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Feasibility of Development of Flood Resiliency Clearinghouse Program

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HB 2187

COMMONWEALTH CENTER FOR
RECURRENT FLOODING RESILIENCY

PARTNERS

VIRGINIA COASTAL
POLICY CENTER

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On the

FEASIBILITY OF DEVELOPMENT OF FLOOD RESILIENCY CLEARINGHOUSE PROGRAM

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Introduction

House Bill 2187[i], introduced by Delegate Keith Hodges in the 2021 session of the Virginia General Assembly, directed the Commonwealth Center for Recurrent Flooding Resiliency (CCRFR), a partnership between Old Dominion University, the Virginia Institute of Marine Science (VIMS) and the William & Mary Law School's Virginia Coastal Policy Center (VCPC) established by Virginia Chapter 440 of the 2016 Acts of Assembly (HB 903), to evaluate the development of a Flood Resiliency Clearinghouse Program (henceforth *Clearinghouse*). The bill stipulated that the Center should work with the Department of Conservation and Recreation (DCR) to evaluate solutions that manage both water quality and flooding and emphasize nature-based solutions. Further, it states that the CCRFR and DCR shall evaluate solutions that include both "approved and not-yet-approved stormwater best management practices". The intent of HB 2187 to provide an easily accessible resource to aid policymakers, state agencies, localities, businesses, and the public in implementing flood protection practices that are protective of water quality is clear. Less clear is the geographic and the programmatic/jurisdictional scope of the best management practices (BMPs) to be considered and the specific roles that the Clearinghouse would play beyond being a repository for information on existing BMPs ranging from shoreline erosion control to stormwater management. This report takes the approach of assuming that the intent of the bill is for the Clearinghouse to be a statewide resource, but much of the analysis is focused on the coastal zone where jurisdictional and regulatory structures include additional levels of complexity.

While there are currently best management practices (BMPs) approved in the Commonwealth for the management of stormwater quantity and quality, these practices were not designed to withstand flooding impacts and have not been evaluated for flood control in the riparian and littoral zones. There is a need in Virginia for innovative shoreline strategies that manage water quality and flooding and protect the coastline from erosion related to rising sea levels and storm surge. A Flood Resiliency Clearinghouse could be a resource to promote resilient shoreline solutions and could provide the cross-agency collaboration needed to evaluate and approve solutions that manage both water quality and flooding. The Clearinghouse could fill the need in the Commonwealth for a one-stop location to identify BMPs for a particular activity intended to provide flood protection while being protective of water quality.

Background

There is a need for the adoption of solutions that address water quality and flooding, emphasizing nature-based solutions, that provide multiple-benefits as they address climate change impacts. Recent legislation supporting climate change action and the development of the Coastal Resilience Master Plan provide the opportunity for implementation of these innovative solutions.

In Virginia, low-lying coastal areas are particularly susceptible to storm surge and flooding from heavy precipitation, and such effects will be intensified by rising sea levels and increased

intensity of rainfall events.[ii,iii] As more scientific studies are completed, data reveal that we are underestimating the effects of climate change on our environment: sea level rise (SLR) is accelerating,[iv] more frequent and heavy rainfall may contribute to flooding impacts,[v] and future temperatures may be greater than predicted.[vi] As sea level rises and water tables approach the ground surface, flooding caused by precipitation will become more frequent and severe in coastal areas.[vii]

More powerful and frequent storms, and warmer and more variable local temperatures will have immediate implications for all of Virginia's residents, while those along the coast will experience effects from sea level rise that include storm surge, recurrent tidal flooding, saltwater intrusion into drinking water, and septic system inundation.[viii]

Implementing BMPs that reduce the impacts of this flooding while being protective of surface water quality will in many cases involve multiple jurisdictional authorities. This is most evident in Virginia's coastal zone, where the management of tidal wetlands is governed by numerous state and federal laws and regulations; in addition, agency guidelines and local ordinances play a role in the process.[ix] Most resource boundaries and resources have more than one regulating authority and each regulatory agency conducts reviews and grants a permit.[x] The riparian zone is managed by local governments implementing the Chesapeake Bay Preservation Act, tidal vegetated and non-vegetated areas are managed by local wetland boards or the Virginia Marine Resources Commission (VMRC), wetlands in nontidal areas are managed by the Department of Environmental Quality (DEQ), and the subaqueous environment is managed by the VMRC. Figure 1 shows the number of distinct agencies with jurisdictions in riverine and coastal riparian and littoral zones. As the sea level rises, the distinction of who is managing what may be further complicated with different regulatory viewpoints and shoreline management approaches. Therefore, for a successful adaptation to sea level rise, collaboration among regulatory agencies will be critical.

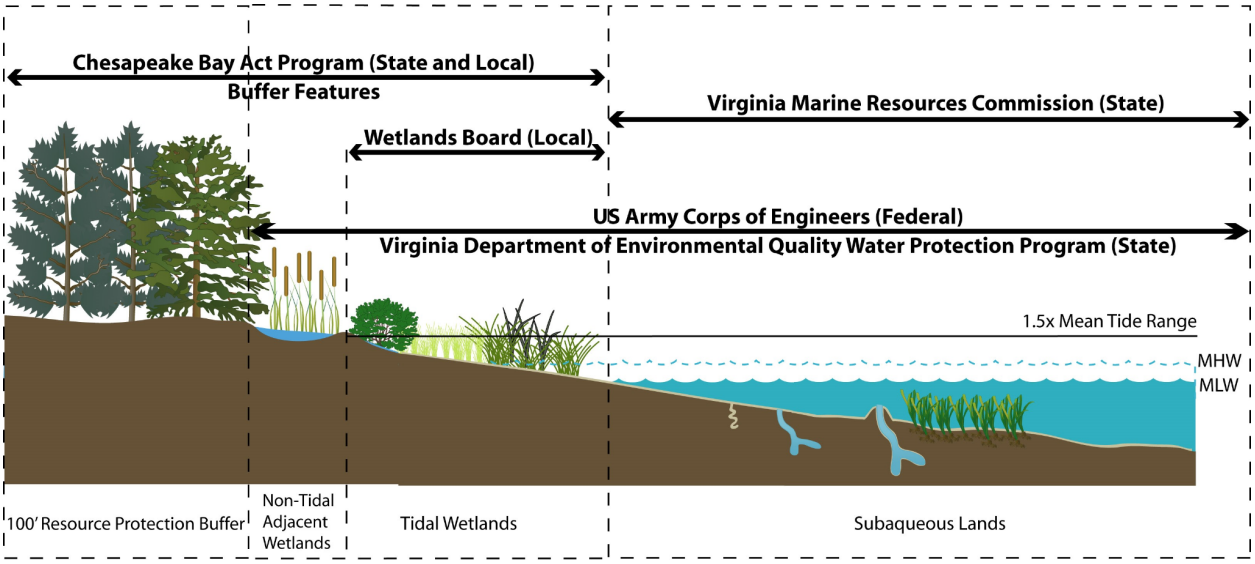

Figure 1. Virginia Riparian and Littoral Zone Jurisdictions
Source: Center for Coastal Resources Management, Virginia Institute of Marine Science.[ix]

Recent Climate Resiliency Legislation and the Virginia Coastal Resilience Master Plan

Virginia's government has recognized the need to develop and implement climate resilience strategies and has taken important steps to build climate resilience. These measures could be supported by the creation of a Flood Resiliency Clearinghouse. Recent executive orders and legislation creating these measures are summarized below:

2020 Tidal Wetlands Act Amendments & Updated Wetlands Guidelines: (SB 776 Living Shorelines; development of general permit; guidance.)
SB 776[xi] requires the use of living shorelines for shoreline control unless the "best available science" indicates the site is not suitable for such methods. (Code of Virginia § 28.2-104.1). The legislation:

- Requires all wetlands applications to include "… *a statement indicating whether use of a living shoreline as defined in §28.2-104.1 for a shoreline management practice is not suitable, including reasons for the determination;….*"
- Defines a "living shoreline" 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".
- Requires the Virginia Marine Resources Commission (VMRC) to promulgate and periodically update minimum standards for the protection and conservation of wetlands. The bill also compels the VMRC to revise wetlands permit requirements to reflect climate change implications for each application.[xii]

2020 Virginia Coastal Resilience Master Plan:

- In 2018, Executive Order 24[xiii] (EO 24) mandated the development of a Coastal Resilience Master Plan by the Commonwealth. The Master Plan will serve as the state's guide for coastal adaptation and conservation initiatives. The Plan's development and implementation are the responsibility of Virginia's Chief Resilience Officer (CRO) and the Special Assistant to the Governor for Coastal Adaptation and Protection (SACAP).
- The Virginia Coastal Resilience Master Plan Technical Advisory Committee (TAC) was formed by EO 71[xiv] in 2020 to assist the CRO and the SACAP in producing recommendations for particular coastal adaptation and protection methods and project prioritization, as well as facilitating the creation of the Master Plan.
- The Virginia Coastal Resilience Master Planning Framework[xv] was announced on October 22, 2020. The framework outlined the objectives and guiding principles that have been used to guide the development of the Virginia Coastal Resilience Master Plan. Coastal protection and adaptation strategies were presented in the framework, aimed to strengthen the flood resilience of coastal communities and economies.

2021 Chesapeake Bay Preservation Act (§ 62.1-44.15:72)[xvi]: HB 504[xvii]

- The General Assembly amended the Chesapeake Bay Preservation Act (CBPA) in 2021 to include "coastal resilience and adaptation to sea-level rise and climate change" and "preservation of mature trees" among the factors that local governments must consider as

they evaluate development proposals in protected riparian areas. New regulations were triggered because of this amendment, which may give local governments in Virginia new adaptation options[xviii].

2021 Virginia Community Flood Preparedness Fund (§ 10.1-603.25)[xix]: HB 981

- In 2021, Virginia became a member of the Regional Greenhouse Gas Initiative (RGGI), a market-based agreement between New England and the Mid-Atlantic states to reduce CO_2 emissions. Forty five percent of the state's RGGI auction revenues are being placed in the Virginia Community Flood Preparedness Fund.[xviii]
- This Fund provides an opportunity for local governments to obtain grants and, starting in 2022, loans to conduct innovative and necessary flood-reduction initiatives that may not be eligible for other funding channels.[xx]

2020 DEQ's inclusion of Climate Change: HB 1164[xxi]

- HB 1164 requires the Virginia Department of Environmental Quality (DEQ) to develop and execute policy and regulatory initiatives to minimize climate pollution and increase climate resilience in the Commonwealth, among other things. According to the legislation, climate impacts and resilience must also be addressed in all DEQ programs and permitting processes.[xviii]

2020 VDOT Regulations Considering Climate Change and Coastal Storms:

- The Virginia Department of Transportation (VDOT) adopted new design standards targeted at increasing the resistance of bridges and other transportation facilities to the effects of climate change.
- The Virginia Department of Transportation's revised chapter 33[xxii] in its guidance manual requires engineers and designers to account for sea level rise, water salinity, temperature change, and rainfall intensity while designing and maintaining hundreds of bridges.[xxiii]

The Need for a Flood Resiliency Clearinghouse

A Flood Resiliency Clearinghouse could serve to support implementation of these recent legislative and executive actions designed to increase resilience to climate change-induced flooding, by providing a comprehensive repository for information on relevant BMPs. In addition, it could provide the cross-agency collaboration needed to 1) evaluate and approve solutions that manage both water quality and flooding, 2) update BMPs as they evolve, 3) interpret how BMPs established for one purpose, such as flood protection in the riparian buffer, affect water quality in adjacent waterbodies, and 4) determine consistency with existing regulations and ordinances.

It was beyond the capacity of CCRFR to determine in the time available what the specific roles for each of these agencies should be and how the process could best be implemented. In addition, there were insufficient resources and time available to evaluate approved and not-yet approved solutions for management of water quality and flooding. Furthermore, the process of evaluating the effectiveness of solutions for providing flood protection and managing water

quality called for by HB 2187 will require ongoing interagency collaboration and could not be accomplished as part of a one-time consideration of the need for a Clearinghouse.
As noted earlier, the Commonwealth of Virginia's agencies and organizations, as well as federal agencies have overlapping roles, that are most complex in the riparian and littoral zones, and each will play a critical role in coordinating approval of BMPs and permitted activities. These agencies include the Department of Conservation and Recreation (DCR) which will act as a lead Virginia agency per the recommendation of HB2187, DEQ, VRMC, VDOT, VIMS, the U. S. Army Corps of Engineers (USACE), and the Environmental Protection Agency (EPA).
As noted earlier, the Commonwealth of Virginia's agencies and organizations, as well as federal agencies have overlapping roles, that are most complex in the riparian and littoral zones, and each will play a critical role in coordinating approval of BMPs and permitted activities.

The Clearinghouse could provide a collaborative web platform for agencies and organizations to share the outcomes of the interagency coordination including information about the BMP approval process, and approved BMPs with detailed specifications and resources to assist in the selection of appropriate BMPs. Additionally, it could demonstrate to end users the critical importance of collaboration across disciplines and sectors to achieve resilience goals and be a resource to assist local planners, engineers, practitioners, policymakers, and the public in planning flood mitigation measures. This collaboration would provide a critical opportunity for state agencies and local governments to understand how future resiliency projects might adapt to local and regional conditions in a rapidly growing field of practice, as well as for visitors to the Clearinghouse to witness firsthand examples from across the state.

Currently, there is not a climate change program structure in state government in Virginia. No one organization is responsible for climate change planning in the Commonwealth. Furthermore, there is a deficit of interagency collaboration for climatic or environmental resilience and sustainability that is mandated by law.[viii] A recommendation from a recent report from the Virginia Academy of Science, Engineering, and Medicine, *The Impact of Climate Change on Virginia's Coastal Areas*, is that the Commonwealth establish a structure for more effective collaboration and coordination to help Virginia adjust to future climate change and improve the state's response.[viii]

There are some proprietary nature-based solutions that address water quality and flooding, and these new nature-based technologies need to be evaluated but there is no standard or process for their evaluation in the Commonwealth. All solutions need to be evaluated using either performance criteria or field verification. This type of evaluation is currently being done in other states.

Recently, House Bill (HB) 882 from the 2020 General Assembly,[xxiv] as passed, directed the State Water Control Board to adopt regulations (§ 9VAC25-870-65)[xxv] allowing the use of a proprietary best management practice (BMP), also known as Manufactured Treatment Devices (MTDs), only if its nutrient or sediment removal effectiveness has been confirmed and certified by another state, regional, or national certification program.[xxiv] It also stated that "any proprietary BMP approved for use after July 1, 2020, must meet the requirements of § 62.1-44.15:28 A 9 of the Code of Virginia". As a result of HB 882, DEQ is working on a draft guidance document which would replace a prior guidance memo developed in 2014.[xxvi] Some of the highlights of the draft

guidance include the addition of definitions for nonproprietary BMPs and proprietary BMPs, and clarification that DEQ will no longer review data to approve or deny a proprietary BMP. Instead, approvals will be based only on General Use Level Designation (GULD) certifications from Washington State's Technology Assessment Protocol – Ecology (TAPE) program and New Jersey Department of Environmental Protection (NJDEP) certification.[xxvii] The Flood Resiliency Clearinghouse could use similar resources for certification and verification of flood resilience solutions, and disseminate knowledge on approved flood management methods.

Virginia Stormwater Management Program Regulations

It is important to understand that currently approved BMPs in the Commonwealth are focused on stormwater quantity and quality and flood control as it relates to the BMPs' performance. The following section describes current stormwater BMPs and how they need to be modified in areas with seasonal high groundwater table (SHGT).

The Virginia Stormwater Management Program (VSMP) Regulations were revised in 2014, requiring all new development and redevelopment to comply with post-construction runoff quantity and quality criteria.[xxviii] The regulations focused on managing increases in stormwater runoff and pollutant loads by regulating stormwater quantity and quality.

Under the revisions related to water quality of the VSMP Regulations,[xxix] new development projects must meet the new Virginia water quality compliance limit of 0.41 pound per acre per year of TP (9VAC25-870-63)[xxviii] calculated utilizing the Runoff Reduction Method (RRM).[xxx] If there is an increase in impervious area on a prior developed site because of redevelopment, then the TP load from this must also meet the same compliance limit. Redevelopment projects that create no net increase in impervious cover, must achieve 20% total phosphorus (TP) reduction if the site is greater than one acre and 10 % reduction in TP if the site is less than one acre.[xxviii] The revised regulations help meet the Chesapeake Bay Total Maximum Daily Load (TMDL) Watershed Implementation Plan requirements since the goal of the revised water quality criteria is to offset future growth that may result in additional impervious cover on newly developed sites and redevelopment sites.[xxxi]

RRM changed the focus of the regulatory requirements from pollutant concentration to runoff quantity and emphasized environmental site design (ESD) and Best Management Practices (BMPs) which reduce runoff volume. The purpose of ESD is to limit the amount of impervious area and use the existing natural resources on the proposed development site. BMPs reduce the runoff volume and treat the amount of stormwater discharged to a storm sewer system. If a site needs to meet the stormwater management goals specified in the VSMP regulations, it must use the combination of ESD and BMPs.

To meet water quality goals, the RRM also requires the use of BMPs that are posted in the Virginia Stormwater BMP Clearinghouse, administered by DEQ and the Virginia Water Resources Research Center.[xxxii] There are 15 non-propriety and approximately 30 proprietary BMP practices approved by the state ranging from bioretention and wet/dry swales to filtering practices (Table 1). The standards and specifications for non-proprietary BMPs are listed in the Stormwater BMP Clearinghouse website and each BMP is assigned TP pollutant removal (PR)

efficiency, and volume reduction or runoff reduction (RR) credits. Both PR and RR provide the mass of TP removed for each BMP.

Each practice listed in the Virginia Stormwater BMP Clearinghouse has two levels of design criteria – Level 1 and Level 2- based on how they will respond to RR and PR capabilities. Level 1 addresses basic, minimal design criteria and Level 2 addresses enhanced design specifications. Level 2 design for BMPs includes specifications such as larger treatment surface area, enhanced design geometries, enhanced hydraulics, and vegetative conditions all of which improve efficiency. Therefore, Level 2 design is anticipated to have higher TP mass load removal than Level 1 design. Table 1 lists the Virginia-approved non-proprietary and proprietary BMPs. Some stormwater BMPs receive only RR credits; others receive PR credits; and some receive both.

Table 1. Virginia Stormwater Best Management Practices

Practice	Volume Reduction (RR Credit)	Pollutant Removal (PR Credit)	Design Levels	Minimum Groundwater Separation Required (ft)
Rooftop Disconnection	X		No	2
Sheet Flow to COS/VFS[a]	X		No	2
Grass Channels	X	X	No	2
Soil Amendments			No	1.5
Green Roofs	X		Yes	N/A
Rainwater Harvesting	X		No	N/A
Permeable Pavement	X	X	Yes	2
Infiltration	X	X	Yes	2
Bioretention	X	X	Yes	2[b]
Dry Swales	X	X	Yes	2
Wet Swales		X	Yes	0
Constructed Wetlands		X	Yes	N/A
Wet Ponds		X[c]	Yes	N/A
Filtering Practice		X	Yes	2
Extended Detention Pond	X[d]	X	Yes	2
Manufactured Treatment Devices		X	No	N/A

[a] COS means Conserved Open Space, VFS means Vegetative Filter Strip
[b] Vertical groundwater separation distance reduced in Coastal Plain areas
[c] PR credit reduced when practice intercepts groundwater
[d] Only Level 2 receives RR credit

Source: VADEQ (2016) https://rga.lis.virginia.gov/Published/2016/HD2/PDF

Coastal Virginia is characterized by a flat landscape, shallow water tables and low permeable soils which may pose significant issues with volume reduction credits associated with the application of BMPs used specifically for infiltration-based practices listed in the Virginia Stormwater BMP Clearinghouse. For example, there must be a minimum vertical separation distance to maintain a positive hydraulic gradient by allowing water to flow out of the BMP and into the unsaturated soil zone. In addition, the vertical distance will protect the groundwater from nutrients and pollutants and protect it from flooding especially if groundwater mounding occurs. This occurrence is caused by accumulation of water on top of the groundwater table. If the mound rises to the same elevation as the BMP, the BMP will flood and become ineffective.

While some design adjustments allow for a shallower water table, there is currently no state standard that would demonstrate the impacts of shallower water tables on BMP effectiveness or groundwater impact at the proposed site, which could be addressed as part of the flood resiliency BMP analysis.

House Joint Resolution 587 [xxxiii]***: (HJR 587, 2015)***

House Joint Resolution 587 was enacted by the Virginia General Assembly in 2015. (HJR 587). The resolution as passed states in part:
"*That the Department of Environmental Quality be requested to study the application of the post development stormwater management technical criteria, as established in the Virginia Stormwater Management Program Regulations, in areas with a seasonal high groundwater table."*

The resolution directed the Department of Environmental Quality (DEQ) to review the existing design specifications for best management practices (BMPs) listed on the Virginia Stormwater BMP Clearinghouse and make recommendations for revisions to allow for effective use of these BMPs in areas with a seasonal high groundwater table (SHGT), if applicable.[xxxiii]

Part of the goal of HJR 587 was to see if existing BMP design criteria may be modified for use in regions with a SHGT, providing these areas have more flexibility in implementing the VSMP Regulations. Existing design standards often stipulate a minimum separation distance of two feet between the stormwater practice and the water table to allow infiltration and protect groundwater. However, in some Virginia coastal places, two feet of separation is often not achievable.[xxxiv]

DEQ conducted a two-year study in which it provided recommendations to identify areas with SHGT and how SHGT affects stormwater BMPs. DEQ also evaluated and compared six state programs including Minnesota, Maryland, Georgia, Delaware, New York and North Carolina that employ different methods for stormwater management in regions with a SHGT, and proposed potential changes to existing BMPs for use in SHGT areas.[xxxiv]

Virginia Stormwater BMPs Applicable for Coastal Plain Areas

Many of the best management practices approved pursuant to the VSMP Regulations already incorporate adjustments to the design requirements that can be implemented in SHGT zones.[xxxiv] The challenge posed by the HJR587 study was to determine whether any additional BMP design changes had the potential to provide volume and TP load reduction credit without compromising overall BMP functionality. Table 2 below highlights concerns for stormwater management in coastal locations and categorizes structural BMPs into three categories: recommended, accepted, and limited for use in the coastal plain. Preferred practices are feasible at coastal plain development sites with some design modifications and have a high rate of runoff volume reduction and/or the ability to remove nitrogen and bacteria in the coastal plain.[xxxv]

In many coastal plain sites, accepted stormwater control measures may work, but they either demand large design changes or only moderately reduce harmful coastal pollutants. In the coastal plain, restricted methods are not suggested as primary stormwater treatment because they are infeasible or ineffective in removing pollutants.[xxxiv]

Table 2. BMP Suitability in Coastal Plain

Practice	Classification	Group
Rooftop Disconnection	Preferred	Runoff Reduction
Sheet Flow to Open Space or Veg. Filter	Preferred	Runoff Reduction
Rainwater Harvesting	Preferred	Runoff Reduction
Dry Swales	Preferred	Runoff Reduction
Wet Swales	Preferred	Pollutant Removal
Constructed Wetland	Preferred	Pollutant Removal
Permeable Pavement	Acceptable	Runoff Reduction
Bioretention	Acceptable	Runoff Reduction
Small Scale Infiltration	Acceptable	Runoff Reduction
Soil Amendments	Acceptable	Runoff Reduction
Vegetated Roofs	Acceptable	Runoff Reduction
Filtering Practices	Acceptable	Pollutant Removal
Wet Ponds	Acceptable	Pollutant Removal
Grass Channels	Restricted	Runoff Reduction
Extended Detention Ponds	Restricted	Pollutant Removal
Large Scale Infiltration	Restricted	Runoff Reduction

Source: HRPDC. (2013). Land and Water Quality protection in Hampton Roads: Phase II: Hampton Roads Planning District Commission and VDEQ (2013). Virginia Stormwater Management Handbook, p. 6C1-6C27

There are five BMP practices that do not require a separation distance from the SHGT in both Virginia and North Carolina.[xxxvi] These BMPs include vegetative filter strips, green roofs, rainwater harvesting, constructed wetlands, and wet ponds.[xxxvi]

DEQ recommended developing BMP design specifications, particularly for tree BMPs and stream restoration (including regenerative stormwater conveyances). DEQ further recommended that more research be done to evaluate dune infiltration systems, and that design specifications for this BMP be produced after staff examination if necessary.[xxxiv] DEQ also suggested review and evaluation of BMPs that are not currently listed in the Virginia Stormwater BMP Clearinghouse but are used in other states. Based on their study, DEQ advised continued

evaluation of research findings, including design modifications and technological advancements that improve removal efficiencies for BMPs listed on the Virginia Stormwater BMP Clearinghouse. Additional research was advised for soil restoration, sand filters regarding lowering the separation distance (filtering procedures), and floating treatment wetlands, as well as the use of electronic sensors and other equipment to enhance the hydraulic performance of BMPs.[xxxiv] Revision of these designs would result in increased pollution load reductions and thus increased use of these BMPs in SHGT areas. Finally, treatment trains were discussed, which comprised of a sequence of BMPs that may be deployed in SHGT areas if the BMPs were non-infiltrating such as using a combination of constructed wetlands, swales, and manufactured treatment devices.[xxxiv]

However, in addition to the climate impacts on a SHGT, tidal communities in Virginia are particularly vulnerable to storm surge and floods from heavy precipitation, and these effects will be exacerbated as sea levels rise and the severity of rainfall events increases. Meanwhile, nuisance flooding that can inundate low-lying neighborhoods is becoming more common in tidal communities and affecting stormwater best management practices' capacities. While there are currently BMPs approved in the Commonwealth for the management of stormwater quantity and quality, these stormwater BMPs are currently not evaluated to address tidal and storm surge flooding impacts. Currently approved stormwater BMPs need further evaluation of their applicability in areas subjected to tidal and storm surge flooding, which could be examined as part of inter-agency collaboration within a Flood Resiliency Clearinghouse.

Natural and Nature-Based Infrastructure

HB 2187 requires that flood resilience solutions manage both water quality and flooding and emphasize nature-based solutions. In addition to safeguarding natural resources, nature-based solutions (generally referred to as Natural and Nature-Based Features, or NNBFs) for coastal resilience include the addition of designed habitats and restoration activities in areas where development has replaced natural features.[xxxvii]

Another similar term used is Green Infrastructure (GI), which is used to describe the creation and networking of natural ecosystems and greenway corridors such as forests and floodplains. Green infrastructure reduces and treats stormwater at its source.

Natural features, according to the VIMS Center for Coastal Resources Management (CCRM), are “features that develop through time as a result of processes that occur in nature, rather than as a result of human intervention”. These include coastal forests, beaches and sand dunes, tidal and non-tidal marshes.[xxxvii]

Nature-Based Features include the use of natural features (e.g., planted marshes, bushes, etc.) integrated with engineering structures (e.g., a rock sill or concrete-based oyster reefs) for risk reduction from coastal hazards and improvements in water quality.[xxxvii] Nature-based features include living shorelines, riparian buffer restoration, stream restoration and stormwater best management practices.[xxxvii]

Living shorelines have become the default approach for preserving coastal property and protecting shorelines unless "best available science" indicates they are not suitable for the site.[xi] VMRC sent a letter to localities telling them to update local ordinances to add "*a statement indicating whether use of a living shoreline as defined in § 28.2-104.1 for a shoreline management practice is not suitable, including reasons for the determination.*"

According to VIMS, living shorelines are "nature-based approaches to reduce erosion caused by waves, tidal currents and stormwater runoff". In addition to preventing erosion of shorelines and surrounding development, these stabilization measures create or restore natural shoreline ecosystems and ecosystem services.[xxxviii] Depending on the natural conditions that exist, several living shoreline techniques are employed. These include:

- Non-structural living shorelines such as tidal marshes, beaches, and shoreline forests enhance or create prominent natural features. Non-structural approaches are appropriate at sites with low to modest erosion rates, low wave energy, and few boat wakes.
- Marsh sills integrate natural and planted wetlands with sills, which are low-elevation stone constructions.[xxxviii] Wave energy is dissipated by sills, which cause waves to break on the offshore structure rather than the natural, more vulnerable beach.[xxxix]
- Shellfish reefs are used in conjunction with other practices to improve habitat diversity or as a replacement for stone sills. They thrive in areas with high natural shellfish productivity, such as native oysters and ribbed mussels.[xxxvii]
- Offshore breakwaters are appropriate along more exposed shorelines and serve to "break" the wave's force and dissipate energy, preventing the waves from eroding the beach or upland banks.[xl]

Coastal hazard mitigation and ecological benefits provided by the NNBF are summarized in Table 3.

Table 3. Coastal hazard mitigation and ecological benefits provided by the NNBF.

	Natural and Nature-Based Features						
Coastal Hazard Service	Dunes and Beaches	Wetlands	Maritime Forests/ Shrub Communities	Submerged Aquatic Vegetation (SAV)	Living Shoreline	Ecologically-Enhanced Revetment	Living Breakwater
Storm surge reduction	X	X*			X*	X*	X
Reduce peak flood height and lengthen time to peak flood	X	X	X	X	X	X	X
Breaking offshore waves		X		X			X
Wave energy attenuation	X	X	X	X	X	X	X
Reduce current velocities		X		X			X
Shoreline erosion/stabilization	X	X	X		X	X	X

*Potential storm surge reduction during smaller storm events.

Source: Dewberry. (2019)[xxxix] Nature-based coastal Flood Mitigation Strategies, Final Report submitted to City of Virginia Beach, Department of Public Works, VA Beach, VA

As noted earlier in the report, Code of Virginia § 28.2-104.1 defines a "living shoreline" 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*". This definition may prohibit the use of new shoreline technologies that reduce erosion and restore or enhance natural shorelines habitat. Innovative manmade shoreline protection techniques that reduce erosion and create or restore natural shoreline ecosystems and ecosystem services are currently approved for use in other coastal states. The Commonwealth needs to develop a review or approval process for these new technologies, and it will require cross-agency collaboration.

The Flood Resiliency Clearinghouse could provide the cross-agency collaboration needed for approval of these new technologies, including exploration of experimental permits to build and test innovative solutions that may include reefs and breakwaters. It is difficult for new technologies to move to market without an understanding of how they can or will be approved for use. Virginia has an opportunity to lead in the development and implementation of new technologies that manage both water quality and flooding and that emphasize nature-based solutions, and a Flood Resiliency Clearinghouse could support those opportunities.

Conclusion

While the Commonwealth has approved best management practices (BMPs) for stormwater quantity and quality management, these practices were not designed to withstand flooding impacts and have not been evaluated for flood control in the riparian and littoral zones. A Flood Resilience Clearinghouse could serve as a resource for promoting resilient shoreline solutions and facilitate cross-agency collaboration in evaluating and approving solutions that manage both water quality and flooding. In addition, the Clearinghouse could assist in the implementation of recent legislative and executive actions intended to increase resilience to climate-change-induced flooding, by serving as a comprehensive repository of information on relevant best management practices (BMPs) related to flood resiliency.

Numerous agencies and organizations in the Commonwealth, in addition to federal agencies, have overlapping roles that are particularly complex in the riparian and littoral zones, and each will play a critical role in coordinating the approval of BMPs and permitted activities. This is most evident in Virginia's coastal zone, where the management of tidal wetlands is governed by a multitude of state and federal laws and regulations, as well as agency guidelines and local ordinances. Most resource boundaries and resources are regulated by more than one agency, and each regulatory agency conducts reviews and grants permits.

The Clearinghouse has the potential to facilitate cross-agency collaboration to:

1) review and evaluate solutions that control both water quality and flooding, emphasizing nature-based solutions,
2) be a resource for flood resiliency solutions for use across agencies and sectors,
3) update flood resiliency solutions as new information and technologies are approved,

4) determine whether BMPs established for one purpose, such as flood protection in the riparian buffer, have an impact on water quality in adjacent waterbodies, and
5) ensure that BMPs are consistent with existing regulations and ordinances.

The application of currently approved stormwater BMPs in locations prone to tidal and storm surge flooding and with SHGT requires further investigation, which can be carried out as part of the inter-agency collaboration with the Flood Resiliency Clearinghouse.

Resource Needs

The development and maintenance of a Flood Resiliency Clearinghouse Program will require additional resources for the agencies involved in the effort. Below is a preliminary estimate of costs associated with the development and maintenance of a Flood Resiliency Clearinghouse. These costs are based on recommendations from representatives of the Virginia Stormwater BMP Clearinghouse, DCR, and DEQ, and include the development and maintenance of a website for the Flood Resiliency Clearinghouse, DCR and DEQ agency personnel to support cross-agency collaboration for development of a flood resiliency approval process, approval of flood resiliency solutions, and dissemination of approved flood resiliency solutions.
It does not include flood resiliency solution performance testing and/or certifications. It is assumed that performance testing and/or certifications will be completed by an established permit-granting agency of another state unless the Commonwealth establishes its own technology verification program. Examples of this include the NJDEP and Washington State's TAPE program as is the case of MTD approval programs. If performance testing and certifications are required to be completed by Commonwealth agencies, there will be additional costs associated with those efforts.

Table 4. Preliminary Estimate for Flood Resiliency Clearinghouse

Cost Type	Item Description	Estimated Cost
Start-Up		
	Website development	$150,000
	Agency support to develop and launch clearinghouse	
	Department of Conservation and Recreation (2 Full Time Equivalents (FTEs)	$250,000
	Department of Environmental Quality (2 FTE's)	$250,000
	Total Start-up Costs	**$650,000**
Annual		
	Website maintenance	$50,000
	Agency support to maintain clearinghouse	
	Department of Conservation and Recreation (2 Full Time Equivalents (FTEs)	$250,000
	Department of Environmental Quality (2 FTE's)	$250,000
	Total Annual Costs	**$550,000**

Recommendations

- A Flood Resiliency Clearinghouse is needed and would serve as a resource to support implementation of the recent legislative and executive actions designed to increase resilience to climate change-induced flooding in the Commonwealth.
- The General Assembly could enact legislation that directs all of the relevant agencies (DCR, DEQ, VDOT, VMRC, etc.) to establish a working group to thoroughly examine the development and maintenance of such a Clearinghouse and to consider:
    - the geographic scope (state-wide, Chesapeake Bay watershed, or coastal) and the programmatic/jurisdictional scope (tidal wetlands, non-tidal wetlands, Chesapeake Bay Protection Act, Virginia Silviculture Water Quality Law) of the BMPs to be included in the clearinghouse.
    - the functions and duties of the Clearinghouse (development of an approval process for flood resilience solutions, communication of approval process, cataloging of approved solutions, etc.)
    - a thorough legal review of the existing statutes, regulations and ordinances that would bear on the permitting of flood control measures in the riparian and littoral zones, to ensure consistency as needed.
- We further recommend that the interagency working group consider the following questions and recommendations.
    1. What management structure should be employed to run an interagency Flood Resiliency Clearinghouse?
    2. What is the relationship between the Flood Resiliency Clearinghouse and the Stormwater BMP Clearinghouse? Should they ultimately be housed on one Commonwealth website, for ease of reference by developers and citizens?
    3. What interagency protocols need to be established to evaluate the efficacy of existing and proposed BMPs that fulfill the water quality and flood protection requirements specified in HB 2187?
        3.1. Should these tasks specifically lie with the Clearinghouse or with a standing Interagency Working Group?
        3.2. How can the development, evaluation and approval of new, innovative solutions that reduce erosion and create or restore natural shoreline ecosystems that provide ecosystems services and protect water quality best be achieved?
    4. How would federal agencies with jurisdictional authority be incorporated into any BMP development and evaluation process?
- DCR should explore opportunities for collaboration with the United States Army Corps of Engineers (USACE) for technical and financial assistance related to flood resiliency BMPs. Applicable USACE programs include Planning Assistance to States, Floodplain Management Services, and the Silver Jackets program.
- The final recommendation is beyond the scope of this report but is included because it could be a benefit of cross-agency collaboration and would support the Commonwealth efforts in climate resiliency. All of Virginia's climate resiliency information should be consolidated into a single website, which could include: the Coastal Resilience Master

Plan, the Flood Resiliency Clearinghouse, the Stormwater BMP Clearinghouse, water quality information, information about Virginia's anticipated climate change impacts, updated Commonwealth intensity-duration-frequency (IDF) curves, information on riverine and coastal flooding issues, and VDOT's hydrological and hydraulic design guidelines. This would be an excellent resource for policymakers, state agencies, localities, businesses, and the public in implementing climate resilience practices. With adequate funding and organization, a Virginia Resiliency Clearinghouse could provide a consolidated, informative resource for those in the Commonwealth seeking to use flood control measures to increase resilience.

NOTES:

[i] See Appendix 1 for the Act.

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APPENDIX 1

VIRGINIA ACTS OF ASSEMBLY -- 2021 SPECIAL SESSION I

CHAPTER 150

An Act to direct study topics for the Commonwealth Center for Recurrent Flooding Resiliency.

[H 2187]

Approved March 18, 2021

Be it enacted by the General Assembly of Virginia:

1. *§ 1. That the Commonwealth Center for Recurrent Flooding Resiliency, as established by Chapter 440 of the Acts of Assembly of 2016, shall evaluate the development of a Flood Resiliency Clearinghouse Program (the Clearinghouse) for coordinating flood mitigation solutions.*

§ 2. The Commonwealth Center for Recurrent Flooding Resiliency shall work with the Department of Conservation and Recreation to evaluate solutions that (i) manage both water quality and flooding and (ii) emphasize nature-based solutions, including currently approved and not-yet-approved stormwater best management practices.

§ 3. The Commonwealth Center for Recurrent Flooding Resiliency shall by November 1, 2021, report the results of its findings to the Chairman of the House Committee on Agriculture, Chesapeake and Natural Resources and the Chairman of the Senate Committee on Agriculture, Conservation and Natural Resources.