

VIRGINIA COASTAL RESILIENCE MASTER PLANNING FRAMEWORK

*Principles and Strategies for Coastal Flood
Protection and Adaptation*



OFFICE OF GOVERNOR RALPH S. NORTHAM
COMMONWEALTH OF VIRGINIA
OCTOBER 2020



COMMONWEALTH of VIRGINIA

Office of the Governor

October 22, 2020

My Fellow Virginians:

As we continue to battle COVID-19, I remain focused on doing everything I can to protect your health and safety, and help rebuild our economy. The pandemic has changed many things, but it has not changed the fact that our planet is warming, our seas are rising, and the storm events we experience are becoming more intense. The science shows clearly that climate change is making an already challenging situation with coastal flooding in the Commonwealth worse, and that millions of Virginians and tens of billions of dollars of private property and public infrastructure are at risk as a result. The time for action is now.

I am pleased to present the Virginia Coastal Resilience Master Planning Framework, laying out the Commonwealth's approach to coastal protection and adaptation which will make our coastal communities and economies more resilient to increased flooding. This document was created pursuant to Executive Order 24, which I signed in November of 2018, and is the result of nearly two years of hard work among state agencies, local and regional partners, and stakeholders. In the coming months, efforts to implement this Framework will drive creation of a full, project-focused Coastal Resilience Master Plan.

This Framework establishes the goals, objectives, guiding principles, and key actions the Commonwealth will pursue to enhance coastal resilience, with a focus on protecting key assets, developing cost-effective strategies, conserving and enhancing natural flood controls, and ensuring equity for underserved communities. We look forward to your feedback, and your participation in helping us tailor and prioritize coastal flooding solutions. Together, we will create a more resilient coastal region, and a more sustainable coastal economy.



Sincerely,

A handwritten signature in blue ink that reads "Ralph S. Northam".

Ralph S. Northam

EXECUTIVE SUMMARY

INTRODUCTION

The Commonwealth of Virginia is pleased to present the Virginia Coastal Master Planning Framework. This Framework lays out the core principles of our approach to coastal adaptation and protection, and the process by which the Commonwealth will develop and begin implementing Virginia's first Coastal Resilience Master Plan by the end of 2021.

Following the guidance of the U.S. Global Climate Change Research Program, we define resilience as the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, health, the economy, and the environment.¹ Similarly, we define adaptation as adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.²

The primary objective of the Virginia Coastal Resilience Master Plan will be to improve the Commonwealth's resilience and ability to adapt to rising seas, increased nuisance flooding, and more frequent and intense storms that result from climate change and threaten our coastal communities. This Framework promotes the roadmap for how we get there.

WHAT'S AT STAKE

The Commonwealth of Virginia has much to lose should the impacts of sea level rise and climate change continue unaddressed. Virginia's coastal region covers 8,950 square miles, approximately one quarter of the state. More than 10,000 miles of tidally influenced shoreline only exacerbate the region's flood risk. Virginia's coastal region lacks the degree of resilience needed to ensure that coastal localities can minimize loss of life and damage to private property and public infrastructure.

Recent estimates show that 250,000 acres of land, 1,469 miles of roads, and property valued at \$17.4 billion lie less than five feet above the high tide line in Virginia.³ This is a concern, as many components of coastal Virginia's economy are simultaneously both water dependent and exposed to coastal hazards. The Department of Defense and its contractors collectively employ 252,187 people; in 2017, they spent more than \$46.2 billion in Virginia.⁴ The Hampton Roads region alone is home to 139,000 military personnel and contractors, and Department of Defense related spending, including shipbuilding and ship repair, is the primary driver of the region's economy.⁵ Rural coastal communities face a separate set of challenges that includes flooded access roads, failure of septic systems, and an acute lack of resources for large-scale resilience initiatives.

Virginia's coastal ecosystems support fisheries, wildlife, aquaculture, navigation, carbon storage and tourism, and provide significant natural defenses against coastal storms. Further, troves of priceless cultural resources that tell the Commonwealth's rich history are still being discovered all along our coast, besides what we have found already at places like Jamestown, Fort Monroe, and sacred Virginia Indian sites. These natural and cultural resources are vulnerable to sea level rise, erosion, flooding, and other coastal hazards and must be protected before they are lost forever.

To protect and preserve Virginia's way of life, its economy, and its diverse cultural and natural resources, it is imperative that the Commonwealth lead a coordinated initiative to ensure improved resilience and to protect our coasts.

THE RISK

Coastal Virginia has some of the highest relative sea level rise rates in the United States due to the combined effects of climate-driven sea level rise and land subsidence.⁶ Using the National Oceanic and Atmospheric Administration's (NOAA) Sewell's Point tide gauge in Norfolk as the primary tidal data reference, Virginia has experienced more than 18 inches of relative sea level rise in the past 100 years.⁷

Multiple studies, including those from the United Nations Intergovernmental Panel on Climate Change (IPCC), the National Climate Assessment, and NOAA Technical Report: Global and Regional Sea Level Rise Scenarios for the United States, report that sea level will continue to rise at an accelerating rate. The NOAA 2017 Relative Sea Level Change Scenarios for Sewell's Point predict as much as 6.69 feet of relative sea level rise by 2100.

In addition to rising seas, the National Climate Assessment states that the Southeast United States has experienced an increase in frequency and intensity of extreme rainfall events, which often cause severe flooding, and this trend is expected to continue.⁸ The combination of relative sea level rise, increases in frequency and duration of rainfall events, rising regional water tables, and storm surge from more frequent and severe weather systems will exacerbate flooding in coastal Virginia.

For example, recurrent flooding in Hampton Roads increased from 1.7 days of flooding per year in 1960 to 7.3 days per year in 2014.⁹ Estimates project the influences of wind and coastal storms may increase this number to 200 per year by 2049.¹⁰ Coastal Virginia is also vulnerable to flooding due to higher water tables as the sea level rises, and the degree to which this impacts current and future coastal flooding is not yet fully understood.¹¹

The impacts of sea level rise and flooding are magnified by population density: Virginia's coastal region is home to more than 70 percent of the Commonwealth's population.¹² Coastal regions across the United States are seeing population increases, with the U.S. Department of Commerce estimating that 47 percent of the U.S. population lives along coastlines, putting a significant portion of the public at risk.¹³ At the same time, the United States has seen an increase in both the number and frequency of billion-dollar disaster events, sustaining 254 weather and climate disasters since 1980 with a total cost exceeding \$1.7 trillion.¹⁴ 2019 was the fifth consecutive year in which the United States suffered 10 or more weather and climate disasters, at an average of 12.6 events per year – more than twice the 40 year average. In 2018-2019, Virginia experienced impacts from nine such events with a total cost of approximately \$1.6 billion.¹⁵

A FRAMEWORK FOR ACTION

As detailed in this summary, Virginia's coastal region faces a serious threat to public safety and economic viability from the various impacts of climate change. Storm surge from tropical storms and hurricanes, sea level rise, nuisance flooding, altered hydrology, and their impacts on poorly planned development are just some of the issues we must address to ensure a resilient, thriving coast for generations to come.

From its first cities to its fishing and farming communities, coastal Virginia faces massive challenges in adapting to the new reality created by climate change and sea level rise. The enormity of this problem requires a whole of government approach, and that is the goal of the Coastal Master Planning Framework and subsequent Virginia Coastal Resilience Master Plan.

This Framework is premised on the stark realities we face, including the fact that current federal, state, regional, and local efforts are insufficient to achieve a resilient coast, and are not optimally aligned. It also accounts for the fact that in most cases, more work is necessary to identify the suite of possible solutions to specific problems posed by coastal hazards. Finally, we recognize that there is not, nor will there ever be, enough funding to protect all homes, businesses, infrastructure, and other coastal assets where they currently exist.

These realities illustrate the difficult task that we as a Commonwealth must undertake. They make it clear that Virginia needs a unified and comprehensive strategy to identify critical assets and areas of concern, and preferred approaches to improve resilience. Virginia needs to decide how to best integrate nature based or green infrastructure – including protection of floodways through strategic coastal relocation – with structural flood control, considering both the direct and indirect benefits. Virginia must decide which areas or projects are most deserving of limited resources, and Virginia must harmonize those projects to ensure that one region’s flood control project does not exacerbate flooding in adjacent areas. Finally, Virginia must create a plan to finance these projects.

These objectives will be accomplished in the Virginia Coastal Resilience Master Plan. A detailed plan, divided by region, will prioritize projects according to state guidelines and local and regional needs. This prioritization will drive state-administered flood preparedness and pre-disaster mitigation funding.

This Virginia Coastal Resilience Master Planning Framework lays out the values, policy objectives, and strategy for developing the Coastal Resilience Master Plan. The pages ahead identify the Goals and Guiding Principles that will inform Master Plan development. This Framework also details ongoing efforts that support the Plan, as well as the scientific, legal, and socioeconomic underpinnings of the planning process.

[Chapter One](#) outlines the Master Planning Goals and Guiding Principles, as well as action items to support the Master Planning Process.

Master Planning Framework Primary Goals:

1. Identify priority projects to increase the resilience of coastal communities, including both built and natural assets at risk due to sea level rise and flooding
2. Establish a financing strategy, informed by regional differences and equity considerations, to support execution of the plan
3. Effectively incorporate climate change projections into all of the Commonwealth’s programs addressing coastal zone built and natural infrastructure at risk due to sea level rise and flooding
4. Coordinate all state, federal, regional, and local coastal adaptation and protection efforts in accordance with the guiding principles of this Framework

Master Planning Framework Guiding Principles:

1. Acknowledge climate change and its consequences, and base decision-making on the best available science.
2. Identify and address socioeconomic inequities and work to enhance equity through coastal adaptation and protection efforts.
3. Recognize the importance of protecting and enhancing green infrastructure like natural coastal barriers and fish and wildlife habitat by prioritizing nature-based solutions.
4. Utilize community and regional scale planning to the maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities.
5. Understand fiscal realities and focus on the most cost-effective solutions for protection and adaptation of our communities, businesses and critical infrastructure.

Central to this process will be the establishment of a Technical Advisory Committee. Utilizing its considerable expertise and the Goals and Guiding Principles above, that Committee will advise the Governor's Chief Resilience Officer and Special Assistant for Coastal Adaptation and Protection in Master Plan development, including resilience project identification and prioritization.

[Chapters Two and Three](#) of this Framework include important background information that underpins the case for state-level action, and the need for the Master Plan. Chapter Two details the social and economic vulnerability of communities along the coast, and Chapter Three explains the science behind the problems we face, and identifies scientific efforts to support sound decision making.

[Chapter Four](#) explains the key units of organization for the Coastal Resilience Master Plan: four coastal regions, made up of localities within the coastal Planning District Commissions and Regional Commissions. Different areas along Virginia's coast have both shared and unique challenges associated with sea level rise and other coastal hazards. Chapter Four examines these challenges and describes ongoing local and regional resilience efforts.

[Chapter Five](#) describes coastal adaptation and protection programs and projects already underway at the state and federal levels. This catalog includes many worthwhile initiatives, but makes clear the fact that coordination of activities through the Governor's office is necessary to maximize their impact and ensure that the Commonwealth is able to increase coastal resilience in a cost-effective way that minimizes duplication of effort and unintended consequences.

[Chapter Six](#) provides a detailed framework for research, organization and planning actions that must be accomplished prior to the finalized Coastal Resilience Master Plan. It calls for three immediate actions: Elevating the Coastal Zone Management Program, establishing a Technical Advisory Committee, and engaging in community roundtables. These three activities are imperative to creating and implementing a Master Plan and must begin as soon as possible. Chapter Six continues by describing near-term actions necessary to increase resilience and finalize the Master Plan.

[Chapter Seven](#) closes the Planning Framework by discussing a number of potential funding options.

SUMMARY

The Commonwealth is poised to assume the lead role in making Virginia's coast more resilient to the impacts of climate change. This leadership is key to addressing the economic, social, environmental, and public health and safety threats of coastal natural hazards. This Coastal Resilience Master Planning Framework provides a sound approach to developing and implementing solutions that will build resilience and maintain thriving coastal communities.

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INTRODUCTION TO THE VIRGINIA COASTAL RESILIENCE MASTER PLANNING FRAMEWORK



Working Waterfront along the Rappahannock River near Topping, VA. Credit: Aileen Devlin | Virginia Sea Grant

From its first cities to its fishing and farming communities, coastal Virginia faces massive challenges in adapting to the new reality created by climate change and sea level rise. We know this because of decades of observation and scientific research, and from modeling that shows what we can expect in the future. We also know the following:

- These challenges differ by region, locality, neighborhood, and individual, as does capacity to address them.
- Current federal, state, regional, and local efforts are insufficient to achieve a resilient coast, and are not aligned.
- In most cases, more work is necessary to identify the suite of possible solutions to specific problems posed by coastal hazards.
- There is not, nor will there ever be, enough funding to protect all homes, businesses, infrastructure, and other coastal assets where they currently exist.
- Low-income and minority communities are particularly vulnerable due to a number of factors.

These facts point to difficult choices that lie ahead. They also make it clear that Virginia needs a strategy for identifying decision points and making decisions that maximize the effectiveness of limited resources to enhance coastal resilience.

Recognizing the challenges coastal Virginia faces, Governor Ralph Northam signed Executive Order Number Twenty-Four (EO-24), Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards, on November 2, 2018 (Appendix A). Section 2A of EO-24 states that "The Commonwealth of Virginia has a responsibility to assist local governments in reducing flood risk through planning and implementing large scale flood protection and adaptation initiatives." It also requires that "The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall create and implement a Coastal Resilience Master Plan for coastal Virginia to reduce the impacts of tidal and storm surge flooding."

This document, the Virginia Coastal Resilience Master Planning Framework, lays out the strategy for developing the Plan. The pages ahead identify the purpose of the Master Planning Framework, the principles that will guide Master Plan development, and the goals we hope to accomplish in creating Virginia's first Coastal Resilience Master Plan (the Plan). This Framework also details ongoing efforts that support the Plan, as well as the scientific, legal, and socioeconomic underpinnings of the planning process. We intend for the Plan itself be issued by December 2021, and to be regularly updated to maintain its utility in the face of both changing conditions and changing understandings.

GUIDING PRINCIPLES

The purpose of the Coastal Resilience Master Plan will be to reduce risk to people and property by anticipating and preparing for sea level rise and coastal flooding, while ensuring equitable treatment for all communities, and protecting the coastal environment. Following the guidance of the U.S. Global Change Research Program, we define resilience as the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, health, the economy, and the environment.¹⁶ Similarly, we define adaptation – the alternative to protection by fortification – as adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.¹⁷

Understanding that significant changes are inevitable, the Plan will identify coastal adaptation and protection strategies and projects that keep coastal Virginia's communities, economy, and environment vibrant. Achieving this will require strengthening relevant laws and policies, leveraging funding opportunities, and coordinating resilience activities across local, state and federal programs. The Commonwealth will lead these activities, guided by five core principles, the key elements of this Framework:

- 1. Acknowledge climate change and its consequences, and base decision-making on the best available science.**

To date, Virginia has slowly advanced efforts to study and mitigate coastal flooding without stating unequivocally that climate change is the root cause of the problem. This approach, born of political necessity, has led to tortured titles like the Center for Recurrent Flooding Resiliency and the Joint Subcommittee to Recommend Short-Term and Long-Term Strategies Minimizing the

Impact of Recurrent Flooding and Coastal Storms.¹⁸ More importantly, it has hampered honest dialogue and broader understanding of the challenges we face.

Developing resilience in Virginia's coastal localities requires understanding that the challenges are long-term, continually evolving, and varied. In order to be comprehensive and effective, our coastal adaptation and protection efforts must incorporate climate science. Decision making with regard to state and regional approaches, as well as specific projects, must be based on the best available information and relevant science. Through the Plan, the Commonwealth will adopt this approach, and will require the same of localities.

2. Identify and address socioeconomic inequities and work to enhance equity through coastal adaptation and protection efforts.

Across the globe and throughout history, racial and ethnic minorities and economically disadvantaged groups have been forced to inhabit the most marginal lands. In coastal areas, this often means lands most susceptible to flooding. The United States saw the acute consequences of this inequity clearly during and after major coastal disasters like Hurricane Katrina in 2005, Superstorm Sandy in 2012, and Hurricane Harvey in 2017. Chronic flooding is also an increasing problem for Alaska Native villages and communities like Louisiana's Isle de Jean Charles Tribe, that are becoming some of the world's first climate refugees.^{19,20}

Similar issues exist in Virginia. We have coastal cities with significant African American populations, economically stressed rural coastal areas, and Native American communities with at-risk reservations and ancestral tribal lands. While discrete initiatives like the Ohio Creek Watershed Project in Norfolk (described later in this document) are making real headway in addressing inequity in coastal resilience, we must do more as we consider adaptation and protection strategies across the entire coastal zone.

The Master Plan will promote coastal resilience strategies and projects that specifically address racial and economic inequities. We have the information necessary to identify the location of affected communities and the risks they face. We will work with these communities to plan, implement, and support successful and lasting adaptation and protection strategies. We must begin now to develop these strategies, which in some cases will include relocation from places that are or will become uninhabitable.

3. Recognize the importance of protecting and enhancing green infrastructure like natural coastal barriers and fish and wildlife habitat by prioritizing nature-based solutions.

The bounty and beauty of coastal Virginia's lands and waters have made the area an economic hub and a desirable place to live for thousands of years. While commerce has diversified from exclusively resource-based and agrarian pursuits, fishing, farming, forestry, and shellfish propagation still support many livelihoods and are a significant component of coastal Virginia's cultural identity. These occupations are also heavily dependent on environmental conditions and the integrity of coastal landscapes and ecosystems.

Further, science shows us that protecting and enhancing natural coastal areas is critical not only to support continued production of renewable resources, but also to protect other key

components of our economy and communities. Barrier islands, beaches, dunes, wetlands, coastal forests, and even oyster reefs and seagrass beds offer significant and quantifiable resilience benefits at a significantly lower cost than shoreline hardening. These natural features also provide the additional benefits of protecting water quality and habitat for fish and wildlife. The Master Plan will support the mutually reinforcing goals of coastal resilience and environmental protection by prioritizing the protection and enhancement of green infrastructure and the use of natural and nature-based solutions where effective.

4. Utilize community and regional scale planning to the maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities.

The Plan will recognize that while each region, locality, and community in coastal Virginia has unique characteristics, they face many similar challenges from sea level rise and other coastal hazards. A piecemeal approach to coastal resilience creates duplication of effort, zero-sum competition for limited resources, unintended negative consequences, and loss of opportunities to accomplish at scale what cannot be done by individual localities. Effective resilience planning requires collaboration, coordination, and communication at all levels of government, and across physical and administrative boundaries.

The Commonwealth has a responsibility through the Coastal Resilience Master Plan to enhance resilience efficiently by prioritizing and coordinating activities among local, regional, state, and federal partners, and by seeking and leveraging funding opportunities to implement strategic coastal adaptation and protection solutions. In order to accomplish this, we will develop the Plan at regional scales, building on local and regional planning efforts. We will encourage creativity and collaboration to find solutions to local problems that fit the Commonwealth's broader view of resilience, while discouraging activities that have unintended negative consequences locally, for other communities, or for the environment.

5. Understand fiscal realities and focus on the most cost-effective solutions for protection and adaptation of our communities, businesses and critical infrastructure.

We must recognize that protecting every component of the built environment exactly where it stands today is not realistic. Science shows clearly that, even if aggressive reduction targets for greenhouse gas emissions are met, response times in the natural system will result in rising global temperatures and sea levels for many decades to come.²¹ In time, some homes, businesses, roads, and communities will become uninhabitable as sea level rises. This includes not only the underserved communities mentioned above, but wealthier communities as well. The nature of Virginia's coastal zone means structural solutions will not be practical for much of the area. Fiscal reality dictates that we will never have adequate resources to armor and/or elevate large sections of our coastline. Further, doing so is undesirable because it would fundamentally alter and degrade the Chesapeake Bay and the ecosystems that support coastal Virginia's economy and define its culture.

Acknowledging these realities, the Coastal Resilience Master Plan will prioritize use of natural and nature-based features to protect infrastructure that is critical for national security, public health and safety, and the economy. Using the best scientific and economic information available,

the Plan will promote structural protective measures only when the science shows that green infrastructure will not offer sufficient protection, and that relocation is not possible.

We have the knowledge and tools to identify which areas are most vulnerable, and which adaptation and protection approaches are most appropriate. We will use this information to engage and align as many existing local, state, and federal programs as possible to support development of a detailed Coastal Resilience Master Plan that is consistent with these guiding principles.

PLANNING FRAMEWORK

Limited resources, undeveloped solution sets, and uneven progress across Virginia's coastal regions have hampered coastal resilience efforts. These underscore the urgent need for state-level leadership. These factors also preclude us from arriving at a full Coastal Resilience Master Plan without first charting the course. That is the purpose of this Master Planning Framework.

We know what is necessary to guide decision-making, and that state government is in the strongest position of any entity to maximize the effectiveness of resilience efforts. At the same time, we do not want to derail important and ongoing local and regional work. Following the five guiding principles, this Framework builds upon efforts to date and facilitates development of the Master Plan by creating a leadership structure, establishing primary goals, and identifying a preliminary set of actions that will help us achieve these goals, and which may expand as conditions change and scientific understanding advances during the master planning process.

LEADERSHIP

As directed by EO-24, the Commonwealth's Chief Resilience Officer (CRO) and the Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP) will lead development of the Coastal Resilience Master Plan. The Governor will appoint a Technical Advisory Committee (TAC) with representatives of state agencies, coastal planning districts and regional commissions, and academic advisors, among others, as described in Chapter 6 of this Framework. This group will assist in preparing the Master Plan by developing and implementing protocols for evaluation of project and strategy proposals. After the Plan is finalized, the TAC will continue to serve to facilitate implementation, evaluate progress, and develop updates.

The CRO, SACAP, and TAC will work with localities, regional entities, citizens, and stakeholder groups to identify critical infrastructure, at-risk communities, adaptation strategies, and specific resilience projects for inclusion in the Plan. This effort will be organized by dividing the Virginia coastal zone into four regions based on a number of defining characteristics related to threats and vulnerabilities. These regions are discussed in depth in Chapter 4. Input from these regions will be evaluated in accordance with the guiding principles described above. The CRO and SACAP, with the assistance of the TAC, will assemble this and other relevant information into a Plan with a prioritized listing of coastal adaptation and protection projects and activities by December of 2021.

GOALS

The four primary goals of the Virginia Coastal Resilience Master Plan are:

1. Identification of priority projects to increase the resilience of coastal communities, including both built and natural assets at risk due to sea level rise and flooding
2. Establishment of a financing strategy, informed by regional differences and equity considerations, to support execution of the plan
3. Effective incorporation of climate change projections into all of the Commonwealth's programs addressing coastal zone built and natural infrastructure at risk due to sea level rise and flooding
4. Coordination of all state, federal, regional, and local coastal adaptation and protection efforts in accordance with the guiding principles of this Framework

INITIAL ACTIONS

Each Goal will have a prioritized list of actions that, together, will move the Commonwealth toward meeting our desired resilience outcomes. Some of these actions have already been identified. Others will arise from the continuing consultations with stakeholders over the next several months. The initial list of actions and desired outcomes for each goal includes the following:

Goal 1: Identification of priority projects for the Master Plan

ACTION 1: in collaboration with local and regional entities, identify critical built and natural infrastructure

- Outcome 1: a prioritized list of built infrastructure critical for national security, public health and safety, and/or the economy will inform all coastal resilience planning and funding
- Outcome 2: a prioritized list of natural infrastructure critical for flood and storm protection, water quality management, and/or wildlife habitat services will inform all coastal resilience planning and funding

ACTION 2: identify projects to protect and sustain the functions of critical built and natural infrastructure

- Outcome 1: adaptation strategies for sustaining benefits from existing infrastructure wherever practical
- Outcome 2: where adaptation is impractical, structural solutions for infrastructure risk reduction over the next 20, 40, and 60 years that consider social and economic equity, ecological impacts, and financial realities
- Outcome 3: relocation strategies for built and natural infrastructure for which adaptation and/or protection is not practical

Goal 2. Establishment of a financing strategy

ACTION 1: develop a detailed needs assessment and list of recommended funding sources to support implementation of the Master Plan

- Outcome 1: funding and financing sources for priority projects
- Outcome 2: authorizations for use of new and innovative funding mechanisms

ACTION 2: establish guidelines for administering the Community Flood Preparedness Fund (described in Chapter 7)

- Outcome 1: evaluation and prioritization of projects based on their effectiveness in reducing current and future risk, meaningful incorporation of equity and natural resource principles, and financial realities
- Outcome 2: monitoring, evaluation, and adaptive management to ensure desired results are achieved

Goal 3: Effective incorporation of climate change projections in state programs

ACTION 1: fully implement Executive Order 45 (Appendix 3)

- Outcome 1: state agency compliance with the new freeboard and sea level rise planning standards
- Outcome 2: all state-sponsored development activities in flood-prone areas meet National Flood Insurance Program (NFIP)-compliant requirements and standards

ACTION 2: amend the Chesapeake Bay Preservation Act (CBPA) guidance to address the anticipated inland migration of regulated areas as sea level rises

- Outcome 1: local implementation of the CBPA addresses pressure to protect developed property from encroaching sea level while avoiding, or minimizing and mitigating, the environmental consequences
- Outcome 2: coordination of the CBPA implementation with the Tidal Wetlands Act implementation to integrate project reviews and compensatory mitigation of unavoidable impacts

ACTION 3: amend the Tidal Wetlands Act guidance to accommodate inland migration of tidal wetlands as sea level rises

- Outcome 1: local and VMRC decisions make no net loss of wetland resources possible by requiring riparian buffers and/or effective compensatory mitigation of probable future impacts
- Outcome 2: coordination of the Tidal Wetlands Act implementation with CBPA implementation

ACTION 4: incorporate coastal resilience considerations into water management programs

- Outcome 1: management of stormwater, wastewater, groundwater, and surface water that accounts for projected sea level rise in a manner that avoids or minimizes and mitigates current and future risks to built and natural infrastructure
- Outcome 2: incorporation of resilience criteria in to water quality grant programs

Goal 4: Coordination of state, federal, regional and local coastal efforts

ACTION 1: ensure that state and federal hazard mitigation and community development grant programs administered by the Commonwealth and localities are aligned under the Master Plan

- Outcome 1: Virginia Department of Emergency Management (VDEM)-administered hazard mitigation grants in the coastal zone align with Master Planning Framework guiding principles and support projects and strategies identified in the Master Plan
- Outcome 2: Department of Housing and Community Development (DHCD)-administered grants in the coastal zone align with Master Planning Framework guiding principles, and support projects and strategies identified in the Master Plan, as appropriate

ACTION 2: empower localities and individuals to make informed decisions

- Outcome 1: localities have access to sea level rise and freeboard guidance
- Outcome 2: a strategic coastal relocation handbook is available to inform local planning
- Outcome 3: localities have the legal tools necessary to prevent irresponsible land development
- Outcome 4: sellers of real estate are required to disclose if a property is located in a special flood hazard area, has sustained flood damage, or contains a dam
- Outcome 5: all coastal localities have engaged in the Resilience Adaptation and Feasibility Tool (RAFT) process (described in Appendix B)

ACTION 3: implement 2019 DCR Dam Safety and Floodplain Management Report recommendations

- Outcome 1: all coastal localities act to protect the natural functions of floodplains and to ensure all essential structures are located outside of known floodways
- Outcome 2: all coastal localities fully participate in NFIP Community Rating System (CRS).

ACTION 4: protect and enhance natural coastal defenses

- Outcome 1: state, federal, regional, and local authorities all fully incorporate the ConserveVirginia assessments (described in Chapter 5) in planning and implementation

- Outcome 2: state, federal, regional, and local authorities utilize restoration and protection of natural shorelines and coastal landscapes as a resilience strategy whenever possible

SUMMARY

This chapter has described the purpose, principles, goals, and some initial actions that will anchor the Master Plan. The following chapters analyze the Commonwealth's coastal challenges, the science behind the case for action, Virginia's coastal regions and current activities, and ongoing state and federal programs and projects. The concluding chapters describe some of the initial actions identified by the CRO and SACAP for the Plan, and provide a discussion of some financing options. All together, these guiding principles, goals, actions, and supporting analyses make up a strong Coastal Resilience Master Planning Framework that will guide the Commonwealth's coastal adaptation and protection efforts.

VIRGINIA'S COASTAL CHALLENGES AND WHAT IS AT STAKE



Waterfront apartments along the marsh bays of Chincoteague, VA. in 2018 Credit: Aileen Devlin | Virginia Sea Grant

Climate change is real, and has real consequences for all of us - particularly people living in coastal areas vulnerable to sea level rise, tidal flooding, and storm surge. This chapter describes the threat climate change poses to Virginia's coast, and outlines what we stand to lose if we do not act to make our coast more resilient.

COASTAL CHALLENGES – THE THREAT

Coastal Virginia has some of the highest relative sea level rise rates in the United States due to the combined effects of climate-driven sea level rise and land subsidence.²² Using the National Oceanic and Atmospheric Administration's (NOAA) Sewell's Point tide gauge in Norfolk as the primary tidal data reference, Virginia has experienced more than 18 inches of relative sea level rise in the past 100 years.²³

Multiple studies, including those from the United Nations Intergovernmental Panel on Climate Change (IPCC), the National Climate Assessment, and NOAA Technical Report: Global and Regional Sea Level Rise Scenarios for the United States, report that sea level will continue to rise at an accelerating rate. The NOAA 2017 Relative Sea Level Change Scenarios for Sewell's Point (Fig. 1) predict as much as 6.69 feet of relative sea level rise by 2100 based on the Intermediate High Scenario.

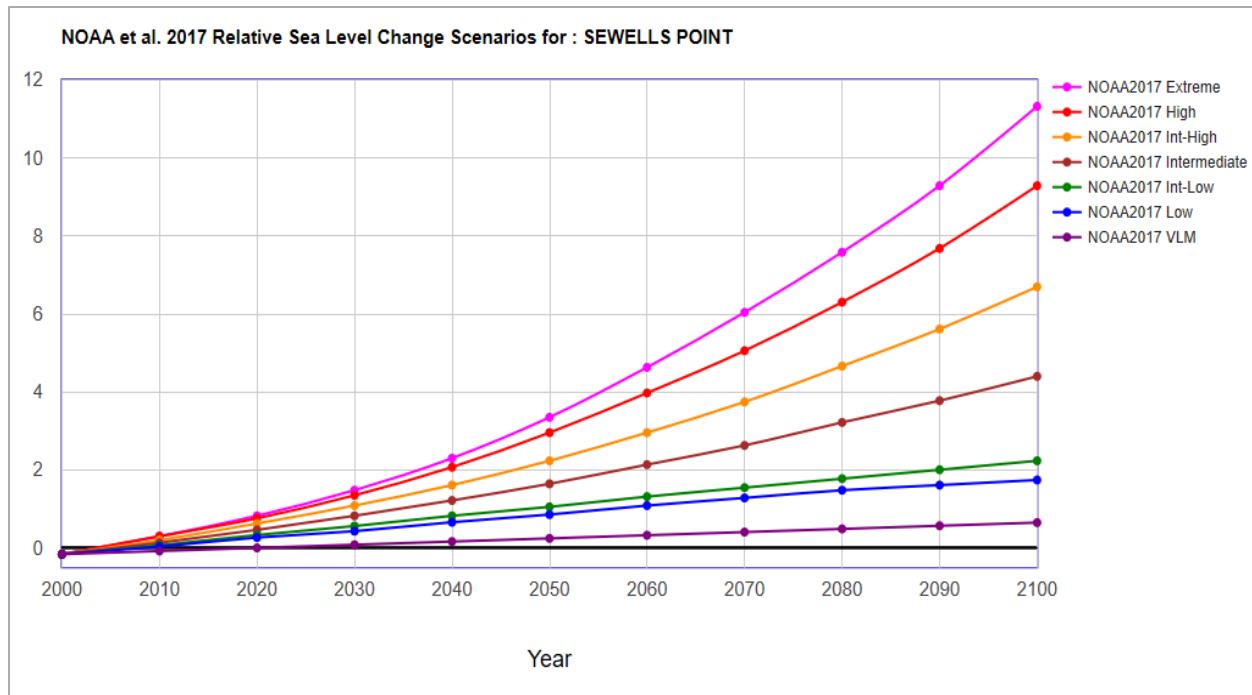


FIGURE 1: PREDICTED SEA LEVEL CHANGE FOR SEWELL'S POINT TIDAL GAUGE (NORFOLK, VA)²⁴

In addition to rising seas, the National Climate Assessment states that the Southeast United States has experienced an increase in frequency and intensity of extreme rainfall events, which often cause severe flooding, and this trend is expected to continue.²⁵ The combination of relative sea level rise, increases in frequency and duration of rainfall events, rising regional water tables, and storm surge from more frequent and severe weather systems will exacerbate flooding in coastal Virginia. Recurrent flooding, sometimes called nuisance flooding, is “flooding that occurs repeatedly in the same area over time due to precipitation events, high tides, or storm surge.”²⁶ Recurrent flooding in Hampton Roads increased from 1.7 days of flooding per year in 1960 to 7.3 days per year in 2014.²⁷ Estimates project the influences of wind and coastal storms could increase this number to 200 per year by 2049.²⁸ Coastal Virginia is also vulnerable to flooding due to higher water tables as the sea level rises. The degree to which this impacts current and future coastal flooding is not yet fully understood.²⁹

The impacts of sea level rise and flooding are magnified by population density: Virginia’s coastal region is home to more than 70 percent of our population.³⁰ Coastal regions across the United States are seeing population increases, with the U.S. Department of Commerce estimating that 47 percent of the U.S. population lives along coastlines, putting a significant portion of the public at risk.³¹ At the same time, the United States has seen an increase in both the number and frequency of billion-dollar disaster events, sustaining 254 weather and climate disasters since 1980 with a total cost exceeding \$1.7 trillion.³² 2019 was the fifth consecutive year in which the United States suffered 10 or more weather and climate disasters, at an average of 12.6 events per year - more than twice the 40 year average. In 2018-2019, Virginia experienced impacts from nine such events with a total cost of approximately \$1.6 billion.³³

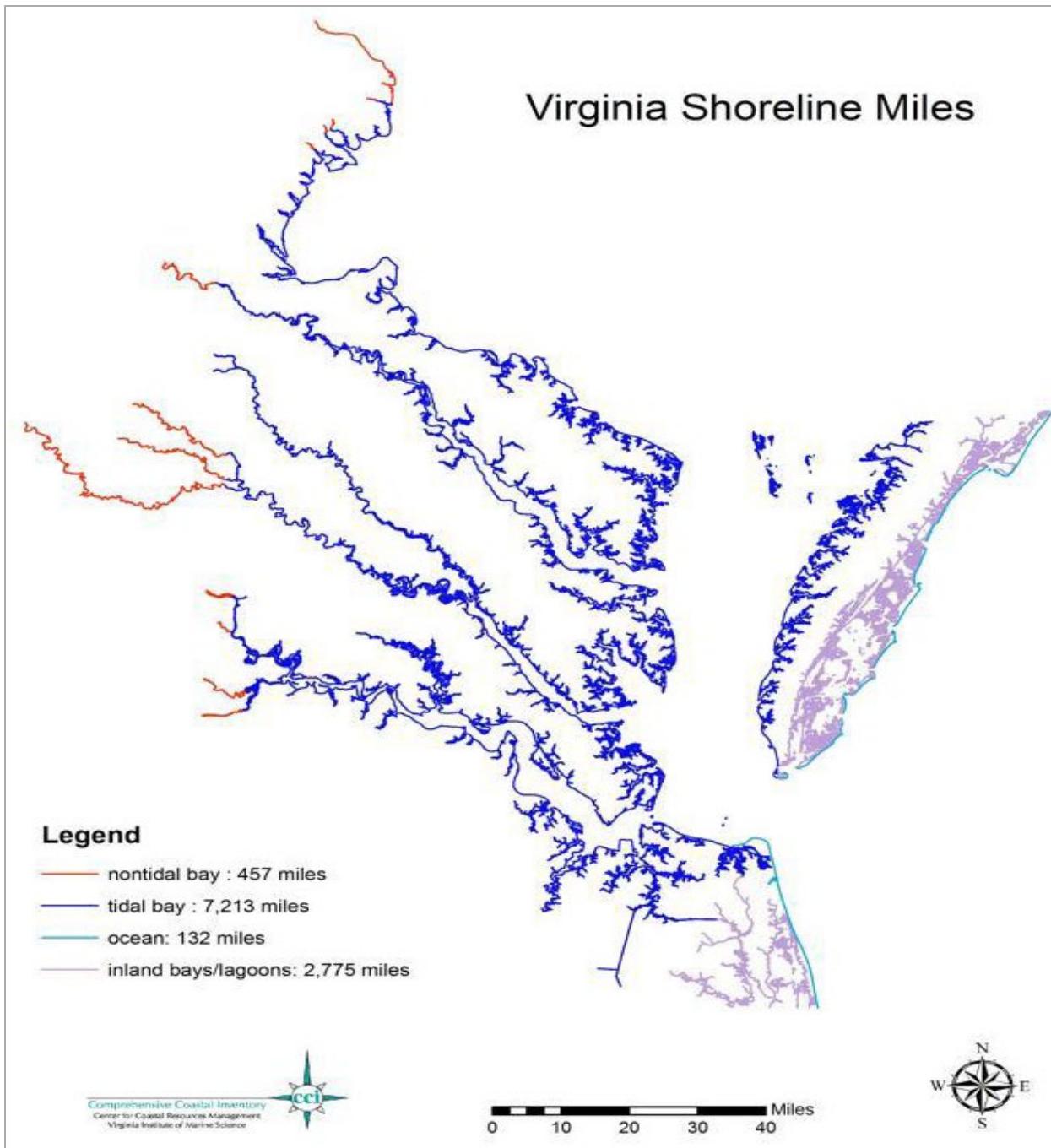


FIGURE 2: VIRGINIA SHORELINE MILES CREATED BY VIMS CENTER FOR COASTAL RESOURCE MANAGEMENT³⁴

VIRGINIA'S UNIQUE COAST

Virginia's coastal region covers 8,950 square miles, or approximately one quarter of the state and has more than 10,000 miles of tidally influenced shoreline (Fig. 2).^{35,36} The coastal plain extends from the Atlantic Ocean and Chesapeake Bay to the fall line, which runs approximately along Interstate 95 and marks the beginning of the piedmont and the end of tidal influence in Virginia rivers.

Recent estimates show that 250,000 acres of land, 1,469 miles of roads, and property valued at \$17.4 billion lie less than five feet above the high tide line in Virginia. These figures jump to 490,000 acres, 4,500 road miles, and \$54.8 billion within nine feet of high tide.³⁷ A changing climate puts all of this and more at risk.

Access to coastal lands and waterways providing transportation routes, strategic defenses, and abundant natural resources has made coastal Virginia a hub of civilization and commerce for thousands of years, from Native American tribes to the first English settlers to today's modern multicultural society. Many components of coastal Virginia's economy are simultaneously both water dependent and exposed to coastal hazards. The Department of Defense and its contractors collectively employ 252,187 people and, in 2017, spent more than \$46.2 billion in Virginia.³⁸ The Hampton Roads region alone is home to 139,000 military personnel and contractors, and Department of Defense related spending, including shipbuilding and ship repair, is the primary driver of the region's economy.³⁹ Overall, defense spending in Virginia accounts for 8.9 percent of the Commonwealth's annual gross domestic product (GDP), the highest percentage of any state's GDP.⁴⁰

The Port of Virginia is the fifth highest ranked port by volume and ninth by tonnage in the United States,⁴¹ and the port-related industry supports 374,000 jobs.⁴² Direct expenditures associated with coastal tourism in Virginia exceed \$5.2 billion dollars annually.⁴³ Commercial and recreational fisheries and aquaculture support nearly 15,000 jobs and \$1 billion in sales.⁴⁴ These economic sectors make Virginia a critical resource for the entire nation, and Virginia's Coast critical to the Commonwealth's economy.

Virginia's coastal ecosystems support fisheries, wildlife, aquaculture, navigation, carbon storage and tourism, and provide significant natural defenses against coastal storms. For example, during Hurricane Sandy, it is estimated that coastal wetlands reduced flood damages by \$625 million across twelve states.⁴⁵ Further, troves of priceless cultural resources that tell the Commonwealth's rich history are still being discovered all along our coast, besides what we have found already at places like Jamestown, Fort Monroe, and Werowocomoco. These natural and cultural resources are also vulnerable to sea level rise, erosion, flooding, and other coastal hazards.

The map below (Figure 3) shows that many of our highest ecological value areas lie close to the coastline and are at grave risk of inundation and loss. These areas include thousands of acres of wetlands that mitigate flooding, serve as nursery areas for juvenile fish, and provide critical habitat to endangered migratory birds, and other wildlife.

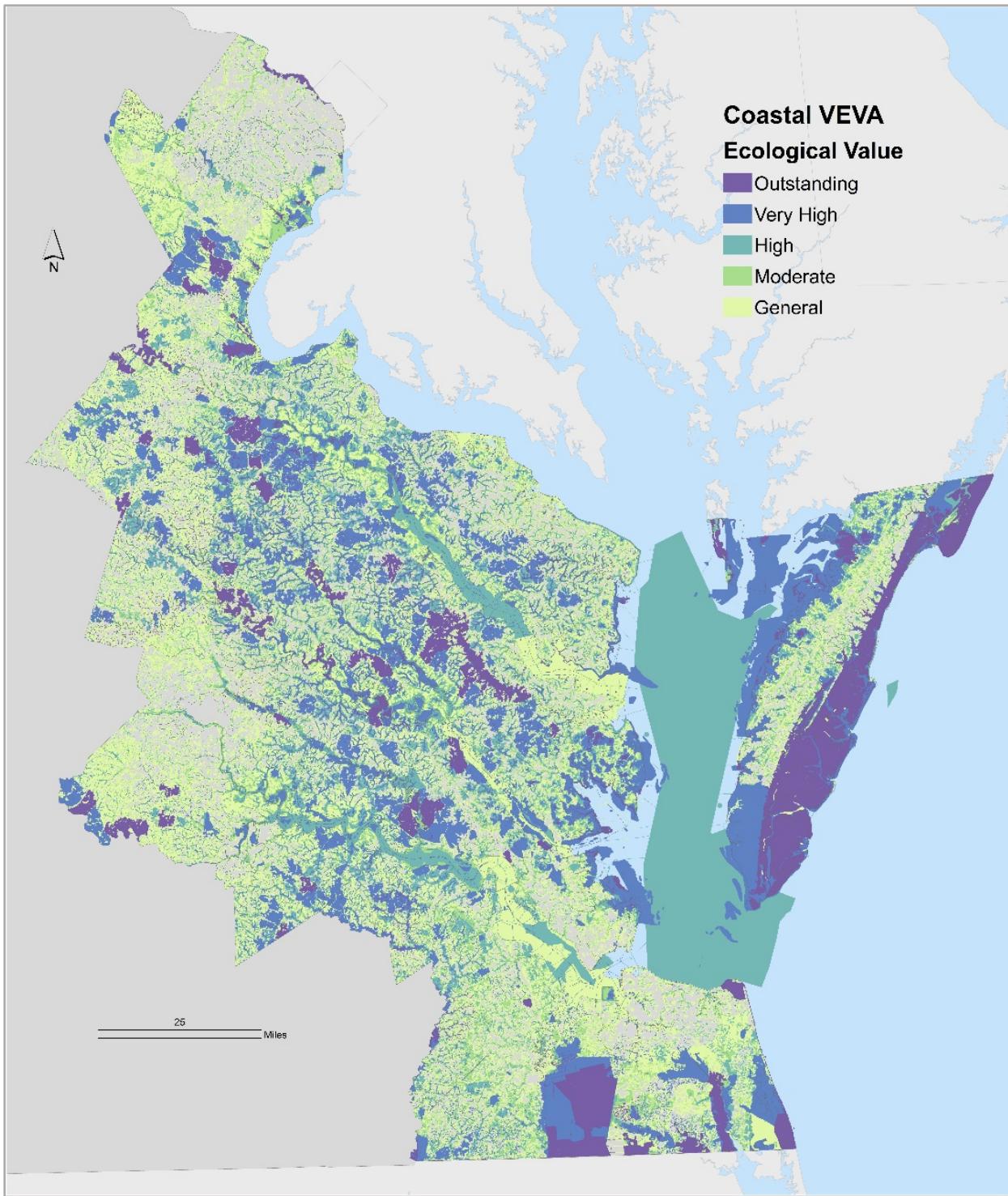


FIGURE 3: COASTAL VIRGINIA ECOLOGICAL VALUES⁴⁶

The Commonwealth already faces heavy costs associated with the combined impacts of coastal hazards and climate change. In 2016 Hurricane Matthew – despite being only a tropical storm when it arrived along Virginia’s coast – cost the Hampton Roads region roughly \$500 million.⁴⁷ Tidal and storm surge flooding can also negatively affect public health by creating favorable conditions for vectors of infectious disease, breaching containers of toxic materials and releasing them into the environment,⁴⁸ and rendering

septic systems ineffective.⁴⁹ Many of these impacts will impose disproportional harm on poor, minority, elderly, and other socially vulnerable and disadvantaged people.

The water defines coastal Virginia's economy, character, and culture. Water has always been a positive force – and it still can be. However, absent proactive efforts to anticipate and adapt to flooding, coastal communities face an inevitable social and economic decline – and an eventual collapse. Virginia must act now. Following and building upon this Framework is necessary to protect lives, property, infrastructure, and ecosystems from sea level rise and other coastal hazards, and reduce taxpayer exposure through implementation and ongoing improvement of our sound coastal adaptation and protection processes.

SUMMARY

As sea levels rise and flooding becomes more frequent and severe, Virginia must protect its economic, cultural and environmental resources in order for coastal communities to remain viable. As detailed in this Chapter, Virginia has far too much at stake to take a passive approach – we must act to increase our coastal resilience. These are the reasons we have created this Framework, laying out a path to develop and implement the Virginia Coastal Resilience Master Plan.

THE SCIENCE BEHIND THE MASTER PLANNING FRAMEWORK



VIMS scientists Dr. Mark Luckenbach and Jennifer Stanhope take water samples in the Chesapeake Bay. Credit: Virginia Sea Grant

The science of climate change is complex, but the basics are clear: polluting the air with substances that trap heat is making our atmosphere warmer, our sea levels higher, and our weather more extreme. This chapter describes the data and analysis that helps us better understand our coastal challenges, and guides our approach to coastal adaptation and protection. The chapter also describes ongoing projects at a number of Virginia and federal academic institutions, with a more comprehensive overview of all research partners included in Appendix B.

GLOBAL WARMING AND SEA LEVEL RISE

Global average annual temperatures have increased 1.8° F (1°C) over the past 115 years (1901-2016), and in that time, significant warming has occurred in Virginia.⁵⁰ Average maximum *and* minimum temperatures from 1986-2016 (Figures 4 and 5) increased during every season and in every region of the Commonwealth when compared to the long term temperature trends from 1895-2016.⁵¹ Models predict that a warmer ocean and atmosphere will cause more intense rainfall, high-precipitation coastal storms, and the observed data from 1986-2016 supports this prediction for the Commonwealth, as shown in Figure 6.⁵²

With continued climate pollution, temperatures will continue to rise. In 2018 the United Nations IPCC reported that “human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a *likely* range of 0.8°C to 1.2°C, [and that] Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.”⁵³ Global warming increases risks for natural and human systems, the specific nature of which depends on the ultimate “magnitude and rate of warming, geographic location, levels of development and vulnerability, and on choices made in implementation and mitigation options.”⁵⁴

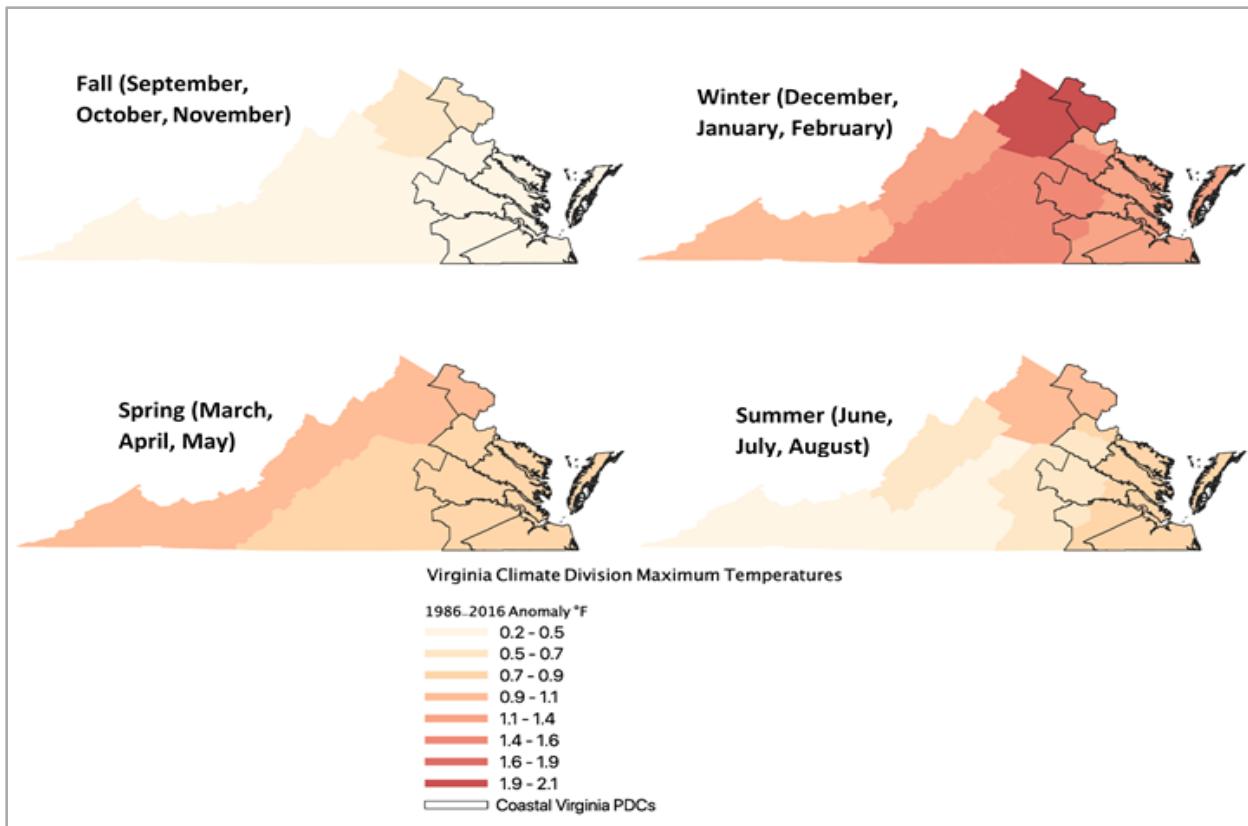


FIGURE 4: SEASONAL MAXIMUM TEMPERATURE ANOMALIES⁵⁵ (TMAX)

These maps show the change in seasonal maximum temperatures - that is, the warmest temperatures of the day that typically occur in the mid-afternoon, averaged over each season - in each of Virginia's climate divisions for the period 1986-2016 relative to 1895-2000. Every climate division has experienced warming of their maximum temperatures across all seasons. The largest changes have been observed in the wintertime.

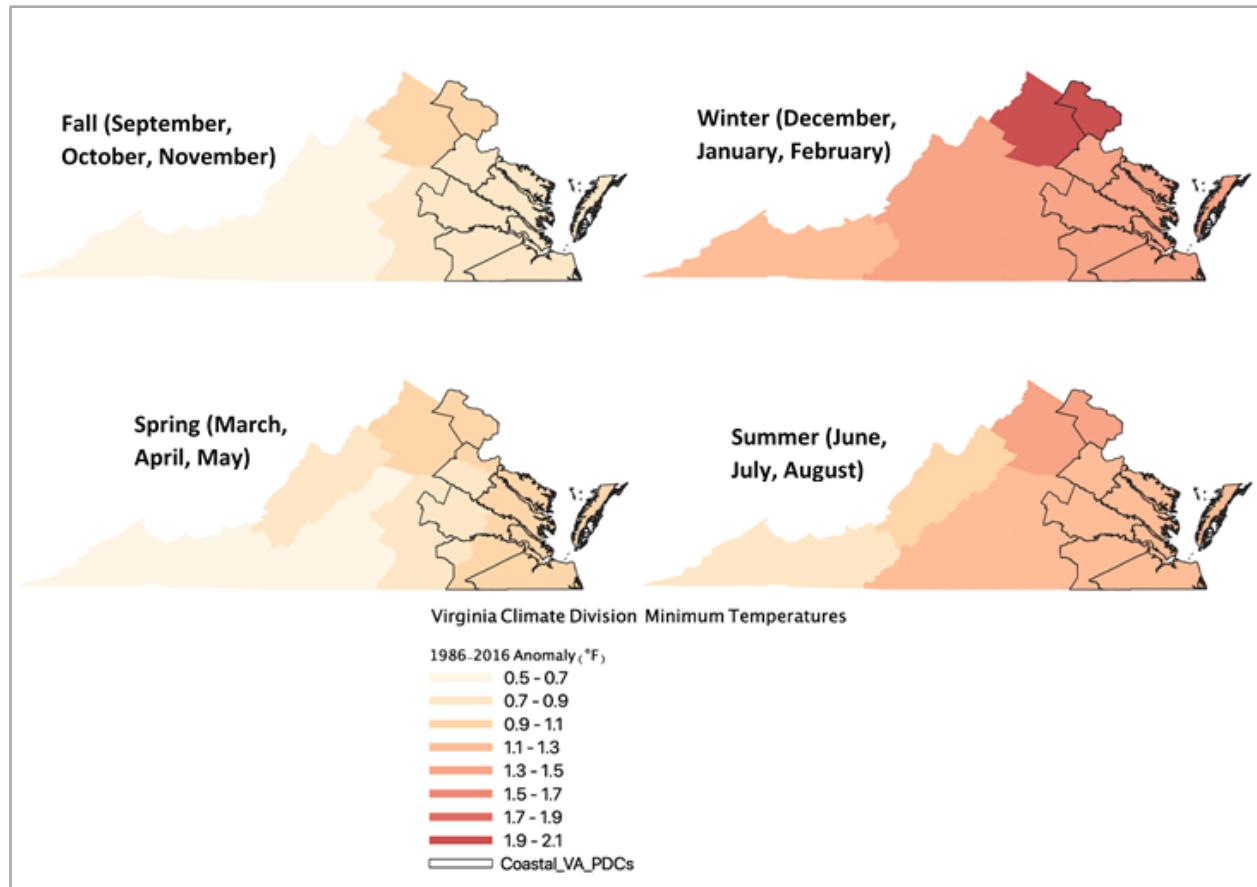


FIGURE 5 SEASONAL MINIMUM TEMPERATURE ANOMALIES (TMIN)⁵⁶

These maps show the change in seasonal minimum temperatures - that is, the coolest temperatures of the day that typically occur just before sunrise, averaged over each season - in each of Virginia's climate divisions for the period 1986-2016 relative to 1895-2000. Every climate division has experienced warming of their minimum temperatures across all seasons. The largest changes have been observed in the wintertime.

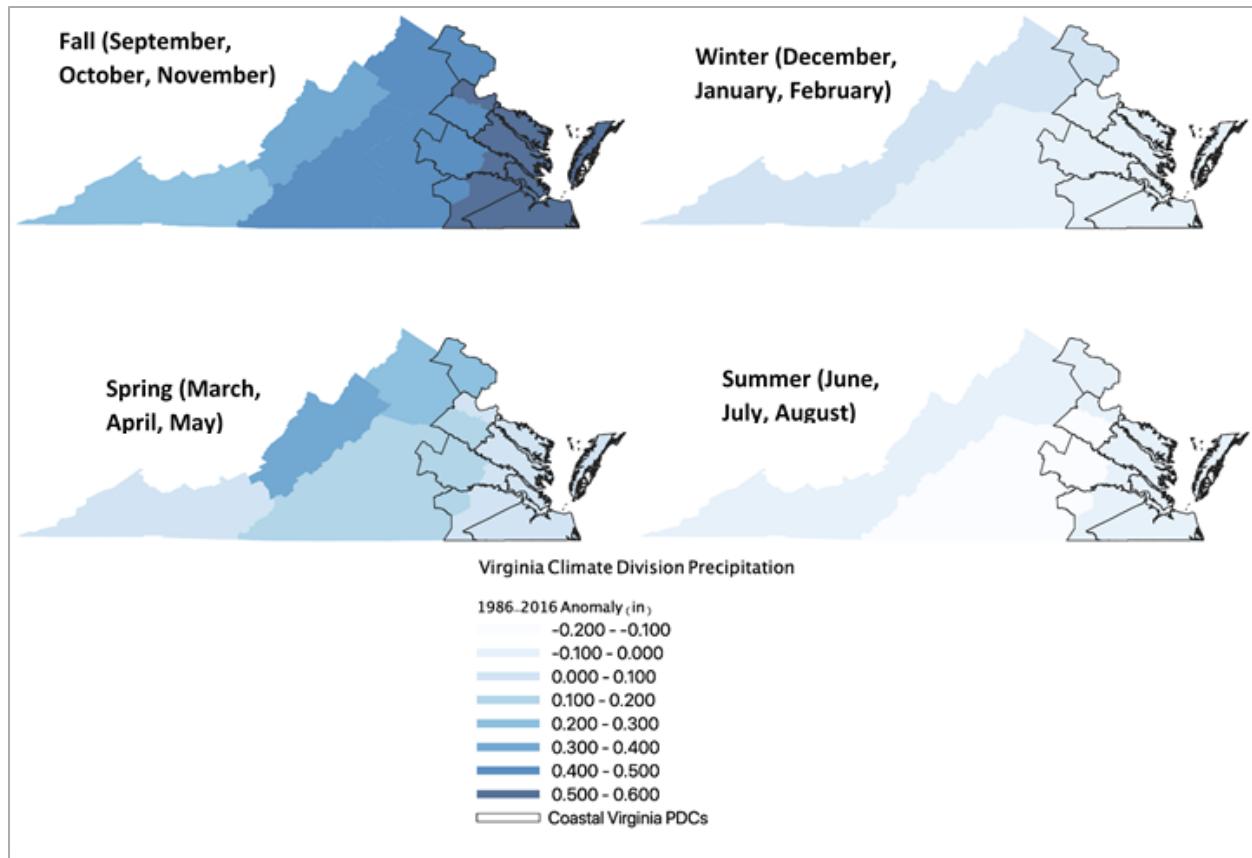


FIGURE 6 – SEASONAL PRECIPITATION ANOMALIES (PRCP)⁵⁷

These maps show the change in seasonal precipitation in each of Virginia's climate divisions for the period 1986–2016 relative to 1895–2000. The largest increases have occurred in the autumn and the largest decreases have been detected during the summer, potentially threatening our agricultural economy.

As global temperatures continue to warm, average sea levels rise. While the global average sea level has increased by about eight inches since 1880, different areas have seen varying degrees of change. Coastal Virginia has experienced one of the greatest rates of relative sea level rise on the East Coast of the United States. NOAA Sewell's Point tide gauge on Naval Station Norfolk (the gauge with the longest consecutive data record in the Commonwealth⁵⁸) has measured an increase of more than 18 inches in the past century.

Global warming contributes to sea level rise in two major ways: thermal expansion and ice melt. Since the ocean absorbs more than 90 percent of the heat that greenhouse gases trap in the Earth's atmosphere, as atmospheric temperatures increase, ocean temperatures increase, and the volume of seawater expands. Thermal expansion has caused approximately one third of global sea level rise.^{59, 60} The loss of ice mass from melting glaciers and ice sheets due to increased atmospheric temperatures has accelerated in recent years and now accounts for roughly twice as much sea level rise as does thermal expansion.⁶¹

In Virginia, climate-driven sea level rise is exacerbated by land subsidence: the sinking or lowering of the land surface. The withdrawal of groundwater, large-scale regional vertical movement of the continental plate (glacial isostatic rebound), and ongoing shifts associated with the Chesapeake Bay meteor impact

crater all contribute to subsidence in coastal Virginia.⁶² Unsustainable extraction of groundwater from aquifers has been shown to cause as much as 40 percent of observed relative sea level rise in some areas.⁶³

Historic land filling and intensive development can also cause and speed land subsidence.⁶⁴ Sinking land in some of the lowest-lying and most vulnerable areas of the Commonwealth further complicates coastal resilience and adaptation efforts.⁶⁵ Finally, oscillations in the flow of the Gulf Stream along the Mid-Atlantic Bight also lead to variation in coastal sea level rise acceleration along Virginia's coast.⁶⁶

APPLYING CLIMATE SCIENCE TO COASTAL RESILIENCE IN VIRGINIA

Developing coastal resilience solutions requires large amounts of high-quality data, coupled with sophisticated analysis and modeling evaluating social, economic and environmental impacts, and supported by adequate sustained funding. Across the Commonwealth, federal and state research institutions are advancing science and leveraging partnerships to help inform decision-making. Virginia has tremendous academic research capacity with exceptional potential to tackle the challenges facing coastal communities. This section highlights some of that work, and Chapter 5 will provide a more comprehensive look at each institution and program that contributed to this Framework.

While scientists in Virginia work to gather additional data and develop more refined models to support hyper-local planning, we already know enough about sea level rise and land subsidence, including increased recurrent flooding, alteration of wetland and coastal ecosystems, and damage to infrastructure, to begin planning for the future. As part of Executive Order 45 (Appendix C), signed by Governor Northam in November 2019, the Commonwealth adopted the NOAA Intermediate-High Sea Level Rise Curve (last updated in 2017) as the planning standard for Virginia state-owned buildings.

This curve projects sea level change for the years 2040, 2060, and 2080 to be approximately 1.61 ft, 2.95 ft, and 4.66 ft, with approximately 6.69 ft of sea level rise possible by 2100, as shown in Figure 7 below.⁶⁷ This decision was based on the best available science and engineering recommendations from the Virginia Institute of Marine Science (VIMS), the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR) and Old Dominion University (ODU). It reflects the most likely sea level rise scenario for coastal Virginia (See Appendices D and E).^{68, 69} Executive Order 45 (EO-45) uses this sea level rise projection to set flood risk management standards for state-owned buildings. VIMS, CCRFR, and ODU will re-evaluate this planning curve selection every five years, and make recommendations for adjustment based on additional observations, updated projections, and engineering best practice. Localities and entities that must plan for future infrastructure needs are encouraged to consider adopting similar standards, and some already have, including the Hampton Roads Planning District Commission, the Port of Virginia, and the City of Virginia Beach.

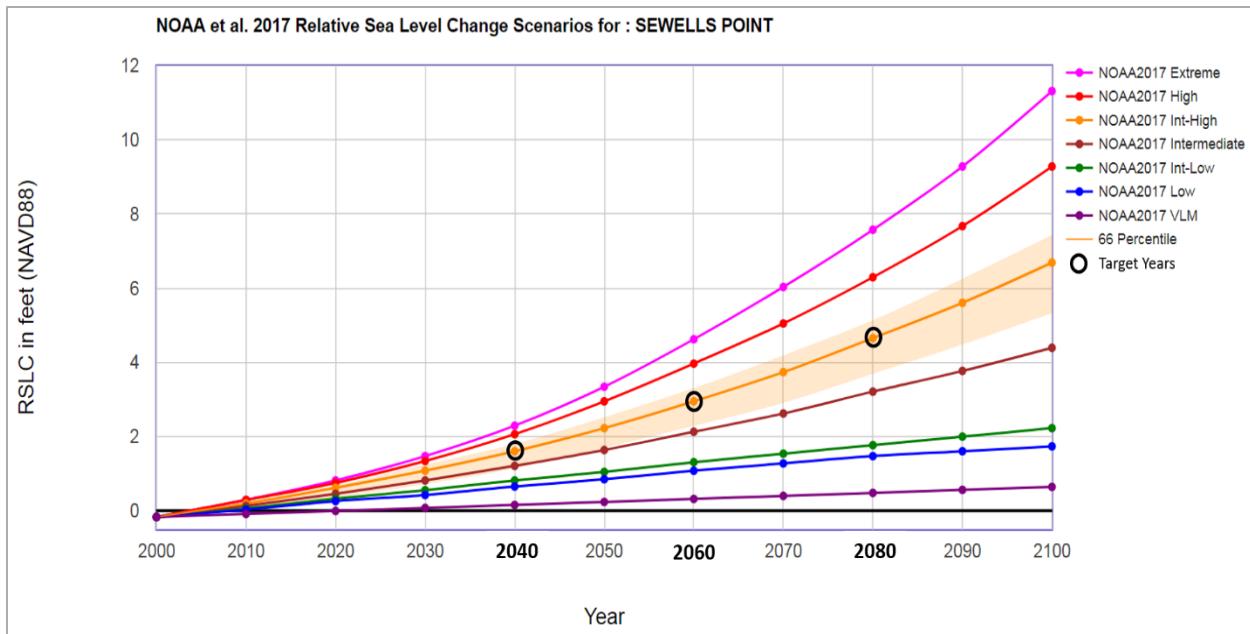


FIGURE 7. RELATIVE SEA LEVEL RISE SCENARIO PROJECTIONS FOR SEWELL'S POINT, VIRGINIA, WITH RANGE AND TARGET YEARS.⁷⁰

To gain further insight into the impact of sea level rise and nuisance tidal flooding on coastal Virginia, researchers at ODU and CCRFR developed an updated Coastal Virginia Sea Level Rise and Recurrent Flooding Predictive Inundation Model. The model was created through analysis of the best available existing data on coastal land elevation, sea level rise projections, land subsidence, and building and transportation assets. The model incorporates the same sea level rise curve chosen by the Commonwealth, and uses publicly available LiDAR elevation data, building site locations, road overlays, and other data to assess impacts to the coast and related assets. These maps show regional and local level comparisons of impact, and provide local planners a tool to support risk assessment and flood preparedness efforts.⁷¹

Geographic areas (Figure 8) examined in the analysis developed using initial model runs include cities and counties in eight coastal planning districts and regional commissions.⁷² This analysis focused on the impacts in years 2040, 2060, and 2080 to assist planners in determining the extent of recurrent flooding and permanent inundation due to sea level rise across planning intervals. The study modeled the impact to land, structures, and roads from moderate tidal flooding seen during nor'easters and lower grade tropical storms, nuisance flooding typical of king tide events, and multi-day wind-driven tidal flooding.

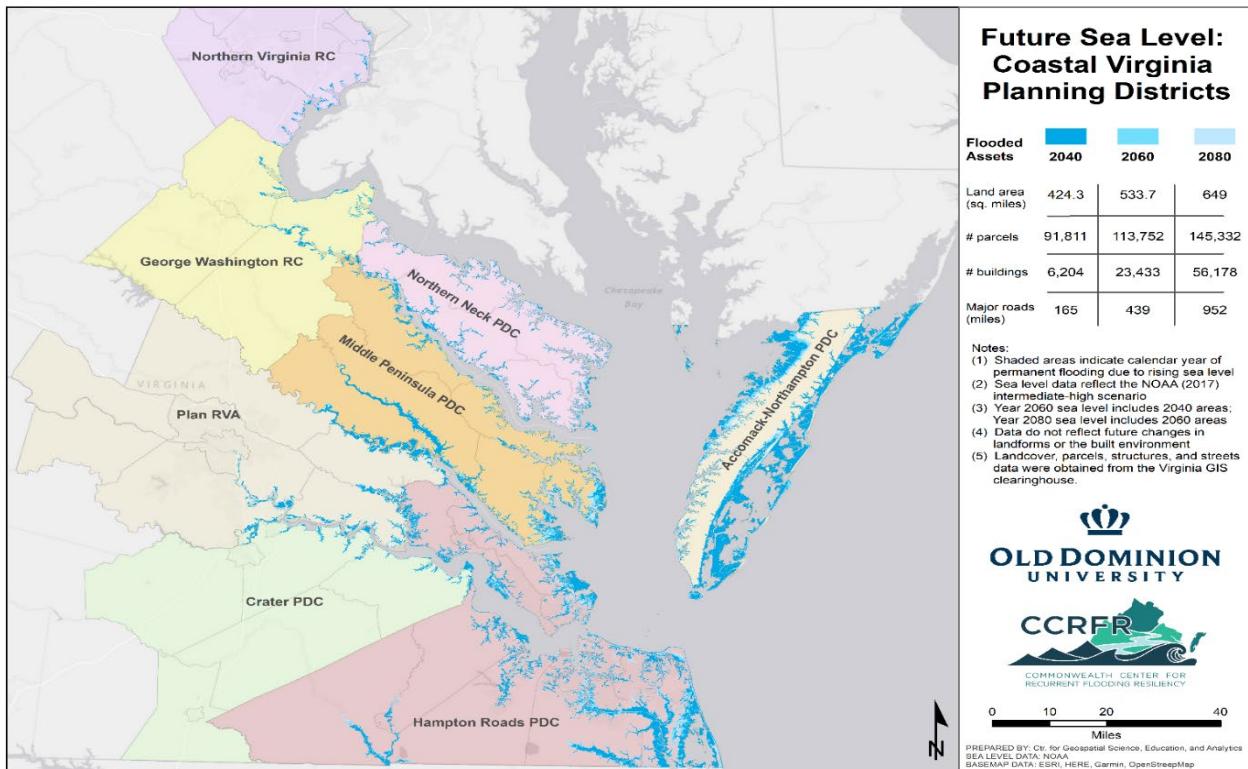


FIGURE 8: COASTAL PLANNING DISTRICTS, WITH PREDICTED FLOOD VULNERABILITY⁷³

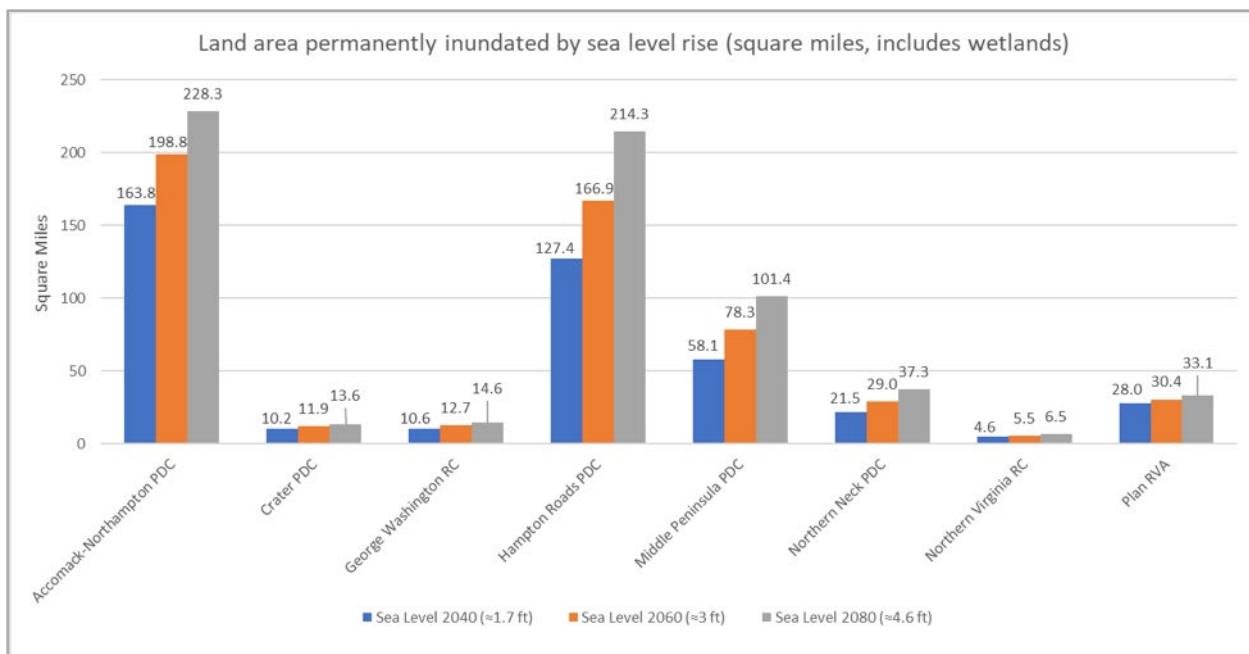


FIGURE 9: LAND AREA PERMANENTLY INUNDATED BY SEA LEVEL RISE WITH MODERATE TIDAL FLOODING BY PDC⁷⁴

The inundation modeling study determined the extent of land area permanently inundated due to sea level rise for Coastal Virginia (Figure 9). Overall, these studies clearly illustrate that the Hampton Roads, Accomack-Northampton, and Middle Peninsula planning districts will be the most severely affected regions in terms of inundation impacts, leading to negative consequences for public safety, environmental quality, and local economies, and will put homes and businesses at risk. The full study and additional details are included in Appendix F.

Storm surge flooding, typically used to describe the flooding from hurricanes or tropical storms, is any abnormal rise in seawater level during a coastal storm. Storm surge, not wind, is the greatest threat to life during a hurricane, and can cause water to rise quickly and with enough force to destroy homes and other property. In some cases, storm surge can exceed 20 feet,⁷⁵ although Virginia's reference storm for high water storm surge is the Chesapeake – Potomac Hurricane of 1933 created a surge of 9.8 feet above low water.⁷⁶

The Virginia Department of Emergency Management (VDEM), working with The Federal Emergency Management Agency (FEMA) and NOAA's National Hurricane Center, maintains interactive maps of potential storm surge hazards for Virginia using the new SLOSH MEOW (Sea, Lake, and Overland Surges from Hurricanes, Maximum Envelope of Water) model.⁷⁷ This model demonstrates that even a Category 1 hurricane can cause extensive surge flooding. With a Category 2 or higher storm, much of Hampton Roads and the low-lying areas of the Eastern Shore and the Middle Peninsula are at risk of destructive inundation, with flooding impacts up the tidal rivers as far as Richmond, Fredericksburg and Northern Virginia (Figure 8).⁷⁸

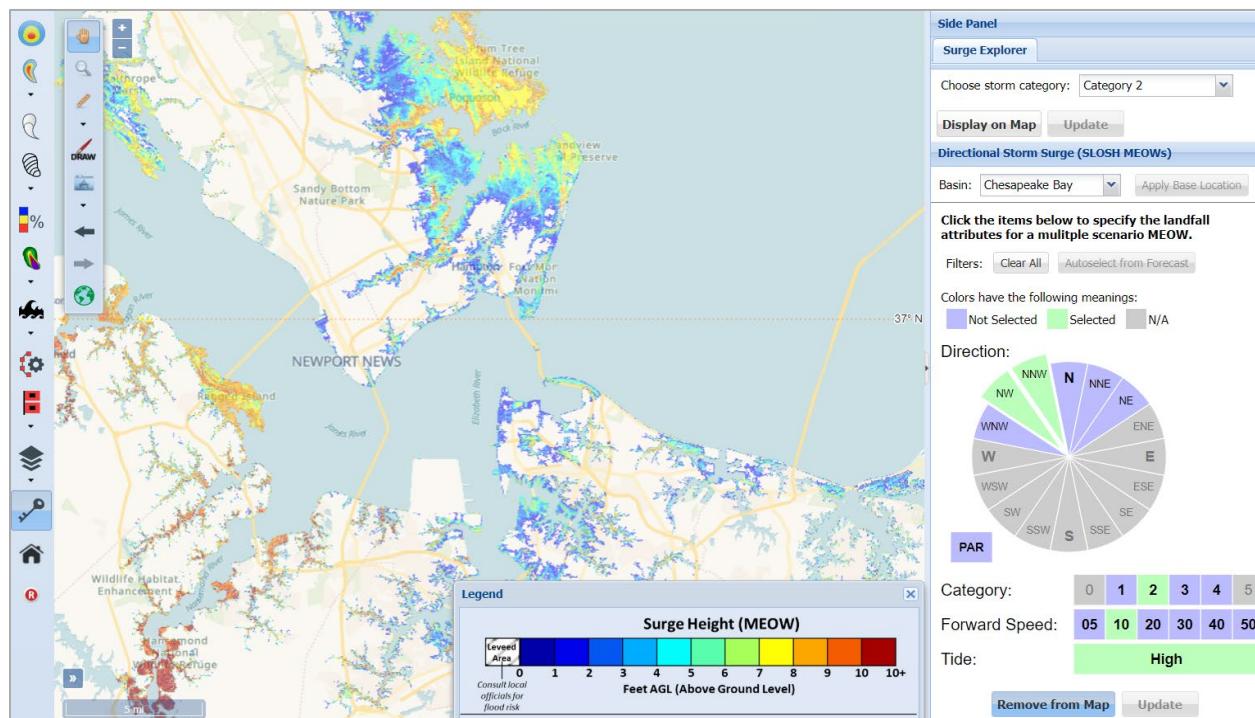


FIGURE 10: CATEGORY 2 STORM SURGE IMPACT IN HAMPTON ROADS⁷⁹

VIMS has developed a state-of-the-art model, SCHISM (Semi-implicit Cross Scale Hydroscience Integrated System Model), which simulates general circulation from oceanic to tidal creek scales, and predicts storm surge inundation with high resolution and precision. As an open-source model, SCHISM has benefited from other developers around the world adding sub-models to characterize sediment transport, water quality, biogeochemical processes, oil spill dynamics, and various aspects of coastal ecology. One particularly relevant sub-model of SCHISM, developed at VIMS, is the Tidal Marsh Model that simulates the changes in tidal marshes under different sea level rise scenarios. This model utilizes information on local hydrodynamics, sediment transport, marsh accretion through sediment deposition, and the effects of local topography and shoreline structures on horizontal migration to predict the response of the marsh to sea-level rise.⁸⁰

Additionally, VIMS maintains a Shoreline Management Model (SMM), a decision support tool which includes a database of shoreline conditions, established as a Geographic Information System (GIS) model that helps recommend best management practices for shorelines, using data and decision tree logic to assess potential future conditions. The latest SMM model, SMM 5.1, includes a comprehensive map viewer showing shoreline condition layers for each coastal locality to assist with review of shoreline natural resources, erosion, regulatory compliance, and comprehensive planning (e.g., Fig. 11).⁸¹

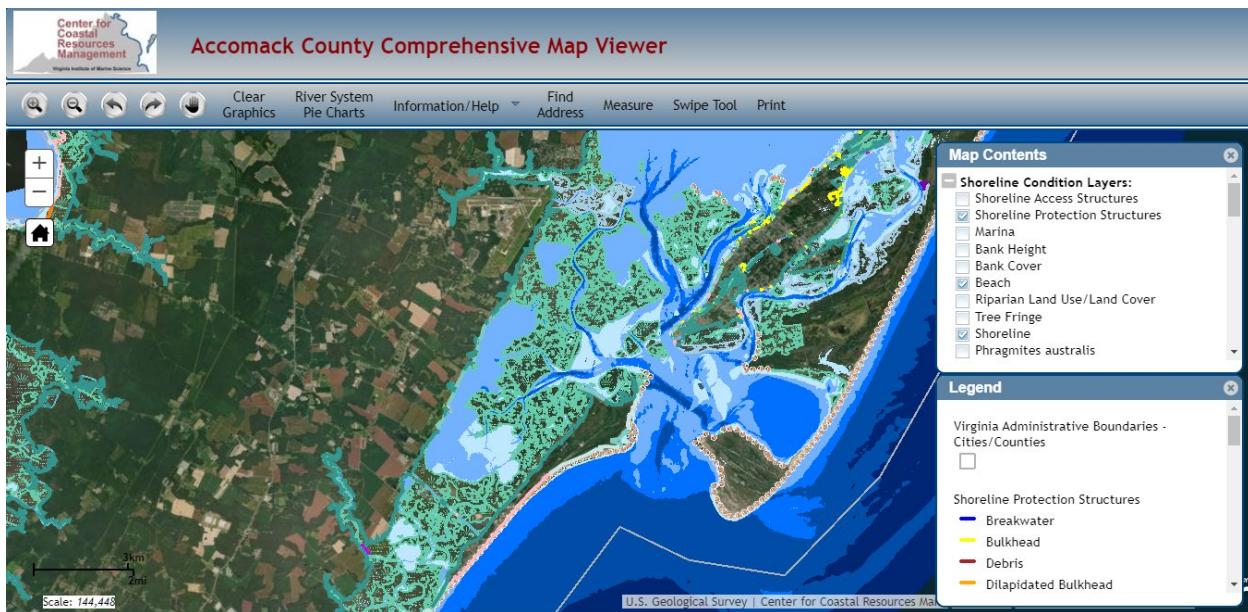


FIGURE 11: SHORELINE MANAGEMENT MODEL MAP VIEWER FOR NORTHEASTERN ACCOMACK COUNTY⁸²

The Virginia Department of Conservation and Recreation (DCR) maintains a Probable Maximum Precipitation (PMP) tool adopted by the Virginia Soil and Water Conservation Board in 2016 for planning for dam and floodplain safety across the Commonwealth.⁸³ This model, created by Applied Weather Associates, used a storm-based approach, and was developed in response to legislation passed by the 2014 General Assembly directing an updated and revised Probable Maximum Precipitation study determination for the Commonwealth. The 2015 PMP study and tool are useful, but were based in part on NOAA Atlas

14 rainfall data, which is now 16 years old and in urgent need of an update to include recent observations and data and to support more accurate predictions.^{i, 84}

The Virginia Coastal Zone Management (CZM) Program is a network of state agencies and coastal localities led by the Department of Environmental Quality (DEQ). DEQ maintains the Virginia Coastal Geospatial and Educational Mapping System (Coastal GEMS) tool, a gateway to Virginia's coastal resources developed in partnership with Virginia Commonwealth University (VCU). Coastal GEMS also includes data and maps, coastal laws and policies, and facts on coastal resource values, with direct links to collaborating agencies responsible for current data. Coastal GEMS includes an expanding inventory of water and land based natural resources, conservation planning tools, and planning examples to assist localities and individuals in protecting Virginia's coastal ecosystems. It further serves as a tool to promote community involvement and environmental education throughout the Commonwealth, and is the product of partnerships, including funding data layer development by CZM partners. Additional data layers will be incorporated into Coastal GEMS as agencies continue to develop data and provide it for inclusion.⁸⁵

Finally, in conjunction with federal, state, regional, and local partners, The Nature Conservancy (TNC) developed and maintains the Coastal Resilience Virginia Eastern Shore Mapping and Decision Support Tool, to provide local governments and other entities with the information they need to better plan for the future. This tool, which used the Coastal Virginia Ecological Value Assessment (Coastal VEVA) as its basis, provides unique predictive habitat and marsh migration information for local planners, along with detailed overlays of coastline change, unique to the Eastern Shore of Virginia.⁸⁶ While created to support one planning district in Virginia, this decision support tool could add value across Virginia's Coastal region, if it were expanded and combined with the marsh migration work being conducted at VIMS.

SOCIAL AND ECONOMIC VULNERABILITY ANALYSIS

The social sciences also play an important role in helping us understand the consequences of climate change, as well as the consequences that unsustainable and unjust development patterns have for people living in Coastal Virginia. In recent years, ODU, William and Mary, VIMS have supported the social science side of the Commonwealth's coastal resilience efforts in several ways. VIMS hosts the Virginia Vulnerability Viewer (Figure 12) on its Adapt Virginia Portal, which includes an overall social vulnerability classification, based on socioeconomic vulnerability, housing vulnerability, and hazardous/toxic material exposure vulnerability - displayed by census tract. The William & Mary School of Public Policy and VIMS maintain this work, and have conducted additional analysis to further refine the data and variables considered. They recently published research examining the vulnerability of the business community and local government to coastal hazards and sea level rise, which could be added to this portal.⁸⁷

ⁱ NOAA Atlas 14 is the official US Government source of precipitation frequency estimates. Atlas 14 data is used for federal, state, and local planning activities, engineering designs, modeling of flood risks, managing floodplain development for the NFIP, and as a baseline in precipitation studies that indicate flooding threats.

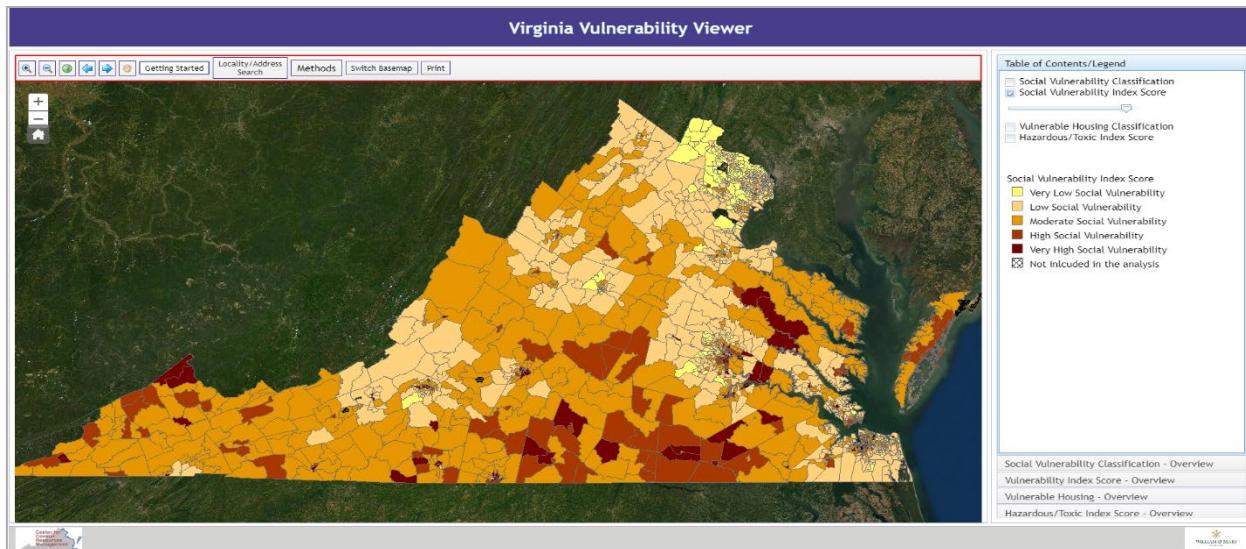


FIGURE 12: VIMS ADAPT VIRGINIA VULNERABILITY VIEWER⁸⁸

In addition, recent work at VIMS mapping septic vulnerability throughout coastal Virginia, and ongoing work by VIMS and VDOT to understand and map road inundation vulnerability, could also be built into overlays for this process. These could help to pinpoint areas experiencing substantial additional stress from these impacts. Other overlays in Adapt Virginia could include groundwater inundation and well contamination by saltwater due to sea level rise, two additional critical stress factors for coastal communities.

Additional work in progress at VIMS, in partnership with Albemarle-Pamlico National Estuary Partnership (APNEP), Wetlands Watch and the Virginia Coastal Policy Center (VCPC), is supported by a NOAA grant. This work identifies and prioritizes areas where vulnerable properties have no known natural or nature-based features in place to offer protection against flooding impacts. It also identifies areas where implementing such solutions could offer other co-benefits, through improved water quality and flood insurance savings achieved by participation the NFIP Community Rating System (CRS) Program. This will assist local governments in determining where to position natural and nature-based features to meet CBPA and stormwater management requirements while generating CRS credits for NFIP. It will also identify communities at the greatest risk so that we can focus efforts to ensure social and environmental equity in prioritizing coastal adaptation and protection for all Virginians.

In addition, ODU, the Virginia Modeling and Simulation Center, and other partners also address social and economic vulnerability through social scientists, economists, physical scientists, and engineers, conducting research assessing business and community resilience across coastal Virginia. This includes but is not limited to work on the economic impact of flooding on the housing market, marine terminal vulnerability studies for the Port of Virginia and along the East Coast, housing recovery in coastal communities, evacuation modeling, and the economic resilience of Hampton Roads.

SUMMARY

The science shows that global warming has severe and worsening consequences for Virginia, and in particular for our coastal regions facing accelerating sea level rise. Understanding and predicting changes, while using the best available science, is critical to planning for regional and local impacts. Virginia is fortunate to have a number of academic and governmental institutions producing the science necessary to support sound resilience planning and decision-making.

DEFINING REGIONS FOR THE MASTER PLANNING FRAMEWORK



A Navy Destroyer undergoes repairs in dry dock on the Southern Branch of the Elizabeth River, Norfolk, VA. Credit: Old Dominion University

Different areas along Virginia's coast have shared and unique challenges associated with sea level rise and other coastal hazards. This chapter uses existing local and regional administrative boundaries to divide coastal Virginia into four regions for the Master Planning Framework, and describes key adaptation and protection actions each has already taken.

SETTING THE STAGE – REGIONAL DIFFERENCES AND SIMILARITIES IN COASTAL VIRGINIA

Virginia's coastal plain has urban, suburban, and rural communities, and it has land use that varies from agriculture and forestry to military and industrial. The coast varies regionally, with steep bluffs, expansive tidal marshes, forested wetlands, intensely developed hardened shorelines, and sandy beaches. Virginia has a complex network of tidal creeks, inlets, and rivers making it the eighth longest tidally influenced shoreline of any state.⁸⁹

The regional differences in shoreline type and development intensity also result in substantial variation in vulnerability and risk. This must be recognized in the Commonwealth's coastal planning process. Planning Districts – the regional planning bodies made up of several localities and created under the Regional Cooperation Act (Va. Code §15.2-4200 through 15.2-4222) – reflect and recognize some of these differences. Some have taken steps to understand and address the impacts of climate change on their

member localities and shared regional interests and assets. This includes developing regional hazard mitigation plans, required by FEMA, to examine the risk and impact of natural disasters and provide strategies for reducing impacts to people and property.⁹⁰

Through grants from the Virginia CZM Program, Virginia's eight coastal Planning Districts meet quarterly to discuss matters of shared interest, including coastal adaptation and protection efforts that cross local boundaries. These bodies are a logical focal point for the Master Planning Framework. The Framework will focus on territory within the boundaries of the eight coastal Planning District Commissions and Regional Commissions (PDCs/ RCs). Those eight PDCs/RCs are:

- Northern Virginia Regional Commission (NVRC)
- George Washington Regional Commission (GWRC)
- Northern Neck PDC (NNPDC)
- Middle Peninsula PDC (MPPDC)
- Accomack-Northampton PDC(A-NPDC)
- PlanRVA (formerly Richmond Regional Planning District)
- Crater PDC
- Hampton Roads PDC (HRPDC)

For this Framework, we have grouped these PDCs/RCs into four master planning regions. While all share similarities, these groupings are based on a number of factors that make them distinct from one another, including geography, geology, population density, primary land uses, and unique challenges. The master planning regions – described below – are:

- Hampton Roads (HRPDC)
- Rural Coastal Virginia (A-NPDC, MPPDC, NNPDC)
- Fall Line North (GWRC and NVRC)
- Fall Line South (Crater and PlanRVA)

HAMPTON ROADS

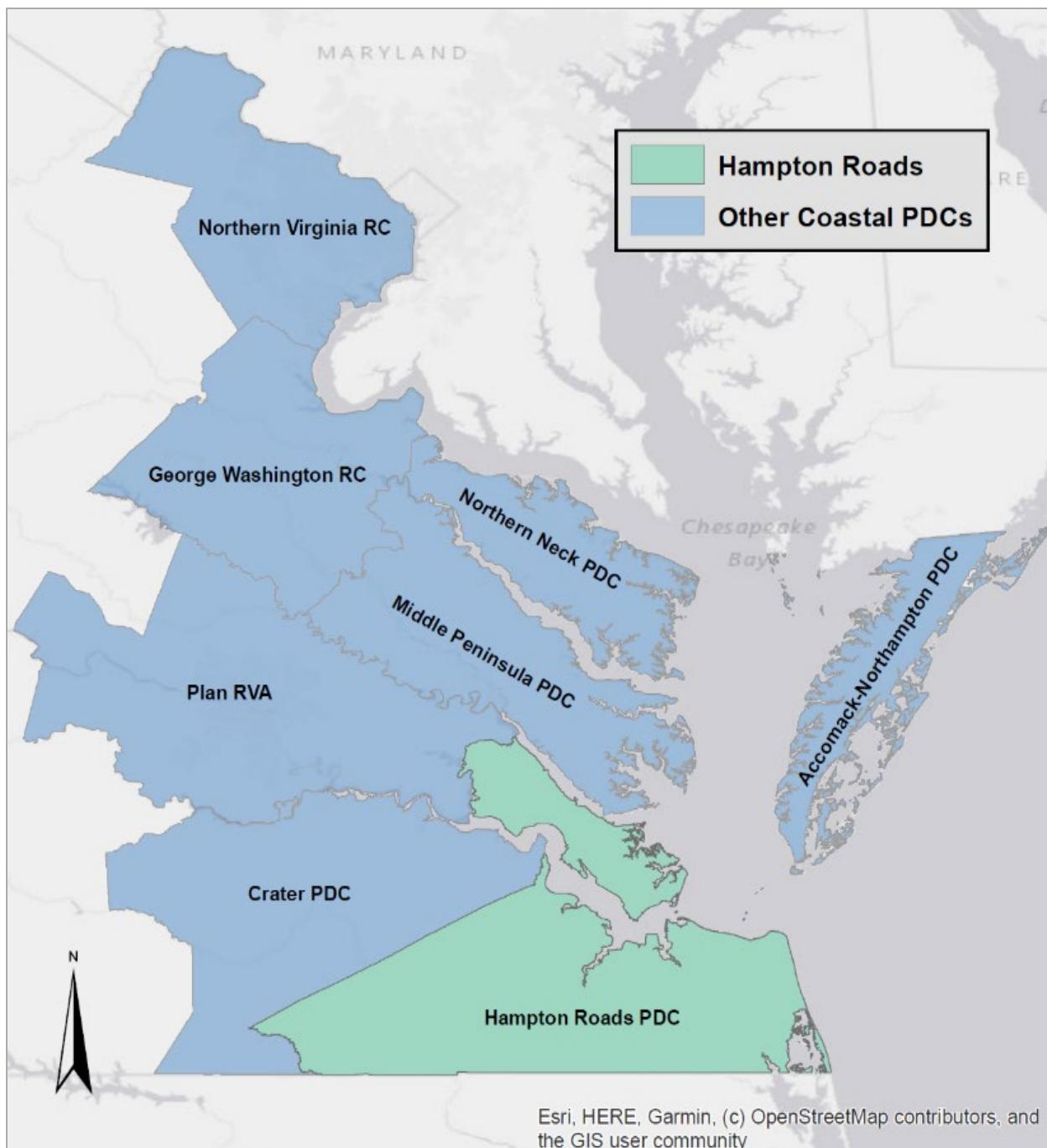


FIGURE 13: HAMPTON ROADS PLANNING DISTRICT COMMISSION

REGION OVERVIEW

Hampton Roads is a metropolitan region with a population of more than 1.7 million people, and is home to three of the five most populous cities in the Commonwealth (Virginia Beach, Norfolk, and Chesapeake).⁹¹ The HRPDC consists of the independent cities of Williamsburg, Hampton, Newport News, Poquoson, Norfolk, Portsmouth, Suffolk, Chesapeake, Virginia Beach, and Franklin, the incorporated town of Smithfield, and the counties of James City, York, Isle of Wight, and Southampton.ⁱⁱ The eastern portion of the Hampton Roads region is primarily urban, suburban, and industrial, with rural areas extending to the southwest. The entire region is located in the coastal plain and characterized by its low, flat relief. The region has a large military presence, including the nation's largest naval base, Naval Station Norfolk. Naval Station Norfolk is the second largest population of military personnel in the country - with approximately 83,000 active duty personnel. The naval station, and its associated supporting industries, make the Department of Defense and other federal entities the primary drivers of the local economy.⁹² In addition, the region is home to the Port of Virginia, the third largest container port on the East Coast.⁹³ Hampton Roads is also home to one federally recognized Indian tribe – the Nansemond Indian Nation, and two state recognized tribes – the Cheroenhaka (Nottoway) and Nottoway.

COASTAL RISKS AND VULNERABILITIES

The Hampton Roads region is highly vulnerable to a wide range of coastal hazards that threaten the safety of residents, infrastructure, and the environment. Climate change is causing more frequent and intense storms, and the combination of sea level rise and relatively significant land subsidence in the region have contributed to some of the highest rates of relative sea level rise along the U.S. Atlantic Coast.⁹⁴ Long term sea level rise is the region's most pressing threat, because it increases recurrent flooding and exacerbates the impact of storm surge, with the potential for catastrophic consequences during individual storm events and over time.

Areal and flash flooding have become a major problem for much of the region as low-lying, impervious areas cannot drain, and older stormwater infrastructure struggles to keep up with high rates of rainfall. Rainfall flooding intensifies during times of high tide and coastal flooding, as is often the case during coastal storms. Tidal, wind, and rain driven flooding – in any combination – occurs in the region multiple times a year and impacts homes, businesses, roadways, and other infrastructure. Predicting these impacts and the real-time locations of flooded roads is one of the biggest challenges the Hampton Roads region faces. This high tide flooding is likely to increase and affect more of the population as sea level rises and land continues to subside.⁹⁵

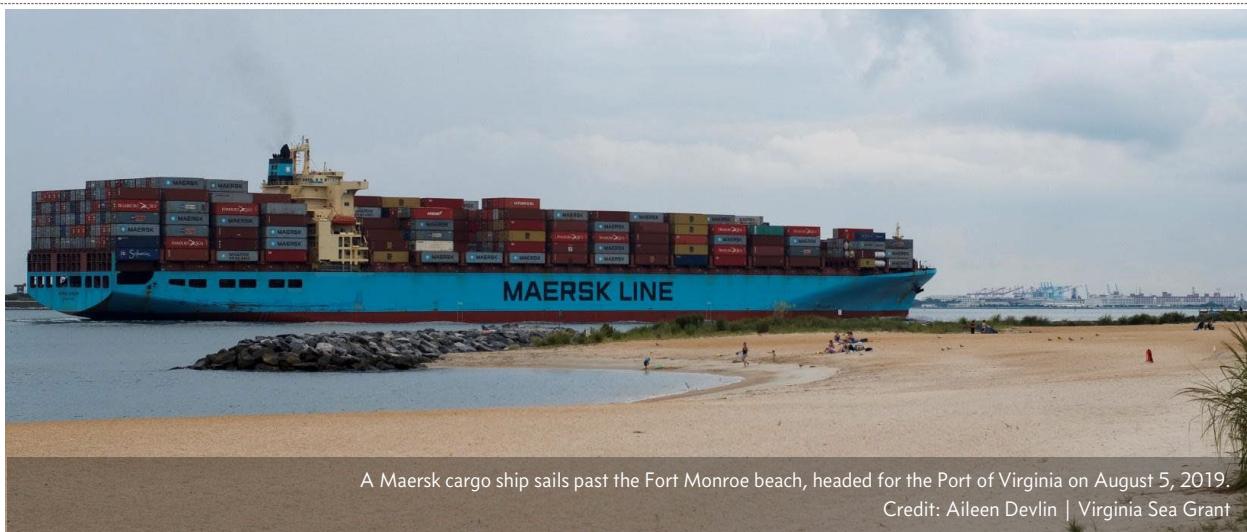
Flooding is possible along all waterways in the region. Localized riverine flooding and flash flooding can occur in areas of Hampton Roads not adjacent to a major body of water. Large portions of the region are low elevation and can experience tidal flooding during hurricanes and severe nor'easters.⁹⁶ This can be particularly acute in the Back Bay area of southern Virginia Beach during prolonged southerly winds,

ⁱⁱ Several Regional Planning Districts in SE Virginia include counties that are enabled to them, and also members of an adjoining PDC for planning continuity purposes. This structure exists for PLANRVA and the Crater PDC for Chesterfield County and Charles City County, for the Middle Peninsula PDC and the Hampton Roads PDC related to Gloucester County, and for the Crater PDC and the Hampton Roads PDC related to Surry County. To avoid confusion in this document, localities with memberships in PDC's other than their enabling PDC are listed only under their enabling PDC.

which drive water north from the Pamlico Sound in North Carolina.⁹⁷ The southwestern, rural counties of the region are less prone to storm surge and coastal flooding because of their distance from the coast and major tidal waterways but face the same challenges of areal and flash flooding from extreme rainfall on flat, poorly drained lands.

Erosion is a problem for most of Hampton Roads' extensive shoreline as a result of wave action and heavy vessel traffic. The built landscape also creates its own vulnerabilities because of extensive impervious surfaces and channelized runoff. In some areas, this has required beach nourishment and other interventions to protect built infrastructure close to the water's edge. Habitat loss is a significant challenge for the region, as much of the ecologically valuable land is at risk from sea level rise and saltwater intrusion. Fringe habitats pinned between rising seas and developed areas are particularly vulnerable. So are freshwater to brackish systems like those in the Great Dismal Swamp and Back Bay. The National Summary of Wetland Resources identifies urbanization, rising waters, and agricultural and pond conversion as leading causes of wetland loss.⁹⁸ More recent research conducted at VIMS shows that Virginia could expect substantial tidal marsh loss this century, most severe between the years 2050-2070. However, rural Bay-front coastal localities will see tidal marsh increase due to the low human development in low-lying areas. They will, in essence, hold their own. Low-lying built out cities with limited marsh migration opportunity, like those in Hampton Roads, will lose much of their existing tidal wetlands buffers.⁹⁹

Hampton Roads is one of the most intensely developed regions in Virginia, and is home to numerous assets of state and national significance. This region is also very low-lying, flat and bisected by many tidal waterways. These factors combine to create a great deal of risk to people and property. Heavily industrialized areas along the Elizabeth River and other tidal rivers in the region create another layer of risk to flooding – environmental contamination. In some areas of the Hampton Roads region, planning and local ordinances can influence adaptation by including a focus on natural and nature-based features, but with so much critical infrastructure at risk, solutions often involve complex engineering and hardened flood control solutions.



A Maersk cargo ship sails past the Fort Monroe beach, headed for the Port of Virginia on August 5, 2019.

Credit: Aileen Devlin | Virginia Sea Grant

The HRPDC has taken major strides towards coastal resilience as local governments have worked on a number of planning studies to reduce flood risk. In 2018, the HRPDC adopted unified sea level rise predictions that member localities should use in future planning and engineering decisions. Defined as a range of possible sea level elevations over time, they closely align with the NOAA Intermediate-High curve (last updated in 2017) that the Commonwealth has chosen for this Framework and the Virginia Flood Risk Management Standard.¹⁰⁰ This was the first regional approach to setting unified standards for sea level rise planning in the Commonwealth. In 2019, the HRPDC began a flood insurance education campaign, Get Flood Fluent, which aims to educate citizens on their flood risk and the costs and benefits of flood insurance, and provides other relevant information on the NFIP.¹⁰¹

The HRPDC has also supervised multiple Joint Land Use Studies (JLUS) between its member localities and their resident defense facilities. In Hampton Roads, flooding has become a primary topic of these studies and represents a challenge where cities and the military must plan together to ensure critical access to the bases is maintained through future sea level rise and tidal flooding events. To date, the HRPDC has overseen five JLUS in the region, including ongoing work in Virginia Beach and Norfolk, and Chesapeake and Portsmouth; and past work in Fort Eustis, Hampton – Langley AFB, and a Hampton Roads region-wide study.

Further, Hampton Roads' regional wastewater authority, the Hampton Roads Sanitation District (HRSD) Commission, has worked closely with the HRPDC and the Commonwealth in developing the Sustainable Water Initiative for Tomorrow (SWIFT) program, designed to ensure a sustainable source of groundwater, while seeking to address environmental challenges such as Chesapeake Bay restoration, sea level rise, and saltwater intrusion. This multi-year initiative is in the testing phase, with plans to re-treat already highly treated wastewater to produce drinking-quality water that will be injected into the Potomac Aquifer. The project could ultimately replenish the aquifer at a rate of 120 million gallons per day (MGD) via seven proposed injection sites in the HRSD. It could also reduce the amount of nutrients discharged into the Bay and its tributaries, and slow the land subsidence that is a major component of relative sea level rise in the region.

Finally, some Hampton Roads localities are developing their own solutions to enhance local coastal resilience. For example, the City of Hampton, along with the City of Norfolk and other Hampton Roads localities, participated in the “Dutch Dialogues” exercise held in Norfolk in 2015.¹⁰² This weeklong conference focused on Dutch planning techniques and processes to reframe the region’s outlook on flooding and water management. The effort concentrated on two chronic flood impact areas: Newmarket Creek in Hampton, and Ohio Creek in Norfolk. Hampton used the outcomes from this program as the basis to develop their ongoing *Resilient Hampton* planning strategy, which outlines their citywide objectives to improve resilience. Hampton selected and funded four initial projects in the Newmarket Creek area – now in the design phase – to implement as pilots that will help the city structure long term work, and provide lessons learned to Hampton and localities across Coastal Virginia.¹⁰³

Norfolk has implemented numerous projects and developed planning documents to address the great flooding risk the city faces. *Norfolk Vision 2100* details Norfolk’s long-term strategy to address the risk of sea level rise and outlines a vision of a resilient, dynamic, water-based city into the next century.¹⁰⁴ Norfolk also adopted an innovative and nationally unique re-write of its zoning ordinance to direct new and more intense development to higher ground. The ordinance includes a scoring system for evaluating projects for approval and new resilience overlay districts.^{105, 106} Norfolk has also completed a three-year Coastal Storm Risk Management Study, partnering with the US Army Corps of Engineers, to plan for long term flood mitigation and protection for the city.¹⁰⁷

The City of Virginia Beach, using a NOAA grant and city funds, partnered with a private consultant, Dewberry, to develop coastal adaptation strategies and plans. In March 2020, the city finalized its first long-term sea level rise and recurrent flooding adaptation strategy, *Virginia Beach Sea Level Wise*. This plan details numerous research and flood mitigation strategies at the watershed scale that will help with future city planning.¹⁰⁸ In June 2020, Virginia Beach adopted a new Public Works Design Standards Manual based on the same studies that support the Sea Level Wise plan, and factor in increased rainfall and sea level rise. The City also hired Dewberry to conduct a preliminary design and study of the potential for constructed marsh terraces to serve as an effective nature-based adaptation strategy for flooding and severe erosion in Back Bay. This project carries an estimated cost of \$9.2 to \$18.4 million depending on the number of marsh terraces created.

RURAL COASTAL VIRGINIA

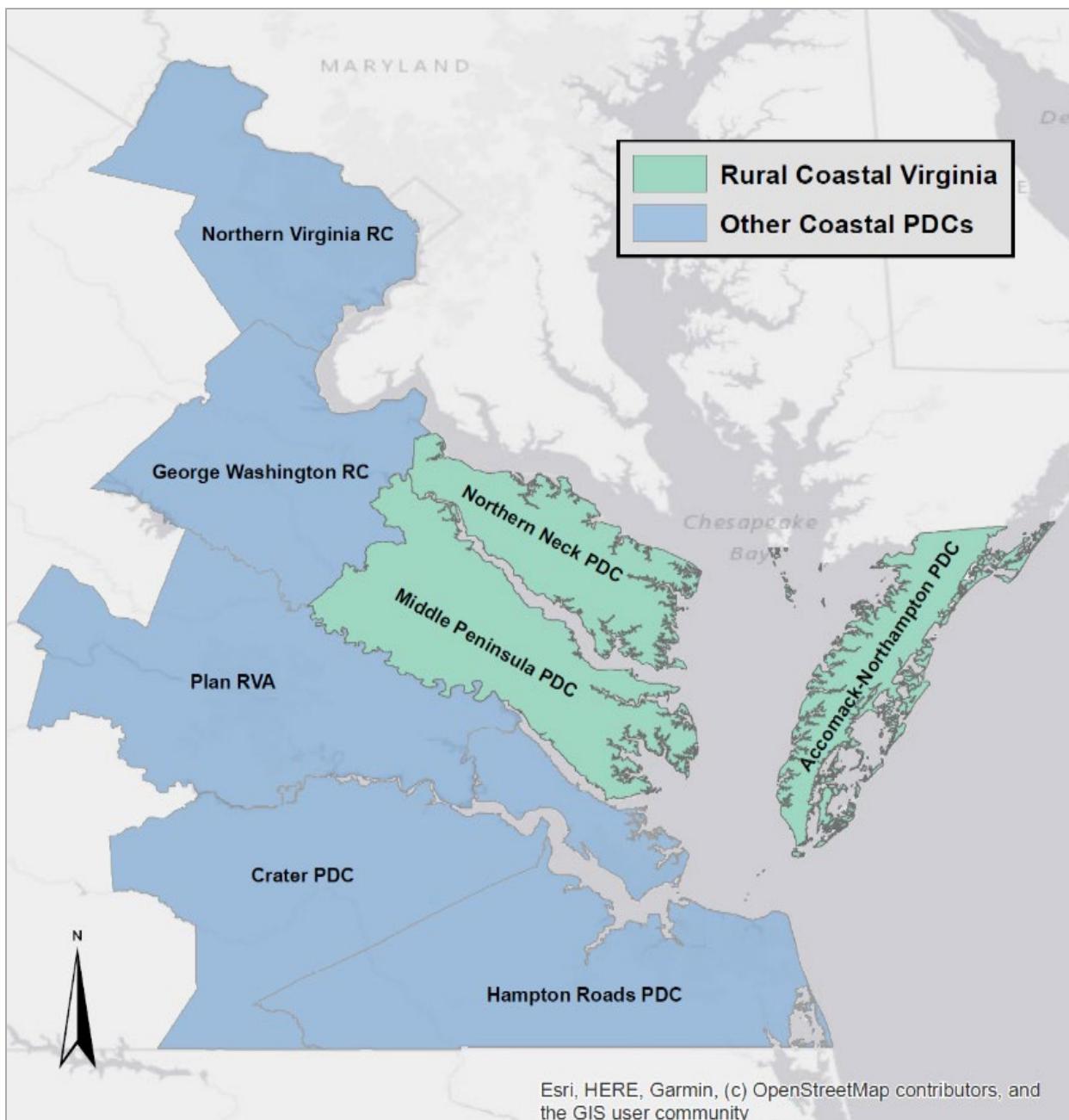


FIGURE 14: RURAL COASTAL PDCS

REGION OVERVIEW

Rural Coastal Virginia is a geographically dispersed, sparsely populated region characterized by its natural and open landscapes and its proximity to the Chesapeake Bay and the Atlantic Ocean. The three Planning Districts that comprise this region – A-NPDC, MPPDC, and NNPDC – have a combined population of 192,000.

The A-NPDC includes the counties of Accomack and Northampton, and the Town of Chincoteague, located between the Chesapeake Bay and the Atlantic Ocean on Virginia’s Eastern Shore. It includes the country’s longest stretch of undeveloped barrier islands, and is home to the National Aeronautics and Space Administration’s (NASA) Wallops Flight Facility, which hosts several partners including the U.S. Navy - Naval Sea Systems Command Surface Combat Systems Center, NOAA, Virginia Commercial Space Flight Authority, and the Mid-Atlantic Regional Spaceport. The federal facilities on one of the barrier islands, Wallops Island, are valued at almost \$1 billion and face significant vulnerabilities to coastal storms and future sea level rise.^{109, 110}

The MPPDC includes the counties of Essex, Gloucester, King and Queen, King William, Mathews, and Middlesex, and the incorporated towns of Urbanna, Tappahannock and West Point, and is bordered on the east by the Chesapeake Bay, to the north by the Rappahannock River, and to the south by the York River. It is home today to three federally recognized Indian tribes: the Pamunkey, the Upper Mattaponi, the Rappahannock, and one state recognized tribe: the Mattaponi. The Pamunkey and Mattaponi also retain reservations, both of which front tidal waters and are vulnerable to erosion and cultural loss due to sea level rise.

The NNPDC includes the counties of Lancaster, Northumberland, Richmond, and Westmoreland, and the towns of Colonial Beach, Irvington, Kilmarnock, Montross, Warsaw and White Stone. The NNPDC is situated between the Potomac River to the north, the Chesapeake Bay to the east, and the Rappahannock River to the south. Its relative proximity to the Washington, DC and Richmond, VA metro areas makes this area an attractive location for tourism and an increasing number of commuters.

Much of Rural Coastal Virginia has similar topography to Hampton Roads, but in the Northern Neck, elevation rises to low rolling hills within a few miles of the coast, and there are bluffs and more vertical shorelines in some areas. Communities are smaller, more dispersed, and tied together by agriculture, aquaculture, fishing, and service industries.

COASTAL RISKS AND VULNERABILITIES

In Rural Coastal Virginia, historic communities established because of water-dependent economic activity are at risk, as are roads that connect those communities, coastal agricultural lands, numerous small ports and harbors, and extensive acres of ecologically significant tidal marsh, barrier islands, and coastal forest ecosystems. With thousands of miles of coastal shoreline, Rural Coastal Virginia is uniquely vulnerable to coastal storms and riverine and coastal flooding associated with tides and extreme or prolonged precipitation, which are being exacerbated by climate change and sea level rise.¹¹¹ Exposure to broad rivers and the open waters of the Chesapeake Bay and Atlantic Ocean result in significant coastal erosion, which threatens private property and public infrastructure. Saltwater intrusion is also a threat to well water

quality and to coastal farms and forests.^{112,113} The region's heavy reliance on septic systems for wastewater disposal presents both economic and public health challenges.

Rural Coastal Virginia has a growing number of waterfront or water accessible residential developments and subdivisions, as the area is an attractive retreat from nearby urban centers. Much of Rural Coastal Virginia's workforce commutes outside the region, especially in the Northern Neck and Middle Peninsula, where 65-75 percent of the regions' 68,000 member workforce out-commutes. This also has the broader implication of reduced economic development for the region.¹¹⁴ For many Rural Coastal Virginia localities, property tax accounts for upwards of 90 percent of government revenue, presenting a clear and significant fiscal challenge to local governments as much of the most valuable waterfront properties are also the most vulnerable. The region also shows high social vulnerability, including older and minority populations living in flood prone areas, and the resulting potential for economic stress.¹¹⁵

Changing coastlines also affect the navigable waterways of the region by changing sediment transport volumes and patterns, which can lead to shoaling. Navigation channels and harbors are critical to the area's fishing and aquaculture economy, but are expensive to maintain and no longer receive federal funding for maintenance. Further, built and natural infrastructure of regional, national, and international significance are key to the survival of migratory bird populations.¹¹⁶ This includes the NASA Wallops Island Flight Facility, extensive tidal marsh complexes, and undeveloped barrier islands. TNC's Virginia Coast Reserve manages the barrier islands and the mainland of the islands is protected by federal and state agencies.ⁱⁱⁱ

Coastal adaptation and protection solutions in places like these can and will differ from the similarly low-lying but more densely developed and populated Hampton Roads region. Nature-based approaches like strategic land conservation, wetland restoration, and living shorelines have greater potential to address water quality and to aid in water management solutions in Rural Coastal Virginia. However, many existing natural coastal defenses are already being stressed, and Rural Coastal Virginia localities do not have the resources to develop specialized plans and undertake capital projects like their urban counterparts.

ⁱⁱⁱ *The Virginia Coast Reserve consists of 14 undeveloped barrier and marsh islands protected by The Nature Conservancy for more than 50 years. The U.S. Fish and Wildlife Service, Virginia Department of Conservation and Recreation and Virginia Department of Wildlife Resources each protect additional barrier and marsh islands along the Virginia coast.*



Despite challenging budget situations and a reluctance of some communities to acknowledge climate change and its consequences, a number of efforts are underway in Rural Coastal Virginia to increase resilience to coastal hazards. Sea level rise and the need to increase resilience appears in some localities' comprehensive plans, and local governments continue to collaborate with federal, state and private entities to complete shoreline protection and restoration projects throughout the region.^{117,118,119,120} NNPDC localities use restrictive growth policies and zoning practices to limit development, and A-NPDC partners with TNC's Virginia Coast Reserve and a broad range of additional stakeholders on the Eastern Shore to manage the A-NPDC Climate Adaptation Working Group.¹²¹ Rural Coastal Planning Districts collaborate on challenges related to ensuring economic and regional resilience through active participation in the VCZM Program, and localities and planning district commissions have assisted with property elevations, buyouts and relocation, using the FEMA Hazard Mitigation Grant Program (HMGP). The A-NPDC has already elevated more than 50 private homes since 1999, and the NNPDC manages a home elevation program using HMGP funds. These options are all practical in this region due to available land and lower development pressures.

The NNPDC is participating in the Resilience Adaptation and Feasibility Tool (RAFT) project, which assists local governments in beginning to understand threats and encourages and facilitates efforts to build regional and community resilience. The A-NPDC participated in the RAFT project in 2019 and the MPPDC plans to participate in the next cycle, slated for 2021. The MPPDC and NNPDC have created programs to provide support for residents dealing with increasing coastal flooding. The Middle Peninsula Chesapeake Bay Public Access Authority (MPCBPA) was created through a grant from the Virginia CZM Program, approved by the General Assembly in 2002, and ratified by local governments the following year. The MPCBPA recognizes that "shorelines are high priority natural areas and that it is critical to set aside access sites for recreational activities important to the economy and citizens."¹²² Besides the recreational and public access benefits, this program provides opportunities for qualifying property owners to turn over their land to the MPCBPA for a structured tax benefit, while permanently protecting vulnerable and flood-prone waterfront from development and ensuring opportunities for public access to land that might otherwise be developed. Similarly, in 2005, The General Assembly codified the Northern Neck-Chesapeake Bay Public Access Authority so residents of the NNPDC could receive the same opportunities.

The MPPDC also manages a Living Shoreline Incentive Program, (LSIP), a low interest loan and grant program available to residents seeking to install living shorelines on their property through low interest loans. This program was started after the Virginia General Assembly designated living shorelines as the preferred alternative for shoreline stabilization projects.¹²³ Legislation approved during the 2015 General Assembly allowed DEQ to provide funding for living shorelines via revolving loan funds, through the Virginia Clean Water Revolving Loan Program. Under this new legislation, the MPPDC has successfully implemented the LSIP, and in 2019, the U.S. Environmental Protection Agency recognized MPPDC for excellence and innovation for creating this program. Building on this project, the MPPDC has just debuted a new “Fight the Flood” program under a 2019 DCR Dam Safety Program, Flood Prevention and Protection Assistance Grant. In 2020, under this program, MPPDC received a National Fish and Wildlife Foundation grant to fund living shoreline projects in Mathews County. The Fight the Flood program is an online business to consumer marketplace, where property owners can find contractors and businesses specializing in flood mitigation and receive their professional services at a discounted rate. Residents who participate in the new program will also receive further discounted loan rates through LSIP. The goal of this program is to attract resilience-focused businesses to the region and help residents improve shoreline management and reduce their overall flood risk.¹²⁴

The NNPDC manages the Northern Neck Living Shorelines Initiative.¹²⁵ The purpose of the initiative is to educate shoreline management designers, engineers, contractors, and landscapers, in addition to property owners, on shoreline management best practices, including living shorelines. The NNPDC oversaw the installation of a number of living shoreline demonstration sites throughout the region, used as educational tools for students and property owners. The sites serve as examples for designers, contractors, and other practitioners of varied methodologies employed on shorelines with unique management challenges. The NNPDC collaborated with Friends of the Rappahannock, VIMS, and localities to hold Shoreline Management Contactor Workshops to educate shoreline management designers and contractors on shoreline management best practices. The NNPDC continues to convene local stakeholders to develop strategies to perform education and outreach to increase the use of living shorelines and nature based solutions on private property, thus improving overall community resilience.

On the Eastern Shore, TNC has pioneered green infrastructure solutions to resilience, partnering with VIMS and the innovative CZM Program-funded Seaside Heritage Program in establishing the world’s largest seagrass restoration project and building oyster reefs for shoreline protection.¹²⁶ Over the past few years, the A-NPDC has sponsored and coordinated several research efforts, including a Transportation Infrastructure Inundation Vulnerability Assessment to determine the extent of transportation infrastructure on the Eastern Shore at risk of inundation from rising sea levels, and to determine when that permanent inundation is likely to occur. The CZM Program-funded study found that 209 miles, or 13.8 percent, of the state-maintained roadways on the Eastern Shore face permanent inundation with 3 feet of sea level rise – possibly as early as 2060.¹²⁷ Finally, the Virginia Eastern Shore Conservation Alliance (formerly the Southern Tip Partnership) is a partnership of CZM, TNC, the U.S. Fish and Wildlife Service (USFWS), DCR, and the Virginia Department of Wildlife Resources (DWR). The alliance formed to acquire and restore coastal lands on the Eastern Shore. It has protected thousands of acres since 1990.

FALL LINE NORTH

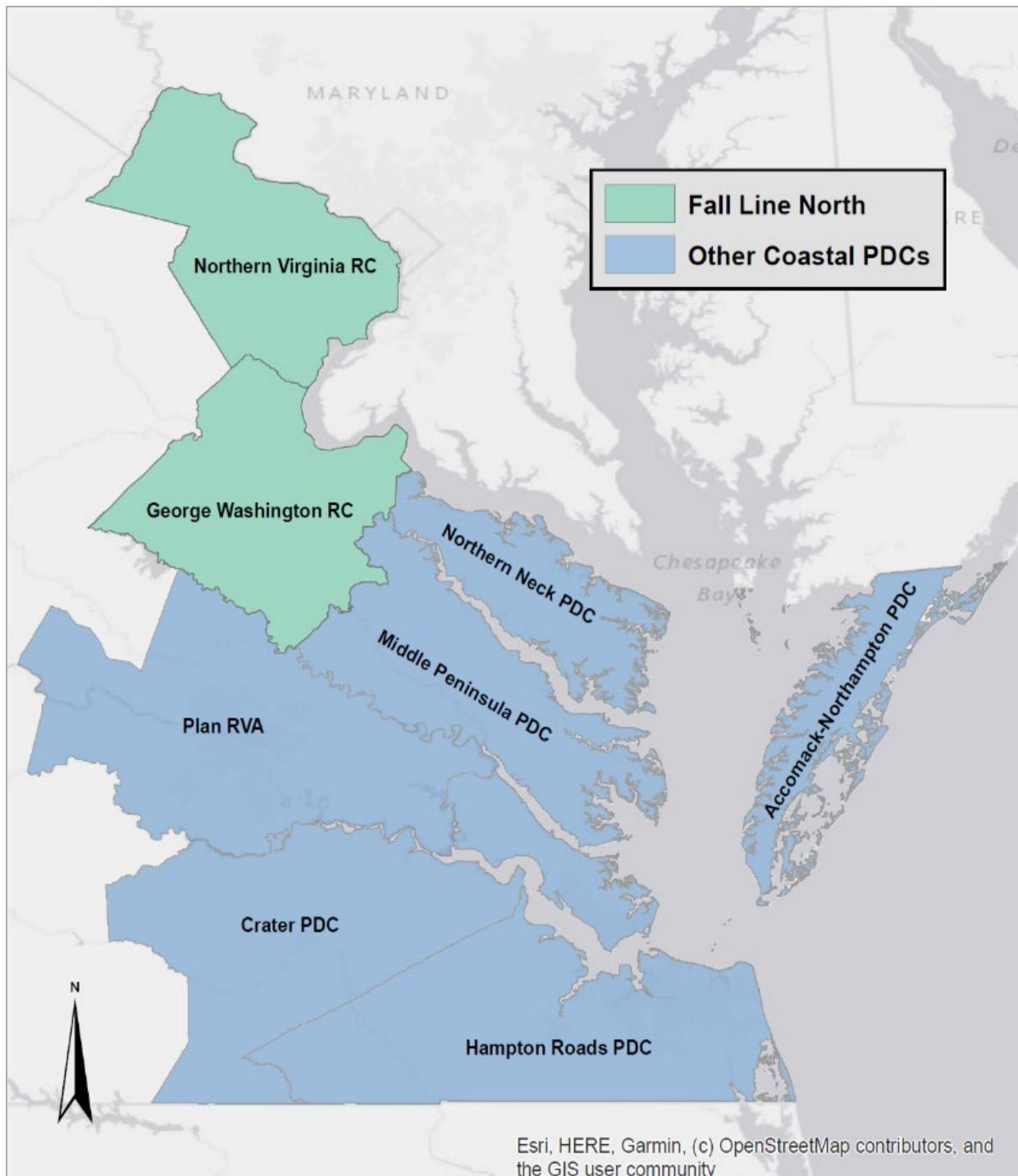


FIGURE 15: FALL LINE NORTH PDCS

REGION OVERVIEW

Removed from the high-energy coastlines of the Chesapeake Bay, Virginia's Fall Line North region is largely urban and suburban, and is home to more than 2.8 million Virginians. It consists of two planning districts – NVRC and GWRC – with localities in the coastal plain that have connections to tidal waters. The falls of the Potomac and the falls of the Rappahannock mark the extent of tidal influence and the coastal plain in this region.

The NVRC includes four counties: Arlington, Fairfax, Loudoun, and Prince William; five independent cities: Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park; and four incorporated towns: Dumfries, Herndon, Leesburg, and Vienna. With a total population of more than 2.5 million people, Northern Virginia is the most populous region in the Commonwealth, and borders the western shore of the Potomac River, across from Maryland and Washington, DC. The GWRC is the fastest growing of the Commonwealth's 21 planning districts, and comprises the independent City of Fredericksburg, and the counties of Caroline, King George, Spotsylvania, and Stafford.¹²⁸ The GWRC is also home today to one state recognized Indian tribe – the Patawomeck.

COASTAL RISKS AND VULNERABILITIES

Unlike Hampton Roads and Rural Coastal Virginia, many of the resilience challenges of the Fall Line North region are not as directly connected – or not understood as directly connected – to the Chesapeake Bay and Atlantic Ocean. However, the region is vulnerable to the effects of extreme weather and sea level rise, especially with low-lying coastal areas of the City of Alexandria, and Arlington, Fairfax, Prince William, Stafford and King George counties. Threats outlined in the region's hazard mitigation plans include extreme rainfall events, flash flooding, and tidal surges.¹²⁹

Riverine, tidal, and stream flooding associated with increased intensity and duration of precipitation events is the main concern for many Fall Line North communities, including the City of Fredericksburg along the Rappahannock River. Riverine flooding has been responsible for some of the most dramatic flood events in Northern Virginia, often due to the tidal flooding of the Potomac during hurricanes and tropical storms. Storm surge presents a threat through riverine flooding of the tidal Potomac.¹³⁰ This inundation threatens densely developed and economically important areas such as Old Town Alexandria, Ronald Reagan Washington National Airport, Department of Defense facilities including Marine Corps Base Quantico and Fort Belvoir, Naval Support Facility Dahlgren, and critical transportation and rail infrastructure along the tidal Potomac.¹³¹

Dam failure is also a growing hazard, particularly for the GWRC, because flooding conditions during tropical systems could exceed dam capacity for the many high-risk dams in the region.¹³² Shoreline erosion is a problem along the tidal Potomac and Rappahannock; both because of natural processes and increased wave action from boat traffic, and is likely to accelerate with increased storm events and sea level rise.

Large portions of the shoreline in Northern Virginia have been hardened, and this approach is likely to continue as the most effective method for protecting major critical infrastructure and intensely developed areas. There are still many opportunities for nature-based solutions, however. Living shorelines can be built with bulkheads and seawalls and, further, “softening” of shorelines that were hardened unnecessarily can have environmental and resilience benefits. Habitat loss is a concern as development

pressures increase and ecologically valuable tidal freshwater marsh and woodlands are potentially lost to rising waters and increased salinity.¹³³

KEY ACTIONS



Ronald Reagan Washington National Airport along the Potomac River. Credit: Arlington County

The NVRC and the Metropolitan Washington Council of Governments, in a cost-share partnership with the United States Army Corps of Engineers (USACE), the Commonwealth of Virginia, the Metropolitan Washington Airports Authority, and Fairfax County, are partnering to complete a USACE Coastal Storm Risk Management Feasibility Study. The study aims to understand, define, and determine solutions for coastal flooding and negative environmental impacts along the Virginia shores of the Potomac River from the fall line to Prince William County. Federal funding for this study was stricken from the USACE 2020 Work Plan, and the future of this critical work, identified as a specific area of need in the 2014 USACE Post-SANDY North Atlantic Coast Comprehensive Survey Report, is in question as of the writing of this report.¹³⁴

In addition, the Northern Virginia Resiliency Planning Work Group has worked with the Virginia Coastal Zone Management Program to create the Northern Virginia Resiliency Roadmap. The Roadmap works to include climate change considerations into local policy and planning, to develop methods and techniques to assess and manage climate change-associated risks, and to work with stakeholders on developing a response to these risks in the region.¹³⁵

The City of Alexandria is in a multi-year redevelopment of the Old Town waterfront. When the project is complete, it will include a flood tolerant park and a seawall to protect against tidal flooding.¹³⁶ The region also continues work on the Four Mile Run Restoration Project to restore a highly urbanized stream that forms the boundary between Arlington County and the City of Alexandria, and frequently floods nearby businesses and neighborhoods. Arlington County, the City of Alexandria, Northern Virginia Regional Commission, the U.S. Environmental Protection Agency, and the U.S. Army Corps of Engineers have a longstanding partnership in this effort.¹³⁷

The George Washington Regional Commission has been preparing for the impacts of climate change as part of its environmental programs and hazard mitigation planning. The Regional Green Infrastructure Plan recommends using natural and nature-based features for stormwater management and surface water

quality improvements that are more resilient to climate change impacts than traditional hard infrastructure. Communities along the Fall Line North region's tidal rivers will face significant impacts from sea level rise and storms, but to more limited geographic areas compared to Hampton Roads and Rural Coastal Virginia. However, because of the dense development and significant infrastructure in the region, the risks are significant, and expensive engineered resilience solutions will be necessary. In the less densely populated areas, solution sets are more likely to focus on nature-based approaches.

FALL LINE SOUTH

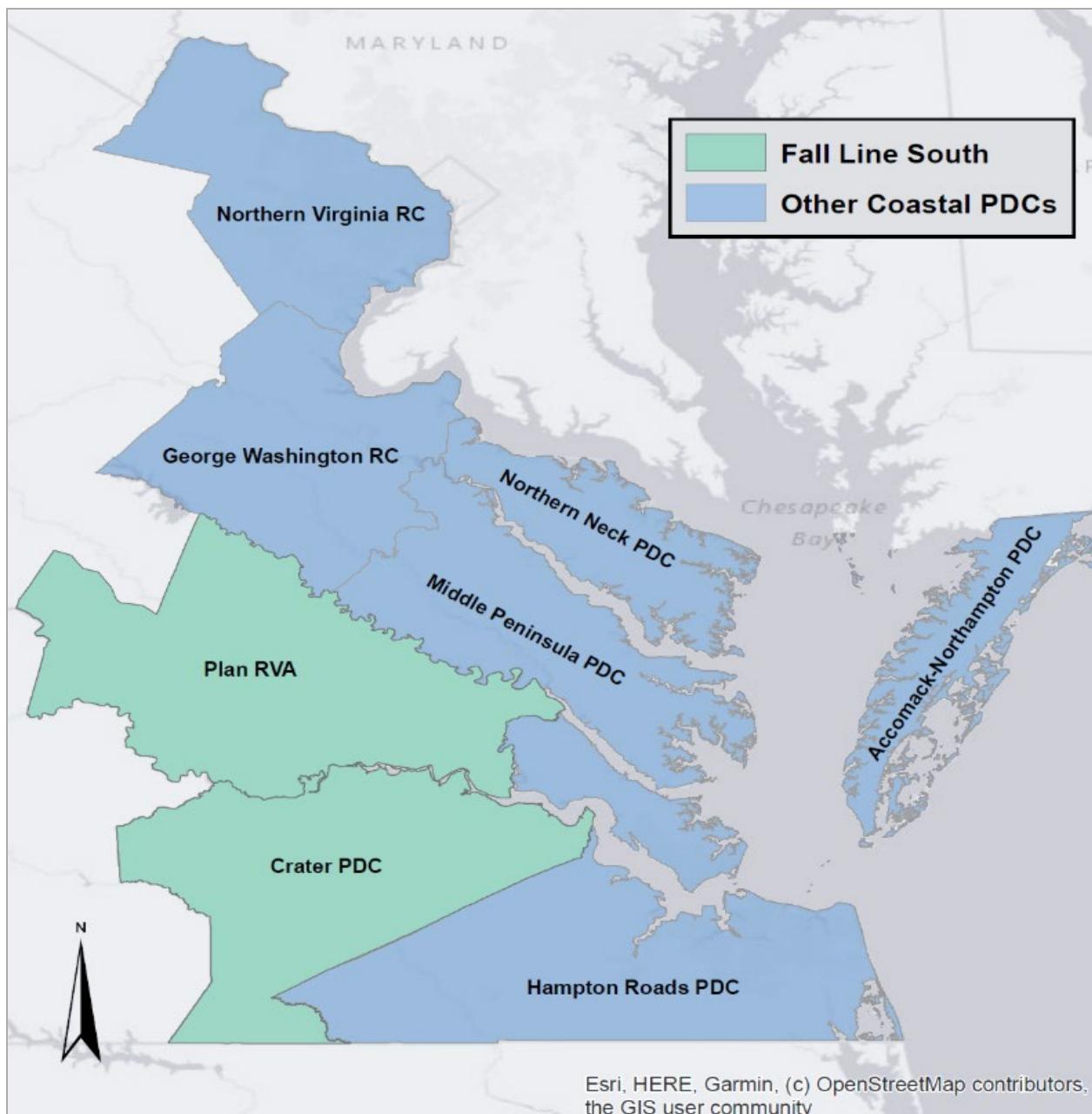


FIGURE 16: PDCS WITHIN THE FALL LINE SOUTH REGION

REGION OVERVIEW

Similar to the Fall Line North region, the Fall Line South region consists of two planning districts partially within the coastal zone, with exposure to tidally influenced rivers. PlanRVA includes the counties of Goochland, Powhatan, Hanover, Chesterfield, Henrico, New Kent and Charles City, the independent City of Richmond, and the incorporated town of Ashland. The Crater PDC comprises nine local governments in south central Virginia. They are the counties of Dinwiddie, Greensville, Prince George, Surry, and Sussex; and the independent cities of Colonial Heights, Petersburg, Hopewell and Emporia. More than 1.2 million people live in urban, suburban, and rural communities throughout the region.¹³⁸

The falls of the James and Appomattox Rivers in downtown Richmond and Petersburg, respectively, mark the extent of tidal influence. These have historically played a key role in development of the region, with port infrastructure and industrial centers located nearby. The region also has two federally recognized tribes – the Chickahominy in Charles City County and the Chickahominy Tribe Eastern Division in New Kent County. The Fall Line South area has less direct influence from the Chesapeake Bay than Rural Coastal Virginia, although it includes more flat, rural areas than farther north on the fall line. The region is anchored by urban and suburban population centers, but also has extensive agricultural land and forested wetlands of high ecological value.

COASTAL RISKS AND VULNERABILITIES

Coastal storms and their impacts are the most significant consideration in the combined Hazard Mitigation Plan for PlanRVA and Crater PDC. Hurricanes and tropical storms can trigger catastrophic flooding, which occurs primarily along the two major watersheds: The James River, which drains to the Chesapeake Bay, and the Chowan River Basin (Nottoway and Blackwater Rivers in Virginia), which drains to the Albemarle Sound in North Carolina. Coastal storms and extreme rainfall events have caused serious flooding in the region, particularly in the more urbanized core area where impervious surfaces and sub-standard stormwater infrastructure fail to keep up with intense rainfall. Among the Fall Line South localities, the City of Richmond has the highest flood risk with at least an estimated \$217 million of property at risk in special flood hazard areas.¹³⁹

Riverine flooding along the James River has been responsible for the region's largest disasters, particularly in the City of Richmond. A record flood has not occurred since the U.S. Army Corps of Engineers built and dedicated the \$143 million flood protection walls along the James River in the City of Richmond in 1994.¹⁴⁰ The risk of riverine flooding within the historically severely flooded areas is low due to this flood protection system, but it will not protect flood prone areas in rural and suburban parts of the region that lie outside downtown Richmond. Additionally, it does little to protect from intense rainfall events that have caused damage to low lying neighborhoods inside the flood protection areas. As an example, in 2004, the remnants of Hurricane Gaston dropped more than 10 inches of rain the Richmond region, causing catastrophic flash flooding. The downtown Shockoe Bottom area, just inside the flood protection system, was devastated.¹⁴¹ After this event, the City of Richmond spent more than \$20 million on flood prevention upgrades, including increased storm drain capacity, additional sidewalk grates, and improvement and installation of additional flap gates on the canal and James River.¹⁴²

While storm surge is of relatively low concern, a hurricane or tropical storm does have the potential to produce catastrophic inland flooding in the region. In addition, shoreline erosion is substantial and is an ongoing problem for most of the tidal James River where the river is wide enough to generate wave action.¹⁴³ Habitat loss associated with sea level rise will be a problem along portions of the tidal James River. Ecologically important fresh water wetlands are at risk from increased water and salinity levels, as rising seas push saltwater farther up the tidal James and Chickahominy Rivers.^{144, 145}

Flooding has recently become a challenge on portions of Route 460, a major transportation corridor along the region's border with Hampton Roads, and a critical hurricane evacuation route. Notably, much of the territory in Crater PDC is not located in the Chesapeake Bay watershed, or in legal definitions of Tidewater Virginia, and this negatively affects the regions' ability to access grants related to the Chesapeake Bay Program and the CZM Program.

KEY ACTIONS



The Appomattox River Trail (ART) boardwalk, at the confluence of the James and Appomattox Rivers, in Hopewell, VA. Credit: Ken Newman

PlanRVA and Crater PDC have partnered to create a Richmond-Crater Multi-Regional Hazard Mitigation Plan for their combined 26 localities. This plan addresses natural disaster vulnerabilities and strategies to mitigate or eliminate the long-term risk associated with these disasters.¹⁴⁶ In 2021, PlanRVA and Crater PDC will work with localities and other stakeholders in the regions to update the Multi-Regional Hazard Mitigation Plan. Preliminary conversations with localities have indicated an interest in harnessing mitigation project co-benefits by investigating strategies that utilize park and conservation lands along waterways. An updated and approved Hazard Mitigation Plan for the two regions is expected in mid-2022.

One specific effort PlanRVA is making to improve coastal resilience is the Below the Falls project. This is a multi-year study and outreach effort on resiliency along a section of the James River stretching from the falls in downtown Richmond eastward to the confluence with the Chickahominy River in Charles City County.¹⁴⁷ Localities involved in this project are Charles City, Chesterfield, and Henrico Counties and the City of Richmond. In addition, PlanRVA and the CZM Program have partnered on a five-year grant to protect the resources of the lower Chickahominy River, in concert with the Chickahominy Tribe and the counties of Charles City, New Kent and James City. Under this grant, PlanRVA will study the natural resources present in the Lower Chickahominy watershed and work with stakeholders to develop policy and action steps to accomplish a dual goal: natural resource conservation and economic development.¹⁴⁸

While no specific coastal resilience projects were identified in the region, PlanRVA believes that education and understanding of risk must increase before local governments in the Richmond region will prioritize resilience projects. In this light, PlanRVA is currently undertaking an analysis of current and future flood risk to the regions' roads, is updating bridge and culvert inventory and has identified "resiliency water zones," areas vulnerable to sea level rise, storm surge, and within FEMA special flood hazard areas.

Crater PDC is sponsoring a greenway project along the Appomattox River. This project entails land acquisition and conservation, which reduces flood risk and provides additional recreational opportunities for the region. Resilience projects were not identified in most of the region's hazard mitigation plans. Economic vulnerability was of especially high concern for the Crater PDC, as evidenced by high rankings of social vulnerability and economic stress in many of the census districts in the region, both urban and rural.

SUMMARY

Virginia's coastal plain is diverse geographically, demographically, and economically. However, the localities within the four planning regions identified above share similar characteristics and vulnerabilities. These regions will serve as the units of analysis and organization for the Master Plan. Using this Framework, the CRO, SACAP, and TAC will identify and support strategies and projects necessary to promote coastal adaptation and protection in each region.

EFFORTS UNDERWAY AT THE STATE AND FEDERAL LEVELS



Drone view of the Ohio Creek Watershed Project, Chesterfield Heights, Norfolk, VA in October 2020. Credit: MEB General Contractors / City of Norfolk

Besides regional and local level initiatives, a number of state and federal coastal resilience efforts are already underway in Virginia. This activity includes legislation, executive action, grant making, planning, and research. This chapter describes those core efforts that will have the greatest impact on coastal adaptation and protection, and will benefit from greater coordination under the Master Planning Framework, with supporting efforts described in Appendix G.

PUBLIC POLICY BACKGROUND

Virginia Governors and the General Assembly have taken important steps to address the climate crisis and its impacts on coastal Virginia, beginning in 2007. That year, Governor Tim Kaine created the Governor's Commission on Climate Change, which produced a Climate Change Action Plan, released in 2008.¹⁴⁹ While the subsequent administration of Governor Bob McDonnell chose not to take any action on climate change, the General Assembly advanced important legislation in 2011 to facilitate the adoption of living shorelines. They defined living shorelines as "a shoreline management practice that provides erosion control and water quality benefits; protects, restores or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural and organic materials."¹⁵⁰ In 2012, The General Assembly directed VIMS to study strategies for adaptation to prevent recurrent flooding in Tidewater localities.¹⁵¹ The resulting VIMS report: *Recurrent Flooding Study*

*for Tidewater Virginia,*¹⁵² led the General Assembly to establish what is now known as the Legislative Joint Subcommittee on Coastal Flooding to review flood preparedness options.¹⁵³

In 2014, Governor McAuliffe convened the Climate Change and Resiliency Update Commission, which produced a final report in December 2015.¹⁵⁴ Also in 2014, based in part on that anticipated Commission report, the General Assembly passed legislation creating the Secure and Resilient Commonwealth Panel to advise the Governor on emergency management, and the Panel created a Recurrent Flooding Subcommittee.¹⁵⁵ In 2015, the legislature adopted a requirement that all HRPDC localities must include strategies to address projected sea level rise and recurrent flooding in their comprehensive plans. The following year, the General Assembly created (but did not capitalize) the Virginia Shoreline Resiliency Fund, a revolving loan fund to help localities increase their resilience to coastal flooding. They also established the Commonwealth Center for Recurrent Flooding Resiliency, a multi-university collaboration that is described elsewhere in this document.¹⁵⁶

Most of this legislation produced useful information and encouraged continued dialogue about climate change impacts and the need for coastal adaptation and protection in the Commonwealth, but failed to generate tangible results for the mitigation of flooding and other coastal hazards. In 2018, however, the General Assembly created the position of Special Assistant to the Governor for Coastal Adaptation and Protection to ensure a permanent focus on addressing coastal hazards.¹⁵⁷ Besides filling the SACAP position, Governor Northam has issued two executive orders intended to foster consistent and sustainable long-term action on climate change mitigation, including coastal resilience.

EO-24 (2018) directed the establishment of sea level rise scenario planning and elevation standards for state owned buildings. It also directed the creation of the Virginia Coastal Resilience Master Plan, and included direction for a report on Virginia's compliance with the NFIP and FEMA Flood Standards (July 2019, Appendix H), and an inventory of Virginia state agencies' existing pre-disaster hazard mitigation programs (June 2020, Appendix I). EO-45 (November 2019) established sea level rise scenario planning standards and elevation standards for new-construction of state-owned buildings. The order also directed actions based on the July 2019 comprehensive review of Title 10, Chapter 6 (Flood Protection and Dam Safety) of the Code of Virginia, and made recommendations to strengthen Virginia's ability to protect life and property from flooding by natural and man-made causes, as directed by EO-24.

In the 2020 General Assembly session, a new majority committed to climate action passed Governor Northam's legislation allowing Virginia to join the Regional Greenhouse Gas Initiative (RGGI). Besides reducing carbon pollution from fossil fuel fired power plants, this legislation allows Virginia to use funds generated through the sale of carbon pollution credits on the RGGI market to improve energy efficiency and resilience to climate change across the state, with a focus on our most vulnerable communities.

Importantly for this Framework, the legislation dedicates 45 percent of these auction revenues – approximately \$45 million per year – to the Community Flood Preparedness Fund (CFPF), an expanded and improved successor to the Shoreline Resiliency Fund.^{158,159} Notably, no less than 25 percent of the funds disbursed each year must be used for projects in low-income areas, and priority must be given to funding community-scale hazard mitigation activities that use nature-based solutions.

Governor Northam also proposed and worked with the General Assembly to pass legislation that will:

- Allow localities to regulate the use and development of floodplains consistent with state and federal floodplain management programs and requirements, giving them the needed authority to build resilience through regulation of their floodplains;¹⁶⁰
- Incorporate climate change and sea level rise considerations in Virginia’s Chesapeake Bay Preservation Act;¹⁶¹ and
- Strengthen requirements for protection of coastal wetlands and require the use of living shoreline approaches to shoreline management wherever the best science shows such approaches are suitable.¹⁶²

CORE STATE AGENCY PROGRAMS AND INITIATIVES

Under their duties and responsibilities in the Code of Virginia, and as directed by EO-24, Virginia state agencies and academic institutions are expanding their focus on coastal adaptation and protection. This section includes brief summaries of their work to improve coastal resilience, with a focus on key programs that drive actions to reduce or mitigate flood risk and other coastal hazards. As noted earlier, supporting programs are described in Appendix E, and a full account of agencies’ pre-disaster and natural hazard mitigation activities is included in Appendix G in the report to the Governor under Executive Order 24, Section 2B, Review of State Pre-Disaster Mitigation Programs, A catalog of state research initiatives is included in Appendix B.

DEPARTMENT OF CONSERVATION AND RECREATION - DAM SAFETY AND FLOODPLAIN MANAGEMENT

DCR is responsible for implementing the Commonwealth’s participation in the NFIP, and for ensuring compliance with dam safety laws. DCR is the lead state agency in helping communities and individual property owners assess and mitigate their flood risk and risks to the public related to dams. Title 10, Chapter 6 of the Code of Virginia grants powers and duties to DCR regarding the protection of life and property from the impacts of flooding, including serving “as the coordinator of all flood protection programs and activities in the Commonwealth,” in partnership with local, state, regional and federal agencies. Working closely with FEMA, DCR is empowered to “[e]stablish guidelines which will meet minimum requirements of the [NFIP].”¹⁶³ The NFIP provides affordable flood insurance to property owners, renters and businesses. By encouraging communities to adopt floodplain management regulations, the NFIP program reduces the impact of flooding on public and private property.¹⁶⁴

In response to direction in EO-24, DCR produced a report on the Commonwealth’s compliance with national floodplain and dam safety laws (Appendix H). EO-45 advanced many of the recommendations made in that report, and set standards for sea level rise planning and elevation standards for future state-owned buildings (Appendix I). This new Virginia Flood Risk Management Standard is the strongest of its kind in the country and corrects significant flaws in Virginia’s approach to floodplain management and compliance with NFIP. The standard (Figure 17) is also the first in the country to incorporate future sea level rise projections, which will be added to a new baseline freeboard standard in areas subject to tidal and storm surge flooding. The sea level rise projections used in this standard are the same as those chosen for

this Framework (NOAA Intermediate High curve), allowing the Virginia Flood Risk Management Standard to fit seamlessly into both state level planning and recommendations to local governments on sea level rise projections and freeboard standards as required by Executive Order 24.

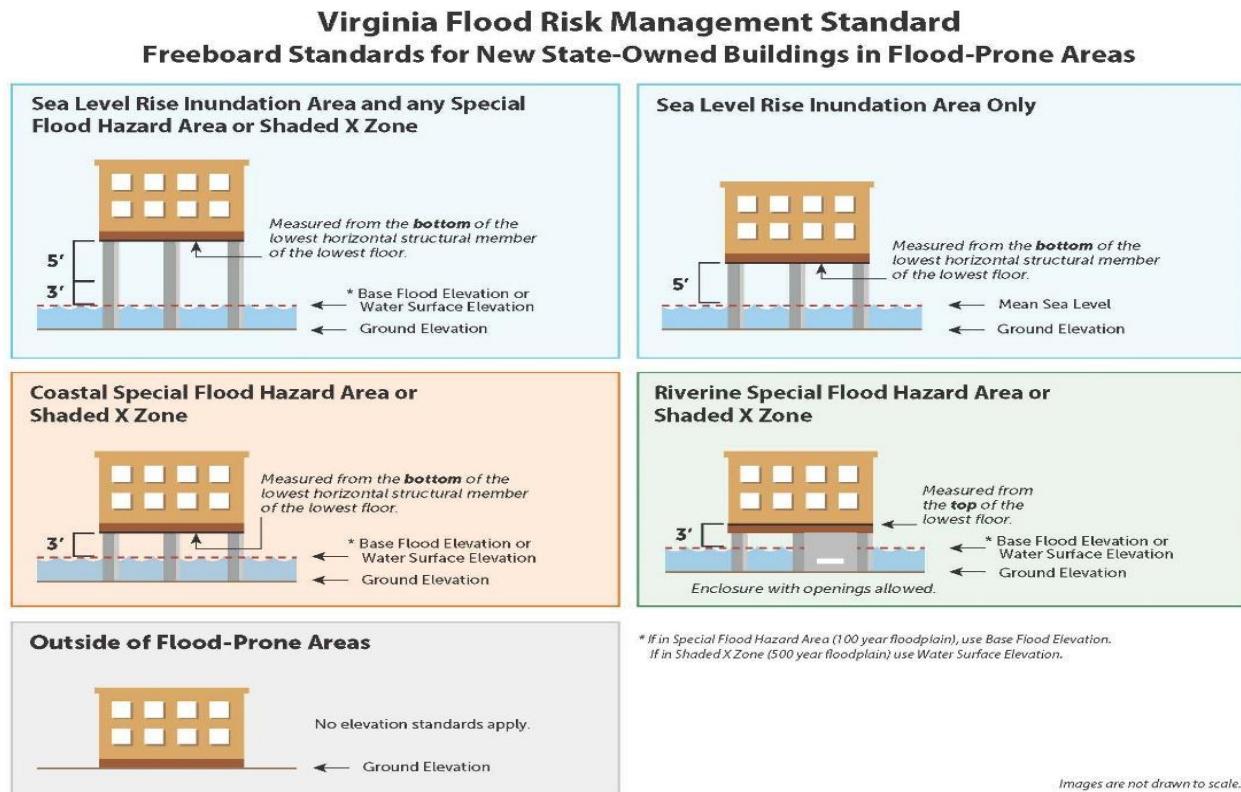


FIGURE 17: VIRGINIA FLOOD RISK MANAGEMENT STANDARD (APPENDIX I)

The standard strongly discourages building in floodplains to reduce vulnerability of buildings and other development constructed in the future by state agencies or by other parties on state land, and creates a workgroup to establish new NFIP compliant requirements for all state development activities. It minimizes risk by ensuring that projects authorized on or after January 1, 2021 are better sited and better designed to handle a greater risk in the future, minimizing damage caused by flooding associated with the consequences of climate change, like sea level rise, storm surge, and extreme precipitation. While the Virginia Flood Risk Management Standard addresses flooding statewide, applying it to coastal areas provides an important foundation for state leadership in building a more resilient Commonwealth.

Department of Conservation and Recreation - Land Conservation

DCR also administers state level land conservation efforts like Virginia Land Conservation Foundation grants, the Virginia Land Preservation Tax Credit, and statewide Land and Water Conservation Fund grants. Each of these can be leveraged to increase coastal resilience. Through Governor Northam's data-driven *ConserveVirginia* initiative, the Commonwealth is using the best science and information to identify the highest value lands to target for conservation based on several metrics, including flood protection and coastal resilience, and using that information to develop improved scoring criteria and conservation requirements for state land conservation expenditures. *ConserveVirginia* can also assist local and regional

land conservation efforts with a coastal resilience component, such as the innovative work being done by the Middle Peninsula Chesapeake Bay Public Access Authority.¹⁶⁵ The GIS-based *ConserveVirginia* Version 2.0 model identifies 342,409.1 acres of land in coastal Virginia as important conservation targets to enhance flood mitigation. It will be continually updated as new information becomes available, making it a critical piece of the Master Planning Framework. Additional information on *ConserveVirginia* can be found in Appendix J.



FIGURE 18: CONSERVEVIRGINIA COASTAL FLOOD MITIGATION¹⁶⁶

The Department of Environmental Quality (DEQ) protects and enhances Virginia's environment, and promotes the health and well-being of the citizens of the Commonwealth, providing cleaner water available for all uses, improved air quality that supports communities and ecosystems, and the productive re-use of contaminated land. DEQ supports coastal adaptation and protection through a variety of programs, including Chesapeake Bay Preservation Act compliance, groundwater and surface water planning and permitting, stormwater management, wetland and stream protection, environmental impact review, and coastal zone management.

The Virginia Coastal Zone Management (CZM) Program is a network of state agencies and coastal localities housed in DEQ. CZM is of particular importance because it funds a variety of projects, at present using all federal dollars, that support resilience and disaster mitigation for Virginia's coastal zone. The Code of Virginia defines the coastal zone as "Tidewater Virginia" and consists of 48 cities and counties adjacent to tidal waters.¹⁶⁷ Besides partnering with planning districts and localities, CZM works closely with the Virginia Institute of Marine Science, the Virginia Coastal Policy Center (VCPC), and other Commonwealth and Federal agencies in pursuit of matching grants and other funding opportunities to address coastal adaptation and protection. The program is guided by an inter-agency/inter-governmental Coastal Policy Team of about 40 members that meet twice per year, and provides annual support to the eight coastal planning districts, meeting with them quarterly. In addition, the program holds biennial Coastal Partners Workshops to share information on coastal issues.



FIGURE 19: COASTAL ZONE BOUNDARIES WITHIN VIRGINIA COASTAL PLANNING DISTRICT COMMISSIONS¹⁶⁸

The Virginia Marine Resources Commission (VMRC) stewards the Commonwealth's marine and coastal resources, and protects its tidal waters and bottomlands. VMRC manages saltwater fishing (both recreational and commercial), submerged lands including public and leased shellfish grounds and shellfish aquaculture, tidal wetlands and shorelines, and coastal sand dunes and beaches. Specific to coastal adaptation, the VMRC Habitat Management Division reviews public and private proposals to alter tidal shorelines and related natural resources.

As the agency responsible for managing and permitting activities that impact Virginia's tidal shorelines and submerged lands, VMRC plays a vital role in coastal adaptation and protection. Built resilience infrastructure and restoration of natural features that reduce the impacts of climate change require VMRC involvement. Legislation passed by the General Assembly and signed by Governor Northam in 2020, strengthens the emphasis on nature-based solutions by requiring the use of living shoreline approaches where the best science shows such approaches are suitable.¹⁶⁹

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

The Virginia Department of Housing and Community Development (DHCD) partners with the federal Department of Housing and Urban Development (HUD), non-profits, other state agencies, and Virginia's communities, to invest more than \$100 million each year into housing and community development projects statewide. Most of these projects help low- to moderate-income Virginians.¹⁷⁰

DHCD administers several HUD programs that support coastal resilience in Virginia – the Community Development Block Grant Program (CDBG), the Community Development Block Grants-Disaster Recovery Program (CDBG-DR), the Community Development Block Grant National Disaster Resilience Competition (CDBG-NDRC), and the Community Development Block Grant Mitigation Grants program (CDBG-MIT).

In 2017, the Commonwealth received a \$120.5 million federal HUD grant through the CDBG-NDRC program. This grant supports a five-year process to implement the Ohio Creek Watershed Project, which will reduce flooding, improve public spaces, and ensure a thriving community in Norfolk's Chesterfield Heights and Grandy Village neighborhoods. It also created a business incubator and accelerator called Rise Resilience Innovations, Inc. (RISE). RISE is a first of its kind resilience innovation hub to test coastal resilience concepts and create partnerships for coastal adaptation and protection. The Commonwealth has also appropriated \$5 million to support RISE.

DHCD also oversees the Uniform Statewide Building Code (USBC) revision and update process, with a particular interest in improving building code standards in vulnerable coastal regions. Virginia's most recent code update adopted the 2015 USBC, effective September 4, 2018. The 2015 update included a one-foot freeboard requirement for new or substantially improved home in the most vulnerable coastal areas (FEMA V-Zones). Development of the 2018 USBC, which will go into effect in September 2021, is underway.

The Virginia Department of Emergency Management (VDEM) manages FEMA's annual grants and post-disaster mitigation grants, both of which can support coastal resilience. The annual grants provide localities funds to reduce risk to individuals, property, and infrastructure. They also include the Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM). FEMA's Building Resilient Infrastructure Communities (BRIC) program will replace the Pre-Disaster Mitigation Grants in Fall 2020. BRIC provides states grants to build resiliency through capacity building, partnerships, innovation, and larger resilience projects.¹⁷¹ Post disaster grants include the Hazard Mitigation Grant Program (HMGP).

Under VDEM's 2019 PDM/FMA grant submission program, 25 applications were submitted to FEMA for approximately \$113.9 million. Of those, 13 projects totaling approximately \$97 million were eligible for the PDM grant program, 12 projects totaling approximately \$16.9 million were submitted for FMA, and all were eligible for the grant program. Projects selected for submission to FEMA were based on peer review score and State/FEMA priorities. Grants selected for further review by FEMA under the PDM program specifically related to coastal pre-disaster mitigation total \$700,000 and include support for updates to the Commonwealth Regional Council and HRPDC local mitigation plans, and updates to the State Hazard Mitigation plan. Under the FMA program, \$15,216,364 was specifically related to coastal flood management assistance, including advanced assistance and a Stormwater Pump Station for the City of Portsmouth, acquisition and demolition of properties in the cities of Virginia Beach and Chesapeake, and elevation of properties in the City of Virginia Beach, Gloucester County, and the Northern Neck Planning District Commission.¹⁷²

CORE FEDERAL PROGRAMS IN VIRGINIA

Besides the formal partnerships with the Commonwealth referenced above, federal agencies lead initiatives to help Virginians plan and prepare for coastal hazards. The most critical programs are run by the Department of Defense (including the Army Corps of Engineers), FEMA, NOAA, and the U.S. Fish and Wildlife Service.

DEPARTMENT OF DEFENSE INSTALLATIONS

Many Department of Defense (DOD) installations in Virginia are in flood hazard and other vulnerable areas, and their resilience is critical to national security and Virginia's economy. In addition to its work to protect critical security infrastructure, DOD is using its Readiness and Environmental Protection Integration (REPI), Joint Land Use Study (JLUS), and Sentinel Landscapes programs to make bases in coastal Virginia more resilient to climate change.

There are seven ongoing REPI projects in Coastal Virginia DOD facilities. In the 2020 National Defense Authorization Act (NDAA), the REPI Program language was modified to include maintaining or improving military installation resilience, which expands the nature and focus of the program beyond its original preservation of habitat to avoid environmental restrictions on military operations.¹⁷³

JLUS studies are cooperative planning efforts that address encroachment threats to military installations and related infrastructure. Compatible use JLUS studies create an implementation plan to address encroachment related to natural hazard resilience, specifically related to the impact of extreme weather

events, tidal flooding, storm surge, and stormwater and floodwater management.¹⁷⁴ Coastal Virginia is fortunate to have been selected to participate in four compatible use studies in progress or completed by DOD Office of Economic Adjustment (OEA).

The Sentinel Landscapes program grew from an interest in expanding the REPI program beyond simple land acquisition, to include additional Federal partners to leverage federal funding, attract private investments, encourage market-based solutions and incentivize desired actions on private lands. The Commonwealth is currently supporting a proposal to designate nearly all coastal Virginia DOD facilities, and large portions of Coastal Virginia, as a Sentinel Landscape. This will improve resilience planning and coordination among DOD installations, as well as with state and local partners.

UNITED STATES ARMY CORPS OF ENGINEERS (USACE) CIVIL WORKS DIRECTORATE

The USACE Directorate of Civil Works conducts water resource development activities including flood risk management, navigation, recreation, and environmental restoration. Until recently, USACE flood risk management and storm damage prevention work has been primarily focused on individual infrastructure projects designed to address discrete problems in small areas. Over the past several years, however, USACE has taken a more comprehensive approach to coastal resilience. As described previously, USACE Norfolk District worked with Norfolk to complete a Coastal Storm Risk Management Study in 2019. They have proceeded into the Preliminary Engineering Design phase on several projects identified by that study.¹⁷⁵ USACE Baltimore District recently initiated the Northern Virginia Coastal Storm Risk Management Study, working with the Metropolitan Washington Council of Governments with support from the Commonwealth. Both the Norfolk and Northern Virginia studies were identified as critical additional study areas in the USACE North Atlantic Coast Comprehensive Survey, completed after Hurricane Sandy in 2015.¹⁷⁶

Of federal, state, local, and regional coastal resilience partners, USACE has by far the most engineering capacity and the most resources to dedicate to flooding and storm risk reduction. USACE has led several important coastal protection projects including the Virginia Beach Hurricane Protection/Sea Wall, Lynnhaven River Basin Ecosystem Restoration (in progress), and Chesapeake Bay Shoreline Erosion Control in Hampton, besides numerous studies intended to prepare Virginia's Coastal region for the opportunity to develop and complete future coastal adaptation and protection projects.

Virginia has also worked with Congress and USACE to secure a full coastal study authorization for the Commonwealth through the 2018 Water Resources Development Act, though that study is not yet underway.¹⁷⁷

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The NFIP is housed within FEMA, and provides affordable insurance to property owners, renters, and businesses to reduce the impacts of flooding.¹⁷⁸ Despite ongoing issues with solvency and operations, the NFIP is a critical tool because standard homeowners insurance and commercial property insurance do not cover flood damage. Specifically related to this Master Planning Framework, the NFIP encourages communities to adopt and enforce floodplain management ordinances. These ordinances are typically set to manage risk and mitigate the effects of flooding, and are tied to FEMA Flood Insurance Rate Maps or Flood Hazard Boundary Maps.¹⁷⁹

Communities that participate in the NFIP may also participate in the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages activities that exceed NFIP minimum requirements by lowering flood insurance premiums. Nationally, the CRS program is one of the primary incentives for community level adaptation. The goals of the CRS are to reduce flood damage to insurable property, strengthen and support the insurance aspects of the NFIP, and to encourage a comprehensive approach to floodplain management.¹⁸⁰ In Virginia, 26 communities containing 80 percent of the Commonwealth's flood insurance policies participate in CRS, saving more than \$7 million annually for approximately 87,000 policyholders.¹⁸¹ However, that accounts for only nine percent of the eligible communities statewide.

The NFIP treats localities and states as different communities. For a locality and its residents to be eligible for flood insurance under the NFIP, the locality must adopt a local floodplain ordinance that meets or exceeds NFIP standards. States can comply with the NFIP either by following NFIP-compliant local floodplain ordinances or by establishing and enforcing a state level regulatory program to ensure state projects do not conflict with NFIP minimum standards. If any state-owned property is in a community not participating in the NFIP, the state must have state level regulations for that property.

DCR implements the NFIP within the Commonwealth of Virginia, and is in the process of improving state compliance and local participation to reduce flood risk and financial exposure.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

NOAA conducts a range of scientific research and resource management activities that increase coastal resilience and disaster preparedness in Virginia. Their research includes weather and ocean condition observations and forecasting, climate monitoring and modeling, coastal surveys and management, and habitat restoration.

NOAA's Coastal and Estuarine Land Conservation Program (CELCP) also helps mitigate coastal flooding. Since being authorized by Congress in 2002, "CELCP protected more than 110,000 acres through funds to state CZM Programs to purchase threatened coastal and estuarine lands or obtain conservation easements, including over 16,000 acres protected as in-kind matching contributions." Between 2002 and 2011 Virginia received \$13.2M in CELCP funds. 10 projects were completed – eight of them through the CZM Program, and over 2,000 acres were acquired for conservation. In addition, through Section 306A CZM funds, 27 land acquisition projects have been completed with over \$4.8M in CZM funds matched with over \$2.4M in state matching funds to acquire over 2600 acres. In order to be eligible for CELCP funding, CZM Programs were required to submit land conservation plans, which the Virginia CZM did in 2001 based largely on its Coastal Virginia Ecological Value Assessment maps. CELCP has not received congressional appropriations since 2017.¹⁸² Targeting proposals for CELCP grants to areas identified for nature-based solutions to coastal flooding and hazard mitigation will help achieve the goals of the Master Planning Framework.

Perhaps most important, NOAA's sea level rise predictions serve as the backbone of Virginia's coastal adaptation and protection planning, enabling detailed current research including the CCRFR report *Future Sea Level and Recurrent Flooding Risk for Coastal Virginia*, and the VIMS Sea Level Report Cards.¹⁸³

In addition, NOAA supports Virginia with the Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA), including assigning a Coastal Climate Extension Specialist for the Chesapeake Bay region at the Center for Coastal Resources Management at VIMS.¹⁸⁴ Until late 2020, MARISA focused only on the Chesapeake Bay Watershed. The recent expansion of scientific coverage and support statewide will enhance this program's utility to Virginia's resilience efforts.

NOAA's Coastal Resilience Grant Program supported the City of Virginia Beach Sea Level Wise project with over \$844,000 in grant funds. It also supported the Virginia Institute of Marine Science with over \$834,000 in funding to develop a model to address flooding issues across coastal Virginia through nature-based infrastructure.¹⁸⁵ NOAA's National Centers for Coastal Ocean Science Ecological Effects of Sea Level Rise Program provided VIMS, Virginia Commonwealth University and USACE \$249,000 to assess the ecological history of dunes in coastal protection from storms and sea level rise.¹⁸⁶ Virginia also participates in NOAA's Coastal Zone Management Program, where NOAA provides roughly \$3,000,000 per year in federal funding, as mentioned earlier in this chapter.

The Commonwealth is also working with NOAA's National Water Center to collaborate on a four-state effort to update Atlas 14 precipitation estimates to support flood preparedness. Atlas 14 data for Virginia was last updated in 2006, and more recent rainfall data is necessary to support accurate estimates of what communities can expect from storm events.

U.S. FISH AND WILDLIFE SERVICE (FWS)

The FWS Coastal Barrier Resources System (CBRS) removes perverse incentives to develop in dynamic coastal environments.¹⁸⁷ The CBRS identifies and depicts undeveloped coastal barriers and other areas on the coast in maps and discourages development of these areas by making projects ineligible for a wide range of federal subsidies, including federal flood insurance through the NFIP.¹⁸⁸ Private developers or other non-federal parties may still develop within the CBRS, but bear the cost and risk. Studies have shown that the CBRS has saved taxpayers billions of dollars by ensuring that federal funds do not incentivize risky coastal development.¹⁸⁹ Virginia has 64 CBRS units covering over 163,000 acres of land and nearly 200 miles of shoreline. Consideration of these units and similar but unprotected coastal areas is an important component of the Framework.

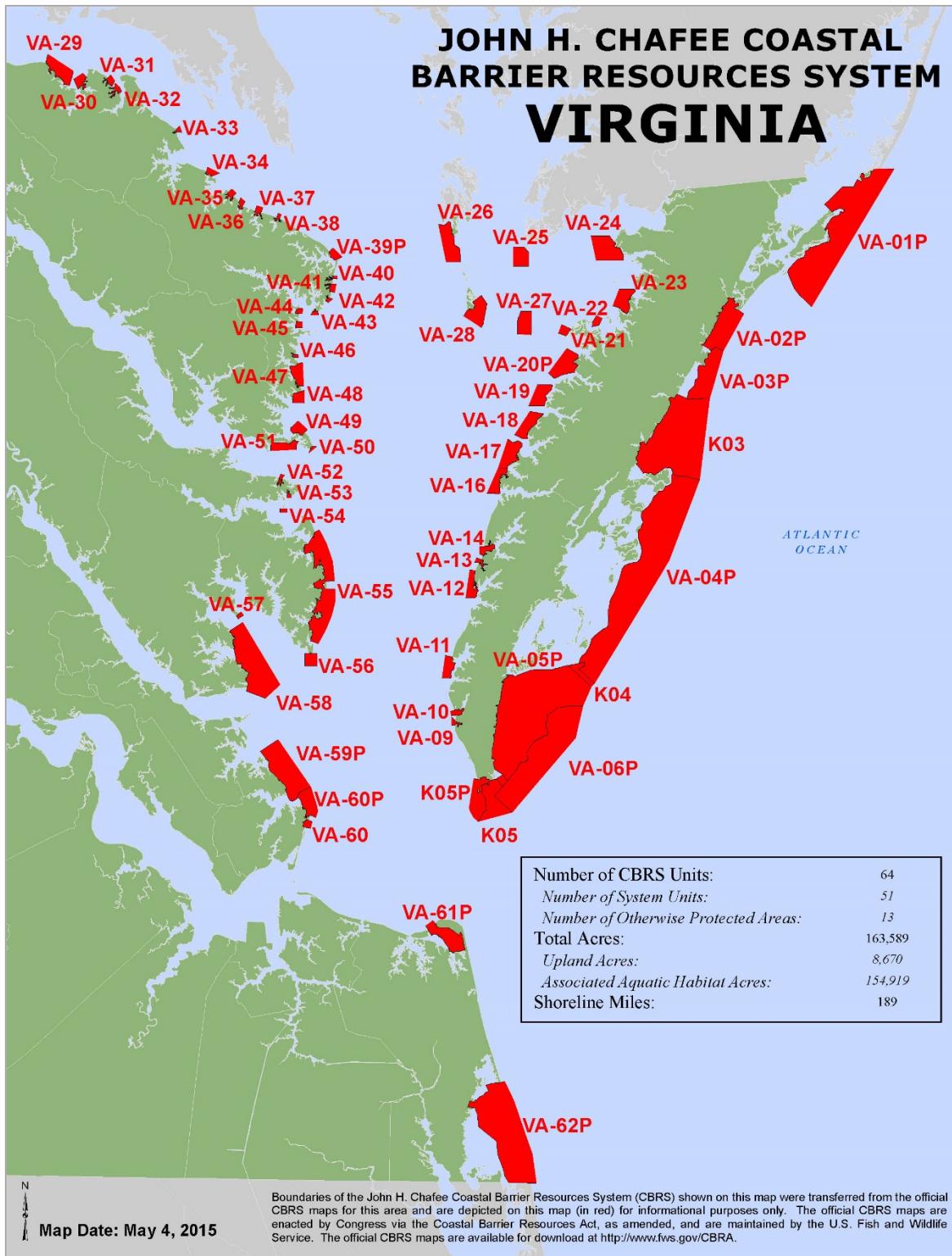


FIGURE 20: COMMONWEALTH OF VIRGINIA COASTAL BARRIER RESOURCES SYSTEM UNITS¹⁹⁰

SUMMARY

Like the regional and local initiatives described in Chapter 4, these efforts are significant, but many are uncoordinated and most are underfunded. The remainder of this document addresses those shortcomings through actions necessary to implement the Master Planning Framework effectively.

INITIAL ACTIONS AND RECOMMENDATIONS



A home is raised in Wachapreague, VA in November 2018. Credit: Aileen Devlin | Virginia Sea Grant

Guided by this Framework, the initial iteration of the Coastal Resilience Master Plan will move the Commonwealth forward in accomplishing the four primary goals outlined in Chapter 1. It will begin a continuing effort that will evolve as our understanding of both the challenges and the response options increase through time and experience. Equally important at the outset is establishment of the defining characteristics of the master planning effort. We intend for this to be a collaborative effort, guided by some very clear principles.

Those principles embody a strong preference for long-term effectiveness in actions undertaken, and a prioritization of accommodation and avoidance strategies over defensive structural solutions. Other desired characteristics are a planning and implementation process that has clear objectives, time-bound tasks, assigned accountability, transparent progress monitoring, and actionable evaluation. With these priorities in mind, and the initial set of actions outlined in Chapter 1 of this document, this chapter provides additional detail on the necessary actions to create and implement a Virginia Coastal Resilience Master Plan.

IMMEDIATE ACTIONS – SCALING UP TO CREATE A COASTAL MASTER PLAN

The challenges of sea level rise and coastal flooding are clearly bigger than any one state or federal agency, regional body, or locality can address alone. The ongoing coastal adaptation and protection efforts described in this document are beginning to achieve positive results in terms of making a subset of coastal Virginia communities more resilient. However, they have not generated substantive, coordinated action, or policy at the state level, which is necessary to ensure consideration of the critical principles and statewide goals described in Chapter 1. Further, many of them lack the funding necessary to be truly effective. The challenge for the Commonwealth is to add value in these areas while continuing to encourage the resilience work of coastal communities that have a head start on planning and implementation. To meet that challenge, the Commonwealth will take the following actions:

ESTABLISH A TECHNICAL ADVISORY COMMITTEE

Getting from where we are now to where we want to be requires thoughtful coordination among the Commonwealth, local and regional leaders, scientist and engineers, and stakeholders. To facilitate such coordination, and develop recommendations for specific, place-based coastal adaptation and protection strategies, Governor Northam will create a Virginia Coastal Resilience Master Plan Technical Advisory Committee (TAC). The TAC will assist in the development of Master Plan updates, including a more robust and refined funding and financing strategy. Additionally, the TAC will track scientific developments, review proposed local and regional actions, and recommend additional risk assessment and scientific and engineering studies necessary to inform decision-making.

Ultimately, The TAC will work closely with the CRO and SACAP in creating a Master Plan and prioritized project list and financing model based on the guiding principles, goals, and actions identified here.

Importantly, the TAC will also make recommendations for strengthening partnerships with Department of Defense and other federal installations, aligning economic development initiatives with Master Planning Framework objectives, and coordinating multiple resilience, pre-disaster, urban development, and flooding adaptation grant programs. This includes those programs administered by DCR, VDEM, DHCD, FEMA, HUD, and USACE.

The Governor will appoint members of the TAC. The Chief Resilience Officer will serve as chair, and the Special Assistant for Coastal Adaptation and Protection will staff the Committee with assistance from the CZM Program. Membership shall include, but shall not be limited to the following individuals or their designees:

- The Executive Directors of each of the eight coastal PDCs/RCS
- The Director of the Virginia Department of Conservation and Recreation
- The Director of the Virginia Department of Emergency Management
- The Director of the Virginia Department of Housing and Community Development
- The Executive Director of the Virginia Resources Authority
- The Director of the Virginia Department of Environmental Quality

- The Director of the Virginia Transportation Research Council
- The Commissioner of the Virginia Marine Resources Commission
- The Coordinator of the Commonwealth Center for Recurrent Flooding Resiliency
- The VIMS Associate Dean for Research and Advisory Services
- The Director of the William and Mary Coastal Policy Center
- The Director of the Virginia Tech Center for Coastal Studies
- The Director of the Environmental Resilience Institute at the University of Virginia
- The Commander of the U.S. Army Corps of Engineers, Norfolk District
- The Director of Virginia Sea Grant
- The Governor's Chief Diversity, Equity, and Inclusion Officer
- The Governor's Chief Data Officer

ELEVATE THE VIRGINIA COASTAL ZONE MANAGEMENT PROGRAM

The nature of the TAC's work will require some significant administrative and technical support. This will include: decision option identification; stakeholder and advisor input management; data collection and synthesis; and performance monitoring. To meet these needs, we will utilize the CZM Program. The CZM Program is currently housed within DEQ, an appropriate arrangement given the conservation and restoration focus of much of the Program's work. However, CZM also has professional coastal planning expertise that should be applied directly to the master planning process. Therefore, Governor Northam will instruct the Director of the CZM Program to report directly to the Secretary of Natural Resources on matters of coastal adaptation and protection, pursuant to the Secretary's role as Chief Resilience Officer. This will allow for closer coordination between CZM, the CRO, and the SACAP, and facilitate important interagency discussions under the Master Planning Framework.

HOLD COMMUNITY ENGAGEMENT ROUNDTABLES

Development of this Planning Framework included close coordination with coastal planning districts and regional commissions, conversations with individual localities, and significant input from scientists and an engaged group of stakeholders. A key element of our efforts going forward is direct outreach to individual communities across the Framework's four coastal regions. In the coming months, the CRO and the SACAP, with assistance from state agencies, will hold a series of community roundtables to introduce the Virginia Coastal Resilience Master Planning Framework. The goal of the roundtables is to gather input on primary issues for citizens who live and work in vulnerable coastal areas. Combined with information gathered through continuing broader public comment, these events will support the development of more detailed coastal adaptation and protection prescriptions under the Framework.

NEAR TERM ACTIONS - CREATING A MASTER PLAN

Once the initial actions described in this Chapter have been accomplished, the Commonwealth will have the resources to create and implement the master plan. The following goals, actions, and outcomes detail the complete set of actions and policies that will create Virginia's first Coastal Resilience Master Plan.

Goal 1: Identification of priority projects for the Master Plan

ACTION 1: in collaboration with local and regional entities, identify critical built and natural infrastructure

- Outcome 1: a prioritized list of built infrastructure critical for national security, public health and safety, and/or the economy informs all coastal resilience planning and funding
- Outcome 2: a prioritized list of natural infrastructure critical for flood and storm protection, water quality management, and/or wildlife habitat services informs all coastal resilience planning and funding

In consultation with the TAC and stakeholders, the CRO and SACAP will lead development of the protocols for prioritization and initial prioritized lists of critical built and natural infrastructure. The first iteration of these lists will need to be available for use in drafting the initial Master Plan. This will be accomplished with the support of the CZM Program and DCR, in consultation with local and regional partners and stakeholders, and with input from state agencies and academic institutions. As noted in preceding chapters, much of the information and analysis necessary to meet this objective already exists. The primary tasks will be to synthesize that information, and develop a prioritization protocol that reflects the guiding principles of the Master Plan. This will allow us to plan our work and to screen projects proposed for implementation and funding.

ACTION 2: identify projects to protect and sustain the functions of critical built and natural infrastructure

- Outcome 1: adaptation strategies for sustaining benefits from existing infrastructure wherever practical
- Outcome 2: where adaptation is impractical, structural solutions for infrastructure risk reduction over the next 20, 40, and 60 years that consider social and economic equity, ecological impacts, and financial realities
- Outcome 3: relocation strategies for built and natural infrastructure for which adaptation and/or protection is not practical

Working with the TAC and stakeholders, the CRO and SACAP will compile a list of potential resilience projects designed to manage sea level rise and flooding risks to critical infrastructure in the coastal zone. The TAC will review project proposals and make recommendations for state engagement in project implementation. The prioritized lists of both built and natural infrastructure developed under Action 1 above, will serve as one element in the TAC evaluation process. A second important consideration will be the Commonwealth's preference for

accommodation and/or strategic relocation over structural solutions for risk management wherever practical.

Goal 2. Establishment of a financing strategy

ACTION 1: develop a detailed needs assessment and list of recommended funding sources to support implementation of the Master Plan

- Outcome 1: funding and financing sources for priority projects
- Outcome 2: authorizations for use of new and innovative funding mechanisms

The financial resources needed to build resilience in Virginia's coastal zone are enormous, far exceeding those currently available. Meaningful efforts to improve current conditions will require purposeful attention to development of new or improved funding mechanisms. A number of useful tools are described in Chapter 7 of this document. The CRO and SACAP will work through the CZM Program to convene a panel of experts to recommend financing strategies to the TAC for priority resilience projects. As part of this assessment, the panel will also recommend priorities for development of new and innovative funding mechanisms to meet the implementation needs of projects identified for the Master Plan. The CRO and the Governor will work to identify the resources necessary to support this effort.

ACTION 2: establish guidelines for administering the Community Flood Preparedness Fund (described in Chapter 7)

- Outcome 1: evaluation and prioritization of projects based on their effectiveness in reducing current and future risk, meaningful incorporation of equity and natural resource principles, and financial realities
- Outcome 2: monitoring, evaluation, and adaptive management to ensure desired results are achieved

The Clean Energy and Community Flood Preparedness Act tasks DCR with developing guidance for issuing grants and loans from the Community Flood Preparedness Fund (CFPF). This guidance needs to be developed and disseminated to potential applicants in advance of the Fund being capitalized with the proceeds of Virginia's first RGGI auction, likely in March of 2021. Though the CFPF is designed to address inland flooding as well, guidance for coastal areas will be based largely on the guiding principles of the Master Planning Framework. To support development of specific eligibility criteria and a process for prioritization of applications, DCR will convene a stakeholder working group to provide input on the guidance. They will also solicit public comment.

Of critical importance, the 25 percent CFPF set-aside for low-income communities – communities we know are often in some of the most vulnerable areas, typically fail to meet cost-benefit analysis targets due to low property values, and have fewer resources – will yield significant results in the areas of equity and environmental justice. DCR will also develop a

monitoring and evaluation protocol to measure success of funded projects, and employ adaptive management to improve outcomes.

Goal 3: Effective incorporation of climate change projections in state programs

ACTION 1: fully implement Executive Order 45 (Appendix 3)

- Outcome 1: state agency compliance with the new freeboard and sea level rise planning standards
- Outcome 2: all state-sponsored development activities in flood-prone areas meet National Flood Insurance Program (NFIP)-compliant requirements and standards

The Virginia Flood Risk Management Standard established by EO-45 gives clear direction to state agencies regarding the necessity of minimizing new development in flood-prone areas. The standard will become fully effective on January 1, 2021, but to ensure consistent adoption and compliance, the Commonwealth must take the following actions:

- DCR, after consulting with DGS, shall develop a guidance document to provide state agencies the methodology for complying with the new freeboard and sea level rise planning standards.
- The CRO shall convene a Cabinet-level workgroup to develop and approve NFIP-compliant requirements and standards for all state-sponsored development activities in flood-prone areas.

Both of these processes are underway, but must be completed to ensure the Commonwealth is setting the right example to limit taxpayer exposure to sea level rise and other coastal hazards.

ACTION 2: amend the Chesapeake Bay Preservation Act (CBPA) guidance to address the anticipated inland migration of regulated areas as sea level rises

- Outcome 1: local implementation of the CBPA addresses pressure to protect developed property from encroaching sea level while avoiding, or minimizing and mitigating, the environmental consequences
- Outcome 2: coordination of the CBPA implementation with the Tidal Wetlands Act implementation to integrate project reviews and compensatory mitigation of unavoidable impacts

Rising sea level is resulting in increasingly frequent flooding of low-lying residential properties. Adding fill material to riparian areas to raise elevations and reduce flooding is a temporary strategy that has some potential negative environmental consequences if not properly managed. Pursuant to HB504, DEQ and the State Water Control Board will update its Chesapeake Bay Preservation Act regulations to promote coastal resilience and adaptation to sea level rise and climate change. This will align water quality and coastal resilience in cooperative state-local partnerships to manage natural buffers adjacent to the Chesapeake Bay's tributaries.

Because filling riparian areas impacts the sustainability of tidal wetlands, DEQ shall coordinate development of amended guidance with VMRC. The guidance will ensure both programs operate in a manner that is consistent and provides clear guidance for property owners and local officials. The Secretary of Natural Resources shall ensure that guidance from DEQ and VMRC is compatible and issued contemporaneously.

ACTION 3: amend the Tidal Wetlands Act guidance to accommodate inland migration of tidal wetlands as sea level rises

- Outcome 1: local and VMRC decisions make no net loss of wetland resources possible by requiring riparian buffers and/or effective compensatory mitigation of probable future impacts
- Outcome 2: coordination of the Tidal Wetlands Act implementation with CBPA implementation

Maintaining the Commonwealth's tidal wetland resources is becoming increasingly difficult due to sea level rise. The long-standing process of compensatory mitigation for regulated losses under the tidal wetlands management program needs revision. It needs to reflect appropriately the anticipated changes in the location of intertidal lands. To accomplish this, VMRC will undertake an analysis of the potential losses of tidal wetlands due to sea level rise and shoreline management practices, and identify options for compensatory mitigation that can be effective for at least 40 years. VMRC will then develop and promulgate new guidance directing use of one or more of those options in local and state regulatory decisions.

VIMS shall assist VMRC in these analyses, and the VIMS Tidal Wetlands Inventory shall provide reports to the CRO on the compensatory mitigation outcomes as an element in its recurring tidal wetland change analysis.

ACTION 4: incorporate coastal resilience considerations into water management programs

- Outcome 1: management of stormwater, wastewater, groundwater, and surface water that accounts for projected sea level rise in a manner that avoids or minimizes and mitigates current and future risks to built and natural infrastructure
- Outcome 2: incorporation of resilience criteria in to water quality grant programs

While not unique to coastal areas, management of stormwater, wastewater, groundwater, and surface water that does not account for climate change can exacerbate flooding problems and harm water quality. Through permits and grant programs such as the Stormwater Local Assistance Fund and the Water Quality Improvement Fund, DEQ serves as Virginia's lead agency for water management. DEQ will incorporate climate change, sea level rise and other coastal hazards into evaluations and decision making within these programs, as well as into criteria for associated water infrastructure grant programs.

Goal 4. Coordination of state, federal, regional and local coastal efforts

ACTION 1: ensure that state and federal hazard mitigation and community development grant programs administered by the Commonwealth and localities are aligned under the Master Plan

- Outcome 1: Virginia Department of Emergency Management (VDEM)-administered hazard mitigation grants in the coastal zone align with Master Planning Framework guiding principles and support projects and strategies identified in the Master Plan
- Outcome 2: Department of Housing and Community Development (DHCD)-administered grants in the coastal zone align with Master Planning Framework guiding principles, and support projects and strategies identified in the Master Plan

The various hazard mitigation and resilience grant programs administered by VDEM, and the community development grants administered by DHCD, are significant sources of funding. They must be utilized in a way that is compatible with the Commonwealth's coastal adaptation and protection efforts under the Master Plan. While these agencies will continue to manage the grants, the Governor will take action to ensure that funds are expended in accordance with the guiding principles of this Framework and, whenever possible, to support resilience projects and strategies identified in the Master Plan.

ACTION 2: empower localities and individuals to make informed decisions

- Outcome 1: localities have access to sea level rise and freeboard guidance

EO-24 required an analysis of state-level flood protection policies, leading to the issuance of EO-45 and creation of the Virginia Flood Risk Management Standard. While the Standard currently applies only to state-owned buildings and construction on state lands, the best available science shows that it is appropriate to use more broadly. Therefore, in accordance with the requirements of Section 2D and 2E of EO-24, the Chief Resilience Officer shall issue guidance to assist localities in adopting the sea level rise and freeboard requirements of the Virginia Flood Risk Management Standard for use in local applications.

- Outcome 2: a strategic coastal relocation handbook is available to inform local planning

We know that eventually, many coastal areas will be inundated permanently by sea level rise, or subject to such intensity and frequency of flooding or other coastal hazards that continuing to utilize them for their current purpose will not be feasible. Being honest and proactive about where and when private and public assets must be moved to higher ground to avoid destruction is a necessary component of any coastal resilience effort. Building on existing models and applying Virginia-specific science and local information, the Commonwealth will develop a handbook to help with strategic relocation planning in areas for which other alternatives are not feasible.

Working through the CZM Program, the Commonwealth will engage the expertise within its academic institutions to develop the Handbook. The CZM Program will also engage the coastal PDCs/RCs as advisors in this process with the goal of producing a first iteration of the Handbook

by December 2021. The CRO and the Governor will work to identify the resources necessary to support this effort.

- Outcome 3: localities have the legal tools necessary to prevent irresponsible land development

During the 2020 General Assembly Session, Governor Northam proposed and legislators approved a bill clarifying local authority to adopt federal and state floodplain management standards by ordinance. That was an important start. Some localities, including the Cities of Virginia Beach and Norfolk, have started using their zoning ordinances to deny development projects in flood-prone areas. As part of the Master Planning Framework, the Northam Administration will support localities in their efforts to prevent irresponsible land development.

- Outcome 4: sellers of real estate are required to disclose if a property is located in a special flood hazard area, has sustained flood damage, or contains a dam

Enabling informed decision-making, particularly when it comes to flooding risks associated with real estate is widely recognized as an important part of the process of increasing resilience in coastal localities. Ideas for requiring disclosure of this information have been developed and proposed many times. The CRO and the Governor will work with the General Assembly to develop and implement requirements for sellers of real estate to disclose the presence of flood hazard areas and dams to any potential buyers.

- Outcome 5: all coastal localities have engaged in the Resilience Adaptation and Feasibility Tool (RAFT) process (described in Appendix B)

The CRO and SACAP will work through the PDCs/RCs to encourage all coastal localities to participate in the RAFT process. The process helps localities become proactive in developing their resilience to coastal hazards. The CRO and SACAP will work through the Virginia CZM program to develop and provide the resources to support these activities.

ACTION 3: implement 2019 DCR Dam Safety and Floodplain Management Report recommendations

- Outcome 1: all coastal localities act to protect the natural functions of floodplains and to ensure all essential structures are located outside of known floodways
- Outcome 2: all coastal localities fully participate in NFIP Community Rating System (CRS).

As noted in Chapter 5, EO-24 required the DCR Dam & Floodplain Safety program to review existing authorities and make recommendations for how to ensure continued NFIP compliance and protect the natural functions of floodplains. The 2019 DCR Dam Safety and Floodplain Management Report contained more than three dozen specific recommendations across a wide array of topics. The Commonwealth intends to address all of the recommendations in time, but initially is focused on actions that will have a clear and immediate impact on resilience. As noted previously, Virginia issued freeboard standard and siting guidelines for all state-owned property

within the floodplain. Virginia has also convened an interagency workgroup to update Virginia's state-level compliance with NFIP standards. In addition to these ongoing efforts, we will work in the coming year to achieve two more of the key recommendations in the DCR report.

The Governor, the CRO, and DCR will create minimum floodplain management requirements that meet standards set in the Code of Virginia, with oversight administered by DCR. The Commonwealth will also work to provide the necessary resources to sustain and upgrade the online Dam Safety Inventory System so the database is as comprehensive as possible. Upgrades will make the information in the system readily accessible and useful for a wide variety of users including state and local officials as well as private citizens. Finally, the Commonwealth will seek to increase local engagement in CRS, and use of CRS-eligible actions, especially those that enhance flood resilience.

ACTION 4: protect and enhance natural coastal defenses

- Outcome 1: state, federal, regional, and local authorities all fully incorporate the *ConserveVirginia* assessments (described in Chapter 5) in planning and implementation
- Outcome 2: state, federal, regional, and local authorities utilize restoration and protection of natural shorelines and coastal landscapes as a resilience strategy whenever possible

Under this Planning Framework, the CRO and the TAC will incorporate Governor Northam's *ConserveVirginia* initiative to support assessment of adaptation and protection strategies.

ConserveVirginia has identified the undeveloped coastal lands that are essential to coastal resilience. The Commonwealth will use that information to encourage conservation and discourage development of these lands. Virginia will continue to prioritize the acquisition or protection of lands identified by the *ConserveVirginia* Flooding and Floodplain layer. This tool should also be used in the development of green infrastructure and natural floodplains approaches.

As part of this effort, we will identify lands adjacent to already identified Coastal Barrier Resource System Units. We will submit a request to USFWS to have the *ConserveVirginia* lands designated as Otherwise Protected Areas under the CBRA statute. The Commonwealth will also consider legislation to codify *ConserveVirginia*, fully integrating it in into coastal resilience efforts. Legislation will also seek to ensure that other government authorities are maximizing restoration and protection of coastal barriers as a resilience solution.

SUMMARY

The guiding principles and major action items described above form the foundation of the Virginia Coastal Resilience Master Planning Framework. We will also work through the TAC to develop a better understanding of specific community vulnerabilities and needs. TAC will provide input on cost effective, sustainable, and equitable strategies to address those vulnerabilities and needs, and funding and financing mechanisms to execute those strategies.

FUNDING AND FINANCING



Hurricane Sandy approaches the Virginia Coast on October 28, 2012. Credit: NASA Earth Observatory image by Robert Simmon

EO-24 requires the Virginia Coastal Resilience Master Plan to include a detailed funding analysis with a needs assessment and recommendations for potential funding sources. In theory, this seems like a straightforward exercise. However, it is complicated by several uncertainties, including the universe of private and public assets that require assistance to become more resilient, which types of coastal adaptation and protection strategies will be deemed most appropriate, and whether and when certain funding sources may be available. This chapter of the Framework describes what we know and offers recommendations for the funding sources and financing strategies that the Commonwealth should consider in its efforts to ensure a more resilient coast.

ASSESSING THE NEED

We know the cost of making coastal Virginia resilient to sea level rise and other coastal hazards is significant. The City of Norfolk – the only jurisdiction in Virginia for which USACE has completed a Coastal Storm Risk Management Study – estimates that designing and constructing key projects will cost \$1.57 billion.¹⁹¹ The City of Virginia Beach is completing studies, including a sea level rise and recurrent flooding study that has an estimated \$2.42 billion in anticipated costs to reduce flooding and surge impacts across that city, alone.¹⁹² The City of Hampton estimates costs to complete just the projects underway to be \$23.75 million.¹⁹³

On top of these, the HRPDC has created the Hampton Roads Resilience Projects Dashboard to display the cost, status, and location of many other coastal protection efforts in the region.¹⁹⁴ The tool includes 11 project types and 154 projects totaling nearly \$1.2 billion under design or under construction.¹⁹⁵ In addition, the Dashboard includes 78 projects totaling an additional \$1.2 billion in proposed projects, and as further planning work is completed, additional projects will be added.

These studies demonstrate a need of more than \$6 billion, and include no estimates for Rural Coastal Virginia or the Fall Line North or South regions, all of which will incur significant costs for flood hazard mitigation. Protecting heavily developed areas along the tidal Potomac River will be costly. One recent study set the price for building seawalls and bulkheads to protect all vulnerable assets in coastal Virginia at \$31 billion over the next 20 years.¹⁹⁶ While seawalls are an expensive form of coastal protection, and are often inappropriate for a variety of reasons, this figure is useful to illustrate the magnitude of the problem, and show how high costs could run without thoughtful planning. While these estimates demonstrate the scale of costs, more studies are needed to estimate nature-based costs and associated costs of climate change including costs to localities, people, and businesses.

MAXIMIZING EXISTING FUNDING AND FINANCING SOURCES

Our knowledge of exactly how high coastal adaptation and protection costs may be limited by a lack of good information. More detailed cost estimates require further study beyond the capacity of state, regional, and local partners to carry out. Studies have shown, however, that the cost of doing nothing is also expensive. A 2016 VCPC study, while limited in scope to private property, found that sea level rise alone over the next 50 years could cause \$50 to \$100 million in damages.¹⁹⁷

To mitigate the costly effects of climate change in the future, this iteration of the Master Planning Framework tasks the TAC with developing a more refined gaps analysis, recommending additional studies, identifying specific projects, and estimating costs. Meanwhile, it is important to identify available resources and recommend for further consideration several potential funding and financing strategies. In particular, given the substantial Department of Defense (DoD) presence throughout Coastal Virginia, and the number of new programs and resilience requirements included in recent National Defense Authorization Act and Defense Appropriations Bills, this should include broader engagement with DoD. Also useful is the consideration of a process by which the Commonwealth could standardize interactions between coastal military installations and their neighboring communities for strengthened collective resilience.

Chapter 5 of this report describes state agency programs that can help fund and finance coastal adaptation and protection. The CZM Program in particular has managed and targeted NOAA funds to invest in coastal resilience projects in the Commonwealth. Increasing appropriations for these state programs is a key component of the Northam Administration's coastal resilience efforts, as evidenced both by the Governor's introduced budget and the approved budget negotiated with the General Assembly. Funding priorities like land conservation, dam safety, stormwater infrastructure, and floodplain management is critical to the Master Plan.

Chapter 5 also describes federal government programs administered either directly or through state agencies. Aligning those funds to achieve the goals of the Master Planning Framework is necessary, as is continuing to advocate for additional appropriations from the U.S. Congress. Some key federal grant programs require a local match, which puts them out of reach for cash-strapped localities in both urban and rural areas. Remedy this is one of the many important potential functions of the new Community Flood Preparedness Fund (CFPF).¹⁹⁸

The 2020 General Assembly passed legislation proposed by Governor Northam allowing Virginia to join the Regional Greenhouse Gas Initiative (RGGI), and deposit 45 percent of the RGGI auction revenues – an estimated \$45 million per year – into the CFPF.¹⁹⁹ This fund will support important studies to maintain the Master Plan and provide loans and grants to local governments for flood protection projects. While the CFPF is a statewide program designed to address both coastal and inland funding, it is still significant enough to be the centerpiece of Virginia’s coastal adaptation and protection funding strategy. Additionally, it will encourage localities to follow the guiding principles of the Master Planning Framework.

A minimum of 25 percent of the money disbursed from the CFPF each year must support work in low-income geographic areas. The CFPF can also accept additional appropriations from the state General Fund, receipts from the repayment of loans by local governments, investment income, federal funds, and private funds, making it a potential repository for significant sums from disaster recovery funds and other sources.

At the local level, the Commercial Property Assessed Clean Energy (C-PACE) initiative is a loan program that was recently expanded by the General Assembly to help localities support clean energy, energy efficiency, and flood hazard mitigation efforts. The program gives preference to projects that use natural or nature-based features and living shorelines. As of June 2020, nine localities either had an active C-PACE program or enacted a C-PACE enabling ordinance. Fairfax County has specifically tailored their program to finance resiliency and stormwater projects, defining measures that “reduce the impact of water or wind-related natural or man-made events” as eligible for the program.²⁰⁰ While Fairfax County is the only locality to take advantage of the program for coastal resilience purposes to date, it is an option with significant potential based on the favorable financing terms on large loan amounts.²⁰¹

Local governments may also fund coastal resilience projects from their general funds, capital budgets, and fee programs. They can also fund projects through their authority to create Special Service Districts (SSDs).²⁰² For example, localities with Municipal Separate Storm Sewer Systems (MS4) use stormwater fees to ensure adequate maintenance for the complicated networks of drains, pipes, and ditches that carry rainwater away from impervious surfaces and into streams, creeks, rivers, and lakes without impact to existing sanitary sewer systems. Stormwater fees generate the funds needed to maintain the MS4 system, and can be aligned to minimize flooding.²⁰³

Norfolk has created SSDs to fund projects related to flood mitigation and coastal protection, based on the demand of residents. Assessment of a potential SSD by Norfolk Public Works and the Office of Budget and Strategic Planning requires a petition from 30 percent of parcel owners within the neighborhood. To begin construction of a project, at least 75 percent of parcel owners representing at least 50 percent of the area’s property value must agree on the SSD plan. The city caps up-front project debt incurred from SSD

projects at \$115 million.²⁰⁴ As voters must approve higher property taxes to fund projects, SSDs may disproportionately benefit higher income neighborhoods that can afford the increase in property taxes. However, SSDs also give localities the flexibility to allow neighborhoods with the means to solve and fund their own resilience measures, and to focus grant funding requiring city matching funds on areas without SSDs.

POTENTIAL NEW SOURCES OF FUNDING AND FINANCING

States and localities across the country are developing creative financing strategies that incorporate both traditional and cutting-edge tools. The following are approaches worthy of expansion or consideration in Virginia, based on demonstrated success. The TAC will review these approaches as it works to assess and meet coastal adaptation and protection needs.

ENVIRONMENTAL IMPACT BONDS

Environmental impact bonds (EIB), also known as social impact bonds, use a pay for success model to finance bond agreement. Pay for success bonds use agreed-upon outcomes and benchmarks to determine payouts upon completing a project. The funder will receive a return on investment only if certain outcomes, such as gallons of wastewater converted or homes insured, are met. Tying repayment to successful outcomes shifts the financial risk from government funders to an investor who provides the up-front capital for the project. It also means that governments only pay for projects that meet their desired outcomes. For an environmental impact bond to work, an independent evaluation is required after the project's completion to determine how much interest the funder will receive from the project. Key participants in environmental impact bonds include governments, funders, financial intermediaries, independent evaluators, service providers, and knowledge intermediaries.²⁰⁵

One example is the wetlands EIB created by the Louisiana Coastal Protection and Restoration Authority (CPRA), in partnership with the Environmental Defense Fund and Quantified Ventures. This bond fills funding gaps that the 2017 Louisiana Coastal Master Plan identified.²⁰⁶ Once CPRA issues the bond, which has a variable interest rate depending on the success of the project, marine contractors will construct the wetlands and an independent validator will assess project outcomes. If the wetland exceeds expectations, investors will receive a “bonus” payout from partner-payers. These partner-payers include local asset owners with a vested stake in the success of the project such as oil and gas companies. In Virginia, the City of Hampton has partnered with Quantified Ventures and the Chesapeake Bay Foundation to finance three green infrastructure solutions through an EIB, as part of the City’s Resilient Hampton Initiative.

RESILIENCE BONDS

Resilience bonds have the same objective as EIBs – enhancement of natural defenses against hazards – but operate slightly differently in that payouts are tied not simply to the successful completion of a restoration project, but to the likelihood that the bonded project will improve resilience. One example is the Forest Resilience Bond (FRB), a partnership between the U.S. Forest Service (USFS) and several philanthropic organizations focused on reducing wildfire risk and impacts through forest restoration.²⁰⁷ Beneficiaries of the restoration work such as USFS, water and electric utilities, and state governments make cost-share

and pay-for-success payments over time (up to 10 years) to provide investors competitive returns based on the project's success.²⁰⁸ Each party participates in the project to achieve multiple co-benefits. Forest restoration improves water volumes for water utilities, reduces fire suppression costs for local governments, and improves flows for hydroelectric facilities. FRB projects generate cash flow by monetizing these water, fire, and ecosystem services created by forest restoration activities.²⁰⁹

CATASTROPHE BONDS

Catastrophe bonds use parametric insurance to protect against losses from disaster events once a triggering event occurs. For a parametric trigger, when the disaster reaches a predetermined threshold, the bond sponsor keeps some of the bond value to pay losses. Investors receive or lose their principal and interest depending on 1) whether the trigger is met and 2) total losses relative to the total bond amount. Insurers can also issue these bonds based on actual insurance losses accrued (indemnity trigger) and aggregate losses to the insurance industry (industry trigger). Since these bonds are riskier than other investments, catastrophe bond owners are typically paid interest rates higher than other municipal or state bonds. Investors may be interested in catastrophe bonds because risks are uncorrelated with market volatility.²¹⁰

The purpose of catastrophe bond projects is to address gaps in insurance. California and Florida created state catastrophe funds to insure against risk from earthquakes and hurricanes that traditional private insurers did not find appealing. The Florida Hurricane Catastrophe Fund began in 1993 after Hurricane Andrew. It uses an indemnity trigger of \$4.5 billion in industry losses to trigger insurance payments.²¹¹ The Middle Peninsula Planning District is structuring a parametric insurance offering for property owners as a part of its *Fight the Flood* program. The concept is based on the opportunity to insure living shorelines, rock sills, bulkheads, piers, and other structures rarely covered under regular insurance policies, but of great value in resilience to property owners and the greater population for broader coastal resilience.²¹² Through a parametric insurance policy, these specifically designated resilience measures could use water elevation as the trigger, which would generate a payout in the event of a pre-designated level of storm surge.

GREEN BANKS

A green bank is an entity established to attract private investment into one or more environmental infrastructure categories, such as clean energy, climate resilience, water, or waste management.²¹³ Green banks use several tools to leverage limited amounts of cash into larger capital investments, much like a traditional bank. While the return on investment still goes to the private investor, the benefit of the capital investment accrues to the public.

This model has global reach, and is proven to work in the United States. The Connecticut Green Bank – the first such entity in the country – has worked with private partners to deploy more than \$1.6 billion in clean energy projects, at a ratio of \$6 in private investment for every \$1 of public funds since its creation in 2011.²¹⁴ Other successful green banks exist in New York, New Jersey, California, Rhode Island, Hawaii, and Maryland.

TAX INCREMENT FINANCING

Tax increment financing (TIF) leverages the anticipated property tax increase generated by a project to finance the capital cost of the project. Localities often use TIF with bonds to finance resilience projects. For example, a local government could fund a stormwater management program with general obligation bonds and then use the TIF revenue to pay interest payments to an investor. In Chicago, the Green Roof Improvement Fund incentivizes commercial buildings to install green roofs to manage stormwater runoff by providing partial reimbursements using TIF dollars.²¹⁵

TIF is intuitive and attractive for coastal resilience. We know reduced flooding has significant positive impacts on property values, and that many properties will benefit if projects and strategies provide adaptation or protection at the community, jurisdiction, or regional scale. TIF could build resilience into transportation, community redevelopment, recreation areas, and other projects.

PHILANTHROPIC SUPPORT

National, regional, and community foundations support a wide range of public service initiatives. While education, public health, and environmental protection are traditionally more popular funding targets, coastal resilience is becoming increasingly attractive because of the ability to make measurable progress at different scales of investment, and the attractive co-benefits of advancing equity, improving environmental quality, and promoting public health, safety, and sustainable economic development.

For example, the Rockefeller Foundation invested \$164 million from 2013-2019 in its now-discontinued 100 Resilient Cities initiative.²¹⁶ This program provided funding for the position of chief resilience officer in cities around the globe, including Norfolk, to institutionalize resilience to climate change and jumpstart adaptation and protection conversations and efforts. Having a Coastal Resilience Master Planning Framework will help Virginia market itself as a place that funders can show returns on their investments. It will put the Commonwealth in a stronger position to encourage the Hampton Roads Community Foundation and other Virginia philanthropic players, as well as national foundations, to invest in addressing the existential threat of climate change, sea level rise, and other coastal hazards.

NEXT STEPS

This Planning Framework outlines the financial tools needed for the Commonwealth, regions, and localities to build a strategy to protect Virginia from climate-induced coastal risks. To succeed, the Commonwealth will need to consider funding availability, funding flexibility, municipal budget impacts, administrative burdens, and legal constraints in determining which funding and financing methods work best for particular projects.²¹⁷ The CRO and SACAP will work with the new TAC to refine this analysis and make more specific recommendations in the Master Plan itself, once more specific strategies and projects are identified.

CONCLUSION AND ACKNOWLEDGMENTS



Working waterfront in Saxis, VA in November 2018. Credit: Aileen Devlin | Virginia Sea Grant

This Planning Framework represents the Commonwealth's first attempt at a coordinated resilience effort for the entire Virginia coast. While many more narrowly tailored resilience initiatives are already underway, the Framework proposes to establish state leadership that will support decision-making, and position us to move boldly forward. State leadership will identify all at-risk assets, prioritize sustainable, equitable, and cost-effective approaches to coastal adaptation and protection, and provide financial assistance to implement effective solutions tailored to the specific circumstances of communities. The Master Planning Framework is a living, breathing document we expect to evolve into a full Coastal Resilience Master Plan by the end of the Northam Administration, and be updated at least once every five years thereafter.

In the coming months, Virginia will take meaningful action to improve coastal resilience. This will include socializing the Master Planning Framework with affected communities through roundtables, standing up a Technical Advisory Committee to guide Planning Framework implementation and development of the full Plan and updates, and making the Commonwealth's first targeted, coordinated investments in coastal resilience through the Community Flood Preparedness Fund. These actions will solidify the Commonwealth's leadership role in coastal adaptation and protection, building on Executive Order 24, Executive Order 45, the Virginia Flood Risk Management Standard, and other important steps the Northam Administration has taken. We will also continue consulting with an array of state, federal, and local leaders, experts and stakeholders as required by EO-24, and thoughtfully consider the many detailed recommendations we have compiled through this engagement to date.

Responsible planning to align local, regional, state and federal coastal hazard mitigation efforts will protect lives and property from multiple threats and reduce taxpayer exposure. Through this ongoing and iterative process, we will reach beyond just flood control, integrating public health and safety, equity, and environmental protection into all aspects of our resilience work. We will assist at-risk communities and safeguard key economic drivers, including our ports and other transportation infrastructure, commercial and industrial centers, tourism assets, federal facilities, farms, and forests. The science and economics are clear, the need for action is urgent. The Master Planning Framework moves Virginia past talking about our coastal challenges and puts us on a path to address them.

This document was prepared with significant assistance from a number of individuals and institutions. We will continue to grow and engage this group of informal advisors, and we acknowledge their contributions here as part of the Master Planning Framework document itself:

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ACKNOWLEDGEMENTS

Center for Coastal Resources Management at Virginia Institute of Marine Science
for research, report preparation, graphics, and technical analysis

Commonwealth Center for Recurrent Flooding Resiliency and partner Universities, Old Dominion University, Virginia Institute of Marine Science, and William and Mary Law School Virginia Coastal Policy Center

for research, analysis of future inundation and tidal flooding, report preparation assistance, graphics, and technical analysis

Coastal Planning District Commissions and Regional Commissions
for guidance and review, recommendations, and local government engagement

Department of Conservation and Recreation
for report preparation and review

Department of Environmental Quality
for report preparation and review

The RAFT (Resilience Adaptation Feasibility Tool) Project
for local government engagement facilitation

US Army Corps of Engineers
for data contribution and support

Virginia Coastal Policy Center at William & Mary Law School
for background legal and adaptation strategy research and engagement

Virginia Coastal Zone Management Program
for mapping and GIS technical support, guidance and review, and Coastal Zone-wide planning coordination

Virginia Sea Grant
for financial support of student and post-graduate fellows, without whom this work would not have been possible, and for report images, where not otherwise attributed

The Virginia Council on Environmental Justice
for engagement and guidance on the impacts of climate change, flooding, and sea level rise on underserved communities in coastal Virginia

Virginia Transportation Research Council
for guidance and technical support

Wetlands Watch
for background legal and adaptation strategy research and engagement

We would also like to extend special thanks to the following individuals for research support, leadership, and providing insight into the impact of sea level rise on the Commonwealth of Virginia:

Michael Allen, Tom Allen, Elizabeth Andrews, Donna Bilkovic, Carol Considine, Jeremy Hoffman, Greg Johnson, Angela King, Mark Luckenbach, Pamela Mason, George McLeod, Molly Mitchell, Dale Morris, Michael Seek, Emily Steinhilber, Mary-Carson Stiff, Skip Stiles, and Rob Young.

LISTING OF ACRONYMS USED

AFB	Air Force Base
A-NPDC	Accomack-Northampton Planning District Commission
CBRS	Coastal Barrier Resources System
CCRFR	Commonwealth Center for Recurrent Flooding Resiliency
CDBG	Community Development Block Grant Program
CDBG-DR	Community Development Block Grants-Disaster Recovery Program
CDBG-MIT	Community Development Block Grant Mitigation Grants program
CDBG-NDRC	Community Development Block Grant National Disaster Resilience Competition
CELCP	Coastal and Estuarine Land Conservation Program
CFPF	Community Flood Preparedness Fund
Coastal GEMS	Virginia Coastal Geospatial and Educational Mapping System
Coastal VEVA	Coastal Virginia Ecological Value Assessment
COMET	Carbon Management and Emissions Tool
C-PACE	Commercial Property Assessed Clean Energy
CPRA	Louisiana Coastal Protection and Restoration Authority
CRO	Chief Resilience Officer
CRS	Community Rating System
CTB	Commonwealth Transportation Board
CZM	Virginia Coastal Zone Management Program
DCR	Department of Conservation and Recreation
DEQ	Department of Environmental Quality
DHCD	Department of Housing and Community Development
DOD	Department of Defense
DOF	Department of Forestry
EIB	Environmental Impact Bond
EO	Executive Order
FEMA	Federal Emergency Management Agency
FMA	Flood Mitigation Assistance
FRB	Forest Resilience Bond
FWS	U.S. Fish and Wildlife Services
GDP	Gross Domestic Product
GIS	Geographic Information System

GWRC	George Washington Regional Commission
HMGP	Hazard Mitigation Grant Program
HRPDC	Hampton Roads Planning District Commission
IEN	Institute for Environmental Negotiation
IPCC	Intergovernmental Panel on Climate Change
JLUS	Joint Land Use Study
MARISA	Mid-Atlantic Regional Integrated Sciences and Assessments
MARS	Mid-Atlantic Regional Spaceport
MCB	Marine Corps Base
MGD	Million gallons per day
MPPAA	Middle Peninsula Public Access Authority
MPPDC	Middle Peninsula Planning District Commission
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NDAA	National Defense Authorization Act
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NNPDC	Northern Neck Planning District Commission
NOAA	National Oceanographic and Atmospheric Administration
NVRC	Northern Virginia Regional Commission
ODU	Old Dominion University
OEA	Office of Economic Adjustment
PDC	Planning District Commission
PDM	Pre-Disaster Mitigation
PMP	Probable Maximum Precipitation
RAFT	Resilience Adaptation and Feasibility Tool
REPI	Readiness and Environmental Protection Integration
RGGI	Regional Greenhouse Gas Initiative
RISE	Rise Resilience Innovations, Inc.
SACAP	Special Assistant to the Governor for Coastal Adaptation and Protection
SCHISM	Semi-implicit Cross Scale Hydroscience Integrated System Model
SLOSH MEOW	Sea, Lake, and Overland Surges from Hurricanes, Maximum Envelope of Water

SMM	Shoreline Management Model
SSD	Special Service District
SWIFT	Sustainable Water Initiative for Tomorrow
TAC	Technical Advisory Committee
TIF	Tax Increment Financing
TMDL	Total Maximum Daily Loads
TNC	The Nature Conservancy
USACE	United States Army Corps of Engineers
USBC	Uniform Statewide Building Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGCRP	United States Global Change Research Program
VCEJ	Virginia Council on Environmental Justice
VCPC	Virginia Coastal Policy Center
VCU	Virginia Commonwealth University
VDEM	Virginia Department of Emergency Management
VDEM	Virginia Department of Emergency Management
VDOT	Virginia Department of Transportation
VIMS	Virginia Institute of Marine Sciences
VMRC	Virginia Marine Resources Commission
WIP	Watershed Implementation Plan

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Appendix J: *ConserveVirginia 2020* Update

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Before and after of the Leesylvania State Park living shoreline construction, completed in 2016. Credit: Northern Virginia Regional Commission

APPENDIX A

**EXECUTIVE ORDER 24 (2018): INCREASING VIRGINIA'S
RESILIENCE TO SEA LEVEL RISE AND NATURAL HAZARDS**



*Commonwealth of Virginia
Office of the Governor*

Executive Order

NUMBER TWENTY-FOUR (2018)

INCREASING VIRGINIA'S RESILIENCE TO SEA LEVEL RISE AND NATURAL HAZARDS

Importance of the Initiative

Sea level rise, land subsidence, higher average temperatures, more frequent and intense weather events, severe drought, and increased development, have increased risk and will continue to increase and exacerbate risk from natural hazards across the Commonwealth of Virginia. The number of federally declared disasters has steadily increased nationally and in Virginia. The number has experienced a 250 percent increase in federally declared disasters over the past 20 years, including declarations for flooding, hurricanes, severe storms, and wildfire.

The best available science predicts that this trend will continue to worsen. A recent report from the United Nations Intergovernmental Panel on Climate Change states that the world is likely to experience dramatic increases in coastal flooding and severe weather events. Additional studies show that water levels in the Hampton Roads region are now 18 inches higher than they were a century ago, and that they are expected to gain up to five more feet, while the land sinks as much as 7.5 inches, by 2100. That combined rise is faster than anywhere else on the East Coast. The most recent National Climate Assessment reported that the intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest hurricanes, have all increased.

This increase in extreme weather events and natural disasters will continue to have a profound impact on Virginia. It threatens public health and safety, our environment and natural resources, and the economic wellbeing of the Commonwealth, including our ports, military installations, transportation infrastructure, tourism assets, farms, and forests. We must act now to protect lives and property from multiple threats and reduce taxpayer exposure through fiscally responsible planning.

Directive

Accordingly, by virtue of the authority vested in me as the Chief Executive by Article V of the Constitution of Virginia and under the laws of the Commonwealth, I hereby order my administration to take the following actions to increase statewide resilience to natural hazards and extreme weather:

Section 1: Making Commonwealth Holdings More Resilient

- A. Designation of the Chief Resilience Officer of the Commonwealth of Virginia: The Secretary of Natural Resources shall serve as the Chief Resilience Officer of the Commonwealth of Virginia. The Chief Resilience Officer shall be responsible for planning and implementing pre-disaster mitigation strategies to reduce the near and long term impacts of natural hazards across the Commonwealth. The Chief Resilience Officer will serve as the primary point of contact on all issues relating to pre-disaster hazard mitigation and shall be responsible for coordination and planning of resilience initiatives across state government.
- B. Review of Vulnerability of Commonwealth Owned Buildings: It is imperative that the Commonwealth assess the vulnerability of state-owned buildings and takes steps to improve the resilience of state-owned buildings when appropriate. To properly assess the need for resilience upgrades and adaptation strategies for state-owned buildings, the Chief Resilience Officer will develop a facility assessment process and define a data set to be used to identify vulnerability of state-owned buildings. The Secretary of Administration shall collect the identified building data to be used by the Chief Resilience Officer in determining the vulnerability of state-owned buildings, identify steps to increase the resilience of those buildings that are most at risk, and where appropriate and feasible, seek alternative locations for state operations.
- C. Unified Sea Level Rise Projection for State-Owned Buildings: The Commonwealth of Virginia must have a standard approach for predicting sea level rise when scoping, designing, siting, and constructing state-owned buildings. The Chief Resilience Officer shall work collaboratively within state government and with assistance from regional, state, and national experts and stakeholders, to issue, within 180 days from issuance of this Order, a regional or statewide sea level rise projection. The standard shall apply to all projects beginning initial design for state-owned buildings, beginning on or after January 1, 2020. This standard shall apply to new construction and not renovations to existing state buildings and be applied barring extenuating circumstances as determined by the Chief Resilience Officer. In creating this standard, the Chief Resilience Officer shall consult with: the Secretary of Administration, the Secretary of Commerce and Trade, the Secretary of Finance, the Secretary of Transportation, and the Virginia Institute of Marine Science.
- D. Freeboard Standard for State-Owned Buildings: The Commonwealth of Virginia must ensure the resilience of state-owned buildings by setting a minimum freeboard standard for state-owned buildings. The Chief Resilience Officer shall collaboratively work within state government and with assistance from regional, state, and national experts, and stakeholders, to issue, within 180 days from issuance of this Order, a regional or statewide freeboard

standard. The standard shall apply to all projects beginning initial design for state-owned buildings beginning on or after January 1, 2020. This standard shall apply to new construction and not renovations to existing state buildings and be applied barring extenuating circumstances as determined by the Chief Resilience Officer. In creating this standard, the Chief Resilience Officer shall consult with: the Secretary of Administration, the Secretary of Commerce and Trade, the Secretary of Finance, the Secretary of Transportation, and the Virginia Institute of Marine Science.

Section 2: Reviews, Reports, and Recommendations

- A. Virginia Coastal Resilience Master Plan: The Commonwealth of Virginia has a responsibility to assist local governments in reducing flood risk through planning and implementing large scale flood protection and adaptation initiatives. The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall create and implement a Coastal Resilience Master Plan for coastal Virginia to reduce the impacts of tidal and storm surge flooding.

The plan shall:

1. Incorporate all ongoing planned and proposed federal, state, and local projects and infrastructure to reduce tidal and storm surge flooding and flood risk. Provide recommendations for additional hazard mitigation, flood control, and adaptation projects to fill in gaps and improve the preparedness and resilience of the entire coastal area of Virginia for flooding and sea level rise;
2. Be based upon the best available science and engineering;
3. Be updated and amended every five years;
4. Mitigate flood risks at the community level or greater whenever possible;
5. Employ natural and nature-based solutions to the maximum extent possible and provide guidance for land conservation efforts by identifying land providing resilience benefits along with other ecological services;
6. Consider potential areas and options for managed coastal retreat when appropriate;
7. Include detailed funding analysis with a needs assessment and recommendations for potential funding sources;
8. Conform to National Flood Insurance Program requirements and incorporate relevant sections of the floodplain protection plan required by 10.1-602 of the *Code of Virginia*.

In developing the Virginia Coastal Resilience Master Plan, the Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall consult with the following:

1. Local governments;
 2. Relevant state agencies, boards, and advisory bodies;
 3. Regional Planning District Commissions;
 4. The Secure and Resilient Commonwealth Panel;
 5. Federal partners, including but not limited to: the Department of Defense, including the U.S. Army Corps of Engineers; the National Atmospheric and Oceanic Administration; the Department of Transportation, the Department of Agriculture; the Department of the Interior; and the Department of Housing and Urban Development;
 6. The Virginia Institute for Marine Science, the partner universities in the Virginia Sea Grant Program, the Commonwealth Center for Recurrent Flooding Resiliency; and
 7. Non-governmental stakeholders including civic organizations, the business community, and non-profit organizations.
- B. Review of State Pre-disaster Mitigation Programs: The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall inventory all state-run programs to encourage and implement pre-disaster mitigation. The inventory shall include pre-disaster mitigation programs for all natural hazards including flooding, wildfire, and earthquake. Within 180 days from issuance of this Order, each Cabinet Secretary shall submit to the Chief Resilience Officer a report on any and all pre-disaster hazard mitigation programs administered by his or her Secretariat.
1. Reports to the Chief Resilience Officer shall include: the formal title of the program, the statutory authorization for the program, a summary of the program and its goals and successes, the name of the lead staff member assigned to the program, a summary of the annual available funding for the program, and a summary of unmet funding needs.
 2. Within 90 days of receiving reports from Cabinet Secretaries, the Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall compile and make available to the public a comprehensive report of the findings from all secretariats, and make recommendations for improvements or additions to pre-disaster mitigation programs.

C. Review of Compliance with Flood Protection and Dam Safety Laws: The Director of the Department of Conservation and Recreation (DCR), in coordination with the Chief Resilience Officer, shall review DCR's implementation of the *Code of Virginia*, Title 10, Chapter 6, Flood Protection and Dam Safety.

This review shall include:

1. Review of existing requirements to ensure that state-owned development is appropriately protected from flooding. The review shall also ensure that state-owned development is designed so that human health, safety, and welfare, as well as the natural and beneficial uses of the floodplain, are not at an increased risk of flooding, as authorized under state and federal law. The Director of DCR shall report his findings to the Chief Resilience Officer within 90 days from issuance of this Order, identifying critical updates to regulations, previous executive actions or guidance necessary to meet the objectives of this Order. In addition, the Director shall assess the effectiveness of current dam safety regulations in accounting for changing precipitation patterns and conditions;
2. Review of existing requirements to ensure the Commonwealth, as a participating community of the National Flood Insurance Program, continues to comply with 44 CFR § 60.11-13 and 23 CFR § 650, as authorized under state and federal law, and identifying within 90 days from issuance of this Order critical updates to regulations or guidance necessary to meet the objectives of this Order;
3. Assessment of the enforceability of existing state requirements, and the use of penalties for violations, and determining if changes are needed;
4. Development of a protocol for engagement with the Office of the Attorney General on enforcement efforts;
5. Assessment of any gaps in DCR resources or authorities necessary to address challenges identified under this review; and
6. The Director of the Department of Conservation and Recreation shall report to the Chief Resilience Officer within 180 days from issuance of this Order on the reviews required under this section.

D. Sea Level Rise Projection Guidance for Local Governments: The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall provide guidance to assist local governments with respect to regional or statewide sea level rise projections and work collaboratively to ensure these projections are useful for local decision-making. In developing this guidance, the Chief Resilience Officer shall consult with the following: localities, planning district commissions, impacted state and

federal agencies, the Virginia Institute for Marine Science, and the Commonwealth Center for Recurrent Flooding Resiliency.

- E. Freeboard Guidance for Local Governments: The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall provide guidance for local governments with respect to local options to ensure best practices in establishing freeboard standards based on regional or statewide data and assistance. In developing this recommendation, the Chief Resilience Officer shall consult with the following: localities with flood prone areas, planning district commissions, impacted state and federal agencies, and the Commonwealth Center for Recurrent Flooding Resiliency.

Section 3: Coordination and Objectives

- A. Risk Communication: The Chief Resilience Officer, the Secretary of Public Safety and Homeland Security, and all relevant state agencies shall work to increase the Commonwealth's risk communication with regard to helping Virginia residents and local governments better understand their current and future risk from natural hazards.
- B. Increased Coordination of Hazard Mitigation Programs and Initiatives: The Chief Resilience Officer, or his designee, shall convene regular cross-agency, cross-secretariat meetings to ensure all programs identified in the report mandated by Section 2, subtitle B, paragraph 2, of this Order are working in concert with one another, removing barriers to success and leveraging one another for maximum benefit.
- C. Enhanced State and Military Collaborative Resilience: The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection and the Secretary of Veterans and Defense Affairs, shall work with military installations, local governments, Department of Defense leaders, and other impacted stakeholders to identify and develop collaborative adaptation and mitigation opportunities in support of military and community readiness.
- D. Increased Scale and Scope of Pre-Disaster Hazard Mitigation: To the maximum extent possible, state agencies, in coordination with the Chief Resilience Officer, or his designee, should use their planning, grant-making, and legal authorities to ensure natural hazard mitigation projects are conducted on a community-wide, rather than individual property scale. This approach will ensure greater protection for all Virginia residents, public and private property, and natural features and ecosystems that provide valuable barriers to flooding and other services.
- E. Empower Localities to Reduce Risk: To the maximum extent possible, state agencies, in coordination with the Chief Resilience Officer, or his designee, should use their planning, grant-making, and legal authorities to empower local governments to plan and create more resilient communities. This may include: technical assistance and planning grants, sample zoning ordinances, assistance engaging federal programs like the National Flood

Insurance Program and the Community Rating System, Federal Emergency Management Agency (FEMA) Hazard Mitigation grants, and others.

The Department of Housing and Community Development shall consult with relevant stakeholders and subject matter experts for the purpose of identifying and suggesting resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update.

- F. Position the Commonwealth of Virginia to be a Leader in Resilience Technology: The Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, shall work with the Secretary of Commerce and Trade to ensure state, local, and regional efforts to test and implement resilience technologies are coupled with a coordinated effort to commercialize research and start and grow these businesses in the Commonwealth.
- G. Empower Individuals to Reduce their Risk: To the maximum extent possible, state agencies should use their planning, grant-making, and legal authorities to empower Virginian residents to take individual actions to increase resilience of private property to natural hazards. This includes creating tools and places where property owners can review data related to their risk, teaching Virginians best management practices to reduce risk to existing structures and planning tools to limit risk to new structures and encouraging the purchase of flood insurance policies both inside and outside of the Special Flood Hazard Area. State agencies and departments shall help Virginian property owners identify and apply for state and federal pre-disaster mitigation grants.

Effective Date of the Executive Order

This Executive Order shall be effective upon its signing and shall remain in full force and effect until amended or rescinded by further executive order.

Given under my hand and under the Seal of the Commonwealth of Virginia this 2nd day of November, 2018.



A handwritten signature of Ralph S. Northam.

Ralph S. Northam, Governor

Attest:

A handwritten signature of Kelly Thomasson.

Kelly Thomasson, Secretary of the Commonwealth

APPENDIX B

STATE UNIVERSITY PROGRAMS AND ACADEMIC CENTERS

Several academic institutions in Virginia have received Commonwealth funding or are funded to support the Commonwealth to provide research and develop tools to support increased coastal resilience in the Commonwealth. This section describes those efforts.

Commonwealth Center for Recurrent Flooding Resiliency

The General Assembly created CCRFR in 2016 to serve, advise, and support the Commonwealth by conducting interdisciplinary studies and investigations and providing training, technical and nontechnical services, and outreach in recurrent flooding and resilience research to the Commonwealth and its political subdivisions.¹ Within CCRFR, faculty, staff, and students at Old Dominion University, the Virginia Institute of Marine Science, and the Virginia Coastal Policy Center at William & Mary Law School work collaboratively on projects and initiatives, pool resources, and jointly pursue grants and other opportunities, in support of coastal resilience.

CCRFR member institutions also work independently to advance scientific understanding of, and technical and policy solutions for, challenges to coastal adaptation and protection in Virginia.

Old Dominion University (ODU)

ODU coordinates with CCRFR through the Office of Research, including managing the CCRFR website and social media, and supports CCRFR and Virginia's Coastal resilience efforts with its other CCRFR partners at VIMS and VCPC through direct support to the Special Assistant for Coastal Adaptation and Protection in preparatory research and development of long-term master planning concepts for the Commonwealth. This includes research and analysis supporting Executive Orders 24 and 45 - including their recent work on nuisance flooding analysis, mentioned in Chapter 2. In addition, they have recently produced academic research publications on hurricane evacuation behavior and evacuation considerations in a pandemic (in progress with the University of South Florida), green infrastructure solutions for repetitive flood buy out areas, economic analysis of hurricane impact on the Hampton Roads region with additional sea level rise, specific hurricane impacts on the economy of the Hampton Roads Region, and the impact of severe weather events on the Hampton Roads Region housing market.²

Coastal resilience, climate change, and sea level rise has been a university-wide priority since 2010. Beyond CCRFR ODU faculty across the university are active in interdisciplinary applied and fundamental research, education and outreach. While not all resilience research falls within the newly launched Institute for Coastal Adaptation and Resilience (ICAR), ICAR is working with CCRFR to synthesize an extensive network of research, outreach, and education in the field of coastal resilience ongoing and growing at ODU. For example, in partnership with Old Dominion engineering faculty partner with Hampton University on the Coastal Community Design Collaborative which engages Engineering and Architecture students respectfully in district level adaptation design.

¹ Chapter 440 2016 Uncodified Acts § (2016).

² CCRFR, "Reports," accessed July 10, 2020, <https://www.floodingresiliency.org/reports/>.

The University is host to significant research and applied GIS services focused on coastal resilience within the Geography department and the Geospatial, Science, Education & Analytics (GeoSEA) team. The GeoSEA team has expertise in data acquisition and development, drone mapping, imaging, and modeling, map design, and more. Faculty members in Public Service, Engineering Technology, English, and Ocean, Earth and Atmospheric Sciences have led citizens in the Action Oriented Stakeholder for a Resilient Tomorrow (ASERT) process and have captured geographic data on an accessible and living map portal.³

Virginia Institute of Marine Science (VIMS)

The Code of Virginia requires VIMS to provide research, education, and advisory service to the Commonwealth's government, citizens, and industry. Research at VIMS extends from inland watersheds to the open ocean, with an emphasis on coastal and estuarine science. VIMS supports Virginia's coastal resilience efforts by conducting fundamental research that extends our understanding of how coastal habitats, including beaches, barrier islands, marshes, shorelines, and coastal forests, change in the face of climate change and sea-level rise. It further advances these efforts by training the next generation of coastal marine scientists, many of whom work at the interface of science and policy. VIMS has for decades played a leading role in advancing understanding and stewardship of Virginia's tidal shorelines and wetlands through research, advisory service, outreach and education, and development of policy guidance, mapping resources, and decision support tools.

Specific areas of support provided by VIMS include integration of water level data from tide gauges throughout Virginia's tidal waters, advanced computer modeling that provides 36-hr forecasting of tidal water levels and high-resolution flood inundation throughout Tidewater Virginia, and real-time access to these predictions on a publicly-accessible web platform. VIMS Sea-Level Report Card provides annual updates of projected sea-level rise by 2050 for 32 localities along the U.S. coast, including Norfolk, Virginia.⁴

Other information, training and implementation guidance, and tools related to climate change, coastal flood risk, and management options are provided by VIMS and are accessible through the Adapt Virginia web portal, which also includes a CZM-funded feature of a coastal resilience projects database (developed by a grant to Wetlands Watch) to house information on projects needing funding and potential funding sources.

The Virginia Flood Risk Information System (VFRIS), an interactive GIS-based tool that informs communities, real estate agents, property buyers, and property owners to discern an area's flood risk was developed by DCR and VIMS, and is accessible in a user-friendly web platform.⁵ Shoreline management guidance informs local governments and property owners on

³ Old Dominion University, "Participatory Mapping – ASERT," accessed July 30, 2020, <https://sites.wpu.edu/asert/participatory-mapping/>.

⁴ Virginia Institute of Marine Science, "Norfolk, Virginia Sea-Level Report Card," accessed July 13, 2020, <https://www.vims.edu/research/products/slrc/localities/nova/index.php>.

⁵ Virginia Department of Conservation and Recreation, "Virginia Flood Risk Information System," accessed July 13, 2020, <https://www.dcr.virginia.gov/dam-safety-and-floodplains/fpvfris>.

approaches to enhance resilience, through living shoreline engineering. Ongoing collaboration between VIMS and VDOT is directed at assessing vulnerability to transportation infrastructure in Virginia's coastal zone from sea-level rise and informing resilience strategies.⁶

Virginia Coastal Policy Center, William & Mary Law School

The Virginia Coastal Policy Center (VCPC) provides science-based legal and policy analysis of issues affecting the state's coastal resources - providing education and advice to a host of Virginia's decision-makers, from government officials and legal scholars to non-profit and business leaders. VCPC works with scientists, local and state government, community leaders, the military, and others to integrate the latest science with legal and policy analysis to solve coastal resource management problems.

VCPC supports Virginia's coastal resilience efforts by conducting legal research and analysis on a host of issues related to Virginia's coastal resources in adaptation and protection, including adaptive planning and zoning for sea level rise, balancing water quality and flood resilience, property rights, social vulnerability, and environmental justice.⁷ In addition, VCPC hosts an annual conference covering a range of coastal policy topics, including a wide range of expert speakers – most recently in 2019 considering “The Three “P’s” of Resilience: Planning, Partnerships, and Paying For It All”, and also in 2019, hosting a Resilience Funding Forum to explore innovative funding options for coastal localities. Finally, as a non-litigation center, VCPC has become a trusted agent to localities, planning districts, state agencies, and other stakeholders, for their assistance in up to the minute analysis of today's complex coastal policy, planning and land use issues.

Virginia Sea Grant

Sea Grant is a federal-state partnership sponsored by NOAA, with a mission to enhance the ecological, economic, social sustainability, and resilience of coastal and ocean communities through university-based research, extension, education, and communication. Virginia Sea Grant includes seven Virginia academic institutions: the University of Virginia, Virginia Tech, Old Dominion University, George Mason University, James Madison University, Virginia Commonwealth University, and William & Mary. These institutions work together and independently through programs such as the Coastal Engineering Institute at ODU, the Center for Coastal Studies at Virginia Tech, UVA's Coastal Research Center, and GMU's Flood Hazards Research Lab.

Recent and ongoing Sea Grant initiatives supporting coastal resilience include support for several graduate research fellowships including the Commonwealth Coastal and Marine Policy fellowship, Coastal Resilience Post-Graduate Fellowship, and a growing range of Coastal Resilience Summer Internships working with business and institutional partners in the coastal

⁶ Stephen C. Brich, John T. Wells, and Matthew J. Strickler, “Memorandum of Understanding Among the Virginia Department of Transportation and The Virginia Institute of Marine Science and Matthew J. Strickler, Chief Resilience Officer of the Commonwealth of Virginia.”

⁷ William and Mary Law School, “VCPC Reports & Collaborative Documents,” accessed July 10, 2020, <https://law.wm.edu/academics/programs/jd/electives/clinics/vacoastal/reports/index.php>.

resilience and adaptation community.⁸ Virginia Sea Grant also co-sponsors the highly successful quarterly Hampton Roads Adaptation Forums with the HRPDC and Old Dominion University's Institute for Coastal Adaptation and Resilience - convening the community of practice in coastal adaptation from across the Hampton Roads Region and beyond - to explore research, policy, regional coordination, and sharing of best practices.

The Resilience Adaptation Feasibility Tool (RAFT)

The Resilience Adaptation Feasibility Tool (RAFT), developed by the University of Virginia Institute for Engagement & Negotiation (IEN), VCPC, and ODU, supported by VASG and VCZM, is a multi-year process that helps Virginia's coastal localities improve resilience to flooding and other coastal storm hazards while remaining economically and socially viable. Partnering with a regional planning district commissions, the RAFT team engages in a three-part process, 1) using a RAFT Scorecard to provide localities an independent assessment of their resilience, 2) working with community leaders to develop a Resilience Action Checklist of measures that can be completed or substantially undertaken within one year, and 3) supporting that year of implementation through the RAFT university collaborative. The RAFT team completed a pilot project in 2018 in the communities of Portsmouth, Cape Charles, and Gloucester, recently completed implementation of the RAFT process for localities on the Eastern Shore in 2019, and is executing their 2020 program on the Northern Neck. The RAFT is supported by a mix of federal, state, and private foundation grants, staff funding from Virginia Sea Grant, and donated services, and is provided at no cost to localities.⁹

Other Coastal Research in Virginia

While not funded by a legislated General Assembly appropriation, other Virginia universities host centers with a specific focus on Coastal adaptation research. These include Virginia Tech's Center for Coastal Studies, the University of Virginia's Environmental Resilience Institute, and George Mason University's Flood Hazard Research Lab.

⁸ "Home," Virginia Sea Grant, accessed July 10, 2020, <https://vaseagrant.org/>; The Hampton Roads Adaptation Forum, "Planning for Sea Level Rise and Flooding in Hampton Roads," accessed July 10, 2020, <https://sites.wp.odu.edu/HRAadaptationForum/>.

⁹ Institute for Engagement and Negotiation: University of Virginia, "The Resilience Adaptation Feasibility Tool (The RAFT)," accessed July 10, 2020, <https://ien.virginia.edu/raft>.

APPENDIX C

**EXECUTIVE ORDER 45 (2019): FLOODPLAIN MANAGEMENT
REQUIREMENTS AND PLANNING STANDARDS FOR STATE
AGENCIES, INSTITUTIONS, AND PROPERTY**



*Commonwealth of Virginia
Office of the Governor*

Executive Order

NUMBER FORTY-FIVE

FLOODPLAIN MANAGEMENT REQUIREMENTS AND PLANNING STANDARDS FOR STATE AGENCIES, INSTITUTIONS, AND PROPERTY

Importance of the Initiative

Executive Order 24 “Increasing Virginia’s Resilience to Sea Level Rise and Natural Hazards,” issued in November 2018, set the Commonwealth on a course towards addressing its risk and resilience to natural hazards, including flooding. A key element of that Order required an analysis of flooding and flood preparedness in the Commonwealth. Based on that analysis, the Commonwealth must establish new policies and directives to ensure that necessary actions are taken to protect state property from the risk of floods.

Background

Flooding remains the most common and costly natural disaster in Virginia and the United States. With more than 100,000 miles of streams and rivers, as well as 10,000 miles of estuarine and coastal shoreline, Virginia’s flood risk is statewide, comes in many forms, and is increasing because of climate change and increased development in flood-prone areas. In 1987, in order to improve Virginia’s flood protection programs and to consolidate all related programs in one agency, responsibility for coordination of all state floodplain programs was transferred from the State Water Control Board to the Department of Conservation and Recreation (DCR). Section 10.1-602 of the *Code of Virginia* names DCR as the manager of the state’s floodplain program and the designated coordinating agency of the National Flood Insurance Program (NFIP). The Code stipulates that the Director of DCR or his designee shall serve as the State Coordinator for the NFIP.

DCR’s Floodplain Management Program was created to minimize Virginia’s flood hazards. In particular, it aims to prevent loss of life, reduce property damage, and conserve natural and beneficial values of state rivers and coastal floodplains. To achieve these goals, DCR promotes

NFIP compliance and participation, offers technical assistance and community education, coordinates with other local, state and federal agencies, and provides funding through the Dam Safety, Flood Prevention and Protection Assistance Fund (§ 10.1-603.16 *et. seq.* of the *Code of Virginia*).

Participation in the NFIP allows the Commonwealth to receive many types of disaster assistance, development loans, and other financial resources. The continued availability of these resources is dependent on compliance with the NFIP. Lack of compliance with the NFIP could result in the Commonwealth's suspension from the program, increased flood insurance costs, loss of NFIP flood insurance policies, inability to secure federally-backed mortgages and loans, and increased unreimbursed disaster costs for the Commonwealth.

The floodplain management policies identified in this Order are intended to avoid unnecessary costs from flooding, to reduce risks to human health, safety, and welfare, and to protect, preserve, and enhance the natural and beneficial uses of properly-managed floodplains to property and development under state ownership.

Virginia state government agencies have been operating under Executive Memorandum 2-97. Much has changed since then-Governor George Allen issued that memorandum. Now, in light of those changed conditions, it is necessary to establish clear policies and standards for state agencies.

Requirements for State-owned Properties in Flood-Prone Areas

Participation in the NFIP is contingent on a community voluntarily adopting floodplain management regulations that meet NFIP minimums as established by the Federal Emergency Management Agency (FEMA). In order to ensure the Commonwealth, as a participating community, complies with the NFIP as outlined in 44 CFR § 60.11-13 and is prepared for current and future flood conditions, this Order establishes mandatory standards for development¹ of state-owned properties in Flood-Prone Areas, which include Special Flood Hazard Areas,² Shaded X Zones,³ and the Sea Level Rise Inundation Area.⁴ These standards shall apply to all state agencies⁵.

¹ Development for NFIP purposes is defined in 44 CFR § 59.1 as "Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials."

² The Special Flood Hazard Area may also be referred to as the 1% annual chance floodplain or the 100-year floodplain, as identified on the effective Flood Insurance Rate Map and Flood Insurance Study. This includes the following flood zones: A, AO, AH, AE, A99, AR, AR/AE, AR/AO, AR/AH, AR/A, VO, VE, or V.

³ The Shaded X Zone may also be referred to as the 0.2% annual chance floodplain or the 500- year floodplain, as identified on the effective Flood Insurance Rate Map and Flood Insurance Study.

⁴ The Sea Level Rise Inundation Area referenced in this Order shall be mapped based on the National Oceanic and Atmospheric Administration Intermediate-High scenario curve for 2100, last updated in 2017, and is intended to denote the maximum inland boundary of anticipated sea levelrise.

⁵ "State agency" shall mean all entities in the executive branch, including agencies, offices, authorities, commissions, departments, and all institutions of higher education.

1. Development in Special Flood Hazard Areas and Shaded X Zones

- A. All development, including buildings, on state-owned property shall comply with the locally-adopted floodplain management ordinance of the community in which the state-owned property is located and any flood-related standards identified in the Virginia Uniform Statewide Building Code.
- B. If any state-owned property is located in a community that does not participate in the NFIP, all development, including buildings, on such state-owned property shall comply with the NFIP requirements as defined in 44 CFR §§ 60.3, 60.4, and 60.5 and any flood-related standards identified in the Virginia Uniform Statewide Building Code.
 - (1) These projects shall be submitted to the Department of General Services (DGS), for review and approval.
 - (2) DGS shall not approve any project until the State NFIP Coordinator has reviewed and approved the application for NFIP compliance.
 - (3) DGS shall provide a written determination on project requests to the applicant and the State NFIP Coordinator. The State NFIP Coordinator shall maintain all documentation associated with the project in perpetuity.
- C. No new state-owned buildings, or buildings constructed on state-owned property, shall be constructed, reconstructed⁶, purchased, or acquired by the Commonwealth within a Special Flood Hazard Area or Shaded X Zone in any community unless a variance is granted by the Director of DGS, as outlined in this Order.

2. Variance Process

- A. The Director of DGS may consider a variance to the requirements listed above if the following conditions are met:
 - (1) It has been demonstrated that granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public, or in the case of NFIP participating communities, conflicts with their existing local floodplain ordinances.
 - (2) The design of the building or structure complies with the freeboard standards adopted in this Order.

⁶“Reconstructed” means a building that has been substantially damaged or substantially improved, as defined by the NFIP and the Virginia Uniform Statewide Building Code.

- (3) Buildings or structures are demonstrated to be a functionally dependent use, such as water treatment facilities, boat houses, fish hatcheries, and other similar uses, or
 - (4) Buildings or structures are historic and require repair or rehabilitation and it has been demonstrated that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure, or
 - (5) Buildings or structures are demonstrated to be necessary to protect public health, safety, and welfare.
- B. The Director of DGS shall not approve any variance to the requirements set forth in Section 1 until the State NFIP Coordinator has reviewed and approved the application for NFIP compliance.
- C. A variance to the requirements set forth in Section 1 does not waive the requirement to comply with a local floodplain ordinance, Virginia Uniform Statewide Building Code, or the requirements outlined in 44 CFR §§ 60.3, 60.4, or 60.5, as applicable.
- D. The Director of DGS shall provide written rulings on variance requests to the applicant, the local community, and the State NFIP Coordinator. The State NFIP Coordinator shall maintain all documentation associated with the variance in perpetuity.
- E. Any state agency that has received a variance prior to this Order shall provide the variance documentation to the State NFIP Coordinator to be maintained in perpetuity.

3. Freeboard⁷ Standards for State-Owned Buildings in Flood-Prone Areas

A. Riverine Areas

- (1) All new state-owned buildings located in a Special Flood Hazard Area shall be constructed so that the top of the lowest floor, including all equipment, is no less than three (3) feet above the Base Flood Elevation (or Flood Depth if an AO Zone), based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area.
- (2) All new state-owned buildings located in a Shaded X Zone shall be constructed so that the top of the lowest floor, including all equipment, is no less than three (3) feet above the Water Surface Elevation or the Base

⁷ “Freeboard” is a factor of safety usually expressed in feet above a flood level for purposes of floodplain management, as defined by FEMA.

Flood Elevation of the adjacent Special Flood Hazard Area, whichever is less, based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area.

B. Coastal Areas

- (1) All new state-owned buildings located in a Special Flood Hazard Area shall be constructed so that the bottom of the lowest horizontal structural member of the lowest floor, including all equipment, is no less than three (3) feet above the Base Flood Elevation (or Flood Depth if an AO Zone), based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area.
- (2) All new state-owned buildings located in a Shaded X Zone shall be constructed so that the bottom of the lowest horizontal structural member of the lowest floor, including all equipment, is no less than three (3) feet above the Water Surface Elevation or the Base Flood Elevation of the adjacent Special Flood Hazard Area, whichever is less, based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area. Wave action must be accounted for in the Water Surface Elevation.

C. Sea Level Rise Inundation Areas

- (1) All new state-owned buildings located in a Sea Level Rise Inundation Area and any Special Flood Hazard Area shall be constructed so that the bottom of the lowest horizontal structural member of the lowest floor, including all equipment, is no less than eight (8) feet above the Base Flood Elevation (or Flood Depth if an AO Zone), based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area.
- (2) All new state-owned buildings located in a Sea Level Rise Inundation Area and any Shaded X Zone shall be constructed so that the bottom of the lowest horizontal structural member of the lowest floor, including all equipment, is no less than eight (8) feet above the Water Surface Elevation or the Base Flood Elevation of the adjacent Special Flood Hazard Area, whichever is less, based on the effective Flood Insurance Rate Map and Flood Insurance Study for that area. Wave action must be accounted for in the Water Surface Elevation in coastal areas.
- (3) All new state-owned buildings located in a Sea Level Rise Inundation Area but not in a Special Flood Hazard Area or Shaded X Zone shall be built so that the bottom of the lowest horizontal structural member of the lowest floor, including all equipment, is no less than five (5) feet above the mean sea level to account for future flood conditions. This freeboard standard is based on the Sea Level Rise Planning Standards identified in Section 4 below.

- (4) The freeboard standards outlined in paragraphs 3C(1) and 3C(2) above is to account for future flood conditions and is based on three (3) feet of freeboard and the Sea Level Rise Planning Standards identified in Section 4 below.
- D. If a Base Flood Elevation or Water Surface Elevation is not available, the state agency constructing the new state-owned building or structure shall have this elevation determined by a professional engineer in accordance with current hydrologic and hydraulic engineering analyses.
- E. To reduce flood damages and allow for future adaptation opportunities, all new state-owned buildings located in Flood-Prone Areas shall be built using adaptive designs below the lowest floor.
- F. The freeboard standards identified in this section shall apply to all new state-owned buildings receiving funding authorization on or after January 1, 2021.

4. Sea Level Rise Planning Standards

- A. Based on recommendations from the Virginia Institute of Marine Science and the Commonwealth Center for Recurrent Flooding Resilience, the Commonwealth shall use the National Oceanographic and Atmospheric Administration (NOAA) Intermediate-High scenario curve, last updated in 2017, as the state standard for predicting sea level rise.
- B. When scoping, designing, siting, and constructing state-owned buildings, a 50-year mid-life estimate for building longevity shall be used, which, under the NOAA Intermediate-High scenario curve, last updated in 2017, equates to nearly four (4) feet of sea level rise by 2070. This standard has been incorporated into the freeboard standards above, with an additional one (1) foot added to account for high tide.
- C. The sea level rise planning standards identified in A and B of this section shall apply to all new state-owned buildings receiving funding authorization on or after January 1, 2021.
- D. Additional studies and periodic updates of these planning standards shall be at the discretion of the Chief Resilience Officer.

5. Establishing Guidance Documentation

- A. The Department of Conservation and Recreation, after consulting with DGS, shall develop a guidance document by October 1, 2020 to provide state agencies the methodology for complying with the freeboard standards and sea level rise planning standards adopted in this Order.

Establishing State-level Floodplain Management Standards for State Agencies

The Chief Resilience Officer shall convene a workgroup to establish state-level, NFIP compliant requirements for all development activities by state agencies on state-owned property within Flood-Prone Areas. The Secretaries of Administration, Commerce and Trade, Education, Natural Resources, Agricultural and Forestry, Public Safety and Homeland Security, Transportation, and Health and Human Resources, as well as the Special Assistant to the Governor for Coastal Adaptation and Protection or their designees, and any additional state officials designated by the Chief Resilience Officer shall comprise the members of the workgroup. The requirements and standards developed by the workgroup and approved by the Chief Resilience Officer shall replace the requirements in paragraphs 1A and 1B and shall incorporate the standards for state-owned buildings adopted in this Order.

1. As the state NFIP coordinating agency, the Department of Conservation and Recreation shall serve as lead staff to the workgroup.
2. The workgroup shall develop mandatory standards applicable to all state development in order to conform such development to the minimum requirements of the NFIP. The workgroup may also develop standards that exceed NFIP minimums that will enhance protection of life and property after analyzing short and long term costs to the Commonwealth.
3. Such standards shall include a process for permitting development in accordance with the established standards, a process for enforcing the established standards, and a process for documenting and maintaining records of any variances and development.
4. Such standards will incorporate the freeboard and sea level rise planning standards adopted in this Order.
5. Such standards shall include a process by which agencies may seek a variance from the standards developed by this workgroup. The process shall include a final review and approval process of any requests for a variance, which shall be done by the Department of Conservation and Recreation.

Effective Date of the Executive Order

This Executive Order rescinds Executive Memorandum 2-97: Floodplain Management Program for State Agencies, issued by Governor George Allen.

This Executive Order shall be effective November 15, 2019, and shall remain in full force and effect until superseded or rescinded by further executive action.



A handwritten signature in black ink that reads "Ralph S. Northam".

Ralph S. Northam, Governor

Attest:

Kelly Thomasson, Secretary of the Commonwealth

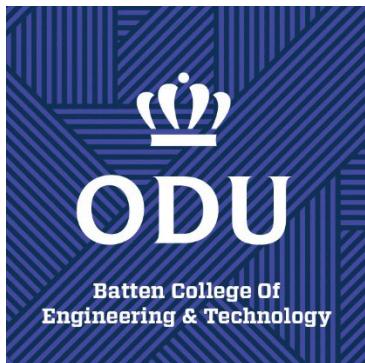
A handwritten signature in black ink that reads "Kelly Thomasson".

APPENDIX D

**RECOMMENDATIONS FOR FREEBOARD STANDARDS FOR STATE
OWNED BUILDINGS IN THE COMMONWEALTH OF VIRGINIA,
CCRFR ODU (2019)**



OLD DOMINION
UNIVERSITY



Recommendations for Freeboard Standards for State-Owned Buildings in the Commonwealth of Virginia

October 23, 2019
Version 1.6

Carol Considine, Associate Professor Engineering Technology
Dr. Michael Seek, P.E., Associate Professor Engineering Technology
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Contact: Carol Considine, cconsidi@odu.edu

The project team acknowledges the contributions of Clark Nexsen for their expert review and comments of these recommendations.

Executive Summary

This report responds to a joint request from The Secretary of Natural Resources and Special Assistant to the Governor for Coastal Adaptation and Protection to assist with meeting the Executive Order Number Twenty-Four (2018), *Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards* directive set forth in Section 1 Part D requiring a freeboard standard for state-owned buildings. This report was prepared by an interdisciplinary team from Old Dominion University, supported by the Commonwealth Center for Recurrent Flooding Resiliency.

The research team combined best available sea level rise data, professional engineering standards and guidelines, GIS visualizations of Coastal Virginia in various flood scenarios, and a survey of other standards implemented on a local or statewide scale. This document also refers to the Virginia Institute of Marine Science recommendations for Sea Level Rise Projections: a Report for the Governor's Coastal Climate Resilience Plan of February 2019, submitted in support of Executive Order 24 Section 1 Part C, by the Center for Coastal Resources Management. The VIMS relative sea level rise projection for Coastal Virginia extends to 2050, and is based on tide gauge projections for the Sewell's Point Tide Gauge, as derived from the VIMS Sea Level Rise Report Card. (Boon et al. 2017.) Due to continued rising seas, and increasing uncertainty beyond 2050, VIMS recommends using NOAA curves for considering planning requirements for infrastructure beyond that point. Specifically, VIMS recommends that projects with lifespans beyond 30 years use NOAA climate scenarios for the target lifespan, and in addition they recommend incorporation of higher curves for flood intolerant infrastructure. ASCE Manual of Practice No. 140 *Climate-Resilient Infrastructure* guidelines recommend utilizing a 50-year mid-term outlook for the life of a project for climate change informed design. Thus, recommendations are based on the NOAA Intermediate-High curve, which would suggest approximately 4 ft of relative sea level rise in 50 years, by 2070.

With regard to the siting of new state-owned structures that begin design after January 1, 2020, this report recommends the following: Except in circumstances as determined by the Commonwealth of Virginia's Chief Resilience Officer - first, avoidance of siting buildings within areas likely to be inundated by sea level rise (SLR) or within areas where access or services will be significantly impacted by SLR during the design life of the building and second, not siting buildings within the Special Flood Hazard Area (Zone A or AE) or the Zone B or Zone X (shaded) as designated under the National Flood Insurance Program (100-year and 500-year floodplains).

With regard to freeboard for new state-owned structures that begin design after January 1, 2020, the report recommends that the Commonwealth lead the nation and adopt a Climate Informed Science Approach for establishing the elevation of buildings sited in Coastal Areas. In this report the Coastal Areas are defined as the Coastal Special Flood Hazard Area and the Combined Coastal/Riverine¹ Special Flood Hazard Area and their adjacent Zone X (shaded) (100- and 500-year floodplains). This strategy

Coastal Area Building Elevation Requirements:

Minimum Elevation of the Top of the Lowest Floor = FBFE + Freeboard

Where:

FBFE = FEMA 100-year BFE + anticipated SLR at 50-year service life

Anticipated SLR is based on the NOAA 2017 Intermediate-High Scenario

Freeboard = 3 feet for all projects.

For Coastal High Hazard and Coastal Zone A above requirements apply to the Bottom of the Lowest Supporting Horizontal Structural Member of Lowest Floor.

requires that the minimum elevation of the top of the lowest floor of a structure be above the maximum of the FEMA Base Flood Elevation plus anticipated SLR based on the Virginia's unified SLR projection at year 50 of anticipated service life, and an additional three feet of freeboard. Flood elevations shall be determined from the highest elevation from either the most recent FEMA Flood Insurance Rate Map (FIRM) or the most recent FEMA Flood Insurance Study (FIS) for the jurisdiction. For new state-owned buildings located outside of, but adjacent to the 500-year floodplain, best engineering practice would dictate analysis and consideration of the need to elevate the first floor to account for future sea level rise and freeboard to minimize future risk. At a minimum, adaptive design measures should be implemented so that future protection of the structure is possible. Importantly, the state must continue to review and revise these standards, at a minimum of every four years, as best available climate science and building codes evolve.

With regard to freeboard for new state-owned buildings that begin design after January 1, 2020, in the riverine area, the report recommends that the current Commonwealth standards are modified to a freeboard of three feet, to ensure FEMA compliance. The standard is provided below:

Riverine Area Building Elevation Requirements:

Minimum Elevation of the Top of the Lowest Floor = BFE + Freeboard

Where:

BFE = FEMA 100-year BFE

Freeboard = 3 feet for all projects.

¹FEMA. (2015). Guidance for Flood Risk Analysis and Mapping, Combined Coastal and Riverine Floodplain. Retrieved from https://www.fema.gov/media-library-data/1436989628107-db27783b8a61ebb105ee32064ef16d39/Coastal_Riverine_Guidance_May_2015.pdf

Implementation of these recommendations will allow the Commonwealth to lead amongst states also at risk to coastal flooding and to lead by example within the Commonwealth.

Introduction

The Commonwealth of Virginia issued Executive Order Number Twenty-Four (2018), *Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards*, on November 2, 2018. The order recognizes that climate change impacts have and continue to increase risk from natural hazards across the Commonwealth, and sets forth a plan to protect Virginia's assets and empower communities and residents of the Commonwealth to build resilience. Citing best available science, the Executive Order states that Coastal Virginia has the highest rate of sea level rise (SLR) on the East Coast, and is threatened by extreme weather events and natural hazards which will impact public health and safety, the environment, and the economy and that fiscally responsible planning is necessary to reduce exposure².

In order to increase statewide resilience to natural hazards and extreme weather Section 1, Part D of the directive requires a freeboard standard for state-owned buildings be established to ensure their resilience. It is our interpretation of EO 24 that these requirements apply only to state-owned buildings that begin design after January 1, 2020.

Executive Memorandum (EM) 2-97 (July 1, 1997) signed by former Governor George Allen and still in effect, provided floodplain management policies and requirements for the Commonwealth and assigned responsibility for leadership and coordination to the Department of Conservation and Recreation under the Secretary of Natural Resources. EM 2-97 aimed to ensure Commonwealth compliance with the National Flood Insurance Program and other related federal programs, and implemented a policy that prohibited the construction of "new state-owned buildings ... within a 100-year floodplain" without a variance granted by the Director, Division of Engineering and Buildings.

This report provides recommendations for a statewide freeboard standard based on current standards and manuals of practice published by the American Society of Civil Engineers (ASCE) including ASCE Standard [ASCE/SEI 24-14], Flood Resistant Design and Construction, and the ASCE Manuals and Reports on Engineering Practice No. 140, *Climate-Resilient Infrastructure: Adaptive Design and Risk Management*.

The Commonwealth Center for Recurrent Flooding Resiliency (CCRFR), established by Virginia Chapter 440 of the 2016 Acts of Assembly (HB 903), is a partnership between Old Dominion University, the Virginia Institute of Marine Science and William & Mary Law Schools' Virginia Coastal Policy Center. CCRFR is charged with providing research services to the Commonwealth in furtherance of building flooding resilience. As such, researchers at Old Dominion University provide this report at the request of the Special Assistant to the Governor for Coastal Adaptation and Protection, Ann C. Phillips, and the Secretary of Natural Resources and Chief Resilience Officer, Matthew J. Strickler.

Sea Level Rise Projections for Coastal Virginia

The National Oceanic and Atmospheric Agency (NOAA), United States Army Corps of Engineers (USACE) and Virginia Institute of Marine Science (VIMS) have each developed and continually update SLR scenarios reflecting rates of relative sea level rise in Hampton Roads Virginia. Figure 1 below, available

²Commonwealth of Virginia, Office of Governor. (2018). Executive Order Number Twenty-Four, Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards. Retrieved from:
<https://www.governor.virginia.gov/media/governorvirginiagov/executive-actions/ED-24-Increasing-Virginias-Resilience-To-Sea-Level-Rise-And-Natural-Hazards.pdf>

on the AdaptVA website shows the relationships between these different curves for Norfolk, VA based on the Sewell's Point tide gauge³:

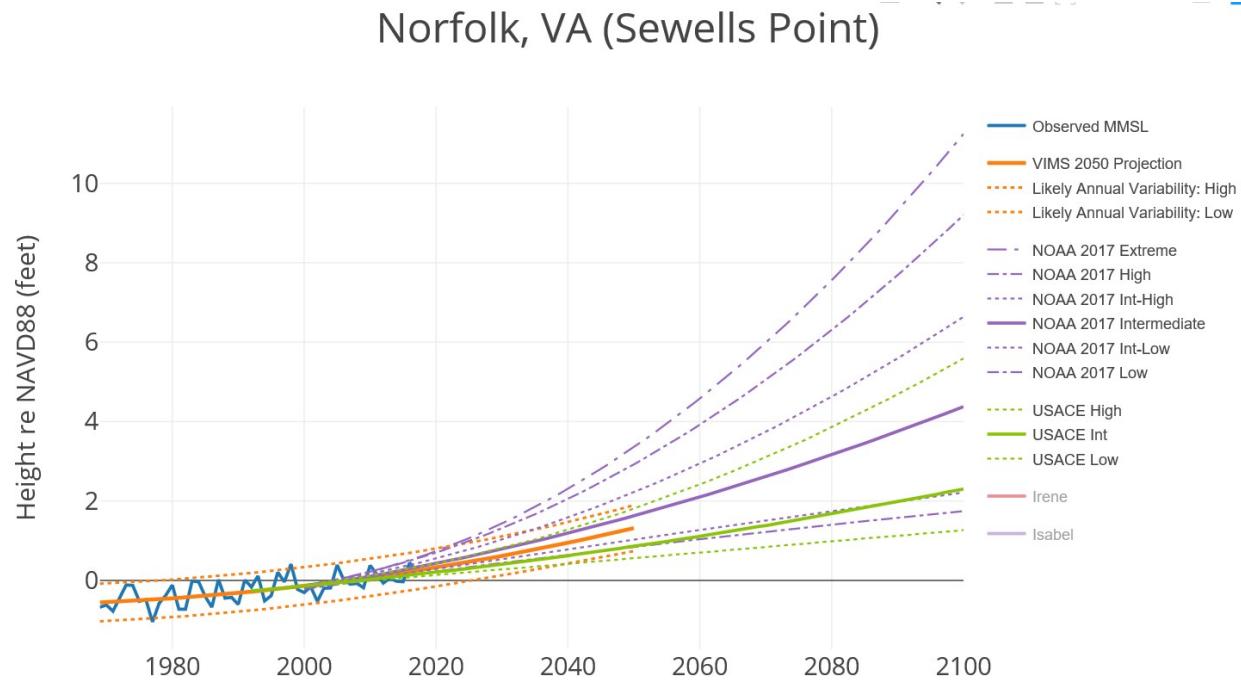


Figure 1. Comparison of Sea Level Rise Scenario Projections for Sewell's Point developed by NOAA, USACE and VIMS

The VIMS projection (shown in orange) is based on analysis of the water observations over the past 40 years and only extends to 2050. Considering that new construction building life would extend beyond the VIMS preferred projection, it is necessary to consider NOAA climate scenarios. Additionally, VIMS recommend that while the "NOAA 2017 Intermediate curve is a potential target for infrastructure that can tolerate moderate flooding, flooding intolerant infrastructure should incorporate higher curves."⁴ Buildings are not typically designed to be flooded and based on this guidance from VIMS the NOAA 2017 Intermediate-High curve is recommended for use in developing freeboard standards for state-owned buildings. Using the NOAA 2017 Intermediate or Intermediate-Low scenario curves would represent a higher tolerance to risk and using the High or Extreme scenario curves would represent a lower tolerance to risk.

As part of the Commonwealth's Executive Order Twenty-Four, a regional or statewide SLR projection will be developed concurrently with the freeboard recommendations that will provide a standard approach for predicting SLR when scoping, designing, siting and constructing state-owned buildings. Selection of SLR scenarios to use in planning should consider tolerance to risk, however, the Commonwealth could

³ AdaptVa. (2018) Virginia Sea Level, Evidence-based planning for changing climate. Retrieved from: http://adaptva.org/info/virginia_sea_level.html

⁴ Center for Coastal Resource Management. (2019). *Recommendations For Sea Level Rise Projections*. Virginia Institute of Marine Science.

choose, based upon VIMS recommendations or emerging data, to use another SLR scenario and still implement the process for determining freeboard presented in this report. For the purpose of this report, the NOAA Intermediate-High scenario curve is used, which represents a moderate tolerance to risk. Figure 2 below provides a table summarizing the NOAA and VIMS scenarios:

Year	NOAA 2017 (Feet)						VIMS 2017
	Low	Int-Low	Int	Int-High	High	Extreme	
2000	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.14
2010	0.03	0.06	0.13	0.19	0.29	0.29	0.07
2020	0.26	0.33	0.46	0.62	0.75	0.82	0.33
2030	0.42	0.56	0.82	1.08	1.34	1.47	0.62
2040	0.65	0.82	1.21	1.61	2.06	2.29	0.95
2050	0.85	1.05	1.64	2.23	2.95	3.34	1.32
2060	1.08	1.31	2.13	2.95	3.97	4.62	
2070	1.28	1.54	2.62	3.74	5.05	6.03	
2080	1.47	1.77	3.21	4.66	6.3	7.58	
2090	1.61	2	3.77	5.61	7.67	9.28	
2100	1.74	2.23	4.39	6.69	9.28	11.32	

Gauge/Grid
Selected:
SEWELLS
POINT

NOAA2017 VLM: 0.00810 feet/yr
 Adjustment to MSL(83-01) Datum: 0.093 feet applied
 Adjustment to NAVD88 Datum: -0.26 feet applied
 All values expressed in feet

Figure 2. Table of NOAA and VIMS Coastal Virginia Sea Level Rise Scenarios for Sewell's Point using NAVD88 values.⁵

Building design life is a key factor to consider in understanding SLR impacts to the structure and effective use of the structure over the life of a structure. While there is little information on building design lives in the literature, the ASCE Manual of Practice No. 140, *Climate-Resilient Infrastructure: Adaptive Design and Risk Management*, recommends that a *mid-term outlook* for the life of a project, approximately 50 years, be used for climate change informed design. The reasoning is that there is great uncertainty in the SLR curves past this time frame and relying on projections to 100 years "may prove overly conservative or insufficient,"⁶ and thus building for such an extended timeline now may result in ineffective use of resources. It is important that adaptive design strategies be incorporated

⁵ US Army Corps of Engineers, Sea-Level Change Curve Calculator, (Version 2019.21). Retrieved from: http://corpsmapu.usace.army.mil/rccinfo/slcc/slcc_calc.html

⁶American Society of Civil Engineers, Committee on Adaptation to Climate Change. (2018). *Climate-Resilient Infrastructure: Adaptive Design and Risk Management*. American Society of Civil Engineers.

into the building design so that future capital improvements to the structure can be made, accounting for changed conditions over the remaining life of the structure, past 50 years. Further, this point reiterates the need to continually review the SLR scenarios in use, based on best available science.

As stated in Commonwealth Executive Order Twenty-Four (2018) additional freeboard requirements for state-owned buildings will be implemented in 2020, which means that the mid-term outlook for the life of a new state-owned building extends to 2070. Based on the table above, using the NOAA Intermediate-High scenario, new construction guidelines should consider sea level rise of 3.91 (3.74+0.17) feet, which is rounded to 4.0 feet for this recommendation. This value lies between the mid-term (2050-2080) recommendation of 3.0 feet of relative sea level rise above MHHW and the long-term recommendation of 4.5 feet of relative sea level rise above MHHW for long-term (2080-2100) planning and engineering decisions⁷ adopted by the Hampton Roads Planning District Commission (HRPDC) as part of their Resolution 2018-01, *Resolution of the Hampton Roads Planning District Commission Encouraging Local Governments in Hampton Roads to Consider Adopting Policies to Incorporate Sea Level Rise into Planning and Engineering Decisions*.

While this report recommends a minimum elevation of the top of the lowest floor calculation that includes freeboard based on a 50-year building life, it is important to consider future conditions in siting and design as well. SLR scenario curves often show the projection of SLR to 2100. As the Commonwealth sets standards related to SLR, it is important to acknowledge that all scientific data indicates that SLR will continue to increase past 2100. Based on the Sewell's Point tide gauge, figure 3 below provides the relative SLR projections from the Sea-Level Change Curve Calculator (Version 2017.55)⁸ for Norfolk VA, that extend to 2200.

⁷Hampton Roads Planning District Commission. (2018). *Resolution of the Hampton Roads Planning District Commission Encouraging Local Governments in Hampton Roads to Consider Adopting Policies to Incorporate Sea Level Rise into Planning and Engineering Decisions*. Retrieved from:

https://www.hrpdcva.gov/uploads/docs/HRPDC%20Resolution_Sea%20Level%20Rise%202018-01.pdf

⁸US Army Corps of Engineers. (2017) Sea-Level Change Curve Additionally, as more scientific studies are completed findings suggest that we are underestimating the impacts of climate change on our environment, sea levels rise is accelerating⁸, and future temperatures may be higher than projected⁸Calculator. Retrieved from: http://corpsmapu.usace.army.mil/rccinfo/slcc_calc.html.

Gauge/Grid Selected: SEWELLS POINT
 NOAA2017 VLM: 0.00810 feet/yr
 Adjustment to MSL (83-01) Datum: 0.093 feet applied
 Adjustment to NAVD88 Datum: -0.26 feet applied
 All values expressed in feet

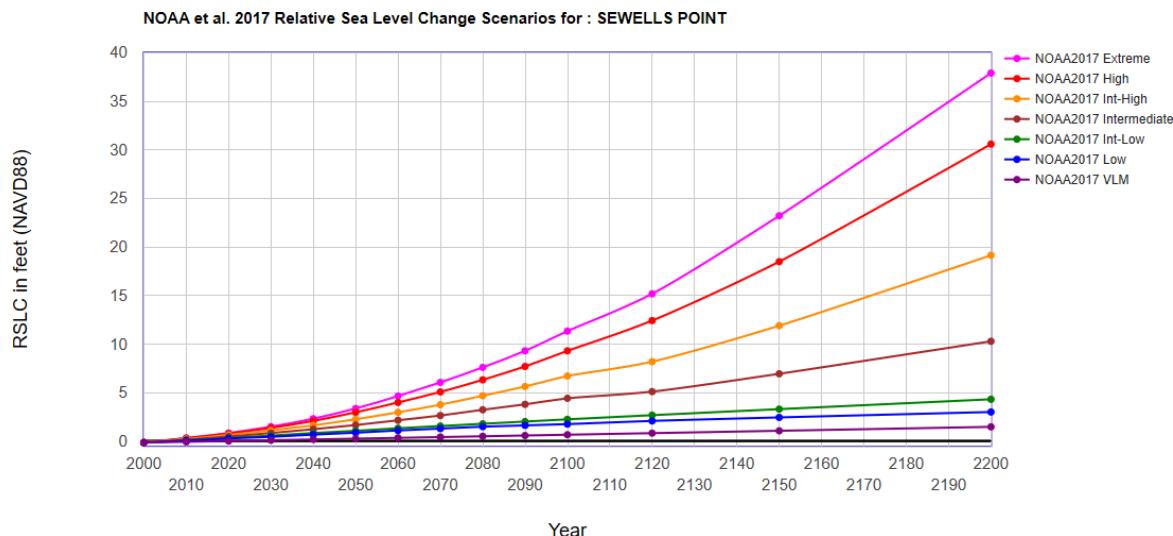


Figure 3. Relative SLR Change Scenarios for Sewell's Point, VA.³

Additionally, as more data is collected and scientific studies are completed, findings suggest that the impacts of climate change on our environment are underestimated; SLR is accelerating⁹, more frequent and intense rainfall will contribute to flooding impacts¹⁰, and future temperatures may be higher than projected¹¹. It is not a matter of *if* SLR will rise 4.0 feet, it is a matter of *when*, and based on current NOAA SLR scenarios, 4.0 feet of SLR may occur as early as 2055 (Extreme scenario) or after 2200 (Low scenario). It is this uncertainty of timing of impacts that supports the adaptive design approach.

In summary, the VIMS projections extend only to 2050, which is 20 years short of the 50-year mid-term building life recommended by the ASCE. The VIMS Center for Coastal Resource Management states that “The Intermediate curve is potential target for infrastructure than can tolerate moderate flooding; flood intolerant infrastructure should incorporate higher curves” in their report titled *Recommendations for Sea Level Rise Projections*, dated February 2019.¹² Buildings are not typically designed to tolerate moderate flooding and ASCE 24-14 requires that buildings that will be flooded meet additional design requirements. Thus, it is recommended that the NOAA Intermediate-High

⁹ NASA, Global Climate Change. (2018) New study finds sea level rise accelerating. Retrieved from: <https://climate.nasa.gov/news/2680/new-study-finds-sea-level-rise-accelerating/>

¹⁰ City of Virginia Beach, Virginia. (2018). Analysis of Historical and Future Heavy Precipitation. Retrieved from: <https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/analysis-hist-and-future-hvy-precip-4-2-18.pdf>

¹¹ Brown, P.T., and Caldeira, K. (2017). Nature. Greater future global warming inferred from Earth's recent energy budget. Retrieved from: <https://www.nature.com/articles/nature24672>

¹² Center for Coastal Resources Management. (2019) *Recommendations for Sea Level Rise Projections*. Virginia Institute of Marine Science.

curve be adopted. This would result in 3.91 (3.74+0.17) feet increase in relative sea level along Virginia's coasts by 2070. Further, the recommended methodology for determining the minimum elevation of the top of the lowest floor, that includes appropriate freeboard, for state-owned buildings presented here can be utilized with any chosen SLR scenario, and it is strongly recommended that the Commonwealth adjust SLR scenarios with best available scientific data on a regular basis, specifically every four years.

GIS Analysis of 100- & 500-year Floodplains based on SLR Projections for the Hampton Roads Planning District

Geographic Information Systems (GIS) analyses were performed to discern the first order impact of rising sea level on high risk Special Flood Hazard Areas (SFHA) and areas at moderate risk of flooding. High risk areas are those which comprise the 100-year floodplain (1% annual chance of flooding) and include the following SFHAs: Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30. Moderate risk areas are those falling between the limits of the 100- and 500-year flood (0.2% annual chance of flooding) which include B and X (shaded) zones.¹³

The examined geographic region includes the 17 member cities and counties of the Hampton Roads Planning District, which are as follows: Chesapeake, Franklin, Gloucester County, Hampton, Isle of Wight County, James City County, Newport News, Norfolk, Poquoson, Portsmouth, Smithfield, Southampton County, Suffolk, Surry County, Virginia Beach, Williamsburg, and York County. The Hampton Roads region (Fig. 4) includes both rural and urban areas, providing a testbed with diverse topography, land use, and population density. The methods employed for this study are easily extensible to other coastal regions within the Commonwealth and beyond.

¹³ FEMA. (2018, 09/14/2018). "Flood Zones." Retrieved 1/25/2019, from <https://www.fema.gov/flood-zones>.

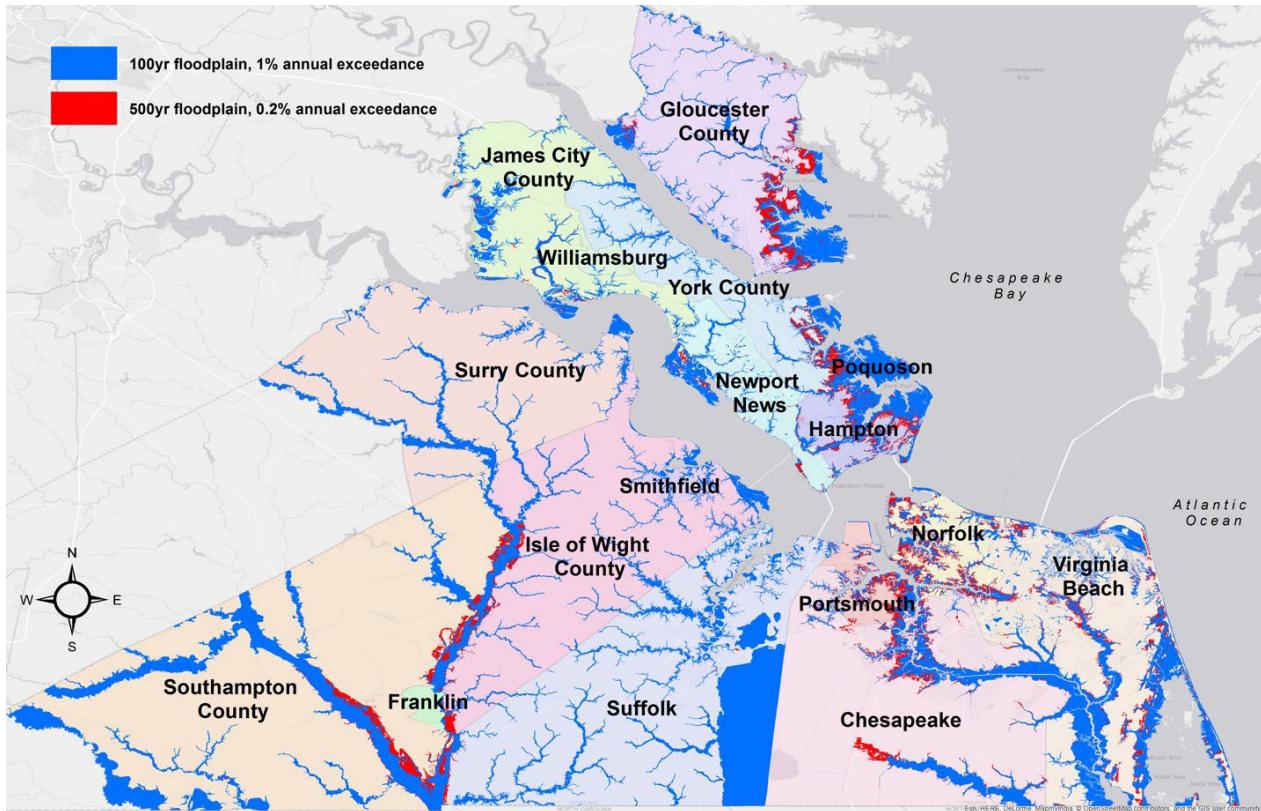


Figure 4. Study area: 17 cities and counties of the Hampton Roads Planning District.

Flood zone GIS data were acquired through the Virginia Flood Risk Information System (VFRIS).¹⁴ These data were aggregated into region-wide 100- and 500-year floodplain layers.

Total areas of 100-year (high risk, 1% annual exceedance probability) and 500-year (moderate risk, 0.2% annual exceedance probability) flood zones were calculated for the entire study region and separately for each municipality. Appendix 1 provides a table detailing the area (mi^2) and % of inundation of the 100 year and 500-year flood zones for each municipality.

Spatial modeling of future SLR of 3.0 feet above Mean Higher High Water (MHHW) was performed in order to delineate which portions of the present day 100- and 500-year floodplains will be permanently inundated at these levels. All land elevation and inundation data were referenced against the MHHW datum, which is the average of the higher high water height of each tidal day observed over the 19-year National Tidal Datum Epoch.¹⁵ Use of the MHHW datum ensures that areas of predicted inundation occur over non-tidal areas which are normally not flooded.

The modeled 3.0 feet SLR inundation layer was overlain atop the SFHA risk layers, allowing for the calculation of the area and percentage of inundation of the 100- and 500-year floodplains. Figure 5 shows this overlay for both a rural (Gloucester) and an urban (Norfolk) area.

¹⁴ DCR. (2019, 06/28/2018). "Virginia Flood Risk Information System." from <http://www.dcr.virginia.gov/dam-safety-and-floodplains/fpvfris>.

¹⁵ NOAA. (2018, 08/08/2018). "Tidal Datums." Retrieved 01/25/2019, from https://tidesandcurrents.noaa.gov/datum_options.html.

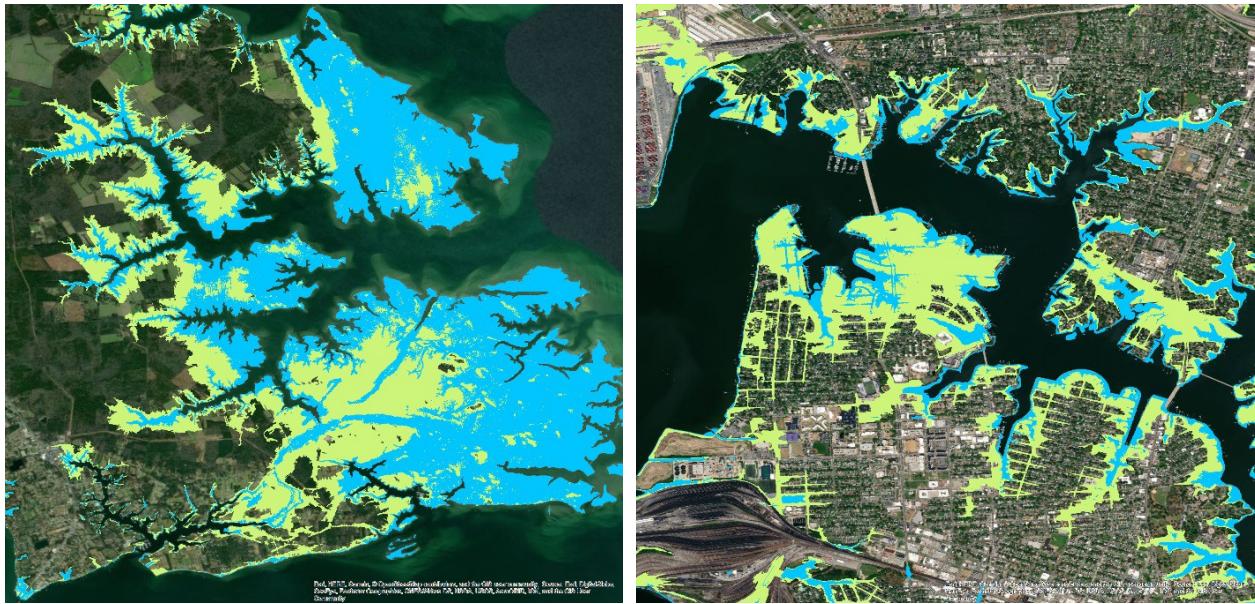


Figure 5. Overlay of 3' of sea level inundation (blue) atop SHFA high risk zones (green) for portions of Gloucester (left at 1:50k scale) and Norfolk (right at 1:20k scale).

As shown in figure 6, approximately 38% of the total area of the current 100-year floodplain will be permanently inundated by +3 feet SLR. It should be noted that inundation percentages are not uniform and vary significantly by municipality, ranging from 10% to 89.3%. These differences are the result of wide variance of topography and SFHA zones between municipalities and should be the subject of further examination.

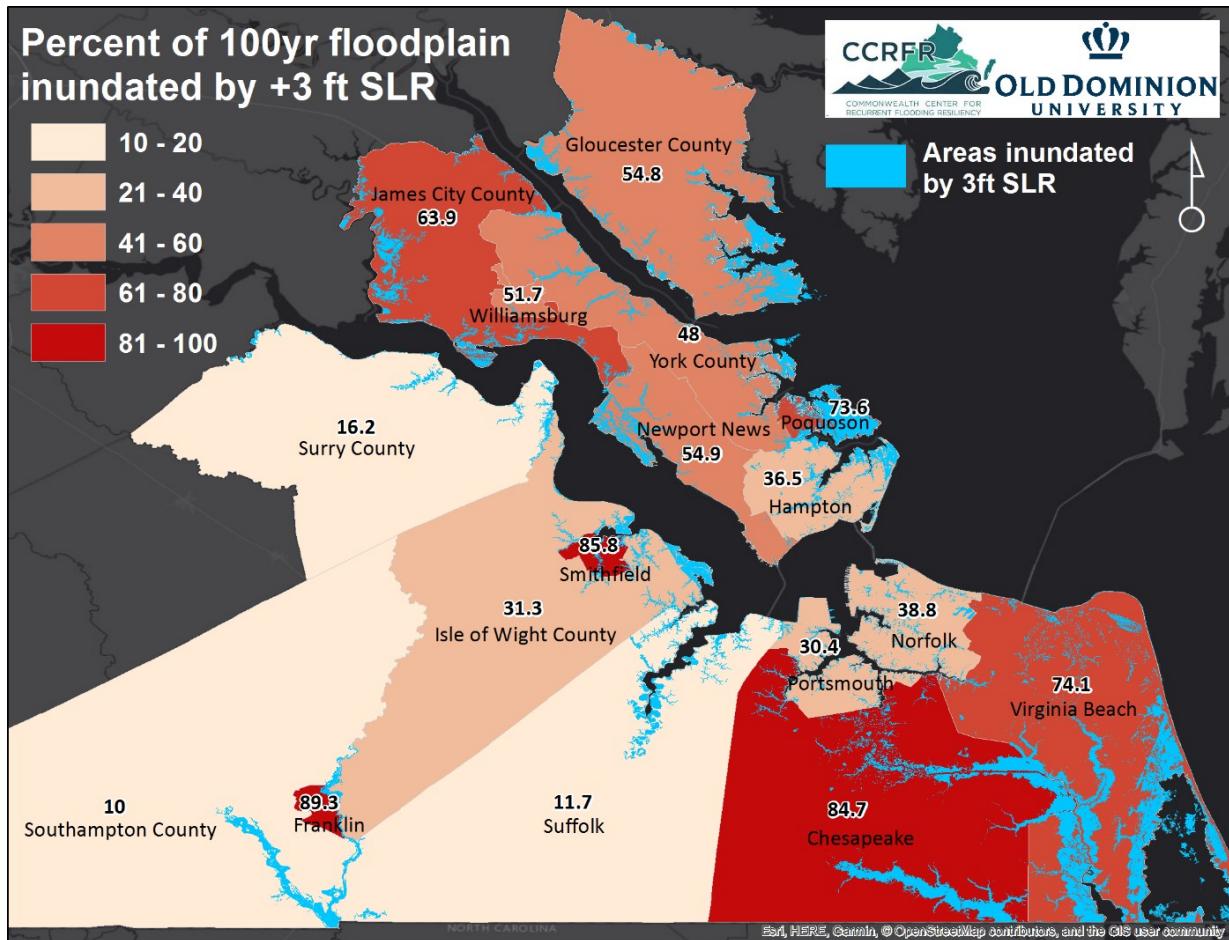


Figure 6. Map shows percentage of 100-year floodplain (by municipality) which will be inundated by 3.0 feet SLR. Approximately 189 square miles, 38%, of the entire 100-year floodplain in the Hampton Roads Region will be perpetually flooded.

Figure 7 illustrates that approximately 5% of the total area of the current 500-year floodplain will be permanently inundated by +3ft SLR. As is the case with the 100-year floodplain, the impacts of SLR are not uniform regarding the 500-year floodplain. Most Hampton Roads municipalities show little or no inundation, while the moderate hazard zones of Virginia Beach (18.7%) and Chesapeake (13.6%) experience non-trivial areas of inundation.

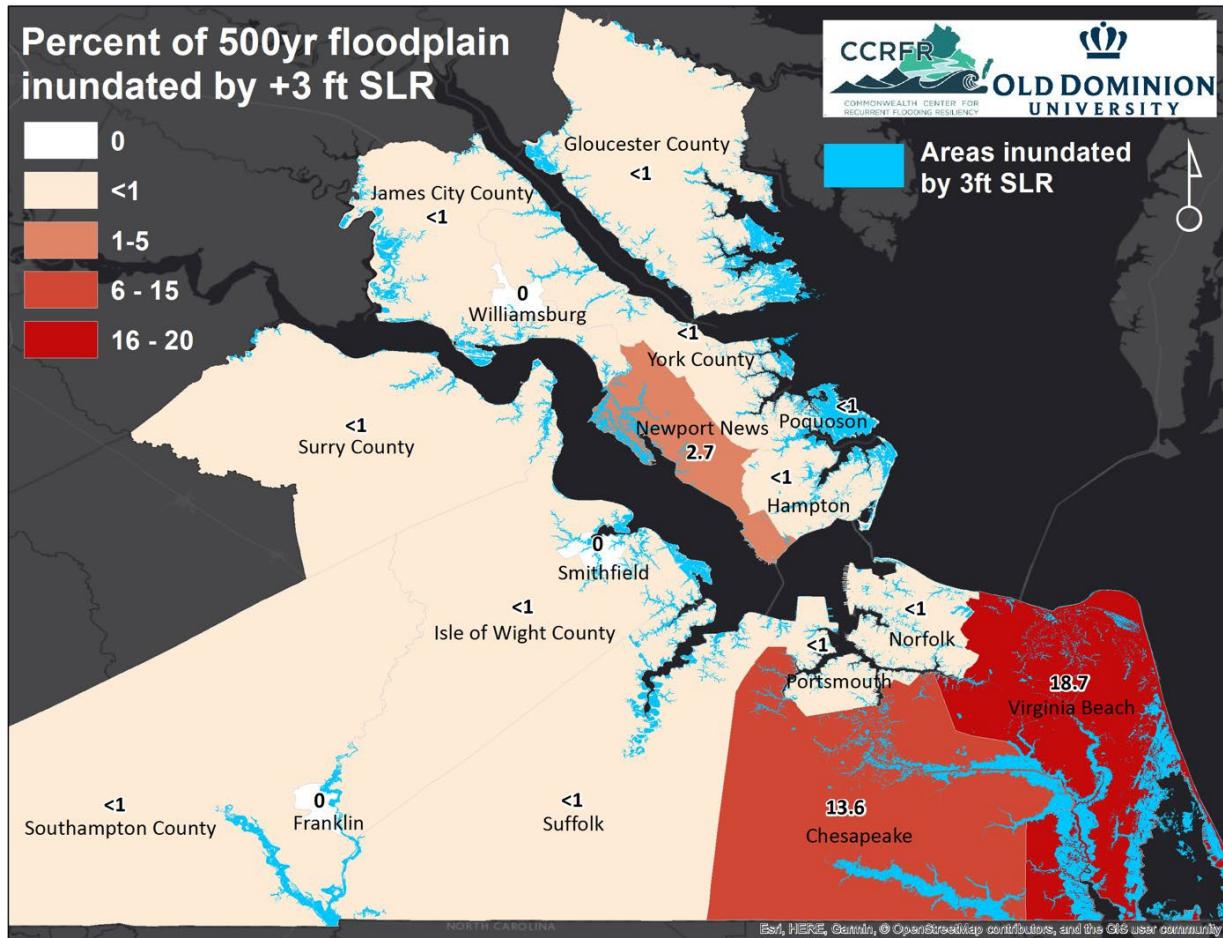


Figure 7. Percentage of 500-year floodplain which will be permanently inundated by 3.0 feet SLR.

It is recommended that this work be extended, and additional analysis performed to quantify the regional impacts of SLR in smaller geographic areas considering *parcel level* data. Areas of potential critical impact should be identified for high-resolution, focused analyses of the physical and economic impacts of SLR.

Building Codes

This report recommends aligning requirements for Commonwealth-owned buildings with standard best engineering practice and allowing for adaptation as additional information and data on SLR and flooding becomes available. Below is an explanation of standards and guidelines from ASCE, a review of freeboard requirements adopted in other states at similar risk and in communities in the Commonwealth, as well as recommendations for application to Section 1 Part D of Executive Order Twenty-Four with regards to new construction that begins design after January 1, 2020.

ASCE Standard, [ASCE/SEI 24-14], Flood Resistant Design and Construction¹⁶

ASCE Standards provide technical standards for engineering professionals worldwide, undergo rigorous review and regular updates, and are a basis for model building codes. ASCE Standard 24-14, revised in 2015, provides minimum requirements for flood resistant design and construction of structures that are subject to building code requirements and that are located, in whole or in part, in Flood Hazard Areas. Further, ASCE Standard 24-14 meets or exceeds FEMAs requirements for buildings or structures. The standard applies to: (1) new construction, including subsequent work to such structures, and (2) work classified as substantial improvement of an existing structure that is not a historic structure.

The standard establishes a Flood Design Class for buildings and structures. Buildings are assigned a flood design class 1 through 4. The flood design class is similar although not equivalent to the occupancy category or risk category (I-IV) assigned to buildings according to the ASCE 7 standard or building code. Description of the Flood design class is shown in figure 8 below (taken from ASCE 24-14 Table 1-1).

Table 1-1 Flood Design Class of Buildings and Structures

Use or Occupancy of Buildings and Structures	Flood Design Class
Buildings and structures that normally are unoccupied and pose minimal risk to the public or minimal disruption to the community should they be damaged or fail due to flooding. Flood Design Class 1 includes (1) temporary structures that are in place for less than 180 days, (2) accessory storage buildings and minor storage facilities (does not include commercial storage facilities), (3) small structures used for parking of vehicles, and (4) certain agricultural structures. ^a	1
Buildings and structures that pose a moderate risk to the public or moderate disruption to the community should they be damaged or fail due to flooding, except those listed as Flood Design Classes 1, 3, and 4. Flood Design Class 2 includes the vast majority of buildings and structures that are not specifically assigned another Flood Design Class, including most residential, commercial, and industrial buildings.	2
Buildings and structures that pose a high risk to the public or significant disruption to the community should they be damaged, be unable to perform their intended functions after flooding, or fail due to flooding. Flood Design Class 3 includes (1) buildings and structures in which a large number of persons may assemble in one place, such as theaters, lecture halls, concert halls, and religious institutions with large areas used for worship; (2) museums; (3) community centers and other recreational facilities; (4) athletic facilities with seating for spectators; (5) elementary schools, secondary schools, and buildings with college or adult education classrooms; (6) jails, correctional facilities, and detention facilities; (7) healthcare facilities not having surgery or emergency treatment capabilities; (8) care facilities where residents have limited mobility or ability, including nursing homes but not including care facilities for five or fewer persons; (9) preschool and child care facilities not located in one- and two-family dwellings; (10) buildings and structures associated with power generating stations, water and sewage treatment plants, telecommunication facilities, and other utilities which, if their operations were interrupted by a flood, would cause significant disruption in day-to-day life or significant economic losses in a community; and (11) buildings and other structures not included in Flood Design Class 4 (including but not limited to facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. ^b	3
Buildings and structures that contain essential facilities and services necessary for emergency response and recovery, or that pose a substantial risk to the community at large in the event of failure, disruption of function, or damage by flooding. Flood Design Class 4 includes (1) hospitals and health care facilities having surgery or emergency treatment facilities; (2) fire, rescue, ambulance, and police stations and emergency vehicle garages; (3) designated emergency shelters; (4) designated emergency preparedness, communication, and operation centers and other facilities required for emergency response; (5) power generating stations and other public utility facilities required in emergencies; (6) critical aviation facilities such as control towers, air traffic control centers, and hangars for aircraft used in emergency response; (7) ancillary structures such as communication towers, electrical substations, fuel or water storage tanks, or other structures necessary to allow continued functioning of a Flood Design Class 4 facility during and after an emergency; and (8) buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. ^b	4

^a Certain agricultural structures may be exempt from some of the provisions of this standard; see Section C1.4.3.

^b Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for assignment to a lower Flood Design Class if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.3 of *Minimum Design Loads for Buildings and Other Structures* that a release of the substances is commensurate with the risk associated with that Flood Design Class.

Figure 8. Flood Design Class of Buildings and Structures, ASCE 24-24, Table 1-1

Flood Zones are defined according to the FEMA Flood Insurance Rate Maps (FIRM). Using the definitions provided in ASCE 24-14:

Coastal High Hazard Area (CHHA)—Area within a *special flood hazard area* extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area

¹⁶ American Society of Civil Engineers. (2015). Flood Resistant Design and Construction. American Society of Civil Engineers.

that is subject to *high velocity wave action* from storms or seismic sources. This area is designated on *FIRMs* as velocity zones V, VO, VE, or V1-30.

Coastal A Zone (CAZ)—Area within a *special flood hazard area*, landward of a *V Zone* or landward of an open coast without mapped *V Zones*. In a Coastal A Zone, the principal source of flooding must be astronomical tides, storm surges, seiches, or tsunamis, not riverine flooding. During the *base flood* conditions, the potential for breaking *wave heights* shall be greater than or equal to 1.5 ft. The inland limit of the Coastal A Zone is (1) the *Limit of Moderate Wave Action* if delineated on a *FIRM*, or (2) designated by the *authority having jurisdiction*.

Within the standard, separate provisions are provided for each flood zone. Within ASCE 24-14, Chapter 4 contains provisions for Coastal High Hazard Zones and Coastal A Zones; Chapter 2 contains provisions for flood hazard zones that are not classified as a Coastal High Hazard Zone or a Coastal A Zone. Additionally, Chapter 3 contains provisions for special High Risk Flood Hazard areas subject to one or more of the following hazards: alluvial fan flooding, flash floods, mudslides, erosion, high-velocity flows, high-velocity wave action, breaking wave heights greater than or equal to 1.5 feet (Coastal High Hazard Area and Coastal A Zone) and damage-causing ice or debris. Areas classified according to Chapter 3 must also satisfy requirements of Chapter 2.

Siting and Elevation Requirements

Separate siting and elevation requirements are established in ASCE 24-14 for Coastal High Hazard and Coastal A zones versus zones that do not fall within those zones. Elevations are specified relative to the Base Flood Elevation (BFE) or the Design Flood Elevation (DFE). The Base Flood Elevation is the elevation of flooding including wave height that has 1% annual probability of exceedance. Similarly, the Design Flood Elevation is elevation of the *design flood*, including *wave height*, relative to the *datum* specified on the community's *flood hazard map*. The design flood is the flood associated with the greater of the following two areas: (1) area within a *floodplain* subject to a 1% or greater chance of flooding in any year, i.e., the BFE, or (2) area designated as a *flood hazard area* on a *community's flood hazard map* or otherwise legally designated. FEMA maps are based on the BFE, so if a locality has adopted the FIRM, the DFE will correspond to the BFE. However, communities may elect to adopt Design Flood Elevations that are higher than those provided by FEMA.

Zones Not Classified as Coastal High Hazard or Coastal A

New construction and substantial improvements are required to set the elevation of the top of the lowest floor (including basements) above a minimum level depending on the Flood Design Class. The elevations are shown in figure 9 (Table 2-1 from ASCE 24-14).

Table 2-1 Minimum Elevation of the Top of Lowest Floor—Flood Hazard Areas Other Than Coastal High Hazard Areas,^a Coastal A Zones,^a and High Risk Flood Hazard Areas^a

Flood Design Class ^b	Minimum Elevation, Relative to Base Flood Elevation (BFE) or Design Flood Elevation (DFE)
1 ^c	DFE
2 ^d	BFE + 1 ft or DFE, whichever is higher
3 ^d	BFE + 1 ft or DFE, whichever is higher
4 ^d	BFE + 2 ft or DFE, or 500-year flood elevation, whichever is higher

^aMinimum elevations shown in Table 2-1 do not apply to Coastal High Hazard Areas and Coastal A Zones (see Table 4-1). Minimum elevations shown in Table 2-1 apply to other high risk flood hazard areas unless specific elevation requirements are given in Chapter 3 of this standard.

^bSee Table 1-1 for Flood Design Class descriptions.

^cFlood Design Class 1 structures shall be allowed below the minimum elevation if the structure meets the wet floodproofing requirements of Section 6.3.

^dFor nonresidential buildings and nonresidential portions of mixed-use buildings, the lowest floor shall be allowed below the minimum elevation if the structure meets the dry floodproofing requirements of Section 6.2.

Figure 9. Minimum Elevation of the Top of Lowest Floor – Flood Hazard Areas Other Than Coastal High Hazard Areas, Coastal A Zones and High-Risk Flood Hazard Areas, (ASCE 24-14, Table 2-1).

Zones Classified as Coastal High Hazard or Coastal A

For new construction and substantial improvements in Coastal High Hazard and Coastal A zones, the minimum elevation is specified in figure 10 (Table 4-1 from ASCE 24-14). Whereas for areas not classified as Coastal High Hazard or Coastal A, the elevation limit was at the top of floor elevation, for areas classified as Coastal High Hazard or Coastal A, the minimum elevation specified is to the bottom of the lowest horizontal structural member. Foundation elements (piles, pile caps, spread footings, grade beams, mat foundations) provided that they are designed to handle the loads imposed by flooding in accordance with section 4.5 Foundation Requirements of ASCE 24-14 are not required to meet the minimum elevation.

Table 4-1 Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor—Coastal High Hazard Areas and Coastal A Zones

Flood Design Class ^a	Minimum Elevation, Relative to Base Flood Elevation (BFE) or Design Flood Elevation (DFE)
1	DFE
2	BFE + 1 ft or DFE, whichever is higher
3	BFE + 2 ft or DFE, whichever is higher
4	BFE + 2 ft or DFE, or 500-year flood elevation, whichever is higher

^aSee Table 1-1 for Flood Design Class descriptions.

Figure 10. Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor – Coastal High Hazard Areas and Coastal A Zones (ASCE 24-14, Table 4-1).

Coastal High Hazard and Coastal A zones must also satisfy the following siting requirements

1. New construction, not including substantial improvements, shall be located landward of the reach of mean high tide;
2. New construction and substantial improvements shall be sited landward of shoreline construction setbacks, where applicable; and
3. New construction and substantial improvements shall not remove or otherwise alter sand dunes and mangrove stands, unless an engineering report documents that the alterations will not increase potential flood damage by reducing the wave and flow dissipation characteristics of the sand dunes or mangrove stands.

Per ASCE 24-14, buildings are assigned to a Flood Design Class 1-4.

ASCE Climate-Resilient Infrastructure: Adaptive Design and Risk Management³

Climate-Resilient Infrastructure is an ASCE Manuals and Reports on Engineering Practice No. 140. While not a Standard, a Manual of Practice consists of an orderly presentation of facts on a particular subject as it would apply to an engineer engaged in day to day work on the subject. Manuals of Practice often serve to inform future developments and updates to Standards.

Manual of Practice #140 includes background information as well as perspective on FIRM Mapping as it relates to engineering design. It also incorporates and reiterates important FEMA definitions, including SWEL - the still water elevation level. The Base Flood Elevation (BFE) is the still water elevation level plus the greater of 1) the maximum wave crest elevation or 2) the maximum vertical extent of wave runup. According to FEMA FIRM mapping, the base flood elevation is given by the extents of the Coastal A and Coastal High Hazard Zones which correspond to the 1% annual exceedance probability (100-year storm). It should be noted that the 0.2% annual exceedance probability (500-year flood which corresponds to the FIRM Zone X) does not include additional flooding resulting from wave crest elevations or wave runup. The recommended best practice is that engineering design decisions be made with the Base Flood Elevation as the basis.

The Design Flood Elevation, DFE, is defined as the Base Flood Elevation in addition to some freeboard. The freeboard can be considered a factor of safety to account for modelling and mapping uncertainties or the many uncertainties that could affect flood heights. *Freeboard is not intended to account for future SLR.* As previously discussed, according to ASCE 24, the recommended freeboard varies according to the risk category of the asset and the flood hazard zone within which the asset is sited. The values of freeboard in ASCE-24 vary from one to three feet.

Climate-Resilient Infrastructure references Presidential Executive Order 13690 which was signed in 2015 and established a federal flood risk management standard (FFRMS). The executive order has since been rescinded, but it established a useful framework for flood protection initially intended for federal buildings and infrastructure. It provides recommendations similar to ASCE 24, however it incorporates recommendations for accommodating SLR. The executive order proposed three methodologies for selecting an elevation for flood protection.

1. Climate Informed Science Approach (CISA) – Use the best available hydrologic and hydraulic data that integrate climate science and other factors to determine the flood elevation and corresponding floodplain.
2. Freeboard Value Approach – use the BFE (or 1% Annual Exceedance Probability (AEP)) and add an additional freeboard height.
3. 0.2 Percent Change Flood Approach (0.2PFA). Use the 0.2 AEP flood elevation (500-year flood elevation)

The climate informed science approach is the preferred approach. Of note, the 2019 National Defense Authorization Act (NDAA) essentially adopted this standard for defense-related infrastructure construction.¹⁷

Climate Informed Flood Design Elevation

Since most areas have FEMA FIRM maps, unless it is a large scale project that warrants more detailed analysis or FIRM data is not available, it is recommended that the FEMA base flood elevation (which is generally based on a 1% AEP) be used as the basis for design elevation.

ASCE Manual of Practice No. 140 recommends that current freeboard standards used in ASCE 24 be adopted when considering climate informed flood design.

For assets intended to have a long service life, considerations of future SLR should be included in the determination of the elevations, so it is recommended that the projected SLR be added to the BFE to obtain a Future BFE (FBFE). Freeboard should then be added to this FBFE to serve as a factor of safety. It should be noted that with increases in sea-level, the effects of surge, wave heights or wave runup will change, potentially extending the hazard area beyond the zone quantified by the BFE + SLR.

ASCE Manual of Practice No. 140 further recommends that long-term structures include an accommodation for SLR based on a benefit-cost or feasibility assessment that weighs costs against various SLR projections (e.g. low, middle, high). When project elements can be designed without significant implications to a higher level (up to a plausible upper-bound SLR projection) they should be, otherwise they should be designed so that additional protection can be added at a later date if SLR levels in the future make that appropriate.

Because the uncertainty of future SLR predictions increases exponentially with time, making design decisions at projected times too far into the future (100 years) may prove overly conservative, or inefficient. It is recommended that engineering design decisions be made at a *mid-term outlook on the order of 50 years*. When making such mid-term projections, provisions should be included in the initial design to accommodate adjustments to the design flood elevation as necessary. Flood elevations should be evaluated periodically, and updated as necessary.

Climate Informed Design for Riverine Flooding

To plan for flooding in Riverine zones, the amount of rainfall is estimated using Intensity-Density-Frequency (IDF) curves that relate the intensity of the rainfall to the duration of the rainfall. IDF curves are derived from historical rainfall data and published for different levels of storm frequency (10-year recurrence interval, 100-year recurrence interval, etc.) A shorter duration storm will have a higher intensity of rainfall (measured in inches per hour) than a longer duration storm. The total volume of water generated by a rainfall event is the product of the intensity and the duration. During a rainfall event, a portion of the water infiltrates and the remainder must be managed as surface runoff. The amount of surface runoff is determined by estimating the area of permeable surfaces versus impermeable surfaces. Naturally, areas that are developed are converted from largely permeable surfaces to impermeable surfaces, which increases the amount of runoff. The interaction between runoff and infiltration, while simplified in this discussion, is quite complex making understanding the

¹⁷ Committee on Armed Services House of Representatives. (2019). National Defense Authorization Act for Fiscal Year 2019. Retrieved from <https://www.congress.gov/115/crpt/hrpt676/CRPT-115hrpt676.pdf>

potential impacts of changes in precipitation on flood probability difficult to quantify. As the area of a watershed increases, the variability increases exponentially.

Engineering design is based on designing for the most extreme event that the structure will encounter in its lifetime with additional consideration for the consequence of failure. Therefore, a critical flood works project may be designed for an event with a recurrence interval of 100 years, whereas a typical building would be designed for an event with a recurrence interval of 50 to 100 years. To climate scientists, an extreme event is typically defined on a much shorter return interval on the order of 10 years, and many trends are observed and projected based on the changing climate. It is likely that some areas of the globe will see an increase in the frequency of heavy rainfall events or an increase in the total precipitation from a heavy rainfall event. Furthermore, while the number of tropical cyclones is projected to remain nearly constant, the intensity of these storms is likely to increase, bringing higher wind speeds and higher total precipitation amounts. It stands to reason that the projected increases in precipitation volumes will contribute to rain generated flooding. While logical reasoning leads to this conclusion, there is limited statistical data at this point to support this conclusion. More high fidelity data collection is required over longer periods of time to be able to make meaningful engineering predictions on increased riverine flooding risks.

There are several resilience strategies proposed for adapting to climate change. In general, initial design is performed based on the most probable event during the project life. Future deviations are anticipated, and a course of action or design modifications are developed at the onset. Performance is monitored over time and modifications implemented as changes are observed. This type of resilience strategy is appropriate for changes that occur slowly over time, such as sea-level rise. Rainfall-induced flooding events are less suited for this strategy as a result of the uncertainty of predicting the impacts of future rainfall events. As additional data is collected and methods for improving the projection of the impacts of future events improve, this methodology may be implemented. Furthermore, as great a threat as climate induced changes in precipitation is changes in urban development represent additional risk. As more land is developed, permeable surfaces are converted into impermeable surfaces and rain induced flooding risks are likely to change. As with climate change, development changes are a time-dependent phenomenon. Philosophies for design considering the effects of changes in development should be applied to and used in conjunction with changes in climate.

Given the uncertainty of the future impacts of climate change on rainfall induced flooding, it is recommended that a freeboard of three feet be used for all riverine area design classes. The standard is provided below:

Riverine Area Building Elevation Requirements:

Minimum Elevation of the Top of the Lowest Floor = BFE + Freeboard

Where:

BFE = FEMA 100-year BFE

Freeboard = 3 feet for all projects.

It is recommended that this topic be revisited every four years as it is anticipated that as additional data is collected, better methodologies will be developed for predicting the impacts of the anticipated changes in precipitation on engineering works.

Freeboard Standards on Atlantic and Gulf of Mexico Coastlines

In determining recommendations for freeboard for the Commonwealth of Virginia other coastal state requirements have been researched. Connecticut, Florida, New Jersey, and Louisiana have adopted ASCE 24 as the flood design standard, which include freeboard standards based on building flood class. These standards were adopted prior to the ASCE Manual of Practice # 140, *Climate-Resilient Infrastructure: Adaptive Design and Risk Management* publication in 2018. New York State has adopted a Climate informed Science Approach (CISA), requiring structure design to consider hydraulic data that integrates climate science and other factors to determine the flood elevation plus 2-3 feet of freeboard depending on type of facility outside of tidal areas, and for tidal areas, they are requiring base flood elevation plus the applicable high sea-level rise projection applicable for the full, expected service life of the facility, plus two to three feet of freeboard, depending on facility type. Delaware, Maryland, Georgia, Maine and Rhode Island set freeboard standards that vary, based on location and type of facility from one foot to three feet.

Freeboard Standards Adopted by Communities in Virginia

Communities in Virginia, especially many of those located in the coastal plain have already begun requiring freeboard standards generally in the Special Flood Hazard Area (SFHA), but sometimes in additional areas to be adopted for new construction or renovation meeting a certain threshold. Further, in 2015, the HPRDC adopted a Resolution 2015-01 a “*Resolution of the Hampton Roads Planning District Commission Encouraging Local Governments in Hampton Roads to Consider Adopting New or Higher Freeboard Requirements to Reduce the Impacts of Recurrent Flooding and Sea Level Rise on Public and Private Property.*” The Resolution does not recommend adoption of a particular freeboard nor does it recommend a particular methodology.

As a component of its Sea Level Rise Adaptation Guide, the non-profit organization Wetlands Watch maintains case studies, sample ordinances, and resources for use by communities.¹⁸ As a part of the FEMA NFIP, participating localities may receive Community Ratings System (CRS) points for adoption of freeboard. Locality freeboard requirements in the SFHA range from BFE to 3 feet. Freeboard requirements outside of the SFHA are less common, however Norfolk and Hampton require freeboard of 18 inches above grade in the Shaded X-Zone. Localities may also require V-Zone standards to apply in the Coastal A-Zone or in the case of York County an additional foot of freeboard in Coastal A-Zones and V-Zones resulting in a total of 4.0 feet of freeboard.

Executive Order Twenty-Four, Section 3, though not the primary focus of this report, directs increased coordination and empowerment of localities and individuals to reduce risk. Adoption and adherence to strong freeboard standards for state-owned structures does just that, and will incentivize localities to adopt and enforce similar standards.

¹⁸ Stiff, Mary Carson and Ross Weaver, “Sea Level Rise Adaptation Guide: Freeboard Requirement”, Wetlands Watch, Available: <http://wetlandswatch.org/freeboard-requirement/>.

Recommendations

Executive Order Number Twenty-Four (2018), Section 1: Making Commonwealth Holdings More Resilient, Item D. Freeboard Standard for State-Owned Buildings requires that a minimum freeboard standard be set for state-owned buildings. While establishing a freeboard standard for the Commonwealth is important because it can be adopted by the local municipalities for a consistent freeboard standard throughout the state, providing siting and design guidelines offers a broader strategy to minimize risk to state-owned buildings under design. Siting and design standards can also provide guidance for coastal communities as they plan to increase their resilience.

New State-Owned Building Siting Guidelines:

The following are recommended siting guidelines that would apply to all state-owned projects beginning initial design on or after January 1, 2020:

1. New state-owned buildings of the Commonwealth of Virginia may not be sited within areas likely to be inundated by SLR or within areas that SLR will cause significant loss of access or services within the design service life of the building based on the Commonwealth's unified SLR projections for state owned buildings.
2. New state-owned buildings of the Commonwealth of Virginia shall not be located within the Special Flood Hazard Area or Zone X (shaded) designated under the National Flood Insurance Program (100-year and 500-year floodplains) and shall be protected from damage and significant loss of access as a result of projected SLR based on the Commonwealth's unified SLR projections for state owned buildings.
3. It is recommended that these guidelines be updated on a regular basis or at a minimum every four years to take into consideration continued refinement of climate change impacts and any building code recommendations.

Exceptions to these guidelines may be warranted under extenuating circumstances as determined by the Commonwealth of Virginia Chief Resilience officer.

Making the Case for Restricting Siting of New State-Owned Buildings in the 100-and 500-year Floodplain:

While it has been Commonwealth policy to avoid construction within the 100 year floodplain since the issuance of EM 2-97 by former Governor George Allen, it is important to reiterate present best practices with regards to siting within the 100 year floodplain as the pre-existing policy allows for variances to be granted by the Chief Building Official for state-owned buildings if certain conditions are met.

GIS analysis has shown that 38% of the 100-year floodplain in the Hampton Roads Region will be inundated with 3.0 feet SLR. While only 5% of the total area of the 500-year floodplain will be permanently inundated by 3 feet of SLR, the impacts are not uniform. While most cities show little or no inundation both the cities of Virginia Beach (18.7%) and Chesapeake (13.6%) experience non-trivial areas of inundation. This could occur as early as 2044 (NOAA extreme scenario) or, based on SLR planning timelines developed by the Hampton Roads Planning District Commission and based on NOAA Intermediate/Intermediate-High scenarios, within 50-80 years (mid-term). It is clear from SLR projections, and projections of inundations of floodplains that the horizontal boundaries of 100-and 500-year floodplains will change as SLR conditions change, shifting landward.

Sustainable building design practices and green building rating systems restrict new site development in the 100-year floodplain, with the purpose of minimizing the environmental or ecological system impact. The Living Building Challenge rating systems specifically restricts development in the 100-year floodplain. This restriction will reduce risk to new state-owned buildings, by removing them from future inundation pathways.

The Federal government, via the United States General Services Administration (GSA), has restricted siting of buildings in the 100-year floodplain since 2010 by Executive order and GSA policy. Additionally, it restricts the siting of “critical action” buildings within the 500-year floodplain.

The Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project, Phase 2 Report: Recommendations, Accomplishments and Lessons Learned, recommended developing building code strategies to mitigate against flooding, severe wind and SLR, including 500-year floodplain management strategies¹⁹.

Currently the 500-year floodplain (0.2% annual exceedance probability) *does not include additional flooding resulting from wave crest run-up or wave run-up*. As SLR increases, and floodplains migrate landward, wave impacts will become a factor in areas that are now the 500-year floodplain, and that will become the 100-year floodplain.

New State-Owned Building Freeboard Standard Guidelines:

The following are recommended design guidelines that apply to all state-owned projects beginning initial design on or after January 1, 2020:

1. The minimum elevation of the top of the lowest floor (see Figure 11) for new state-owned buildings in the coastal area shall be the Future Base Flood Elevation (FBFE) (defined below) plus three feet of freeboard. In this report the Coastal Areas are defined as the Coastal Special Flood Hazard Area and the Combined Coastal/Riverine²⁰ Special Flood Hazard Area and their adjacent Zone X (shaded) (100- and 500-year floodplains).

¹⁹ Steinhilber, E., Boswell, M., Considine, C., and Mast, L. (2016). Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project, Phase 2 Report: Recommendations, Accomplishments and Lessons Learned. Retrieved from:

https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1003&context=hripp_reports

²⁰ FEMA. (2015). Guidance for Flood Risk Analysis and Mapping, Combined Coastal and Riverine Floodplain. Retrieved from https://www.fema.gov/media-library-data/1436989628107-db27783b8a61ebb105ee32064ef16d39/Coastal_Riverine_Guidance_May_2015.pdf

Coastal Area Building Elevation Requirements:

Minimum Elevation of the Top of the Lowest Floor = FBFE + Freeboard

Where:

FBFE = FEMA 100-year BFE + anticipated SLR at 50-year service life

Anticipated SLR is based on the NOAA 2017 Intermediate-High Scenario

Freeboard = 3 feet for all projects.

For Coastal High Hazard and Coastal Zone A above requirements apply to the Bottom of the Lowest Supporting Horizontal Structural Member of Lowest Floor.

The use of a freeboard of 3 feet is intended to supersede the provisions of ASCE 24-14 which prescribe a variable freeboard according to the Flood Design Class of the building. The Future Base Flood Elevation (FBFE) is defined in the ASCE Manual of Practice No. 140, *Climate-Resilient Infrastructure: Adaptive Design and Risk Management*, as the Base Flood Elevation (BFE) plus an accommodation for sea level rise. The BFE shall correspond to the elevation of the nearest 100-year floodplain (1% annual exceedance probability) and the anticipated SLR shall be based on the NOAA 2017 Intermediate-High Scenario at year 50 of anticipated service life. Flood elevations shall be determined from the highest elevation from either the most recent FEMA Flood Insurance Rate Map (FIRM) or the most recent FEMA Flood Insurance Study (FIS) for the jurisdiction. For new state-owned buildings located outside of, but adjacent to the 500-year floodplain, best engineering practice would dictate analysis and consideration of the need to elevate the first floor to account for future sea level rise as well as freeboard to minimize future risk. At a minimum, adaptive design measures should be implemented so that future protection of the structure is possible. **The Commonwealth of Virginia will lead as the first state to incorporate sea level rise into first floor elevation.**

2. The minimum elevation of the top of the lowest floor (see Figure 12) for new state-owned buildings in the riverine area shall be:

Riverine Area Building Elevation Requirements:

Minimum Elevation of the Top of the Lowest Floor = BFE + Freeboard

Where:

BFE = FEMA 100-year BFE

Freeboard = 3 feet for all projects.

3. It is recommended that these guidelines be updated on a regular basis or minimum of every four years to take into consideration continued refinement of climate change impacts and any building code revisions.

Exceptions to these guidelines may be warranted under extenuating circumstances as determined by the Commonwealth of Virginia Chief Resilience officer.

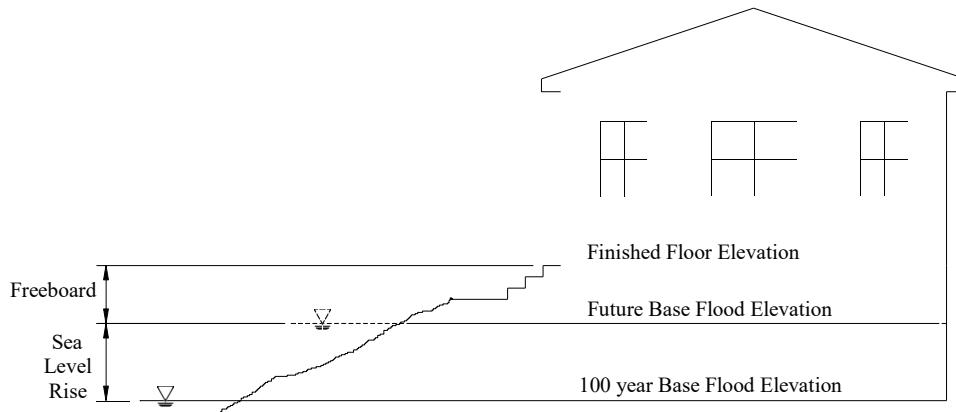


Figure 11. Coastal Area Finished Floor Elevation relative to the Base Flood Elevation. (Note: For Coastal High Hazard and Coastal Zone A above requirements apply to the Bottom of the Lowest Supporting Horizontal Structural Member of Lowest Floor.)

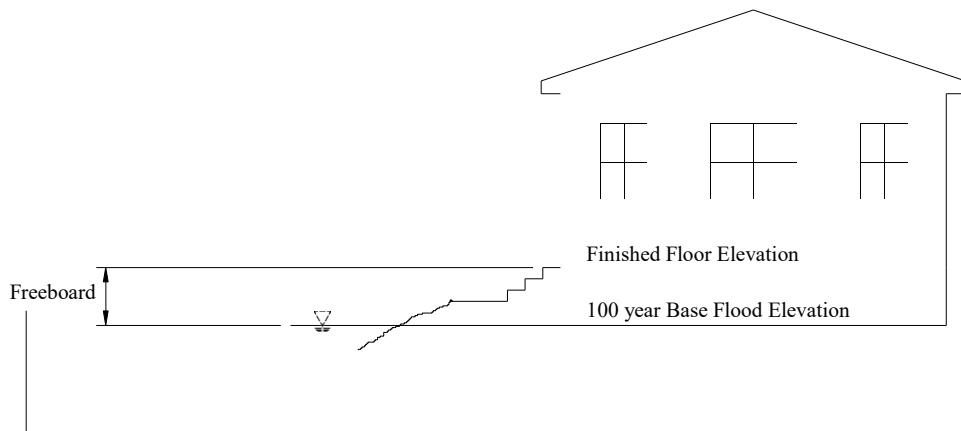


Figure 12. Riverine Area Finished Floor Elevation relative to the Base Flood Elevation.

Recommendations for Additional Data Needs and Evaluation

The following data and analysis needs have been identified as a result of these recommendations:

1. Additional GIS analysis should be performed to quantify the regional impacts of SLR in smaller geographic areas considering *parcel level* data. Areas of potential critical impact should be identified for high-resolution, focused analyses of the physical and economic impacts of SLR.
2. Percentage of land inundated by +3 feet of SLR are not uniform and vary significantly by municipality, for the 100-year floodplain, ranging from 10% To 89.3%. These differences are the result of wide variance of topography and SFHA zones between municipalities and should be the subject of further examination
3. Accurate mapping of 100- and 500-year floodplains is still needed in some localities within the Commonwealth. Where 100- and 500-year floodplain data is out of date, inaccurate, or not available additional hydrologic and hydraulic modeling will be required to determine extent of floodplains prior to siting state-owned building.
4. The Commonwealth should designate Coastal and Riverine Areas explicitly based on tidal influences. Currently the boundary between coastal, combined coastal and riverine and riverine only boundaries are not labeled on the FIRM.
5. Analysis of how floodplains will migrate landward as sea level rises and the extent of additional flooding resulting from wave crest run-up or wave run-up is needed. From this data, freeboard recommendations outside the 500-year floodplain should be developed for future coastal flood zones.

Conclusion

While there is some uncertainty of the timing of the impacts of SLR, it is clear that SLR poses a threat to coastal communities in Virginia and that the rising seas will change the boundaries of the 100- and 500-year floodplains in coastal regions, moving them inland. It is prudent for the Commonwealth of Virginia to consider the risks of SLR and the threats of extreme weather and natural hazards in establishing siting and freeboard standards for state-owned buildings, which will ultimately reduce the impact of these conditions to public health and safety, the environment, and the economy of the Commonwealth.

Appendix 1

The table below summarizes the areas (**mi²**) and percent inundated of the 100 year and 500-year flood zones by +3 feet SLR for each municipality in Hampton Roads.

Municipality	100-yr FP area	500-yr FP area	100-yr area flooded by 3' SLR	100-yr % flooded by 3' SLR	500-yr area flooded by 3' SLR	500-yr % flooded by 3' SLR
Chesapeake	35.577	8.797	30.14	84.7	1.2	13.6
Gloucester	36.883	10.623	20.22	54.8	0.0001	0.0
Hampton	19.349	5.365	7.057	36.5	0.049	0.9
Isle of Wight	32.803	3.416	10.26	31.3	0.002	0.1
James City	21.5	1.111	13.74	63.9	0.00014	0.0
Newport News	12.127	1.4098	6.659	54.9	0.0375	2.7
Norfolk	10.596	8.196	4.108	38.8	0.038	0.5
Poquoson	13.221	1.581	9.725	73.6	0.007	0.4
Portsmouth	6.088	4.414	1.848	30.4	0.011	0.2
Southampton	95.525	12.552	9.565	10.0	0.05	0.4
Suffolk	98.816	1.103	11.609	11.7	0.006	0.5
Surry	27.015	0.115	4.364	16.2	0.0001	0.1
Virginia Beach	68.844	10.997	51.002	74.1	2.051	18.7
York	14.19	2.681	6.814	48.0	0.015	0.6
Williamsburg	0.238	0.019	0.123	51.7	0	0.0
Franklin	0.028	0.002	0.025	89.3	0	0.0
Smithfield	1.77	0.017	1.519	85.8	0	0.0
Total	494.57	72.3988	188.778	38.2	3.46684	4.8

APPENDIX E

**RECOMMENDATIONS FOR SEA LEVEL RISE PROJECTIONS,
CCRFR VIMS (2019)**



RECOMMENDATIONS FOR SEA LEVEL RISE PROJECTIONS

A report for the Governor's Coastal Climate
Resiliency Plan

Prepared by: Center for Coastal Resources Management



Contact: Molly Mitchell (molly@vims.edu)

February 2019

Sea level rise projections for Virginia planning purposes

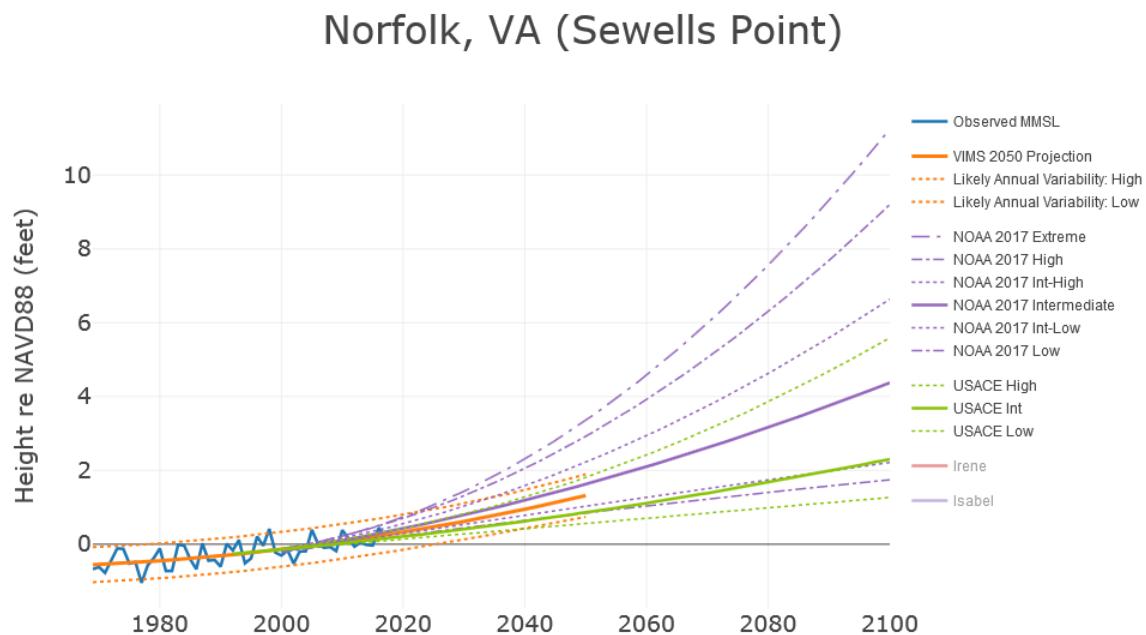
Among long-term tide gauge records, Virginia has the highest rate of change of any station on the East Coast. Sea level rise will significantly increase the flooding threat to low-lying roads, residences and critical infrastructure. Selecting an appropriate sea level projection for planning purposes is a critical step towards promoting resiliency. There are several important considerations in the selection of a sea level projection, which are: climate and oceans dynamics are in a period of active change which affects the inherent uncertainty in the projections, sea level changes can be affected by local conditions and future storm surges will occur on top of sea level rise, increasing the reach of storm surge flooding.

Recommended projection

For a single state-wide projection, we recommend the use of a tide-gauge based analysis for Sewell's Point, Norfolk until 2050 and the use of the NOAA (2017) climate model-based projections for times beyond 2050. Sewell's Point was chosen because it has the longest record of any Virginia tide gauge stations and is located in the Hampton Roads area. This area is among the most vulnerable to flooding due to their high population and low land elevations.

Sea level projections for Norfolk, VA have increased over time, as climate and ocean dynamics have shifted (Boon and Mitchell 2015). Therefore, the state projection should be re-considered annually, and updated if necessary to reflect the best available science. To enable annual re-consideration, AdaptVA.org provides a graph with both tide-gauge (to 2050) and climate model-based (to 2100) projections (http://adaptva.org/info/virginia_sea_level.html). The current graph (2017) is shown below:

Figure 1. Virginia Sea Level Rise Projections



The tide gauge projection (VIMS 2050 Projection) is derived from the Sea Level Rise Report Cards (Boon et al. 2017). This analysis is updated annually and provides a single target sea level for 2050. The climate model-based projections (NOAA 2017 Low-Extreme) provide several climate scenarios and potential target sea levels through 2100. These will be updated with the next NOAA publication. The USACE Low-High projections are also provided for projects which need to be compliant with USACE requirements.

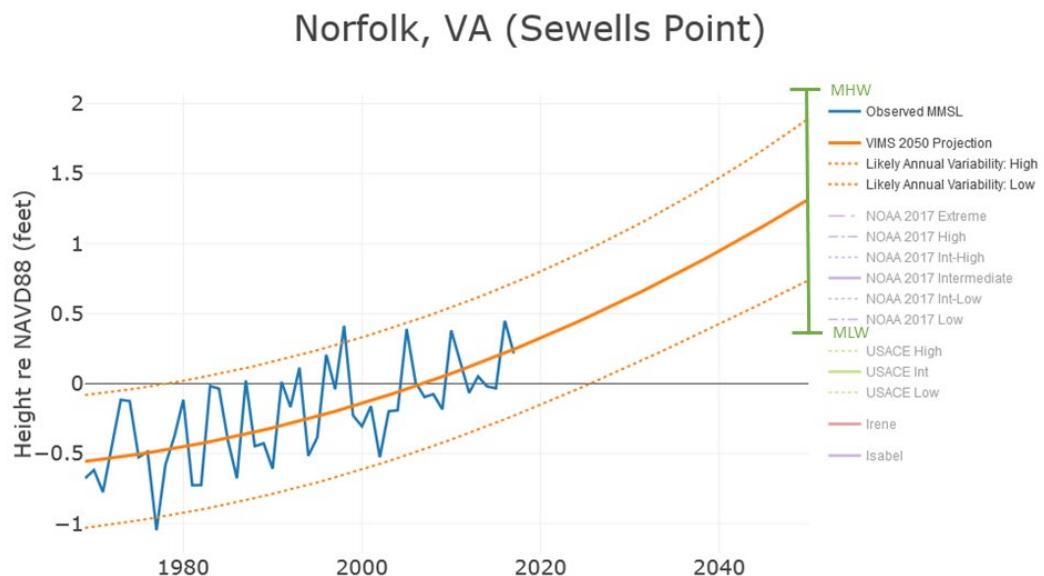
All projections are provided relative to NAVD88. This is a land-based elevation and therefore directly relatable to first-floor elevations and other land-based engineering criteria. For more information on NAVD88 or to see the projection relative to a tidal datum, please see Appendix A.

Using the sea level projections

There are three important considerations when using sea level projections for planning purposes. These have been illustrated on the graph below for Norfolk, VA.

- Since all of the projections are for mean sea level, the daily high tide will be above this level and must be accounted for in the planning process. An example is shown on the graph in green. The elevation of the high tide varies along Virginia shorelines and should be adjusted accordingly (see map of tidal heights below). At Sewell's Point, **mean sea level in 2050 is expected to be 1.32 ft NAVD88 and mean high water is expected to be 2.3 ft NAVD88.**
- Annual mean sea level (shown in blue on the graph) is dynamic through time, oscillating around the mean trend line (solid orange). The dotted orange lines show the outer bounds of this oscillation. For a given year, the mean sea level is expected to be between the orange dotted lines, not exactly on the solid orange line. This means that mean sea level in 2050 may be above the trend line. At Sewell's Point, **mean sea level in 2050 could be up to 1.89 ft NAVD88 and mean high water would be 2.9 ft NAVD88.**
- Storm surge can be significantly higher than the tide range and occurs on top of mean sea level. The effect will vary by location, storm characteristics and point in the tidal cycle. **An Isabel-like storm could produce surges above 5 ft NAVD88 by 2050.**

Figure 2. Tide range above 2050 projection



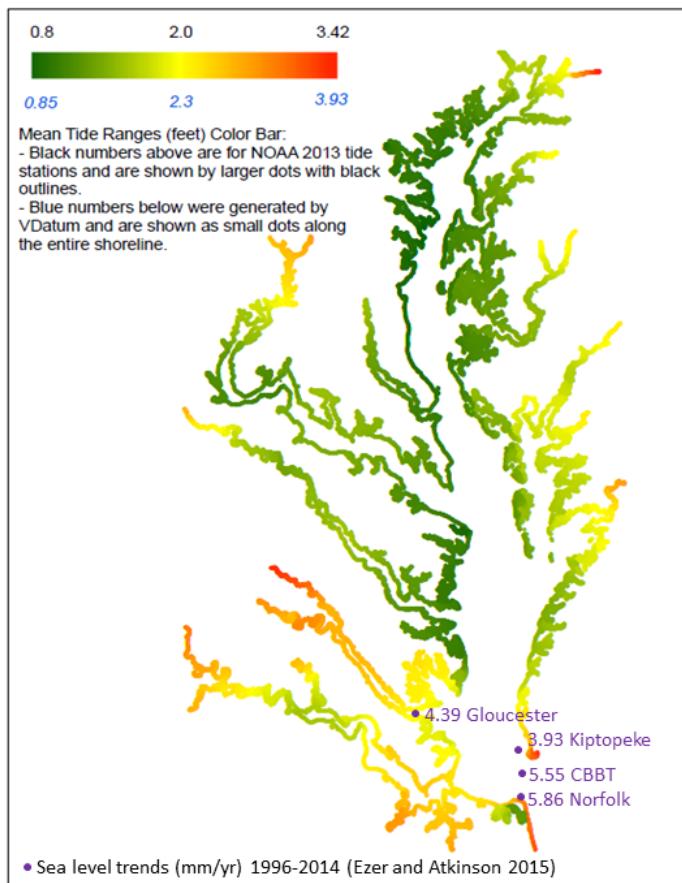
Variations around the Bay

Sea level rise rates (purple dots on the map) show small variations around the Virginia portion of the Bay (Ezer and Atkinson 2015).

Unfortunately, there are not many gauges with long enough records to confidently detect sea level trends. None of the tide gauges with the necessary length of record are located in the upper reaches of the tributaries. Therefore, it is impossible to justifiably project sea level rise spatially at this time. Until tide gauges in the upper parts of the tributaries have useable records, **we recommend using the Norfolk gauge as the state standard**. Since Norfolk has the highest known rate of rise in Virginia, this approach is conservative and will reduce the likelihood of underestimating future water levels; improving flood resiliency.

Tide range varies from about 0.5 ft to around 3.5 ft along Virginia shorelines. The highest ranges are in the lower part of the Bay and the upper parts of the tributaries. Tide range is lowest on the Bay-front Northern Neck and the Potomac River. Tide range should be considered as part of the planning on a local basis.

Figure 3. Tide range and sea level trends around the Bay



Other planning considerations

The incorporation of project lifespan and flood tolerance can assist with selecting a sea level projection.

- For projects with short lifespans (e.g., less than 30 years), the 2050 mean projection (orange curve) is ideal for projects with short life spans.
 - All infrastructure should be constructed at elevations above the projected mean sea level for 2050.
 - Infrastructure that can tolerate moderate flooding (e.g., some roads) can be constructed in elevations between the orange curve and the orange dotted lines.
 - Infrastructure that can tolerate only occasional flooding (due to storm events) should be built at elevations above the upper dotted line.
 - Infrastructure that cannot tolerate flooding should include a consideration of storm surges, by adding 3+ feet to the elevation of the dotted line. Additional flood proofing measures should be considered for this type of critical infrastructure.
- Projects with longer lifespans (30-100 years) should consider the NOAA climate scenarios for the target lifespan.
 - The Intermediate curve is potential target for infrastructure that can tolerate moderate flooding; flood intolerant infrastructure should incorporate higher curves.

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https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf

Sea level rise report cards. <https://www.vims.edu/research/products/slrc/>

Appendix A. Comparing NAVD88 and the current tidal datum

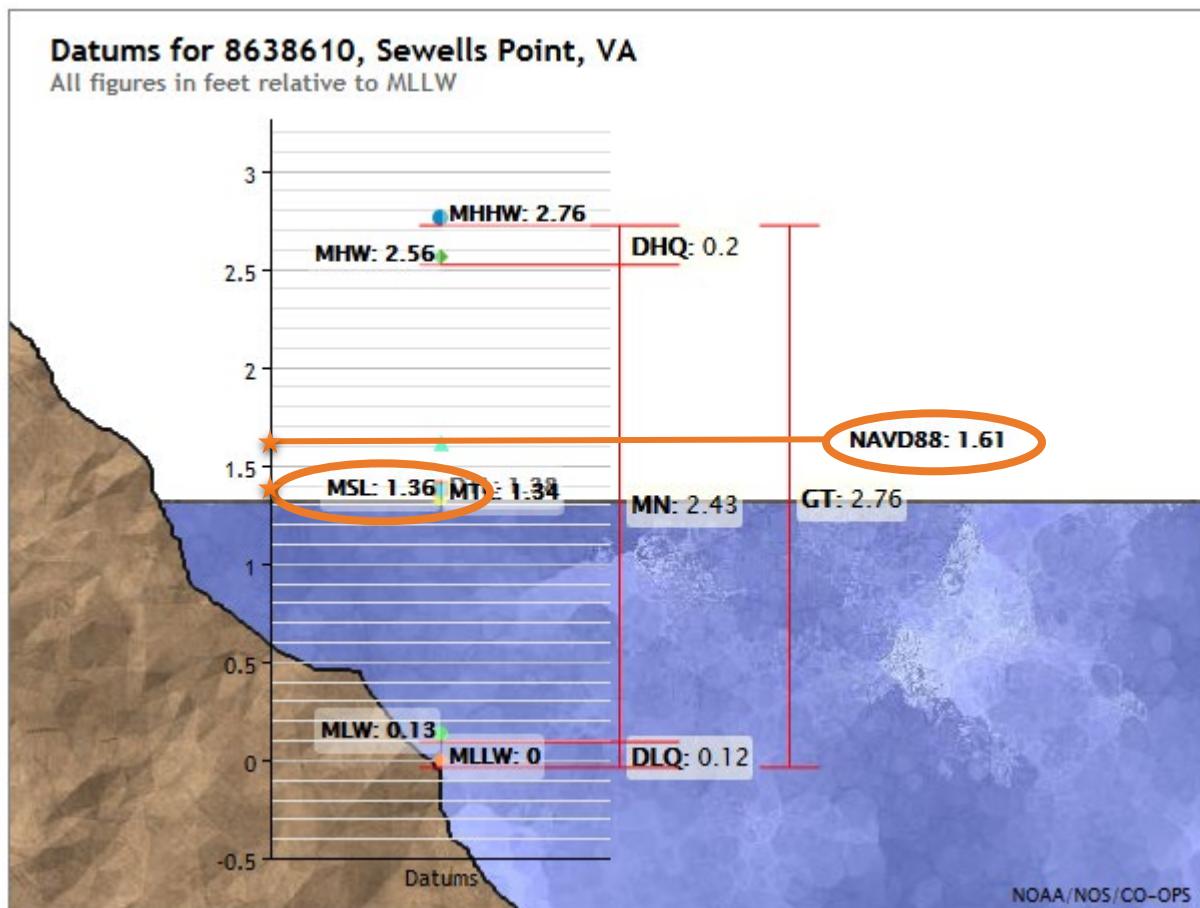
NAVD88 is a land-based datum and therefore is most relevant to the engineering of buildings, roads and shoreline protection structures. Mean sea level values relative to NAVD88 can be interpreted as the depth of the water over the land. This datum does not change with sea level rise.

The **tidal datum** is a water level datum and is relevant to channels, navigation and other water-based activities. In Virginia, the current tidal datum was calculated using the 19-year period from 1983-2001. This datum does change with sea level rise and is periodically recalculated. It is hard to relate to current conditions, since annual MSL has risen above the current tidal datum MSL. NOAA does provide a station datum, which is a surveyed benchmark that does not change. This can be used to relate MSL between tidal datums after they change.

The VIMS sea level rise projection for Sewell's Point in MSL of the current tidal datum can be found at: <https://www.vims.edu/research/products/slrc/localities/nova/index.php>

At the Sewell's Point gauge in Norfolk, MSL and NAVD88 are very similar, but not identical. 0 ft NAVD88 is 0.25 ft above 0 ft MSL. Therefore, values in NAVD88 can be converted to MSL by adding 0.25 ft.

Figure 4. Tidal datum chart for Sewell's Point. All data relative to MLLW in the current tidal datum. Source: <https://tidesandcurrents.noaa.gov/datums.html?id=8638610>



APPENDIX F

**FUTURE SEA LEVEL AND RECURRENT FLOODING RISK FOR
COASTAL VIRGINIA**

FUTURE SEA LEVEL AND RECURRENT FLOODING RISK FOR COASTAL VIRGINIA



COMMONWEALTH CENTER FOR
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FUTURE SEA LEVEL AND RECURRENT FLOODING RISK FOR COASTAL VIRGINIA

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Acknowledgements: This study was supported by funds from the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR) and Old Dominion University's Institute for Coastal Adaptation and Resilience (ICAR). Special thanks to Matt Pendleton and Doug Marcy of NOAA's Office for Coastal Management for their helpful collaboration and provision of tidal surface correction data.

ADDITIONAL PARTNERS



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EXECUTIVE SUMMARY

A report developed in response to a request from the Secretary of Natural Resources and Special Assistant to the Governor for Coastal Adaptation and Protection to assist with meeting the Executive Order No. 24 (2018), Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards directive set forth in Section 2 Part A requiring the development of a Coastal Resilience Master Plan.

The report presents analysis of the best available existing data on coastal land elevation, sea level rise projections, vertical land motion (subsidence), and building and transportation assets.

The report presents analysis of the best available existing data on coastal land elevation, sea level rise projections, vertical land motion (subsidence), and building and transportation assets. Sea level rise (SLR) projections are analyzed as Relative SLR (RSLR), combining the effects of vertical water rise (or "eustatic" change) with regional trends in vertical land motion, or subsidence. The study made use of available Commonwealth LiDAR elevation data, buildings, and roads as well as several sources of federal data, including sea level trends, tidal flooding and datums, and peer-reviewed and government reports. Maps of potential future inundation provided here represent a baseline assessment of impacts to land areas, including wetlands, parcels and development, roadways and buildings within the Commonwealth.

The total area at risk with RSLR in coastal Virginia is 424 square miles in 2040, 534 square miles in 2060, and 649 square miles in 2080. An additional 144 square miles will be vulnerable to minor tidal flooding by the year 2040, with similar areas of impact for 2060 and 2080. The total length of roadway potentially affected by RSLR and tidal flooding is 545 miles in 2040, 972 miles in 2060, and 1762 miles in 2080. The total number of buildings

potentially affected by RSLR and tidal flooding is 30,795 in 2040, 57,740 in 2060, and 111,545 in 2080. Hampton Roads, the Eastern Shore, and the Middle Peninsula are the most severely and critically impacted. Additional metrics describing the potential risk from RSLR, minor (tidal) flooding, and moderate flood events can be found in the body of this report.

Impacted parcels, buildings, and roads are tabulated and presented in a series of charts, tables, and maps delimited by Planning District Commissions across coastal Virginia. The maps and related digital data promote sub-regional comparison and provide these organizations and municipalities a spatial product for first-order risk assessment and planning. Maps and tables are provided digitally in this report are also available as digital geospatial data for local spatial planning. The report further outlines inherent limitations and future improvements in the available data and emerging methods and scientific understanding to reduce uncertainty.



BACKGROUND



This report provides information in furtherance of the objectives of Executive Order No. 24 (2018) Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards and at the request of the Special Assistant to the Governor for Coastal Adaptation and Protection.

Inundation modeling was conducted to determine the extent of permanent flooding due to relative sea level rise for the years 2040, 2060, and 2080

Inundation modeling was conducted to determine the extent of permanent flooding due to relative sea level rise for the years 2040, 2060, and 2080 in support of the Commonwealth's initial Coastal Resilience Master Plan. These benchmark timelines were selected to closely coincide with common planning time horizons, similar to the Hampton Roads Coastal Resilience Working Group's adopted Sea Level Rise Planning Policy¹. Following the recommendation of the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR)², the National Oceanic and Atmospheric Agency (NOAA) 2017 Intermediate-High curve was used to model flood surfaces. Values for these flood surfaces were obtained by examining the NOAA Intermediate-high curve at tide stations throughout coastal Virginia. The US Army Corps of Engineers Sea Level Rise Calculator (USACE)³ was used to derive the relative SLR heights of tidal flooding, combining a NOAA SLR projection (Intermediate-High) for

eustatic water level rise with local subsidence taken from regional measurements. The graph shown in **FIGURE 1** details sea level rise predictions for the Sewells Point tide gauge in Norfolk, Virginia.

For any given scenario, sea level rise estimates vary slightly throughout coastal Virginia and the Chesapeake Bay. Accordingly, inundation modeling was conducted independently for the following four geographically contiguous coastal study areas: (1) Southern Bay and Atlantic (Hampton Roads), (2) Middle Peninsula, (3) Northern Neck and Northern Virginia, and (4) the Eastern Shore.

The examined geographic regions include the member cities and counties that comprise the following 8 coastal planning districts: Northern Virginia Regional Council (NVRC), George Washington Regional Council (GWRC), Northern

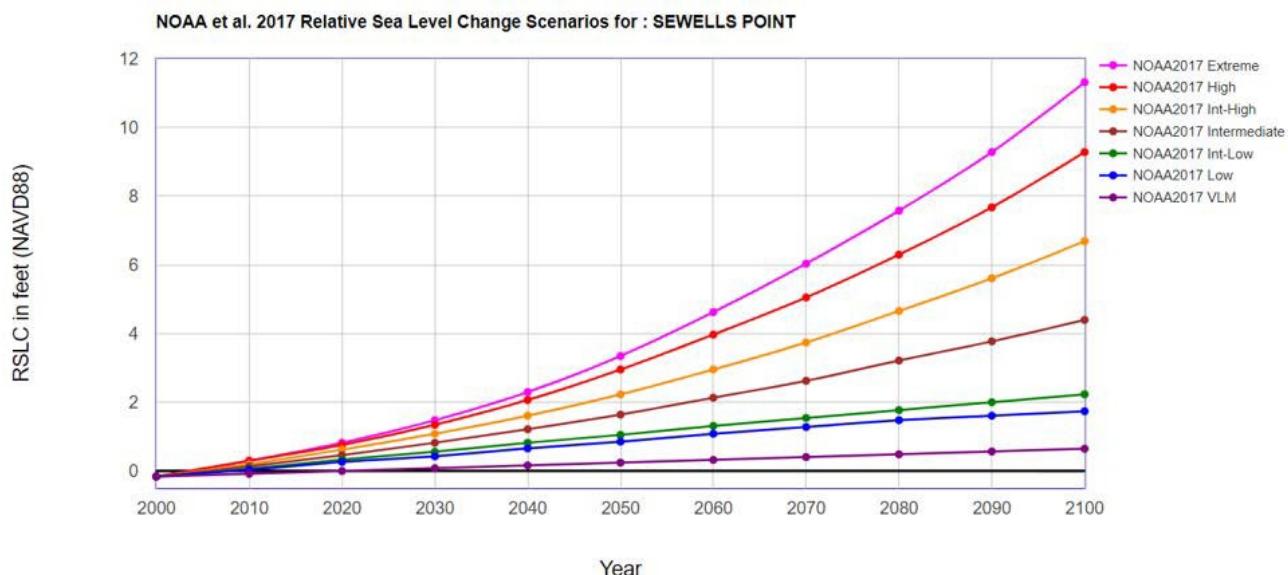
1. Hampton Roads Planning District Commission. Resolution Adopted October, 18, 2018. HRPDC Sea Level Rise Planning Policy and Approach. https://www.hrpdcva.gov/uploads/docs/05A_Attachment%20-%20HRPDC%20Sea%20Level%20Rise%20Planning%20Policy%20and%20Approach%20-%20Adopted%20101818.pdf

2. Considine, C., Seek, M., Erten-Unal, M., McLeod, G., and E. Steinhilber. October 23, 2019. Old Dominion University –Commonwealth Center for Recurrent Flooding Resiliency. Recommendations for Freeboard Standards for State-Owned Buildings in the Commonwealth of Virginia, Version 1.5. https://www.naturalresources.virginia.gov/media/governorvirginiagov/secretary-of-natural-resources/images/ODU-Freeboard-Recommendations-Ver-1.5-10_31_19-FINAL.pdf

3. US Army Corps of Engineers Sea-Level Change Curve Calculator (Version 2019.21). Last accessed January 21, 2020. http://corpsmap.usace.army.mil/rccinfo/slcc_calc.html

FIGURE 1

Relative Sea Level Rise Scenario Projections for Sewells Point, Norfolk, VA (NOAA 2017), including the projected Relative Sea Level Change (RSLC) for the selected NOAA 2017 Intermediate High scenario in this study. (Source: US Army Corps of Engineers Sea Level Rise Calculator, http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html)



Neck Planning District Commission (NNPDC), Middle Peninsula Planning District Commission (MPPDC), Richmond Regional Planning District Commission (PlanRVA), Crater Planning District Commission (CPDC), Hampton Roads Planning District Commission (HRPDC), and Accomack-Northampton Planning District Commission (A-NPDC).

Inundation modeling was conducted utilizing methods modified from those outlined in the “Mapping Coastal Inundation Primer” produced by NOAA’s Office for Coastal Management⁴. Future sea level surfaces for the years 2040, 2060, and 2080 were created using values derived from the NOAA (2017) Intermediate-high scenario. Each surface was adjusted to the mean higher high water (MHHW) datum to ensure that modeled inundation represents land area that would be

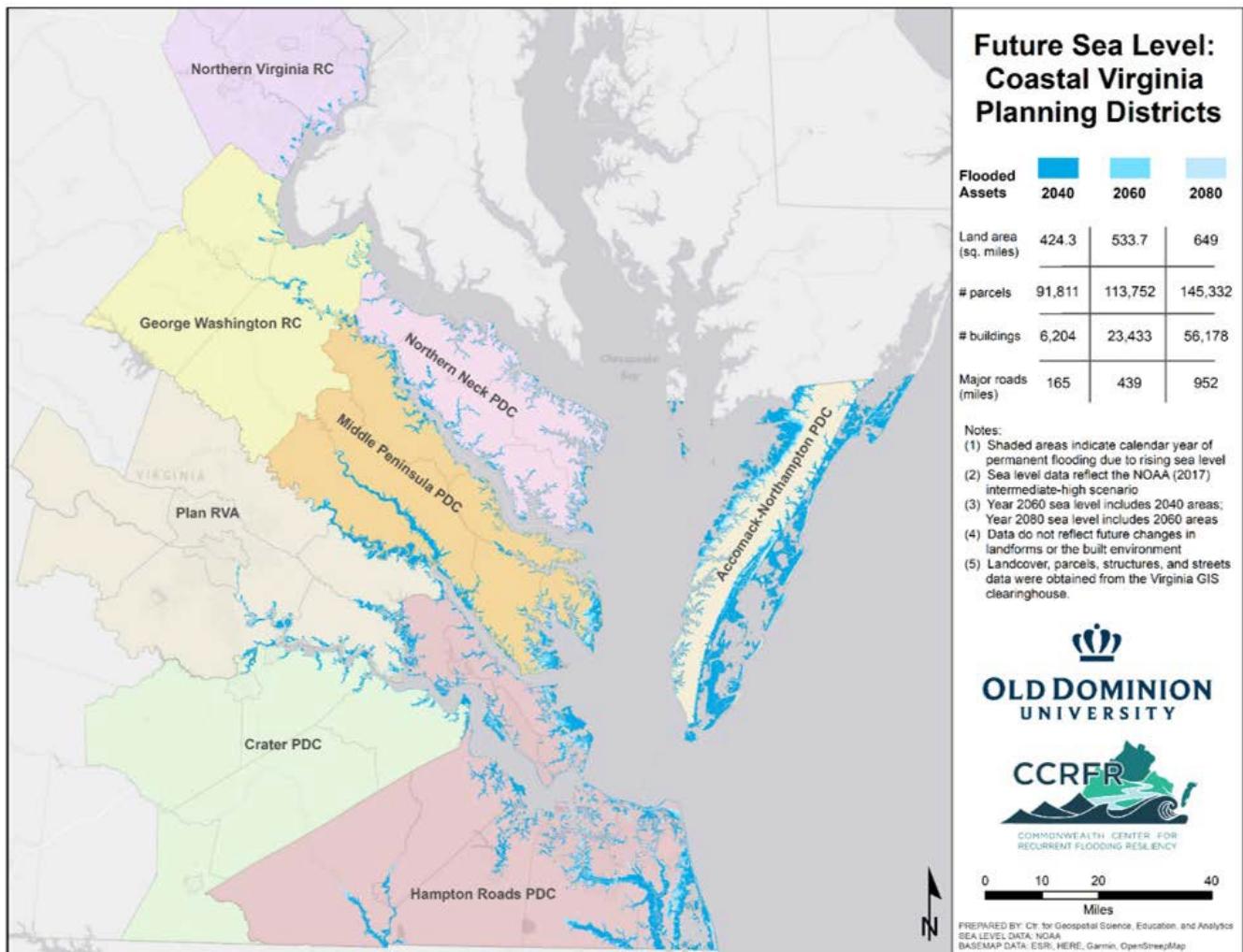
inundated during normal tidal cycles. Digital depth models (DDMs) that define the areal extent and depth of flooding predicted by the model were developed using the best available LiDAR elevation data. All calculations for the impacts of RSLR for each modeled year (2040, 2060, 2080) are naturally inclusive of all prior years and not additive. However, calculations of the additional impacts of minor and moderate flooding are in addition to the impacts of RSLR.

To enhance their utility in ongoing planning efforts throughout the Commonwealth, these data were aggregated to the planning district level. The Appendix contains an expanded version of **FIGURE 2** and eight additional map figures that provide an overview of sea level rise inundation for each of the coastal planning districts.

4. NOAA Office for Coastal Management (formerly Coastal Services Center). April 2012. Mapping Coastal Inundation Primer.

FIGURE 2

Future Sea Level: coastal Virginia planning districts. Shown larger in Appendix I. Gloucester was included in the Middle Peninsula PDC for this study.



RELATIVE SEA LEVEL RISE MODELING



Land Area Vulnerable to Sea Level Rise:

As RSLR impacts to wetlands include both loss and migration inland, these environmental resources are at great risk and require additional, careful study and monitoring.

Virginia statewide land cover data (2016) were analyzed in conjunction with modeled sea level to assess the amount of predicted inundated area for the following land cover classes: Open Water, Developed, Barren, Forested, Shrub/Scrub, Harvested/Disturbed, Turf Grass, Planted/Cultivated, Wetlands.⁵

Cumulative inundation for all land cover(open water excluded) for coastal Virginia was predicted to be 424 square miles in 2040, 534 square miles in 2060, and 649 square miles in 2080 (figures rounded to the nearest mile).

Calculation of dry land-only inundation (wetlands excluded) predicted a total combined flood extent for coastal Virginia of 40 square miles in 2040, 86 square miles in 2060, and 170 square miles in 2080. In comparison, the total areas of Alexandria, Norfolk, and Richmond are 15 square miles, 54 square miles, and 60 square miles, respectively.

For the purpose of examining and highlighting potential disparity of impact between coastal regions, the flooded area total for the entire coastal region was broken down to the planning district level. **FIGURES 3 and 4** provide graphical representation of permanent sea level inundation for each district.

It should be noted here that future analysis should also consider the geomorphological impacts of relative SLR on tidal and non-tidal wetlands. As RSLR impacts to wetlands include both loss and migration inland, these environmental resources are at great risk and require additional, careful study and monitoring.

Further analysis was conducted to approximate the impact of future sea level inundation on real property parcels, buildings, and major roads throughout coastal Virginia and within each planning district. Data for these features were obtained through the Virginia GIS Clearinghouse data portal hosted by the Virginia Geographic Information Network (VGIN) through the Virginia Information Technologies Agency (VITA).⁶

5. VITA, VA DEQ. May 6, 2016. Technical Plan of Operations -Virginia Statewide Land Cover Data Development. https://www.vita.virginia.gov/media/vitavirginiagov/integrated-services/pdf/LandCover_TechnicalPlanOfOperations_v7_20160506.pdf

6. VITA. Virginia GIS Clearinghouse. <https://vgin.maps.arcgis.com/home/index.html>. Last accessed 11/01/2019.

FIGURE 3

Present day land area (including wetlands) in each planning district that will be flooded by sea level rise

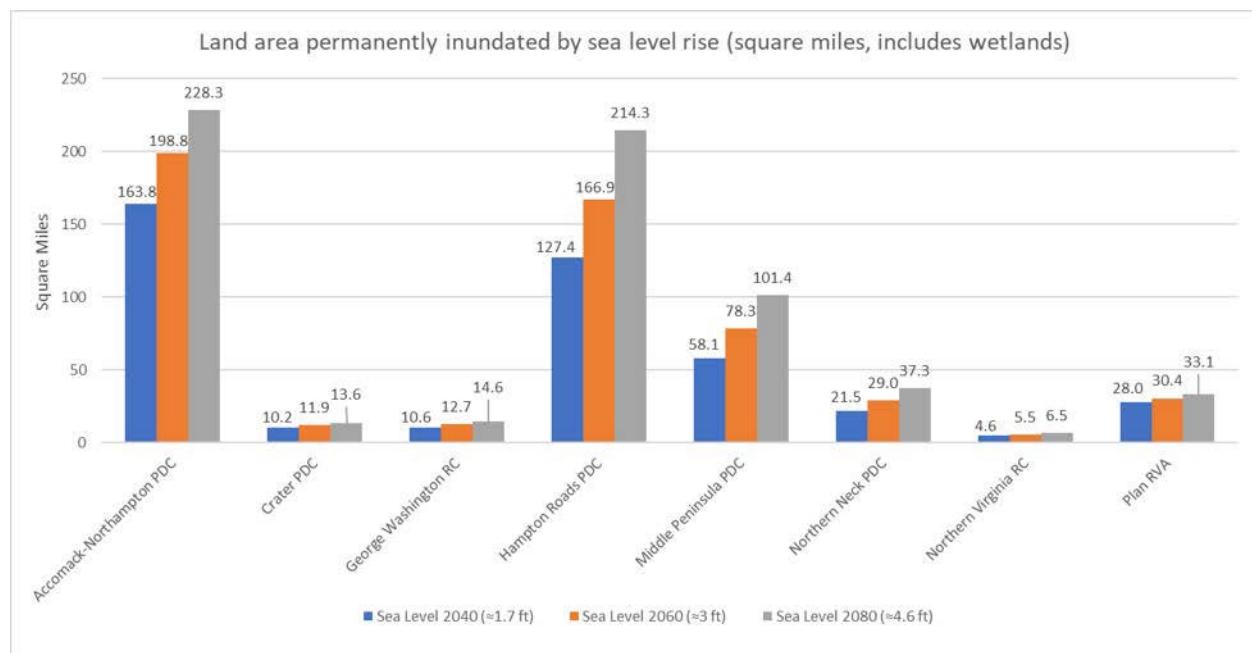
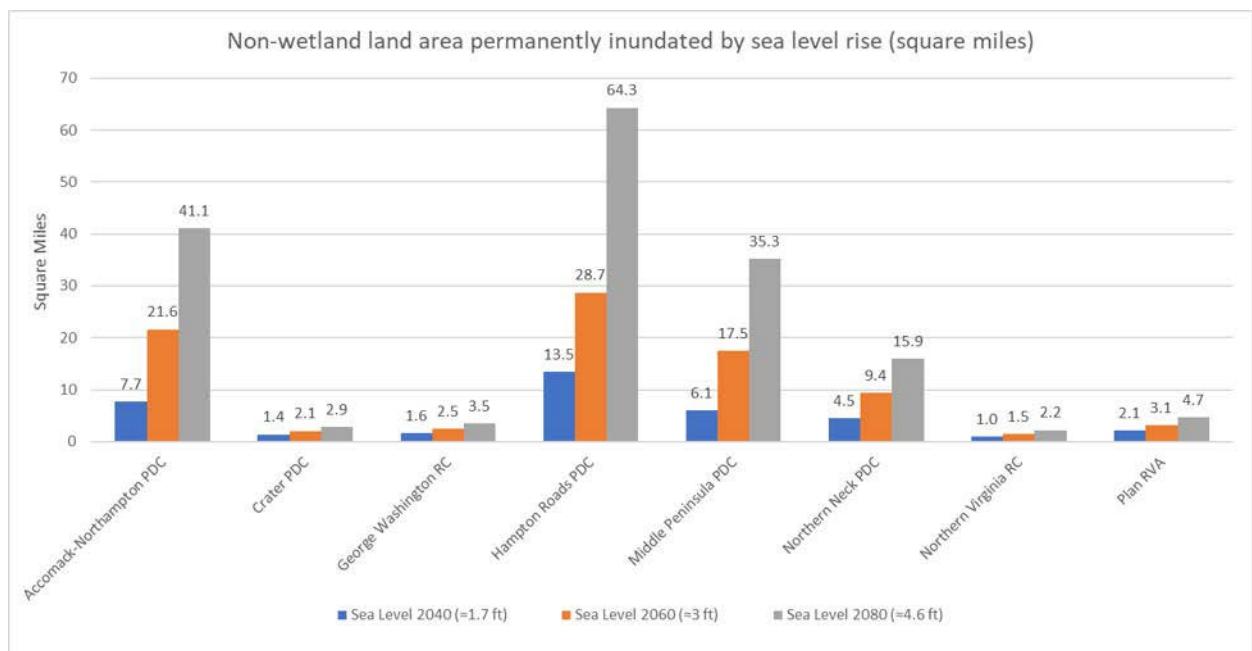


FIGURE 4

Present day land area (excluding wetlands) in each planning district that will be flooded by sea level rise



Real Property Parcels Impacted by Sea Level Rise:

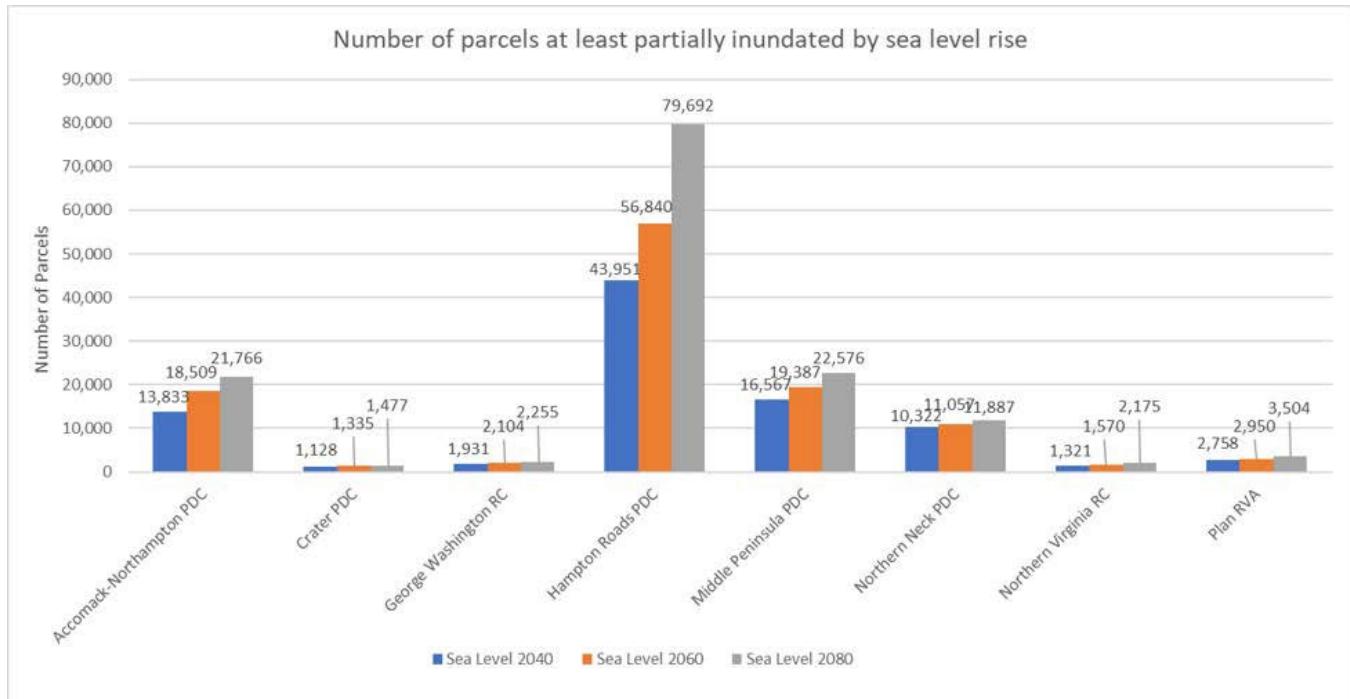
Real property comprises land ownership boundaries (parcels) and the buildings on them. For the purpose of this assessment, we subdivide the analysis into potential parcel impacts and buildings.

For parcels, the study considers a potential impact any inundation that either wholly or partially overlays with the predicted relative sea level rise extent. Such parcels are tallied as "impacted" by future sea level rise.

Hence, it provides a first approximation of exposure of a parcel, whereas more detailed vulnerability study would also incorporate susceptibility of a parcel flooding by functional use, assessed value, or damage, including acreage of land loss to permanent flooding. **FIGURE 5** enumerates the number of impacted parcels for each planning district at each modeled year. This overlay by intersection captures the extent that future high tide extends within the boundary of a parcel, thereby reducing or eliminating (in many cases) the land area available for use or development.

FIGURE 5

Existing Property Parcels in each planning district that will be impacted by sea level rise



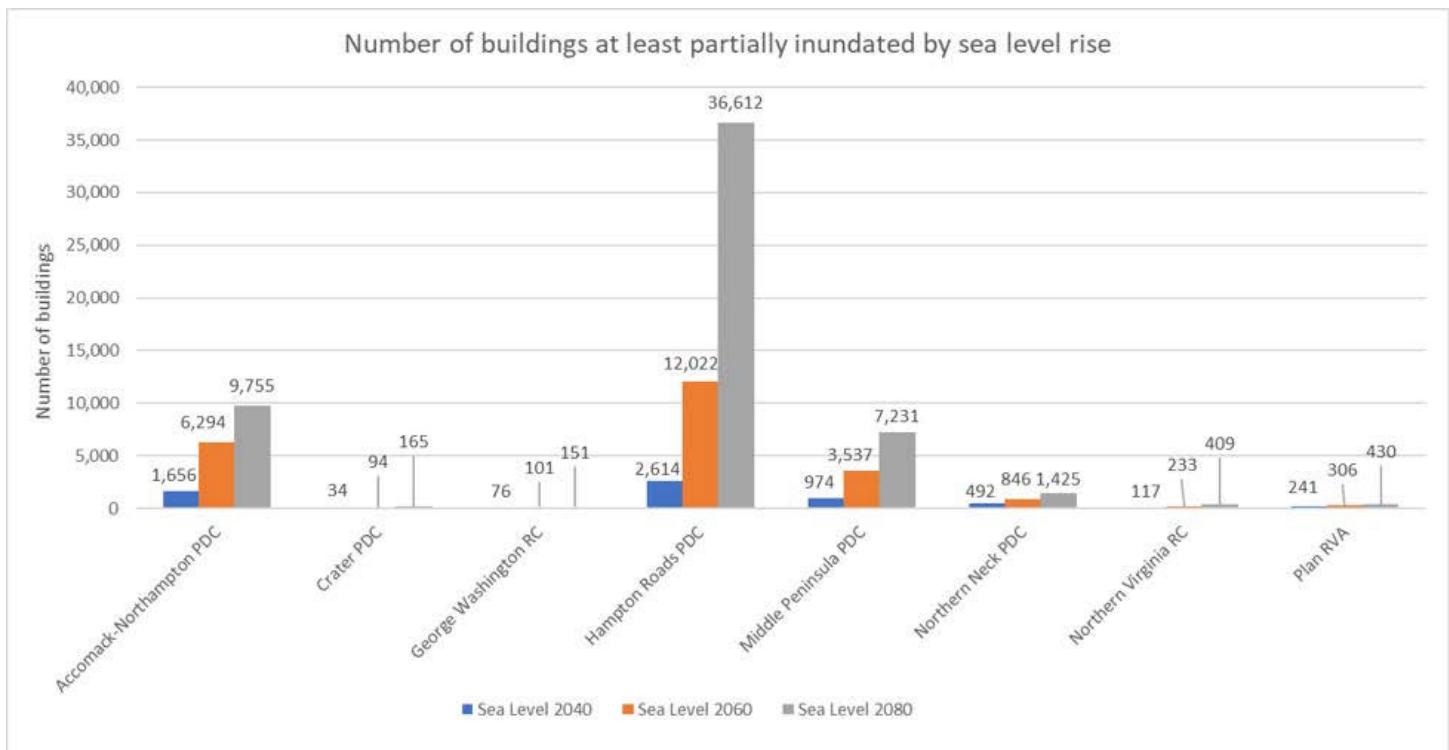
Buildings Impacted by Sea Level Rise:

Impacts to existing buildings and other building-like structures were also modeled. The data supplied by VGIN for this analysis are described as follows, “Building footprints are polygon outlines of built structures digitized by Virginia Base Mapping Program’s digital ortho-photogrammetry imagery, or digitizing of local government subdivision plats.”⁷ Those buildings that have a footprint either entirely within or intersecting the predicted future sea level boundary were considered to be impacted by sea level rise.

It is probable that buildings at or below the future high tide line will be rendered entirely unusable, necessitating relocation or demolition. **FIGURE 6** details the number of impacted buildings for each planning district at each modeled year.

It is unlikely that the building footprint data set captures 100% of buildings in the study area. However, the data are sufficiently complete to provide an indication of relative risk to buildings in the coastal planning districts.

FIGURE 6
Existing buildings in each planning district that potential impacted by sea level rise



7. VITA. Virginia GIS Clearinghouse. 2019 Q3Download: Building Footprint polygons (published quarterly). <https://vgin.maps.arcgis.com/home/item.html?id=994d0afa44c046498f9774613671ce9a>. Last accessed 11/01/2019.

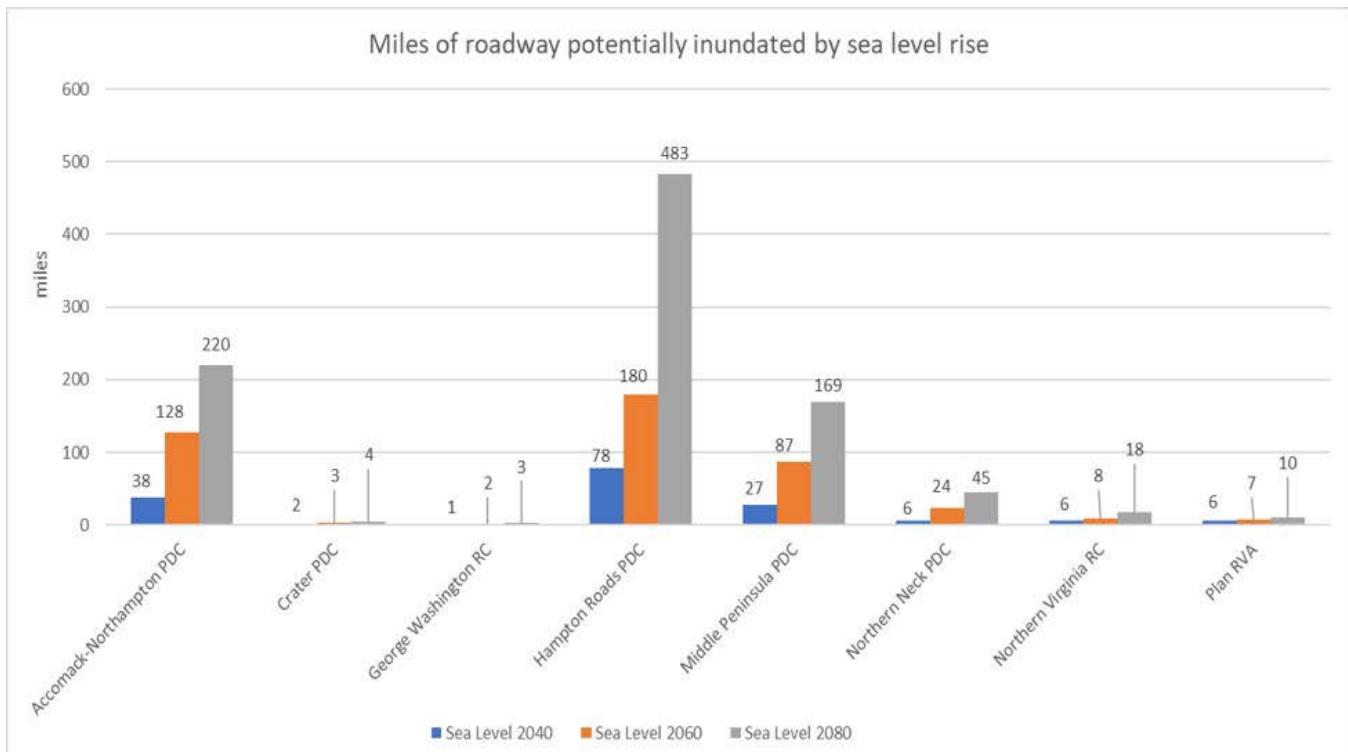
Roadways Flooded by Sea Level Rise:

The impact of future sea level on roadways was also considered. Portions of the street centerline located within the boundaries of future predicted sea level, and therefore below the high tide line, were deemed to be impacted.

This preliminary, screening-level assessment does not differentiate among road type or function, USDOT classification, or vehicle miles traveled per day. Nonetheless, the spatial overlay of future flooding and existing roadways provides a baseline for further detailed transportation studies, including capturing vulnerability and susceptibility and structural adaptation or mitigation.

Many states, for instance, are conducting detailed transportation planning studies to inform future capital improvements, state and federal budget priorities, and identifying engineering alternatives for mitigation or roadway adaptation. Roadway impacts are also notable for potential underestimation, such as not considering the right of way and stormwater drainage conveyance, vegetated swales, or culverts and catch-basins bridges, etc. In addition, indirect impacts are not addressed here, including ecological flows, stormwater, fish passages, and other cascading impacts beyond this study. **FIGURE 7** details the total miles of roadway lost to sea level rise for each planning district at each modeled year.

FIGURE 7
Miles of roadway in each planning district that will be flooded by sea level rise



Cumulative Exposure of Relative Sea Level Rise:

TABLES 1 and **2** detail the exposure of sea level rise for each of the study area planning districts and the cumulative total for coastal Virginia.

TABLE 1

Total land and street flooding from sea level rise for coastal Virginia PDCs

PLANNINGDISTRICT	YEAR					
	2040	2060	2080			
LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)	
Accomack-Northampton	164	38	199	128	228	220
Crater	10	2	12	3	14	4
George Washington	11	1	13	2	15	3
Hampton Roads	127	78	167	180	214	483
Middle Peninsula	58	27	78	87	101	169
Northern Neck	22	6	29	24	37	45
Northern Virginia	5	6	6	8	7	18
Richmond	28	6	30	7	33	10
TOTAL	424	165	534	439	649	952

TABLE 2

Total parcels and buildings impacted by SLR in coastal Virginia

PLANNINGDISTRICT	YEAR					
	2040	2060	2080			
PARCELS	BUILDINGS	PARCELS	BUILDINGS	PARCELS	BUILDINGS	
Accomack-Northampton	13,833	1,656	18,509	6,294	21,766	9,755
Crater	1,128	34	1,335	94	1,477	165
George Washington	1,931	76	2,104	101	2,255	151
Hampton Roads	43,951	2,614	56,840	12,022	79,692	36,612
Middle Peninsula	16,567	974	19,387	3,537	22,576	7,231
Northern Neck	10,322*	492	11,057*	846	11,887*	1,425
Northern Virginia	1,321	117	1,570	233	2,175	409
Richmond	2,758	241	2,950	306	3,504	430
TOTAL	91,811	6,204	113,752	23,433	145,332	56,178

*NNPDC data excludes Northumberland County, for which no parcel data was available through the VA GIS Clearinghouse

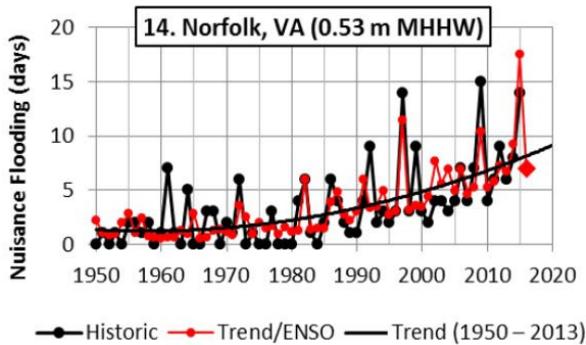
MINOR AND MODERATE FLOODING WITH RSLR MODELING



Reports of recurrent tidal flooding, often called “nuisance” flooding, in coastal Virginia have been increasing. Nuisance flooding is defined as a water level measured by NOAA tide gauges above the local NOAA National Weather Service (NWS) threshold for minor impacts established for emergency preparedness (Sweet and Marra, 2016).⁸ A study by Fugro(2016) confirmed that tidal flooding in Norfolk’s Lafayette River watershed occurs frequently and is expected to worsen over time as sea level rises.⁹

FIGURE 8

Annual flood frequencies (black circles) with 1950-2013 quadratic trends in Norfolk and bivariate regressions including ENSO effects and 2016 Outlook (adapted from Sweet and Mara, 2016)



A study by Fugro(2016) confirmed that tidal flooding in Norfolk’s Lafayette River watershed occurs frequently and is expected to worsen over time as sea level rises.

In 2016, Sweet and Marra (2016) calculated the “nuisance flooding” threshold level for Norfolk, VA to be 0.53m above MHHW and predicted an accelerating trend of tidal flooding days per year (**FIGURE 8**).

NOAA has established three thresholds for coastal flood severity: (1) minor, (2) moderate, and (3) major. These thresholds are “based upon water

level heights empirically calibrated to NOAA tide gauge measurements from years of impact monitoring.”¹⁰ Minor refers to flooding which is more disruptive than damaging (includes tidal nuisance flooding), moderate refers to damaging flooding, and major is used to describe destructive flooding.

Concurrent with our analysis of SLR impacts using

8. Sweet, W. and J. Marra. 2016. State of U.S. “Nuisance” Tidal Flooding. National Oceanic and Atmospheric Administration’s Center for Operational Oceanographic Products and Services and National Centers for Environmental Information. June 8, 2016. 5pp.

9. Fugro. 2016. Lafayette River Tidal Protection Alternatives Evaluation: City of Norfolk, City-wide Coastal Flooding Contract, Work Order No. 7. Fugro Project No. 04.8113009. 56pp.

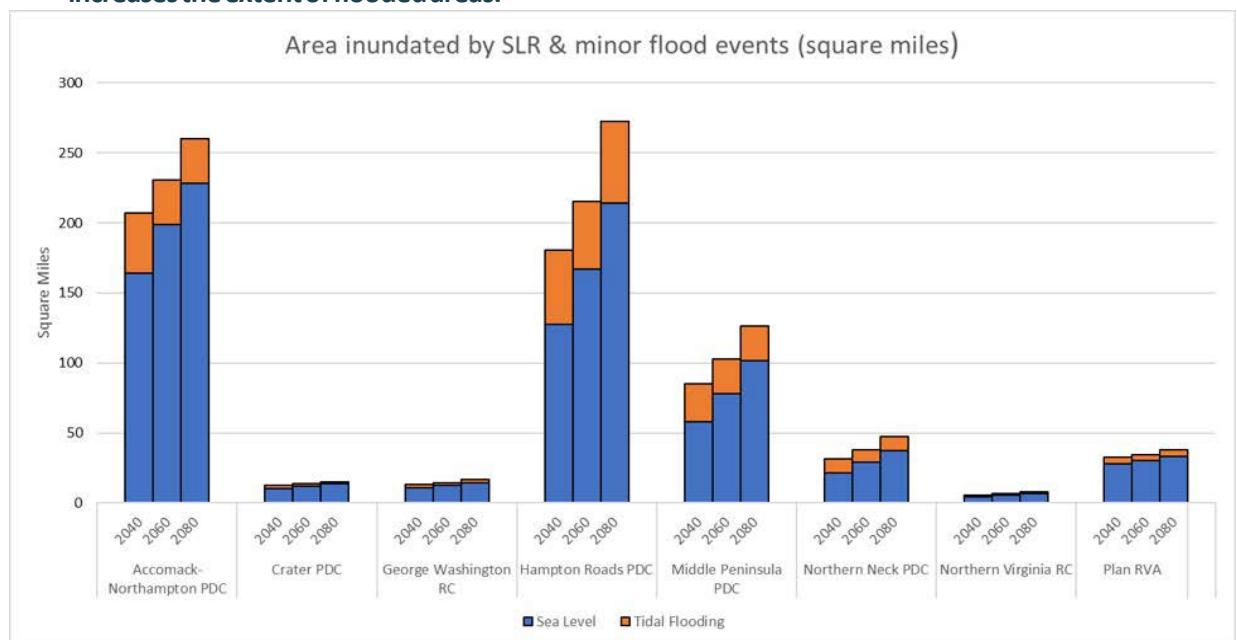
10. Sweet, W., Dusek, G., Obeysekera, J., & Marra, J. (2018). Patterns and projections of high tide flooding along the U.S. coastline using a common impact threshold. NOAA technical report NOS CO-OPS, Vol. 86, National Oceanic and Atmospheric Administration, Silver Spring, Maryland, USA.

NOAA's intermediate-high curve, we have modeled the additional potential impacts of both minor (tidal) and moderate flood events for the entire study region for the years 2040, 2060, 2080. Tidal flooding water surface elevation data provided directly by NOAA were employed in these modeling efforts. Per NOAA staff, these experimental data are "based on interpolation from the NOAA report thresholds" (M. Pendleton, personal communication, September 17, 2019).¹¹

Rather than relying only on a single tidal flooding threshold value (i.e. 0.53m), these surfaces establish a range of tidal water levels which would generate minor or moderate flooding throughout coastal Virginia. Predictive modeling using these data reveals which areas are at highest risk of being inundated during minor and moderate flooding events.

FIGURE 9

Present-day land area (including wetlands) in each planning district that will be flooded by sea level rise (blue) and at-risk during minor flooding events (orange). The stacked bars indicate that sea level rise progressively increases the extent of flooded areas.



11. Pendleton, M. Lynker Technologies for NOAA OCM. September 17, 2019. Email communication.

FIGURE 10

Buildings potentially affected by relative sea level rise (blue) and at-risk during minor flooding events (orange)

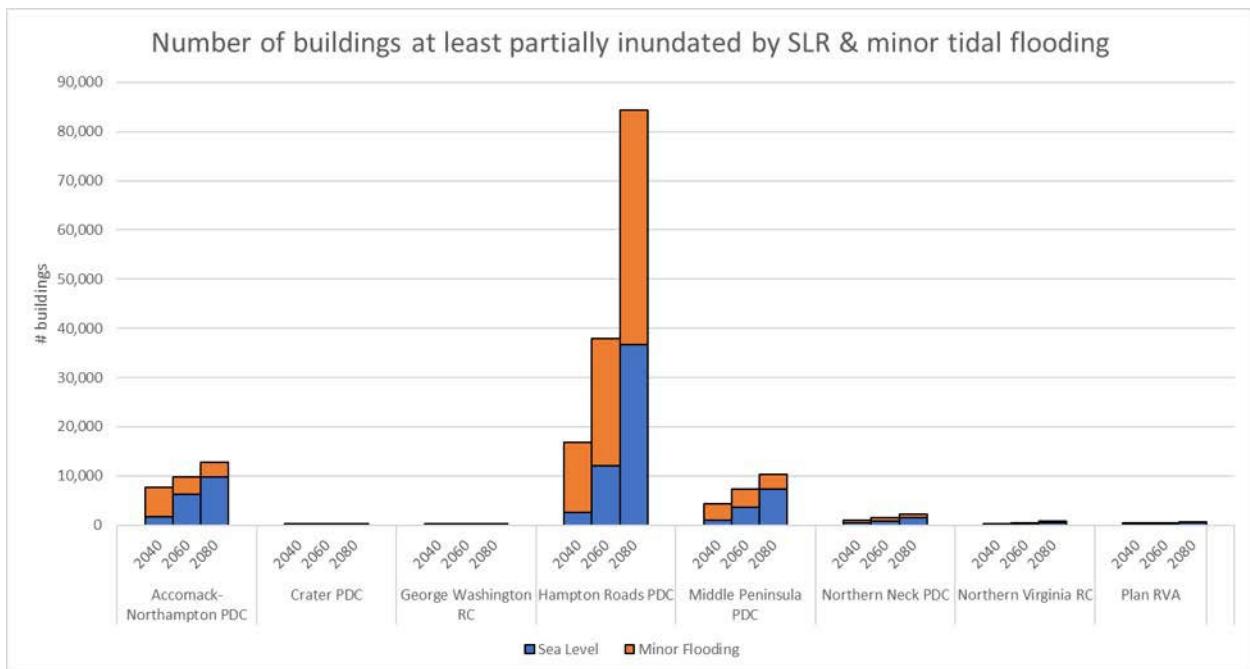
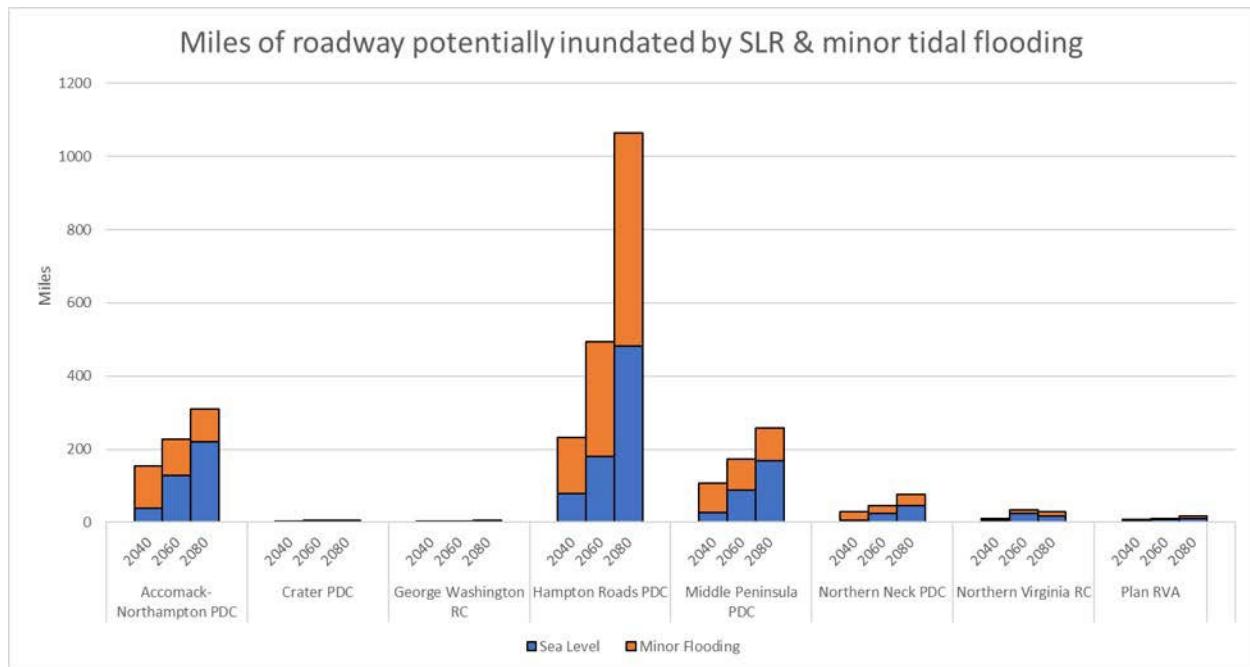


FIGURE 11

Streets potentially flooded by sea level rise (blue) and at-risk during minor flooding events (orange)



Cumulative Exposure of Minor (Tidal) Flooding with RSLR:**TABLES 3 and 4** detail the additional potential exposure of minor flooding with increasing relative sea level**TABLE 3****Total additional land and streets at-risk from minor flooding for coastal Virginia PDCs****YEAR****2040****2060****2080**

PLANNINGDISTRICT	LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)
Accomack-Northampton	44	116	32	99	32	90
Crater	2	1	2	1	2	1
George Washington	3	1	2	1	2	2
Hampton Roads	53	152	48	313	58	580
Middle Peninsula	27	79	24	85	25	90
Northern Neck	10	24	9	22	10	30
Northern Virginia	1	5	1	9	1	11
Richmond	4	2	4	3	5	6
TOTAL	144	380	122	534	135	810

TABLE 4**Total additional parcels and buildings at-risk from minor flooding for coastal Virginia PDCs****YEAR****2040****2060****2080**

PLANNINGDISTRICT	PARCELS	BUILDINGS	PARCELS	BUILDINGS	PARCELS	BUILDINGS
Accomack-Northampton	5,721	5,970	3,478	3,563	3,195	2,961
Crater	232	90	143	73	135	47
George Washington	233	35	165	53	186	65
Hampton Roads	15,795	14,200	23,939	25,858	39,106	47,734
Middle Peninsula	3,612	3,439	3,282	3,828	2,907	3,045
Northern Neck	919*	525	849*	613	1,020*	822
Northern Virginia	352	245	471	187	1,475	429
Richmond	287	87	599	132	1,041	264
TOTAL	27,151	24,591	32,926	34,307	49,065	55,367

*NNPDC data excludes Northumberland County, for which no parcel data was available through the VA GIS Clearinghouse

Land Area Vulnerable to Moderate Flooding with RSLR:

Areas at risk from moderate flood events are naturally inclusive of those that would also be impacted by minor tidal flooding. The threshold for moderate flooding, as defined by NOAA, is met when there is damaging flooding not associated with tropical storms (includes hurricanes). **FIGURE 12** shows the cumulative area of potential inundation from both sea level rise and moderate flood events for each planning district.

FIGURE 12

Present-day land area (including wetlands) in each planning district that will be flooded by sea level rise(blue) and at-risk during moderate flooding events (orange).

The additional areas of potential inundation by moderate flooding are significant, particularly in Hampton Roads, the Eastern Shore, and the Middle Peninsula. Examination of the potential impact to buildings and roadways once again underscores regional disparities and highlights the critical nature of the problem for Hampton Roads. **FIGURES 13 & 14**, respectively, show the number of buildings and miles of roadway located within the area of highest risk during moderate flooding events.

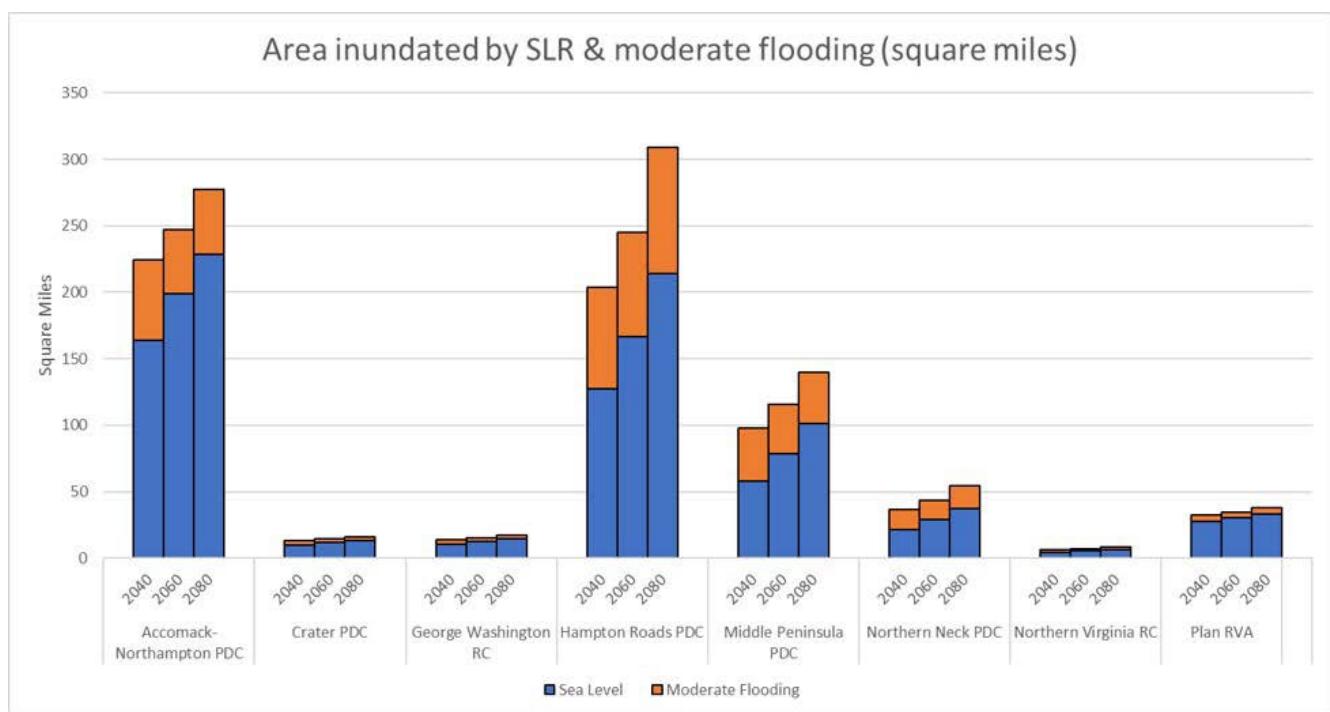


FIGURE 13

Buildings flooded by sea level rise (blue) and at-risk during moderate flooding events (orange)

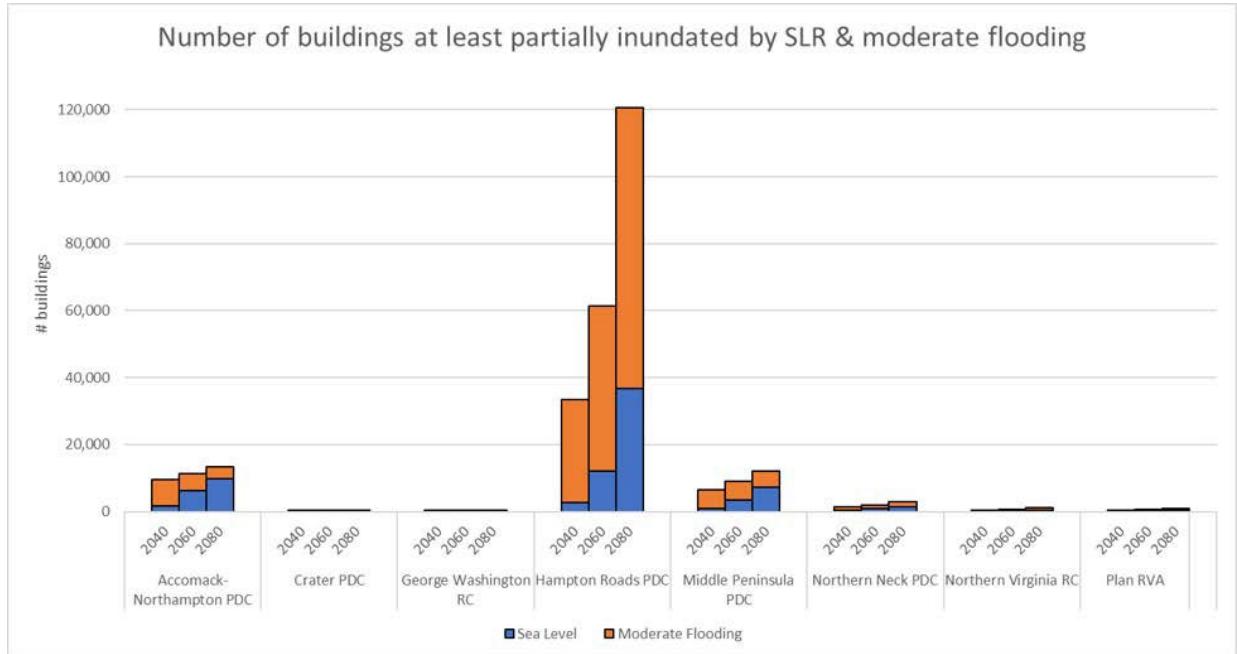
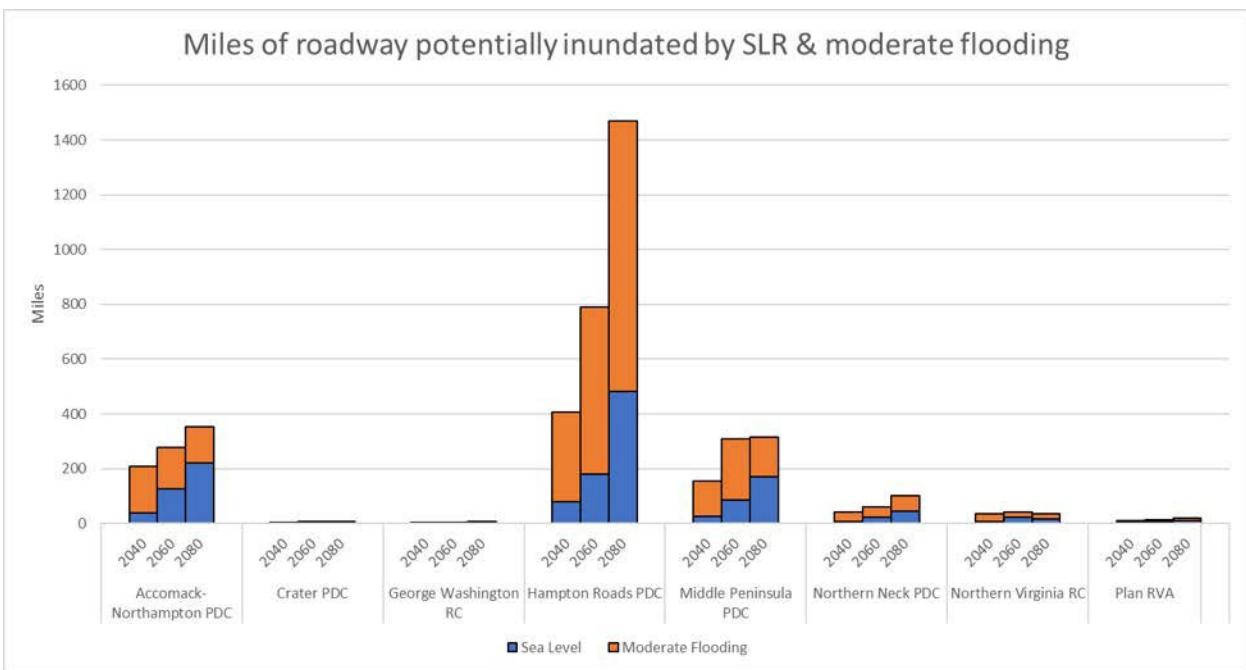


FIGURE 14

Roads flooded by sea level rise (blue) and at-risk during moderate flooding events (orange).



Cumulative Exposure of Moderate Flooding with RSLR:

TABLES 5 and 6 detail the cumulative exposure of moderate flooding with rising relative sea level for the entire study region.

TABLE 5

Total additional land and streets at-risk from moderate flooding for coastal Virginia PDCs YEAR

PLANNINGDISTRICT	LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)	LANDAREA (mi ²)	STREETS (mi)
Accomack-Northampton	61	170	48	149	49	135
Crater	3	2	3	2	2	2
George Washington	4	2	3	2	3	4
Hampton Roads	77	328	78	610	95	987
Middle Peninsula	40	127	38	222	39	147
Northern Neck	15	37	14	38	18	57
Northern Virginia	2	30	2	17	2	18
Richmond	5	4	5	6	5	11
TOTAL	207	700	191	1,046	213	1,361

TABLE 6

Total additional parcels and buildingsat-risk from moderate flooding for coastal Virginia PDCs YEAR

PLANNINGDISTRICT	PARCELS	BUILDINGS	PARCELS	BUILDINGS	PARCELS	BUILDINGS
Accomack-Northampton	7,561	7,808	5,279	5,068	4,089	3,638
Crater	315	121	221	94	222	78
George Washington	305	68	276	85	302	119
Hampton Roads	29,908	30,756	46,626	49,300	70,312	83,941
Middle Peninsula	5,432	5,575	4,922	5,569	4,832	4,836
Northern Neck	1,471*	870	1,469*	1,075	1,805*	1,404
Northern Virginia	792	272	1,594	415	2,050	669
Richmond	641	170	1,178	229	1,621	486
TOTAL	46,425	45,640	61,565	61,835	85,233	95,171

*NNPDC data excludes Northumberland County, for which no parcel data was available through the VA GIS Clearinghouse

This study focused on developing the future potential extent of various tidal and non-tidal flooding events, presented in the included maps and charts. In addition, recurrent tidal flooding will have impacts attributed to frequency and duration of flooding, particularly for wetlands and roadway not previously affected by increasingly higher tides and, especially, salinity.

Another compounding factor bearing on recurrent flooding is that of “combined flooding” owing to both extreme rainfall and tidal flooding. As tidal flooding increases in extent, frequency, and duration with sea level rise, rainfall runoff co-occurring with tidal flooding will exacerbate flood extent, depth, and impacts. Multiple recent studies also point to increasingly extreme rainfall events, evidenced in rainfall intensity and shorter return periods and affirming predicted regional climate change.^{12,13} Thus, combined flooding bears further research and study, as rainfall hydrology is likely to co-occur and compound tidal flooding. In order to meet the need for an expedited assessment, this study was not able to include the rapidly developing scientific understanding of combined flooding and the interaction of extreme rainfall and increasing tidal water levels.

-
12. Allen, Michael J. and Allen, Thomas R. 2019. “Precipitation Trends across the Commonwealth of Virginia (1947 –2016),” Virginia Journal of Science: Vol. 70 : No. 1 , Article 4. DOI: 10.25778/3cay-z849. <https://digitalcommons.odu.edu/vjs/vol70/iss1/4>
 13. Dewberry. 2017. Joint Occurrence and Probabilities of Tides and Rainfall, City of Virginia Beach, Virginia. CIP 7-030, PWCN-15-0014, Work Orders 2 and 5A. Final Report. October 9, 2017. 55pp. <https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/joint-occ-prob-of-tides-rainfall-4-24-18.pdf>

WEB MAP AND DATA LAYER SHARING



Data developed by this study for land areas, buildings, and streets vulnerable to inundation by sea level rise and both minor (tidal) and moderate flooding are available for viewing in a web map at the below address (subject to future update).

Web Map: Coastal Virginia Sea Level with Minor and Moderate Flooding (NOAA Int-High Scenario2017)

URL: <https://tinyurl.com/CoVA-SLR-Inundation-NOAA2017>

Planners or other users can access the publicly shared map as streaming Web Map Services (WMS) layers or may email geovis@olddominion.onmicrosoft.com to request download access.



STUDY LIMITATIONS

The accuracy of inundation modeling is largely dependent upon the quality of digital elevation data used in the analysis. Errors in elevation surfaces will naturally propagate to final model results. Elevation discrepancies may result in shifts in the predicted flood boundary. These shifts may have the effect of either over- or under-predicting flooding extent depending on the direction (positive or negative) of elevation error.

The use of high-quality LiDAR-derived elevation surfaces for this study helps to minimize positional errors.

The use of high-quality LiDAR-derived elevation surfaces for this study helps to minimize positional errors. Further improvements could be developed to refine the areas of impact by applying fine scale hydrocorrection (Allen and Howard 2014), which would also improve roadway and drainage analyses and property susceptibility by reducing areas of omission of flooding impacts.¹⁴

In addition to the accuracy of underlying elevation data, some variables were not modeled and require further research, such as dynamic geomorphology and the developing data on vertical land motion and subsidence, infrastructure improvements, storm water system connectivity, groundwater hydrology, and other local factors may all impact future flooding severity and connectivity.

Local land subsidence data are very limited and presented a constraint to this study, which relied on long-term, high-precision tide gage data.

The study did not address storm surges and changes in storminess associated with climate change that will co-occur with sea level rise. Integrating climate change more widely into sea level rise risk assessment requires

highly computational modeling and consideration of multiple, interacting probabilistic changes (increasing tidal flooding, increasing storm energy, potential increase frequency of storms) well beyond the scope of tidal flooding in this project.

14. Allen, T. and R. Howard. 2015. Improving Low-Relief Coastal LiDAR DEMs with Hydro-Conditioning of Fine-Scale and Artificial Drainages. *Front. Earth Sci.* 3:72. doi: 10.3389/feart.2015.00072

CONCLUSIONS AND FUTURE WORK



Model results and related graphics clearly illustrate that the Hampton Roads, Accomack-Northampton, and Middle Peninsula planning districts will be the most severely and disproportionately impacted.

Broad studies such as this should be used to inform and assist with the prioritization of more detailed, fine-scale analyses.

Map data and graphics are included in both the online web map and in the Appendix to provide more detailed illustrations of the localized impacts of sea level rise and tidal flooding. Hydrologically disconnected areas of potential inundation were preserved to highlight areas of increased, yet uncertain, vulnerability. Identifying these potential vulnerabilities provides opportunity for further analyses needed to better define localized flooding risk.

Broad studies such as this should be used to inform and assist with the prioritization of more detailed, fine-scale analyses. The final maps in the Appendix provide examples of how the implications of sea level rise can be examined at local scales for areas of critical risk and/or high value. Localized impacts analysis allows for the inclusion of comprehensive and highly specific asset inventories, which are unique to each study area. Highly developed asset inventories, combined with sea level and tidal flooding modeling, are necessary for identifying and quantifying the level of risk and potential cost of response.

It is recommended that this work be extended, and additional analysis performed to quantify the regional impacts of SLR in smaller geographic areas. Areas of potential critical impact should be identified for high-resolution development of asset inventories and focused analyses of physical and economic impacts of SLR.

This screening-level assessment is distinctly different from narrow spatial land feature-based risk assessments driven by land or resource managers, engineers, or planners. The limitations noted above should not detract from the potential to utilize the products and GIS data for planning today. Nonetheless, a series of prioritized enhancements are provided below, which could increase resilience to coastal hazards associated with sea level rise, especially flooding.

1. Need for Fine-Scale Elevation Data

This study used the best available elevation, tidal projections, and subsidence data, yet additional research has illustrated new techniques can further refine these data. Even higher resolution LiDAR, fine-scale hydrocorrection, digitally mapping ditches and low-relief drainage features, and expanding the availability of these improved GIS datasets could (a) reduce the uncertainty that areas at risk are accidentally or unknowingly missed or omitted in flood risk mapping and (b) provide more accurate data for detailed flooding modeling, stormwater engineering, and road or other construction, potentially reducing costs for adaptation and mitigation.

2. Assess Compounding Risk from Combined Flooding

Only a few very recent studies have quantitatively verified the increases in extreme rainfall, corroborating global and regional climate models. Yet, few spatial risk assessments have been conducted that identify these risks and impacts (primarily in larger cities with the capacity to fund them). Projects that could support more extensive regional rainfall study and climatology could inform stormwater engineering and drainage planning as well as coupling dynamic rainfall interactions with tidal flooding and sea level rise.

3. Assimilating Real Property, Building, and Infrastructure Data

Some data gaps were revealed in the analysis of coastal parcels. Building structures almost universally lack detailed First Floor Elevations (FFEs) which are essential to assessing susceptibility and mitigating flood risks. Future studies might develop cost-effective techniques to capture FFEs as well as building structural characteristics (e.g., foundation types) that are critical to damage assessment, flood insurance costs, and other floodplain policy and emergency management.

4. Assessing Emerging Risks and Cascading Impacts

This project assessed potential SLR impacts in unique features, land areas, parcels, buildings and roads. However, interacting, indirect, and even cumulative impacts may affect vulnerability. Wetlands loss or migration, also not a focus of this study, could lead to increasing inundation and

loss of flood protection and ecosystem services. Ground water inundation could reduce storage during tides and rainfall flooding, resulting in increased surface flooding and damage to underground septic systems and utilities.

5. Storm Surge and Flood Modeling

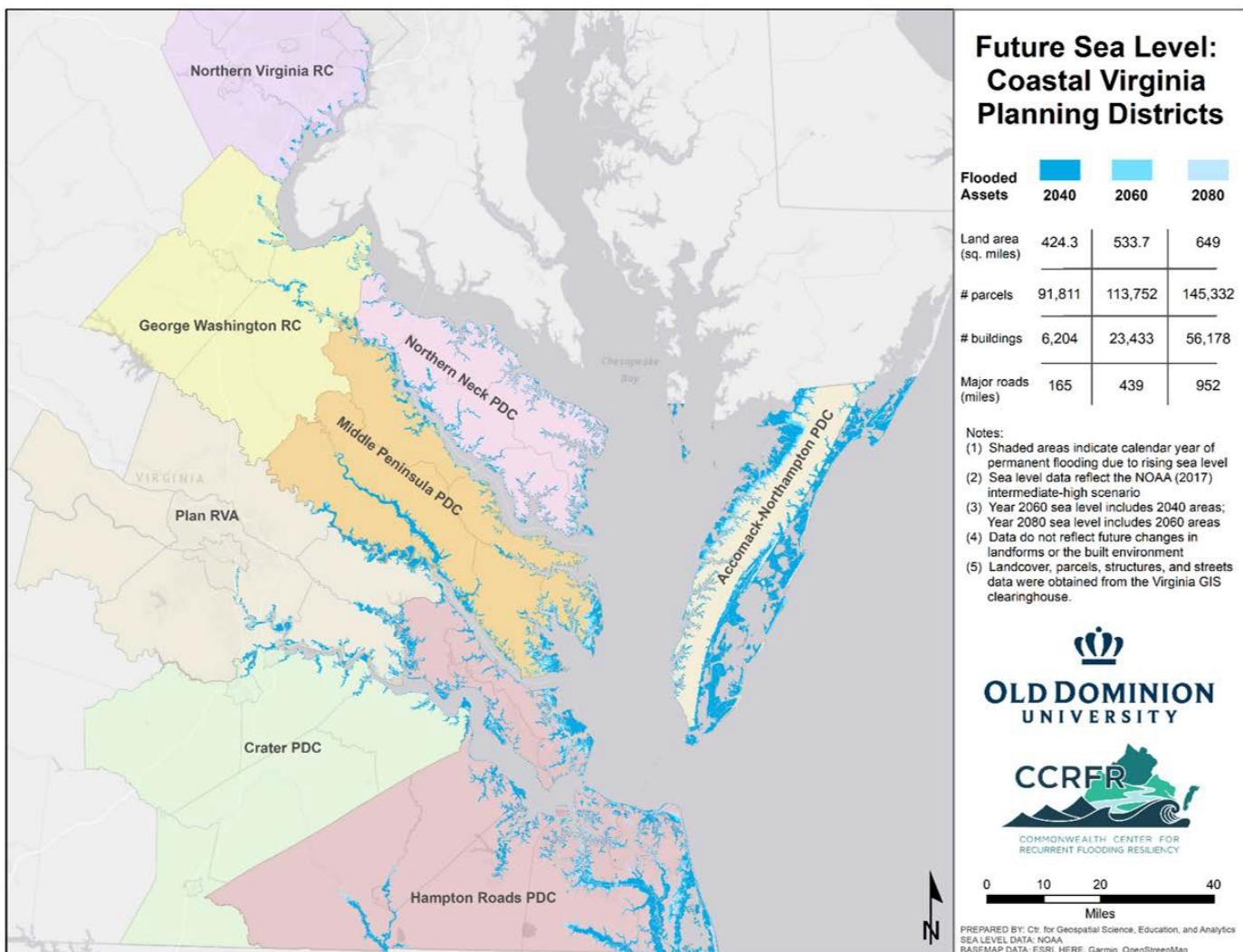
Whereas this study focused on dynamic changes in sea level rise and tidal flooding, additional research is critically necessary to capture future storm surge flood risk. This would entail the inclusion of multiple, joint probabilities, including storminess, storm tracks and frequency, strength, and other meteorological dynamics with climate change (e.g., extreme rainfall, tropical storms, and extra tropical or nor'easter storms.)



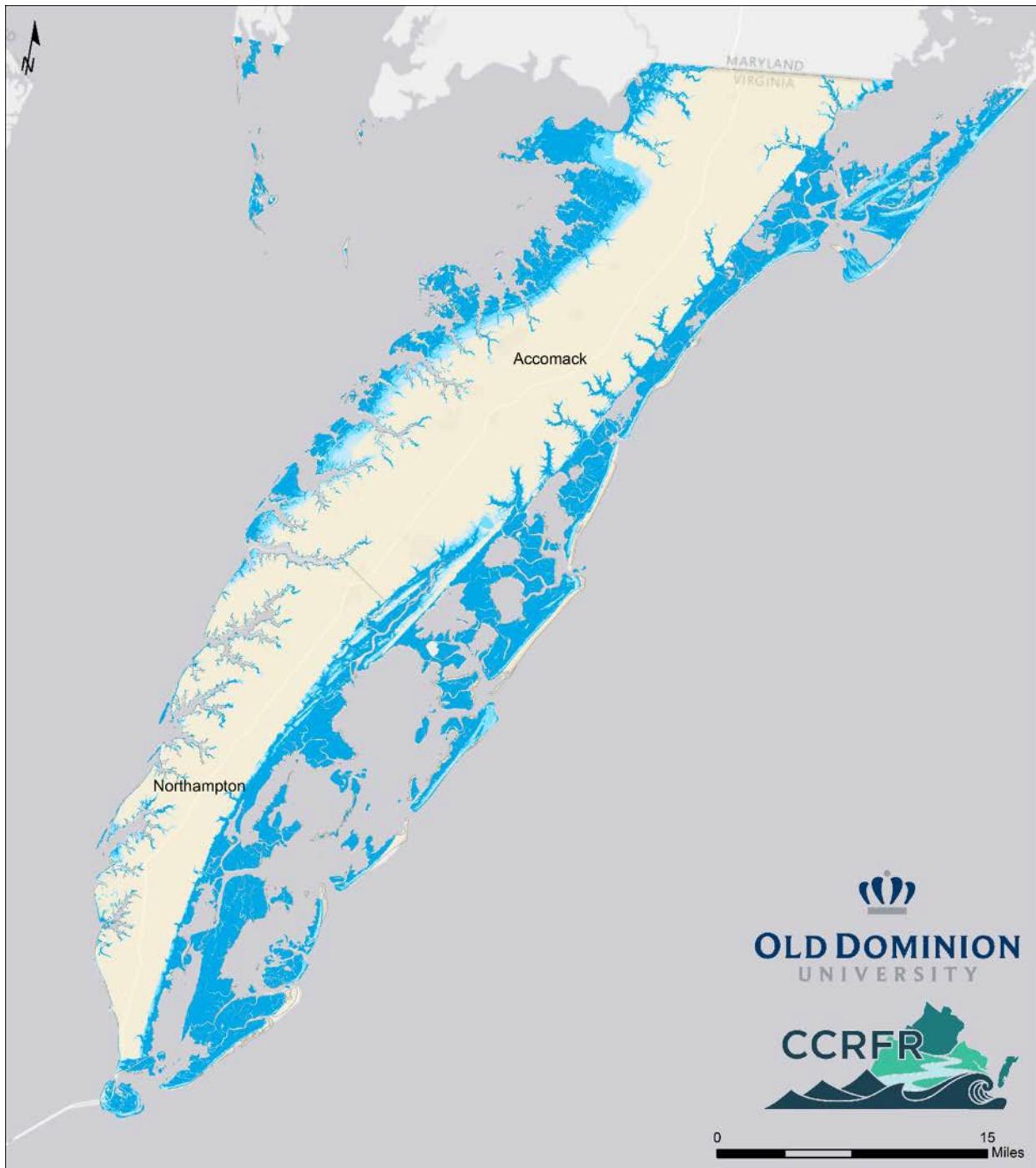
APPENDIX

MAP 1

All Planning Districts



MAP 2
Accomack-Northampton PDC



Future Sea Level: Accomack-Northampton Planning District

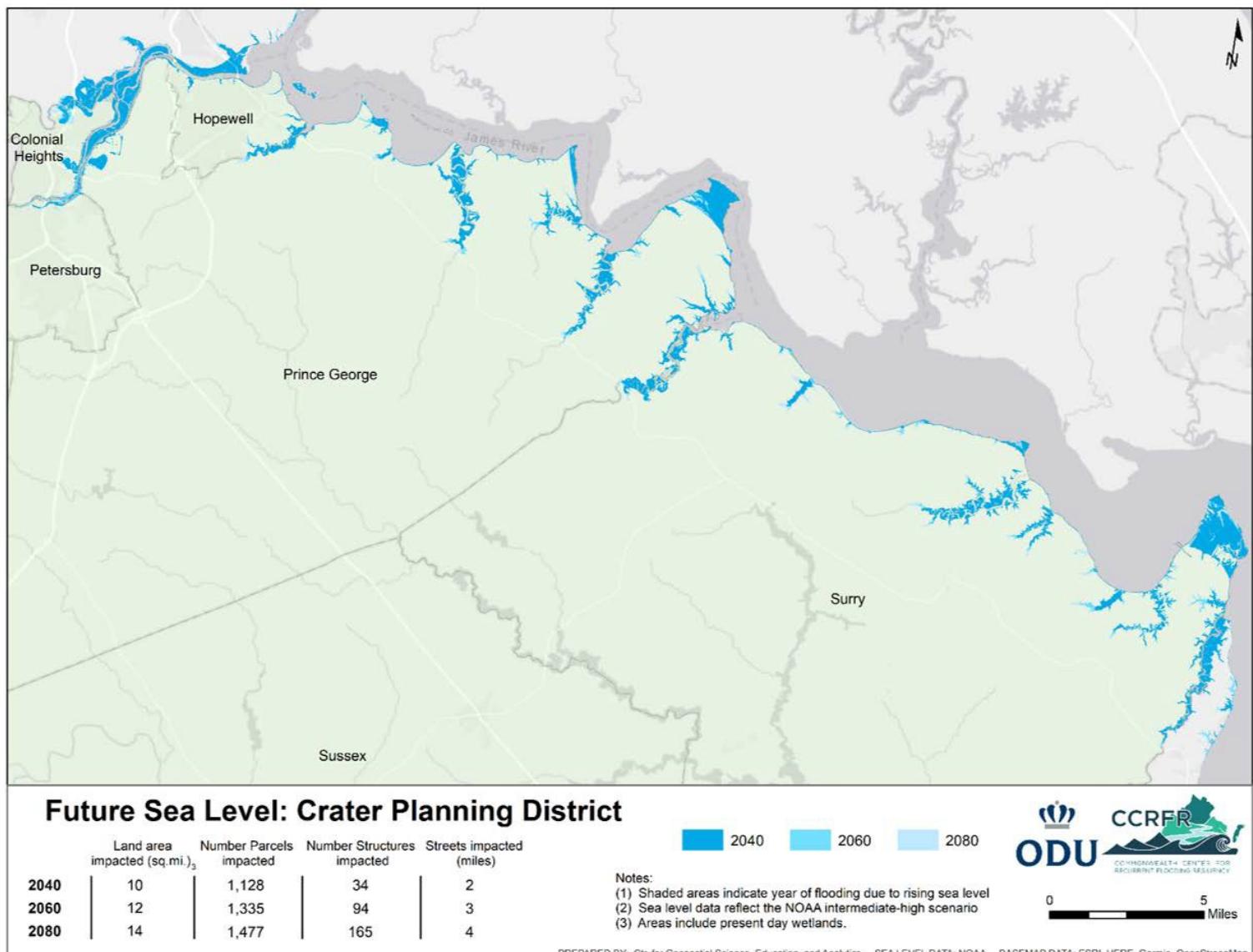
	Land area impacted (sq.mi.)	Number Parcels impacted	Number Structures impacted	Streets impacted (miles)		2040	2060	2080
2040	164	13,833	1,656	38				
2060	199	18,509	6,294	128				
2080	228	21,766	9,755	220				

Notes:

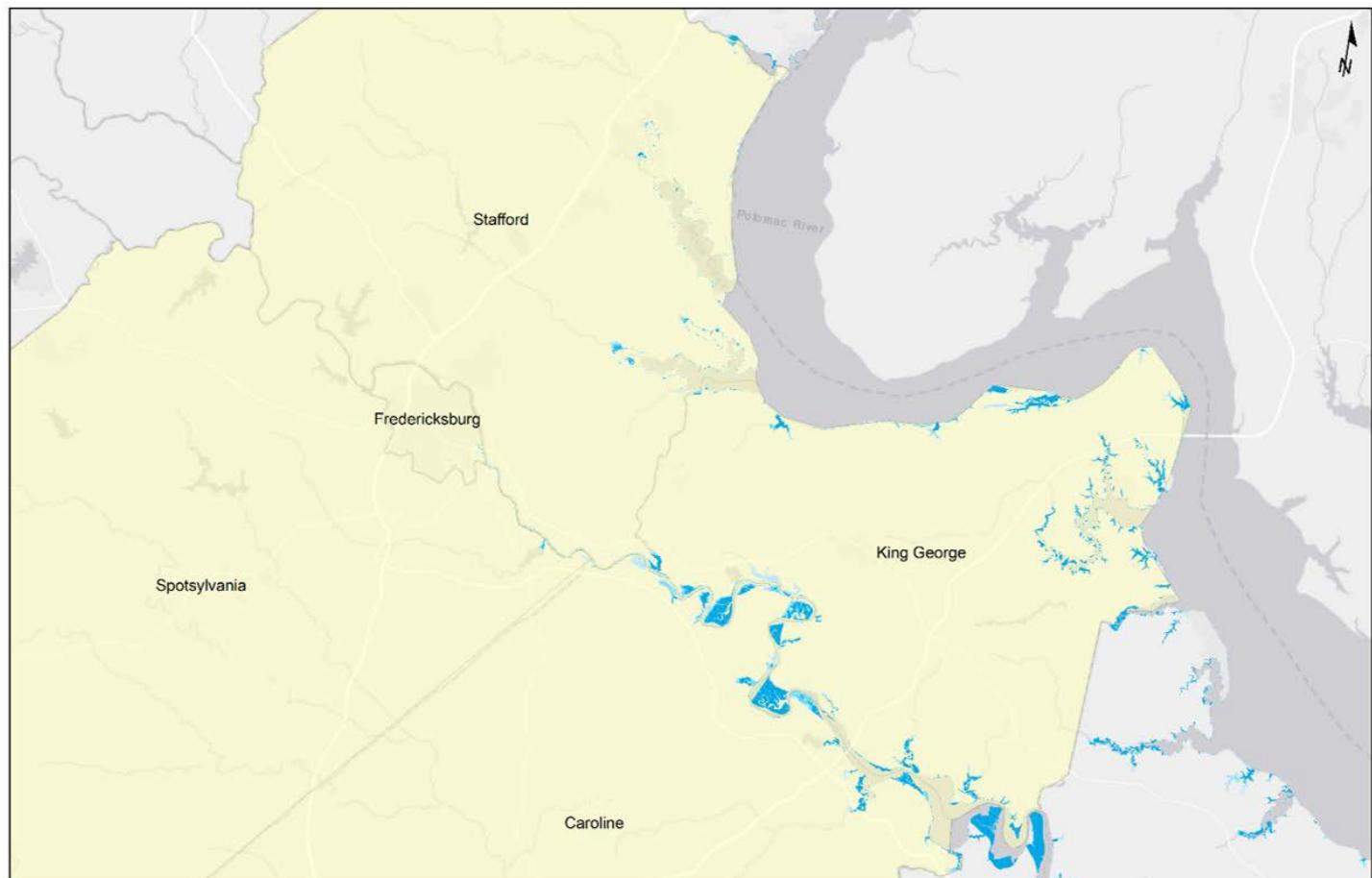
- (1) Shaded areas indicate year of flooding due to rising sea level
- (2) Sea level data reflect the NOAA intermediate-high scenario
- (3) Areas include present day wetlands.

PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap

MAP 3
Crater PDC



MAP 4
George Washington RC



Future Sea Level: George Washington Regional Commission

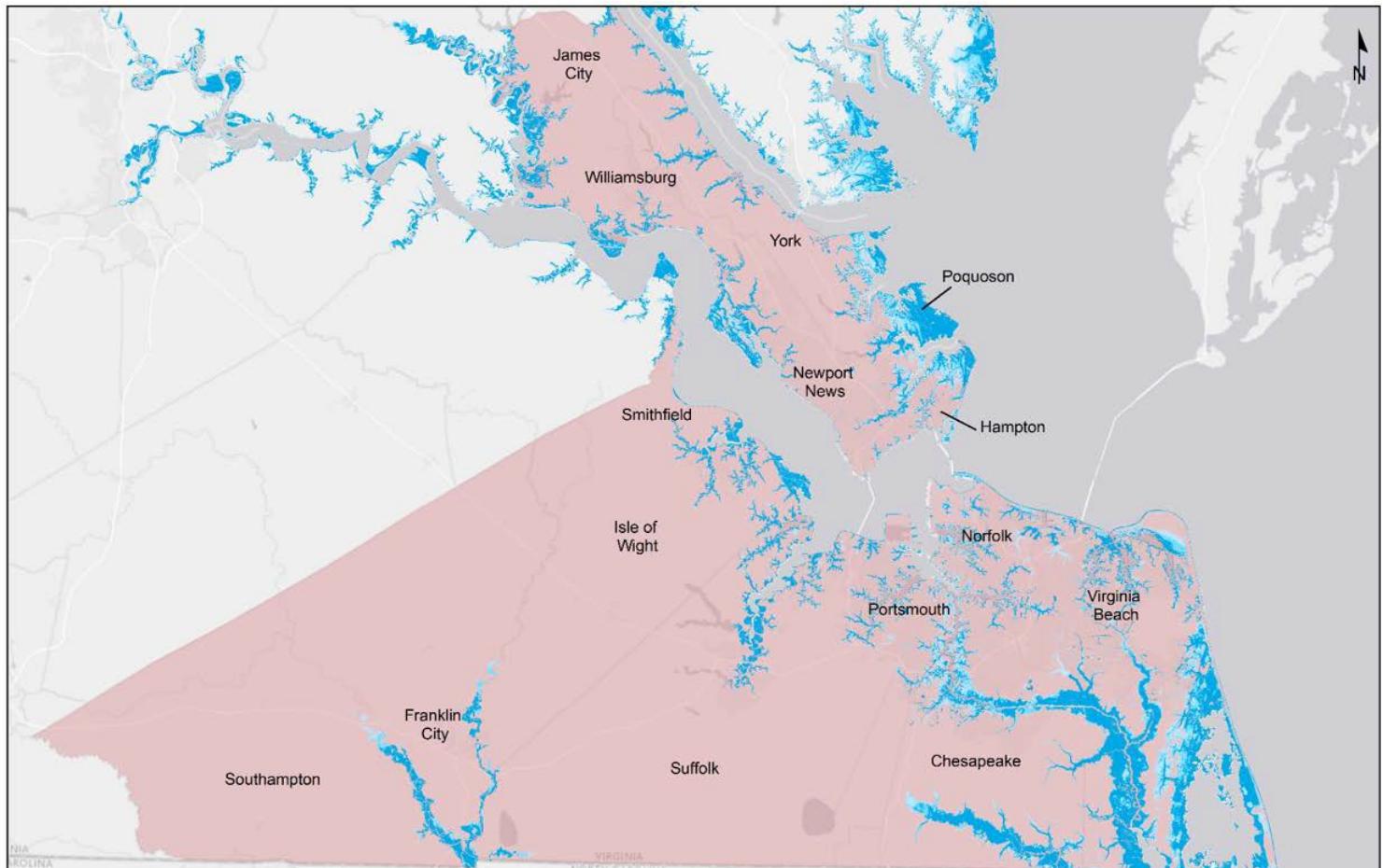
	Land area impacted (sq.mi.) ⁽³⁾	Number Parcels impacted	Number Structures impacted	Streets impacted (miles)			
2040	11	1,931	76	1		2040	
2060	13	2,104	101	2		2060	
2080	15	2,255	151	3		2080	

Notes:
 (1) Shaded areas indicate year of flooding due to rising sea level
 (2) Sea level data reflect the NOAA intermediate-high scenario
 (3) Areas include present day wetlands.

PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap



MAP 5
Hampton Roads PDC



Future Sea Level: Hampton Roads Planning District

	Land area impacted (sq.mi.)	Number Parcels impacted	Number Structures impacted	Streets impacted (miles)
2040	127	43,951	2,614	78
2060	167	56,840	12,022	180
2080	214	79,692	36,612	483

Notes:
 (1) Shaded areas indicate year of flooding due to rising sea level
 (2) Sea level data reflect the NOAA intermediate-high scenario
 (3) Areas include present day wetlands.

PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap



MAP 6
Middle Peninsula PDC



Future Sea Level: Middle Peninsula Planning District

	Land area impacted (sq.mi.) ⁽³⁾	Number Parcels Impacted	Number Structures Impacted	Streets impacted (miles)
2040	58	16,567	974	27
2060	78	19,387	3,537	87
2080	101	22,576	7,231	169

Notes:

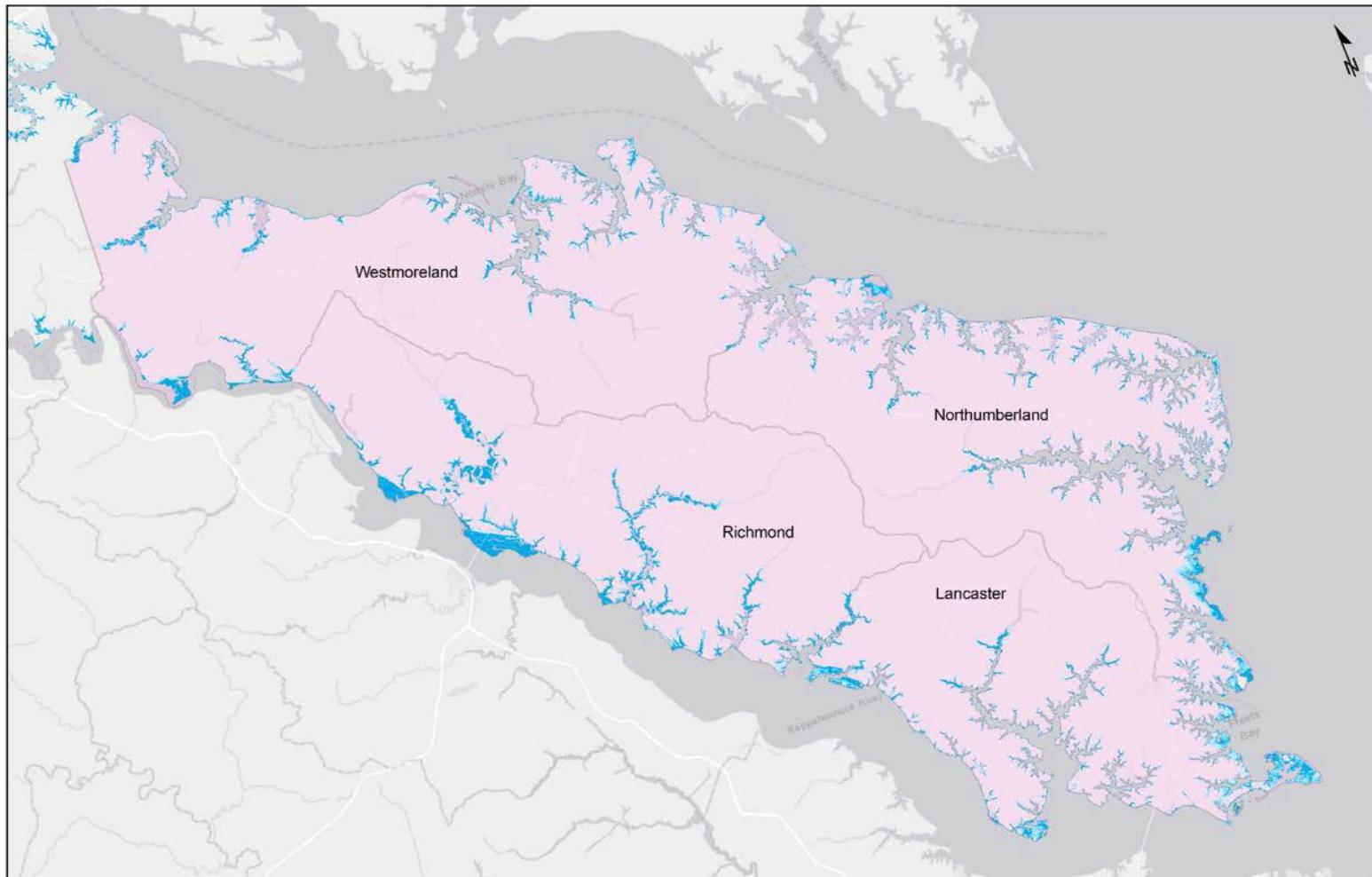
- (1) Shaded areas indicate year of flooding due to rising sea level
- (2) Sea level data reflect the NOAA intermediate-high scenario
- (3) Areas include present day wetlands.

2040 2060 2080



PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap

MAP 7
Northern Neck PDC



Future Sea Level: Northern Neck Planning District

	Land area impacted (sq.mi.) ³	Number Parcels impacted ⁴	Number Structures impacted	Streets impacted (miles)
2040	22	10,322	492	6
2060	29	11,057	846	24
2080	37	11,887	1,425	45

Notes:

- (1) Shaded areas indicate year of flooding due to rising sea level
- (2) Sea level data reflect the NOAA intermediate-high scenario
- (3) Areas include present day wetlands.
- (4) Northumberland Co. parcel data unavailable

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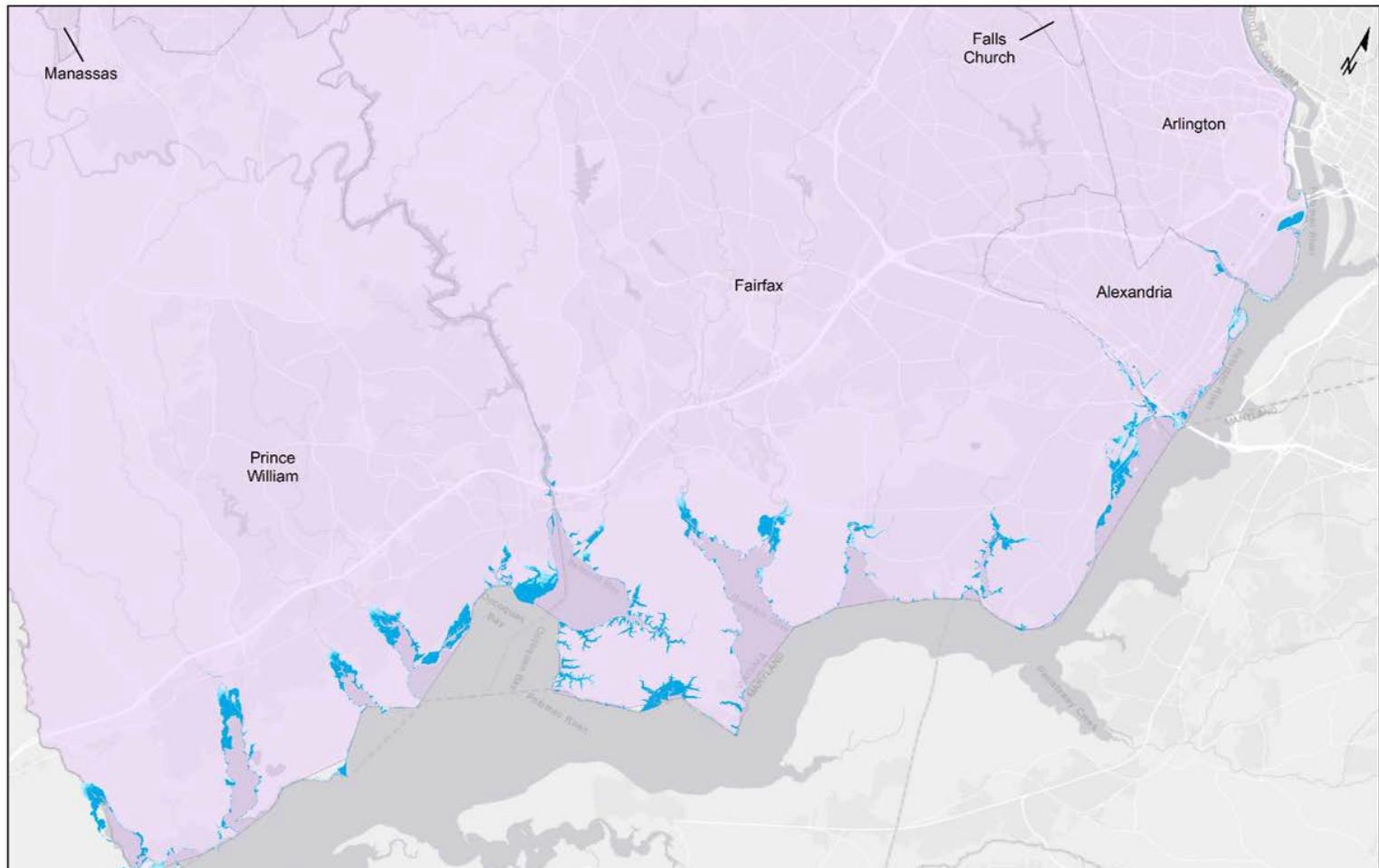
SEA LEVEL DATA: NOAA

BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap



0 10 Miles

MAP 8
Northern Virginia RC



Future Sea Level: Northern Virginia Regional Commission

	Land area impacted (sq.mi.) ⁽³⁾	Number Parcels impacted	Number Structures impacted	Streets impacted (miles)
2040	5	1,321	117	6
2060	6	1,570	233	8
2080	7	2,175	409	18

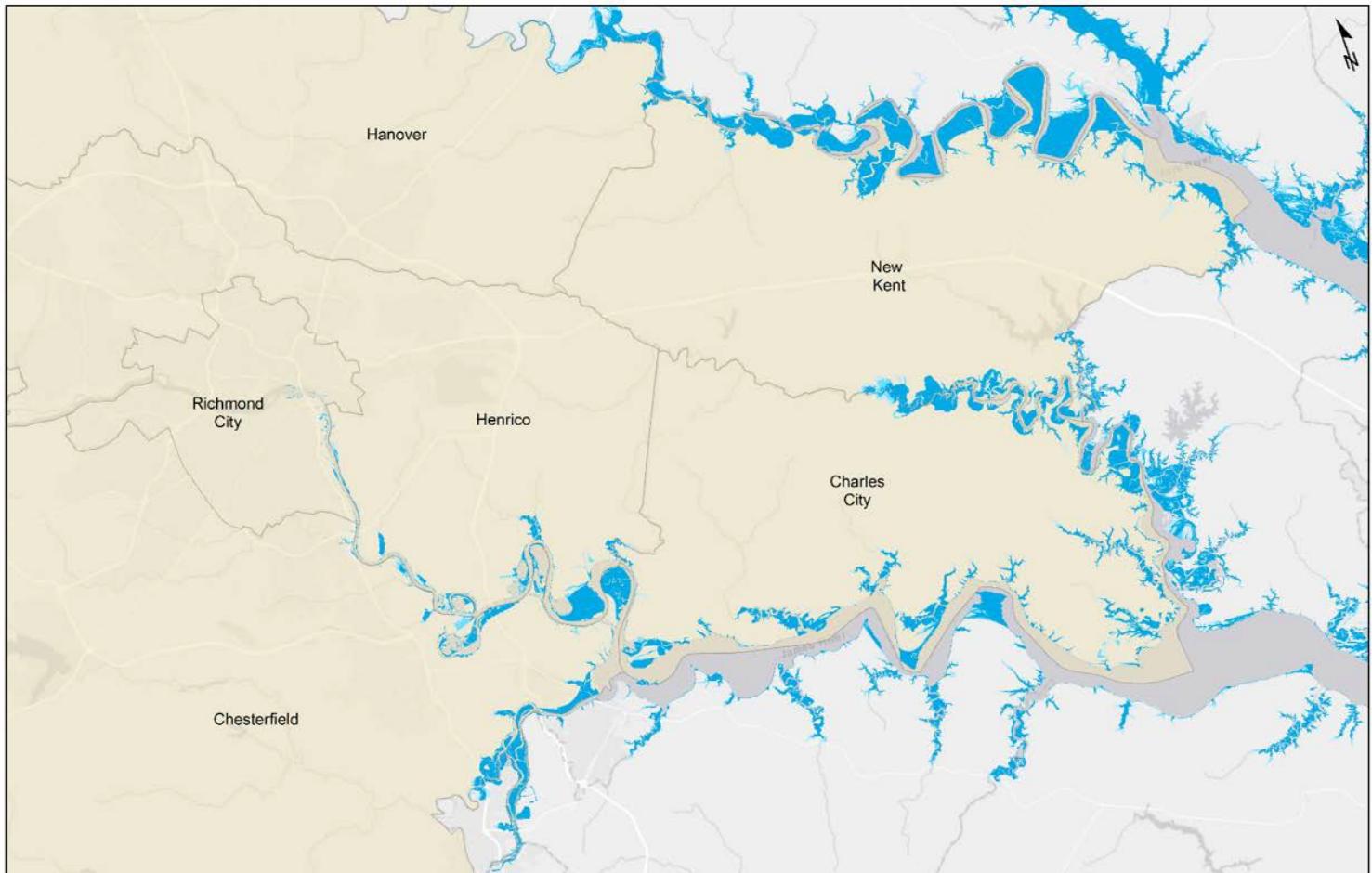
Notes:

- (1) Shaded areas indicate year of flooding due to rising sea level
- (2) Sea level data reflect the NOAA intermediate-high scenario
- (3) Areas include present day wetlands.

PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap



MAP 9
Plan RVA (Richmond VARegional PDC)



Future Sea Level: Plan RVA Regional Commission

	Land area impacted (sq.mi.)	Number Parcels impacted	Number Structures impacted	Streets impacted (miles)	2040	2060	2080
2040	28	2,758	241	6			
2060	30	2,950	306	7			
2080	33	3,504	430	10			

Notes:
 (1) Shaded areas indicate year of flooding due to rising sea level
 (2) Sea level data reflect the NOAA intermediate-high scenario
 (3) Areas include present day wetlands.

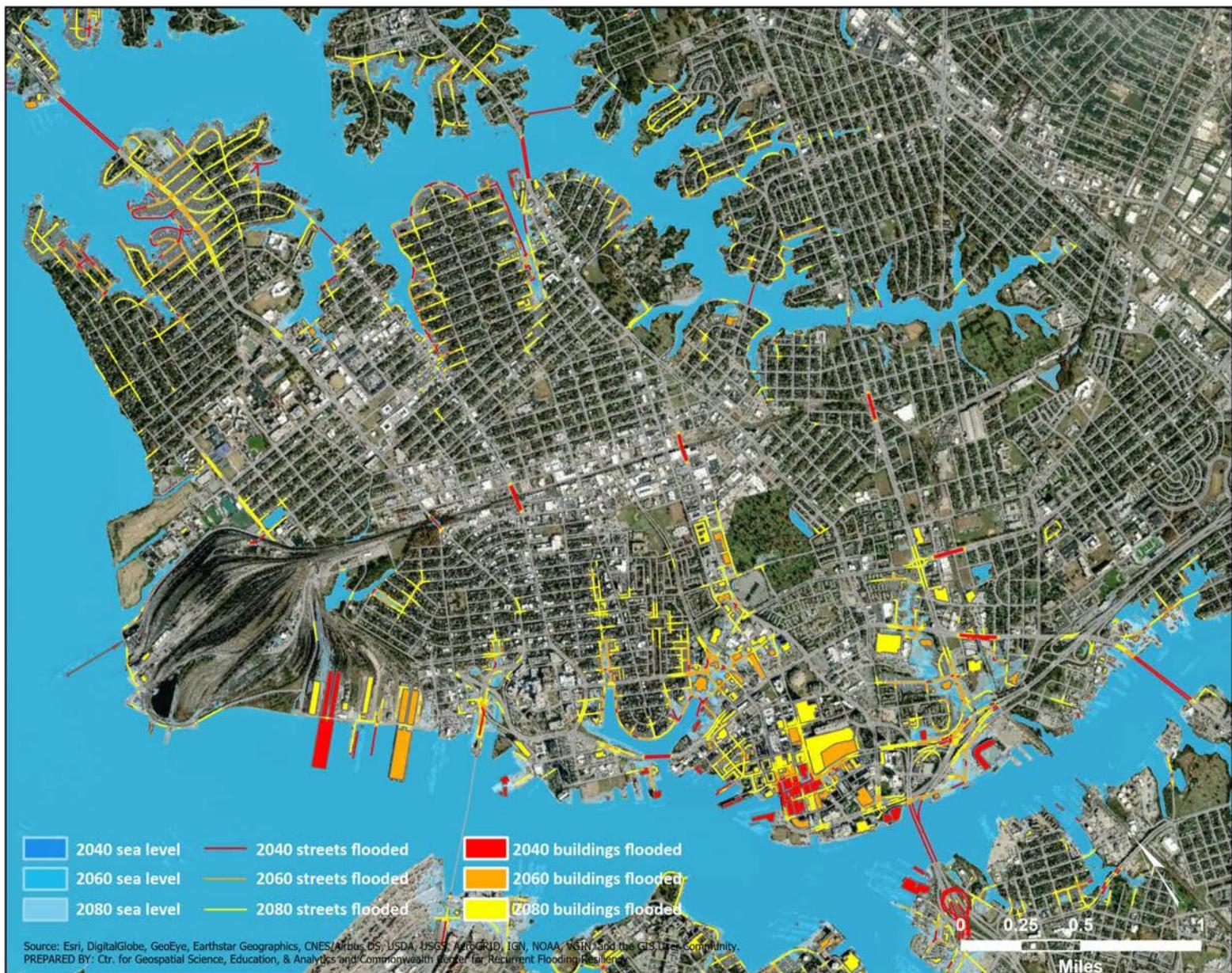
PREPARED BY: Ctr. for Geospatial Science, Education, and Analytics SEA LEVEL DATA: NOAA BASEMAP DATA: ESRI, HERE, Garmin, OpenStreetMap



10 Miles

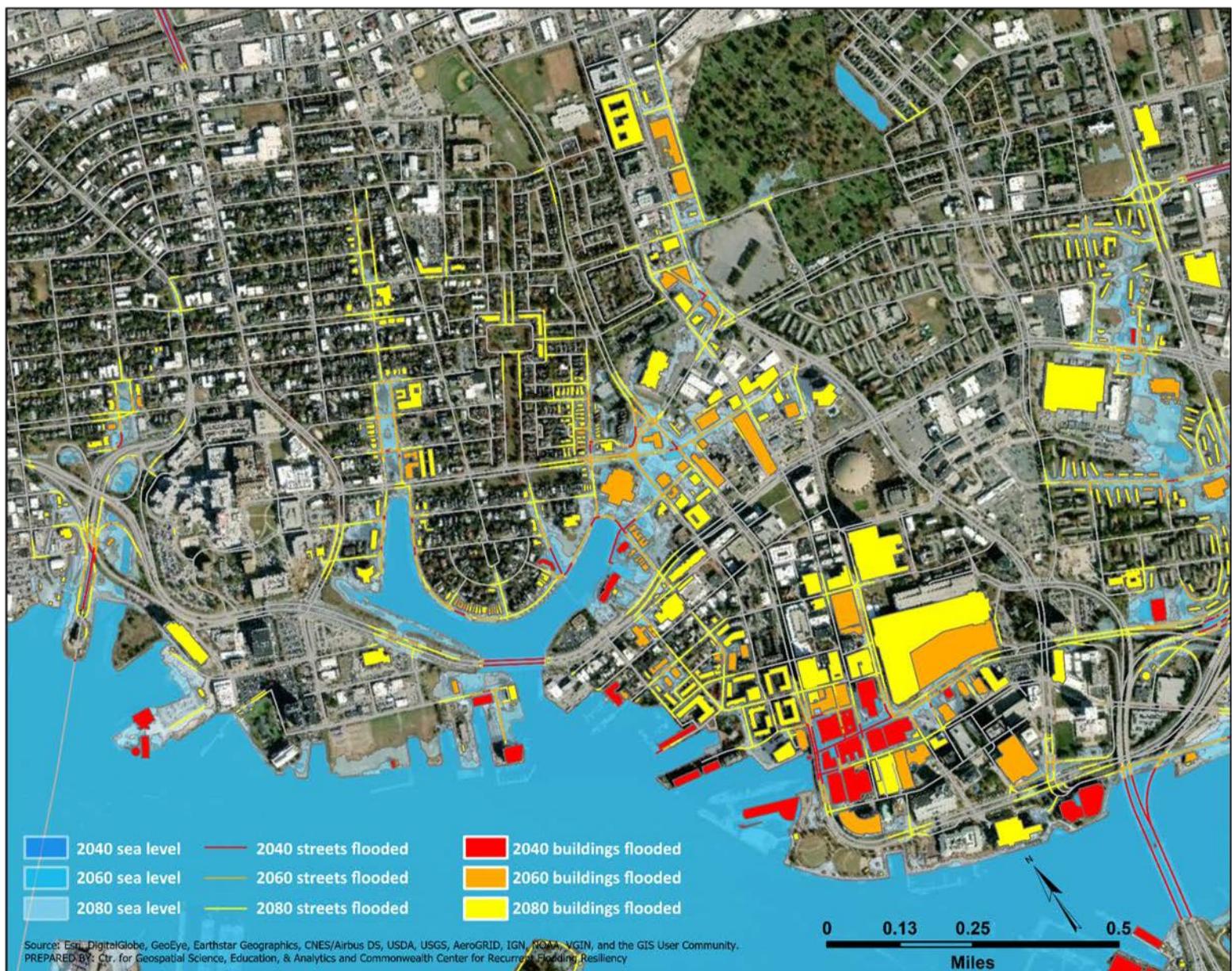
MAP 10

Norfolk



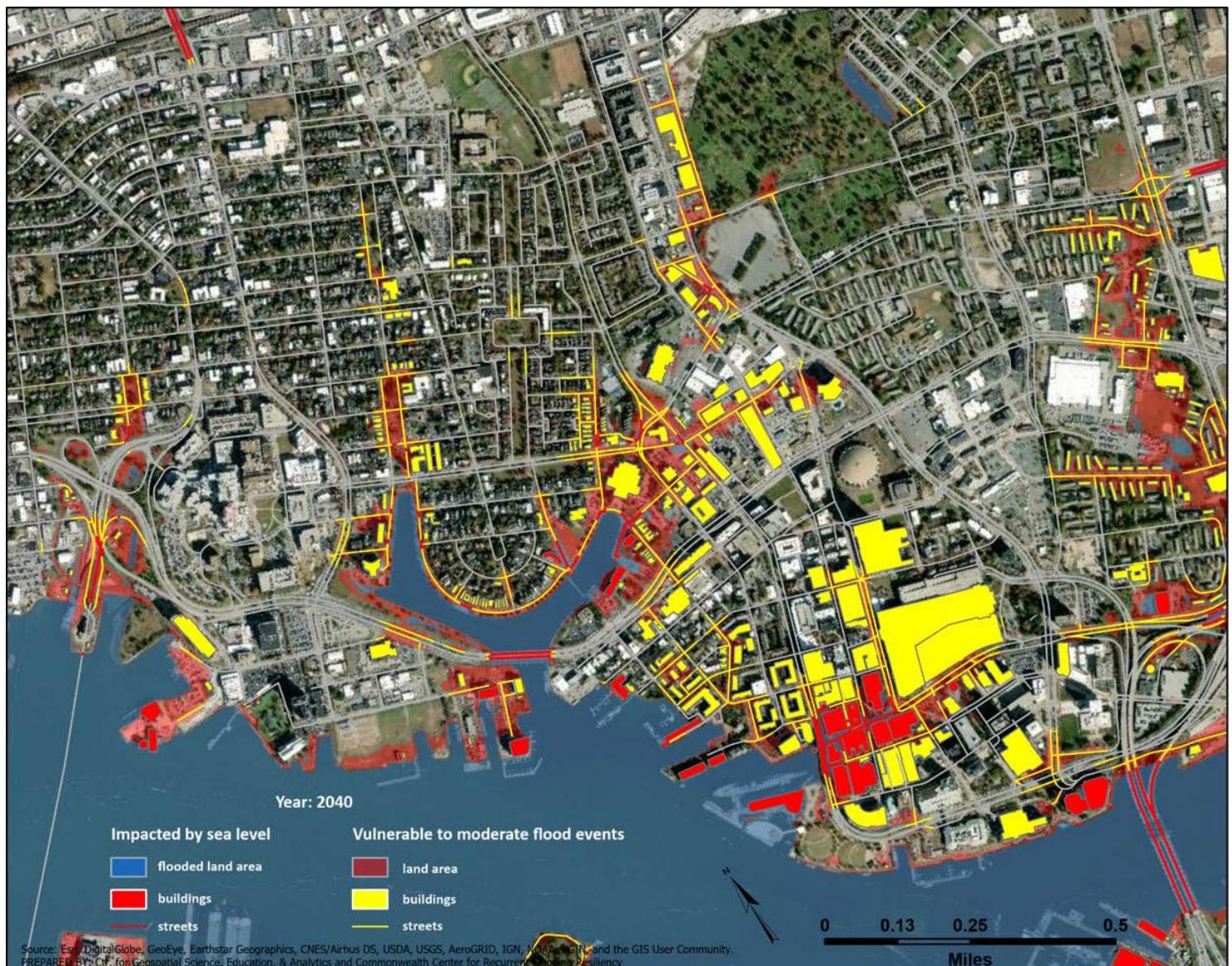
MAP 11

Norfolk



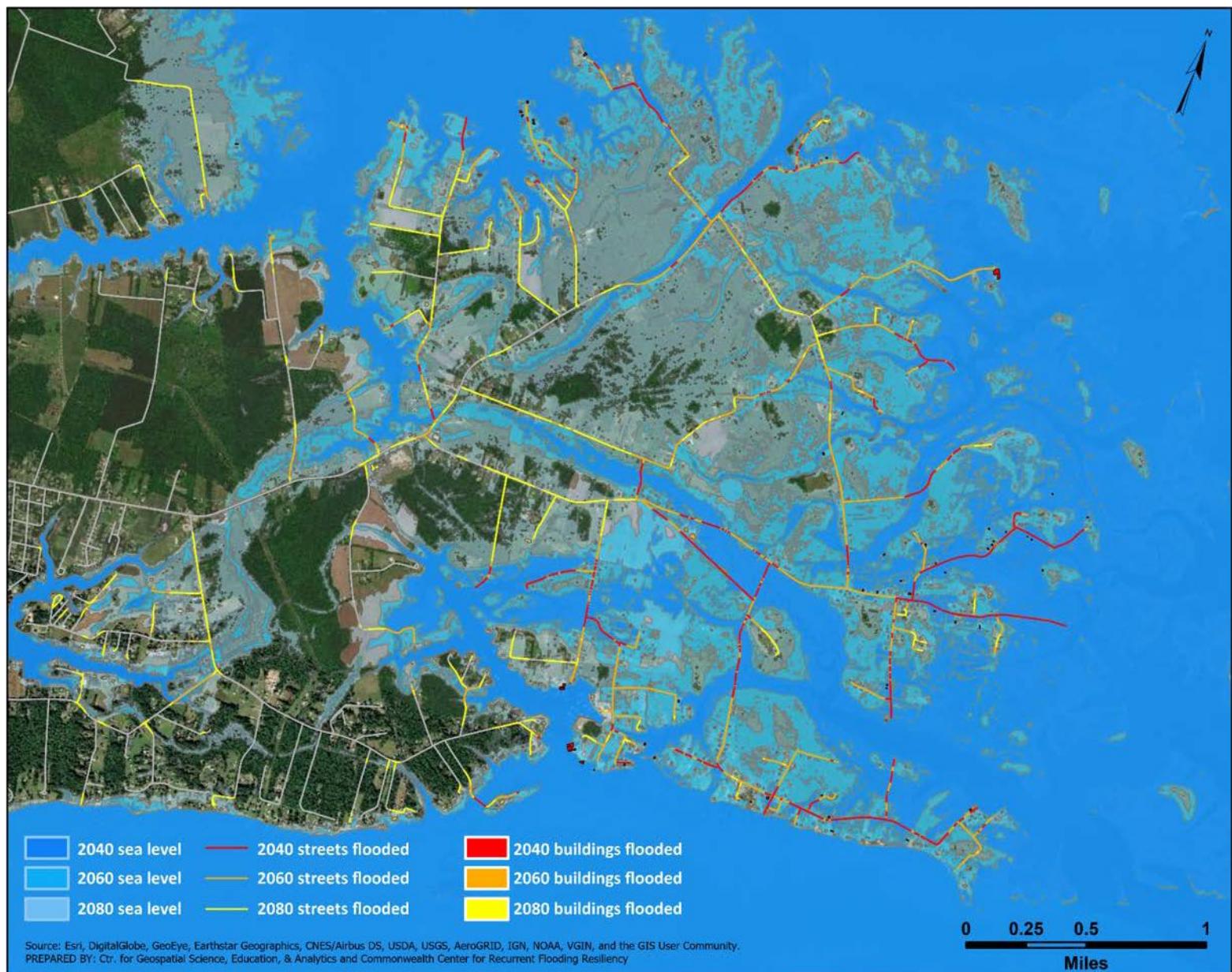
MAP 12

The Hague, Norfolk, including SLR and Moderate Flood Events for year 2040



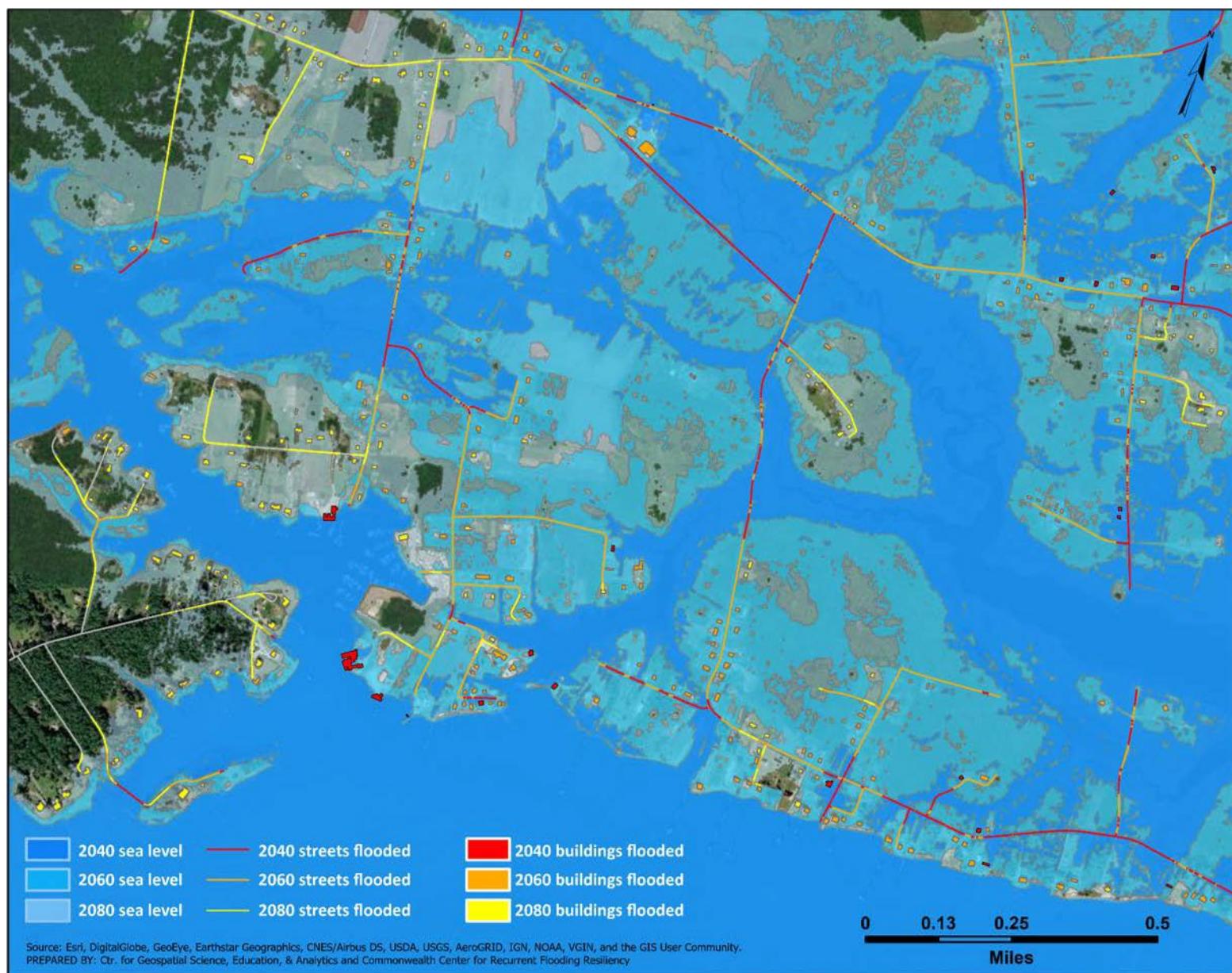
MAP 13

Guinea



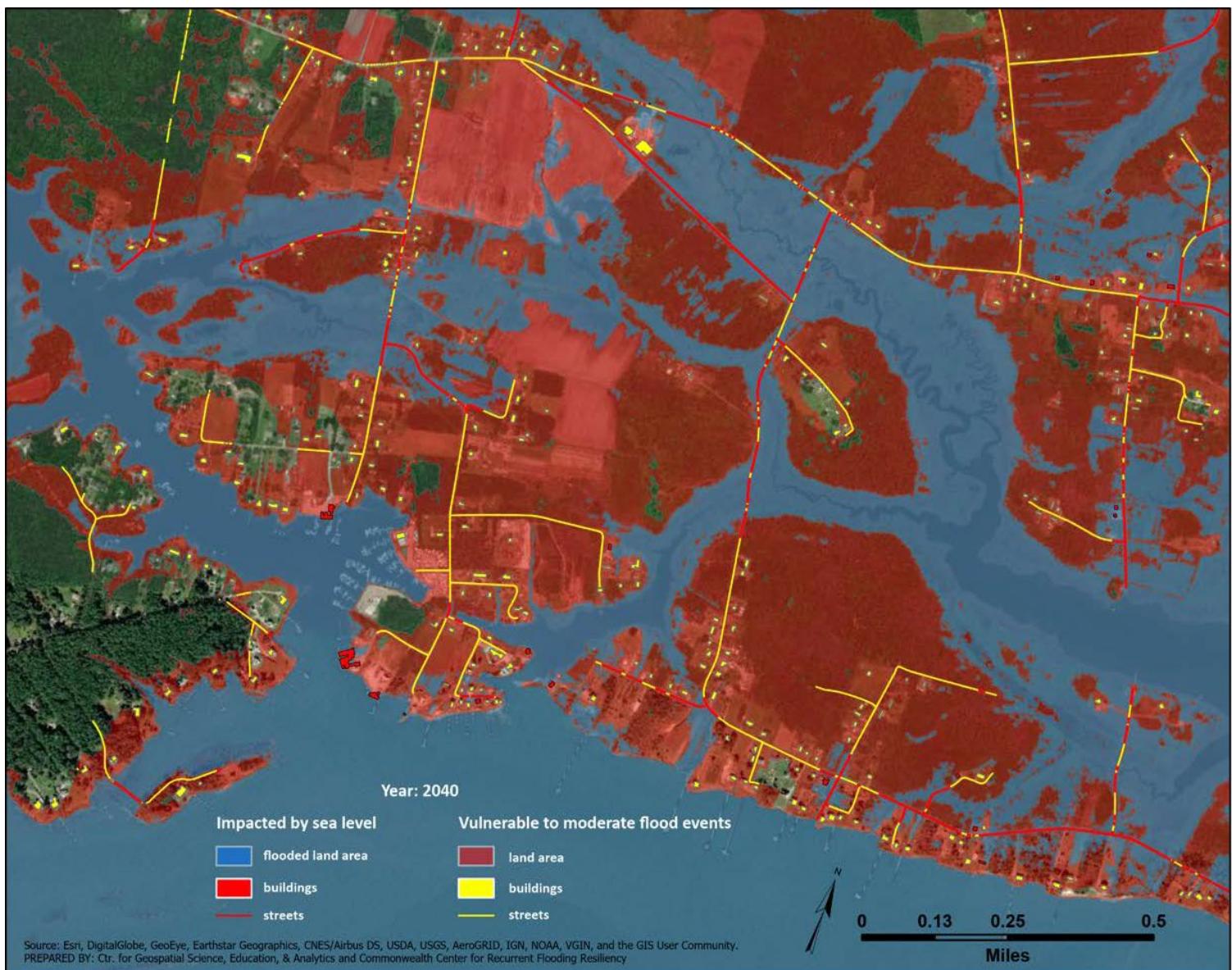
MAP 14

Guinea



MAP 15

Guinea (subset), including SLR and Moderate Flood Events for year 2040





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APPENDIX G

SUPPORTING STATE PROGRAMS

Secretary of Natural Resources

Department of Conservation and Recreation

The DCR Natural Heritage Program conserves Virginia's biodiversity, through the protection of lands critical for species habitat. Besides playing a lead role in the *ConserveVirginia* effort, the Natural Heritage Program strategically protects coastal and flood prone landscapes through the Natural Area Preserve System, managing twenty-four Natural Area Preserves (NAPs) and over 32,000 acres in Virginia's coastal zone. These lands, all protecting shoreline, riverine and/or wetlands, provide flooding resilience by protecting natural buffers against floodwaters and storm surge.

DCR's Division of State Parks has initiated several shoreline erosion and restoration projects on state park land, and has prioritized state park shorelines on the tributaries of the Chesapeake Bay for specific restorative actions. DCR State Parks also collaborate with the U.S. Army Corps of Engineers to focus on habitat restoration and erosion control at state parks.

Department of Environmental Quality

The DEQ protects and enhances Virginia's environment, and promotes the health and well-being of the citizens of the Commonwealth, providing cleaner water available for all uses, improved air quality that supports communities and ecosystems, and the productive re-use of contaminated land. DEQ supports coastal adaptation and protection through a variety of programs, including Chesapeake Bay Preservation Act compliance, groundwater and surface water planning and permitting, stormwater management, wetland and stream protection, environmental impact review, and coastal zone management.

DEQ coordinates Virginia's multi-agency response for achieving the nitrogen, phosphorus and sediment total maximum daily loads (TMDL) for the Chesapeake Bay and its tidal tributaries, including development of the Phase III Watershed Implementation Plan (WIP).¹ The Phase III WIP, issued August 2019, accounts for the additional pollution load expected from climate change impacts such as increased runoff. Two-year milestones further define the state's actions to achieve the TMDL through pollution reductions from the municipal wastewater, urban, and agriculture sectors.² Onsite wastewater systems are also a source of nitrogen pollution and threaten human health when not functioning properly; climate impacts can shorten the useful life of onsite systems. Many of the best management practices called for in the Phase III WIP for reducing nutrient and sediment pollution from farmland also provide some measure of climate adaptation and coastal resilience, including wetland restoration, streamside buffers, tree planting, cover crops, and conservation tillage. Using the shared capacity of combining funding resources to maximize co-benefits, the United States Department of Agriculture (USDA) Natural

¹ "Virginia's Final Phase III Watershed Implementation Planning," accessed July 13, 2020, <https://www.deq.virginia.gov/Programs/Water/ChesapeakeBay/ChesapeakeBayTMDL/PhaseIIIWatershedImplementationPlanning.aspx>.

² "Virginia's Programmatic Milestones," accessed July 13, 2020, <https://www.deq.virginia.gov/Programs/Water/ChesapeakeBay/ChesapeakeBayTMDL/ChesapeakeBayNutrientandSedimentReductionMilestones.aspx>.

Resources Conservation Service Carbon Management and Emissions Tool (COMET), DEQ estimates that full implementation of the Phase III WIP in 2025 will sequester over 2 million tons of CO₂e, including over 228,000 tons of soil carbon.

Virginia Council on Environmental Justice

The Virginia Council on Environmental Justice (VCEJ) was established by Governor Northam's Executive Order 29 in 2019, and made permanent in legislation passed by the General Assembly in 2020. The VCEJ is an advisory body that provides the Governor and the executive branch with recommendations intended to protect vulnerable communities from disproportionate impacts of pollution, and provide those communities with a voice and access to meaningful involvement in the decision-making process. The VCEJ submits an annual report to the Governor, and recommends policies and procedures to ensure that the Commonwealth addresses environmental justice issues proactively.

A significant goal of the VCEJ is to strengthen partnerships among government agencies, including federal, tribal, and local governments on environmental justice issues. As codified, tribal membership, local and state government, and community grass roots representation is required. Specific to climate change and resilience, the VCEJ's recommendations have centered on flooding, flood insurance, preparedness and evacuation plans, hotspot identification and zones, and enhanced research and an assessment of approaches related to identifying potential risks or disproportionate public health and economic impacts that threaten or could threaten low-income and historically underserved communities.

Secretary of Agriculture and Forestry

Department of Forestry

The Department of Forestry (DOF) protects and develops healthy, sustainable forest resources for Virginians. DOF protects 15.8 million acres of forest land from fire, insects and disease, and manages 24 State Forests totaling 68,626 acres for timber, recreation, water, research, wildlife and biodiversity. DOF uses its expertise in trees and timber management to support nature-based solutions to coastal resilience. DOF partners with private landowners, municipalities, and federal and state land managers to help incorporate stands of timber and the scientifically based silvicultural practices needed to effectively manage them into coastal landscape planning.

In this context, DOF has worked with the City of Virginia Beach, the Virginia Department of (now Department of Wildlife Resources), and Back Bay National Wildlife Refuge to develop and implement components of the city's Sea Level Wise Coastal resilience strategy, released in January 2020. DOF is also a partner in a York River Project with the Green Infrastructure Center to map the extent and location of the coastal forest, and determine the benefits it provides, and partners with DEQ, DCR, and non-governmental organizations on projects related to coastal forest and riparian buffer restoration and management.

Secretary of Transportation

Department of Transportation

Virginia has the third-largest state-maintained highway system in the country, behind Texas and North Carolina. The Virginia Department of Transportation (VDOT) builds, maintains and operates the state's roads, bridges, and tunnels.³ The Commonwealth Transportation Board (CTB) oversees VDOT, and provides funding for airports, seaports, rail, and public transportation.

In 2019, the CTB established an Environmental Subcommittee with a focus on climate change impacts. In addition, VDOT has partnered with the Virginia Institute of Marine Science (VIMS) to develop a proactive strategy for understanding and addressing sea level rise, land subsidence and recurrent flooding impacts on existing and planned road infrastructure.⁴ VIMS will further assess how that infrastructure will affect natural ecosystems in Virginia's coastal zone as the climate changes.

VDOT's research arm, the Virginia Transportation Research Council, recently completed a study in partnership with the University of Virginia focused on climate change adaptation. Released in December 2019, *Incorporating Potential Climate Change Impacts in Bridge and Culvert Design*, considered rainfall intensity, duration, and frequency in evaluating existing culvert and bridge design standards.⁵ The study found an increase in rainfall volume and frequency in the test area, and recommended updating design standards to accommodate climate-driven precipitation increases. VDOT also updated its Maintenance and Repair Manual to comply with EO 45, and adopted the NOAA intermediate high SLR curve as the planning standard for future construction of bridges over tidally influenced waters.

Secretary of Veterans and Defense Affairs

Besides assisting military veterans, the Secretary of Veterans and Defense Affairs works to strengthen Virginia's relationships with military and defense installations. Many Department of Defense (DOD) installations in Virginia are in flood hazard and other vulnerable areas, and their resilience is critical both to national security and Virginia's economy. The Secretary's office implements DOD's Readiness and Environmental Protection Integration (REPI), Joint Land Use Study (JLUS), and Sentinel Landscapes programs, which are being used to make bases in coastal Virginia more resilient to climate change.

There are seven ongoing REPI projects in Coastal Virginia DOD facilities, including; Marine Corps Base Quantico, Fort AP Hill, Naval Support Facility Dahlgren, Naval Weapons Facility

³ Virginia Department of Transportation, "The Commonwealth's Transportation Agency - About VDOT," Government, accessed July 1, 2020, http://www.virginiadot.org/about_vdot/default.asp.

⁴ Stephen C. Brich, John T. Wells, and Matthew J. Strickler, "Memorandum of Understanding Among the Virginia Department of Transportation and The Virginia Institute of Marine Science and Matthew J. Strickler, Chief Resilience Officer of the Commonwealth of Virginia," June 20, 2019.

⁵ Mohamed M. Morsy et al., "Incorporating Potential Climate Change Impacts in Bridge and Culvert Design" (Virginia Transportation Research Council, October 2019), http://www.virginiadot.org/vtrc/main/online_reports/pdf/20-r13.pdf.

Yorktown, Joint Base Langley-Eustis, Naval Air Station Oceana, and Naval Support Activity Hampton Roads NW Annex. Besides maintaining the viability of critical DOD installations and training ranges, these specific projects each contribute to both facility and coastal resilience in Virginia through identified outcomes including: improving water quality, preserving working agricultural lands, maintaining sensitive ecosystems, preserving tidal and non-tidal wetlands, sustaining sensitive species, and maintaining natural wildlife corridors.⁶ In the 2020 National Defense Authorization Act (NDAA), the REPI Program language was modified to include maintaining or improving military installation resilience, which expands the nature and focus of the program beyond its original preservation of habitat to avoid environmental restrictions on military operations.⁷ “REPI projects to improve or maintain resilience may now protect, restore and support off-base natural infrastructure that contributes to preventing, preparing for, or recovering from extreme weather - related events, or from anticipated or unanticipated changes in environmental conditions, including. . . storm surge, sea level rise, and coastal and riverine flooding.”⁸

JLUS studies are cooperative planning efforts that address encroachment threats to military installations and related infrastructure. Compatible use JLUS studies create an implementation plan to address encroachment related to natural hazard resilience, specifically related to the impact of extreme weather events, tidal flooding, storm surge, and stormwater and floodwater management.⁹ Coastal Virginia is fortunate to have been selected to participate in four compatible use studies in progress or completed by DOD Office of Economic Adjustment (OEA). These include a Hampton Roads Study, the Joint Base Langley-Eustis Study, Resilience Addendum (completed in 2018), Norfolk/Virginia Beach JLUS (completed in 2019), and an ongoing Chesapeake/Portsmouth study scheduled for completion in late 2020. Because of the recently completed JLUS for Virginia Beach and Norfolk, is working with HRPDC to continue planning to reduce encroachment by recurrent flooding through considering one or more additional grant submissions. The City of Hampton, working with Joint Base Langley, continues to work with OEA, leveraging their JLUS recommendations and outcomes, to begin detailed planning for a relocation of the JB Langley Main Gate to an area with improved access and resilience to flooding.

The Secretary is coordinating with the Secretary of Agriculture and the Secretary of Natural Resources to apply for a Sentinel Landscapes designation and program for the Commonwealth. The Sentinel Landscapes program grew from an interest in expanding the REPI program beyond simple land acquisition, to include additional Federal partners to leverage federal funding, attract private investments, encourage market-based solutions and incentivize desired actions on private

⁶ “Readiness and Environmental Protection,” accessed July 10, 2020, <https://www.repi.mil/Resources/State-Fact-Sheets/>.

⁷ U.S. Department of Defense Office of the Secretary of Defense for Sustainment, “REPI Program Guide” (U.S. Department of Defense, April 2020), 4.

⁸ U.S. Department of Defense Office of the Secretary of Defense for Sustainment, 12.

⁹ U.S. Department of Defense Office of Economic Adjustment, “Military Installation Sustainability,” accessed July 10, 2020, <https://www.oea.gov/our-programs/military-installation-sustainability>.

lands. The Commonwealth's proposal includes 4 anchor facilities, MCB Quantico, Fort AP Hill, Fort Pickett, and Joint Base Langley-Eustis, whose extended regional geographic security corridor boundaries include nearly all coastal Virginia DOD facilities, and large portions of Coastal Virginia, and Chesapeake Bay and other watersheds. Under the new authority for REPI to promote installation resilience, if selected, this program will provide the Commonwealth with expanded opportunities for land conservation, shoreline, wetlands, watershed, and natural and working lands preservation in critical and vulnerable areas of Coastal Virginia.

APPENDIX H

**DEPARTMENT OF CONSERVATION AND RECREATION REPORT TO
THE GOVERNOR PURSUANT TO EXECUTIVE ORDER 24 SECTION
2C: REVIEW OF COMPLIANCE WITH FLOOD PROTECTION AND
DAM SAFETY LAWS (2019)**

Matthew J. Strickler
Secretary of Natural Resources

Clyde E. Cristman
Director



Rochelle Altholz
Deputy Director of Administration and Finance

Russell W. Baxter
Deputy Director of Dam Safety & Floodplain Management and Soil & Water Conservation

Thomas L. Smith
Deputy Director of Operations

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION

July 30, 2019

The Honorable Ralph S. Northam
Governor of Virginia
1111 E. Broad St.
Richmond, Virginia 23219

Dear Governor Northam;

On behalf of the Department of Conservation and Recreation please accept the enclosed report as directed by Executive Order 24 (2018).

Section 2 C. of the Order directed the Department, in coordination with the Commonwealth's Chief Resilience Officer, to review Title 10, Chapter 6 (Flood Protection and Dam Safety) of the Code of Virginia and make recommendations that would strengthen Virginia's ability to protect life and property from flooding by natural and man-made causes. This report offers extensive recommendations that, if fully implemented, will make the Commonwealth safer and more resilient from the undeniable changes in climate that have already begun to affect our ability to protect our land, infrastructure, businesses and citizens.

In addition to our dedicated staff in the Division of Dam Safety and Floodplain management, I would like to thank Secretary Strickler and Deputy Secretary Saks for their assistance and guidance in the development of this report.

With kind regards, I am,

Sincerely,

Clyde E. Cristman
Director

Cc: The Honorable Matthew Strickler
The Honorable Joshua Saks
Mr. Russell W. Baxter
Ms. Wendy Howard-Cooper

600 East Main Street, 24th Floor | Richmond, Virginia 23219 | 804-786-6124

*State Parks • Soil and Water Conservation • Outdoor Recreation Planning
Natural Heritage • Dam Safety and Floodplain Management • Land Conservation*

Response to Executive Order 24
Department of Conservation and Recreation

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INTRODUCTION

Flooding has major consequences for the Commonwealth of Virginia. It impacts public safety, environmental quality, local economies, and can devalue or destroy the most significant financial asset for many individuals - their home or business. With more than 100,000 miles of streams and rivers, as well as 10,000 miles of estuarine and coastal shoreline, Virginia's flood risk is statewide, comes in many forms, and is increasing because of climate change and increased development in flood-prone areas.

2018 was the wettest year on record for 21 localities across Virginia, including Roanoke, Lynchburg, and Arlington which each received more than five feet of rain. Based on preliminary data, the statewide annual precipitation record of 86.06 inches was surpassed by nearly a foot, with a station in Nelson County receiving more than 97 inches.¹ We can expect more wet conditions in the coming years. The 2018 National Climate Assessment, published by the U.S. government, anticipates that "Both the frequency and severity of extreme precipitation events are projected to continue increasing in the [Southeast] region under both lower and higher scenarios. By the end of the century, projections indicate as much as double the number of heavy rainfall events (2-day precipitation events every 5 years) and up to a 21% increase in the amount of rain falling on the heaviest precipitation days (days with a 20-year return period)."²

According to the National Oceanic and Atmospheric Administration (NOAA), during 2016-2018 alone, six different billion-dollar hurricanes hit the United States, causing nearly \$330 billion in damage. During this same time period, National Flood Insurance Program (NFIP) flood insurance claims exceeded \$95 million in Virginia. Since the NFIP's creation in 1976, Virginians have filed more than 48,000 claims and received more than \$733 million in damage payments. Although flooding continues to become more frequent and more severe, only three percent of Virginians are covered by federally backed flood insurance.

Several federal programs are in place to address flood risk across the United States including the NFIP, the Community Rating System (CRS), and the Coastal Barrier Resource System (CBRS). These programs provide critical services and flood risk reduction measures, including access to flood insurance, disaster assistance, flood insurance premium discounts, and conservation of undeveloped coastal barriers. However, these programs alone cannot reduce all flood risk, and the Commonwealth must build upon the foundation these programs create to further protect life, public infrastructure and private property in Virginia.

To address this growing threat, on November 2, 2018, Governor Northam issued Executive Order 24: Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards. Section 2C of that order requires the Director of the Department of Conservation and Recreation (DCR), in coordination with the Chief Resilience Officer of the Commonwealth, to review DCR's

¹ https://www.richmond.com/weather/year-of-extremes-richmond-and-virginia-s-biggest-weather-stories/article_a2c08eb0-07ec-5f10-b582-b66904c53a08.html

² Fourth National Climate Assessment, Southeast Region Section <https://nca2018.globalchange.gov/>

implementation of the Code of Virginia, Title 10, Chapter 6, Flood Protection and Dam Safety. Implementation of this Code section entails: assisting the Federal Emergency Management Agency (FEMA) with mapping the Commonwealth's flood risk, assisting communities in reducing their flood risk through participation in the NFIP and CRS, providing education and outreach related to flood risk and flood insurance, and regulating construction, operation and maintenance of dams, among other activities.

Through the work outlined above, DCR is the lead state agency in helping individual property owners assess and mitigate their flood risk and risks to the public related to dams. While Virginia's Coastal Resilience Master Plan will work from a regional or statewide level to deliver large scale, coastal flood protection measures, the recommendations in this report focus on reducing both riverine and coastal flood risk at a property or community level across the Commonwealth. This report also addresses the risks associated with poorly maintained dams and the costs to dam owners in the Commonwealth to properly operate and maintain their dams. These approaches, in many cases, will build off of existing local, state and federal programs and work in concert to protect people and property from flooding, sea level rise, and extreme weather.

This report, submitted per the requirements of Executive Order 24, provides an overview of Virginia's Dam Safety and Floodplain Management laws and regulations and makes recommendations for improving dam safety and floodplain management across the Commonwealth.

FLOODPLAIN MANAGEMENT

Overview of Existing Laws, Regulations, and Requirements

Title 10, Chapter 6 of the Code of Virginia grants powers and duties to DCR regarding the protection of life and property from the impacts of flooding. DCR is empowered to serve "as the coordinator of all flood protection programs and activities in the Commonwealth" with local, state, regional and federal agencies. DCR is also empowered to "[e]stablish guidelines which will meet minimum requirements of the National Flood Insurance Program."

The Code of Federal Regulations (44 CFR 60.11-13) defines how states may comply with the NFIP. There are two options for compliance. First, state agencies must follow local floodplain ordinances (so long as those ordinances meet NFIP minimums) or states must establish and enforce a state-level regulatory program to ensure state projects do not conflict with NFIP minimum standards. If any state-owned property is located in a community that is not participating in the NFIP, the state must have state level regulations for that property. Virginia has 290 communities that participate in the NFIP and 33 communities that do not. Of the communities that do not participate in the NFIP, only 16 have mapped special flood hazard areas, effectively masking their risk and leaving people and property vulnerable.

The Code of Federal Regulations (23 CFR 650) also "prescribes Federal Highway Administration (FHWA) policies and procedures for the location and hydraulic design of highway encroachments on flood plains, including direct Federal highway projects administered by the FHWA."

Regulations in this section of Code “apply to all encroachments and to all actions which affect base flood plains, except for repairs made with emergency funds (23 CFR part 668) during or immediately following a disaster.” Requirements are identified for public involvement, location hydraulic studies, alternatives, and design standards for encroachments, including that the “design of encroachments shall be consistent with standards established by the FEMA, State, and local governmental agencies for the administration of the National Flood Insurance Program”.

In 1997, Governor George Allen issued Executive Memorandum 2-97 (the Memorandum) which required that state owned development in participating NFIP communities must comply with the standards of the NFIP. According to the Memorandum, DCR, as the designated “state coordinator” of the NFIP, is responsible for ensuring that “all construction or land disturbing activities initiated by an agency of the Commonwealth, or by its contractor, in floodplains shall comply with the locally adopted floodplain management ordinance.” The Memorandum also requires state agencies “undertaking land disturbing or construction activity” in communities without floodplain ordinances, “shall comply with the standards of the Program” and that new state-owned buildings are prohibited in floodplains unless a variance is granted by the Department of General Services (DGS) which, per the Memorandum, must consult with DCR prior to issuance.

In addition to DGS reviews, DCR receives some projects for review from the Virginia Department of Transportation (VDOT) through their inter-agency coordination meeting, as well as other state agency projects through Joint-Permit Application reviews or the Environmental Impact Review (IER) process. When reviewing these projects, DCR provides comments that the state agency must reach out to the local floodplain administrator and comply with the local floodplain ordinance in accordance with the memorandum. DCR is not aware of the project status after comments are submitted, and DCR does not review all state agency projects through these review processes.

It is our assessment that the state is not in full compliance with 44 CFR 60.11-13 or 23 CFR 650. It is unclear if all new state-owned buildings are reviewed by DGS in accordance with the memorandum during the EIR process or if those buildings are complying with local floodplain ordinances. DCR has discussed complying with the Memorandum on several occasions with VDOT, and VDOT believes it is not required to be permitted on a local level per the Memorandum. During local program reviews conducted by DCR and FEMA, it has been reported that not all state projects have been permitted in compliance with local floodplain ordinances, as required by the Memorandum. Examples include bridges and boat ramps. Furthermore, due to staffing constraints, DCR has been unable to fully discharge its responsibilities outlined in Code and the Memorandum.

There is no place in Code, regulation, or executive guidance that clearly defines the standards for agency compliance with the NFIP in non-participating communities. The Uniform Statewide Building Code (USBC), the regulations that must be complied with when constructing a new building, outlines the regulations for construction and rehabilitation of buildings, structures, and equipment across the Commonwealth, with which state agencies must comply. The current edition of the USBC (2015 Version, effective September 4, 2018) addresses some provisions for construction in flood zones, but it does not currently meet NFIP minimums. At this time, we are unable to ascertain whether the state has developed land in floodplains in the 16 communities that

have mapped floodplains but do not participate in the NFIP. It is possible that no state-owned development has taken place in these areas, but we would require further investigation to make any definitive determination.

Recommendations

In our judgement, an update to the Commonwealth's approach to managing activities in floodplains – including sustained investments to improve services – is overdue in order to reflect current authorities, requirements, and conditions. This update will result in a safer, more resilient Virginia with a lower potential for flood related deaths, reduced damage to infrastructure and buildings, lower insurance costs, more efficient and targeted use of current and future resources, and achievement of administrative efficiencies. We offer the following recommendations to help achieve those goals by:

A. Building Stronger State Government Capabilities

A strong foundation of proper authorities, communication, consultation, and review will ensure state agencies are supporting each other and acting in full compliance with the NFIP and other relevant local, state, and federal requirements. With such a foundation, state property will be better protected, reducing taxpayer exposure to the costs of recovering from flooding.

1. Establish a process to increase communication and coordination on flood-related activities between state and federal agencies, as well as state and federally-recognized Indian tribes in the Commonwealth

§10.1-602 of the Code of Virginia establishes DCR as the coordinator of all flood protection programs and activities in the Commonwealth, including the coordination of federal flood protection programs administered by the United States Army Corps of Engineers (USACE), the United States Department of Agriculture, FEMA, the United States Geological Survey (USGS), the Tennessee Valley Authority (TVA), other federal agencies and local governments.

In order to properly discharge these responsibilities, DCR must be aware of activities being proposed or conducted by other agencies to ensure information being shared among state, federal and local agencies and the public is accurate and that efforts are not duplicated.

1.1. Create a formal process for all state agencies to submit information on all flood-related activities or projects they propose to conduct to DCR for review, evaluation, and feedback.

- a. Information provided to DCR should include, but not be limited to, development projects in a floodplain, flood-related educational or outreach materials, communications with localities about flooding, flood-related projects

- being funded by any agency of the Commonwealth, including independent agencies and institutions of higher learning.
- 1.2. Create a formal process that federal agencies may use to share flood-related information with DCR.
 - 1.3. Continue the Virginia Silver Jackets team (an interagency team of federal and state agencies primarily funded by the USACE that was established in Virginia in 2010 to address flood risk) and work to add more state and federal partners. Utilize this group and associated funding opportunities to coordinate and implement flood-related activities. DCR is the lead state agency on the team, and the current Silver Jackets co-chair is a DCR employee.
 - 1.4. Require the state and federal recognized tribes to commence discussions about flood risk.
- 2. Create a state level program for NFIP compliance for all state agencies, to be administered by DCR**
- NFIP compliance can be best assured with clear standards and a proper review, approval, and enforcement process for state agencies. The current authority, Executive Memorandum 2-97, is more than two decades old, is deficient in scope and requires an update to ensure current NFIP compliance. A program with one set of requirements applicable to all state agencies will reduce the administrative burden on both state agencies and localities, and assist in maintaining compliance with the NFIP as state agencies will not have to adjust activities based on multiple local ordinances
- 2.1. Request that the Governor issue an Executive Order that replaces Executive Memorandum 2-97 to create a new policy and conditions that are compliant with the NFIP, and direct DCR to develop such a program until requirements are established in Virginia.
 - 2.2. Amend §10.1-603 of the Code of Virginia to include state-level floodplain management requirements that conform to NFIP minimums including a review, approval, and enforcement process for relevant activities covered by all state agencies, to be administered by DCR. Such state regulations should not be confined to NFIP minimums if other factors dictate additional protections, such as future flood conditions and sea level rise. Additional resources will be required to accommodate the administrative review, approval, and enforcement and additional staff resources would be necessary to properly implement such a program in a timely manner.

B. Engage, Assist, and Strengthen Virginia Communities

In order to fully realize the benefits of the NFIP and for the safety and protection of life and property, local floodplain ordinances must be in compliance with NFIP minimums. This will require some revisions to local ordinances and other local land use regulations and plans. Leadership from the state is necessary to ensure localities fully protect life and property in conformance with NFIP standards. Therefore, the Commonwealth should establish minimum floodplain management requirements for local ordinances and by a specified date, require all localities to participate in the NFIP.

- 1. Create minimum floodplain management requirements identified in Code, with oversight administered by DCR, which mandates NFIP participation for all localities and local compliance with the established requirements. Such regulations should not be confined to NFIP minimums if other factors dictate additional protections, such as future flood conditions and sea level rise**

§10.1-602 of the Code of Virginia empowers DCR to establish guidelines that comply with the minimum NFIP standards “to assure that all citizens living in flood-prone areas may have the opportunity to indemnify themselves from flood losses through the purchase of flood insurance” through the NFIP and to “[m]ake, in cooperation with localities, periodic inspections to determine the effectiveness of local flood plain management programs, including an evaluation of the enforcement of and compliance with local flood plain management ordinances, rules and regulations.”

Thirty-three (see [Appendix C](#)) of Virginia’s 323 communities do not participate in the NFIP. Of those that do not participate, 16 have been mapped by FEMA with special flood hazard areas and 17 have been mapped as having no special flood hazard areas. Regardless of such status, the benefits of participation as noted above can accrue to localities even where no special flood hazard areas exist, and NFIP flood insurance is only available to citizens residing in participating communities.

Participation in the NFIP allows communities to be eligible for NFIP flood insurance, disaster assistance, certain federal grants and loans, and federally backed mortgages in special flood hazard areas. It can also increase awareness to flood risk among residents of those communities.

A program with uniform standards for all localities will reduce the administrative burden on local governments and DCR, assist in maintaining compliance with the NFIP, provide CRS credits, and address flood risk more consistently across Virginia. This would also allow the Commonwealth more control over the floodplain program by decreasing dependency on FEMA for determining and enforcing compliance. The Commonwealth has this authority as §10.1-658.A. of the Code of Virginia states that “Flood waters disregard jurisdictional boundaries, and the public interest requires the management of flood-prone areas in a manner which prevents injuries to persons, damage to property and pollution of state waters.”

- 1.1. Propose legislation establishing authority in Code for DCR to develop such a program. Additional resources will be required to accommodate the administrative review, approval, and enforcement of this program.
- 1.2. Amend §15.2-9 of the Code of Virginia to clarify the powers of local governments to adopt floodplain regulations outside of their zoning ordinances.
- 1.3. Amend §15.2-2223 of the Code of Virginia to require that flood risk is addressed in Comprehensive Plans so that local development and planning goals are established to limit or reduce flood risk within the community similar to the requirements for Hampton Roads localities to address recurrent flooding in §15.2-2223.3.
- 1.4. Amend the Library of Virginia retention policies to add a special category that requires floodplain documents be maintained in perpetuity, in compliance with NFIP minimums.
 - a. The NFIP requires that records related to development in all special flood hazard areas be maintained as a prerequisite for participation in the NFIP (44 CFR 59.22(a) (9)). These records must be available for review if DCR or FEMA requests these documents, such as part of a community assistance visit to review the local program's compliance with the NFIP. These records (i.e. permit files, elevation certificates, flood proofing certificates, variances, etc.) currently fall under several different categories, with different retention periods, identified in the Library of Virginia Records Retention of Disposition Schedule.

2. Encourage participation in NFIP's Community Rating System (CRS)

NFIP participating communities can reduce policyholders' premiums by participating in the CRS program. The program awards points to communities that implement flood protection policies beyond minimum NFIP participation requirements. In Virginia, 26 communities participate in the CRS program, as shown in Figure 1 below (see [Appendix D](#) for additional information).

Although this is just nine percent of the 290 NFIP communities in Virginia, 80 percent of all flood insurance policies in Virginia are written in CRS communities. This amounts to a total statewide savings of more than \$6.8 million for about 86,000 policyholders. Nationally, CRS communities represent about 5 percent of all NFIP communities and about 69 percent of all flood insurance policies written according to FEMA. Encouraging greater CRS participation amongst Virginia's localities will lower flood insurance rates, better communicate risk and sometimes reduce risk

Virginia
NFIP Community Rating System Participation
May 1, 2019

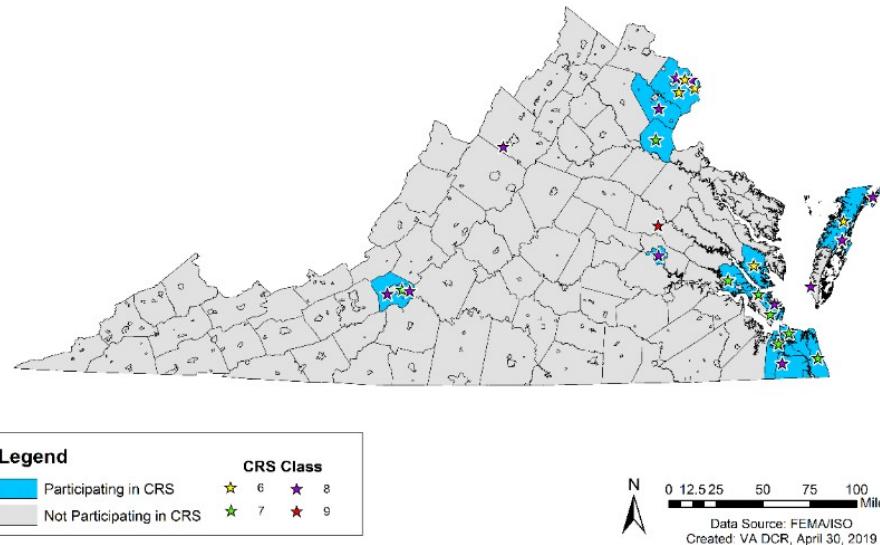


Figure 1: Virginia CRS Participation and Class effective May 1, 2019

- 2.1. Provide assistance localities to help with joining CRS, as well as maintaining and improving their program. Establish a CRS Assistance Team on the state level to provide this assistance. Additional staff resources and associated funding would be necessary to effectively implement this program and as CRS participation increases, additional resources may be needed.
- 2.2. Create a CRS tool kit to aid communities in joining the CRS program, including, but not limited to, an outline of eligible activities localities are already required to implement and opportunities to receive more CRS credits by taking actions to reduce flooding and better communicate risk.
- 2.3. Pursue developing a regional CRS model for localities to implement to lessen the burden on local governments that wish to participate in CRS.
- 2.4. Encourage local implementation of CRS eligible activities to reduce flood risk even if CRS participation is not desired by the locality.
 - a. Although CRS participation can benefit all Virginia communities, we do not believe it should be mandatory for localities to join the CRS program at this time because acceptance into the program is entirely dependent on FEMA and its contractor's approval. Programmatic changes and additional resources on the state and federal level would be needed to implement a mandatory program.
3. Establish a comprehensive post-disaster damage assessment process

- 3.1. As part of the responsibilities of the Emergency Operations Center (EOC) develop a state-level damage assessment procedure involving DCR, FEMA, the Virginia Department of Emergency Management (VDEM), and the Virginia Department of Housing and Community Development (DHCD) to establish a comprehensive damage assessment process that complies with NFIP, Hazard Mitigation Assistance, and building code requirements.
- 3.2. Upgrade Crisis Track, damage assessment software purchased by VDEM for localities, to incorporate floodplain information and substantial damage forms to make this process more efficient.
- 3.3. Develop guidance and training related to implementing this comprehensive damage assessment process on the local level for both local and state agency staff.

B. Improve Risk Identification and Risk Communication

A key to ensuring proper planning, awareness, and response is the development and maintenance of state-of-the-art flood risk maps and associated mapping tools for all of Virginia. The Virginia Flood Risk Information System (VFRIS) should be upgraded, based on the example set by North Carolina that contains digitally accessible flood hazard data, models, maps, risk assessments, and reports. It also provides geospatial base map data, imagery, LiDAR data, along with hydraulic and hydrologic models that are available for download and use.

I. Create a statewide floodplain mapping program to produce more detailed and accurate floodplain maps for the entire state, available through VFRIS

- 1.1. Secure new mapping models to update the A flood Zones throughout the state that do not currently have elevation data or floodways delineated. (Descriptions of all flood zones referenced in this report are available in Appendix B.)
- 1.2. Secure new mapping models to update the AE Zones throughout the state to accurately reflect the flood risk in those areas and delineate floodways where they do not exist.
- 1.3. Model flood risks beyond the one percent annual chance flood that is mapped by FEMA, including but not limited to future conditions, stormwater runoff, sea level rise, and different storm frequencies throughout the state.
 - a. Additional resources will be required to create, implement, and maintain a mapping program. Additional staff resources would be not be necessary, but additional contract support would be needed.
 - b. By providing the state, localities, and property owners with information needed to better manage flood risk and reduce flood damages, it would also allow the

state more control over the floodplain program by decreasing dependency on FEMA for such mapping.

2 Create a clearinghouse of flood-related information and inundation mapping in Virginia

More and better data regarding flood risk, repetitive loss, and other information will enhance Virginia's ability to plan for and protect against flooding.

- 2.1. Integrate a variety of datasets into VFRIS to provide a comprehensive analysis of risk. Include data such as parcel information, property and structure values, structure construction data, flood zones and associated data, stream gauges, ground elevations, evacuation routes, first floor elevations, historic flood damages, and other attributes.
- 2.2. In accordance with §10.1-602 of the Code of Virginia, include all flood protection projects implemented by federal agencies and the estimated value of property damaged by major floods.
- 2.3. Obtain or create first floor elevations for all structures across the Commonwealth to incorporate into this data.
 - a. Make elevation data publicly available to help Virginians better understand flood risk, flood insurance rates, and potential damages faced by property owners and localities. To address the potential significant cost of such an effort, limit analysis only for structures that exceed a certain size.
 - b. Create a public database for elevation certificates in the state. Certificates could be obtained from localities or property owners.
- 2.4. Identify and compile maps and other relevant information regarding historic flood damage for the Commonwealth.
- 2.5. Identify all rain gauges, stream gauges, forecast points, dam monitoring devices, and other available sensors in the Commonwealth, identify areas without coverage, and add or update equipment where needed to improve Virginia's Integrated Flood Observing and Warning Systems (IFLOWS) a statewide network to track flood risk in real-time.
 - a. Use this statewide gauge network to develop flood warning and response systems for state agencies and local governments to be better prepared for flooding disasters, including potential dam failures. Ensure warning and response systems are implemented in accordance with CRS requirements to maximize local benefits.

- b. Use this data, with mobile LiDAR and the floodplain mapping program, to assist with real time disaster efforts, such as identifying road closures, shelters that may be inundated, etc.
 - c. Partnerships with federal, state, and local agencies will be vital to implement an effective statewide network.
 - d. Ensure DCR's role in developing and administering the IFLOWS network as maintained by VDEM.
- 2.6. Use this clearinghouse to prioritize mitigation opportunities, support grant applications, and target outreach efforts.
- 2.7. Ensure updated CBRS maps developed by the U.S. Fish and Wildlife Service (FWS) are incorporated into Virginia's mapping program and that future changes reflect the Commonwealth's interest in protection and resilience.
 - a. The CBRS maps are currently a layer in VFRIS, but these maps are no longer included on FEMA Flood Insurance Rate Maps (FIRM). CBRS maps in Virginia were updated in 2014 and changes are currently being proposed.
 - b. DCR should identify areas for FWS to include in the CBRS as System Units or Otherwise Protected Areas.

3. Acquire mobile LiDAR along roadways across the Commonwealth

This data would allow for flood models to be developed that more accurately determine how flooding will impact roadways and travel routes throughout the Commonwealth, including how flood waters will inundate roadways and the depth of that water.

- 3.1. Use data to develop flood models based on different storm frequencies for roadways and travel routes throughout the Commonwealth and make available on VFRIS.
- 3.2. Use these new flood models to create and/or update state and local evacuation routes and plans based on inundation of roadways.
- 3.3. Use these new flood models to steer maintenance and future development plans of roadways.
- 3.4. Use these new flood models to update local community development plans, statewide development plans, hazard mitigation plans, etc.

C. Encourage Broader Adoption of Flood Insurance

Flood insurance provides building and contents coverage for property owners and renters to recover from flood damage and is intended to restore property to its pre-damage state. Flood damages are not typically covered by homeowner's insurance, and federal disaster assistance is only available when a Presidentially Declared Disaster occurs. The cost of flood damages can be catastrophic, so it is imperative that Virginians have flood insurance coverage to protect their property and be able to recover faster after a flood event.

According to FEMA, only three percent of Virginians have flood insurance for residential properties, slightly less than the national average, and 31 percent of Virginians located in the special flood hazard area have flood insurance for residential properties. Old Dominion University, as part of their 2018 Life in Hampton Roads Survey, found that 60 percent of homeowners that said they purchased flood insurance thought flooding was covered by their homeowner's insurance; however, most homeowner's insurance policies do not cover flooding. Outreach and education related to flood insurance coverage is necessary.

Additional staff resources will be required to provide regular and consistent messaging and to effectively manage dedicated flood insurance and flood risk outreach through DCR.

- 1. Identify and implement strategies to increase flood insurance coverage in Virginia and support FEMA's goal to increase flood insurance coverage by 50 percent by 2022.**
 - 1.1. In concert with the insurance industry, FEMA, the State Corporation Commission (SCC), and others, promote flood insurance and encourage all Virginians in the mapped floodplain to purchase flood insurance.
- 2. An evaluation of the adherence to the requirement in §38.2-2125 of the Code of Virginia should be undertaken by the Commissioner of Insurance with a report to the Commonwealth's Chief Resilience Officer.**
 - 2.1. §38.2-2125 of the Code of Virginia requires that "any insurer that issues or delivers in this Commonwealth a new or renewal contract or policy of fire insurance, or a new or renewal contract or policy of fire insurance in combination with other insurance coverages, which policy or contract excludes coverage for damage due to flood, surface water, waves, tidal water, or any other overflow of a body of water, shall provide written notice that (i) explicitly states that flood coverage is excluded; (ii) states that information regarding flood insurance is available from the insurer, insurance agent or the National Flood Insurance Program; and (iii) advises the policyholder that contents coverage may be available with the flood policy for an additional premium."
- 3. Establish a long-term, multi-agency effort to increase outreach through media campaigns, social media, local and regional utility mailings, and other means to increase public awareness regarding the importance of acquiring flood insurance.**

- 3.1. Declare flood awareness and dam safety awareness days, weeks, and/or months.
- 3.2. Develop targeted outreach materials, training, and activities to coordinate with awareness weeks, hurricane season, etc.

4. Evaluate and implement options to increase access to private flood insurance

- 4.1. This may include incentives for insurance agents, removing any legal barriers to writing non-NFIP policies, and making it less attractive for insurers to only write low risk policies.
- 4.2. Work with the SCC to identify companies (both admitted and non-admitted³) that sell private flood insurance and make the list publicly available.

5. Evaluate the cost of flood insurance and identify policies to increase affordability of NFIP and private flood coverage.

- 5.1. Any policies should address the ability of low-income households to bear any additional costs and should consider a “means test” to determine priorities for premium subsidies or other support.

D. Improve Education and Training Programs

There is a need for improved and increased education and training related to flood risk and floodplain management across Virginia. This applies to local and state agency employees that are implementing and enforcing floodplain management regulations, as well as private sector professionals whose work directly relates to floodplain management. Better informed and trained floodplain managers and other officials from state and local agencies will advance Virginia’s capabilities to address flood risk and prevention. Furthermore, all Virginians should be aware of their flood risk and flood insurance options to better prepare themselves and reduce their flood risk.

Additional staff resources will be required to implement a comprehensive training program.

1. Develop a training curriculum for floodplain management regulations, floodplain mapping, NFIP compliance, and other flood related topics for state and local agencies.

- 1.1. Require all localities to have a designated floodplain administrator, and require at least six hours of floodplain management training each year.

³Admitted insurers are licensed by the state to sell insurance and are covered by the Virginia Property and Casualty Insurance Guaranty Association. Non-admitted insurers are not licensed, but they can still sell insurance in the state, and they are not covered by the Guaranty Fund. Additional information can be obtained from the SCC or here <https://www.gfms.org/faq/state/virginia>

- 1.2. Make training available to other local officials, including but not limited to building officials, planners, zoning administrators, emergency managers, engineers, etc.
 - 1.3. Partner with all appropriate state agencies to coordinate and implement this training.
 - 1.4. Require representatives of state agencies that maintain and build facilities to attend at least one training per year.
- 2 Develop a training curriculum for the private sector, including but not limited to real estate agents, insurance agents, mortgage companies, design professionals, and professional engineers.**
 - 2.1. Where appropriate, incorporate this training into continuing education requirements for professional certifications and licenses administered in Virginia. This may involve partnerships with the Department of Professional and Occupation Regulation and professional associations.
 - 2.2. Evaluate existing continuing education requirements for insurance agents and determine if changes are necessary to ensure agents that sell flood insurance have been adequately trained to do so.
- 3 Incorporate information on flood insurance coverage into homebuyer training provided by the Virginia Housing Development Authority.**
 - 3.1. Where feasible, encourage other organizations that provide homebuyer education, such as Housing Opportunities Made Equal of Virginia, Inc. (HOME), to incorporate information on flood insurance coverage.
- 4 Identify and promote existing programs and research topics at community colleges and state universities. Encourage incorporating flood-related coursework when feasible.**
 - 4.1. Encourage community colleges and state universities to partner with localities through course projects or independent studies to undertake flood-related projects that provide students with invaluable work experience and a needed service to the locality.
- 5 Identify opportunities to incorporate flood-related information and programs into Virginia Public Schools through science and environment Standards of Learning.**
 - 5.1. Partner with Virginia Public Schools to spread flood awareness through activities such as education days, demonstrating a flood model, providing student-friendly flood materials, etc.

E. Review Existing and Potential Funding Sources for Pre-disaster Hazard Mitigation

In §10.1-658.B. of the Code of Virginia, the General Assembly declared that “the expenditure of public funds and any obligations incurred in the development of flood control and other civil works projects, the benefits of which may accrue to any county, municipality or region in the Commonwealth, are necessary expenses of local and state government.” The Commonwealth should identify existing funding sources and opportunities that may provide financial assistance to localities or property owners to make flood risk reduction more affordable.

Several federally funded grant programs that provide flood-related assistance are administered in Virginia. NFIP participation is required if these funds will be used in a special flood hazard area (SFHA), and if development occurs, compliance with the local floodplain ordinance is required. As the coordinator for all flood protection programs and activities in the Commonwealth, DCR’s Floodplain Management program should have a formal role in the administration of these grants.

- 1. Determine the ability of the existing Dam Safety and Flood Prevention and Protection Assistance Fund to address this issue.**
- 2. Review all existing funding sources administered by state agencies to determine the eligibility for funding flood risk reduction projects.**
- 3. Determine DCR’s role in administering a portion of FEMA’s Pre-Disaster Mitigation (PDM) funds related to flooding that are currently under the purview of VDEM.**

The Disaster Recovery Reform Act of 2018 amended Section 203 of the Robert T. Stafford Disaster Relieve and Emergency Act to authorize the National Public Infrastructure Pre-Disaster Mitigation fund. This new program is named Building Resilient Infrastructure and Communities (BRIC). FEMA is currently working to develop and implement the BRIC program, so it is unclear at this time how the PDM program will transform. It is anticipated that BRIC will be implemented in the fall of 2020.

- 4. Determine DCR’s role in administering FEMA’s Flood Mitigation Assistance (FMA) funds that are currently under the purview of VDEM.**

The FMA program funds mitigation projects and planning efforts to reduce or eliminate long-term flood risk to NFIP insurance structures. This grant program is designed specifically for flood-related projects. Although FMA grants are often administered through state emergency management departments, some states administer these grants

through their NFIP Coordinating office. For example, Arkansas,⁴ Nebraska,⁵ Texas,⁶ and South Carolina⁷ manage their FMA programs through their NFIP coordinating offices.

- 5. Expand DCR's role in administering a portion of post-disaster funds related to flooding, such as Hazard Mitigation Grant Programs funds currently under the purview of VDEM or Community Development Block Grant Disaster Recovery funds currently under the purview of DHCD.**
- 6. Determine DCR's role in administering Coastal Zone Management (CZM) funds related to flooding and CRS that are currently under the purview of the Department of Environmental Quality.**
- 7. Develop a fund to cover (all or partial) the costs of surveying or engineering work for low income residents to obtain elevation certificates, determine base flood elevations, or similar work necessary to properly document flood risk for flood insurance policies or allocate necessary funds for state employees to provide this service.**
 - 7.1. Determine the feasibility of other options for Virginians to reduce their flood insurance costs, such as vouchers or subsidies for this work.**
- 8. Conduct an evaluation of using taxes (sales, property, etc.) to fund flood risk reduction projects in individual communities or on the state level, with a report to the Commonwealth's Chief Resilience Officer.**
- 9. Support existing or future federal initiatives that provide funding for pre-disaster mitigation.**
 - 9.1. Encourage Congress to increase the total amount available for Increased Cost of Compliance (ICC) funds, make these funds available in addition to maximum policy limits, and consider making these funds available after a non-flood damage or without a substantial damage determination.**

F. Encourage Flood Risk Reduction Efforts that Protect and Conserve the Natural Functions of Floodplains

The Governor's *ConserveVirginia* initiative seeks to identify the highest quality of lands for protection through the Commonwealth's land conservation actions. Land conservation can be a key tool to protect the integrity of natural infrastructure and features like wetlands,

⁴ <https://www.anrc.arkansas.gov/divisions/water-resources-management/floodplain-management-programs/>

⁵ <https://dnr.nebraska.gov/floodplain/flood-mitigation>

⁶ <http://www.twdb.texas.gov/flood/grant/FMA.asp>

⁷ <http://www.dnr.sc.gov/water/flood/mitgrants.html>

natural floodplains, dunes and others can reduce flooding and provide additional ecosystem benefits.

- 1. Encourage the use of conservation easements for flood risk reduction and promote the Land Preservation Tax Credit's eligibility for this activity.**
 - 1.1. Conservation Easements that protect floodplains are currently eligible for Land Preservation Tax Credits outlined in §58.1-512 of the Code of Virginia if conveyed for the conservation purpose of watershed Preservation, as identified in 4VAC5-20-20, the Virginia Land Conservation Foundation's Conservation Value Review Criteria.
 - 1.2. Evaluate the Conservation Value Review Criteria for Watershed Preservation easements under the Land Preservation Tax Credit program and evaluate any allowable uses that may prevent these easements from qualifying as open space for CRS purposes. Open space is one of the highest scoring activities in CRS, with a maximum point value almost worth 3 class changes – 15 percent discount on insurance.
- 2 Allow localities to use Transfer of Development Rights as a way to protect floodplains via an amendment to §15.2-2316.2. Develop a model that localities may use for administering and implementing such a program.**
- 3 Prioritize mitigation projects that conserve floodplains, such as relocating structures outside of the floodplain, converting properties to open space, stream restoration, etc.**

DAM SAFETY

Overview of Existing Dam Safety Regulations

In accordance with the Dam Safety Act (§10.1-604 et seq. of the Code of Virginia), DCR administers the Commonwealth's Dam Safety Program, which is overseen by the Virginia Soil and Water Conservation Board. The Dam Safety Program is governed by the Virginia Impounding Structure Regulations. The Program seeks to provide for the safe design, construction, operation, and maintenance of dams to protect public safety. "Regulated dams" or "impounding structures" in Virginia include those structures that are at least six feet in height and that impound a maximum capacity of at least 50 acre-feet, and those that are at least 25 feet in height and that impound a maximum capacity of at least 15 acre-feet.

Executive Order 24 directs DCR to "assess the effectiveness of current dam safety regulations in accounting for changing precipitation patterns and conditions."

In 2014, the Virginia General Assembly authorized DCR to develop a new Virginia Probable Maximum Precipitation Study (VA PMP Study) to update hydrological information in use by the

Dam Safety Program. DCR Dam Safety contracted with Applied Weather Associates (AWA) in Colorado to complete the analysis. From July 2014 to December 2015, AWA developed the Virginia PMP Study and it was approved for use by the Virginia Soil and Water Conservation Board in December 2015. In March 2016, PMP information from the VA PMP Study for 6 hr., 12 hr., and 24 hr. storm events was required to be used for all Dam related calculations in Virginia (hydrological/flow related calculations). Virginia now has over 24,000 grid points filled with 100 years of real world storm data developed solely for use with the physiographic regions of Virginia.

Prior to May 2018, a licensed Professional Engineer had the choice to use a variety of accepted hydrologic temporal distribution curves to estimate hydrological flows with no guidance on which curve should be utilized in Virginia. A majority of these curves were developed more than 40 years ago with limited data and were never intended to be utilized with values such as the Probable Maximum Precipitation.

These engineering calculations are the basis of Dam Failure Analysis studies required by regulation in the Commonwealth. These analyses offer predictions of the downstream consequences if a dam were to fail. These analyses also include maps which aid emergency personnel in warnings and evacuations of downstream residents, schools, or businesses.

In May 2018, the Virginia Soil and Water Conservation Board adopted new temporal distribution curves that are specific to Virginia based on the study conducted by AWA. The use of these new curves based on Virginia specific rainfall data provide a greater degree of accuracy in assessing downstream impact. No changes are currently required to the Dam Safety regulations to ensure the most accurate precipitation data is being used; however, periodic updates will be necessary to account for changing precipitation patterns.

With the potential for more frequent and heavier precipitation events, the Dam Safety Program must be more robust to protect the lives and property of Virginians. Unfortunately, by a number of measures, the Commonwealth's Dam Safety program falls short. Virginia is ranked 15th among states for the number of regulated dams, but ranked 34th in the number of personnel dedicated to the Dam Safety Program. The national average for regulated dams is 294 per full-time equivalent, DCR's average is 409 dams for each FTE.

There are more than 3,000 dams in the Commonwealth, many constructed 50 years ago or longer. More, than 2,000 of these dams are regulated by DCR, with the majority being privately owned by individuals, families, and home owners associations or other common interest communities. This privately owned category of dam owners represent approximately 52 percent (1046) of regulated dams in the Commonwealth. Of these 1046 dams, 17 percent (178) are classified as High or Significant Hazard meaning they pose the greatest risk to public safety and the lives and property of the citizens of the Commonwealth. Another 66 percent have an unknown hazard classification and may include a number of High or Significant Hazard Dams. During the period from January 1, 2018 until January 31, 2019, there were 18 reported dam incidents and failures. Not all incidents and failures were to privately owned dams, but 45 percent of those failures related to High or Significant Hazard Dams.

While DCR is able to fund certain engineering, planning, and other activities through the Dam Safety, Flood Prevention and Protection Assistance Fund (Fund) (§10.1-603.16 et seq.), there is no funded source of grants or loans for owners for repair, upgrades, alteration, and construction activities who may be unable to afford to keep their dams in compliance with state law and regulation. A fund specifically dedicated to assisting dam owners would increase the safety of Virginia's dams. According to a 2019 Association of State Dam Safety Officials (ASDSO) report, of the \$65.89 billion needed to rehabilitate non-federal dams in the United States, about one-third – \$20.42 billion – is needed to repair high-hazard structures, both publicly and privately owned. This is up from the \$18.71 billion estimate in 2016.

No comprehensive cost analysis has occurred related to Virginia Dams since 2011. In DCR's 2011 report entitled Costs, Funding and Prioritization of Virginia Dams to Meet Minimum Public Safety Standards submitted to the Governor and the Chairmen of the Senate Finance Committee and The House Appropriations Committee the following data was provided.

High Hazard Dams

In 2011, the total number of high hazard dams was 221 and of those, 104 dams either met minimum public safety standards or money was already allocated for their repair. Virginia had 117 high hazard dams in need of repairs to meet minimum public safety standards. Of those, 21 were owned by the state, 37 by the Soil and Water Conservation Districts (SWCD), 23 by the local government, 33 were privately owned, and three were utility owned. The total estimated cost for each owner group was:

- State Owned (21) \$21,399,619
- SWCD (37) \$62,590,242
- Local Government (23) \$36,713,402
- Privately Owned (33) \$41,789,763
- Utility (3) \$5,174,208

Significant Hazard Dams

In 2011 the total number of significant hazard dams was 398, and of those, 75 met minimum public safety standards or money was already allocated for their repair. Of the 399 significant hazard dams, 323 were in need of repairs. Of those, ten were owned by the state, 14 by the SWCDs, 28 by the local government, 267 were privately owned, and four were utility owned. The total estimated cost for each owner group was:

- State Owned (10) \$17,374,976
- SWCD (11) \$14,920,953

- Local Government (28) \$58,435,535
- Privately Owned (266) \$323,612,385
- Utility (4) \$9,602,094

Recommendations

The number of dams in disrepair across the Commonwealth continues to rise as does the cost of maintaining and upgrading these dams. Even in 2011, an estimated \$41 million price tag just to bring privately owned high hazard dams into compliance with regulations would require a significant investment from private dam owners.

Therefore, the following recommendations are offered:

A. Building Stronger State Government Capabilities

A strong regulatory program requires more than solid regulations. A strong program must incorporate adequate human, technological, and financial resources to ensure full compliance with Virginia Impounding Structure Regulations. A strong program supports state, local, and private dam owners with the following priority goals:

- Reduce risks to life and property associated with dams
 - Increase awareness of the benefits and risks related to dams
 - Advance the state of practice of dam risk management
1. **Establish a permanent budget and provide additional staff resources to manage the online Dam Safety Inventory System (DSIS) and fund continuing system upgrades.**
 - 1.1. DSIS was implemented in the summer of 2017. DSIS provides a web-based platform to aggregate regulatory information related to all dams in the Commonwealth and has been an invaluable asset in the EOC. At a cost of more than \$600,000 in federal, general and special funds, Phase I II and III have been completed and provide access to dam owners, engineers, emergency managers, and the general public to review, update and submit data, and submit online payment of fees.
 - a. Phase IV development in DSIS will create an emergency dashboard. The dashboard will provide dam specific data related to weather warnings and watches, including predicted rainfall and potentially staging based on the existing emergency action plan and provide critical safety information. The system will also be evaluated for the integration of a statewide gauge network to develop flood warning and response systems for state agencies and local governments to be better prepared

- for flooding disasters. The warning and response systems would be implemented to meet CRS requirements to maximize local benefits.
- 1.2. The emergency dashboard and reporting functionality will allow users to quickly export and download essential files and documents for guidance and sharing as well as view real time data from internal and external data sources.
 - 1.3. DCR will continue to work to identify and integrate connections between DSIS, ConserveVirginia and the ongoing development and updates to VFRIS where datasets may meet multiple user needs.
2. **Provide additional resources for dam safety regional engineers with a goal of each regional engineer being responsible for 200 dams or less.**
 - 2.1. Currently there are five regional dam safety engineering positions responsible for the regulation of more than 2,000 dams. Additional staffing will create more manageable workloads and increase program compliance.
- B. Engage and Assist Dam Owners and Localities**
- In 2016, Congress passed the National Dam Rehabilitation Program Act that establishes a grant program to assist local communities to rehabilitate, repair, or remove a high-hazard potential dam before it fails. Funding should be made available on the state level to leverage these and other dollars to perform the most work possible.
1. **Provide initial investment for dam repair or removal (decommissioning) of \$20M to be administered by DCR and the Virginia Resources Authority and additional funding at a minimum of \$5M-\$10M annually thereafter.**
 - 1.1. Create a separate grant source to fund repairs for high and significant hazard dams with spillway deficiencies and/or poor or unsatisfactory conditional assessments that is related to the ability of the owner to pay.
 - a. This separate source could be used independently or as a source of match for federal or other state grant programs.
 2. **Collaborate with localities and United States Army Corps of Engineers (USACE) to perform specified work on all potentially high or significant hazard dams in a locality with the goal of bringing them into compliance with Virginia Impounding Structure Regulations.**
 - 2.1. In an effort to address the priorities of the Virginia Soil and Water Conservation Board and DCR to bring dams of regulatory size with unknown hazard class under certificate, ensure emergency action plans and inspection reports for all high hazard dams are recorded in DSIS, and further promote flooding awareness, the Board

approved the establishment of a Pilot Project with USACE-Norfolk District to perform initial assessments of all known dams of regulatory size within a selected locality or localities. After initial assessments, dams will be prioritized for inspections, dam break inundation zone mapping, emergency action plans, and, where the dam resides in a special flood hazard area, flood inundation zone mapping. All studies and mapping will be performed by the USACE.

USACE, through the Planning Assistance to States Program, is provided authority to assist the states, local governments, and other non-federal entities by performing studies such as dam safety/failure studies, flood damage reduction studies and floodplain management studies. These studies are cost shared on a 50 percent Federal and 50 percent non-Federal basis and may include 100 percent work in kind. The success and lessons learned through this pilot project can be replicated across the state.

Example: City of Lynchburg has 12 dams. Six have Regular Maintenance and Operation Certificates and six have no hazard determinations, but appear to be of regulatory size. DCR through the Fund, would coordinate with USACE to complete the required dam safety and flood protection studies. USACE would provide labor equivalent to 50 percent of costs, the locality in coordination with DCR, obtains permissions from all owners to complete the studies and commits up to 50 percent of costs up front; DCR reimburses the locality from the fund. This collaboration would result in zero final costs to the owner or locality and potentially provide additional CRS credit to communities. With adequate funding this model could be replicated across the Commonwealth where dams believed to be of regulatory size exist. At the current time there are more than 800 dams of unknown regulatory status in the Commonwealth.

3. Amend §15.2-2243.1 of the Code of Virginia related to downstream development.

Dam owners have no control over upstream or downstream development that may compromise storage capacity or the hazard classification of the dam.

- 3.1. Amend §15.2-2223 of the Code of Virginia to require that upstream and downstream development of a dam is addressed in Comprehensive Plans so that local development and planning goals are established to limit or reduce impact to existing dams.
- 3.2. Amend §15.2-2243.1 of the Code of Virginia to require the following:
 - a. Estimates of cost to upgrade the dam to be provided by the owner, at the cost of the developer.

- b. Remaining 50 percent of costs to be made available from the Dam Safety Flood Prevention and Protection Assistance Fund where funds have been specifically appropriated for this purpose or split 50/50 with the Fund and the locality.
 - c. Development must be restricted below high hazard dams until dams are upgraded to meet Virginia Impounding Structure Regulations based on proposed and or approved development.
 - d. Local governments must contact DCR if no inundation map is on file with the locality.
4. **Require approval by DCR before ownership of a dam and any attendant certificates or permits are transferred.**

DCR has encountered situations where developers purchase undeveloped or underdeveloped property with a dam on site. The developer obtains a Regular Operation and Maintenance Certificate or General Permit, Inspection Report and Emergency Action or Preparedness Plan based on current conditions. Significant development then occurs downstream of the dam. Prior to expiration of the Certificate or Permit, ownership and/or maintenance and repair responsibilities of the dam are transferred to the home owners. Because a Regular Operation and Maintenance Certificate or General Permit is being conveyed, home owners are often unaware of the needed upgrades and are left with the expense of upgrading the dam to the requirements due to a higher hazard classification.

- 4.1. 4VAC50-20-90. Transfer of Permits and 4VAC50-20-170. Transfer of Certificates of the Virginia Impounding Structure Regulations only relate to the transfer of regulatory documents, not transfer of ownership of the dam.
 - 4.2. Changes to the Code of Virginia and Impounding Structure Regulations are needed to ensure developers upgrade impounding structures prior to any transfer of ownership, repair or maintenance responsibilities to the home owners in a developed neighborhood where development has occurred downstream of the dam.
 - 4.3. DCR must certify the dam meets Impounding Structure Regulations prior to any legal transfer of ownership, repair, or maintenance responsibilities. The DCR certification must be provided to the transferee at the time of transfer. Transfers without DCR certification should be null and void and subject to penalty.
5. **Establish permanent budget and necessary personnel to fund a position to manage the online Dam Safety Inventory System and fund continuing system upgrades and capabilities.**

C. Improve Education and Training Programs

1. There is a need for improved and increased education and training related to dam safety across Virginia.

There is a need for improved and increased education and training related to dam safety across Virginia. This applies to local zoning and emergency management and public safety officials, state agencies responsible for emergency response, owners, engineers and the general population. Better informed and trained dam owners, officials from state and local agencies and those who live or recreate near dams will advance Virginia's capabilities to address dam safety. Furthermore, all Virginians should be aware of their flood risk related to dams and prepare themselves to reduce that risk.

Additional staff resources will be required to implement a comprehensive training program.

- 1.1. Develop a comprehensive training curriculum for Virginia Impounding Structure Regulations for private, state, and local dam owners.
- 1.2. Develop a comprehensive training curriculum for local planning, zoning and emergency management, and public safety officials related to emergency action/preparedness plans and dam break inundation zone requirements.
- 1.3. Develop a comprehensive public education and outreach strategy to educate the general public about flood risk related to dams and safe behaviors while recreating around dams.
 - a. Declare flood awareness and dam safety awareness days, weeks, and/or months.
 - b. Develop targeted outreach materials, training, and activities to coordinate with awareness weeks, hurricane season, etc. This may include activities such as awareness days, community days, demonstrations of the flood model, providing dam safety materials, etc.
 - c. Collaborate with Floodplain Management to participate in school and community-based opportunities to incorporate dam-related information and programs into any training to spread dam safety awareness.

CONCLUSION

As the Governor stated in Executive Order 24, “[s]ea level rise, land subsidence, higher average temperatures, more frequent and intense weather events, severe drought, and increased development, have increased risk and will continue to increase and exacerbate risk from natural hazards across the Commonwealth of Virginia.” As directed by the Governor, the purpose of this report is to evaluate our current programs and offer recommendations regarding the need to improve them.

For Virginia to realize its goals of improving resilience and protecting life and property, ongoing improvements to the management of floodplains, dams, and related grey and green infrastructure are required. Virginia is long overdue in establishing updated policies and procedures, improving communication and awareness, and building an expert workforce to establish necessary programs, advise governmental agencies, and work cooperatively with citizens, businesses, and local, state, and federal agencies to advance these reforms.

This report demonstrates that much must be done and that we must begin now.

APPENDIX A: FLOODPLAIN RECOMMENDATION ACTION TABLE

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
A. Building Stronger State Government Capabilities						
1: Increase communication and coordination	X			X		X
1.1: Formal process for state agencies	X			X		
1.2: Formal process for federal agencies				X		X
1.3: Continue Virginia Silver Jackets Team				X		X
1.4: Establish relationships with state and federally recognized Indian tribes				X		X
2: Create a state level program for NFIP compliance	X	X		X	X	
2.1: Replace Exec. Memo. 2-97 with new Exec. Order	X					
2.2: Amend Va. Code to add state floodplain requirements		X		X	X	
B. Engage, Assist, and Strengthen Local Communities						
1: Require NFIP participation and create minimum floodplain requirements for localities	X	X	X	X	X	
1.1: Propose legislation establishing authority for DCR to develop such a program		X		X	X	
1.2: Amend Va. Code to clarify local powers to adopt floodplain regulations outside of zoning			X			
1.3: Amend Va. Code to require flood risk is addressed in Comprehensive Plans			X			
1.4: Amend Library of Virginia retention policies to comply with NFIP				X		
2: Encourage participation in CRS				X	X	
2.1: Provide assistance to localities to help join CRS				X	X	
2.2: Create a CRS tool-kit to aid communities in joining CRS				X		
2.3: Pursue developing a regional CRS model for localities				X		
2.4: Encourage local implementation of CRS activities even if not participating	X			X		

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
3: Establish a comprehensive post-disaster damage assessment program				X	X	
3.1: Establish a comprehensive damage assessment process that complies with NFIP, Hazard Mitigation Assistance, and building code requirements				X	X	
3.2: Upgrade Crisis Track to incorporate floodplain information and substantial damage forms				X		
3.3: Develop guidance and training related to implementing this comprehensive damage assessment process						
C. Improve Risk Identification and Risk Communication						
1: Create a statewide floodplain mapping program				X	X	X
1.1: Secure new mapping models to update A Zones				X	X	X
1.2: Secure new mapping models to update AE Zones and delineate floodways where not available				X	X	X
1.3: Model flood risks beyond the one percent annual change flood that is mapped by FEMA				X	X	X
2: Create a clearinghouse of flood-related information and inundation mapping in VA	X	X		X	X	X
2.1: Integrate a variety of datasets into VFRIS to provide a comprehensive analysis of risk				X		
2.2: Include all flood protection projects implemented by federal agencies				X		X
2.3: Obtain or create first floor elevations for all structures				X	X	
2.4: Identify and compile maps and other relevant information regarding historic flood damage				X		
2.5: Identify all rain gauges, stream gauges, forecast points, etc. to improve Virginia's statewide network to track flood risk in real-time	X	X		X	X	X
2.6: Use this clearinghouse to prioritize mitigation opportunities				X		
2.7: Ensure updated CBRS maps are incorporated into Virginia's mapping program and future changes reflect the Commonwealth's interest				X		X

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
3: Acquire mobile LiDAR along roadways across the Commonwealth	X			X	X	
3.1: Use date to develop flood models for roadways and travel routes				X	X	
3.2: Use new flood models to create/update evacuation routes	X	X		X	X	
3.3: Use new flood models to steer maintenance and future development plans for roadways	X	X		X		
3.4: Use new flood models to update local community development plans, statewide development plans, hazard mitigation plans, etc.	X	X		X		
D. Encourage Broader Coverage of Flood Insurance						
1: Identify and implement strategies to increase flood insurance coverage				X	X	X
1.1: Promote flood insurance and encourage all Virginians to purchase flood insurance.				X	X	X
2: Evaluate the adherence to the requirements in Va. Code by the Commissioner of Insurance with a report to the Commonwealth's Chief Resiliency Officer	X			X	X	
2.1: Va. Code requires that insurers statements related to flood coverage	X			X	X	
3: Establish a long-term, multi-agency effort to increase outreach and public awareness related to flood insurance	X			X	X	
3.1: Declare flood awareness days, weeks, and/or months	X				X	
3.2: Develop targeted outreach materials, training, and activities to coordinate awareness weeks, hurricane season, etc.				X	X	
4: Evaluate and implement options to increase access to private flood insurance	X	X	X	X	X	X
4.1: May include incentives for insurance agents, removing legal barriers, etc.		X	X	X		X
4.2: Work with the SCC to identify companies selling private flood insurance				X		

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
5: Evaluate the cost of flood insurance and identify policies to increase affordability of NFIP and private flood coverage	X	X		X	X	X
5.1: Any policies should address the ability of low income households to bear any additional costs and should consider a “means test” to determine priorities	X	X		X	X	X
E. Improve Education and Training Programs						
1: Develop a training curriculum for floodplain management regulations, floodplain mapping, NFIP compliance, etc. for state and local agencies	X	X	X	X	X	
1.1: Require all localities have a designated floodplain administrator and require 6 hours of training each year			X	X		
1.2: Make training available to other local officials				X		
1.3: Partner with all appropriate state agencies to coordinate and implement these trainings						
1.4: Require state agencies that maintain and build facilities to attend at least one training per year	X	X		X		
2: Develop a training curriculum for the private sector				X	X	
2.1: Where appropriate, incorporate this training into continuing education requirements for professional certificates and licenses administered				X		
2.2: Evaluate existing continuing education requirements for insurance agents				X		
3: Incorporate information on flood insurance coverage into homebuyer training provided by the Virginia Housing Development Authority				X		
3.1: Where feasible, encourage other organizations to incorporate flood insurance information into their trainings						
4: Identify and promote existing programs and research topics at community colleges and state universities				X		
4.1: Encourage community colleges and state universities to partner with localities				X		

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
5: Identify opportunities to incorporate flood-related information and programs into Virginia Public Schools	X			X		
5.1: Partner with Virginia Public Schools to spread flood awareness through activities as education days				X		
F. Review Existing and Potential Funding Sources for Pre-disaster Hazard Mitigation						
1: Determine the ability of existing Dam Safety and Flood Prevention and Protection Assistance Fund address this issue	X					
2: Review all existing funding sources administered by state agencies to determine eligibility for funding flood risk reduction projects	X					
3: Determine DCR's role in administering a portion of FEMA's Pre-Disaster Mitigation funds related to flooding that are currently under the purview of VDEM	X					
4: Determine DCR's role in administering FEMA's Flood Mitigation Assistance funds that are currently under the purview of VDEM	X					
5: Determine DCR's role in administered a portion of post-disaster funds related to flooding, such as Hazard Mitigation Grant Programs or Community Development Block Grant Disaster Recovery funds	X					
6: Determine DCR's role in administering Coastal Zone Management funds currently under the purview of DEQ	X					
7: Develop a fund to cover the costs of surveying or engineering work for low income residents to obtain elevation certificates, determine BFES, or similar work	X	X	X	X	X	
7.1: Determine the feasibility of other options, such as vouchers or subsidies	X	X	X	X	X	
8: An evaluation of feasibility of using taxes to fund flood risk reduction projects	X					
9: Support existing or future federal initiatives that provide funding for pre-disaster mitigation	X					X

Floodplain Recommendation	Action Needed					
	Executive	Legislative State Authorities	Legislative Local Authorities	Operational	Budgetary	Federal
9.1: Encourage Congress to increase the total amount for Increased Cost of Compliance funds	X					X
G. Encourage Flood Risk Reduction Efforts that Protect and Conserve the Natural Functions of Floodplains.						
1: Encourage the use of conservation easements for flood risk reduction and promote the Land Preservation Tax Credit's eligibility	X			X		
1.1: Conservation Easements that protect floodplains are currently eligible for Land Preservation Tax Credits	X			X		
1.2: Evaluate the criteria for Watershed Protection easements	X			X		
2: Allow localities to use Transfer of Development Rights to protect floodplains	X		X			
3: Prioritize mitigation projects that conserve floodplains	X			X		X

APPENDIX B: FLOOD ZONE EXPLANATIONS

The NFIP defines Special Flood Hazard Area as *the land in the flood plain within a community subject to a 1 percent or greater chance of flooding in any given year. The area may be designated as Zone A on the FHBM. After detailed ratemaking has been completed in preparation for publication of the flood insurance rate map, Zone A usually is refined into Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, or V1-30, VE, or V.* (44 CFR 59.1)

Below is a description of each flood zone, as defined in the April 2019 NFIP Flood Insurance Manual.

Special Flood Hazard Areas (High Risk Hazard Areas)

Zone A

Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown on the map. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zones A1–A30

Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. The maps show the BFEs. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Note: Virginia does not have any A1-A30 Zones on currently effective FIRMs; they have been replaced with AE Zones.

Zone AE

Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. The maps show the BFEs. Mandatory flood insurance purchase requirements and floodplain management standards apply. Some maps use AE in place of A1-A30.

Zone AH

Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. In this zone the maps show BFEs derived from detailed hydraulic analyses. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AO

Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Maps show the average flood depths derived from detailed hydraulic analyses in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone A99

The A99 zone applies to areas with sufficient progress on the construction or repair of a protective system including features such as dikes, dams, and levees, to consider it complete for insurance rating purposes. The map does not have BFEs. Treat A99 Zones as non-SFHAs when determining Community Rating System (CRS) premium discounts. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AR

The AR zone reflects the decertification of a previously accredited flood protection system that the community is in the process of restoring to provide base flood protection. Treat all AR Zones as non-SFHAs to determine CRS premium discounts. Mandatory flood insurance purchase requirements and floodplain management standards apply

Zones AR/AE, AR/AH, AR/AO, AR/A1–A30, AR/A

These are dual flood zones subject to flooding from other water sources that the restored flood protection system does not contain. Treat all AR Zones as non-SFHAs when determining CRS premium discounts and determining mandatory purchase requirements.

Zone V

The V zones are areas along coasts subject to inundation by the 1-percentannual-chance flood event with additional hazards associated with storm induced waves. The map does not have BFEs or flood depths because detailed hydraulic analyses were not performed. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zones V1–V30

Areas along coasts subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. The maps show BFEs derived from detailed hydraulic analyses. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Note: Virginia does not have any V1-V30 Zones on currently effective FIRMs; they have been replaced with VE Zones.

Zone VE

Used in place of V1-V30 on some maps. Zone VE areas are subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action. The maps show BFEs derived from detailed hydraulic analyses. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Moderate or Minimal Hazard Areas

Zones B, C, and X

B, C, and X zones designate areas of moderate or minimal flooding hazard resulting from severe storm activity or local drainage problems. Zone X equals the designation for B and C zones on some maps.

Note: Virginia does not have any B or C Zones on currently effective FIRMs; they have been replaced by X Zones. There are two different types of Zone X: shaded and unshaded. The shaded Zone X designates areas of moderate flood hazard subject to the 0.2% annual chance flood (also known as the 500 year flood). Unshaded X Zones designates areas of minimal flood hazard outside of the 0.2% annual chance flood.

Zone D

The D zone reflects an area where the flood hazard is undetermined and where there is sparse population. Agents may use Zone D for rating when a community incorporates portions of another community's area where no map has been prepared. Agents also use Zone D if the map shows an area as being unmapped.

APPENDIX C: NON-PARTICIPATING NFIP COMMUNITIES IN VIRGINIA

Virginia Communities Not Participating in the National Flood Insurance Program as of June 2019			
Community ID	Community Name	SFHA	Comments
510066	Galax, City of	Yes	Withdrawn from the NFIP
510092	Louisa County	Yes	Suspended from the NFIP
510208	Bowling Green, Town of	No	
510202	Brodnax, Town of	No	
510381	Capron, Town of	No	
510178	Cheriton, Town of	Yes	In process of joining NFIP
510045	Clintwood, Town of	Yes	
510300	Dendron, Town of	Yes	Suspended from the NFIP
510271	Floyd, Town of	No	
510268	Gordonsville, Town of	Yes	In process of joining NFIP
510331	Gretna, Town of	Yes	
510316	Hillsboro, Town of	Yes	
510277	Keller, Town of	Yes	
510171	Kenbridge, Town of	No	
510270	Keysville, Town of	No	
510165	La Crosse, Town of	Yes	
510378	Louisa, Town of	No	
510031	Madison, Town of	No	
510012	Melfa, Town of	Yes	
510377	Mineral, Town of	No	
510116	Montross, Town of	Yes	
510258	Newsoms, Town of	Yes	
510326	Nickelsville, Town of	No	
510285	Painter, Town of	Yes	
510299	Scottsburg, Town of	Yes	

**Virginia Communities Not Participating in the
National Flood Insurance Program as of June 2019**

Community ID	Community Name	SFHA	Comments
510008	South Hill, Town of	Yes	
510376	Surry, Town of	No	
510244	The Plains, Town of	Yes	
510051	Troutdale, Town of	Yes	
510278	Victoria, Town of	No	
510195	Virgilina, Town of	No	
510115	Warsaw, Town of	No	
510097	Waverly, Town of	Yes	

APPENDIX D: CRS COMMUNITIES IN VIRGINIA

Community Rating System Communities in Virginia, with Policies and Savings, Effective May 1, 2019*									
Community ID	Community Name	Current Class	% Discount for SFHA	% Discount for non-SFHA	Total NFIP Policies	Total Premium	Average Premium	Savings per Community	Savings per policy
510001	Accomack County	6	20	10	1,347	\$925,054	\$687	\$200,683	\$149
515519	Alexandria, City of	6	20	10	1,608	\$1,347,137	\$838	\$245,825	\$153
515520	Arlington County	8	10	5	1,022	\$389,978	\$382	\$17,706	\$17
510075	Ashland, Town of	9	5	5	52	\$44,400	\$854	\$1,978	\$38
510134	Bridgewater, Town of	8	10	5	54	\$81,170	\$1,503	\$8,233	\$152
510106	Cape Charles, Town of	8	10	5	195	\$86,530	\$444	\$839	\$4
510034	Chesapeake, City of	8	10	5	9,086	\$5,503,432	\$606	\$426,073	\$47
510002	Chincoteague, City of	8	10	5	1,781	\$1,347,910	\$757	\$141,147	\$79
515525	Fairfax County	6	20	10	6,881	\$3,530,844	\$513	\$476,192	\$69
510054	Falls Church, City of	6	20	10	173	\$191,754	\$1,108	\$38,274	\$221
510071	Gloucester County	6	20	10	1,539	\$1,266,259	\$823	\$271,936	\$177
515527	Hampton, City of	7	15	5	10,530	\$9,094,281	\$864	\$1,286,155	\$122
510201	James City County	7	15	5	1,023	\$629,404	\$615	\$63,193	\$62
510104	Norfolk, City of	7	15	5	12,383	\$9,118,547	\$736	\$1,207,988	\$98

Community Rating System Communities in Virginia, with Policies and Savings, Effective May 1, 2019*									
Community ID	Community Name	Current Class	% Discount for SFHA	% Discount for non-SFHA	Total NFIP Policies	Total Premium	Average Premium	Savings per Community	Savings per policy
510183	Poquoson, City of	8	10	5	3,200	\$2,822,590	\$882	\$291,523	\$91
515529	Portsmouth, City of	7	15	5	4,097	\$3,025,097	\$738	\$392,766	\$96
510119	Prince William County	8	10	5	1,357	\$856,369	\$631	\$48,551	\$36
510129	Richmond, City of	8	10	5	616	\$685,813	\$1,113	\$55,660	\$90
510130	Roanoke, City of	7	15	5	539	\$1,189,713	\$2,207	\$191,625	\$356
510190	Roanoke County	8	10	5	422	\$451,971	\$1,071	\$40,723	\$97
510154	Stafford County	7	15	5	710	\$432,579	\$609	\$38,338	\$54
510053	Vienna, Town of	8	10	5	126	\$74,654	\$592	\$3,639	\$29
510131	Vinton, Town of	8	10	5	33	\$62,649	\$1,898	\$6,465	\$196
515531	Virginia Beach, City of	7	15	5	24,628	\$13,721,604	\$557	\$1,138,847	\$46
510005	Wachapreague, Town of	8	10	5	79	\$48,808	\$618	\$3,706	\$47
510182	York County	7	15	5	3,189	\$2,170,202	\$681	\$259,757	\$81
<i>*Based on May 2019 data from FEMA and ISO.</i>				Totals	86,670	\$59,098,749	\$22,327	\$6,857,822	\$2,607

APPENDIX E: NFIP POLICY INFORMATION

NFIP Policy Coverage and Losses in Virginia[†]					
Total Policy Count	Total Coverage (in Thousands)	Total Losses*	Total Dollars Paid*		
107,788	\$28,766,558	48,935	\$735,118,470		
Repetitive Loss Properties in Virginia[‡]					
Total Losses	Properties	Total Building Payments	Total Contents Payments	Total Payments	Average Payments
18,960	6,720	\$349,928,854.79	\$61,629,471.61	\$411,558,326.40	\$140,055,930.07

Data Source: FEMA; current as of March 31, 2019.

[†]Losses and payments include NFIP claims from 1976 through March 31, 2019.

[‡]FEMA defines a Repetitive Loss Property as an NFIP-insured structure that has had at least 2 paid flood losses of more than \$1,000 each in any 10-year period since 1978.[§]

[§]<https://www.fema.gov/national-flood-insurance-program/definitions#R>

APPENDIX F: DAM SAFETY RECOMMENDATION ACTION TABLE

Dam Safety Recommendation	Action Needed					
	Executive	Legislative <i>State Authorities</i>	Legislative <i>Local Authorities</i>	Operational	Budgetary	Federal
A. Building Stronger State Government Capabilities						
1. Establish a permanent budget and additional staff resources for DSIS	X	X		X	X	
2. Provide additional resources for dam safety regional engineers	X	X		X	X	
B. Engage and Assist Dam Owners and Local Communities						
1. Establish baseline funding for dam repair or removal of \$20M	X	X		X	X	
2. Collaborate with localities and USACE to perform specified work on all potentially high or significant hazard dams	X	X		X	X	X
3. Amend Va. Code related to downstream development	X	X	X	X	X	
4. Require approval by DCR before ownership of a dam is transferred	X	X	X	X	X	
C. Improve Education and Training Programs						
1. Improve and increase education and training				X	X	

APPENDIX I

**REPORT TO THE GOVERNOR PURSUANT TO
EXECUTIVE ORDER 24, SECTION 2B**

Review of State Pre-Disaster Mitigation Programs
June, 2020

Matthew J. Strickler, Secretary of Natural Resources and Chief Resilience Officer

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Introduction

Natural disasters such as floods, fires, extreme weather, and seismic events pose serious threats to life and property, and can have significant negative impacts for Virginia communities, our economy, and our environment. In 2018, Hurricanes Michael and Florence caused almost \$45 million in damage according to FEMA.¹ In 2016, Hurricane Matthew, despite being only a tropical storm when it impacted Virginia's coast, cost the Hampton Roads region roughly \$500 million.² Extreme winter weather events in 2016 cost the Commonwealth an estimated \$40.5 million in emergency protective measures.³ The 2011 Louisa County earthquake inflicted more than \$200 million in damages, of which only about \$100 million was insured.⁴

Damage from hurricanes, floods, and extreme weather will continue to increase in the future, further exacerbated by global warming. Tidal and recurrent flooding events are likely to increase in the coming decades due to sea level rise and increased rainfall intensity. Sewell's Point tide gauge in Norfolk has recorded more than 18 inches of relative sea level rise in the past 100 years.⁵ National Oceanic and Atmospheric Administration (NOAA) modeling predicts as much as 6.69 feet of relative sea level rise for Hampton Roads based on its 2017 Intermediate High Scenario.⁶⁷ Recurrent flooding, sometimes referred to as nuisance flooding, is "flooding that occurs repeatedly in the same area over time due to precipitation events, high tides, or storm surge."⁸ Recurrent flooding in Hampton Roads has increased from 1.7 days of flooding in 1960 to 7.3 days in 2014.⁹ Estimates project the influences of wind and

¹ "Virginia--Tropical Storm Michael FEMA-4411-DR," December 18, 2018, <https://www.fema.gov/media-library-data/1572395663354-ac47e4a7d5a230bcd8c029fee353e63d/FEMA4411DRVA.pdf>; "Virginia-Hurricane Florence FEMA-4401-DR," October 15, 2018, <https://www.fema.gov/media-library-data/1572390069862-e30da24217fc51172f79d42ca070b193/FEMA4401DRVA.pdf>.

² Mary Beth Gahan, "Hurricane Season Is over, but Hampton Roads Saw \$500 Million in Damage," *Virginian-Pilot*, accessed July 22, 2019, https://pilotonline.com/news/local/weather/storms/article_2bc3125c-0056-5def-af77-42d6ed7f6e43.html.

³ "Virginia--Severe Winter Storm and Snowstorm FEMA-4262-DR," accessed April 1, 2020, <https://www.fema.gov/media-library-data/1460119494869-4c75c5527d9b97d7f785d11e820f33f8/PDAReportFEMA4262DRVA.pdf>.

⁴ "Earthquakes in Virginia | Virginia Department of Emergency Management (VDEM)," accessed April 1, 2020, <https://www.vaemergency.gov/earthquakes/earthquakes-in-virginia/>.

⁵ "Sea Level Trends - NOAA Tides & Currents. Sewell's Point VA Station.," 2019, https://tidesandcurrents.noaa.gov/slrends/slrends_station.shtml?id=8638610.

⁶ Molly Mitchell, "Recommendations for Sea Level Rise Projections: A Report for the Governor's Coastal Climate Resiliency Plan" (Center for Coastal Resources Management, Virginia Institute of Marine Science, February 2019), [https://www.naturalresources.virginia.gov/media/governorvirginiagov/secretary-of-natural-resources/images/1c.-Sea-level-rise-projections-for-Virginia-planning-purposes-\(2\)-FINAL-10_31.pdf](https://www.naturalresources.virginia.gov/media/governorvirginiagov/secretary-of-natural-resources/images/1c.-Sea-level-rise-projections-for-Virginia-planning-purposes-(2)-FINAL-10_31.pdf).

⁷ Carol Considine et al., "Recommendations for Freeboard Standards for State-Owned Buildings in the Commonwealth of Virginia" (Old Dominion University, October 23, 2019), https://www.naturalresources.virginia.gov/media/governorvirginiagov/secretary-of-natural-resources/images/ODU-Freeboard-Recommendations-Ver-1.5-10_31_FINAL.pdf.

⁸ "Recurrent Flooding Study for Tidewater Virginia, Submitted to the Virginia General Assembly, by the Virginia Institute of Marine Sciences" (VIMS, 2013).

⁹ W.V. Sweet and J Park, "From the Extreme to the Mean: Acceleration and Tipping Points of Coastal Inundation from Sea Level Rise." 2, no. 12 (2014): 579–600.

coastal storms will increase this number to as many as 200 days per year by 2049.¹⁰ In addition, an estimated 410,000 homes in Virginia with an estimated value of \$100 billion are at risk for storm surge damage.¹¹ Further, research has shown that natural hazards disproportionately impact low income and minority communities, making it critical that we incorporate equity considerations and protections for vulnerable populations into disaster planning.^{12¹³}

While responding to these disasters quickly and effectively is certainly critical, preparing for them minimizes damage, makes response easier, and reduces the time and expense associated with disaster recovery. A National Institute of Building Sciences report found that mitigation has a savings in benefit-cost ratio (BCR) that ranges from 4:1 to 11:1.¹⁴ Disaster preparedness requires seamless coordination among all institutions with hazard mitigation responsibilities, which is why Governor Northam required an assessment of the Commonwealth's pre-disaster mitigation programs under Executive Order 24: Increasing Virginia's Resilience to Sea Level Rise and Natural Hazards (EO-24).

Subsequently, in September 2019, Governor Northam issued Executive Orders 41 and 42, which specifically cover the statewide approach to disaster preparedness. Executive Order 41 (EO-41) outlines emergency preparedness responsibilities of state agencies and public institutions of higher education. In order to prepare for disasters, EO-41 instructs each Cabinet Secretary to conduct an annual review of disaster preparedness, response, and recovery roles assigned to their office and state agencies. Agencies are directed to include emergency preparedness training in basic responsibilities, and strategic planning, and develop continuity of operations (COOP) plans. These COOP plans outline how an agency will operate during disasters and periods of interrupted workflow. Each executive agency shall appoint a liaison officer and one alternate to serve on the Virginia Emergency Support Team (VEST). This VEST Liaison officer will participate in monthly exercises and follow a training program as determined by the Virginia Department of Emergency Management (VDEM). In addition to a VEST liaison officer, agencies must also appoint an Emergency Management Coordinator (EMC) and one alternate who will be responsible for developing plans and drills for emergency situations and COOP planning. The EMC will annually update the State Agency's COOP plan to conform with the VDEM template. All state employees are required to complete the Emergency Management for State Employees online training annually, through the Commonwealth of Virginia Learning Center website.

To further prepare Virginia in advance of disaster, Executive Order 42: "Promulgation of the Commonwealth of Virginia Emergency Operations Plan (COVEOP) and Delegation of Authority" (EO-42) outlines specific emergency response responsibilities by secretariat and agency according to

¹⁰ A. G. Burgos et al., "Future Nuisance Flooding in Norfolk, VA, From Astronomical Tides and Annual to Decadal Internal Climate Variability," *Geophysical Research Letters* 45, no. 22 (November 28, 2018): 12,432-12,439, <https://doi.org/10.1029/2018GL079572>.

¹¹ Aarti Desai et al., "2019 Storm Surge Report" (Core Logic, May 2019), https://www.corelogic.com/downloadable-docs/storm-surge-report_052919-screen.pdf.

¹² U.S. Global Change Research Program, "Fourth National Climate Assessment," November 2019, <https://nca2018.globalchange.gov>.

¹³ Engineering National Academies of Sciences, *Framing the Challenge of Urban Flooding in the United States*, 2019, <https://doi.org/10.17226/25381>.

¹⁴ Multihazard Mitigation Council, "National Hazard Mitigation Saves: 2018 Interim Report" (Washington, DC: National Institute of Building Sciences, 2018), https://cdn.ymaws.com/www.nibs.org/resource/resmgr/docs/MS_FederalGrants.pdf.

emergency support function. Agencies must ensure that they have the capacity to carry out their designated emergency support functions. Under the federal Disaster Mitigation Act of 2000, all state funded universities are required to have Hazard Mitigation Plans. These plans outline how a university will take proactive steps to reduce loss of life and property associated with natural disasters and other hazards. Each university develops mitigation strategy priorities to address the vulnerabilities identified in the plan.

While Executive Orders 41 and 42 create a broad framework for emergency preparedness in the Commonwealth, EO-24 directed the Chief Resilience Officer and the Special Assistant to the Governor for Coastal Adaptation and Protection to inventory and report on all state pre-disaster mitigation programs, and to make recommendations for improving these programs. This report satisfies that requirement. However, the process of producing this report has made it clear that while Virginia has a number of ongoing pre-disaster mitigation efforts, those efforts are uncoordinated and inadequate to help the Commonwealth minimize the negative impacts of natural disasters. The following pages offer an overview and assessment of those programs, as well as recommendations for improvement.

Figure A: Virginia Port Authority COOP Plan

Several agencies had COOP plans in place before EO-41, including the Virginia Port Authority (VPA). VPA conducts its own in-house program to prepare, respond, mitigate, and recover from all-hazard events including severe weather, pandemics, earthquakes, cyber-attacks, and other events that could impact port operations. VPA updates and verifies information within the COOP plan, familiarizes colleagues with VPA's Emergency Operations and planning efforts, continues to build and train the VPA internal Incident Management Team, prepares for all-hazards events, and identifies needs to ensure all colleagues are well informed and prepared for all-hazards events. It has used exercises to help prepare colleagues, identify gaps, and expand the use of the VPA mass notification process (Everbridge). During multiple severe weather events over the past two years, the planning and coordination between both internal and external partners has demonstrated its effectiveness during a number of real world situations managed by its Administrative and Operations Teams.

Summary of Pre-Disaster Mitigation Programs by Secretariat

In response to requests made by the Chief Resilience Officer and the Special Assistant for Coastal Adaptation and Protection, 15 agencies from eight secretariats submitted information on more than 50 programs related to pre-disaster mitigation. While not all programs submitted were included this report, hazards addressed by these programs include flooding, fire, earthquakes, and disease. This section of the report summarizes those programs. It is worth noting that this report focuses solely on pre-disaster mitigation programs. This is in contrast to the 2018 Commonwealth of Virginia Hazard Mitigation Plan, which focuses on both pre- and post-disaster mitigation and response. Some agency programs may have disaster response and recovery elements but this report addresses only the pre-disaster mitigation components of a program. It is also worth noting that the term “pre-disaster mitigation” is not defined in Virginia law or regulation, which led to a wide range of responses from the different agencies.

While no official definition of pre-disaster mitigation exists for the Commonwealth, this report drew on current definitions of mitigation, preparedness, hazard mitigation and resilience to inform requests to agencies and evaluate responses. EO-42 defines mitigation as “activities designed to reduce or eliminate risks to persons or property or to lessen the actual or potential effects or consequences of an incident.” EO-42 defines hazard mitigation as “any action taken to reduce or eliminate the long-term risk to human life or property.”¹⁵ Using these definitions as a guide, the Chief Resilience Officer, with the assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, asked agencies to list their programs that either 1) reduced risks to persons or property before a disaster or 2) reduced the potential effects or consequences of an incident. Summaries of agency responses to that inquiry are below.

Secretary of Agriculture and Forestry

Agencies within the Secretariat of Agriculture and Forestry, including the Virginia Department of Agriculture and Consumer Services and the Virginia Department of Forestry, oversee Virginia’s largest private sector industry segment. Agriculture and forestry have a combined economic impact of \$91 billion annually including more than 400,000 employees - 8.7 percent of the Commonwealth’s workforce.¹⁶

Virginia Department of Agriculture and Consumer Services (VDACS)

Food Safety Program Rapid Response Team

The VDACS Food Safety Program Rapid Response Team (VA RRT) began in October 2009 when the Virginia Department of Agriculture and Consumer Services entered a cooperative agreement with the

¹⁵ Ralph S Northam and Jeffrey D Stern, “Commonwealth of Virginia Emergency Operations Plan,” 2019, 113.

¹⁶ (2017). “The Economic Impact of Virginia’s Agriculture and Forest Industries.” The Weldon Cooper Center. Retrieved from: https://www.ag-forestry.virginia.gov/media/governorvirginiagov/secretary-of-agriculture-and-forestry/pdf/ag_forestry_study_final_06_21_17.pdf

Food and Drug Administration (FDA) to form an all-hazards food and animal rapid response effort. This team exists to minimize social, economic, and public health impacts to the Commonwealth by providing a rapid and unified multi-agency response to human food and animal feed emergencies. As part of this responsibility, VA RRT conducts pre- and post-disaster activities including preparing for foodborne illness outbreaks and other food emergencies, identifying preventive practices, training staff to be ready for events, and improving inter/intra agency communication.

In addition to VDACS, VA RRT consists of several agencies including the Virginia Department of Health, the Division of Consolidated Laboratories (state public health lab), the United States Department of Agriculture Food Safety Inspection System, and the U.S. Food and Drug Administration. VA RRT holds weekly calls with a core group of team members to provide agency updates and determine whether or RRT activation is needed. If a majority of the Core Team votes to activate, a modified Incident Command Structure is put into place as described in the Standard Operating Procedure. When an incident is resolved, an After Action Review (AAR) is required to address the strengths and weaknesses of the activation. These AAR reports are shared with all agency partners and posted on the national RRT database.

Recently, VA RRT provided funding to print and distribute QR code magnets to promote the My Meal Detective Direct Consumer Reporting Website where citizens can report suspected cases of foodborne illness. To prepare for future events, the Rapid Response Team distributes outreach materials on preparation planning and keeping food safe during a disaster through the VDACS Communications Office. They also deploy feed inspectors to firms to assess food and feed supplies. If the feed supply is unsafe, staff temporarily closes down the operation and provides instruction on proper disposition of unsafe feed to reopen the operation as quickly as possible.¹⁷ VDACS recently deployed VA RRT in response to 10 illnesses associated with a health supplement product, after patients became seriously ill from a counterfeit supplement. VA RRT coordinated response and surveyed activities at 23 firms to determine distribution channels, collect samples, and seize product. The VA RRT also coordinated with the FDA's Office of Criminal Investigations (OCI) to collect evidence for a criminal investigation.

The VA RRT program receives federal funding through the FDA and receives no state funding. The FDA awarded VA RRT a four-year grant of 900,000 for the 2018-2022 grant cycle (\$225,000 a year for four years). As part of funding requirements, VDACS is required to submit an annual end of year report that includes how the VA RRT program would continue should federal funding cease. VDACS previously requested two grant funded personnel, an RRT coordinator position, and a .5 FTE Agriculture Commodities Feed Subject Matter Expert which was not approved by the General Assembly. Since these positions were not approved, federal funding cutbacks would severely limit VA RRT operations. In the event of cutbacks, the VDACS Food Safety Program would continue recall audit checks and field response in a limited capacity. Environmental assessment investigations, provided through the cooperative agreement with the FDA, would also be greatly diminished. Further, communication and coordination among the RRT partners would occur less often.

¹⁷ "Virginia Rapid Response Team," accessed May 27, 2020, <http://www.vdacs.virginia.gov/pdf/rrt-ccw.pdf>.

Virginia Department of Forestry (VDOF)

All-Hazard Emergency Response and Management Program

VDOF is responsible for suppressing wildfires and enforcing forestry laws for over 15.5 million acres of private and state lands in the Commonwealth. VDOF conducts ongoing wildfire suppression and incident management, maintaining Virginia's only Type 2 Incident Management Team (IMT), maintaining a fleet of specialized equipment, and maintaining a focus on the training and development of local volunteer fire departments. The agency employs approximately 150 responders who serve as both firefighters and fire related law enforcement officers. Their fleet of frontline wildfire response equipment includes 89 small bulldozers and 12 Type 6 brush trucks. VDOF works closely with rural volunteers and fire departments to maintain a network of approximately 300 "call-when-needed" part-time firefighters. This network helps VDOF increase response capacity during the busy spring and fall wildfire seasons.

Training fire firefighters throughout the year helps VDOF prepare for wildfire mitigation. Training includes developing wildfire suppression capabilities, all-hazard incident management, and operation of response equipment. VDOF trains 800 responders, representing 10,000 student hours of training annually. The VDOF Statewide Wildfire Training Academy is in its 19th year and is one of the largest training events of its kind in the nation. Local fire department participation is encouraged since their assistance in wildfire suppression is critical to the overall success of the program.

No specific state funding is dedicated to the All-hazards Emergency Response and Management Program. Some other agency operations, however, are used to match federal funding received. In support of this program, VDOF incurs \$600,000 annually in staff time including fringe benefits and indirect costs for its training, response and mitigation activities. VDOF also receives approximately \$200,000 in federal grants through the U.S. Forest Service's State Fire Assistance Preparedness Grant Program.

Firewise Virginia Program

The purpose of the VDOF Firewise Program is to prevent wildfire damage in Virginia's highest risk woodland home communities. VDOF does this by providing information to homeowners about critical improvements and wildfire risk. VDOF has identified more than 5,200 woodland home communities that are at risk of wildfire threat. These at-risk communities are rated for wildfire threat to prioritize hazard mitigation efforts. Communities with the highest priority complete community wildfire protection plans and on-the-ground wildfire prevention and hazard mitigation projects using federal funding. Communities that complete the wildfire prevention program can be recognized nationally as a "Firewise USA Community." Virginia currently has 57 Firewise USA Communities, ranking in the top fifteen states in the nation. The Coal Bank Ridge Community in Montgomery County was one of only four communities in the United States, and the only community east of the Mississippi River, to be recognized as a National Firewise Community of Excellence in 2019.

To supplement the Firewise Program, VDOF has collaborated with other southeastern state forestry agencies to form the Southern Wildfire Risk Assessment Portal (SouthWRAP). This portal is an online GIS-based tool that standardizes wildfire hazard and risk, wildfire suppression difficulties, and community risk assessment levels from Virginia to Texas. Having a uniform system allows for more efficient prioritization of federal wildfire hazard mitigation program funding.

VDOF receives both federal and state funding to run the Firewise Virginia Program. Federal funding includes \$400,000 annually in wildfire hazard mitigation funding from the U.S. Forest Service. The state provides VDOF \$150,000 annually in staff time including fringe benefits and indirect costs. However, the lack of additional funding and staff shortages make it difficult to expand the Firewise Program to the level necessary to meet estimated demand. Estimations require at least three times the current level of service.

Virginia Dry Hydrant Program

The Virginia Dry Hydrant Program installs new dry hydrants in ponds and rivers throughout the Commonwealth to increase the availability of accessible water supplies for firefighting in rural areas. These hydrants are designated water source drafting locations that make firefighting operations more efficient by providing water quickly and reducing the damage to homes and other property. Since 1997 the Virginia Dry Hydrant program has installed over 900 dry hydrants, distributed across Virginia in rural areas that do not have municipal water supply available to fight fires. Local volunteer fire departments identify possible new sites for installation and are required to maintain hydrants and conduct periodic testing after the dry hydrant is in place.

State funds finance the Virginia Dry Hydrant Program. The funds pass through the Virginia Department of Fire Programs and the Virginia Department of Forestry. The program receives \$100,000 in annual program funding from the Virginia Fire Programs Fund special set-aside, and VDOF provides \$25,000 annually in staff time including fringe benefits and indirect costs. Additional funding would allow for a higher number of new hydrants to be installed each year. These new hydrants would increase firefighting efficiency in rural areas and reduce damage to homes and other property. In addition to new hydrants, more funding is needed to repair older dry hydrants that are approaching 30 years of age. The gap between available funds and funds needed to repair and/or replace these older hydrants has been increasing every year.

[Secretary of Commerce and Trade](#)

The Secretary of Commerce and Trade is dedicated to developing and growing an economy for all Virginians. Each of the 12 agencies under the secretariat strives to make Virginia the best place to live, work, and conduct business.

Virginia Department of Housing and Community Development (DHCD)

Community Development Block Grant Program (CDBG)

The CDBG Program is housed within the U.S. Department of Housing and Urban Development (HUD), with grants administered by the states. The objectives of the CDBG program are to 1) benefit low and moderate income persons; 2) aid in the prevention and elimination of slums or blight; and 3) meet a need having a particular urgency (referred to as urgent need).¹⁸ Funding is provided by contract to eligible units of local governments, which then disburse funds. State CDBG funds can generally not be used in HUD defined entitlement communities (i.e. large cities and urban/suburban counties) that receive their own CDBG funds directly from HUD.

Program funding is not specifically designed for pre-disaster mitigation efforts but urgent community need funds can provide hazard mitigation if a federally declared disaster occurs in a locality. DHCD reserves a limited amount of CDBG funds on an annual basis for urgent need projects. HUD provides annual funding for twenty-seven different categories including “public works” which can include flood resilience projects. Buyouts of damaged properties in a floodplain and relocation can also be eligible activities. In addition to the annually appropriated CDBG program, there are also individual grant programs that support resilience efforts. Funding for these programs is typically nationally competitive or dependent on federally declared disasters. The Community Development Block Grants-Disaster Recovery Program (CDBG-DR) provides recovery grants to states and localities after a nationally declared disaster. These funds can be used to build back better and address flooding concerns. The Community Development Block Grant National Disaster Resilience Competition (CDBG-NDRC) is a nationally competitive grant program that provides funding for disaster recovery and long-term community resilience.¹⁹ The newly created Community Development Block Grant Mitigation Grants (CDBG-MIT) help states and localities mitigate disaster risks in addition to transforming state and local planning. In order to be eligible for these grants, a state needed to be recovering from a qualified 2015, 2016, or 2017 disaster.²⁰ While Virginia did not have a disaster that qualified for current funding, CDBG-MIT grants could be a helpful mitigation tool in the future, should HUD choose to expand the program.

DHCD receives roughly \$1 million in federal HUD funding to make available annually for urgent need situations in rural and small cities. Larger localities that are entitlement areas receive funds directly from HUD.

¹⁸ Kelsey McNeill and Alyssa Glass, “Benefit-Cost Analysis for Federal Funding Programs” (Virginia Institute of Marine Science, College of William and Mary, Fall 2019).

²⁰ “Allocations, Common Application, Waivers and Alternative Requirements for Community Development Block Grant Mitigation Grantees,” accessed April 23, 2020, <https://files.hudexchange.info/resources/documents/FR-6109-N-02-CDBG-Mitigation-Notice.pdf>.

National Disaster Resilience Competition (NDRC)

In 2017, the Commonwealth received a \$120.5 million federal grant from HUD through its National Disaster Resilience Competition (NDRC) program. This federal grant includes \$109.5 million in funds for the Ohio Creek Watershed project in Norfolk, \$5 million for the creation of a costal resilience laboratory and accelerator center, and \$6 million in administrative costs. The state agreed to provide \$5 million in matching funds over five years to support the accelerator portion of the grant.

The NDRC grant supports a five-year project to implement the Ohio Creek Watershed Project in the City of Norfolk, and creates a business incubator/accelerator [Rise Resilience Innovations, Inc. \(RISE\)](#). The Ohio Creek Watershed Project will reduce flooding, improve public spaces and ensure a thriving community in Norfolk's Chesterfield Heights and Grandy Village neighborhoods. The project uses a combination of green and gray infrastructure to help the community deal with increased flooding and create economic opportunity.

The NDRC grant also provides \$5 million in federal funding to support the development of the nation's first of its kind resilience innovation hub. The Resilience Innovation Fund's (RISE) mission is to create a "living laboratory" to test costal resilience innovation and create partnerships in the resilience and coastal adaptation fields. The goal is to position Hampton Roads as the global leader in addressing impacts of sea level rise, recurrent flooding, and extreme weather events through a regional approach. The "Coastal Community Resilience Challenge" uses approximately \$1 million in RISE funding annually to finance innovators with financially sustainable solutions that enhance the resilience of coastal communities. Topics include water management, data analytics, viability of buildings, critical systems functionality, reconnecting neighborhoods, and workforce development. The first challenge resulted in six funded projects ranging from innovative retrofitting of flooded buildings to enhanced oyster reef restoration substrate development.

Uniform Statewide Building Code

The Uniform Statewide Building Code (USBC) provides regulations to protect the health, safety and welfare of the residents of the Commonwealth in the built environment. It also encourages consistent application of the code throughout the Commonwealth. Virginia's building codes are updated regularly with the 2015 USBC building codes in effect as of September 4, 2018, and development of 2018 USBC (which will go into effect in September 2021) underway. The 2015 update included a one-foot freeboard requirement for new homes, added in 2019 for homes located in vulnerable coastal areas (FEMA V-Zone). The Board of Housing and Community Development promulgates the USBC based on national model codes developed by the International Code Council (ICC). The codes are regularly updated and amended specifically for use in Virginia. Stakeholder participation in development in regulations is encouraged and remains high throughout the building code process. While stakeholder engagement is important, the lack of consensus on new updates and regulations can prevent DHCD from maintaining updated regulations that reflect the latest improvements in the regularly updated national codes. DHCD also operates the Virginia Building Code Academy, which is nationally recognized and trains local building officials at no cost. Regular updates of the codes and proper training of building officials, as provided by DHCD, supports resilient structures across the Commonwealth.

Specific to flooding, the USBC requires that substantially damaged buildings (i.e. repair costs are equal to or exceed 50 percent of the market value before the damage occurred) must meet the Code's flood proofing requirements for new buildings. DHCD coordinates with the Department of Conservation and Recreation's Dam Safety and Floodplain Management Program, to ensure that the USBC works in tandem with the National Flood Insurance Program guidelines.

For the current (2018) Code development cycle, DHCD has implemented a feature in [Virginia's code development system](#) that requires a resilience impact statement to be included with any proposed Code change to ensure that consideration is given to the positive or negative impact each proposed change might have on resilience. This documentation will allow the agency to evaluate the net change in resilience achieved each time the State Building Code is updated. DHCD and its board are considering a number of other resilience-related Code changes, including stronger freeboard and first floor elevation standards and wind design criteria for new construction and alteration or improvement projects.

A combination of state and local funds support development and implementation of the USBC. DHCD received an annual state appropriation of \$2,922,902 for FY2019 and FY2020 for state building code administration. Local building departments also collect a two percent levy on building permit fees. This is remitted to DHCD to support training through the nationally recognized Virginia Building Code Academy.

Virginia Department of Mines, Minerals and Energy (DMME)

VDEM/DMME Pre-Disaster Landslide Hazard Mitigation Grant (Nelson and Albemarle Counties)

Landslides can occur everywhere in the Commonwealth, but the mountainous regions, valleys, and ridges of the Blue Ridge and Southwest Virginia are most vulnerable. The topography of these areas includes steep slopes that are susceptible to landslides during periods of intense rainfall. While not as common, some landslides have occurred in the Coastal Plain region. Several landslides in 2018 occurred east of Richmond resulting in home condemnations.

DMME began its landslide mitigation mapping project in 2019 after receiving a Pre-Disaster Mitigation Grant from FEMA through VDEM. This two-year grant will map landslide risk in western Nelson and Albemarle counties, both of which experienced significant landslides during Hurricane Camille in 1969 and a strong thunderstorm in June 1995. Significant financial damage occurred, including \$975 million during Hurricane Camille and \$188 million from more than 70 landslides during the June 1995 storm.²¹ The landslide mitigation project has mapped more than 6,000 landslides in both counties using 2016 1-meter LiDAR remote sensing data. DMME will use this data to identify areas with the greatest landslide failure and inundation risk. Localities and emergency managers can then use these maps to aid in local

²¹ "Division of Geology and Mineral Resources - Landslide Hazard Mapping: Landslide Mapping in Nelson and Albemarle Counties," Government, Virginia Department of Mines, Minerals and Energy, accessed March 24, 2020, https://www.dmmr.virginia.gov/dgmr/FEMA_Landslide.shtml. (NOTE: Damage estimates converted to 2019 dollars. Hurricane Camille caused \$140 million in damage in 1969 dollars and June 1995 storms caused \$112 million in 1995 dollars.

planning and zoning, update regional hazard mitigation plans, and educate citizens about their landslide risk. It can also help emergency personnel target specific areas of need for early warning and evacuation procedures during landslide-triggering rain events.

Federal resources fund 75 percent of the landslide mitigation mapping program, along with a 25 percent state match. FEMA provides \$78,640 for the project, and \$26,213 in state funds fulfill the match requirement. DMME is in the process of applying for a second round of FEMA/VDEM Pre-Disaster Mitigation Funding to finish mapping in Nelson and Albemarle.

While this funding from FEMA is only for this project, landslide hazard mapping could be completed in other parts of the Commonwealth with adequately trained staff and additional resources.

Commercial Property Assessed Clean Energy (C-PACE)

C-PACE financing is a local government administered loan program designed to support energy efficiency, resilience improvements, and flood hazard mitigation efforts at the local level. The General Assembly amended the Code of Virginia in 2019 to make resilience projects eligible for C-PACE financing. The amendment states that loans can be used to finance “initial acquisition and installation of resiliency improvements, including improvements for the mitigation of flooding or the impacts of flooding or stormwater management improvements with a preference for nature or nature-based features and living shorelines.” Localities are required to pass an ordinance to establish a C-PACE program in their jurisdictions. Although no C-PACE loans have been issued to date, Arlington, and Loudoun counties, along with the cities of Fairfax and Fredericksburg, have or will soon offer C-PACE programs, and Fairfax County amended its local ordinance in March 2019 to include a C-PACE program. While C-PACE is locally controlled, DMME provides loan underwriting guidelines and leads the federally funded Mid-Atlantic Pace Alliance (MAPA) between Virginia, Maryland and the District of Columbia. MAPA exists to accelerate C-PACE implementation and provide guidance in the region.

Legislation from the 2020 General Assembly gives DMME the authority to serve as the statewide sponsor for the clean energy financing program. DMME will contract with a private entity through a competitive process to develop and administer the program. In support of this effort, DMME expects to receive \$50,000 in state general funds for FY20 and FY21, for a total of \$100,000, to sponsor the C-PACE program and designate and coordinate with a program administrator.

Bureau of Ocean Energy Management (BOEM)- Offshore Sand Resources

DMME receives federal funds through the Department of Interior to administer the Bureau of Oceanic Energy Management Offshore Sand Resources program. The program is a State Cooperative Agreement between BOEM and DMME to assess offshore sand resources in federal waters for beach re-nourishment. DMME identifies high quality offshore sand resources for beachfront re-nourishment and coordinates with the Virginia Marine Resources Commission (VMRC) and the Department of Environmental Quality's (DEQ) Coastal Zone Management program on permitting and on Federal Consistency Determinations, respectively.

Seventy percent of the program is funded using federal dollars and 30 percent is funded using a state match. This includes a Federal Department of Interior Grant via the Bureau of Ocean Energy Management for \$200,000 plus \$85,017 in a state General Fund match.

Informal Seismic Monitoring

The informal seismic monitoring program determines the location of seismic events. DMME currently operates two portable seismometers that they deploy on a temporary basis to investigate earthquake clusters. The program recently monitored two different locations in Southwest Virginia for seismic activity (Russell County and Tazewell County) to determine possible trends or problem areas.

DMME does not currently have a permanently funded, formal seismic monitoring program and there are no full-time staff for this position. Current employees work on informal seismic monitoring in addition to their full-time roles. Current capabilities and the lack of permanent staff makes it difficult to interpret seismometer data. Creating a permanent program would require procuring and maintaining seismometers and funding for at least one geophysicist to interpret data from the devices. A rough estimate for a permanent program according to DMME would be about \$200,000 annually.

Mining Dam Safety

Three agencies at DMME regulate impoundment dams for both coal and non-coal mineral mining operations. The Division of Mines (DM) and Division of Mined Land Regulation (DMLR) regulate coal mine waste impoundment dams, and the Division of Mineral Mining (DMM) regulates large impoundments on permitted mineral mines. DMME inspects both mineral and coal mining impoundments to ensure the short and long-term stability and safety of these structures. DMME and the Mine Safety and Health Administration (MSHA) conduct joint annual inspections in addition to mine operator weekly inspections and individual monthly/quarterly inspections.

Coal waste impoundment dams are one of many mining operations under DM and DMLR's regulatory oversight. These impoundments follow regulations effectively the same as the Department of Conservation and Recreation Dam Safety Division. Operators are required to make daily safety inspections and DM requires each impoundment dam to have an emergency response and evacuation plan in case of failure. If a dam is unsafe, DM and DMLR will shut down the slurry pumping into the impoundment. DM and DMLR work together to determine appropriate enforcement levels to ensure worker, public, and environmental protection. Enforcement can include closure orders, financial penalties and adherence to the emergency response plan. DMLR assess financial penalties and DM has the authority to issue closure orders to any operator that does not comply with regulatory requirements.

Mineral mining regulations and enforcement are similar to coal mining. The design and construction details of impoundment dams must be submitted to DMME's Division of Mineral Mining (DMM) and approved before construction. These dams are maintained under the same requirements under the DCR Dam Safety Division. Mineral mine safety law requires that mine operators conduct daily inspections to identify any potential hazards. In cases of significant rainfall inspections occur multiple

times a day. If a dam is found unsafe, inspectors issue regulatory orders and can force closure if necessary. DMM does not have the authority to levy fines but can issue closure orders for noncompliance. MSHA also conducts mineral mine inspections and can issue fines or closure orders for federal violations.

State general funds and collected fees primarily fund the DM and DMLR coal mining program. The federal Office of Surface Mining oversees the SMCRA portion of the DMLR program through the Virginia primacy program. DMLR receives \$3.6 million annually from the federal government in addition to \$3.6 million in matching state dollars. Regulatory fees are also a source of funding for DMLR. State funding and operator fees fund DMM in addition to a small number of federal grants from MSHA and the EPA.

Virginia Energy Storage Study (Micro-Grid Energy Storage)

The 2018 General Assembly directed the Virginia Solar Energy Development and Energy Storage Authority to conduct an energy storage study. While not intended as a strictly pre-disaster preparedness plan, the study does address some resilience efforts including the potential for micro-grids to serve as backup power during an emergency. Micro-grids are local energy grids, which can disconnect from the main grid with local energy generation. Micro-grids are typically paired with renewable sources, like solar, or diesel generation to provide backup power in an emergency. The energy storage micro-grids provide allow them to operate as an “island” disconnected from the grid for extended periods. Many cities utilize solar plus micro-grid storage to provide power to critical resources like hospital or schools during disasters. One of the Virginia Energy Storage Study’s recommendations was to develop a strategic plan for accelerating microgrid deployment to enhance resilience at critical facilities. This plan would create “make ready” provisions that would allow utilities to make investments in micro-grid infrastructure.²²

VDEM is the lead for coordinating grid security during a natural disaster or crisis. They work with investor-owned utilities, public utilities, and co-ops to ensure the security of the grid. DMME and the State Corporation Commission (SCC) serve as backup for grid security. DMME also has a supporting function to communicate fuel industry concerns and fuel waivers to relevant parties including VDEM, DEQ, VDACS, and Federal agencies.

The General Assembly provided a General Fund appropriation of \$50,000 in FY19 and FY20 for a total of \$100,000 to complete the study.

[Secretary of Health and Human Resources](#)

The Secretary of Health and Human Resources ensures that all Virginians have access to often vital services including social services, medical care, and clean drinking water. Individuals with disabilities,

²² “Commonwealth of Virginia Energy Storage Study,” Government, Department of Mines, Minerals and Energy, August 2019, <https://www.dmme.virginia.gov/de/LinkDocuments/Virginia%20Energy%20Storage%20Study%20-%20Final%20Report%20%202019.pdf>.

the aging community, low income families, children, caregivers and providers are supported by this Secretariat and its twelve state agencies.

Department of Behavioral Health and Developmental Services (DBHDS)

Office of Emergency Management

The DBHDS Office of Emergency Management conducts disaster preparedness and response coordination activities throughout the Commonwealth. While emergency management is not a mitigation program per se, mitigation is included in any comprehensive emergency management program. The mission of OEM is to 1) coordinate the all-hazards disaster preparedness and response efforts for all state-operated facilities, 2) develop, maintain, and deploy state level disaster behavioral health capability, 3) collaborate with Virginia's Community Services Boards to ensure resilience to all-hazards events, and 4) agency level crisis management and COOP planning.

Virginia Department of Health

Drinking Water State Revolving Fund (DWSRF)

VDH's Office of Drinking Water (ODW) manages the Drinking Water State Revolving Fund (DWSRF). This fund is a financial assistance program to help water systems and states achieve health protection objectives of the federal Safe Drinking Water Act (SDWA). The goals of the program are to improve drinking water treatment, fix leaky pipes, improve water supply sources, replace finished water storage tanks, and other infrastructure projects to improve public health. Projects are ranked according to greatest risk to public health. A 15 percent set-aside funds the Emergency Preparedness and Security Coordinator position. Waterworks are encouraged to work with the Emergency Manager for the county where they are located to apply for and use Homeland Security Mitigation Grant Program funds managed by VDEM. Between 2006 and 2009, drinking water utilities spent just over \$4 million from this program to purchase back up power such as generators, quick connects, and transfer switches. These investments allow drinking water utilities to function in the event of a disaster with mass power outages.

Federal funds make up 70 percent of program funding and a state match makes up 30 percent. The amount of state funds dedicated to DWSRF varies depending on the size of the federal grant. In FY2019, VDH received a federal grant of \$18.1 million with a state match of \$3.62 million from the Water Supply Assistance grant. However, as the DWSRF program is structured as loans to local governments, some localities do not have the ability to take on debt and cannot participate. Increasing funding to allow grants would give these localities an opportunity to participate in the program.

Harmful Algal Bloom (HAB) Program and Response

The Harmful Algal Bloom (HAB) program is a cross-division effort led by the Office of Environmental Health Services Division of Shellfish Safety and Waterborne Hazards and supported by the Office of Epidemiology and the Office of Drinking Water. This program monitors and responds to events in

marine waters where shellfish may become contaminated with biotoxins. The State Health Commissioner may issue an “emergency order” to stop the use of a water supply for a defined period of time to prevent human exposure to HAB organisms and their toxins which may be present in Virginia marine and fresh water bodies. Currently the program conducts lab testing through VDH sample collection and VDH funded MOUs with state academic partners. DEQ also conducts bloom response in support of their Chesapeake Bay Monitoring Program.

The Virginia Department of Health (VDH) does not have a routine monitoring program for inland freshwater blooms but does provide response to these events. The need to respond to freshwater toxic cyanobacteria blooms has grown over the last 10 years but funding to support laboratory analyses has remained static. An inland freshwater monitoring program would allow VDH to conduct seasonal monitoring and surveillance on freshwater and non-coastal sites that have high public recreational use. Those waters with high bacteria levels that coincide with areas of high recreational use create an opportunity to alert the public on potential exposure to bacteria that can cause human illness. The agency could develop a protocol for public recreational waters, which will include specifics on signage, maintenance, and frequency of review of water quality results. Further, the protocol would provide the framework for assessing long-term advisory sites for recreational use, program partners, review of criteria, mapping of LTAs locations, and removal of LTAs.

VDH utilizes a combination of Office of Epidemiology, Office of Drinking Water and Office of Environmental Health Services state and federal funds to support the HAB program. The Office of Drinking Water uses \$20,000 from the EPA Drinking Water State Revolving Fund Set-Asides to fund special sampling and purchase test strips on an as-needed basis. This funding is not earmarked for HAB but is used in the event of an outbreak. The Office of Environmental Health Services, Division of Shellfish Safety and Waterborne Hazards supports marine monitoring and response through state General Funds. This includes approximately \$150,000 to support laboratory MOUs, portions of 2 FTEs, and supplies used to support response efforts.

Sustainable Water Initiative for Tomorrow (SWIFT)

The VDH Office of Environmental Health Services (OEHS) and Hampton Roads Sanitation District (HRSD) collaborate to administer SWIFT. This program is designed to ensure a sustainable source of groundwater while addressing environmental challenges such as Chesapeake Bay restoration, sea level rise, and saltwater intrusion. It is a multi-year initiative that re-treats already highly-treated wastewater to produce drinking water, which is then injected into the Potomac Aquifer. The project will ultimately inject up to 120 million gallons per day of highly treated wastewater back into the Potomac aquifer at seven proposed injection sites in the HRSD including James City County, York County, Newport News, Norfolk, and Suffolk. HRSD indicates its first full scale injection site near Williamsburg to come online in 2022. Adding this sustainable groundwater will significantly reduce the number of nutrients the Hampton Roads Sanitation District (HRSD), will replenish groundwater supply, reduce land subsidence in Hampton Roads, and protect groundwater from saltwater intrusion due to a shrinking aquifer.

SWIFT currently does not receive its own state, federal, or local funding and VDH diverts time from other projects to meet the current needs of the SWIFT program. Staff from VDH's Office of Environmental Health Services and the Office of Drinking water currently work on the SWIFT program in addition to their designated tasks. HRSD has proposed a grant agreement with VDH to provide necessary funding to VDH for the Technical Services Engineer position to accomplish tasks associated with SWIFT.

Vectorborne Disease Program (VDP)

The Vectorborne Disease Program is designed to prevent and control human diseases transmitted by mosquitos and ticks. VDH monitors environmental conditions and data on reported illnesses, and coordinates with local health. This surveillance and communication can prevent vectorborne disease outbreaks from occurring, particularly after flooding incidents.

While the Code of Virginia gives localities the authority to create mosquito control districts, there is no overarching mosquito control program funded or overseen by the Virginia Department of Health. Although there are a few localities that have strong mosquito control programs, most jurisdictions in eastern or Southside Virginia have no mosquito control capability. This means that after major flood events in Virginia, floodwater mosquito control operations are only authorized when FEMA funds are made available. Virginia Code requires that local governments are responsible for mosquito control. Localities that have well established mosquito control programs, such as Chesapeake and Suffolk, may use their own mosquito control funding to purchase insecticides or contract local aerial spray contractors and may be reimbursed directly through FEMA if approved.

This becomes problematic when large areas in multiple jurisdictions are affected by floodwater mosquitos that result from a storm event and aerial insecticides are the only solution. Since most jurisdictions cannot afford to pay for aerial spraying, VDH identifies areas that need to be sprayed and applies for FEMA reimbursement. This allows for mosquito abatement by aerial insecticide applications in and around human population centers along Virginia's coastal plain, or along broad river floodplains after severe flooding events.

There is currently no tick control or invasive insect control program overseen by VDH or a Virginia locality. With regards to ticks, the VDP maintains and improves tick surveillance programs, reports on tick infection rates, and assists local health departments with individual case follow up and reported outbreaks from surveillance programs.

The VDP is funded almost entirely with federal funds through a Centers for Disease Control and Prevention Epidemiology Laboratory Capacity grant. VDP received \$623,787 through this grant in FY2019.

[Secretary of Natural Resources](#)

The Secretary of Natural Resources advises the Governor on natural resource issues and works to advance the Governor's top environmental priorities. The five agencies under this secretariat work to

protect and restore the Commonwealth's natural and historic resources. As the designated Commonwealth Chief Resilience Officer as outlined in Executive Order 24, the Secretary is also responsible for planning and implementing pre-disaster mitigation strategies to reduce the near and long-term impacts of natural disasters for the Commonwealth.

Department of Conservation and Recreation (DCR)

Community Assistance Program- State Support Services Element

This program exists to strengthen and enhance the effectiveness of the National Flood Insurance Program (NFIP). The primary goals of the Community Assistance Program are to fund NFIP technical assistance to communities and evaluate community performance in implementing NFIP floodplain management activities. It helps achieve these goals by fostering strong federal, state, tribal, regional, and local partnerships to identify flood risks, reduce flood losses, and promote community resilience. Starting in FY2019, states are expected to collaborate with FEMA regions to establish annual performance commitments that FEMA will monitor on a quarterly basis in the Community Information System (CIS). States must also ensure enhanced community compliance with substantial damage provisions of floodplain management regulations and support 2019 Endangered Species Act implementation activities.

As part of the NFIP, the Community Rating System provides localities with decreased flood insurance premiums if the locality meets certain goals beyond NFIP minimum requirements. As of 2018, 323 communities in the Commonwealth include Special Flood Hazard Areas (SFHAs) within their boundaries and are eligible to participate in NFIP. Two hundred and ninety of the 323 communities participate in the program. Of those 290 NFIP communities, 25 participate in the CRS program resulting in a total statewide savings of more than \$4.8 million. To help community members assess their flood risk, DCR collaborated with VIMS to develop the Virginia Flood Risk Information System (VFRIS). This online tool helps users view and assess flood risk by providing Special Flood Hazard Areas (SFHAs), flood depth grids, the Limit of Moderate Wave Action, and parcel boundaries. Users can also download flood insurance studies and flood risk reports for their area of interest.²³

DCR received \$201,118 in federal funding for FY2018. An additional \$50,279 in state general funds was applied to the program to satisfy federal match requirements. This funding supported approximately 42 percent of the salaries for three full time staff who administer this program. Staffing and resource limitations prevent effective implementation of the Community Assistance Program and prevent adequate technical assistance for all NFIP communities.

Cooperating Technical Partners (CTP)

The Cooperating Technical Partners Program strengthens and enhances the effectiveness of NFIP. CTP supports the mission of the NFIP's Flood Hazard Mapping Program by conducting risk mapping and developing the [Risk Mapping, Assessment and Planning \(Risk MAP\)](#) initiative. Risk MAP develops flood

²³ "Commonwealth of Virginia Hazard Mitigation Plan" (Virginia Department of Emergency Management, March 2018).

hazard data and maps for communities that previously did not have identified risks. It also builds on effective flood hazard data and FEMA flood insurance rate maps (FIRM). Metrics gathered as part of CTP include cost efficiency for projects (“Cost Performance Index”), the number and type of project changes, and ongoing maintenance through non-federal funds.

In the FY2018 biennium, DCR received \$80,000 in federal funds to administer CTP. These funds covered 30 percent of the salary for two full time staff and two wage staff. Additional funding would allow DCR to hire sufficient staff to meet program requirements and keep up with the number of NFIP communities.

Dam Safety Flood Prevention and Protection Assistance Fund

The Dam Safety Flood Prevention and Protection Assistance Fund (Fund) mitigates flooding risks through 1) providing assistance to local governments to develop flood prevention or protection studies, 2) providing assistance to private entities for engineering studies related to certain approved dam safety activities including dam safety and construction, and 3) administration and management of the Fund. The Fund provides grants and loans to accomplish these activities. Grants require a 50 percent project match by the applicant and loans require a minimum 10 percent project match by the applicant. State-owned dams, federally-owned dams, and dams not regulated pursuant to the Dam Safety Act are ineligible for funds.

The Fund consists of money set by the General Assembly to be set up as a permanent and non-reverting fund. The Fund includes General Assembly Appropriations, loan principal interest from localities or other public/private sources participating in the program, all Fund investment income, or any other sums as designated. Any money remaining in the Fund at the end of the biennium, including appropriated funds, remains in the Fund and does not revert back to the General Fund. The Virginia Resources Authority (VRA) manages the Fund in cooperation with the Department of Conservation and Recreation. DCR was appropriated \$464,294 in state funds during FY2018 and \$884,294 during FY2019. \$420,000 of the FY2019 funds was earmarked for the rehabilitation of the Hearthstone Dam. The state FY2020 appropriation increased by \$267,853 for a total of \$732,147 for FY2020. With more than 2,000 regulated dams in the Commonwealth, and many more unregulated dams likely in need of repairs, current funding levels cannot meet dam safety needs. DCR estimates that it would cost an additional \$225.7 million to bring high hazard (\$125.7 million) and significant hazard (\$100 million) public dams into compliance. They estimate that it would cost roughly \$323 million to repair and rehabilitate privately owned dams.

Virginia Community Flood Preparedness Fund

The 2020 General Assembly created the Virginia Community Flood Preparedness Fund as a special non-reverting fund to replace the existing but not capitalized Virginia Shoreline Resiliency Fund. DCR will manage this fund to promote and support Commonwealth-wide flood prevention and protection and coastal resilience measures. 45 percent of the revenues from the sale of carbon credits under Virginia’s participation in the Regional Greenhouse Gas Initiative will accrue to the Fund, as authorized by HB 981/SB 1027. Localities may apply for grants or loans to use the fund to implement flood prevention

and protection projects and studies for areas subject to recurrent flooding. No less than 25 percent of funds distributed by the Community Preparedness Fund will be for projects in low-income geographic areas. DCR is developing guidelines for management of the fund, and will give priority to projects that implement community-scale mitigation activities and use nature-based solutions to reduce flood risk. With an estimated annual revenue stream of nearly \$50 million, the Virginia Community Flood Preparedness Fund will be the beginning of state support for flood preparedness and resilience in Virginia.

National Dam Safety Program

The National Dam Safety Program supports FEMA's strategic goals to build a culture of preparedness, and to ready the nation for catastrophic disasters. The mission of the program is to reduce risks to lives, property, and the environment from dam failure by guiding public policy and leveraging industry best practices across the dam safety community. The program aims to ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction, encourages acceptable engineering policies and procedures to be used, encourages the establishment and implementation of effective dam safety programs, develops and implements a comprehensive dam safety hazard education and public awareness initiative, develops mechanisms to provide federal technical assistance for dam safety to non-federal dam safety practitioners, and develops technical assistance materials, seminars, and guidelines to improve security for dams in the United States. DCR receives federal funding from FEMA every year to implement the National Dam Safety Program.

DCR received \$221,385 in federal funding for FY2019. This money supports two full time staff assigned to carry out dam safety-related activities. State general funds of \$1.4 million and \$200,000 of Dam Safety and Flood Prevention and Protection Assistance funding are used for staff and supporting non-grant activities. In order to receive federal funds, the state must maintain aggregate expenditures of the state from all other funding sources for programs that ensure dam safety for the protection of human life or property. Expenditures must be reported for any program that at or above a level equal to the average annual level of such expenditures for the two fiscal years preceding the current fiscal year.

High Hazards Potential Dams (HHPD)

DCR administers the High Hazard Potential Dam Grant Program (HHPD) in conjunction with the National Dam Safety Program (NSDP). The HHPD grant provides technical, planning, design, and construction assistance for rehabilitation of eligible high hazard potential dams. Dams are eligible if they are 1) non-federal dams located within a state dam safety program, 2) classified as "high hazards potential" dams by the state, 3) have an emergency action plan approved by the relevant state dam safety agency and 4) the state determines that the dam fails to meet minimum safety standards and poses an unacceptable risk to the public. HHPD promotes flooding mitigation by providing financial assistance for rehabilitation of high hazard dams, requiring participants to develop and implement floodplain management plans, and public education and awareness of flood risks. DCR uses a risk-

based prioritization method using failure models, potential consequences from a dam incident, and expected risk-reduction.

Natural Heritage Program

The DCR-Natural Heritage Program manages 30 Natural Area Preserves (NAPs). These preserves provide shoreline, riverine and/or wetland flooding resilience by providing a natural area buffer to uptake flood waters and storm surge. Natural Heritage constantly works to identify lands most important for protection and incorporation of Natural Area Preserves based on Natural Heritage resources present on those lands. They want to strategically expand coastal NAPs in order to permanently protect and manage adjacent uplands, and the habitats and ecosystem services those lands provide.

There are currently over 30,000 acres of protected land throughout the state. Crow's Nest Natural Area Preserve in the Northern Region is over 3,000 acres and permanently protects 900 acres of wetlands which comprise 60 percent of Stafford County's marshes. Six of the twelve in the Southeast Region, totaling over 14,200 acres, are associated with coastal areas and/or low-lying riparian areas. Recent closings and acquisitions underway will help to assure flooding resilience at Crow's Nest NAP, Cape Charles NAP, and South Quay Sandhills NAP.

ConserveVirginia

In addition to Natural Area Preserves, DCR identified the most important lands to protect riverine flooding, coastal flooding, and wetland values as part of Governor Northam's *ConserveVirginia* strategic land conservation initiative. With every *ConserveVirginia* update, DCR is supplementing these databases with new information.

ConserveVirginia represents a new, data driven approach to land conservation, based on identifying how and where to achieve the best conservation outcomes. This living "smart map" identifies approximately 6.3 million acres of priority lands for conservation, including lands specifically chosen to reduce flooding impacts through pre-disaster mitigation by conserving them and ensuring the natural function of the floodplain. Land conservation projects funded through the Virginia Land Conservation Foundation (VLCF) Grants and federal Land and Water Conservation Fund (LWCF) are ranked, in part based on whether or not the property is identified on *ConserveVirginia* and whether or not the identified conservation value or benefit is protected. The Commonwealth also uses *ConserveVirginia* to guide acquisitions of Wildlife Management Areas, State Park expansions, Natural Area Preserves, State Forests, mitigation projects, and other work.

ConserveVirginia is the synthesis of 19 mapped data inputs, which have been divided into six categories, each representing a different overarching conservation value. The Floodplains & Flooding Resilience category is designed to protect wetlands, wetland migration areas and riverine floodplains, while other categories also provide some flood benefits and limit development and impervious surface. These include Agriculture & Forestry; Natural Habitat & Ecosystem Diversity; and Protected Landscapes Resilience. As with most land conservation, resources benefit multiple categories.

Included in the total acreage of *ConserveVirginia* is the Floodplains and Flooding Resilience Layer, which identifies 545,461 acres of high priority conservation land to provide a buffer against fast moving flood water, helping to absorb and store excess runoff. By doing so, natural wetlands and floodplains reduce flood damage and cleanup costs and allow for faster recovery from flood events. One-acre of wetland can typically store up to one million gallons of water.

This proactive, targeted approach to land conservation is an excellent way to leverage land conservation dollars to achieve a variety of benefits and provide important pre-disaster hazard mitigation to less developed areas of the Commonwealth.

Planning and Recreation Resources

The Planning and Recreation Resources Division (PRR) of DCR manages the Master Plan Process for State Parks which are updated every ten years. PRR recently added technical assistance from the Division of Floodplain Management to updated master plans. As of March 2020, all updated master plans contain 100-year and 500-year floodplain information and Natural Heritage and Historic Resource data to provide park planners in-depth information regarding future site planning. This makes it possible for proposed new facilities to be located outside of flood prone areas. Dam inundation study evaluations are also used where applicable.

Virginia Silver Jackets

The Virginia Silver Jackets is an interagency affiliated with the US Army Corps of Engineers to leverage multiple programs and perspectives to solve state and local water resource problems. The alliance includes many state and federal agencies including DCR, VDEM, FEMA, the National Weather Services, and the U.S. Geological Survey, with DCR serving as the current chair of the program. The Silver Jackets' mission is to identify and resolve flood hazards to support flood risk reduction in the Commonwealth.

Virginia Department of Environmental Quality (DEQ)

Virginia Coastal Zone Management Program (CZM)

The Virginia Coastal Zone Management Program is Virginia's response to the 1972 federal Coastal Zone Management Act (CZMA) which authorizes coastal states and territories to develop and implement Coastal Zone Management Programs. Virginia's CZM program began in 1986 and until recently, has been reauthorized annually by executive order. In 2018 Governor Northam approved extending the Program in perpetuity. DEQ serves as the lead agency for this program and is responsible for allocation and assignment of all federal funds received for the Virginia Coastal Zone Management Program Implementation Grant. Multiple state agencies, academic institutions, and nonprofit groups partner with Virginia CZM to improve management of the Commonwealth's coastal resources.

The Virginia CZM program's mission is to create more vital and sustainable coastal communities and ecosystems. While the program has several goals ranging from restoring ecosystems to encouraging sustainable development to carry out this mission, the fourth goal is most closely aligned with pre-disaster mitigation. Goal four aims to "reduce or prevent losses of coastal habitat, life, and property caused by shoreline erosion, storms, relative sea level rise, and other coastal hazards in a manner that balances environmental and economic considerations."

Virginia receives federal funding through sections 306 and 309 of the Coastal Zone Management Act to fund the CZM program. Section 306 funds are Administrative Grants and Section 309 funds are Coastal Zone Enhancement Grants.²⁴ A one to one state match is required of all projects funded under Section 306 of the CZMA and no state match is required for projects funded under Section 309. Virginia receives roughly \$2.5 million annually through the federal CZM program since it is a "maximum funded state." Since 1986, Virginia has received over \$61 million in federal CZMA funds matched with over \$51 million in state and local funds.²⁵ Existing state programs may count as a match under the CZM program. VCZM cannot use the annual in-kind match for its coastal resilience projects. Projects related to pre-disaster mitigation for FY20 and FY21 are supported by \$1,006,097 in federal funds, \$262,508 in state matching funds and \$524,169 in local matching funds.

As the General Assembly does not appropriate funding specifically for CZM use, it is not a formal member of the Coastal States Organization (CSO) - a non-profit that represents the interests of states with tidal shorelines.

Office of Wetland and Stream Protection

Healthy and functioning wetlands, watersheds, and streams help make the places we live more resilient and less vulnerable to natural hazards. The DEQ Office of Wetland and Stream Protection developed two GIS layers outlining current marsh vulnerability and living shoreline locations for the DEQ/VIMS [WetCAT](#) planning tool. WetCAT has an online interactive user interface which allows users to overlay data including previously permitted impacts, impaired waters, and cumulative impacts to make better permitting decisions. The tool is open-source so anyone can access the data. The additional GIS layers will help Virginia prioritize future resilience projects. DEQ received \$75,000 in state general funds to produce these two layers. Previous funding to maintain the WetCAT inventory included \$6.1 million in federal funding and \$2.6 million in state funding for a total of \$8.7 million over several decades. DEQ estimates that there are currently \$600,000 in unmet funding needs per year, including updating the layers to factor in sea level rise.

²⁴ "The Coastal Zone Enhancement Program: Coastal Zone Management Act of 1972," accessed April 1, 2020, <https://coast.noaa.gov/czm/act/sections/#309>.

²⁵ "Virginia DEQ - Coastal Zone Management (CZM)," accessed March 12, 2020, <https://www.deq.virginia.gov/programs/coastalzonemanagement.aspx>.

Chesapeake Bay Preservation Act Local Government Assistance

The Chesapeake Bay Preservation Act Local Government Assistance program began in Virginia in the 1980s and plays a central role in land use planning and protecting water quality. The “resource protection areas” this program identifies and protects makes communities more resilient to natural hazards by preserving natural resources. The program within DEQ funds several coastal hazards mitigation projects including: 1) presentations to rural PDCs outlining Chesapeake Bay Preservation Act (CBPA) sunny day flooding and turf grass requirements, 2) an application for a \$160,000 NOAA grant to develop coastal hazards guidance with the Virginia Institute of Marine Science (VIMS) and the Virginia Coastal Policy Center (VCPC), and 3) brainstorming with coastal policy partners to map existing turf grass areas that may be suitable for mitigation. The NOAA grant outlines which mitigation activities can be taken for a limited, defined period within the existing regulatory framework. This grant would give localities and property owners a chance to prepare for longer-term solutions like retreat from coastal areas or other adaptation and protection solutions. HB504, approved by the 2020 General Assembly and signed by the Governor, amends the CBPA to give Virginia the explicit authority to promote “coastal resilience and adaptation to sea-level rise and climate change” in its policies.²⁶ Including this language in the CBPA gives DEQ more authority to continue these resilience projects in the future.

The CBPA program is funded by state funds. Current state funding for FY2020 of \$457,543 does not allow DEQ to fully implement the Chesapeake Bay Preservation Act.

Water Supply Programs

Several DEQ initiatives assess and protect the Commonwealth’s water quality and watersheds. Adequately functioning watersheds promote resilience by creating flood control benefits similar to functioning floodplains. These programs including groundwater and surface water permitting; healthy watershed programs; the Virginia Stormwater Management Program; and the Drought Task Force, collectively guide the Commonwealth’s permitting and restoration programs. They also protect existing critical habitats and support partners through funding projects that improve water quality and build resilience.

Groundwater Withdrawal Permitting Program

The DEQ Groundwater Withdrawal and Permitting Program manages groundwater withdrawals, monitors water levels, and evaluates the effects of sea level rise on confined and unconfined aquifers. Managing withdrawals prevents individual and cumulative withdrawals from damaging the aquifer and prevents land subsidence or saltwater intrusion. Monitoring ensures that water levels remain above regulated levels and ensures groundwater quality through chloride monitoring wells. Water levels and subsidence have improved in some areas which is expected to continue because of DEQ actions in 2017 to reduce total withdraws. Sea level rise mitigation for aquifers is especially important on the

²⁶ “HB504: Chesapeake Bay Preservation Areas; Preservation of Mature Trees,” 504, accessed April 23, 2020, <https://lis.virginia.gov/cgi-bin/legp604.exe?201+ful+HB504ER2+pdf>.

Eastern Shore of Virginia where no other water resource is available and surface water use would require expensive desalination plants.

Funding for the Groundwater Withdrawal and Permitting Program includes a mixture of state and federal funds. Total funding for the Groundwater Withdrawal Permitting Program is approximately \$970,000 for FY20 including \$269,000 for groundwater withdrawals and \$701,000 for groundwater monitoring. A federal EPA Performance Partnership Grant (PPG) of \$280,000 for federal fiscal year 2019-2021 funds 1.75 FTE, and contractual funds are used in the Groundwater Characterization Program. FY 2020 contractual funds are obligated to build a new Eastern Shore Groundwater Model, and DEQ received \$421,658 in state funds for FY20 to implement the Groundwater Characterization Program. The roughly \$421,000 in state funds also provides for monitoring the effects of sea level rise on aquifers. Federal and state funds make up \$701,658 of the groundwater monitoring program.

Unmet financial needs are roughly \$6.1 million as identified in a recent program review. This includes \$462,000 in unmet needs for the water withdrawal permitting program and \$5.7 million in unmet personnel and capital needs for the Groundwater Characterization Program and Sea Level Rise efforts.

Surface Water Withdrawal Permitting Program

The DEQ Surface Water Withdrawal Permitting Program includes many projects such as managing surface water withdrawals, modeling drought impacts, developing models for climate change, and addressing salinity changes due to sea level rise. Modeling allows DEQ staff to assess climate change risks to instream and off stream beneficial uses that can be used in permit evaluation or future water supply project development. VWP Water Withdrawal permits include controls designed to preserve instream flows that may also serve to protect downstream riparian wetlands. Wetlands have been shown to provide a significant buffer to impacts from hurricanes as well as other recurring high water events. DEQ also evaluates surface water withdrawal to monitor the effects of anticipated salinity changes due to sea level rise. As sea levels rise, brackish water will move further inland which affects surface water withdrawals in existing tidal water fresh watersheds.

The Surface Water Withdrawal Permitting Program is funded by state general funds. The General Assembly provided DEQ with \$269,200 for FY20 to run the program. A recent program review identified \$462,000 in unmet personnel needs.

Healthy Watershed Programs

DEQ successfully applied for two five-year EPA grants to improve water quality. The first allows up to three grantees to install select BMPs that accomplish the dual goals of improving water quality and reducing flooding risk. Projects will be located in areas impacted by Hurricane Florence that also have watershed clean-up plans in place. This grant from the EPA is for a total of \$224,900. The second grant makes Virginia's water quality assessment data more accessible to counties that have significant impacts from Hurricane Florence. This will allow localities and state agencies to develop more comprehensive watershed management and restoration plans to address recovery and resiliency. This grant from the EPA is for a total of \$88,162.

Water Supply Planning Program

The 2020 State Water Resources Plan Update features expanded projections through the year 2040, improved handling of consumptive use (point sources), climate change scenarios and higher resolution water withdrawal intake locations. The plan will feature three climate change scenarios based on atmospheric CO₂ in 2055 using emission models and changes in greenhouse gas concentration. Localities are encouraged to use this information to inform the new 2023 local and regional water supply plans. DEQ also successfully applied for an EPA grant to support a pilot project at VIMS to develop a methodology to assess threats to individual wells serving as domestic water supply by using archival private well records and sea level inundation zone information.

Virginia Stormwater Management Program

The Virginia Stormwater Management Program (VSMP) minimizes water quality and quantity hazards from new development. VSMP uses one year, two year, and ten year site-specific rainfall precipitation estimates from NOAA's Atlas 14 Volume 2 estimates to integrate climate data into decision making processes. As a recommendation in Virginia's Water Improvement Plan (WIP) III, DEQ recommends updating Atlas 14 Volume 2. The updated Atlas 14 will be accounted for future climate projections when designing and constructing stormwater Best Management Practices (BMPs) and is embedded in Virginia's Water Improvement Plan (WIP) III. DEQ would need approximately \$800,000 to work with NOAA and FHWA to update Atlas 14 rainfall projects for Virginia. This update would allow DEQ to have more accurate forecasting projections to prepare for future rain events.

Virginia Drought Monitoring Task Force (DMTF)

The Virginia Drought Monitoring Task Force (DMTF) is an interagency group of technical representatives from state and federal agencies, of which DEQ is the lead. The task force monitors national resource conditions and drought impacts. DMTF meets as needed to assess conditions and make recommendations regarding drought status and periodically releases Drought Status Reports summarizing drought conditions in the Commonwealth. In the summer of 2019, the DMTF recommended that Governor Northam declare a drought State of Emergency for portions of Virginia based on significant rainfall shortages across the Commonwealth. Within a few weeks the precipitation patterns changed and the State of Emergency lifted. DMTF makes recommendations for declaring three drought stages in order of increasing severity including Watch, Warning, and Emergency. In addition to typical drought indicators, DEQ projects the probability of drought state streamflow using a methodology based on winter recharge as a surrogate. This forecast allows DMTF to track the effect of warmer and drier winter seasons and is developed in March every year.

Office of Environmental Impact Review

The Office of Environmental Impact Review coordinates the Commonwealth's response to environmental documents for proposed state and federal projects by distributing documents to appropriate state agencies. Two projects within the Office of Environmental Impact Review focus specifically on coastal hazard preparation. The first is implementation of DEQ's Climate Adaptation

Strategy which is an assessment of DEQ programs for climate adaptation strategies for implementation in the short-term, medium-term and long-term. The second project includes changes to the Virginia Coastal Zone Management Program to address federal consistency reviews for offshore oil and gas exploration. The Office is seeking approval of a Geographic Location Description and Listed Activities from NOAA.

Department of Game and Inland Fisheries (DGIF)

Wildlife Management Areas (WMAs)

The Virginia Department of Game and Inland Fisheries maintains 46 Wildlife Management Areas (WMAs) totaling more than 203,000 acres for all citizens to use for a variety of outdoor recreational opportunities. These lands are purchased and maintained with hunting, fishing, and trapping license fees and with Wildlife Restoration Funds.²⁷ These WMAs promote several coastal resilience measures, in conjunction with other public land and open space networks, such as mitigation for sea level rise, impoundment rehabilitation, shoreline protection, and shoreline stabilization. As an example, the Cavalier WMA restored the hydrology of 4,000 acres that were historically part of the Great Dismal Swamp using a Hurricane Sandy Grant. The increased storage capacity generated by these wetlands provides mitigation for storm water flooding and improves the habitat for wetland dependent species.

Department of Historic Resources (DHR)

Threatened Sites Fund

The mission of the Threatened Sites Program is to conduct archaeological research on sites of state-wide and national significance that are faced with threats resulting in site destruction or data loss. Key parts of this program include assessing potential threats, addressing imminent threats through data recovery and analysis, ensuring that collections resulting from this research are curated to accepted standards, and finally ensuring that project results are presented in a format suitable for public use. Types of projects funded include archaeological assessments, archaeological excavations, recovery and stabilization of an archaeological collection, project-specific specialized analysis, and human remains analysis/reinternment if necessary. A summary report is completed as part of all projects and will be in publishable form. Occasionally the Threatened Sites Program will fund a multi-year project resulting in a yearly interim report with a final publishable report being funded separately after completing all fieldwork and specialized analyses. As of 2017, 547 historic resources are threatened with sea level rise including 237 archaeological resources and 310 architectural resources. Twenty-four of these historic properties are currently listed on the Virginia Landmarks Register including Fort Wool in Hampton, VA. Fort Wool is a 15-acre island coastal fortification constructed in 1819 under President James Madison which played a significant role in the Civil War, WWI and WWII.²⁸

²⁷ "Wildlife Management Areas | Virginia DGIF," accessed March 30, 2020, <https://www.dgif.virginia.gov/wma/>.

²⁸ Virginia Department of Historic Resources, "Report on the Stewardship and Status of Virginia's State-Owned Historic Property: 2019-2021," May 2019, https://www.dhr.virginia.gov/wp-content/uploads/2019/05/SSR_2019_FINAL_High_Res.pdf.

The Threatened Sites Fund receives \$50,000 a year in state General Funds to run the program. This represents a significant decrease from the Fund's previous budgets of \$99,000. Requests for funding exceeds \$90,000 and the lack of funding means that DHR rejects approximately one half of eligible proposals. With additional funding, the program could fund a greater number of project resulting in the documentation of more archaeological sites and salvaged data. Space and resources to store collections are also a challenge. One full time curatorial staff must manage more than 6 million objects and provide access for research, education, and outreach purposes.

Virginia Marine Resources Commission (VMRC)

Coastal and Submerged Lands Management

The Virginia Marine Resources Commission Habitat Management Division is responsible for reviewing shoreline projects involving submerged land, wetlands, and coastal primary sand dunes and beaches. Where feasible, the program requires living shoreline techniques for erosion control and increasing resilience of natural shorelines features including fringe marshes and beaches. Large marsh complexes, like those found on the seaside of the Eastern Shore, lower Gloucester County, and eastern Mathews County reduce storm surge during hurricanes and nor'easters. The Wetland Zoning Ordinance, administered by localities and with oversight provided by VMRC, insures these resources are protected. Sand dunes and beaches along the shoreline are also protected for their resilience benefits through the Coastal Primary Sand Dune Ordinance.

Most of VMRC's work is reactionary to manage private use of the shoreline since protecting marshes and managing erosion occurred through the permit review process. SB776, which was passed by the General Assembly and signed by Governor Northam on 2020, requires the Commonwealth to "permit living shoreline approaches to shoreline management unless the best available science shows that such approaches are not suitable." In the event that living shoreline approaches are not suitable, they should be used to the maximum extent possible. These living shoreline techniques provide erosion control and water quality benefits by protecting, restoring, or enhancing the natural shoreline habitat.²⁹

Federal and state resources fund VMRC coastal and submerged lands management. There is currently no specific set aside funding for pre-disaster mitigation resilience projects, despite the clear connection. VMRC receives an annual \$182,000 from NOAA through the DEQ Coastal Zone Management program for permit review and compliance. The Marine Habitat and Waterways Improvement Fund, which receives an average of \$500,000 a year in state funds, has half of its funds obligated which diverts resources available for resilience projects.

²⁹ "SB776: Living Shorelines; Development of General Permit; Guidance," accessed April 15, 2020, <https://lis.virginia.gov/cgi-bin/legp604.exe?201+ful+SB776ER+pdf>.

Oyster Resource Management

Oyster Resource Management is a core function of VMRC. Maintaining oyster habitats provides many pre-disaster hazard mitigation benefits including shoreline stabilization through living shoreline designs, preventing marsh erosion and, in limited areas, support marsh expansion. The Conservation and Replenishment Department (CRD) of VMRC maintains (replenishes) and expands (restores) the Commonwealth's oyster population and its associated habitat. CRD's geographically widespread approach to restore and maintain oyster populations and habitats helps ensure that the stock of wild oyster populations is healthy enough to provide enhanced and cost-effective recruitment of oysters when oyster reef substrate is incorporated into living shorelines. VIMS is working with NOAA to coordinate oyster components of the recent Middle Peninsula Near Shore Habitat Initiative which restores nearshore habitat for fish and other Bay species in the Middle Peninsula

Multiple funding sources fund the Oyster Resource Management program, including federal and state funds, with amounts varying over the years. The organization received approximately \$540,000 from NOAA for FY2020, 2021, and 2022.

[**Secretary of Public Safety and Homeland Security**](#)

The Public Safety and Homeland Security Secretariat includes ten agencies that help protect the Commonwealth through public awareness, education, training, emergency response, disaster preparedness, prevention, policy development and enforcement. With respect to pre-disaster mitigation, VDEM plays the largest role.

Virginia Department of Emergency Management (VDEM)

The Virginia Department of Emergency Management is the State Administrative Agency for FEMA grants. This means that VDEM submits potential projects to FEMA for review on behalf of localities that are sub-recipients.

VDEM manages two types of FEMA mitigation grants: annual grants and post-disaster grants under its Hazard Mitigation Assistance (HMA) grant programs. Annual HMA grants, including Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) grants, provide localities funds to reduce risk to individuals, property, and infrastructure. The Hazard Mitigation Grant Program (HMGP) is a post-disaster grant which helps communities implement hazard mitigation measures following a Presidential Disaster Declaration. Localities can only receive HMGP funds for a presidentially declared disaster. A summary of each grant program within VDEM's HMA grants is below. Additional information can also be found in the 2018 Commonwealth of Virginia Hazard Mitigation Plan.³⁰

³⁰ "Commonwealth of Virginia Hazard Mitigation Plan" (Virginia Department of Emergency Management, March 2018).

Flood Mitigation Assistance (FMA)

FMA is an annual nationally competitive FEMA grant. VDEM manages these grants through application, award, quarterly reporting, site visits, closeout, and sub-recipient monitoring. FMA's goal is to reduce the long-term flood risk to National Flood Insurance Program (NFIP) insured structures. Only structures insured by NFIP are eligible for FMA funding. Community projects that have at least 50 percent NFIP insured homes can include privately insured homes. Local governments typically use FMA funds for home acquisition projects.

FMA funds are nationally competitive so the amount of funding Virginia receives varies from year to year. There was \$210 million available nationally for the FY2019 FMA grant of which \$70 million is for community advance assistance projects and \$140 million for technical assistance and SRL projects. VDEM received \$6.5 million for FMA projects in FY2019.³¹ These projects include awards to the cities of Norfolk, Hampton, Chesapeake, Portsmouth, Virginia Beach and the Northern Neck Planning District Commission to conduct flooding studies and elevations/acquisitions. The two largest awards were \$3.2 million in Norfolk to elevate eleven structures in a Special Flood Hazard Area (SFHA) and \$1 million in Chesapeake to acquire five properties that suffered costly repetitive losses.

Pre-Disaster Mitigation (PDM) Grant

The goal of the PDM program is to reduce overall risk to population and structures, while at the same time reducing reliance on federal funding from the Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) disaster declarations. The PDM grant is a nationally competitive grant with \$250 million available for the FY2019 PDM grant. Virginia has a \$575,000 state set-aside and is guaranteed at least that much in PDM funds. These funds are used for activities such as updating regional hazard mitigation plans, other planning projects or eligible structural projects. Under the PDM grant program, projects are submitted for grant funding that reduce the long-term risk to natural hazards. PDM evaluates each project based on how effectively it reduces future risk of hazard (benefit-cost analysis) and is a factor in prioritization. VDEM typically uses PDM funds for hazards that are non-flooding and local governments typically request these funds for public infrastructure projects. These projects require a 25 percent non-federal match that is provided by localities. VDEM consistently receives more PDM project requests than it can fund since FEMA only allows VDEM to submit nine projects for funding review.

Hazard Mitigation Grant Program (HMGP)

The Hazard Mitigation Grant Program (HMGP) helps communities implement measures to reduce or eliminate long-term risk to people and property from natural hazards and their effects. HMGP requires all governments within the state, including tribal governments, to develop hazard mitigation plans that identify natural hazards, assess risk, vulnerabilities, and capabilities. Each county, city, and incorporated town has a FEMA approved and locally adopted hazard mitigation plan. In order to

³¹ "FEMA Approves \$6.5 Million for Virginia Mitigation Projects | FEMA.Gov," accessed April 13, 2020, <https://www.fema.gov/news-release/2020/01/06/fema-approves-65-million-virginia-mitigation-projects>.

receive funds, the state must have a presidentially declared disaster. The amount of HMGP funds available is based on the amount of Federal Public and Individual Assistance received by the Commonwealth for each disaster. VDEM received \$6,684,797 in FEMA funds for Hurricane Florence and \$7,051,421 for Hurricane Michael. Eighty-eight percent of these funds go towards structural mitigation—seven percent are for mitigation planning, and 5 percent are for initiative programs. VDEM will use these funds for disaster mitigation and updating local Hazard Mitigation Plans. Initiative programs include education and outreach efforts that do not require a benefit cost analysis. Many of these projects could be supported at the regional and local level by state funds.

Secretary of Transportation

The Secretary of Transportation oversees Virginia's multimodal rail, water, air and roadway transportation network. This transportation network is central to Virginia's economy and the Secretariat works to tie transportation to economic competitiveness with innovative transportation projects. The Secretariat oversees eight agencies including the Department of Transportation, the Department of Aviation, the Department of Motor Vehicles and the Virginia Port Authority.

Virginia Department of Transportation (VDOT)

Flood Protection Program (FPP) / Stormwater Management Program (VSMP)

The Virginia Department of Transportation's Flood Protection Program coordinates with federal, state and local flood prevention and water quality programs to minimize loss of life, property damage and negative impacts on the environment. VDOT activities that fall within the purview of the program include construction activities which result in hydrologic modification of rivers, streams and flood plains; the water quality, Chesapeake Bay Preservation Area criteria, storm water management, erosion and sediment control and other DEQ water management programs.

VDOT construction activities must comply with the Virginia Stormwater Management Program; the purpose of which is to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources by controlling soil erosion and the quality and quantity of runoff. The Infrastructure Coordination & Chesapeake Bay Total Maximum Daily Load (TMDL) Action Plan outlines how VDOT will implement reductions required by the Chesapeake Bay TMDL Special Conditions and Reductions through VDOT's Municipal Separate Storm Sewer System (MS4) permit.

The Flood Protection Program (FPP) and Stormwater Management Program (VSMP) share a program budget. Both programs received a little over \$13.1 million in state non-general funds for FY2019 and \$10.2 million for FY2020.

Inspection and Maintenance of Storm Water Management Facilities Program

VDOT's Inspection and Maintenance of Storm Water Management Facilities Program facilitates the inspection, maintenance, and repair of storm water management (SWM) facilities. Maintenance of SWM facilities reduces runoff and prevents downstream/off-site flooding, stream channel erosion, and

nutrient/sediment pollution. VDOT performs routine maintenance of right-of-way Stormwater management facilities in addition to emergency maintenance work necessitated by storms, floods, and other conditions in accordance with the Virginia Storm Water Management Law and Regulations. Right-of-way stormwater management facilities include impoundment, filtration, conveyance, and manufactured stormwater quality structures.

The Inspection and Maintenance of Storm Water Management Facilities Program is included in each transportation district's maintenance budget. A district's annual maintenance budget fluctuates annually based on where the district is located and how many weather events occur. The Northern Virginia (NOVA) District, for example, spent an average of \$504,000 annually based on 2016-2018 data. Annual expenditures, however, varied from \$285,000 to nearly \$629,000 based on the number of disasters that occurred. Funding capacities are also disparate among the different districts. While the NOVA District had an average of \$504,000 in annual funds from 2016-2018, the other districts had an average of \$87,500 during that same time period. It is likely that many routine maintenance activities are not being addressed in these other districts.

Maintenance and Repair Manual

VDOT's Location and Design Division has developed a Maintenance and Repair manual along with a drainage manual which directs resilience measures in VDOT planning and construction projects. This manual outlines research-based guidance for new and existing projects, backed by historical and current data, for mitigation best practices to address scour, run off, rising tides and flooding. VDOT recently updated Chapter 33 of the manual to comply with EO 45—which adopted the NOAA 2017 intermediate high SLR curve for future construction of bridges. This standardization will promote flood resilient initiatives across all VDOT projects, and is an important pre-disaster mitigation strategy.

Secretary of Veterans and Defense Affairs

The Secretary of Veterans and Defense Affairs has a two-fold purpose to 1) provide opportunities and resources to veterans and 2) focus on relationship building with military and defense installations. In this capacity, the Secretariat engages with resilience matters regarding military installations affected by issues such as sea level rise and recurrent flooding. The Secretariat has oversight over two agencies including the Department of Veterans Services and the Department of Military Affairs.

Readiness and Environmental Protection Integration Program (REPI)

Many Department of Defense (DOD) installations are located in flood zones and other vulnerable areas across Virginia. The Readiness and Environmental Protection Integration Program (REPI) is a key tool the DOD uses to protect military installations and operations in Virginia from loss of habitat in installation vicinities. REPI is increasingly targeting resilience efforts in their projects. The DOD works with state and local governments, conservation organizations, and private landowners to address environmental challenges and protect military installations. Currently, REPI projects in Virginia are partnerships between localities and the Department of Defense. These projects include installations at

Fort A.P Hill, Fort Pickett, Joint Base Langley-Eustis, MCB Quantico, NAS Oceana, NSA Hampton Roads, NSF Dahlgren and NWS Yorktown. The Secretary of Veterans and Defense Affairs provides assistance, coordination, and input.

REPI currently does not receive state funds but the General Assembly could appropriate funds in the future. The program requires a 50/50 match including 50 percent federal money and 50 percent from a locality or other partner which could be the state or a nonprofit. Through FY2019, the DOD and its partners have spent nearly \$145 million on REPI projects at eight installations in Virginia.

In addition to REPI, the Secretary of Veterans and Defense Affairs oversees and works with several other resilience-focused efforts including Joint Land Use Studies (JLUS), Sentinel Landscape Program, and the Office of Economic Adjustment (OEA) at the DOD. JLUS create an implementation plan to address encroachment from sea level rise. The OEA funds the projects at the local level and provides limited funds to address aspects of implementation. In addition to JLUS, the OEA is also looking at providing funding to address resilience on installations. While this is a new program, the OEA is seeking a grant from the Hampton Roads Planning District Commission (HRPDC) to support VB-Norfolk JLUS recurrent flooding recommendations. The Sentinel Landscape program provides easements and creates an opportunity to access federal defense, forestry and agriculture funds. The Office of the Secretary of Veteran's and Defense Affairs is coordinating with the Offices of the Secretary of Agriculture, and the Secretary of Natural resources on applying for a Sentinel Landscapes designation and program for the Commonwealth.

[**Secretary of Administration**](#)

The Secretary of Administration is in charge of managing the Commonwealth's buildings, employee policies, elections, and information technology systems. The Secretariat oversees five agencies including the Compensation Board, the Department of Elections, the Department of General Services, the Department of Human Resource Management, the Virginia Information Technologies Agency and the Office of the Chief Data Officer.

Department of Human Resource Management (DHRM)

Teleworking Policy

The Department of Human Resource Management provides guidance to agencies on how to incorporate teleworking policies into their operations. The Code of Virginia requires agency heads to annually report to the Secretary of Administration on the status and efficiency of telecommuting and alternate working schedules.³² Many agencies have adopted teleworking policies over the years. While not explicitly used for disaster response, agencies have expanded their teleworking capabilities in emergency situations, in particular in support of Virginia's ongoing COVID- 19 response. The Virginia Department of Transportation's (VDOT) teleworking policy, as one example, allows essential staff to

³² "§ 2.2-2817.1. State Agencies to Establish Alternative Work Schedules; Reporting Requirement," accessed April 13, 2020, <https://law.lis.virginia.gov/vacode/title2.2/chapter28/section2.2-2817.1/>.

work remotely and continue operations during emergencies. Even before the COVID-19 pandemic, more than 21 percent of VDOT's workforce participated in the teleworking program and a growing portion of the workforce now uses the program routinely. Not all agencies, however, utilize teleworking to this degree and several may find teleworking more difficult because they handle sensitive information such as medical records. There also may be technological challenges such as licenses and internet access that make teleworking difficult.

Findings and Recommendations

Many programs within a number of state agencies are related to pre-disaster mitigation. However, there are clear signs that we can do better. There are more than 70 state agencies in the Commonwealth, and only 15 responded for this report. Many more agencies likely have pre-disaster mitigation programs that were not included in this report. Programs that do address pre-disaster mitigation often lack coordination with related programs. Funding and staffing limitations prevent programs from addressing long-term mitigation strategies. The following section further describes how the Commonwealth can improve its pre-disaster mitigation efforts.

Finding #1:

Most state agencies lack a clear understanding of what the term “pre-disaster mitigation” means and whether or how their existing programs address it—in part because there is no definition of pre-disaster mitigation in Virginia’s code or regulations.

Recommendation #1:

The Governor should, through Executive Order, direct the Chief Resilience Officer to determine and issue guidance to Cabinet Secretaries and state agencies to clarify what constitutes pre-disaster mitigation.

Finding #2:

Almost all programs listed in this report work with several other layers of government including state, and local governments. The state agencies often act as an intermediary between federal and local government. Several pre-disaster mitigation programs rely on relationships with local governments to implement their programs. Miscommunication surrounding program funding, implementation, and guidelines can often prevent localities from adopting pre-disaster mitigation measures. The programs and initiatives described above are all valuable in helping Virginia prepare for and reduce the impacts of natural disasters. However, many of them are narrowly focused and not coordinated with similar programs in other state agencies.

Recommendation #2:

The Governor should direct the Chief Resilience Officer to develop, in consultation with the Special Assistant for Coastal Adaptation and Protection and with the cooperation of relevant Cabinet Secretaries and agency heads, a framework and strategy for coordinating and improving the effectiveness of the Commonwealth’s pre-disaster mitigation efforts, including developing a process to improve collaboration with federal and local partners. As part of this effort, the Governor should pursue legislation codifying the Chief Resilience Officer’s responsibilities and requiring agencies across state government to coordinate with the Chief Resilience Officer on pre-disaster mitigation efforts, including development of a strategic approach to targeting federal mitigation grant funds.

Finding #3:

It is clear that the state programs listed in this report do not address the full range of pre-disaster mitigation needs of the Commonwealth. Some of these gaps are likely to be real, while others may be perceived because we lack knowledge and understanding of efforts that were not accurately reported by state agencies.

Recommendation #3:

The Governor should direct the Chief Resilience Officer to continue efforts to identify existing state programs that assist with pre-disaster mitigation, and to develop, in consultation with the Special Assistant for Coastal Adaptation and Protection and with the cooperation of relevant Cabinet Secretaries, detailed recommendations for new initiatives necessary to address gaps in the Commonwealth's preparedness for natural disasters. These efforts should include actions to build racial equity into pre-disaster mitigation work, and to ensure the equitable treatment of low income communities.

Finding #4:

Funding for existing programs may not be adequate and funding for new initiatives may not be available to ensure that the Commonwealth is effectively mitigating potential damage from natural disasters.

Many current pre-disaster mitigation projects are temporary grant-funded pilot projects that do not have a dedicated funding source once their grant term expires. Of the 47 programs included in this report, 11 are pilot programs or have temporary components. Several agencies expressed concerns as to how their programs would continue after the initial pilot stage ended. Related to funding concerns, many agencies are unable to conduct pre-disaster mitigation activities fully because of inadequate staffing. This means pre-disaster activities often fall on current full-time employees as a secondary task, which results in a net loss of program productivity or a lack of capacity. Pre-disaster mitigation activities as secondary tasks become a more acute problem when programs rely on multiple levels of government for funding and assistance.

Recommendation #4:

The Governor should direct the Chief Resilience Officer to develop, in consultation with the Special Assistant for Coastal Adaptation and Protection and with the cooperation of relevant Cabinet Secretaries, a detailed analysis of the fiscal resources dedicated to or available for pre-disaster mitigation, as well as recommendations on funding levels necessary to ensure the successful operation of existing programs and new initiatives identified in recommendation #3. This analysis should also include identifying possible non-state funding sources and recommendations for a process to align, prioritize, and track federal, state, non-governmental, and other grant opportunities across state agencies.

Finding #5:

The significant impacts of climate change and sea level rise are not fully considered in many long-term plans, capital projects, and budgets of the Commonwealth's agencies. In some cases, a lack of adequate funding and capacity prevents an agency from attaining this level of planning and modeling updates. Planning for climate change as an existential threat must be prioritized. Prior to DEQ's formation in 1993, the Council on the Environment oversaw five key functions including Environmental Education, Environmental Impact Review, Chesapeake Bay Compliance, Coastal Zone Management and Long Range Environmental Planning. While DEQ still supports most of these functions in its current structure, the agency does not currently operate a long-range environmental planning function. Long range environmental planning would help Virginia prepare for the impacts of our changing climate and build a resilient Commonwealth.

Recommendation #5:

The Governor should issue, via Executive Order, a directive and structure to include development and implementation of climate adaptation strategies and consideration of climate change impacts in decision making processes, across all Commonwealth agencies. Climate change mitigation and adaptation efforts must be viewed as pre-disaster mitigation. The long-range environmental planning function must be reinstated, across and between state agencies, and including the coordination and cooperation with planning districts and regional commissions. This recommendation must go hand in hand with recommendation #4, so that agencies have the financial and staff resources to ensure they can meet the increased planning needs.

Finding #6

While a program or initiative may not be primarily focused on hazard mitigation, it may provide immense hazard mitigation benefits if leveraged properly. Programs like the Department of Defense REPI Program, Community Development Block grants, DOT recreation, access and enhancement funds, *ConserveVirginia*, oyster management, or stormwater management programs can play an important role in reducing a community's risk.

Recommendation #6:

The Governor should direct the Chief Resilience Officer to investigate, in consultation with the Special Assistant for Coastal Adaptation and Protection and with the cooperation of relevant Cabinet Secretaries, how existing programs can be improved to provide secondary benefits including flood protection and work with the relevant secretaries, agencies, planning districts, and localities and the General Assembly to initiate those improvements.

Conclusion

We as a Commonwealth have a responsibility to help reduce the impacts of flood, storm, fire, and earthquake risk through planning and implementing adaptation initiatives. This report demonstrates an urgent need to do more to align and increase our capacity and make the most of every dollar spent, and every hour expended, across Virginia state agencies on pre-disaster mitigation.

Appendix A: Pre-Disaster Mitigation Programs by Hazard Type

Pre-Disaster Mitigation Programs by Hazard Type (as of April 2020)

All-hazards	DBHDS	Office of Emergency Management
	DHCD	Uniform Statewide Building Code
	DHR	Threatened Sites Fund
	DMME	Virginia Energy Storage Study (Micro-Grid Energy Storage)
	VDACS	Food Safety Program Rapid Response Team
	VDEM	Hazard Mitigation Grant Program (HMGP)
	VDEM	Pre-Disaster Mitigation Grant (PDM)
	VDOF	All-Hazard Emergency Response and Management Program
Drought	DEQ	Virginia Drought Monitoring Task Force
Earthquake	DMME	Informal Seismic Monitoring
Flooding	DCR	Community Assistance Program-State Support Services Element
	DCR	<i>ConserveVirginia</i>
	DCR	Cooperating Technical Partners
	DCR	Dam Safety Flood Prevention and Protection Assistance Fund
	DCR	High Hazards Potential Dams (HHPD)
	DCR	National Dam Safety Program
	DCR	Natural Heritage Program
	DCR	Planning and Recreation Resources
	DCR	Virginia Community Flood Preparedness Fund
	DCR	Virginia Silver Jackets
	DEQ	Chesapeake Bay Preservation Act Local Government Assistance
	DEQ	Groundwater Permitting Program
	DEQ	Healthy Watershed Programs
	DEQ	Office of Environmental Impact Review
	DEQ	Surface Water Withdrawal Permitting Program
	DEQ	Virginia Coastal Zone Management Program
	DEQ	Water Supply Planning Program
	DEQ	Office of Wetland and Stream Protection
	DGIF	Wildlife Management Areas
	DHCD	Community Development Block Grant Program (CDBG)
	DHCD	National Disaster Resilience Competition (NDRC)
	DMME	Bureau of Ocean Energy Management (BOEM) Offshore sand Resource
	DMME	Commercial Property Assessed Clean Energy (C-PACE)
	DMME	Mining Dam Safety
	DMME	VDEM/DMME Pre-Disaster Landslide Hazard Mitigation Grant
	VDEM	Flood Mitigation Assistance (FMA)

	VDOT	Flood Protection Program (FPP) / Stormwater Management Program (VSMP)
Flooding Cont.	VDOT	Inspection and Maintenance of Stormwater Facilities Program
	VDOT	Maintenance and Repair Manual
	VMRC	Coastal and Submerged Lands Management
	VMRC	Oyster Resource Management
		Readiness and Environmental Protection Integration Program (REPI)
Other	VDH	Drinking Water State Revolving Fund (DSWRF)
	VDH	Harmful Algal Bloom (HAB) Program and Response
	VDH	Sustainable Water for Tomorrow (SWIFT)
	VDH	Vectorborne Disease Program
Wildfire	VDOF	Firewise Virginia Program
	VDOF	Virginia Dry Hydrant Program

Appendix B: Pre-Disaster Mitigation Program Funding (FY2019)

Pre-Disaster Mitigation Program Funding—Ongoing Programs (FY2019)

Agency	Pre-Disaster Mitigation Program	Federal Funding	State Funding	Local/Other Funding	Total Funding
DCR	Community Assistance Program-State Support Services Element	\$201,118	\$50,280		\$251,398
DCR	Cooperating Technical Partners	\$80,000			\$80,000
DCR	Dam Safety Administration Fund		\$75,000		\$75,000
DCR	Dam Safety Flood Prevention and Protection Assistance Fund*		\$732,147		\$732,147
DCR	National Dam Safety Program	\$221,385	\$1,400,000		\$1,621,385
DCR	Virginia Community Flood Preparedness Fund		\$50,000,000		\$50,000,000
DEQ	Chesapeake Bay Preservation Act Local Government Assistance*		\$457,543		\$457,543
DEQ	Groundwater Withdrawal Permitting Program*	\$280,000	\$970,858		\$1,250,858
DEQ	Surface Water Withdrawal Permitting Program*		\$269,200		\$269,200
DEQ	Virginia Coastal Zone Management Program	\$3,200,000			\$3,200,000
DEQ	Water Supply Planning Program*		\$205,694		\$205,694
DHCD	Community Development Block Grant Program (CDBG)	\$1,000,000			\$1,000,000
DHCD	Uniform Statewide Building Code		\$2,922,902		\$2,922,902
DHR	Threatened Sites Fund		\$50,000		\$50,000
VDACS	Food Safety Program Rapid Response Team	\$225,000			\$225,000
VDEM	Flood Mitigation Assistance (FMA)	\$6,500,000			\$6,500,000
VDEM	Pre-Disaster Mitigation Grant (PDM)	\$575,000		\$143,750	\$718,750
VDH	Drinking Water State Revolving Fund (DWSF)	\$18,100,000	\$3,620,000		\$21,720,000
VDH	Harmful Algal Bloom (HAB) Program and Response	\$20,000	\$150,000		\$170,000
VDH	Vectorborne Disease Program	\$623,787			\$623,787
VDOF	All-Hazard Emergency Response and Management Program	\$200,000	\$600,000		\$800,000

Agency	Pre-Disaster Mitigation Program	Federal Funding	State Funding	Local/Other Funding	Total Funding
VDOF	Firewise Virginia Program	\$400,000	\$150,000		\$550,000
VDOF	Virginia Dry Hydrant Program		\$125,000		\$125,000
VDOT	Flood Protection Program (FPP)/ Virginia Stormwater Management Program	\$13,176,790			\$13,176,790
VDOT	Inspection and Maintenance of Storm Water Management Facilities Program		\$1,200,000		\$1,200,000
VMRC	Coastal and Submerged Lands Management*	\$181,200	\$994,913		\$1,176,113
VMRC	Oyster Resource Management*^	\$540,000	\$6,375,609		\$6,915,609
TOTAL		\$49,124,280	\$76,949,146	\$143,750	\$126,217,176

*Funding reported for FY20 instead of FY19

^Funds listed include totals as of the General Assembly Adopted Biennium budget on March 12, 2020. Changes might occur in final budget due to COVID-19.

Note: This chart represents ongoing programs that receive an annual appropriation from either the federal or state government every year. Funds are listed based on state and federal funding levels for the most recent fiscal year available (either FY19 or FY20 depending on data). Some state funds may include “in-kind” contributions as matching funds and represent existing projects (i.e. are not funds readily available for new projects). Funds may include some non-pre-disaster mitigation activities since some programs perform pre-disaster mitigation in addition to other tasks. More specific funding breakdowns by multiple years are located within the body of the report. Not all ongoing programs listed in this report provided specific funding information (15 of 43 ongoing programs). Some of these programs that did not report are informal and do not receive designated funding sources.

Pre-Disaster Mitigation Program Funding—Temporary/Pilot Projects (as of April, 2020)

Agency	Pre-Disaster Mitigation Program	Federal Funding	State Funding	Local/Other Funding	Total Funding
DCR	Dam Safety Flood Prevention and Protection Assistance Fund	\$0	\$420,000	\$0	\$420,000
DEQ	Healthy Watershed Programs	\$313,062			\$313,062
DEQ	Office of Wetland and Stream Protection		\$75,000		\$75,000
DEQ	Water Supply Planning Program	\$122,838			\$122,838
DHCD	National Resilience Disaster Competition (NDRC)	\$120,549,000	\$5,000,000	\$140,156,698	\$265,705,698
DMME	Bureau of Ocean Energy Management (BOEM) Offshore Sand Resources	\$200,000	\$85,017		\$285,017
DMME	VDEM/DMME Pre-Disaster Landslide Hazard Mitigation Grant	\$78,640	\$26,213		\$104,853
DMME	Virginia Energy Storage Study (Micro-Grid Energy Storage)		\$100,000		\$100,000
VDEM	Hazard Mitigation Grant Program (HMGP)	\$13,736,038	\$2,747,208	\$686,802	\$17,170,048
VMRC	Oyster Resource Management (FY2021)^		\$10,000,000		\$10,000,000
SVDA	Readiness and Environmental Protection Integration Program (REPI)	\$72,500,000		\$72,500,000	\$145,000,000
TOTAL		\$207,499,578	\$18,453,438	\$213,343,500	\$439,296,516

[^]Funds listed include totals as of the General Assembly Adopted Biennium budget on March 12, 2020. Changes might occur in final budget due to COVID-19.

NOTE: Temporary projects are either one-time grant funded or pilot projects. Some of these projects include one-time funding that is in addition to annually funded base amounts (ex. Oyster Restoration). More specific funding information breakdowns by multiple years is within the body of the report if applicable to the program. Funds may include some non-pre-disaster mitigation activities since some programs perform pre-disaster mitigation in addition to other tasks.

APPENDIX J

CONSERVEVIRGINIA 2020 UPDATE



COMMONWEALTH of VIRGINIA

Office of the Governor

ConserveVirginia *2020 Update*

In April 2018, Governor Ralph Northam announced a new approach to land conservation in Virginia:

"I believe that we need a land conservation strategy that is focused and targeted toward making measurable progress on our natural resource goals...Through this data-driven process, we will prioritize the most important targeted lands and direct limited resources toward those conservation projects that provide the greatest benefit in the most cost-effective manner."

Virginia's land conservation investments are essential to making the Commonwealth a wonderful place to live and visit. Land and water conservation protects the places we love, supports a high quality of life and fosters economic growth and prosperity. In 2016, the Trust for Public Land reported that every \$1 invested in land conservation returns \$4 in economic value in natural goods and services in the form of improved air and water quality, carbon sequestration, and enhanced fish and wildlife habitat¹. Governor Northam is dedicated to ensuring the highest conservation outcomes from state funds spent on protecting land. *ConserveVirginia* will be a key tool in guiding those investments.

ConserveVirginia represents a data driven approach to land conservation that builds upon work already underway here and in other states. Virginia's first in the nation strategy takes the next step in identifying how and where to achieve the best conservation outcomes, and meets the Governor's directive to prioritize the most important lands from a statewide perspective, target limited resources toward those areas, and measure the progress we make toward achieving multiple conservation goals. *ConserveVirginia* creates a roadmap for land conservation across Virginia now and for years to come.

ConserveVirginia's central feature is a living "smart map" that identifies approximately 6.9 million acres of priority lands for conservation. The *ConserveVirginia* map is the synthesis of 21 mapped data inputs, which have been divided into seven categories, each representing a different overarching conservation values. The categories are: Agriculture & Forestry; Natural Habitat & Ecosystem Diversity; Floodplains & Flooding Resilience; Cultural & Historic Preservation; Scenic Preservation; Protected Landscapes Resilience and Water Quality Improvement. The categories contain more than 5.45 million acres of agricultural and forest lands. Outdoor recreation is a critical component of the Strategy and will be addressed across the categories. As with most land conservation, resource benefits cross multiple categories.

The *ConserveVirginia* map is designed to be regularly updated as new data become available, and additional resources and protection tools emerge. Similarly, the administration will work to add new data models to the *ConserveVirginia* map as data and technology allow.

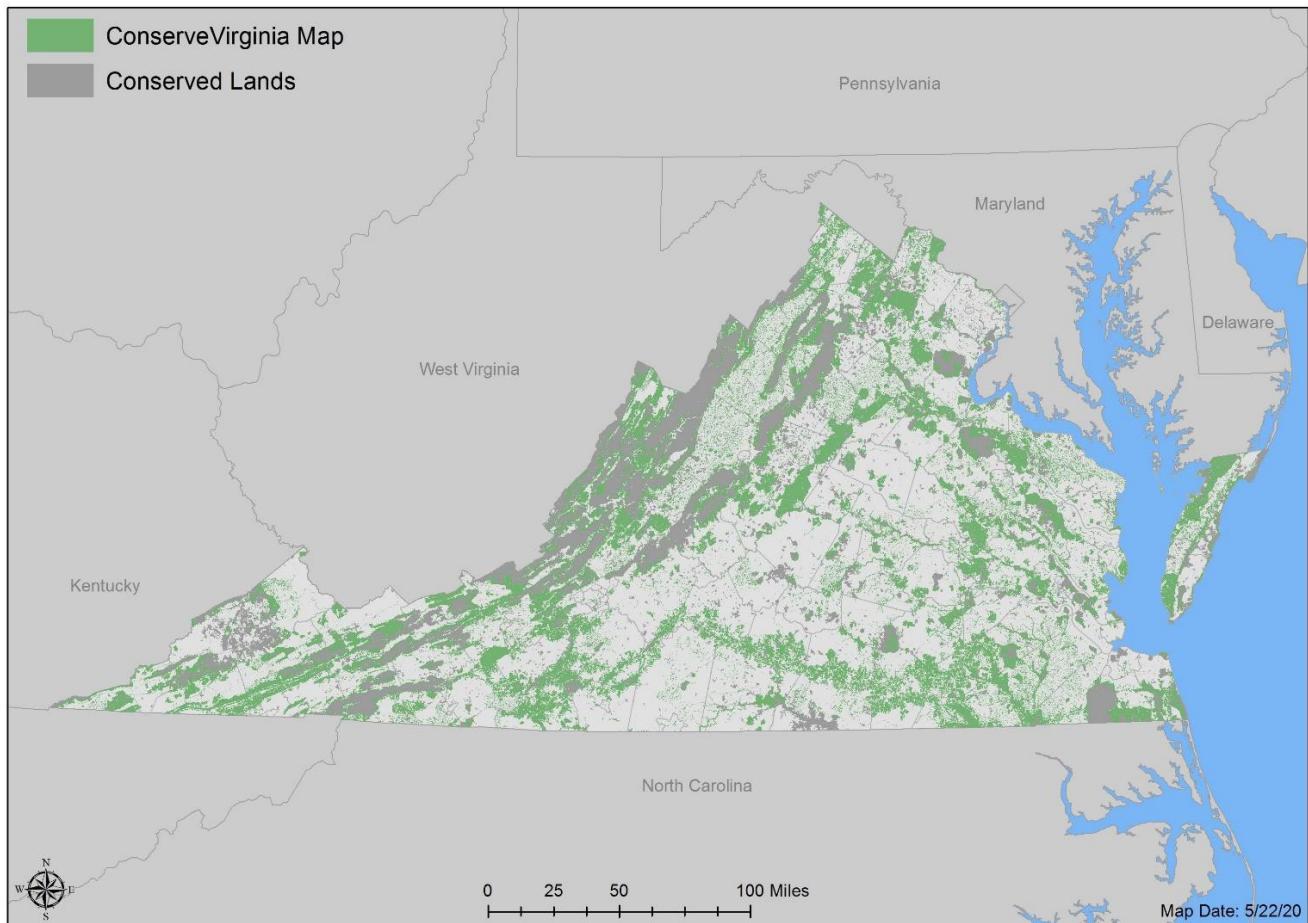
The 6,863,268 acres outlined in this Strategy are envisioned to guide land conservation in Virginia for the next generation. This Strategy charts a new path for data driven prioritized land conservation and a method by which to set both conservation and funding needs and monitor progress.

To help advance *ConserveVirginia*, Governor Northam has outlined three broad approaches;

- Engage the Virginia Land Conservation Foundation and other state grant programs to place emphasis on funding projects identified in the strategy.
- State agencies will focus land conservation funds and efforts on these priority lands.
- Expand existing funding sources and create new funding sources and tools to advance protection of these priority lands.

Through the *ConserveVirginia* initiative, Virginia will be a leader in targeted, value-based land conservation to ensure the greatest conservation outcomes and prosperity for future generations across the Commonwealth of Virginia.

ConserveVirginia Map



ConserveVirginia Methodology

To create *ConserveVirginia*, the Office of the Secretary of Natural Resources led an extensive effort to identify and map the Commonwealth's highest value conservation lands. Knowing that land conservation can address a wide array of interests and needs, the process began by identifying what conservation values were important to Virginians. In total, the Secretary, working closely with the land conservation community and a number of state agencies, identified 21 mapped data models, which have been divided into seven categories, each representing a different overarching conservation value. The categories are: Agriculture & Forestry; Natural Habitat & Ecosystem Diversity; Floodplains & Flooding Resilience; Cultural & Historic Preservation; Scenic Preservation; Protected Landscapes Resilience, and Water Quality Improvement.

To ensure that *ConserveVirginia* identifies high value lands of concern to each community, 25 Land Trusts based or working in Virginia were consulted and their maps cross-referenced against priorities provided by 14 Land Trusts that had priority maps, or descriptions for which maps of Land Trust priorities could be produced. A similar cross reference exercise was conducted for regional projects such as the Department of Environmental Quality's Coastal Virginia Ecological Value Assessment and the Chesapeake Conservation Partnership's watershed-wide maps.

Each category is composed of multiple data models, each based on the best available information and science. Existing datasets were shared by 14 state and federal agencies and organizations including the U.S. Department of Agriculture, VA Department of Agriculture and Consumer Services, Department of Interior, The Nature Conservancy, VA Department of Game and Inland Fisheries, VA Department of Conservation and Recreation, U.S. Geological Survey, VA Institute of Marine Sciences, VA Department of Emergency Management, VA Department of Historic Resources, National Park Service, VA Department of Transportation, the U.S. Fish & Wildlife Service, and VA Department of Environmental Quality. When a conservation value was requested for which a data model was unavailable, a methodology and a dataset were created, whenever possible. New methodologies and/or data models have been created for the Floodplains & Flooding Resilience, Cultural & Historic Preservation, Scenic Preservation, and Water Quality Improvement categories.

Outdoor recreation is a significant component of Virginia's economy and tourism industry and growing as new generations engage with the outdoors. These needs can often be met by a small trailhead or water access point to existing public lands and waters, thus it does not directly correlate to the modeling effort used for the seven categories. A Recreation Model has been developed to identify priority recreation gaps across Virginia and will be used to help sort funding and protection priorities for grant programs, public land acquisitions and easements as permitted.

Existing datasets were refined by selecting the highest ranked lands within each category using pre-existing prioritizations. Data models created specifically for this exercise only include the highest ranked lands within that category.

All told, the exercise identified 6,863,268 acres of land deemed to be of the highest conservation value across the seven categories detailed above. Just over 670,000 of the 6.86 million acres already have some level of permanent protection, but lack the specific conservation requirements necessary to protect the resource for which the acres were identified. For example, some open space easements that restrict development lack permanent protection for priority forests or riparian buffer protections that will ensure water quality protection.

ConserveVirginia Categories, Datasets and Methodologies

Agriculture & Forestry: Virginia's agriculture and forestry industries contribute a combined \$91 billion annually to Virginia's economy and generate more than 450,000 jobs throughout the Commonwealth. Whether it is beer, wine, equine, aquaculture, timber or livestock – Virginia's agricultural and forestry products are enjoyed locally, used throughout the country and exported around the world. To support this important industry, it's important that Virginia conserve high value agricultural and forest lands that face potential development. A total of 5.45 million acres of agricultural and forest lands are included across the seven *ConserveVirginia* categories.

The Agriculture & Forestry Category identifies priority agricultural and forest lands across Virginia. It is comprised of two datasets. The Virginia ConservationVision *Agricultural Model* quantifies the relative suitability of lands for agricultural activity across the state. This model went through rigorous testing and review by state and federal agricultural professionals. Agricultural value is assessed primarily based on inherent soil suitability, but also accounts for current land cover and travel time between agricultural producers and consumers. These mapped lands include five categories and the largest contiguous agricultural blocks from the top class distributed proportionally by locality are included in *ConserveVirginia*.

The Department of Forestry's *Forest Conservation Value (FCV) Model* strategically identifies priority forestland in Virginia for conservation by identifying those of the highest quality, most productive, and most vulnerable statewide. The model classifies forestlands based on watershed integrity; size of forested blocks; management potential; connectivity and proximity to other conserved lands; threat of conversion, and diminished tree species and significant forest community attributes. The model assigns a relative FCV rank to all forestland in Virginia from 1 (lowest) to 5 (highest); the highest class was used for the Strategy. The *ConserveVirginia* mapped lands include the largest contiguous forest blocks from the Class 5 category. The data resource areas in the Agriculture & Forestry Category represent a total of 1,396,356 acres.

Natural Habitat & Ecosystem Diversity: Virginia's natural lands protect water and air quality, support tourism and outdoor recreation, contain a rich biological diversity and array of wildlife corridors, enhance economic development and increase our fiscal and human health. Outdoor recreation generates \$13.6 billion in consumer spending and \$923 million in state and local tax revenues¹. The 2017 Virginia Outdoors Demand Survey found that the most popular activity is visiting natural areas. Large diverse landscapes provide a buffer against climate change and sea-level rise and support exemplary habitats and species.

The Natural Habitat & Ecosystem Diversity category has been developed by working with five key data resource areas. The *Virginia Natural Landscape Assessment* identifies large patches commonly referred to as Cores of forests, marshes, dunes and beaches with at least 100 acres of interior natural habitat. The cores are ranked based upon many variables including environmental diversity, species diversity, water quality benefits and habitats. The Outstanding category (C1) was used in the strategy, excluding the four lower ranked categories. *Landscape Corridors* of natural land cover were included connecting C1 Cores to maintain connectivity to allow species movement between larger natural land patches, elevations, latitudes and from ocean to inland.

¹"Virginia's Return on Investment in Land Conservation," The Trust for Public Land. August 2016. Available at: <https://www.tpl.org/virginias-return-investment-land-conservation#sm.000008332nxb7mem0pn44a9f9sm98> [Accessed November 29, 2018].

Resilient and Connected Landscapes represent a map developed by The Nature Conservancy and its partners highlighting areas that represent climate resilient sites and species movement areas (corridors) across Virginia that include key habitats and the space for nature to adapt and change in the face of a changing climate. *Natural Heritage Conservation Sites* are areas of the landscape that contain Virginia's and the planet's rarest aquatic and terrestrial natural communities and plant and animal species. This set includes cave and karst habitats, terrestrial sites and aquatic systems, and only the top ranked sites have been included. *Brook Trout Streams* identified by Game and Inland Fisheries are streams supporting native brook trout that are in a natural state representing high ecological integrity. The data resource areas in the Natural Habitat & Ecosystem Diversity Category represent a total of 3,940,770 acres.

Floodplains & Flooding Resilience: Flooding represents a major and growing threat to Virginia. It is the most common and costly disaster in the state. The vast majority of disasters in Virginia have been flood-related, and the state has experienced many additional local flood events. From 1996 to 2016, flood insurance claims in Virginia totaled more than \$515 million. Floodplains support local economies and increase the quality of life by providing valuable ecosystem services and recreational opportunities. Natural floodplains and wetlands boost nearby property values and can provide recreational tourism opportunities, increasing personal and shared wealth in the community. These areas also provide a buffer against fast moving flood water, absorb and store excess runoff, and filter pollutants from our water resources. As a result, protected floodplains reduce flood damage and cleanup costs and allow for faster recovery from flood events. Community projects in floodplains can tie together multiple goals including hazard mitigation, open space, historic preservation, recreation, and quality of life, giving these projects the potential to use multiple funding sources. Wetlands protect against flooding with one-acre typically storing one million gallons of water. The Floodplains & Flooding Resilience Category is comprised of four data-models.

Riverine flooding is addressed by mapping the undeveloped forest and agricultural lands upstream of the 10 worst flooding disasters across Virginia based upon jurisdictional risk, dollar losses and federal disaster declarations based on data from the Commonwealth of Virginia Hazard Mitigation Plan.

Statewide flooding is also addressed by wetlands maps. *Wetlands* are included directly via the ConservationVision Virginia Wetlands Catalog map project. Wetlands include mapped and predicted wetlands, streams and floodplains. They are prioritized based on variables including water quality, natural land networks and buffers, ecosystem services and biodiversity. The two highest-class priorities are included.

Coastal Flooding is addressed by the wetlands maps and coastal ecological resiliency map models developed by the Virginia Institute of Marine Science and by The Nature Conservancy. Coastal wetlands are critical to the productivity and diversity of marine ecosystems and to the human economies they support. Mapped priorities include those wetlands identified as above average and far above average resilience indicating the greatest long-term potential for adaptive response, based on a projected rise in sea level of six feet. Coastal resilience is also addressed via wetlands identified by the VIMS model that represent the highest class in estuarine and freshwater areas that provide the highest ecological services and provide for the highest marsh migration potential to adjacent natural lands. The data resource areas in this Category represent a total of 538,868 acres.

Cultural & Historic Preservation: Virginia's rich cultural and historical resources represent a significant component of the state's economic well-being. Heritage tourism is an important driver of Virginia's economy, generating almost \$7.7 billion a year, according to a study commissioned by Preservation Virginia and

conducted by the L. Douglas Wilder School of Government and Public Affairs at Virginia Commonwealth University². The Historic Rehabilitation Tax Credit Program alone in 2014 resulted in \$467 million in economic output, supported 9,960 jobs and generated \$3.50 for every \$1 invested through the first three years.

The Cultural & Historic Preservation category includes lands identified by the Department of Historic Resources as those unprotected National Historic Landmarks, Priority 1 Class A Battlefield Study Areas, Priority 1 Class B Battlefield Core Areas, National Register of Historic Places and the Virginia Landmarks Register or with potential for eligibility in these registers. National Historic Landmarks are nationally significant historic places designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States. The model includes lands categorized as “Priority 1, Class A Battlefield Study Areas,” the most intact and threatened battlefield landscapes according to the American Battlefield Protection Program, and “Priority 1 Class B Battlefield Core Areas” within which fighting actually occurred. Also included are lands in the National Register of Historic Places and the Virginia Landmarks Register or with potential for eligibility in these registers. The resource areas in the Cultural & Historic Resource Category represent a total of 1,181,326 acres.

The *USCT-African American Units Involvement Battlefields* input identifies 128,964 acres from the American Battlefield Protection Program's (ABPP) study area data that include American Civil War battlefields in Virginia with involvement from the United States Colored Troops (USCT) and/or other African-American units. The list of the battlefields included for this dataset was provided by Civil War Trails®.

Note: Within the Cultural & Historic Preservation category, lands already protected by conservation easement held by the Virginia Board of Historic Resources are not included.

Scenic Preservation: Nearly 90% of Virginians think scenery is important when making travel plans, and 51% feel protecting scenery and scenic views is very important, according to the 2017 Virginia Outdoors Demand Survey.

The Scenic Preservation Category identifies lands by mapping national and state designated scenic byways, state designated scenic rivers, All-American roads, national scenic trails, national historic trails, national millennium trails, and national recreational trails. A statewide map for these resources did not exist. These resources were mapped and boundaries created using river banks, shorelines and jurisdictional boundaries where necessary and then expanded by 200 feet on either side of the resource to capture adjacent lands. The individual resource areas in this category represent a total of 270,870 acres.

Protected Landscapes Resilience: Virginia's publicly owned lands provide a wealth of natural goods and services in the form of clean air and water, carbon sequestration and flood reduction, benefiting local economies and improving physical health by providing safe outdoor recreation. In 2019, visitors to Virginia State Parks alone spent an estimated \$286.2 million in the Commonwealth. Approximately \$130.2 million of this spending was by out-of-state visitors, and the total economic activity stimulated by Virginia State Parks during 2019 was approximately \$437.7 million³.

² Accordino, J. and F. Fasulo. 2014. Economic Impact of Historic Rehabilitation Tax Credit Programs in Virginia. Virginia Commonwealth University. Available at: https://www.dhr.virginia.gov/pdf_files/VCU_Historic%20Tax%20Credit%20Report_FINAL_21-1-2014.pdf [Accessed November 29, 2018]

³ Magnini, V.P. 2020. Virginia State Parks 2019 Economic Impact Report. Available at: <https://www.dcr.virginia.gov/state-parks/document/virginia-state-parks-2019-economic-impact-study.pdf> [Accessed May 26, 2020]

Protected Landscapes Resilience represents priority areas identified by five public resource agencies as lands and waters around existing protected lands that are important habitats, connections to the landscape, critical to enhance climate resilience, and protect key scenic and recreational values. The Protected Landscapes Resilience category was developed and provided by the U.S. Fish and Wildlife Service, National Park Service, Department of Game and Inland Fisheries, Department of Conservation and Recreation and Department of Forestry. The resource areas in this category represent a total of 596,954 acres.

Water Quality Improvement Category: When rain runs off farmland and suburban lawns, it often carries harmful substances including excess nutrients and sediments into nearby waterways. This type of pollution is called nonpoint source because it does not come from a single source, or point, such as a sewage treatment plant or an industrial discharge pipe. Nutrients are substances that help plants and animals live and grow, but excessive amounts of nutrients, especially nitrogen and phosphorus, can result in algal blooms and depleted oxygen levels that can suffocate animals and plants. An estimated 50% of the nitrogen and 29% of the phosphorus entering surface waters come from farmland. Sediments are caused mainly by water running over bare land and carrying soil particles into streams, lakes, rivers, and bays, where they reduce light needed by aquatic plants, cover aquatic habitats, plants, and animals, and obstruct waterways. Comprehensive estimates of the damages from agricultural pollution are lacking, but soil erosion alone is estimated to cost water users \$2 billion to \$8 billion annually. Virginia's nonpoint source pollution prevention efforts focus strongly on managing nutrients and sediments because they pose the most significant threat to the health of our waterways, especially the Chesapeake Bay and its tributaries.

The *Water Quality Improvement Opportunity Areas* input identifies 790,112 acres of the highest priority lands for conservation in the interest of water quality improvement in general. It was developed via collaboration between the Department of Conservation and Recreation and the Department of Environmental Quality using estimates of nitrogen, phosphorus, and sediment loadings from agricultural sources from the Chesapeake Bay Program Phase 6 Watershed Model (CAST-2017d) and the Virginia Water Quality Assessment, and with consideration of the goals of the Chesapeake Bay Watershed Implementation Plan (WIP III). The basic approach was to identify watersheds (12-digit hydrologic units) with the highest (i.e., those in the 90th percentile) loadings of nitrogen, phosphorous, or sediment from any of the assessments used. Riparian areas along streams, creeks, and rivers in those watersheds are the focus of this *ConserveVirginia* input. Buffers were mapped for these waterways, where buffers ranged from 100 to 400 ft., depending on steepness of slope of adjacent lands. Generally, wider buffers were mapped for steeper slopes and for headwater streams. These buffer lands are where land conservation would be most effective to maintain and improve water quality. Once conserved permanently, water quality benefits of these lands will be further increased by establishing and maintaining natural vegetation in buffers. Conservation easements including deed requirements for such vegetated buffers will qualify as a *ConserveVirginia* success.

Outdoor Recreation: This *ConserveVirginia* category represents a significant component of Virginia's tourism and economy. Access to hiking trails and water are consistently two of the most sought after outdoor recreation amenities. The Virginia ConservationVision Recreation Access Model has been developed to quantify access to outdoor recreation opportunities in Virginia, and to identify areas where more recreational access is needed at both local and regional scales. Quantifying access to outdoor recreation is complex, and this model is not directly comparable to the models used for the other seven *ConserveVirginia* categories. This model will be used to help sort funding and protection priorities.

This model quantifies public access to outdoor recreation in the state of Virginia, with attention given to both terrestrial (i.e., land-based) and aquatic (i.e. water-based) recreational access. Data used in the development of the terrestrial component of the model include all public access lands and trails, along with access points to these lands and trails. Data used in the development of the aquatic component of the model include boat launches, public fishing lakes, stocked trout reaches, public beaches and other non-pool swimming access, along with access points to these and other public waters. The model provides a variety of informative attributes based on the number or size of recreational opportunities within reasonable driving or walking distances, the size of the population served by these resources, and benchmarks for adequate levels of service (i.e. recreational access need). Thus, the model is designed to identify where access to these outdoor recreation resources are in short supply, and what would be needed to bring an area up to specific benchmark standards.

Agriculture and Forestry Category

Agriculture & Forestry Category

Conserved Lands

Pennsylvania

Maryland

Delaware

West Virginia

Kentucky

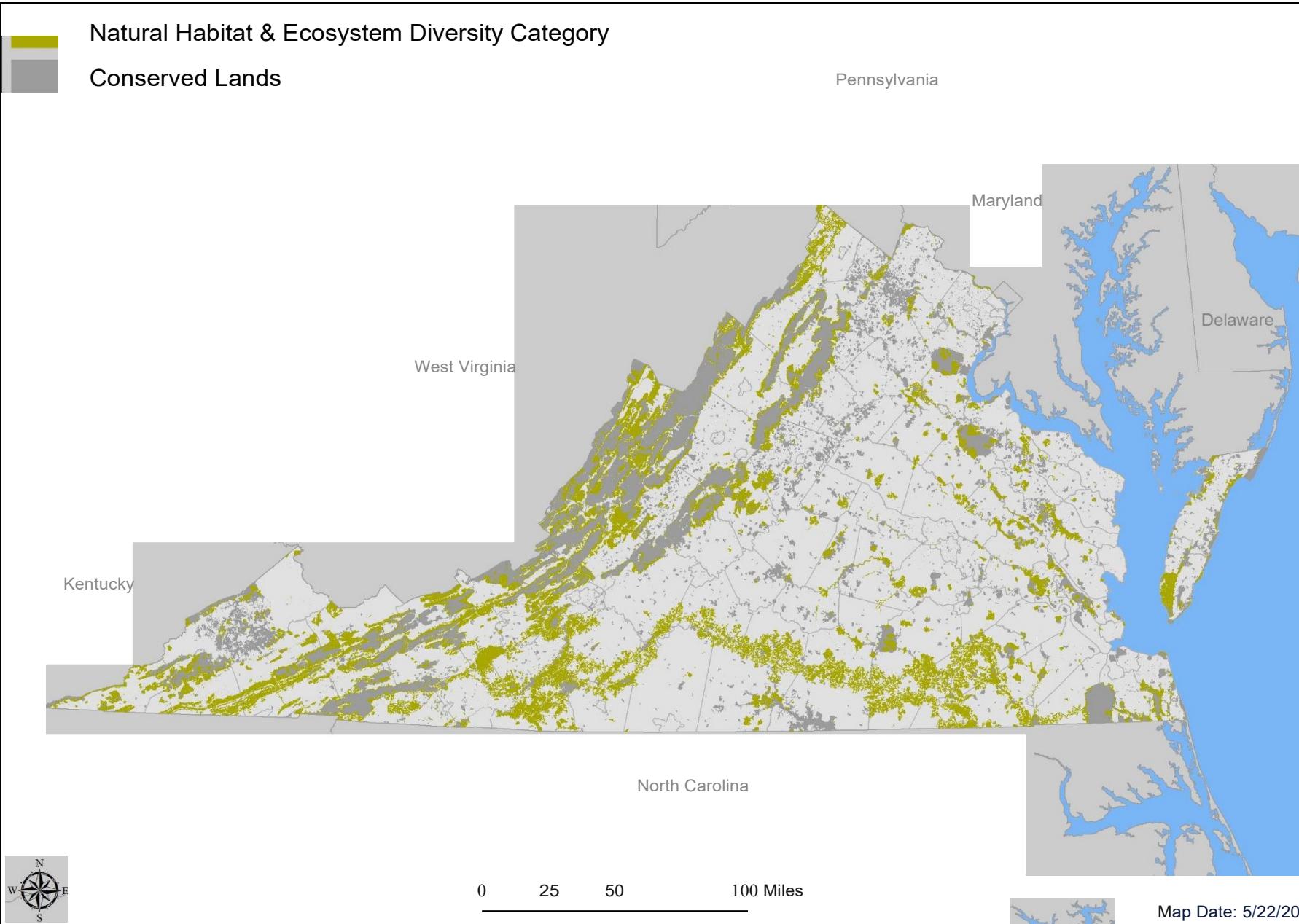
North Carolina

0 25 50 100 Miles

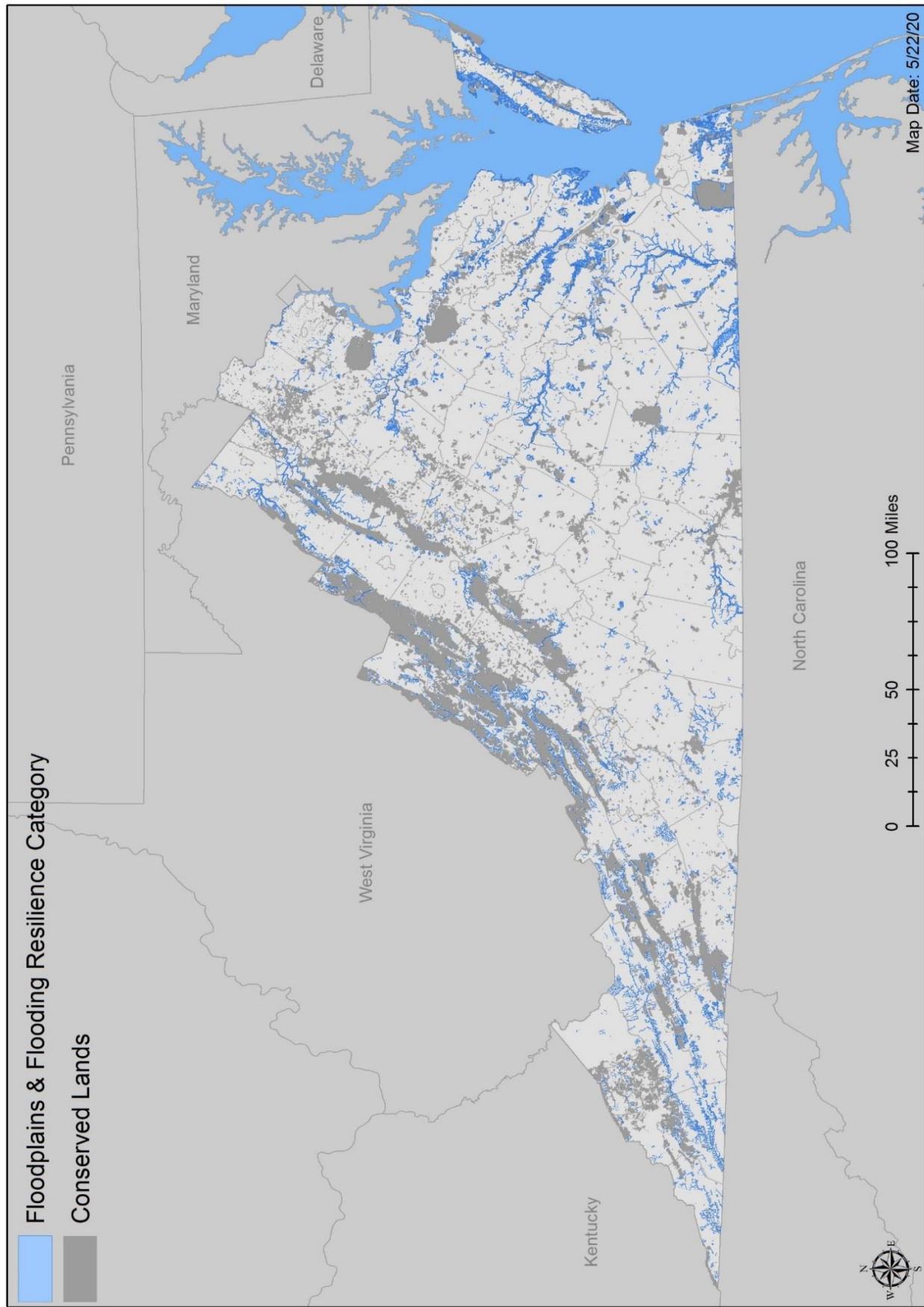


Map Date: 5/22/20

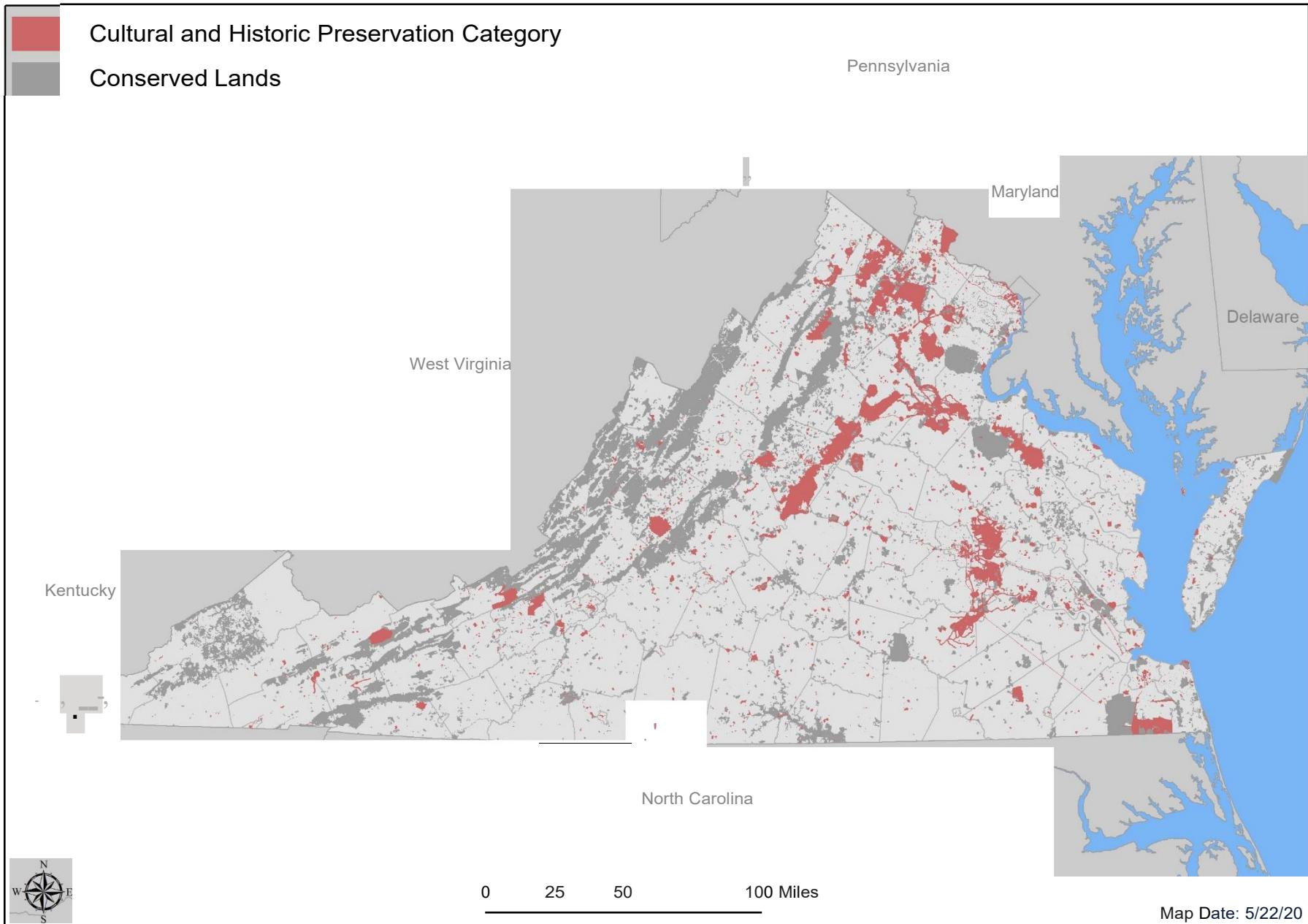
Natural Habitat and Ecosystem Diversity Category



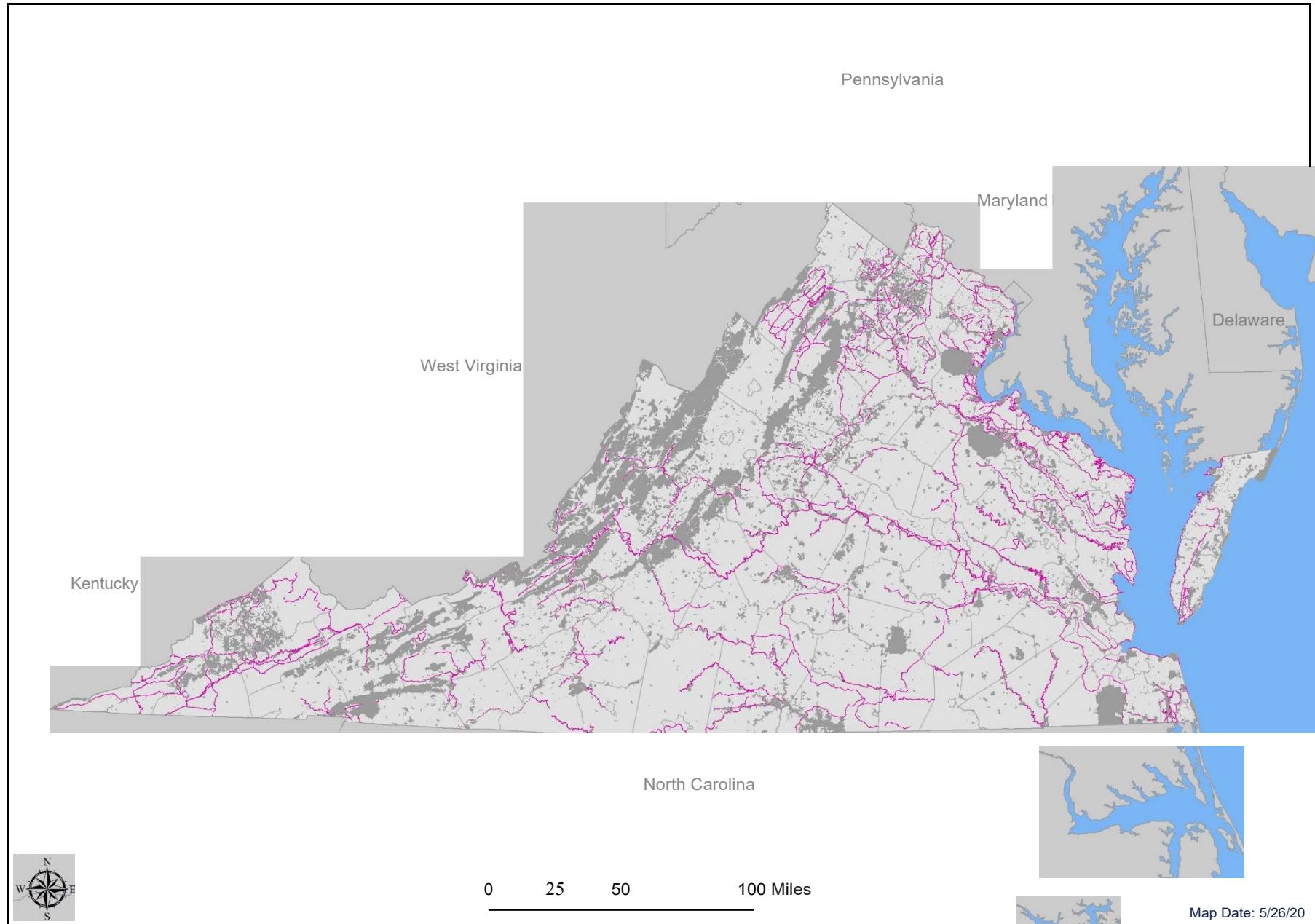
Floodplains and Flooding Resilience Category



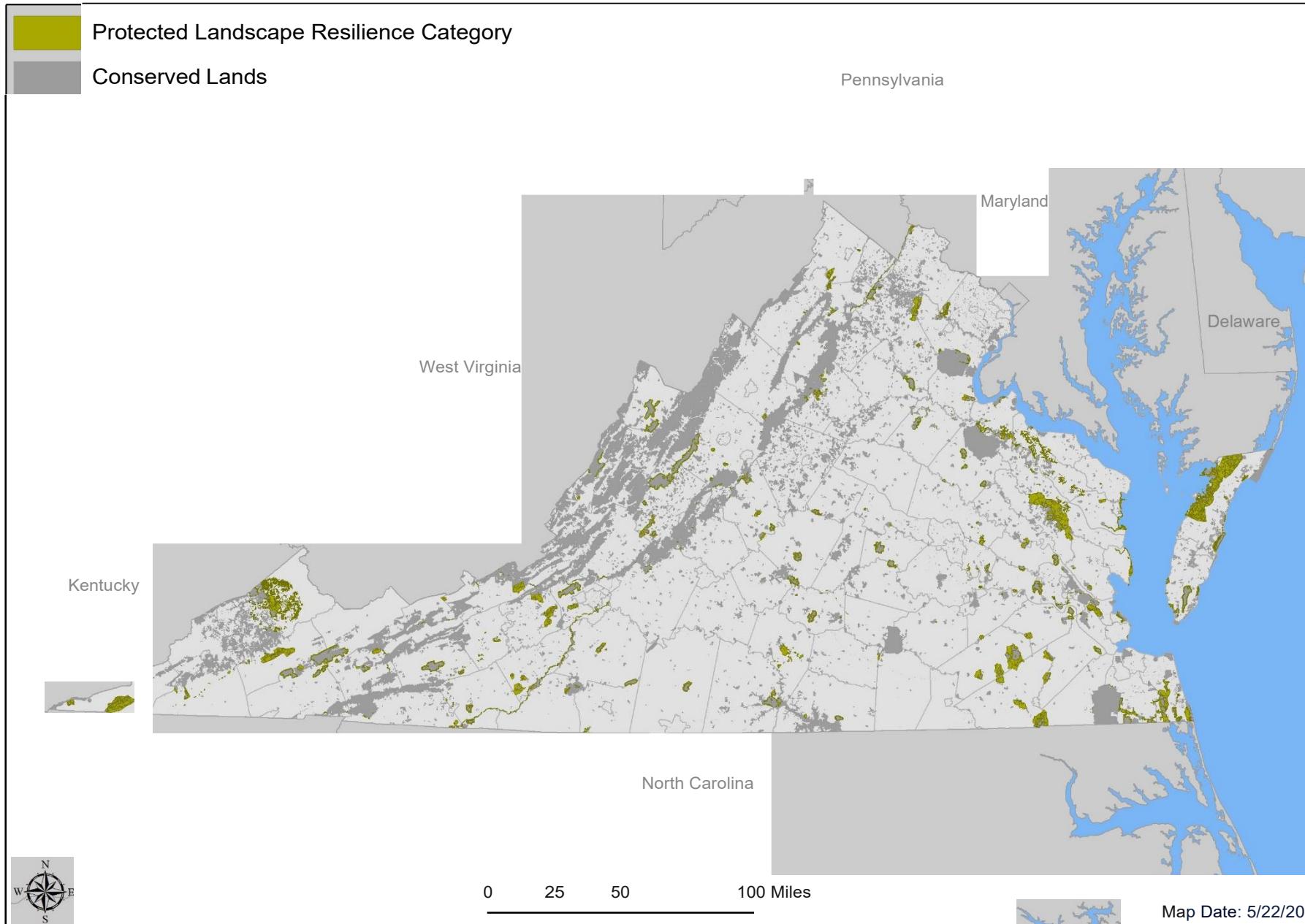
Cultural and Historic Preservation Category



Scenic Preservation Category



Protected Landscapes Resilience Category



Water Quality Improvement



Water Quality Improvement Opportunity Areas

Conserved Lands

Total Acres: 790,112

New ConserveVirginia Acres: 505,422*

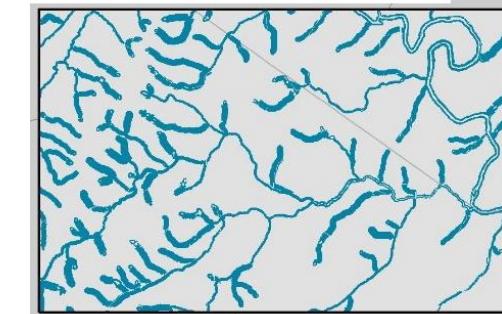
*Includes 29,322 acres currently protected but lacking adequate water quality permanent protection

Pennsylvania

Maryland

Delaware

West Virginia



Kentucky

North Carolina



0 25 50 100 Miles



Map Date: 5127120