastructure Network (above)
- City data- parks, trails, sidewalks, bus stops, water access sites

Existing Natural Infrastructure Corridors Come Back

Inputs

- GI Habitats
- NHD Flowline

Analysis

- Habitat Cores from GI Habitats dissolved into one connected Feature
- Open water was selected from the GI Habitats and identified as open water connections
- Natural Streams and Canals from NHD dataset were then buffered and merged into the GI Habitats layer and dissolved.

Results

- Four layers of connectivity identified
- Arrows indicate likely urban wildlife corridors

Photo by City of Hampton

Appendix C: Technical Appendix

Overlay Mapping Methods

Themed overlay maps were created to show recreation, culture, and water assets supported by the natural infrastructure network. The following data sources were used to create these themed overlays.

Recreation Assets Map

Inputs

- City data
- Stakeholder input verified and located from various datasets available from ArcGIS online published by Hampton Roads District Planning Commission.

Cultural Assets Map

Inputs

- National Register data
- City data
- Stakeholder input verified and located from various datasets available from ArcGIS online published by the Hampton Roads District Planning Commission.

Water Assets Map

Inputs

- City data
- Stakeholder input verified and located from various datasets available from ArcGIS online published by the Hampton Roads District Planning Commission.
- Virginia Institute of Marine Sciences (VIMS) Oyster Reefs, Aquaculture Sites and Hardened Shoreline

Risks Mapping Methods

Development Risk Map

Inputs

- Land cover 2021
- Virginia Water Protection (VWP) permits from VA DEQ
- City data- Chesapeake Bay Preservation Act (CBPA) water buffers, parks data, parcel data- vacant parcels, protected parcels

Analysis

- Risk applied to Natural Infrastructure (NI) features based on the following:
- NI in parks or open spaced managed for nature or historic significance, CBPA water buffers, and parcels having a conservation easement were categorized as the lowest risk
- NI in parks managed for recreation/sports facilities and NI on a military base were categorized as moderate risk
- NI on parcels that did not fall into any of these protected classes were categorized as moderate-high risk
- NI on parcels determined to be vacant by the city or parcels with VWP permits were categorized as high risk

Results

- Natural infrastructure features displayed at four layers of development risk:
- Green is low risk
- Yellow is moderate risk
- Orange is moderate-high risk
- Red is high risk

Sea Level Risk Map

Inputs

- Land cover 2021
- 1.5′ Sea Level Rise from Hampton Roads Planning District Commission
- Inundated areas
- Low lying land

Analysis

- Intersected with land cover classifications

Results

- Wetlands inundated by 1.5′ of sea level rise
- Land inundated by 1.5′ of sea level rise
- Roads and buildings impacted by 1.5′ of sea level rise
- Low-lying land

Storm Risks Map

Inputs

- Historic storm events from ODU ASERT Program and HRPDC
- NOAA Maximum of the Maximum data

Analysis

- NOAA MOM Data modeled for Category 3 Hurricane

Note- no single hurricane will produce this scale of regional flooding- the data is intended to demonstrate the worst-case high-water value at any location

Results

- City broken into 5 levels of risk from high winds only through high winds and up 14′ of storm surge

Flood Risk Map

Inputs

- FEMA FIRM 100- and 500-year flood zones
- Repetitive loss clusters from the city

Impaired Land and Water Map

Inputs

❑ Water Quality Assessment data from VA DEQ:

— Rivers and Estuaries used DEQ Water Datasets from Virginia Environmental Data Hub (descriptions below)

❑ Brownfield data provided by city:

— **USACE FUDS**- Army Corps of Engineers Formerly Used Defense Sites

— **EPA FRS**- Environmental Protection Agency Facility Registry Service

— **EPA BRS**- Environmental Protection Agency Biennial Reporting System

— DOT HMIRS- Virginia Department of Transportation Haz**ardous Materials Information Resource System**

— **DEQ VRP**- Virginia Department of Environmental Quality Voluntary Remediation Program

— **DEQ VPDES**- Virginia Department of Environmental Quality Virginia Pollutant Discharge Elimination System

— **DEQ LPST**- Leaking Petroleum Storage Tanks

❑ Categories used in Map: Water Datasets | Virginia Environmental Data Hub https://geohub-vadeq.hub.arcgis.com/pages/Water%20Datasets

—**EPA Category 2** – Available data and/or other information indicate that some, but not all of the designated uses are supported.

— **Va. Category 2A** - waters are supporting all of the uses for which they are monitored.

— **EPA Category 3** - Insufficient data and/or information to determine whether any designated uses are met.

— **Va. Category 3A** - no data are available within the data window of the current assessment to determine if any designated use is attained and the water was not previously listed as impaired.

— **EPA Category 4A** - water is impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.

— **EPA Category 5** - Waters are impaired or threatened and a TMDL is needed.

— **Va. Category 5A** - a water quality standard is not attained. The water is impaired or threatened for one or more designated uses by a pollutant (s03d list).

— **Va. Category 5D** - a water quality standard is not attained where TMDLs for a pollutant(s) have been developed, but one or more pollutants are still causing impairment requiring additional TMDL development.

Appendix C: Technical Appendix

Tree Canopy Analysis Mapping Methods

Tree Canopy

Inputs

- Landcover 2023

Analysis

- Removed large areas of tree canopy loss identified and lost during this project

Results

- Final tree canopy updated based on 2023 NAIP

Existing Tree Canopy Coverage by Parcel

Inputs

- Landcover 2023
- City parcel data provided by the city

Analysis

- Tree canopy analyzed by each parcel boundary

Results

- Tree canopy percentage by parcel based on city goal of 33% tree canopy:
  — 50-100%
  — 33-50%
  — 25-33%
  — 15-25%
  — 0-15%

Existing Tree Canopy Coverage by Census Block Group

Inputs

- Landcover 2023
- Census block group data from 2020 Census.
- Home owners Loan Corporation Historically Redlined Communities- University of Richmond. Downloaded from ArcGIS online: https://www.arcgis.com/home/item.html?id=d77c640241d84b6889ab290cd4cb755b
- CEJST Outline- Source: White House Council on Environmental Quality https://screeningtool.geoplatform.gov/en

Analysis

- Tree canopy analyzed by CBG boundaries

Results

- Tree canopy percentage by CBG based on the city goal of 33% tree canopy in city
  — 50-100%
  — 33-50%
  — 25-33%
  — 15-25%
  — 0-15%

Walkability: Existing Tree Canopy Coverage by Park, School, and Street

Inputs

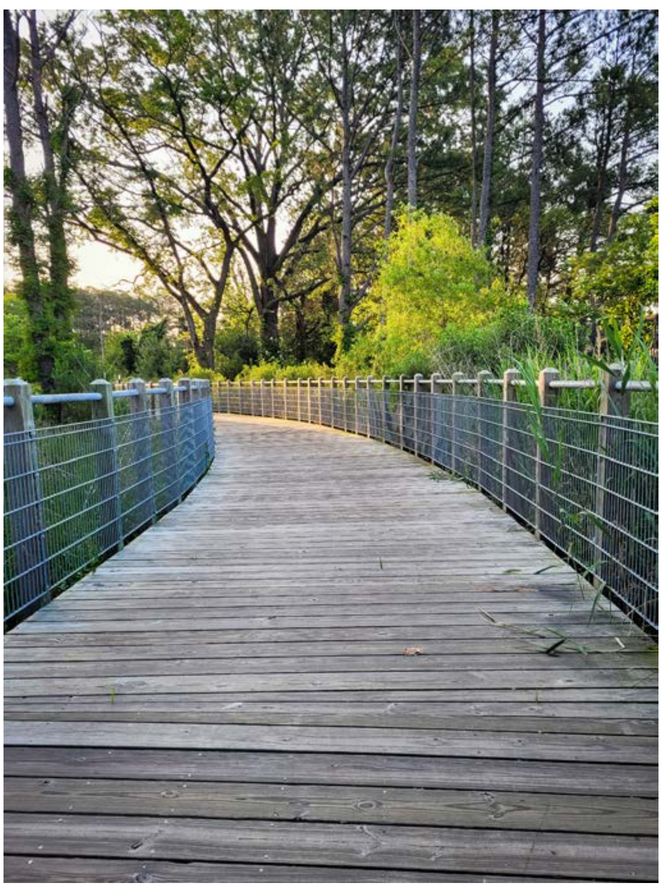
- Landcover 2023
- City data- parks and schools
- Roads from city data

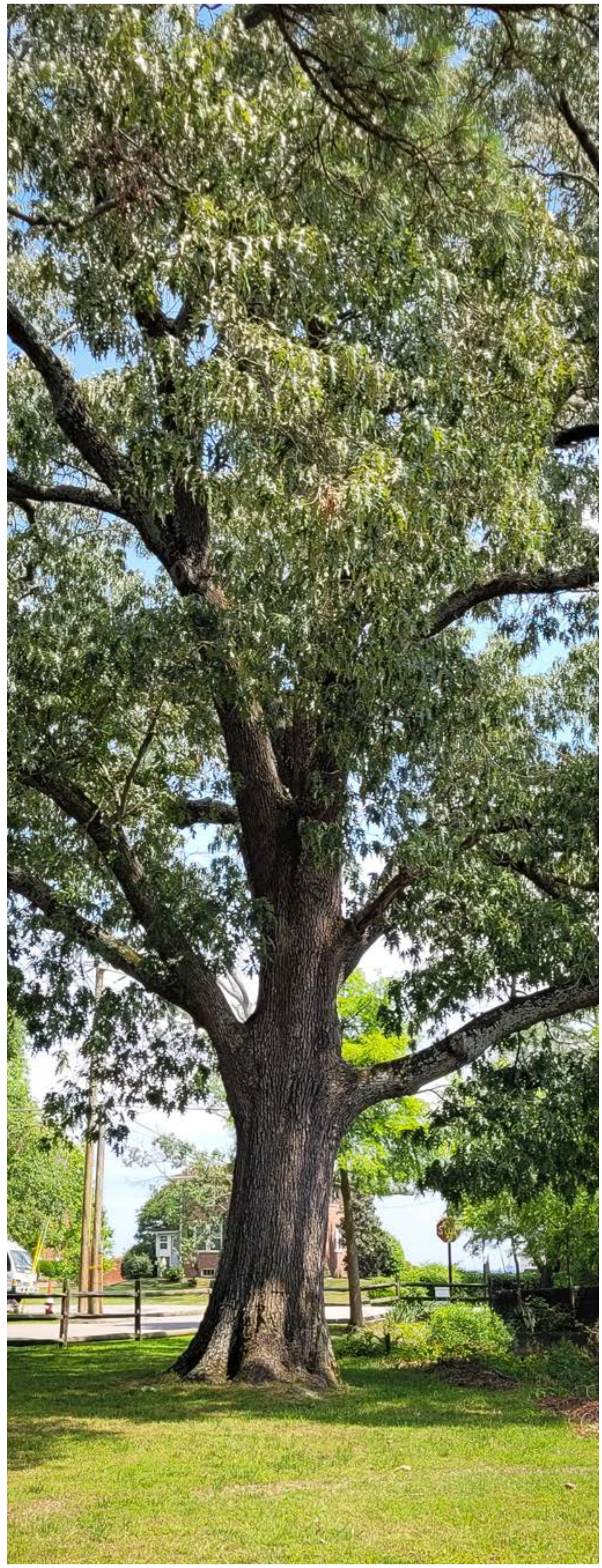
Analysis

- Tree canopy analyzed along streets- from the centerline of the road segment a 50 ft buffer is created and the tree canopy percentage for the road segment is captured within this buffer
- Tree canopy analyzed by park and school parcels

Results

- Tree canopy percentage by streets, parks and schools
  — 51-100%
  — 26-50%
  — 16-25%
  — 6-10%
  — 0-5%

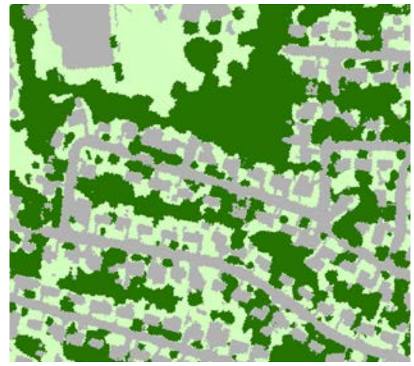




Appendix C: Technical Appendix

Potential Tree Planting Area Modeling Methods

The Potential Planting Area dataset has three components. These three data layers are created using the landcover layer and relevant data in order to exclude unsuitable tree planting locations or where it would interfere with existing infrastructure.


NAIP Image

The Potential Planting Area (PPA) is created by selecting the landcover features that have space available for planting trees, then eliminating areas that would interfere with existing infrastructure.

Initial inclusion selected from GIC-created land cover pervious surfaces class.


Potential Planting Area (PPA)

Exclusion features applied:

- The pervious surfaces were buffered in 10 ft. from all impervious surfaces including buildings and roads.
- Playing fields (i.e.: baseball, soccer, football) as well as golf courses, cemeteries, airports and other incompatible land uses were identified where visually possible. (Digitized by GIC)
- Power Line Corridors and Major Road Median exclusions were created by buffering their representative line data.
- Once this initial phase was completed, the Potential Planting Area data were reviewed by the city and manually edited to best represent expectations of where planting was allowed (e.g., not on play fields). In addition, areas that were projected to be inundated by 1.5′ of sea level rise were excluded.

This additional work to exclude known areas that cannot be planted resulted in a more accurate and realistic calculation of plantable areas and the number of new trees that can be added.


Potential Planting Spots (PPS)

Potential Planting Spots (PPS) are created from the PPA. The potential planting areas (PPA) are run through a GIS model that selects spots a tree can be planted depending on the size tree's that are desired.

- Tree planting scenarios were based on a 20 ft. and 40 ft. mature tree canopy with a 30% overlap. Therefore, the planting spots are 16 ft. and 32 ft. apart respectively.

Potential Canopy Area (PCA) is created from the PPS. The possible planting spots are given a buffer around each point that represents a tree's mature canopy. First, larger canopy trees are digitally added, followed by smaller trees in the remaining spaces. Planting spots were assigned a buffer of 10 or 20 ft. to result in 20 and 40 ft. tree canopy that overlaps by 30%. This reduces gaps that would be found at the corners of adjacent circles and reflects the reality that trees overhang and intermingle with adjacent trees.

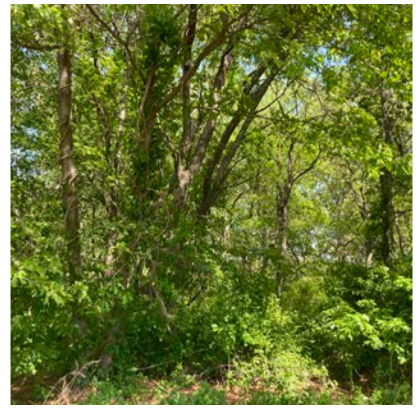

Potential Canopy Area (PCA)

Trees to Offset Stormwater Calculator

The trees and stormwater calculator (TSW) tool developed by GIC uses modified TR-55 curve numbers to calculate stormwater uptake for different land covers, since they are widely recognized and understood by stormwater engineers. A canopy interception factor is added to account for the role trees play in interception of rainfall based on location and planting condition (e.g., trees over pavement versus trees over a lawn or in a forest).

Cities usually use TR-55 curve numbers developed by the Natural Resources Conservation Service (NRCS) to generate expected runoff amounts. The modified TR55 curve numbers (CN) provided by GIC includes a factor for canopy interception. Cities can use the stormwater calculator tool for setting goals at the watershed scale for planting trees and for evaluating consequences of tree loss as it pertains to stormwater runoff. Curve numbers produced for this study can be utilized in the town's modeling and design reviews.

Tree over street



Trees over forest

Tree over lawn

Tree over parking lot

Tree canopy reduces the proportion of precipitation that becomes stream and surface flow, also known as water yield. A study by Hynicka and Divers (2016) modified the water yield equation of the NRCS model by adding a canopy interception term (Ci) to account for the role that canopy plays in capturing stormwater, resulting in:

$$R = \frac{(P - C_i - I_a)^2}{(P - C_i - I_a) + S}$$

Where **R** is runoff, **P** is precipitation, **Ia** is the initial abstraction (the fraction of the storm depth after which runoff begins), and **S** is the potential maximum retention after runoff begins for the subject land cover **(S = 1000/ CN – 10)**.

Major factors determining **CN** are:

- The hydrologic soil group (defined by surface infiltration rates and transmission rates of water through the soil profile, when thoroughly wetted)
- Land cover types
- Hydrologic condition – density of vegetative cover, surface texture, seasonal variations
- Treatment – design or management practices that affect runoff

This new approach allows for more detailed assessments of stormwater uptake based on the landscape conditions of the city's forests. It distinguishes whether the trees are within a forest, a lawn setting, a forested wetland or over pavement, such as streets or sidewalks because the conditions and the soils in which the tree is living affect the amount of water the tree can intercept and infiltrate.

The analysis can be used to create plans for where adding trees or better protecting them can reduce stormwater runoff impacts and improve water quality. This methodology was developed and tested in 13 communities in the south under a grant from the Southern Region of the USDA Forest Service. For more about the project, please visit: https://gicinc.org/projects/resiliency/trees-and-stormwater/

Appendix C: Technical Appendix

Trees and Stormwater Mapping Methods

Optimal Tree Planting Locations for Stormwater Infiltration

Inputs

- Landcover 2023
- PPA
- Soils data- from SSURGO Soil survey

Analysis

- Land Cover and Hydrologic Soil groups are combined and resulting combination is multiplied by curve numbers explained in the Trees to Offset Stormwater Calculator.

Results

- Values are given in inches of rainwater per acre representing where the best places are to plant trees.

Priority Tree Canopy Retention Locations for Stormwater Infiltration

Inputs

- Landcover 2023
- PPA
- Soils data- from SSURGO Soil survey

Analysis

- Land Cover and Hydrologic Soil groups are combined and resulting combination is multiplied by curve numbers explained in the Trees to Offset Stormwater Calculator.

Results

- Values are given in inches of rainwater per acre representing where the most important places are to retain trees.

Trees, Heat, and Equity Mapping Methods

Surface Temperature Map

Inputs

- Surface temperature map- July 20th, 2022 from Landsat 9 (band 8) Imagery

Results

- Color ramp illustrating the surface temperature from hottest (97 degrees) to coolest (69 degrees) across the city

Heat and Equity Priority Tree Planting Areas

Inputs

- Census block group data and MHHI- 2020 Census
- Surface temperature map- July 20th, 2022 from Landsat 9 (band 8) Imagery
- Landcover 2023
- PPA

Analysis

- Categorized CBGs by 5 natural breaks based on MHHI where 5 is the lowest MHHI
- Categorized surface temperature by 5 natural breaks where 5 is the highest temperature?
- Sum rank yields results where 10 is the lowest income and highest temperature and 1 is the highest income and lowest temperature

Results

- PPA for Trees is ranked on a continuum from 1-10 with 10 being the highest priority to plant with trees to address heat and equity

Photo by City of Hampton

Potential Vegetation Planting Areas Mapping Methods

Potential Vegetation Planting Areas for Shoreline Restoration

Inputs

- Landcover 2023
- VIMS Shoreline Structures

Results

- Identified pervious areas along shorelines behind hardened structures and soft shoreline

Potential for Unimpeded Marsh Migration

Inputs

- Landcover 2023
- 1.5' Sea Level Rise from HRPDC
- 3' Sea Level Rise HRPDC

Results

- As sea levels rise marsh migration would be possible in these areas if it were unimpeded by trees, roads, buildings, bulkheads etc.

Current Open Space Available for Marsh Migration

Inputs

- Landcover 2023
- 1.5' Sea Level Rise from HRPDC
- 3' Sea Level Rise HRPDC

Results

- As sea levels rise marsh migration is possible in these pervious areas

Potential Vegetation Planting Areas for Habitat Restoration

Inputs

- Landcover 2023
- Overhead Powerlines- USGS: U.S. Electric Power Transmission Lines. This feature layer, utilizing data from Homeland Infrastructure Foundation-Level Data (HIFLD), depicts electric power transmission lines in the United States.
- 1.5' Sea Level Rise from HRPDC
- Streams and rivers- National Hydrologic Dataset's flowlines.

Analysis

- Categorized PPA for trees and non-tree plantable areas

Results

- PPA for Trees and other vegetation is broken out into stream buffer planting, tidal water body buffer planting, and future coastal buffer planting
- PPA for non-tree plantings categorized by area covered by 1.5' of sea level rise and area under powerlines

Potential Vegetation Planting Areas for Pollution Mitigation

Inputs

- Landcover 2023
- Major roads
- Stream and canals- National Hydrologic Dataset's flowlines
- Brownfields- city data

Analysis

- Consolidated large impervious surfaces
- Categorized pervious surfaces based on distance from sources of pollution such as brownfields, major roads and impervious surfaces and further categorized by adjacency to river, stream or canal

Results

- Pervious areas classifications that can be planted with vegetation to mitigate air, water and/or ground pollution based on pollution source and surrounding features

Appendix D: Community Feedback

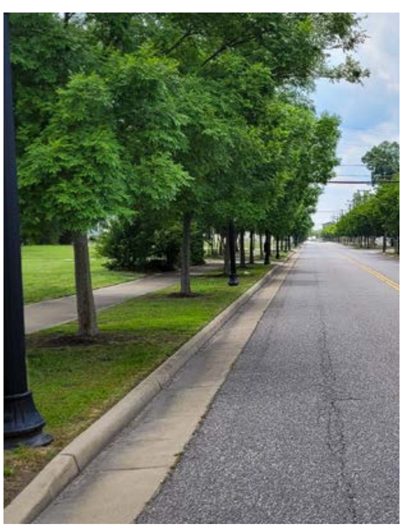
There were 88 responses to the community survey online and also paper surveys. Following are the full set of responses to each question. These comments are not edited, they are as submitted.

1. I am a…

- City resident (82)
- Work in the city but live elsewhere (3)
- Other (3)

2. What neighborhood do you live or work in?

- District 1- Northampton (3)
- District 2- Magruder area (3)
- District 3- Mercury Central (5)
- District 4- North King (7)
- District 5- Foxhill (24)
- District 6- Buckroe (10)
- District 7- Phoebus (7)
- District 8- Downtown (8)
- District 9- Greater Whythe (18)
- District 10- Aberdeen (3)



3. Which of these assets do you want to see more of in your community?

(Choose top three)

- Native habitat for birds and pollinators (41)
- Walkable streets shaded by street trees (40)
- Nature trails (34)
- Shade trees in parks and playgrounds (23)
- Parks (23)
- Bike trails (18)
- Access to water for fishing (10)
- Access to water for kayaking (10)
- Boat ramp (9)
- Other, please specify (22)

A. Year-round beach access for licensed and well behaved dogs

B. Viewable waters ways. i.e. the waters alongside of several of our roads such as La Salle Ave. from Armistead Ave. toward LAFB. Removal of the underbrush and smaller trees would grant us the opportunity to see our beautiful water ways, creeks etc.

C. Streets that don't flood

D. Respondent also selected Bike trails, Access to water for kayaking, Native habitat for birds and pollinators, Trees providing shade in parks, and Parks

E. Respondent also selected Access to water for kayaking, Native habitat for birds and pollinators, Trees providing shade in parks, Parks

F. Protect existing tree canopy and expand tree canopy! Have incentive programs for residents, businesses and organizations to plant and maintain trees

G. None of the above, can't think of any

H. Lighting at night

I. Less land clearing for new residences. Use current vacant/ condemned lots for new buildings.

J. Increase in the navigability and boat access to existing waterways.

K. Improved parking for beach access

L. Grocery store

M. Fruit trees on sidewalks

N. For the city to clean the ditches along Harris creek road from creek view to the end of road. Some areas of these ditches haven't been cleaned in 16-19 years.

O. Fix up excessing neighborhood Parks. (Ridgeway Park).

P. Dense housing

Q. Community gardens

R. Cleaned ditches along Harris creek road. Ditches haven't been cleaned in 20 years or more. Mayor Tuck says he has drones to inspect ditches with; perhaps he could send one along Harris creek from Creekview on down.

S. Clean ditches along Harris creek road. They haven't been cleaned in years.

T. Buckroe and Phoebus area is great. We could use a community center in the area.

U. A sidewalk on Atlantic Avenue(The section between Pembroke & Mallory). This section of Atlantic Ave. is very narrow, and has wide ditches on both sides.)

4. What are the places you and your family want to be able to walk to? (Choose top 3)

- Neighborhood parks (48)
- Nature trails (45)
- Commercial districts (shops and restaurants) (36)
- Water access points (29)
- Schools (20)
- Libraries (20)
- Community and Neighborhood Centers (17)
- Other, please specify (12)

A. Rural area, nothing close by.

B. Respondent checked Schools and Commercial districts (shops and restaurants)

C. Respondent also selected Neighborhood parks, Libraries, Nature trails, and Water access points

D. Respondent also selected LIBRARIES; under Other, responded "all of it frankly"

E. Quality grocery store

F. Neighborhood parks

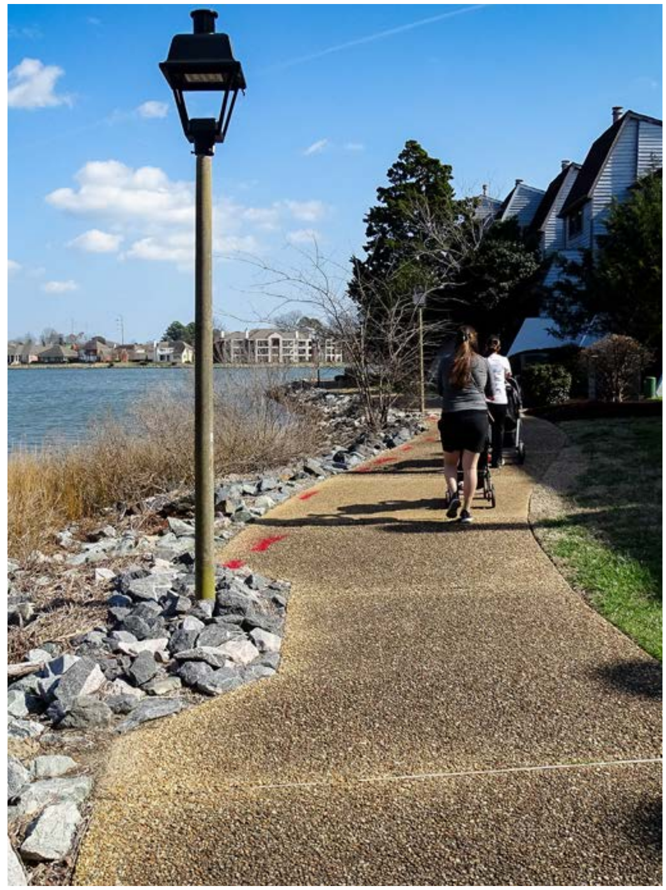
G. Grocery store

H. Grocery

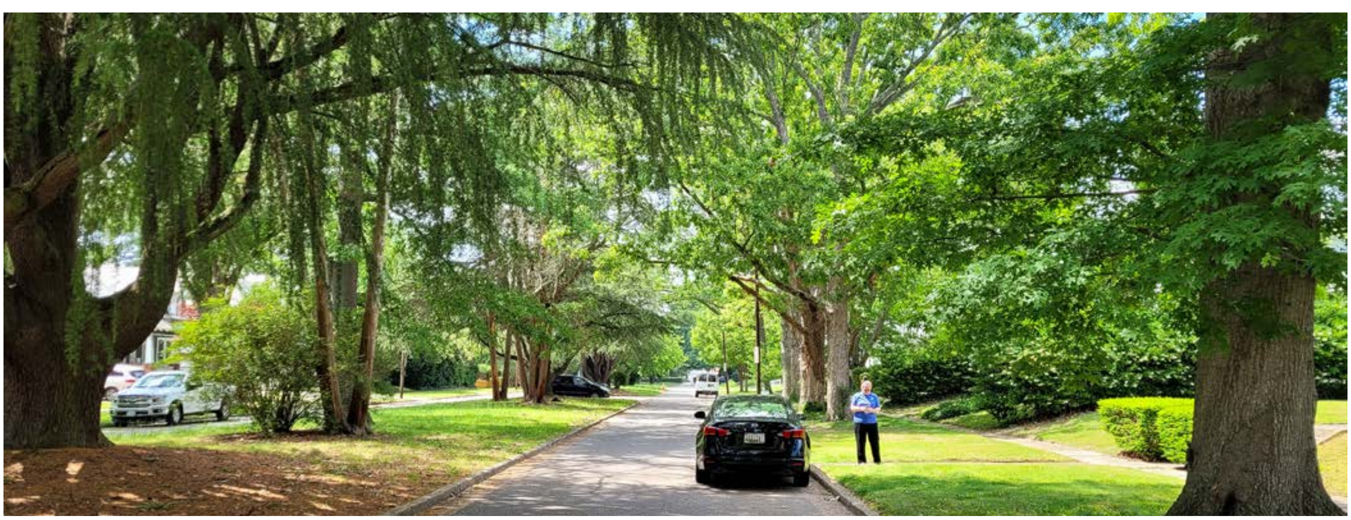
I. Few walkable decent neighborhood restaurants in Olde Wythe. Kecoughtan Rd. business area deteriorated. Must drive to Hampton, Phoebus or Fort Monroe, or much farther. I drive to do all grocery shopping Whole Foods or Costco in Newport News.

J. Don't have family, none of the above

Parks, nature trails, native habitat and water access are popular natural assets of the residents of Hampton.



In addition to water accesss, Hampton residents value walkable streets shaded by street trees.



Appendix D: Community Feedback *(continued)*

5. Locate your favorite natural asset on the map. Describe the natural asset location identified on the map.

- I love Grandview, but I can't stand now the beaches that used to be public (2 of them - 1 in Buckroe, 1 in Grandview) are now private.
- Water and places to go outside.
- This is Grunland Creek and the surrounding marsh- it is a beautiful, living wetland. It's full of osprey, bald eagles, herons, deer, foxes, raccoons, woodpeckers and the occasional coyote. Plus all the marsh plants and crabs and snails and oysters. It is essentially undeveloped and I hope it stays that way. It gives you a glimpse of what this whole area must have looked like before it was settled, like a little Garden of Eden.
- The walk along Chesapeake Blvd. to LaSalle road. I love to watch the waterfowl and the view of the estuary.
- The walk along Chesapeake Blvd allows wonderful views of water birds, ospreys and the estuary. I love that there are small city owned places with benches to sit on to watch the water.
- The sidewalk along the water downtown from the city vehicle lot to the hotel. It is a great (usually) safe place to walk, and I wish the signs prohibiting bicycles would be put up again.
- The seawall at Fort Monroe-I enjoy the long walk along the water
- The Matteson trail. Perfect mix of sun and shade and perfect distance with the flexibility of taking a 3 mile trail and making it into 2, 6 or 9 miles, etc.
- The extended portion of Back River that is nearby to LaSalle Road & Armistead Road.
- The beginning of the Waterwalk Trail by the Space Park is wondrously beautiful. On a foggy, frosty morning, there can't be a prettier place in Hampton than the river and marshes there. I love to walk there and watch it change through the seasons. Plus, the wooden walkway is much easier on my joints than pavement. Thank you for building that!
- The beach, Hampton Coliseum (so far from my house)
- Sunset Creek Boat Ramp, small boat access in sheltered waters. Great for beginning kayakers, boaters. Would love to see restrooms and benches.
- Seawall at Ft Monroe. Trees, green space. History to explore.
- Sandy Bottoms. We love the Playground, trees, nature trails, and lakes. It is the closest and most accessible natural area near us.
- Sandy Bottom. It is a natural area that is large enough for many plants and animals to live there. I enjoy walking and birding there.
- Sandy bottom Running walking openness
- Sandy Bottom park, great location with accessible hours and parking.
- Sandy Bottom Park
- Sandy bottom nature park. Open, easy access

Photo by City of Hampton

- Sandy Bottom Nature Park, really the only natural area in Hampton other than Grandview Nature Preserve. It's a place to observe nature. It's too bad there's not a sound barrier to block the highway noise - it's loud and continuous.
- Sandy Bottom Nature Park I like the natural habitat, the location, easy access. Family friendly place.
- Sandy Bottom Nature Park is important to myself and the community at large. The park showcases many native southeastern Virginia plant species and offers a visitors a glimpse of the natural environment that existed on the southern peninsula before our area become heavily developed. In addition, the park is a true "comeback" story following highway development activity and years on prior neglect. Sandy Bottom's story provides insights into the true resiliency of the nature environment and should be used as a model to guide future resiliency and habitat restoration projects.
- Sandy Bottom Nature Park
- River View Farm Park in Newport News. Beautiful, full of native trees and plants. I would appreciate if you could give away some fruit trees saplings (pawpaw, persimmon etc.), as Norfolk does.
- Respondent circled downtown and Buckroe. (Map only allows one pin.)
- Our parks are great assets, especially Bluebird Gap Farm and Sandy Bottom Nature Preserve.
- Only one I can think of is Briarfield Park. Why? Used to deliver newspapers on E Street in the a.m. and later. Afternoon papers in the p.m. (Times-Herald) when it was Copeland Park in the mid-60s. Later worked with Parks & Rec on weekends.
- not techno savvy enough to read map
- Newmarket creek. It is an active waterway that stretches deep into Hampton reaching the Newport News line. It has so much potential. The re-engineering of the bridges over the creek at Armistead, Mercury and King St bridge onto LAFB (from arched to flat bridges) has taken away navigability by most boats. This has also hurt the property value potential for a large stretch that used to offer boat access. A long term denial of important tax revenue!
- Nature Preserve. Beautiful and preserves wetlands.
- Love Fort Monroe natural scenery, want wetlands protected
- Living on Ft. Monroe naturally makes it my favorite asset - but it is so cut off from the rest of the city unless you have a car. I want to see Hampton be BRAVE and connect the city with safe comfortable walking/biking routes. And bike graphics don't count.
- Kraft park. Closest park and walking trail to my house.
- Kayak launch at Mill Point Park to Hampton River
- I love Gosnold Park and the wetlands down Harris Creek Road.
- I enjoy all of the above locations. Fort Monroe, Grand View Nature Preserve and walk along Chesapeake Blvd top of the list.
- Hampton River and its watershed is one of the gems of Hampton. Its history and present day natural assets makes it an urban oasis—one that needs protected as well as restored. Need more and improved access for people to experience it and care.
- Grandview, Bluebird Gap Farm, Sandy Bottom Nature Park
- Grandview wildlife preserve
- Grandview Preserve--use to be a really nice beach to walk
- Grandview park/beach
- Grandview NATURE PRESERVE. I capitalize this area because in the past 5 years, it has become well-known as "Grandview Beach..." This Preserve has a well-maintained and educational 1/4 mile walking trail accessing 2.5 miles of mostly sandy beach, a nesting area for migratory birds. Once a coastal forest, it still has some trees and natural grasslands inhabited by other wildlife. What makes it so special is that the only non-natural sites and sounds are from occasional jets from Langley and personal jet-skis, making it a haven for experiencing nature's wonder, the bay, quiet contemplation, beach walks and fishing. It's a true "get-away" from any traffic, buildings, and the noise of human activity. With increased beach-goers &limited resources to ensure non-access to the dunes, woodlands and beach nesting areas, it appears to becoming endangered for the natural wildlife, for which City, State and Federal funding had originally intended. Hampton has enough supervised beaches!
- Grandview Nature Preserve -- introverts like myself needs a quiet place to walk and refresh

continued

Appendix D: Community Feedback *(continued)*

5. Favorite natural asset (continued)

- Grandview marsh birding
- Grandview and the city nature preserve
- Grandview
- Grand View Access to the park is ok. I know it's got to wear thin on residents sometimes… I live 2 blocks from Buckroe Beach, and when I want a quieter beach during the summertime, I go down there. I am also a naturalist, bird watcher and a member of the Sierra Club. Pristine areas for shorebirds and other sea life are critical . I am concerned about the shore birds that have been displaced due to HRBT construction. I know they have a temporary barge to nest upon right now, but I'm really anxious about the plans for a secondary nesting site for them later
- Grand view & Factory Point; this area is an excellent habitat for endangered or protected nesting birds, and insects.
- Gosnolds Hope Park is the best --lots of natural green space and a waterway. It's a different type of entertainment venue.
- Gosnold Hope Park, is a high utilized city park, that provides open and safe spaces for citizens and visitors. It is important because it provides that safe, open space for neighboring communities that further enhances a sense of "community" in our city. I would love to see updates and upgrades as simple as more restrooms and water fountains.
- Gosnold Hope Park is close to my house and is a beautiful park with small campground, but the large space seems to be mostly utilized for sports practice. I would enjoy it if their more outdoor events there and if the playground was shaded. The equipment gets too hot in the summer time.
- Gosnold Hope Park has everything-boat ramp, sheds for gatherings, walking trails, playground for children, public bathrooms. Love it.
- Ft Monroe. The beach, board walk, green space and big trees, bike riding. Shade.
- Ft Monroe has nice boardwalk and beaches, Wish that Dog Beach was open to public
- Ft Monroe & Grandview Preserve.
- Fort Monroe: lots of shade, quiet streets, beautiful views of Chesapeake Bay, YMCA, beautiful views of the moat and casemates, beaches, coffee shop, visitor center But there are NO public restrooms!
- Fort Monroe. Awesome view and beach. Love the gazebo as well as concerts
- Fort Monroe, Ridgeway Park, Grandview,
- Fort Monroe lookout from top of fort: Views of wildlife, water, ships, submarines, dolphins, birds, historical areas, up a hill. Wish we had a bike path from downtown Hampton to Phoebus/Fort Monroe.
- Fort Monroe Board walk. I enjoy walking and viewing birds, dolphins and once in a while a whale. I like the Buckroe board walk as well, but I don't feel particularly safe there at this time. I also like the Grandview nature trails.
- Fort Monroe beach. Best place to sit on the beach that is not crowded
- Fort Monroe - for walking and beach activity Downtown Hampton - for walking
- Fort Monroe - a lot to while walking outside. I can still go inside at the Visitor's Center or grab a bite to eat, but can walk everywhere.
- Don't know
- Buckroe Beach-clean and safe-numerous people can walk at the same time and have plenty of space.
- Buckroe Beach is my favorite place, however it has had a lot of investment and is in pretty good shape. My next favorite thing would be better access to Hampton River for kayaking. Now that the River Street Park and kayak launch is gone, there are very limited places to put in.
- Buckroe Beach is a beautiful place to walk, take kids to play, walk dogs, ride bikes, relax on the beach and fish. Currently we have to drive there since Old Buckroe rd. does not have good biking or walking access.
- Buckroe Beach and Park. It is a pleasant place to relax even in the Winter time, and it is close to my home.
- Buckroe Beach and Ft. Monroe beaches
- Buckroe Beach
- Boardwalk on the Chesapeake Bay at Ft. Monroe: place to walk, observe the birds and dolphins; enjoy the ever changing skies; Watch the shipping vessels, military vessels and fishing vessels; think about the history of the place (Ft. Wool included).
- Bluebird Gap Farm, animals, park, nice place to visit and take friends. Like the use of the pavilion. Boat Ramp, good resource for putting a boat off.
- Beach
- Sandy Bottom

6. If there is an area where you experience flooding in your neighborhood, locate it on the map. Describe the flooding location identified on the map.

- We get flooding on Beach Rd., Johnson Rd., and Wind Mill Pt. Rd. all the time. It is now worse since the city has allowed new homeowners to bring in tons of dirt, thereby flooding the rest of us even worse. (The map only allows one pin for a flood marker.)
- Wythe (where I have family) experiences extreme flooding on the waterfront. My home along the Little Back River area can also see a lot of water on the roads during events like hurricanes.
- When there is a bad storm, we can get some flooding down the street. Not always. Just sometimes.
- This intersection regularly flooded with bad storms- though it has been closed for the past months due to utility work and it's possible it was fixed. But it's the only intersection leading in to our part of Fox Hill and it would flood pretty badly in the past.
- There are only two ways out of Fox Hill - via Bloxom's Corner and Colonial Acres at Old Buckroe Road with Bloxom's Corner being the major carrier of traffic. When Bloxom's Corner was flooded, we made many attempts to take neighborhood roads to Colonial Acres, but several of those streets were flooded. We worried about emergency vehicle access, especially because Mom was frail. (A secondary flooding spot was the intersection of Eastlawn Drive and Cardinal. We lived just two houses away; luckily we could use Hall Rd.)

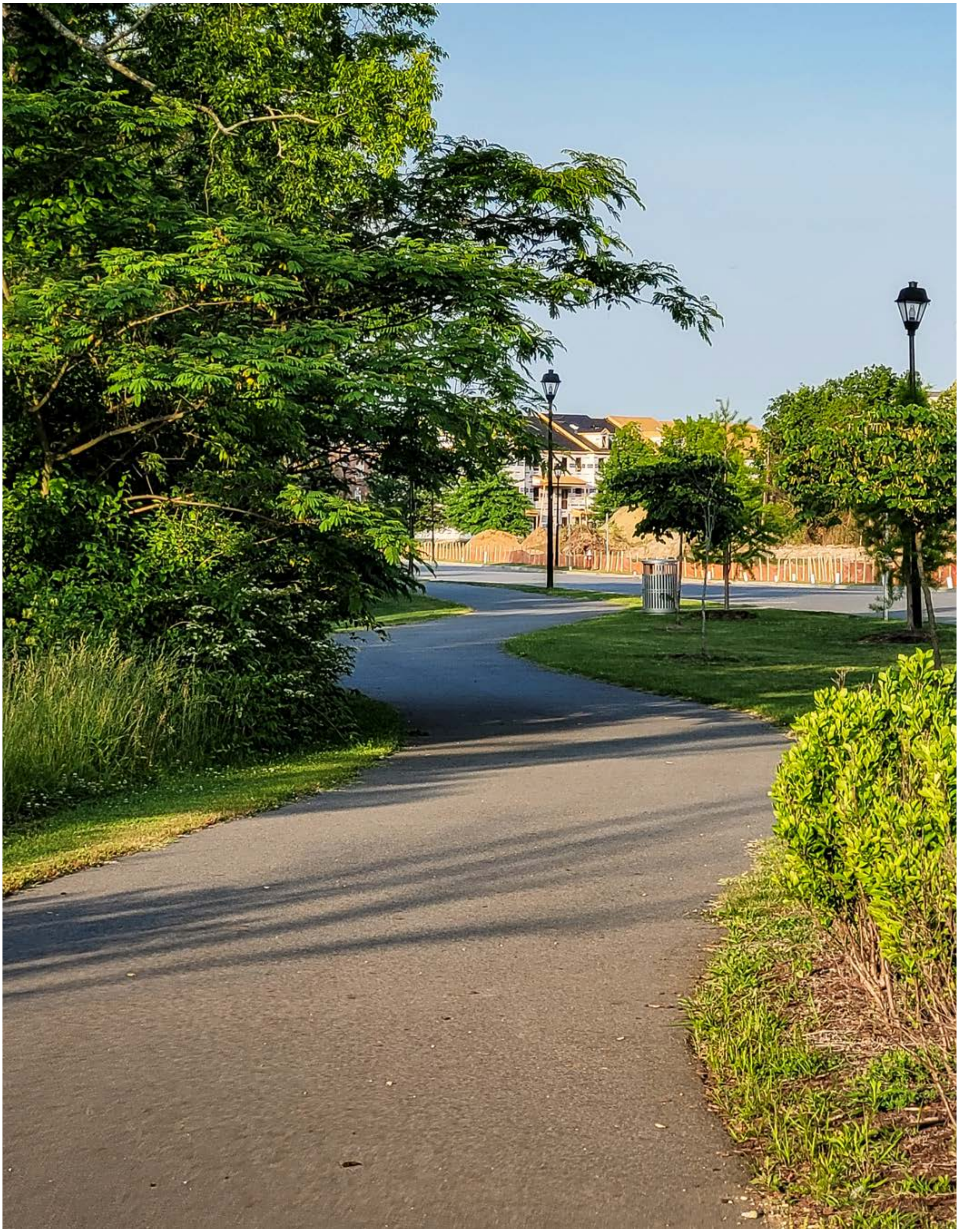
- The streets tend to flood in the areas surrounding my neighborhood on both sides (Little Back River and Fox Hill Rd). If you're patient and wait, the water recedes relatively quickly after a storm passes, but can be difficult for emergency vehicles or those who don't have the option to stay home. Flooding in my neighborhood is worse than it was when I moved in 12 years ago.
- The sidewalk behind mill point to the city lot. Severity depends on location.
- Street has poor drainage
- Unknown
- This area floods when it rains. The more it rains, the more it floods towards the intersection.
- The nearest, yet less frequent flooding I experience in my immediate neighborhood is particularly on Bonita Drive, Constance and Discovery Roads. This usually occurs when there are multiple high tides that don't go out. Lighthouse Drive is higher, with flooding being more of a "pass-thru", except during Hurricane Isabelle. More frequent flooding and impacting a greater number of residents, is Beach Road west of Long Creek and for a mile or so. Again, this is mostly tidal flooding, as is flooding along Grundland, Canal, and Dandy Point Roads, where woodlands are being stripped for residential development...
- The Indian River area of Wythe is vulnerable to flooding of streets, yards, and even residences depending on the severity of the tidal flooding event. Thankfully, I personally have not had home flooding.
- Street: Water St. In front of the new waterfront park in Phoebus
- Street. It floods when it rains and definitely during a north-easter
- Street. Armistead right off of the Hampton YMCA
- street at the base of the Hampton river bridge
- Storm and tidal flooding. The design of storm drains emptying into the adjacent canal (many of which have the outflow pipe below mud level) has left them only as a point of backup.
- Roads flood very badly, especially in Phoebus, making it very hard to drive in rainy weather.
- Pembroke Avenue by the bridge
- Pembroke Avenue both sides of the bridge
- On Mercury Blvd - near LaSalle On Fox Hill Rd (unspecified location) - This seems to be more frequent recently.

continued

Appendix D: Community Feedback *(continued)*

6. Flooding locations (continued)

- Old buckroe and foxhill/silver isles
- N/A
- My basement flooded from ground water during Hurricanes Isabel and Floyd.
- Last quarter mile on Harris creek road. This area floods 20-30 times a year restricting police and fire and all emergency personnel.
- Intersection of Bay Ave and Tabb Street. Rain flooding. Needs better drainage and higher sidewalks.
- In our backyard and sometimes our street. Also the intersection of foxhill and old buckroe roads.
- If anything, there's less flooding in this part of Riverdale than in the 60s and 70s, despite flood map changes saying there should be more. Thanks for taking care of our city!
- I haven't experienced flooding in the areas I travel.
- I have water damage to my basement at 44 Algonquin because of a situation created by my neighbors next door (north) and behind me (east). My yard does not flood but my north neighbor's yard is a lake during periods of heavy rain. With nowhere to drain the water table rises creating hydrostatic water leaks to my basement floor. The neighbor behind me built a shed with excessive runoff from the roof. The alley is blocked by stored junk causing water damage around my garage foundation. I require assistance from the city to prepare a plan and work with them to establish proper drainage. Early in 2024 I contacted the City of Hampton and created a case # for someone to come to look. It has been longer than 60 days, no response.
- Home.
- Grandview, especially across Beach Rd adjacent to both bridges onto island and Bonita Drive. This would also include the erosion of the beach and sand of Grandview Beach which protects White Marsh.
- Garrett Drive. Flooding only happens when there is a bad northeaster. Water backs up from the ditch behind the homes, from the drain in the street. Probably because the ditch behind the houses between Howmet fence and residential homes isn't cleaned out on a regular basis.
- Grand View
- Foxhill. Street. Storm flooding. Heavy rain flooding.
- Fox Hill Rd
- Floods frequently from rain water. Ditches very seldom cleaned out. Drop drains and drainage system holds water.
- Flooding on Woodland Rd.—a main road leading in and out of our neighborhood.
- Flooding during heavy rains. It starts in the circle and moves up the street as the rain continues.
- During Northeasters and Heavy rains, corner of Ivy Home and Marina go under water.
- Don't know..
- Ditches are maintained by the city, but when there's a hard rain some of our yards get flooded and water rises into the street.
- Corner of Bay Ave and Tabb Street (Wythe area) - Flooding and severe and costly property damage; Continued need for pest control and repairs (water related); Poor drainage
- Boat basin -- but it has gotten MUCH better since Public Works put in the additional drainage.
- Beach Road, mild irregular flooding
- Beach Road whenever the tide exceeds 4.5 feet above mean low water. Twenty times in 2023.
- Along Catesby Jones Avenue
- A street and neighborhood that regularly experiences standing water.
- 5th St at Long Creek. It is often impassable due to sunny day flooding, and predictably underwater anytime there is a storm, especially with strong east winds and/or at high tide.
- 104 GREENWELL DR Hampton, constant flooding when Tidemill Creek fills up on Diggs Street, Canal or creek needs mud cleaned out
- "S" turn of N. First Street
- "Alley Way", so to speak, behind my unit/townhouse floods every time it rains, as well as other areas in the Magruder One complex. Also, on occasion, the entire cul-de-sac floods up to "mid-lawn" for an extended period of time. Some residents refer to it as "Lake Vanasse" as we now have waterfront property.



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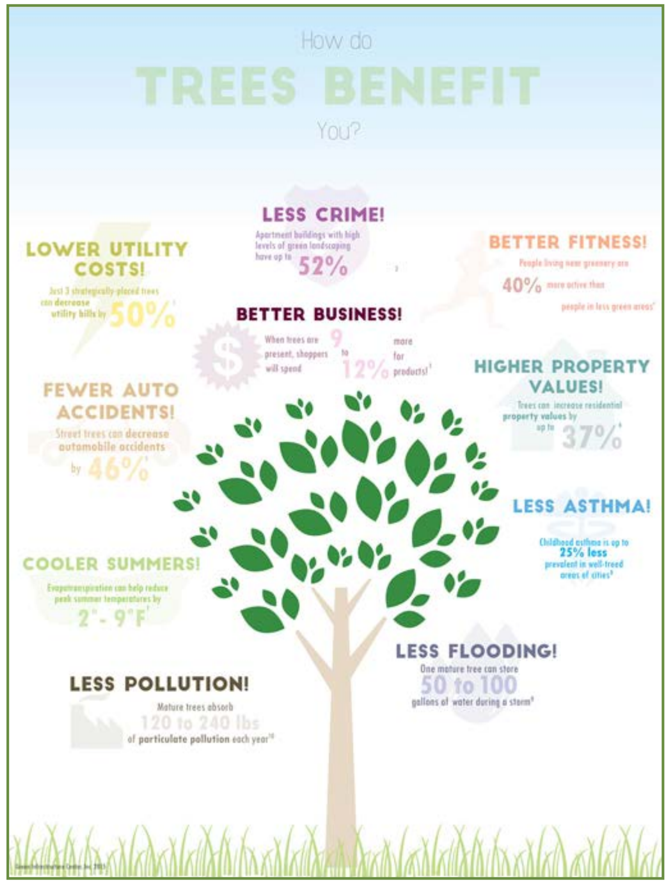
Tree Benefits Graphic Sources



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