Climate Change and the Chesapeake Bay TMDL

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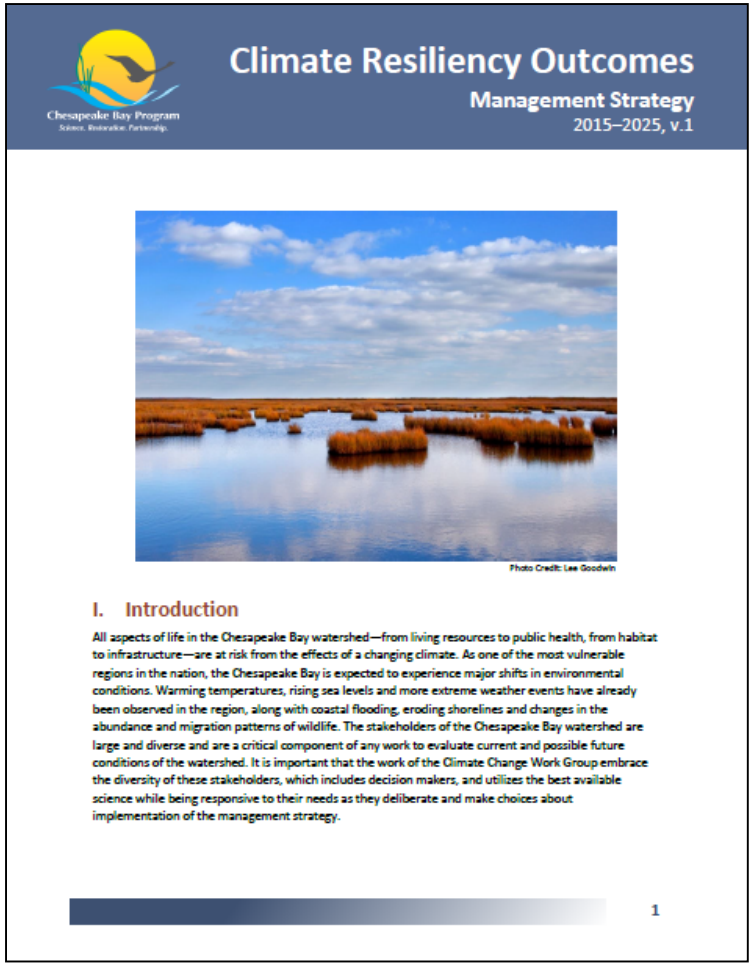
Key Partnership Climate Change-Related Commitments and Recommendations

- *2010 Chesapeake Bay TMDL*
- *2010 Executive Order 13058: Strategy for Protecting and Restoring the Chesapeake Bay Watershed*
- *2014 Chesapeake Bay Watershed Agreement*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Climate Resiliency Outcomes
Management Strategy
2015–2025, v.1

Photo Credit: Lee Goodwin

I. Introduction

All aspects of life in the Chesapeake Bay watershed—from living resources to public health, from habitat to infrastructure—are at risk from the effects of a changing climate. As one of the most vulnerable regions in the nation, the Chesapeake Bay is expected to experience major shifts in environmental conditions. Warming temperatures, rising sea levels and more extreme weather events have already been observed in the region, along with coastal flooding, eroding shorelines and changes in the abundance and migration patterns of wildlife. The stakeholders of the Chesapeake Bay watershed are large and diverse and are a critical component of any work to evaluate current and possible future conditions of the watershed. It is important that the work of the Climate Change Work Group embrace the diversity of these stakeholders, which includes decision makers, and utilizes the best available science while being responsive to their needs as they deliberate and make choices about implementation of the management strategy.

1

2014 Chesapeake Bay Watershed Agreement

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CLIMATE RESILIENCY

GOAL: Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure and communities, to withstand adverse impacts from changing environmental and climate conditions.

- **Monitoring and Assessment Outcome:** Continually monitor and assess the trends and likely impacts of changing climatic and sea level conditions on the Chesapeake Bay ecosystem, including the effectiveness of restoration and protection policies, programs and projects.

- **Adaptation Outcome:** Continually pursue, design and construct restoration and protection projects to enhance the resiliency of Bay and aquatic ecosystems from the impacts of coastal erosion, coastal flooding, more intense and more frequent storms and sea level rise.

2014 Chesapeake Bay Watershed Agreement

Climate Resiliency

2017 & 2025 WIP Outcomes

- By 2017, have practices and controls in place that are expected to achieve 60 percent of the nutrient and sediment pollution load reductions necessary to achieve applicable water quality standards compared to 2009 levels

- By 2025, have all practices and controls installed to achieve the Bay's dissolved oxygen, water clarity/submerged aquatic vegetation and chlorophyll a standards as articulated in the Chesapeake Bay TMDL document.

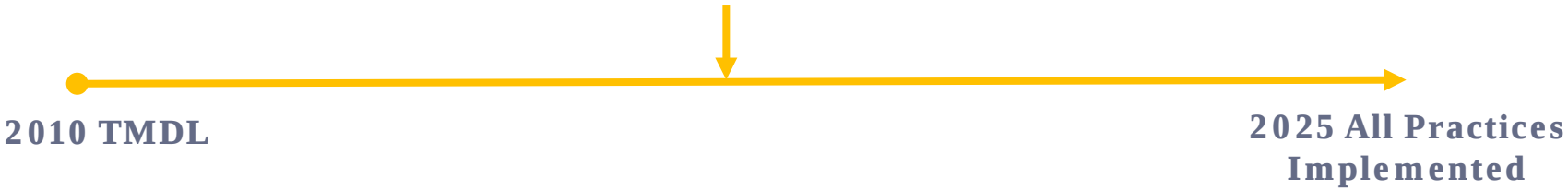
Elements of a WIP:
A Roadmap to Achieve Water Quality Standards

- Phase I WIP and Phase II WIPs were developed and submitted to EPA in 2010 and 2012, respectively.
- These documents focused on the following elements:
  - Interim and final N, P, and SED Target Loads
  - Current Loading Baseline and Program Capacity
  - Account for Growth
  - Gap Analysis
  - Tracking and Reporting Protocols
  - Contingencies
  - Appendix w/ Detailed Targets & Schedule

What's Different in Phase III WIPs?

- Programmatic and numeric implementation commitments for 2018-2025
- Strategies for engagement of local, regional and federal partners in implementation
- Account for changed conditions: climate change, Conowingo Dam infill, growth
- Develop, implement local planning goals below the state-major basin scales
- Use of Phase 6 suite of modeling tools, expanded monitoring and trends data
- Consideration of co-benefits of BMPs

Chesapeake Bay TMDL
2017 Mid-Point Assessment



Goal: Determine whether the implementation the CBP Partnership's restoration strategies by 2025 will achieve water quality standards in the Bay.

Objective: Make this determination based on the best available science data, tools, Best Management Practices (BMPs), and lessons-learned.

Commitment: Conduct a more complete analysis of climate effects on nitrogen, phosphorus, and sediment loads and allocations in time for the mid-course assessment of Chesapeake Bay TMDL progress in 2017.

Climate Change & the TMDL Mid-Point Assessment
3 Components

#1
Climate Change Impact Assessment

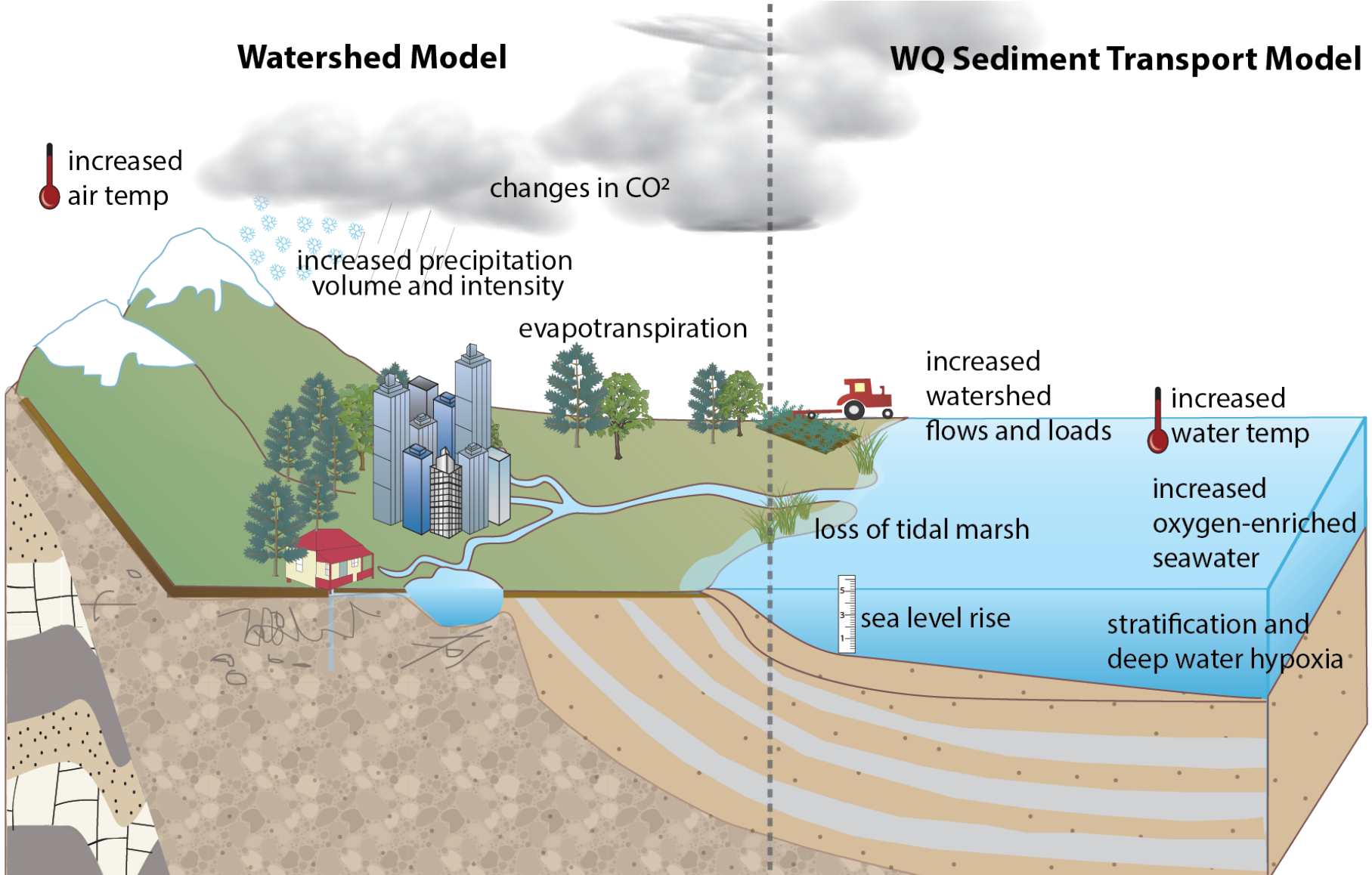
#2
Policy Provisions

#3
Guiding Principles for Phase III WIPs

Component #1:
Climate Change Assessment

Accounting for Changing Conditions

(1995-2025)

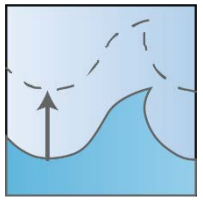


To Limit Uncertainty

- The Partnership used STAC recommended projections for 2025 that have a high level of confidence[1]
- Selection of projections for sea level rise and precipitation change were based on past records of observed climatic and resultant river flow conditions
- Downscaled temperature projections for 2025 are closely aligned with observed trends

1. CBP Scientific and Technical Advisory Committee. 2016. The Development of Climate Projections for Use in Chesapeake Bay Program Assessments. March 2016 Workshop.

Major Climate Variables: 2025 Projections

 Relative Sea Level Rise	17 centimeters	Extrapolation of NOAA observed sea level trends (Swells Point, VA)
 Temperature Increase	1.98° F / 1.1° C Increase	Downscaled climate projections (RCP 4.5)
 Precipitation Change	3.1% Increase	Observed trends in 88-years of annual PRISM[1] data

Accounting for Changing Conditions

Cumulative Assessment of Bay Low Dissolved Oxygen Impacts

Watershed Model

increased precipitation volume =

increased precipitation intensity =

increase in temp and evapotranspiration =

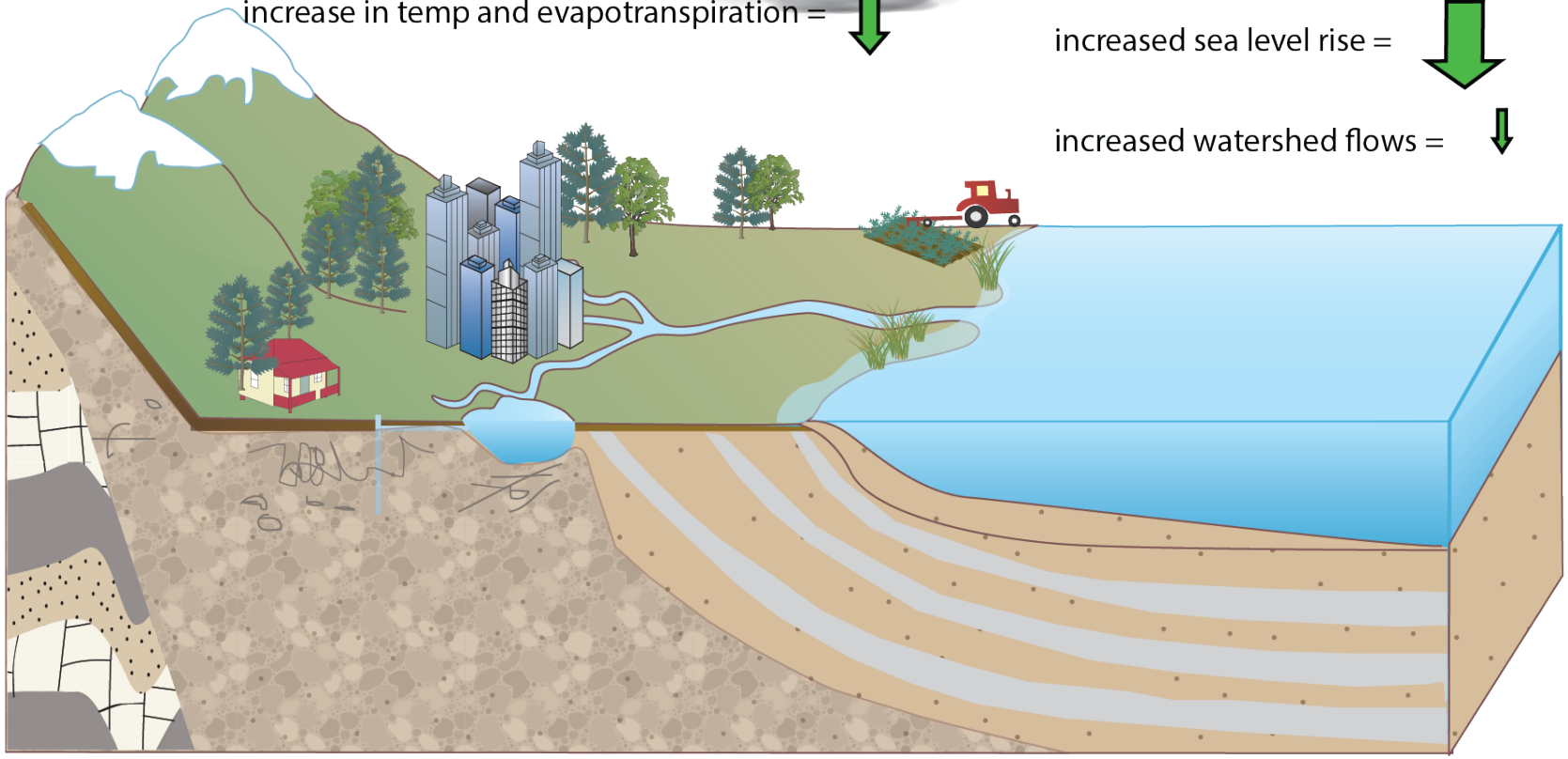
WQ Sediment Transport Model

increased watershed loads =

increased temperature =

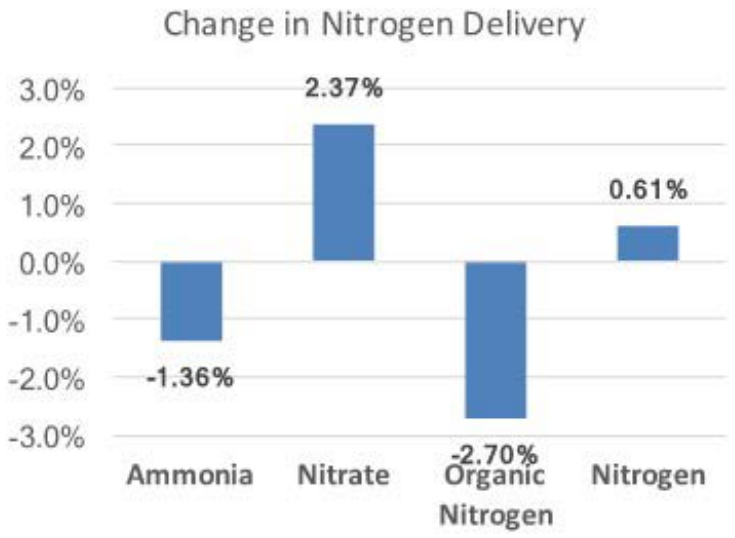
increased sea level rise =

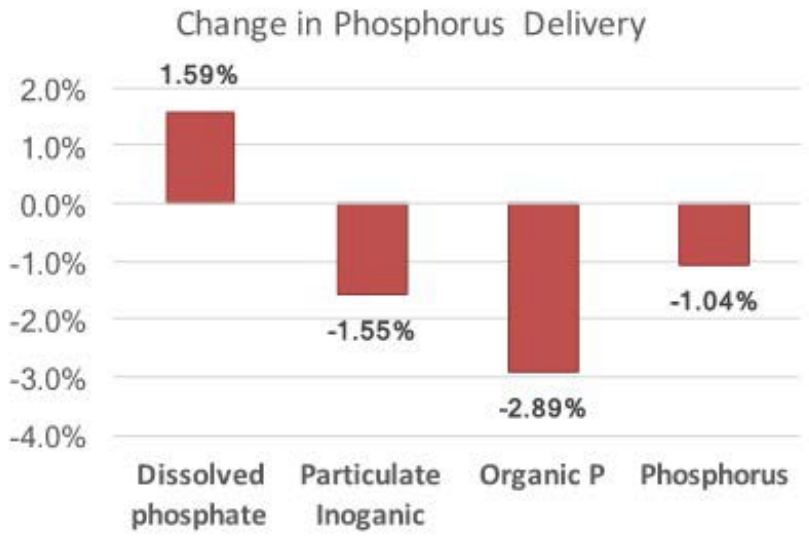
increased watershed flows =



Estimated Changes in Watershed and Bay Loads by 2025 Due to Climate Change

- Total nitrogen and phosphorus are expected to stay about the same
- Dissolved nitrate and phosphate have a strong effect on dissolved oxygen and increase with climate change
- Ammonia decreased as a percentage, but the absolute amount is small
- Organic nutrients decrease, but they have a weak effect on dissolved oxygen





Climate Change Loads: Nitrogen

Jurisdiction	Draft Phase III Planning Target*	Climate Change
NY	11.59	0.400 (3.8%)
PA	73.18	4.135 (5.7%)
MD	**45.30**	**2.194 (4.8%)**
WV	8.35	0.236 (3.7%)
DC	2.43	0.006 (0.3%)
DE	4.59	0.397 (8.5%)
VA	55.82	1.722 (3.1%)
Basinwide	**201.25**	**9.09 (4.6%)**

*Units: millions of pounds

Climate Change Loads: Phosphorus

Jurisdiction	Draft Phase III Planning Target*	Climate Change
NY	0.606	0.014 (2.9%)
PA	3.073	0.141 (4.7%)
MD	**3.604**	**0.114 (3.2%)**
WV	0.456	0.019 (3.9%)
DC	0.130	0.001 (0.8%)
DE	0.120	0.006 (5.1%)
VA	6.186	0.193 (3.0%)
Basinwide	**14.173**	**0.489 (3.4%)**

*Units: millions of pounds

Component #2: Policy Provisions

Policy Questions

- What are the policy options to address projected climate impacts on water quality?
- How will climate impacts affect the effectiveness of existing water quality best management practices over time?
- Do some water quality management practices also help to reduce other impacts associated with climate change and extreme events?

1. Incorporate Climate Change in the Phase III WIPs

- Include a **narrative strategy** in the Phase III WIPs that describes the state and local jurisdictions' current action plans and strategies to address climate change and **commit to adopting climate change targets by 2021**, employing the Partnership's suite of models that factor in climate change and other relevant local information.
- Acknowledging the challenges that lie ahead, **reference the preliminary modeling estimates attributable to climate change** by 2025 to be roughly an additional 9 million pounds of nitrogen and 0.5 million pounds of phosphorus.

2. Understand the Science

- By refining the climate modeling and assessment framework, continue to sharpen the understanding of the science, the impacts of climate change, and any research gaps and needs.
- Develop an estimate of pollutant load changes (nitrogen, phosphorus, and sediment) due to 2025 climate change conditions.
- Develop a better understanding of BMP responses, including new, enhanced and resilient BMPs, to better address climate change conditions such as increased storm intensity.
- In March 2021, the Partnership will consider results of updated methods, techniques, and studies and refine estimated loads due to climate change for each jurisdiction.
- In September 2021, jurisdictions will account for additional nutrient and sediment pollutant loads due to 2025 climate change conditions in a Phase III WIP addendum and/or 2-year milestones beginning in 2022.

3. Incorporate into Milestones

- Starting with the 2022-2023 milestones, the Partnership will determine how climate change will impact the BMPs included in the WIPs and address these vulnerabilities in the two-year milestones.

Component #3: Guiding Principles for Phase III WIPs

Guiding Principles
Phase III WIP Development

- **Capitalize on "Co-benefits"** – maximize BMP selection to increase climate resiliency
- **Account for and integrate planning and consideration of existing stressors** – consider existing stressors in establishing reduction targets or BMP selection
- **Align with existing climate resilient plans and strategies** – document jurisdictions' action plans and strategies to address climate change
- **Manage for risk and plan for uncertainty** – employ risk management and flexible implementation strategies to achieve and maintain water quality standards
- **Engage Local Agencies and Leaders** – work cooperatively with local partners to provide best available data on local impacts

Guiding Principles
Phase III WIP Implementation

- **Reduce vulnerability** – use “Climate Smart” principles to site and design BMPs

- **Build in flexibility and adaptability** – allow for adjustments in BMP implementation to consider potential uncertainties and response options

- **Adaptive manage** – allow for changes in BMP selection or WIP implementation over-time

Resilient BMPs:
Good Risk Management

"Risk management is critical in any restoration project. Risks include those associated with climate patterns, such as more intense storms, as well as those associated with land use change, site selection, and design. Addressing these risks in conjunction with ongoing restoration efforts will prepare communities for greater variability and may result in cost savings and reduced risk. (MD DNR 2013)"

Characteristics of Resilient BMPs

- ***Sensitivity*.** Is the BMP and its performance sensitive to the range of potential changes in climate, weather or resultant hydrologic and water quality changes? Sensitivity refers generally to system response to a change in a driver (e.g., temperature, precipitation, sea level). Future changes, such as climate and land use, will affect both BMP performance and the flows and loads that BMPs must address.
- ***Adaptability.*** Can the practice be modified to be resilient to potential changes as they emerge? BMP performance can depend on precipitation, soil moisture, temperature, and other factors. The degree to which a BMP can be modified to address changing environmental conditions, or is locked into a fixed design with respect to current conditions over a long period of time, is a measure of its adaptability. To build in flexibility and adaptability, there is a need to allow for adjustments in BMP implementation in order to consider a wider range of potential uncertainties and a richer set of response options (e.g., load allocations, BMP selections, BMP redesign).
- ***Timeliness.*** How quickly can BMPs be altered or implemented to adapt to changes? BMPs with short maturation periods (e.g., riparian buffers) or lead times for implementing modifications to address changing environmental conditions will be more resilient.
- ***Cost-effectiveness***. Will the cost to modify BMPs to prevent or remove projected increases in pollutant loads be feasible and reasonable? Large capital costs should be avoided that may not be appropriate to the actual future conditions. An analysis of the benefit to cost ratio of designing to a higher standard should be assessed in the context of an excepted level of risk tolerance, over the intended design-life of a proposed practice.
- ***Robustness.*** Will BMPs perform well over a range of projected future environmental conditions? Robustness refers to that ability to meet a stated goal, e.g., to remain above/below a defined threshold. “Climate-smart” principles can be used to site and design BMPs to reduce future impact of sea level rise, coastal storms, increased temperature, and extreme events.
- ***Auxiliary or Co-Benefits***. In addition to reducing pollutant loads to the Bay, will BMPs provide other co-benefits (e.g., recreational, heat amelioration, flood control)? On the flipside, maladaptive practices should be examined and avoided.

Areas for Future Focus

1. Develop **design guidance** to increase BMP resilience.
2. Improve **simulation modeling** capabilities, with the goal of addressing a wide range of uncertainty related to climate, extreme weather patterns, or other future changes (e.g., population, land use).
3. Conduct **targeted research** to enable quantification of impacts on structural integrity as well as nutrient and sediment removal effectiveness.
4. Develop **monitoring protocols and parameters** to better assess the impact of extreme events on structural integrity and effectiveness of BMPs.
5. Advance **programmatic practices, legal, and regulatory tools** (i.e., a roadmap for moving from science to policy to regulation, especially looking beyond Phase III WIPs).
6. Improve **communication and outreach** to end-users.
7. Identify, prioritize, and fill **data, research, and information needs**.

Communication & Decision-Support Materials

Communication & Decision-Support Materials

- Draft Guidance and Narrative Template for Phase III Watershed Implementation Plans
- STAC Workshop Report: *Monitoring and Assessing Impacts of Changes in Weather Patterns and Extreme Events on BMP Siting and Design* (2018).
- Fact Sheet: *Resilient BMP Planning Tools and Resources*
- Fact Sheet: *Climate Resiliency Principles for Phase III WIPs*

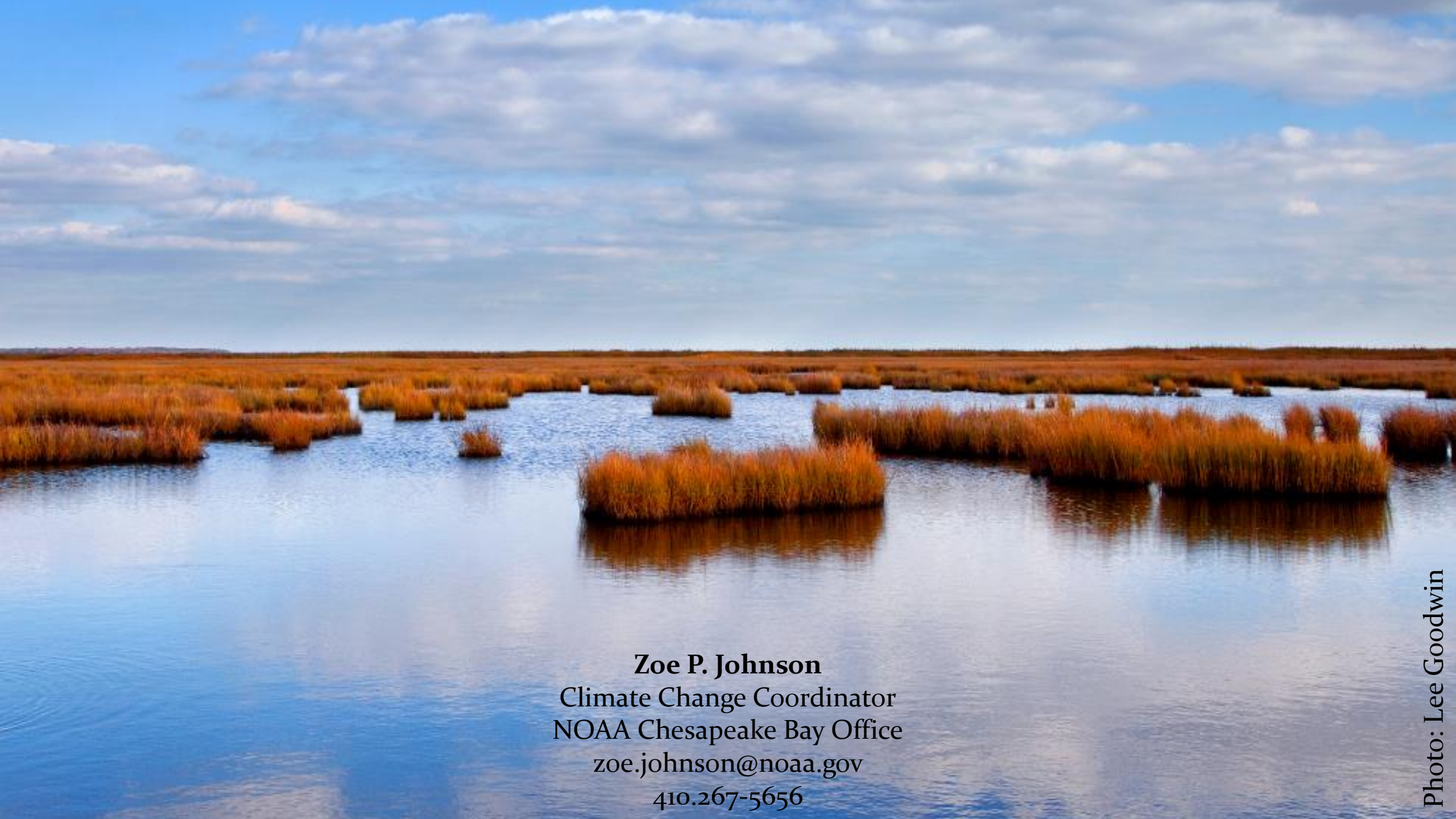


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Photo: Lee Goodwin