CLIMATE CHANGE ADDENDUM TO MARYLAND'S PHASE III WATERSHED IMPLEMENTATION PLAN

Executive Summary

This climate load allocation Addendum to Maryland's Phase III Watershed Implementation Plan addresses Maryland's additional nutrient loads due to 2025 climate change conditions. It describes a strategy that offsets additional nutrient loads attributable to the impacts of climate change as determined and allocated by the Chesapeake Bay Program. An Appendix describes recent climate change related legislation, research, and incentives that are important to achieving Maryland's broader climate mitigation and adaptation goals.

To achieve the additional required load reduction of 750,000 pounds of nitrogen, Maryland will expand its wastewater sector strategy beyond the Phase III Watershed Implementation Plan wastewater reduction goal. Further improvements in the performance of Maryland's wastewater treatment plant operations are a viable solution to address the gap caused by the combination of the Chesapeake Bay watershed model updates and Maryland's additional nitrogen reductions required to offset impacts from 2025 climate conditions. The significant wastewater treatment plant statewide aggregate average nitrogen concentration goal should be reduced from 3.25 mg/l to a new goal of 2.85 mg/l. The Enhanced Nutrient Removal technologies used in Maryland's significant wastewater treatment plants are capable of and are already, in many cases, achieving concentrations lower than 3 mg/l of nitrogen.

Maryland can secure these additional wastewater reductions with performance incentive programs, including Bay Restoration Fund Operation and Maintenance grants. MDE will continue to incentivize plants to perform at optimal levels in order to account for the new climate change allocations.

This Addendum, along with 2022-23 milestones and a Bay model scenario that numerically demonstrates that the additional nutrient load reductions will address 2025 climate change conditions, was submitted to EPA by January 14, 2022.

I. Introduction and Background

This climate load allocation Addendum to Maryland's Phase III Watershed Implementation Plan (WIP), together with the 2022-2023 milestones, satisfies both EPA expectations and the requirement of Maryland's 2021 Stormwater Management Regulations and Watershed Implementation Plans - Review and Update Act (Subtitle 9 - Miscellaneous 4-901.(A)) to submit to EPA a WIP "climate load allocation addendum and updated 2-year milestones that fully offset additional nitrogen, phosphorus, and sediment loads attributable to the impacts of climate change as determined and allocated by the Chesapeake Bay Program."

The Chesapeake Bay TMDL and successive WIP planning targets were established based on 1995 climate conditions. In March 2018, the Chesapeake Bay Partnership Principals' Staff Committee (PSC), who represent the Chesapeake Bay jurisdictions, EPA and the Chesapeake Bay Commission, agreed that the Phase III WIPs would include a narrative strategy to address changes in climate between 1995 and 2025. As part of the same decision, the PSC agreed to refine the climate modeling and assessment framework based on improved understanding of the science of the impacts of climate change.

The partnership further committed to adopting revised numerical climate change targets by 2021 using updated versions of the Chesapeake Bay Program's (CBP) modeling tools. Changes were made to model inputs of rainfall, air temperature, wetland area, sea level rise, and ocean temperature and salinity. Watershed delivery of nitrogen, phosphorus, and sediment were modeled using improved processes to capture the effects of climate change on watershed loads. In 2020, the CBP revised and adopted the jurisdictions' climate change targets. More information on modeling and Maryland's WIP can be found in Section III of this Addendum.

At its December 17, 2020 meeting, the PSC approved the Partnership recommendation that jurisdictions will be expected to address additional nutrient loads due to 2025 climate change conditions in a Phase III WIP addendum and/or 2-year milestones beginning in 2022. EPA expects each jurisdiction to also submit a Bay model input scenario that numerically demonstrates that the additional nutrient load reductions will address 2025 climate change conditions. According to the CBP, sediment targets for 2025 climate change conditions will be developed after the overall modeling scenario addressing 2025 climate change is finalized.

This climate load allocation Addendum to Maryland's Phase III Watershed Implementation Plan (WIP) describes a strategy that offsets additional loads attributable to the impacts of climate change as determined and allocated by the Chesapeake Bay Program (CBP). The Appendix to this Addendum also describes recent climate change related legislation, research, and incentives that are important to achieving Maryland's broader climate mitigation and adaptation goals.

II. Chesapeake Bay TMDL WIP Climate Load Allocation Addendum

The strategy described in this Addendum addresses the load reduction gap between Maryland's Phase III WIP commitments and CBP climate change allocations. The Maryland Department of the Environment (MDE) and its local partners will implement the Addendum on or before December 31, 2025.

EPA expects Bay jurisdictions to account for 2025 climate change conditions in the Phase III WIPs, addendums, and/or two-year milestones. EPA stated that "unless they have already done so in their existing Phase III WIPs, jurisdictions will be expected to account for additional nutrient pollutant loads due to 2025 climate change conditions in a Phase III WIP addendum or two-year milestones beginning in 2022." In addition, EPA expects jurisdictions to submit 2022-2023 milestones by January 14, 2022 that include programmatic and numeric milestones

for key Best Management Practices. If a jurisdiction chooses to address climate change conditions via a Phase III WIP Addendum, it is due January 14, 2022.

A. Strategy to Fully Offset Additional Climate Change Loads by 2025

In its Phase III WIP, submitted to EPA in 2019, Maryland committed to additional nutrient load reductions beyond its Phase III WIP targets. The 2017 Bay watershed model used by CBP to evaluate Maryland's Phase III WIP indicated that the nitrogen load reduction achieved by implementing the WIP would provide a surplus of 1.0 million pounds of nitrogen and a surplus of 0.44 million pounds of phosphorus beyond the EPA targets. These additional reductions not only provided Maryland with a margin of safety, but more importantly, provided a surplus that could be applied toward achieving the anticipated climate change allocations.

In 2020, the CBP revised and adopted the jurisdictions' climate change targets. These revised CBP allocations require Maryland to reduce an additional 1.142 million pounds of nitrogen and 111,000 pounds of phosphorus per year to address Bay water quality impacts due to 2025 climate change conditions. The most recent version of the Bay watershed model (updated in 2019) indicates that after factoring in the revised climate change allocations, Maryland is now facing a nitrogen load reduction deficit of about 750,000 pounds per year, but still has a surplus reduction of about 218,000 pounds of phosphorus. Therefore, this climate strategy will focus on addressing the nitrogen load reduction deficit. See Section III for a more detailed explanation of the load reduction gap and model updates.

Maryland's Phase III WIP includes robust strategies that are achievable, balanced, and locally-driven, with implementation in the agricultural and wastewater sectors as the main drivers for nutrient reductions. To close the nutrient reduction gap described above, Maryland will expand on one of its wastewater strategies, the improvement of WWTP performance with grants and other incentives. This represents the most effective and timely strategy to ensure climate load reductions are fully implemented by the 2025 restoration deadline.

The Enhanced Nutrient Removal technologies used in Maryland's significant wastewater treatment plants (WWTPs) are capable of and are already achieving concentrations lower than 3 mg/l of nitrogen. Further improvements in the performance of the State's WWTP operations are a viable solution to address the gap caused by the combination of Chesapeake Bay model updates and Maryland's additional nitrogen reductions required to offset impacts from 2025 climate conditions. Using the Maryland Department of Planning growth rates by county, it is anticipated that the 2025 statewide significant WWTP (capacity > 0.5 million gallons per day (MGD)) annual flow will be around 600 MGD. For this aggregate flow, each reduction of 0.1 mg/L in nitrogen concentration in plant effluent yields a load reduction of about 180,000 pounds of nitrogen per year. To achieve a reduction of 750,000 pounds of nitrogen in the wastewater sector beyond the Phase III WIP wastewater reduction goal, the statewide aggregate average nitrogen concentration goal should be reduced from the Phase III WIP goal of 3.25 mg/l to a new goal of 2.85 mg/l.

Maryland can secure these additional WWTP reductions from two main performance incentive programs: the Bay Restoration Fund (BRF) Operation and Maintenance (O&M) grants and the Clean Water Commerce Act (CWCA). The most reliable and cost effective wastewater incentive program to achieve Maryland's Bay restoration goals by 2025, including the climate allocations, is the BRF O&M grant. MDE will continue to incentivize WWTPs to perform at optimal levels in order to account for the new climate change allocations. This O&M assistance will provide additional financial incentive to WWTPs, beyond the current base O&M grant, to achieve an aggregate average nitrogen concentration goal of 2.85 mg/l or less by 2025. As we approach the year 2025, if Maryland is not close to attaining the 2.85 mg/l aggregate average significant WWTP concentration goal, the shortfall should be addressed constructively by considering enhancements to these financial incentives. MDE will continue to provide incentives not only through the BRF O&M grant but also through the CWCA. See Section B for more information on the BRF and CWCA.

Planning to achieve these additional load reductions through pollution source sectors other than the wastewater source sector is difficult and costly. It is unrealistic that they would be able to complete the implementation necessary to address additional load reductions of this magnitude by 2025. With this expanded WWTP performance incentive strategy, Maryland will be achieving cost-effective nutrient load reductions. In addition to the cost savings, water quality is likely to improve in the near term, as better WWTP performance will result in rapid nutrient reductions from WWTPs and lower nutrient loads to the Bay. Maryland will continue to incentivize WWTP nutrient load reductions and agricultural best management practices to meet the 2025 restoration deadline, while the stormwater and septic sectors continue their steady progress and build the capacity to maintain those nutrient reductions beyond 2025.

The Appendix (attached) describes recent achievements and expected advances in stormwater management, including climate change resiliency strategies. Stormwater practices are expensive, do not reduce much nitrogen relative to wastewater and agricultural practices, and take longer to implement and produce environmental results; however, stormwater management practices provide important co-benefits, such as climate mitigation and adaptation, healthier communities and wildlife habitat that are not achieved with additional wastewater treatment. Maryland continues to prioritize implementation of green infrastructure, environmental site design, and natural filters to reduce flooding, heat island effect, increase resiliency, and to maintain our Bay restoration goals into the future. For more information on MDE's plans to update stormwater quantity standards and stormwater management regulations, please see the 2021 report Advancing Stormwater Resiliency in Maryland.

B. Bay Restoration Fund and Other Incentives

Maryland Senate Bill 320 (Bay Restoration Fund) (BRF) was signed into law on May 26, 2004. The main purpose of the bill was to create a dedicated fund, financed by wastewater treatment plant users, to upgrade Maryland's WWTPs with enhanced nutrient removal (ENR) technology so they are capable of achieving wastewater effluent quality of 3.0 mg/l total nitrogen and 0.3 mg/l total phosphorus. A similar fee paid by septic system users is utilized to reduce nitrogen loading to the Bay. As of June 2020, through its BRF Wastewater Fund, Maryland has

provided $1.314 billion in ENR grants to build ENR treatment facilities at significant WWTPs. As a result of these capital expenditures, the significant WWTPs (flow capacity > 0.5 MGD) received annual effluent limits of 4 mg/L of nitrogen and 0.3 mg/l of phosphorus in their discharge permits. To help in achieving these discharge permit limit concentrations, the BRF also provides funding as a grant for operation and maintenance costs (O&M) to WWTPs upgraded to ENR treatment levels. MDE is authorized to provide up to 10% of the BRF Wastewater revenue toward O&M grants.

These BRF O&M grants are given to WWTP facilities only after they achieve effluent concentrations lower than ENR levels. The grants are given every year after MDE analyzes the entire previous year discharge monitoring data for each facility. The ENR technologies used in Maryland's WWTPs have achieved concentrations lower than 3 mg/l of nitrogen and 0.3 mg/l of phosphorus. In 2021, the BRF regulations were amended and the BRF O&M grant can now be distributed in a way that pays for nutrient load reductions below the current grant threshold of 3.0 mg/l of nitrogen and 0.3 mg/l of phosphorus, providing additional grants to incentivize facilities achieving better than ENR.

In addition to the BRF grants already discussed, the Clean Water Commerce Act (CWCA) can also be used to incentivize additional nitrogen reductions for Maryland's WWTPs . The CWCA was designed to incentivize reductions below 3.0 mg/l of nitrogen and 0.3 mg/l of phosphorus. Some county-owned facilities have taken advantage of this incentive to achieve nutrient concentrations below the ENR limits.

III. More Information on the Chesapeake Bay Model and Phase III WIP

Maryland's Phase III WIP targets for Bay restoration are 45.8 million pounds of total nitrogen per year and 3.68 million pounds of total phosphorus per year. During the 2017 mid-point assessment, the CBP estimated that Maryland had achieved its aggregate phosphorus Phase III WIP target. Therefore, for the period 2021 to 2025, Maryland needs to focus specifically on nitrogen load reductions.

Implementation in the agricultural and wastewater sectors are the Phase III WIP's main drivers of nutrient reduction. Maryland's Phase III WIP nutrient reduction goals in the agricultural sector are 4.6 million pounds of nitrogen and 0.17 million pounds of phosphorus. For wastewater, by upgrading the last few major wastewater treatment plants (WWTP) and by incentivizing better WWTP performance with grant funding, load reductions in the wastewater sector are expected to achieve 4.7 million pounds of nitrogen and 0.12 million pounds of phosphorus per year. This results in a combined total Maryland Phase III WIP nitrogen reduction of 9.4 million pounds per year and a combined total phosphorus load reduction goals of 0.29 million pounds per year. Both reductions are above and beyond the EPA nutrient load reduction targets, under the 2017 Chesapeake Bay model assumptions. Specifically, the nitrogen load reduction achieved by implementing Maryland's Phase III WIP provided a surplus of 1.0 million pounds of nitrogen reduction above the 8.4 million pounds of nitrogen reduction required to meet the EPA nitrogen target, and a surplus of 0.44 million pounds of phosphorus reduction above the phosphorus EPA

target. These additional reductions not only provided Maryland with a margin of safety, but more importantly, provided a surplus that could be applied toward achieving the anticipated climate change allocations. Maryland's Phase III WIP demonstrated that the State had adequately planned for additional nitrogen and phosphorus loads associated with climate change under the 2017 Chesapeake Bay model assumptions.

Recent model updates, developed consistent with Partnership decisions and incorporating the latest science and information, were approved in 2020. The updated model (2019 model) had significant impacts on Maryland's Phase III WIP strategies. New model estimates show that the State will still meet its 2025 Phase III WIP planning targets, but there is insufficient reduction available to meet the additional load reductions associated with 2025 climate change conditions. The updated 2019 model indicates that after factoring in the recent climate change allocations, Maryland is now facing a nitrogen load reduction deficit of about 750,000 pounds, but still has a surplus load reduction of about 218,000 pounds of phosphorus. A comparison of the impacts of model revisions and climate change on Maryland's Phase III WIP goals is shown below.

	Nitrogen (pounds/year)		**Phosphorus (pounds/year)**	
	Phase III WIP Target 45,830,000		**Phase III WIP Target** 3,680,000	
	Phase III WIP Goal (2017 Model)	**Phase III WIP Goal (2019 Model)**	**Phase III WIP Goal (2017 Model)**	**Phase III WIP Goal (2019 Model)**
	44,666,425	45,435,828	3,233,970	3,351,247
Surplus Phase III WIP (Target – Goal)	1,163,575	394,172	446,030	328,753
Climate Change Allocation	1,142,000		111,000	
Surplus/Deficit (Phase III WIP + Climate Change)	21,575	***-747,828***	335,030	***217,753***

APPENDIX

This Appendix is provided for additional information. The Appendix is not part of Maryland's Climate Change Addendum to address additional nutrient load reductions attributable to climate change by 2025. These programs and initiatives will be implemented in conjunction with the strategy described in the Addendum.

Maryland Climate Accomplishments and Initiatives

The Addendum describes the strategy to reduce nutrient loads attributable to climate change; however, there is more to addressing climate change than nutrient reductions. This section describes recent legislation, research, and incentives that are important to achieving Maryland's long-term Chesapeake Bay goals.

Highlights of Accomplishments and Initiatives Since 2019 Phase III WIP

- **Offsetting Additional Pollution Due to Climate Change:** Maryland is finalizing a strategy to account for the reductions needed to offset predicted increases in nutrient loads caused by climate change by 2025. This will be provided in Maryland's Phase III WIP Load Allocation Addendum due to the EPA in January 2022.
- **Precipitation Research:** Maryland is closely engaged with researchers who are estimating the increased amount of rainfall in future storms, which will drive the design of resilient Bay restoration BMPs and other critical infrastructure.
- **Incentives and Funding:** Maryland agencies and other partners are revamping their grant and loan evaluation systems to give higher scores to funding requests that build climate resilience and climate co-benefits.
- **Accountability:** The Maryland Commission on Climate Change's Adaptation and Resiliency Workgroup has developed a draft Maryland Climate Adaptation and Resilience Framework that covers five key sectors and three intersectional focus areas that identify tangible goals, strategies and activities for future implementation and tracking.
- **Strategies by Sector:** All sectors, like agriculture, stormwater, wastewater and natural working lands are actively adapting programs and conducting pilot projects to mainstream climate change considerations into their business practices.
- **Legislative, Governance and Strategic Climate Frameworks:** Maryland's legislature has actively pursued climate change legislation that affects the planting of trees, stormwater management, flood control, the agricultural sector and resilience building in general. Maryland's Draft Climate Adaptation and ResilienceFramework proposes a suite of cross-framework priorities that provide direction, structure and accountability for implementing climate adaptation goals, many of which provide Bay restoration co-benefits.

Introduction

In August 2019, Maryland published its Phase III Watershed Implementation Plan (WIP) to restore Chesapeake Bay by 2025. At that time Maryland included a Phase III WIP section on Climate Change, which highlighted the imminent risks of climate change and identified strategies that address both climate change management and Bay restoration. Although the climate section of the Phase III WIP provided bay-wide estimates of the increased pollution loads resulting from climate change, it did not quantify the pollution strategies for reducing Maryland's share of those loads. Current estimates of these additional loads are presented below.

The Principals Staff Committee (PSC), who represent the Bay-state governors, agreed that Bay jurisdictions must begin accounting for these additional nutrient and sediment loads in their 2022-2023 two-year milestones, through a Phase III WIP addendum, or both. Maryland has decided to do both, and is referring to these collectively as the Phase III WIP Climate Change Update. Maryland's Phase III WIP Climate Update consists of the following three components: (1) an updated climate section of the Phase III WIP that identifies the climate accomplishments and new initiatives planned since the Phase III WIP; (2) identification and quantification of the pollution reduction strategies that will be implemented by 2025 to reduce the increased climate-driven nutrient loads; and, (3) by January 15, 2022, the 2022/2023 programmatic and numeric milestones that will be implemented over that two year period to begin addressing those increased climate loads and help meet Maryland's overall Chesapeake Bay restoration goals. This document represents the first of those three components.

Recent Accomplishments and New Initiatives:

Although it has only been two years since completing the Phase 3 WIP, Maryland can report several accomplishments and new initiatives. These are organized by the relevant sections of the 2019 Phase III WIP Climate Section.

Climate Trends and Updated Bay Nutrient Reduction Accounting

A variety of factors associated with climate change have an influence on how nutrients impact the dissolved oxygen of the Chesapeake Bay. These include sea level rise, increased water temperature and increased precipitation, which generates more nutrient laden runoff. The ocean water dilution caused by an estimated increase in volume of the Bay, due to sea level rise, is predicted to benefit water quality. However, increased temperature and runoff are predicted to degrade water quality in terms of dissolved oxygen. Modeling analyses conducted by the Chesapeake Bay Program since 2019 estimate these factors will lead to a net degradation of water quality, which will necessitate additional nutrient reductions.

The analysis predicts that an additional reduction of 5 million pounds/year of nitrogen and 600,000 pounds/year of phosphorus in the average annual loading rate, watershed wide, will be

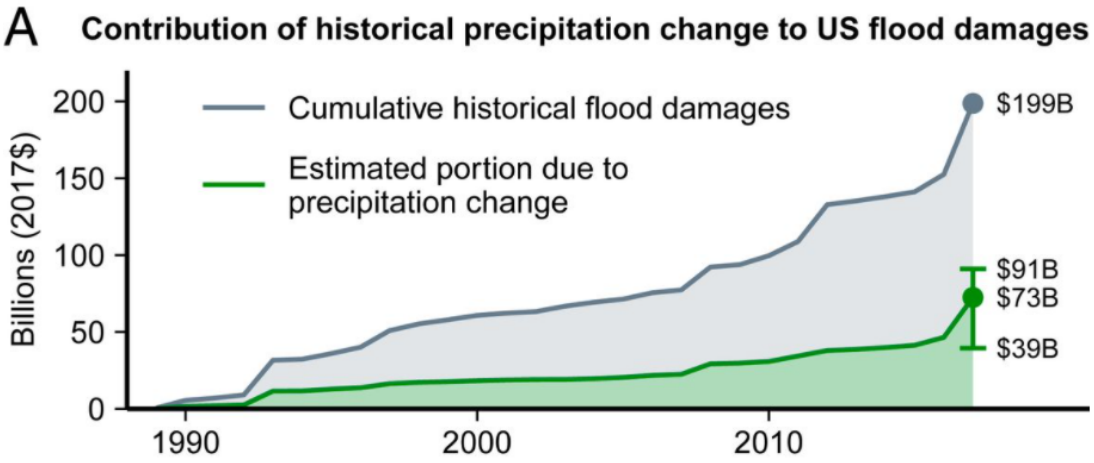
needed in 2025 to meet the water quality goals. This is predicted to increase to approximately 10 million pounds/year for nitrogen by 2035. The Bay states have agreed to begin adopting pollutant control strategies in 2021 to account for the reductions needed to offset these impacts caused by predicted climate change out to 2025. The following table shows the additional nutrient reductions by state.

Predicted Additional Reduction in Average Annual Loads to the Chesapeake Bay Needed to Meet Water Quality Goals that Account for Climate Change in 2025

State	Nitrogen (million lbs/yr)	Phosphorus (million lbs/yr)
District of Columbia	0.007	0.001
Delaware	0.039	0.003
Maryland	1.142	0.111
New York	0.399	0.044
Pennsylvania	1.811	0.095
Virginia	1.589	0.337
West Virginia	0.000	0.009
TOTAL	4.986	0.599

A strategy for achieving the additional reductions is provided in Maryland's Phase III WIP Load Allocation Addendum (Section I.A.).

As noted above, one of the primary threats posed by climate change to meeting water quality goals for Chesapeake Bay is increased precipitation. The 4th National Climate Assessment predicts increasing rainfall intensity in the Northeast U.S. as a result of climate change, particularly in the winter and spring seasons. Increased flooding is an indicator of this threat. Recent research findings suggest that a third of the $200 billion in flood damages over the past thirty years is due to climate change's effect on precipitation. This finding was published in the Proceedings of the National Academies of Sciences and is summarized in the figure below.



General Strategies

a. Climate Science and Research

Anticipated changes in precipitation due to climate change is a key driver of impacts to the Chesapeake Bay. For this reason it has been a priority for research and development.

Understanding Historical Changes in Storm Events. NOAA Atlas 14 Precipitation Statistics Update: Maryland has secured funding and a contract to update these important storm event statistics. This information is a primary basis for BMP design.

Probable Maximum Precipitation (PMP) estimates for Dam Safety: Maryland has secured initial funding to begin updating the PMP estimates that determine dam design standards. In addition to public safety, this will prevent breaches that damage streams and discharge pollutants. Dams are associated with some smaller urban stormwater and agricultural BMPs.

Predicting Changes in Future Storm Events: Several studies have been conducted to assess how the intensity, duration and frequency (IDF) of precipitation events (storms) might change in the future. This information will enable the assessment of impacts and development of adaptation options.

- Tetra Tech, Jonathan Butcher[1]. The study projected rainfall statistics for each of Maryland's 74 Atlas 14 stations for the years 2055 and 2085. These were used to assess the impacts and design implications for 1) Bioretention and extended wet detention BMPs, 2) Culverts and roadway flooding risk, and 3) Stream channel stability.

- Eastern Shore Land Conservancy. Charochak, et al.[2] The study developed rain intensity and depth curves for the Eastern Shore of Maryland as a 30-year average

[1] Butcher, Jonathan, Climate Impacts to Restoration Practices – Project Report, Prepared for the Chesapeake Bay Trust, September, 2020.

[2] Charochak, Michelle and James Bass, Preparing for Increases in Extreme Precipitation Events in Local Planning and Policy on Maryland's Eastern Shore. A report prepared for the Eastern Shore Climate Adaptation Partnership by Eastern Shore Land Conservancy, 2019. Principal technical investigator, Dr. Kaye L. Brubaker, University of Maryland.

centered on the period 2040 -2070. The study provided seven extreme precipitation policy recommendations for local communities.

- Chesapeake Bay Program, RAND/Carnegie Mellon/Cornell[3]. The project has developed projected probabilistic IDF curves for the Chesapeake Bay watershed states, which are hosted on the Mid-Atlantic Regional Integrated Science Assessments (MARISA) website.

Maryland's Plan to Adapt to Saltwater Intrusion and Salinization: Over the last century, the relative sea level in the Chesapeake Bay region has risen by about one foot, and is continuing to rise at an accelerating rate. This has a number of implications for the health of the Chesapeake Bay and associated management needs.

- Ongoing research is evaluating the potential for increased phosphorus loading from agricultural areas impacted by saltwater intrusion due to sea level rise. The Plan calls for the investigation of alternative crops, soil amendments, decision tools and farming practices as mitigation measures. The Plan also calls for research into the rate of loss of nitrogen and phosphorus from wetland soils and forested wetlands affected by saltwater intrusion, the rate of forest loss (due to combined effects of saltwater intrusion and sea level rise), and the longer term effects of ghost forests, migrating wetlands and new saltmarsh. Lastly, the Plan recommends a statewide wetland adaptation plan and the need to create wetland and forest migration corridors.

Living Shorelines: Maryland participated in securing grant funding and guiding consultants to research ways to increase the adoption rate of living shoreline methods for stabilizing eroding shorelines. One project involved social marketing research to assess what drives people's decisions on whether to adopt hardened shoreline or living shoreline practices. The second on-going project built upon the first to conduct research, design strategies, and improve materials to help shoreline property owners keep shorelines natural or adopt living shoreline methods of stabilization.

Coastal Marsh Adaptation: Maryland developed a grant funding proposal in 2020 to conduct a technical workshop to align research and management priorities for collaborative marsh adaptation to the impact of climate change. This project will consider how intentional marsh adaptation strategies can benefit Bay restoration goals.

b. Local Engagement

Public review of MDE a) Construction Stormwater General Permit, b) Industrial Stormwater General Permit.

Maryland Climate Adaptation and Resilience Framework: Local stakeholders were involved in the development of the draft Framework during 2020-21.

Maryland Climate Leadership Academy: MCLA will have hosted three virtual cohorts in 2020 (Summer, Fall, Winter) and four virtual cohorts by the end of 2021 (Spring, Summer, Fall, Winter). The Spring 2020 cohort successfully transitioned to finish virtually after

[3] Miro, M., DeGaetano, A., Samaras. C., Romita Grocholski, K., López-Cantú, T., Webber, M., Eck, B. (2021). "Projected Intensity-Duration-Frequency (IDF) Curve Tool for the Chesapeake Bay Watershed and Virginia". Northeast Regional Climate Center.

COVID-19 prevented completing it in person as it had started. Four sector specific webinars developed and offered through the Academy. 1) Energy Efficiency and Conservation (Oct. 23, 2020); Clean Fuels and Transportation & Maryland Smart Energy Communities (Nov. 9, 2020); 3) Environment and Climate Tracking Tools (Nov. 13, 2020); and MEMA Hazard Mitigation Programs Webinar (April 7, 2021).

In 2020 MDE conducted design and construction workshops focused on small ponds to ensure these stormwater management and erosion and sediment control basins and their dams are resilient to changing climate conditions.

c. Incentives and Funding

In 2021, EPA approved MDE's revisions to the Integrated Project Priority System (IPPS) criteria that give credit for projects with climate change mitigation and adaptation co-benefits. The IPPS is used to score proposed projects that seek water quality capital grants and loans from MDE. Extra points are now provided for projects in communities that are part of the FEMA flood mitigation Community Rating System (CRS), in flood prone areas identified in local hazard management plans, to mitigate public health and safety from hazards posed by flooding and climate change or that more generally have climate mitigation, adaptation and resiliency co-benefits. These climate-related criteria apply to about $230 million/year in grants and loans.

Resiliency through Restoration: This program, managed by Maryland DNR, has funded 19 nature-based community resilience for design, permitting, or construction since adoption of the Phase III WIP.

Coast Smart Construction Program (CSCP): This program protects state funded infrastructure projects from climate impacts. The guidelines for this program were updated effective Sept. 1, 2020. The guidelines include the updated Coast Smart Climate Ready Action Boundary with a mapper, which increases the resiliency protective factor for the CSCP.

Maryland's Innovative Technology Fund: The following climate research and development grants and seed investments have been initiated since the WIP was developed: Neighborhood Sun, DataKwip, Dynamhex, International BioRefineries, SolarCube, SVE Technology, ActiveCharge, Great Alga.

Water Quality and Climate Change Resiliency Portfolio: This project portfolio initiative is intended to line up projects to make Maryland more competitive for federal capital funding. The draft Resiliency Opportunity Zone Analysis (ROZ) targeting framework has been completed. The ROZ will be used to identify communities for developing area specific water quality and climate change project portfolios.

Building Resilient Infrastructure and Communities (BRIC): This new FEMA flood mitigation grant provides opportunities to install green infrastructure that both mitigates flooding and benefits the Chesapeake Bay. Since the WIP was developed, State agencies have begun aligning programs with this federal grant ($0.5B available in 2020, $2B in 2021).

Dam Emergency Repair Funding:The physical integrity of dams, which include some urban and agricultural BMPs, is vital to water quality protection in addition to public safety. MDE is actively exploring options for funding emergency dam repairs for private owners who lack the financial capacity. These include use of linked deposit mechanisms to help private borrowers receive lower interest rates from private lenders, partnering to generate environmental credits associated with the benefits of a dam removal, and partnering to install renewable hydropower generating capacity to help fund the dam upgrades.

The following funding initiatives are described under the “Legislative Initiative” section below: Resilience Authority and the Comprehensive Floodplain Management Program.

d. Accountability

The Maryland Coastal Adaptation Report Card, which includes fifteen indicators that measure progress on various climate adaptation and resilience goals, is planned for release by the end of the calendar year 2021. The indicators, and Report Card overall will provide a measurement tool for climate adaptation and resilience efforts in the coastal zone of Maryland, many of which are closely associated with Bay restoration.

See Maryland’s Draft Climate Adaptation and Resilience Framework under the “Climate Change Plans and Strategies" section below. The Framework provides direction, structure and accountability for implementing climate adaptation goals as one of its core elements.

Strategies by Sector

a. Agriculture

Further development of MDA’s Healthy Soils Program, including:

- Two grants providing direct financial and technical assistance to producers to implement soil health practices. The first grant, funded by USDA, is fully obligated and MDA is working with federal partners to renew project funds. The second grant, funded by the National Fish and Wildlife Foundation (NFWF), is enrolling for Year 2 with ~3,500 acres to date. Both grants involve a data component to evaluate nutrient reductions and track soil health changes through multiple metrics.
- Establishment of the MDA Soil Health Advisory Committee. The Committee meets at least quarterly to guide the Department of Agriculture's program and incentive structure consistent with the goals of HB 1063.
- Partnering throughout the Bay watershed to increase outreach and funding assistance for soil health.

MDA is co-leading a state team at US Climate Alliance to focus on the role of natural and working lands as part of the climate solution.

Collaborating with MDE and DNR on best methods to account for soil carbon within the state’s GHG inventory, as a co-benefit to best management practices.

MDA became the first state agency to endorse the U.S. Farmers and Ranchers in Action (USFRA) Decade of Ag Vision.

Pilot Programs and Programmatic Expansion:

- Expansion of cost-shared eligible practices, encouraging the installation of woody vegetation in and along fields -serving as natural filters in order to improve water quality by filtering runoff and reducing soil erosion, as well as sequester carbon from the atmosphere and improve soil health, all while creating biodiversity and wildlife habitat.
- The department undertook a 2021 Conservation Buffer Initiative pilot to encourage and accelerate conservation buffers along streams and field ditches by offering more flexible contract lengths and site management than federal or state programs.

Maryland Clean Water Commerce Outcomes Project: Sand County Foundation partner-led Alternative Funding Arrangement (AFA) component of the Regional Conservation Partnership Program (RCPP). The project "will help scale up the pay-for-performance program and expand access to nutrient reduction funding to more producers, including historically underserved producers. Many of the practices and systems implemented by farmers to improve water quality in the Chesapeake Bay watershed will have climate co-benefits." More

b. Wastewater Treatment Plants

Numerous local governments, with State financial assistance, have undertaken planning, design and construction of projects to reduce inflow and infiltration (I & I). This will help preserve future wastewater treatment capacity and effectiveness as climate change is predicted to increase I & I.

MDE is developing permit special condition language to manage for peak flow events and other threats associated with climate change.

c. Onsite Sewage Disposal Systems

MDE has invested effort into resolving emerging failures of bermed infiltration pond (BIP) onsite sewage systems, which are experiencing problems due to increased rainfall and water tables.

d. Urban/suburban stormwater and E&SC

Construction Stormwater General Permit (20-CP): In response to public comments on the draft Construction SW GP, the Department will address shifting expectations for engineers, and others responsible for sediment and erosion control by accounting for the impacts of climate change in terms of "the expected amount, frequency, intensity, and duration of precipitation", as the State's ESC Handbook and Design Manual are updated (see the amendments to the Stormwater Quantity Control Standards being proposed below) with new state standards. The Construction GP now allows the use of cationic chemical additives that promote the clumping of fine sediments, which increases the effectiveness of settling and filtering processes that control sediments. The Construction GP also

includes the concept of Steam Protection Zones, consisting of a natural buffer from the site's earth disturbances to the edge of the stream and more robust control practices. The permit also requires a SWPPP to address pollutants that are not currently addressed in E&SC or SWM plans. Climate change will potentially increase runoff of these pollutants, and thus a renewed focus on all potential pollutants provides a more robust permit.

Industrial Stormwater General Permit (20-SW): The new Industrial GP calls for siting of new structures and stored material at higher levels to avoid flooding. In response to public comments on the draft Industrial SW GP, the Department will address adapting operations and updating pollution prevention measures based on ongoing changes in climate. The permit requires minimization of polluted discharges and ongoing monitoring for potential impacts from stormwater discharges. It also informs permittees that operations within the floodplain may require additional permit coverage and may justify flood insurance in those flood-prone areas, especially due to climate change effects on increased frequency of flooding.

Stormwater Phase I MS4 Impervious Cover Restoration Goals: The goals for future MS4 permits are to reach 40% restoration by 2030 and 50% by 2035, which is consistent with the Maryland's Phase III Watershed Implementation Plan and the overall pace local jurisdictions' restoration to date.

Stormwater Quantity Control Standards: 2021 amendments to Maryland's Stormwater Management Law required MDE to provide a plan to the Maryland General Assembly, by November 1, 2021, for updating the State's stormwater quantity controls standards and codified certain Bay Restoration actions. The report, Advancing Stormwater Resiliency in Maryland (A-StoRM): Maryland's Stormwater Management Climate Change Action Plan, includes the following:

- Precipitation Data: Plans to update historical storm event data (Atlas 14) and the latest information about forecasted storm event statistics that account for climate change.
- Plans for Updating Quantity Control Standards: The plan includes collaborating with local governments to clearly define a flooding event, and identify watersheds with flood prone areas. MDE will lead a stakeholder consultation process for updating Maryland's stormwater quantity control standards.
- Flood Management: The plan identifies the role of Maryland's 1976 Flood Hazard Management Act in an integrated stormwater and flood control management framework.
- Financial Considerations: The plan begins to lay out financial considerations for a comprehensive planning approach to preventing flooding before it occurs and minimizing its impacts where it cannot be prevented.
- Action Schedule: The plan provides a three-phase action plan covering the period from the present through 2023.

In addition to enhancing stormwater quantity controls, this process is intended to counteract the anticipated increased pollution impacts of climate change. This will likely be achieved by strengthening the resilience of stormwater controls and conveyance networks, improving stormwater control pollutant removal efficiencies, and by enhancing inspection and maintenance procedures. Incentives are also provided in the stormwater accounting

guidance to capture more stormwater through green infrastructure practices that will treat and infiltrate stormwater runoff, while also providing carbon sequestration and flood prevention benefits.

e. Conservation and Natural Working Lands

Marylanders Plant Trees supported 5,293 trees and shrubs in 2019 and 3,781 in 2020. 2021 is still underway.

Natural Filters Program: Natural Filters program has a renewed focus on state land projects, working closely with DNR Park staff to assess watershed restoration needs and pursue successful projects.

See: The Tree Solutions Now Act under Legislative Initiatives.

Legislative, Governance and Strategic Climate Frameworks

a. Legislative Initiatives

Local Resilience Authority - Authorization SB457/HB538 (2020). Local governments can establish resilience authorities that provide more flexibility to finance climate resilience projects. As an example, Charles County, Maryland, has adopted an authority and is considering using the authority to fund repair and enhancements to stormwater conveyance pipes that are failing widely across the County.

The Tree Solutions Now Act HB991 (2021) requires the State to plant 5 million trees in eight years, including 500,000 in urban underserved areas, starting in 2023. This is likely to result in planting between twelve and fourteen thousand acres by 2031. However, recent trends in land use change may offset these gains in forest area. Observing the trends of past Maryland Forest Healthy Surveys coastal forests are being impacted by sea level rise and salinization at a growing rate. The loss of coastal forest often results in the creation of wetlands, which partially mitigates the loss of forest carbon. Global Forest Watch forest change data indicates inland forest is also being lost, most likely to development. The Tree Solutions Now Act requires a study of recent trends in Maryland forests.

Department of Transportation Urban Tree Program SB359/HB80 Establishes a program to develop an urban tree program to replace trees removed during the construction of certain transportation projects.

Stormwater Management Law: Per amendments adopted per SB227/HB295 (2021):

- MDE is required to submit to the U.S. Environmental Protection Agency a Chesapeake Bay total maximum daily load phase 3 watershed implementation plan climate load allocation addendum to fully offset additional nitrogen, phosphorus, and sediment loads attributable to the impacts of climate change as determined by the Chesapeake Bay Program. MDE must also update 2-year milestones for 2022/2023 that identify actions during that period to make progress toward meeting the climate load allocation addendum goals in 2025.

- MDE was required, by November 1, 2021, to provide the Maryland General Assembly a plan for updating water quantity control standards, which will benefit water quality in addition to flood control. See: Advancing Stormwater Resiliency in Maryland (A-StoRM) Maryland's Stormwater Management Climate Change Action Plan.

Comprehensive Floodplain Management Program (CFMP): Between FY 2020 - FY 2022 Governor Hogan and the Maryland General Assembly authorized over $34 million in capital funding for flood mitigation, which can have Bay restoration co-benefits.

b. Governance Structures for Managing Climate Change

New Climate Justice Subgroup of the Maryland Commission on Climate Change intended to ensure climate activities of the commission are just and equitable.

c. Climate Change Plans and Strategies

Maryland's Draft Climate Adaptation and Resilience Framework: The Maryland Commission on Climate Change's Adaptation and Resiliency Workgroup (ARWG) leading a process to develop a framework for implementing climate adaptation goals among five sectors: Human Health, Water Resources, Protecting Critical Infrastructure, Working Lands & Natural-Resources-Based Economics and Natural Resources & Ecosystems. In addition to the five sectors are three cross-cutting focus areas: Justice, Equity, Diversity & Inclusion, Local Government Action & State Service Delivery, and Climate Jobs & Training.

Maryland's Ocean Acidification (OA) Action Plan - 2020: This plan highlights the Chesapeake Bay WIP as one of two major strategies for controlling the causes of an acidification trend in the Chesapeake Bay.

Maryland's Plan to Adapt to Saltwater Intrusion and Salinization - 2019: This plan provides research and adaptation recommendations based on Maryland-specific impacts of saltwater intrusion and salinization on Aquifers, Surface Waters, Agriculture, Coastal Wetlands, Coastal Forests and Infrastructure.

Under the leadership of the Maryland Department of Planning, State agencies are updating guidance for the Water Resources Element of Local Comprehensive Plans to ensure land use planning considers climate impacts to water quality and quantity.

Two Forest Stewardship Plans for drinking water reservoirs are being developed to increase climate adaptation of the protective forest around source waters, coordinating with Northern Institute of Applied Climate Science. These plans will inform other local government planning for watershed management in source water watersheds.

MDA, MDE and Harry Hughes Center, as the lead, will conduct an assessment in preparation for a study on Maryland agriculture's vulnerability to climate change, and identify the stakeholders who should be involved in planning for the future.

In 2020 MDE revised Maryland's Greenhouse Gas Reduction Act (GGRA) strategy to meet a new statutory goal of 50% reduction by 2030 from the 2006 baseline, which is a stretch goal beyond the statutory goal of 40%. The GGRA strategy includes many carbon

sequestration methods that align with Bay restoration practices like afforestation and agricultural practices that build healthy, carbon rich soil.

Challenges and Opportunities

The nonstationarity of climate change and its impacts is a major challenge; increased nutrient and sediment loads reflected in this WIP Update only account for projected changes up to 2025. Further increases in loads due to climate change are anticipated beyond 2025 for which Bay states will need additional load reduction strategies.

Meeting this challenge will benefit from rapidly growing awareness of the need to reduce greenhouse gases (GHGs) and build resilience to the impending impacts of climate change. Many of the carbon sequestration strategies for controlling GHGs, like actions that build healthy agricultural soils, tree planting and forest management, seagrass and tidal marsh restoration (blue carbon sequestration), and others have concomitant benefits for Bay restoration and building climate resilience, e.g., flood mitigation. In addition to tackling many societal problems at once, the multiple benefits gained by investing in these activities translates into a more persuasive benefit/cost evaluation.

The urgency that informed federal policy makers are beginning to place on responding to the climate change crisis has a good chance of generating more federal resources in the fairly near term. This opportunity will come with new challenges of scaling up the capacity to effectively administer those resources and implement tangible actions on the ground. Fortunately, given Maryland's history of doing that as part of the decades long Bay restoration process, our State is well positioned to rise to that challenge.