Conowingo Watershed Implementation Plan

DRAFT

Prepared by the Center for Watershed Protection, Inc

As part of the U.S. EPA Cooperative Agreement 96366901

January 2020

Revised February 28th, 2020

Revised March 30th, 2020

Revised May 8th, 2020

THIS PAGE IS INTENTIONALLY LEFT BLANK

Contents

List of Figures

List of Tables

List of Acronyms

BMP	Best Management Practice
CAP	Countywide Action Plan
CAST	Chesapeake Assessment Scenario Tool
CBC	Chesapeake Bay Commission
CBP	Chesapeake Bay Program
CIT	Conowingo Implementation Team
CWIP	Conowingo Watershed Implementation Plan
CWP	Center for Watershed Protection, Inc.
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
GIS	Geographic Information System(s)
LRS(s)	Land-River Segment(s)
MDE	Maryland Department of the Environment
MPA	Mid-point Assessment
MS4	Municipal Separate Storm Sewer System
N	Nitrogen
NEIEN	National Environmental Information Exchange Network
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
P	Phosphorus
PA DEP	Pennsylvania Department of Environmental Protection
PFP	Pay for Performance
PSC	Principals' Staff Committee
QAPP	Quality Assurance Project Plan
RFA	Request for Application(s)
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency
WIP	Watershed Implementation Plan

Executive Summary

Established in 1983 with the signing of the first Chesapeake Bay agreement, the Chesapeake Bay Program (CBP) partnership—currently consisting of the seven jurisdictions in the Chesapeake Bay watershed (Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), the U.S. Environmental Protection Agency (EPA), and the Chesapeake Bay Commission (CBC)—has set a goal to restore the Chesapeake Bay by 2025. This restoration framework is driven by federal Clean Water Act requirements and a 2010 Total Maximum Daily Load (TMDL) that sets pollution reduction targets for each Bay jurisdiction in order to achieve their respective water quality standards.

Appendix T of the 2010 TMDL recognized that the Conowingo Reservoir was filling with sediments and nutrients, resulting in increased pollution flowing over the dam into the Chesapeake Bay. The TMDL also recognized that the reservoir's ability to capture sediment and nutrients (i.e., its trapping capacity) is affected by sediment transport into the reservoir, scour removal events, and sediment trapping efficiency. Due to the uncertainty with these factors, the TMDL assumed that Conowingo Reservoir would continue to trap nutrients and sediment through 2025. The TMDL also stated that "if future monitoring shows the trapping capacity of the dam is reduced, then EPA would consider adjusting the Pennsylvania, Maryland and New York 2-year milestone loads based on the new delivered loads" (US EPA, 2010; Appendix T, p. T-5).

In 2017, as part of the CPB partnership's phased planning process, there was a Mid-point Assessment (MPA) to evaluate jurisdictions' progress in achieving 60% of the necessary 2025 pollution reductions. The MPA also adopted the latest science and monitoring information in an updated Phase 6 suite of modeling tools used to measure restoration progress. This new science demonstrated that the Conowingo Reservoir was effectively full, reducing dissolved oxygen (DO) concentrations in the Bay due to an additional 6 million pounds of nitrogen and 260,000 pounds of phosphorus pollution. The Principals' Staff Committee (PSC) agreed to address these Conowingo pollution loads through a separate Conowingo Watershed Implementation Plan (CWIP) that all jurisdictions would work collectively to achieve by pooling partnership resources and by reducing implementation costs through targeting pollution reduction practices in the most effective areas. The PSC also agreed the CWIP must incorporate innovations in financing that leverage both private capital and market forces to reduce restoration costs.

This draft CWIP provides the PSC, CWIP Steering Committee members, EPA, and stakeholders with a first phase adaptive strategy that will build upon CWIP implementation successes, challenges, and innovations in CWIP pollution loads. The CWIP realizes the PSC's vision as a collaborative approach that complements jurisdictions' WIPs by accelerating the pace of restoration, recognizing water quality and ecosystem protection as cost-effective, setting the stage for financing innovations that can help reduce costs and stimulate investments in clean water, and fostering healthy competition in ecosystem restoration markets.

This draft CWIP presents a set of best management practice (BMP) implementation scenarios for review and evaluation by the CBP partnership and the public. These scenarios vary both in their geographic extents and BMP types included; they offer alternatives to previously presented scenarios. These alternatives seek to reduce the overall cost of implementation while meeting nitrogen and phosphorus reduction targets by expanding the suite of BMPs and geographic scale of the planning area. A common theme across the scenarios and geographic options is the targeting of BMP implementation to the Land-River Segments (LRSs) within that geography that are most effective at delivering nitrogen to the Chesapeake Bay and, therefore, offer the best opportunity to improve conditions in the Bay by reducing nitrogen loads. More specifically, implementation is targeted to those areas where actions to reduce nitrogen locally have the greatest impact on increasing DO in the deep water/deep channel areas of the Bay (i.e., the areas where achievement of water quality standards is most difficult). Table 1 provides a comparison of the characteristics and results of each scenario.

Table 1. BMP scenarios run in the Chesapeake Scenario Assessment Tool (CAST) for the Conowingo Watershed Implementation Plan (CWIP); see next page.

Table 1. Overview of all CAST scenarios, including geographic extent ("Geography"), BMP categories ("BMPs"), the total nitrogen reduction ("Total N Reduction (lbs/year)"), the total annualized cost ("Total Annualized Cost"), the cost effectiveness for nitrogen removal ("Cost Effectiveness ($/lbs)"), the name and affiliation of the person who ran the scenario ("Developer"), and additional notes for context and clarification ("Description & Notes").

Scenario	Attributes						
	Geography	**BMPs**	**Total N Reduction (lbs/year)**	**Total Annualized Cost ($/Year)**	**Cost Effectiveness ($/lbs)**	**Developer**	**Description & Notes**
1	Conowingo Shell > All counties in PA & MD > Drains to Chesapeake Bay > Excluded Phase I jurisdictions*	Agricultural + Urban	6.0 Million	$369 Million	$61	CWP	This is the only scenario that is aggregated by county; everything else is by land-river segment (LRS). This scenario uses the WIP3 baseline.
2	Susquehanna watershed > Added Q1 N-effective[1] LRS outside of the Susquehanna	Agricultural + Urban	6.1 Million	$236 Million	$39	CWP	This scenario uses the WIP3 baseline.
3	Only Q1 N-Effective[2] LRS within Bay Watershed	Agricultural	6.4 Million	$51 Million	$8	EPA CBP	Uses Modified WIP 3 baseline; Scenario 10 is a modification of this scenario that uses the same BMPs, with a different focus geography
4	Only Q2 N-effective LRS within the Susquehanna watershed[3]	Agricultural	6.6 Million	$51 Million	$8	EPA CBP	
5	Only Q2 N-effective LRS within the Susquehanna watershed	Agricultural + Urban	6.6 Million	$51 Million	$8	CWP	The BMPs in this scenario are the same as Scenario 4, but it also includes urban forestry and urban buffer practices.
6	Conowingo Shell	Agricultural +Urban	6.2 Million	$124 Million	$20	CWP	Cost-Effective Ag Practices plus Urban Forestry and Bioswales
6.1	Conowingo Shell	Agricultural + Urban	6.2 Million	$90 Million	$14	CWP	This is a modification to Scenario 6 that incorporates BMP implementation levels

Table 1. Overview of all CAST scenarios, including geographic extent ("Geography"), BMP categories ("BMPs"), the total nitrogen reduction ("Total N Reduction (lbs/year)"), the total annualized cost ("Total Annualized Cost"), the cost effectiveness for nitrogen removal ("Cost Effectiveness ($/lbs)"), the name and affiliation of the person who ran the scenario ("Developer"), and additional notes for context and clarification ("Description & Notes").

Scenario	Attributes						
	Geography	**BMPs**	**Total N Reduction (lbs/year)**	**Total Annualized Cost ($/Year)**	**Cost Effectiveness ($/lbs)**	**Developer**	**Description & Notes**
							and Urban BMPS (bioswale and infiltration) consistent with other Final scenarios.
7	Conowingo Shell	Agricultural	6.0 Million	$65 Million	$11	CWP	Same as Scenario 6.1 but without urban BMPs
8	Only Q2 N-effective LRS within the Conowingo Shell	Agricultural + Urban	6.3 Million	$96 Million	$15	EPA CBP	Uses the same BMPs as Scenario 6.1 but focuses on the upper quartile LRSs. Uses modified WIP3 Baseline.
9	Only Q2 N-effective LRS within the Conowingo Shell	Agricultural	6.0 Million	$50 Million	$8	EPA CBP	Same BMPs as Scenario 8, but without urban BMPs
10	Susquehanna watershed > Added Q1 N-effective[1] Bay-Wide LRS outside of the Susquehanna	Agricultural + Urban	6.2 Million	$82 Million	$14	CWP	Same BMPs as Scenarios 6.1 and 8.
11	Susquehanna watershed > Added Q1 N-effective[1] Bay-Wide LRS outside of the Susquehanna	Agricultural	6.1 Million	$66 Million	$11	CWP	Same as Scenario 10 but without Urban BMPs

* If a county drains to the Chesapeake Bay and is partially within the Conowingo shell, then the whole county was included in the scenario output. Then, Phase I jurisdictions were removed (already heavily regulated and in less effective areas).
[1]Q1 Nitrogen (N)-Effective: Most effective land-river segments (LRS) for nitrogen reduction delineated by the upper quartile.
[2]Q2 Nitrogen (N)-Effective: Most effective land-river segments (LRS) for nitrogen reduction delineated by the median.
[3]This scenario uses 1995 CAST data.
Red font indicates scenarios recommended to present to the PSC (includes three geographies and Urban/Ag or Ag BMP options)

Since the BMP scenarios developed for the draft CWIP specifically target nitrogen, these scenarios approach but do not all achieve the phosphorus goal. The jurisdictions are on track to exceed the 2025 phosphorus target, so the phosphorus target for the Conowingo was not a priority. The additional phosphorus load reductions for the Conowingo could come from a nitrogen-phosphorus nutrient exchange process or basin-to-basin exchange if approved by EPA. The implementation strategies presented here target specific geographies but are not project scale; once a final scenario is selected, CWIP implementation will rely upon a phased and cooperative multi-jurisdictional effort that includes field assessments to identify specific locations for and types of BMPs. This draft CWIP serves as a starting point for outreach and coordination with local stakeholders on a phased implementation framework that begins with web-based outreach to reach the widest audience, followed by more targeted outreach in the selected geographies that are aligned with the jurisdictions' outreach strategies for WIP III.

A central focus of the CWIP is to promote flexible, cost-effective, and innovative approaches to address both CWIP financing needs and load reductions, as well as to accelerate the implementation of practices that maximize co-benefits, particularly climate change resiliency and mitigation co-benefits. The CWIP also recognizes that in-water practices—such as reservoir dredging and reuse, submerged aquatic vegetation, and a restored aquatic ecosystem—also have pollution reduction benefits that must be further explored and utilized. Such BMPs may be explored in subsequent versions of the CWIP and are not included in this draft, as additional information is needed with these innovative practices.

The CWIP identifies opportunities and contingencies for reducing Conowingo loads that are either underway or should be further explored, including:

1. Identifying, leveraging, or expanding market mechanisms (e.g., pollution trading) that can be scaled up to accelerate restoration progress;
2. Using in-water practices like dredging and reuse of dredged material for beneficial uses such as living shorelines or other innovative end products and developing nutrient reduction crediting science and frameworks for restored aquatic ecosystems (e.g., submerged aquatic vegetation, oysters, and other filter feeders like shad, menhaden, and freshwater mussels);
3. And implementing other cost-effective BMP opportunities across all sectors (wastewater, agriculture, developed, air) with additional pollution reduction capacity.

The draft CWIP is intended to initiate discussion with the CWIP Steering Committee and stakeholders, providing the opportunity for feedback on the direction of the strategy and guidance on adjustments and modifications as the CBP partnership initiates the implementation process. A financing strategy to implement the CWIP will be available in 2021. As implementation advances, the CWIP will utilize annual progress evaluations, two-year milestones, and continued public engagement to manage this collaborative effort in an adaptive way that complements and adds value to the watershed-wide restoration effort.

Introduction

The Conowingo Watershed Implementation Plan (CWIP) is developed to address the additional nutrient loads entering the Chesapeake Bay that were not previously addressed by the 2010 Chesapeake Bay Total Maximum Daily Load (TMDL) as a result of the Conowingo Reservoir reaching dynamic equilibrium. When the Chesapeake Bay TMDL was established in 2010, it was estimated that the Conowingo Dam would be trapping sediment and associated nutrients through 2025. New information has discovered that this is not the case, and the reservoir behind Conowingo Dam has now reached dynamic equilibrium (USACE & MDE, 2015), whereby more nitrogen and phosphorus are now entering the Chesapeake Bay than was estimated when the TMDL was established.

No jurisdictions were assigned the responsibility to achieve these additional reductions when the TMDL allocations were finalized in 2010. Even with full implementation of the seven Bay jurisdictions' Watershed Implementation Plans (WIPs), this additional pollutant loading will contribute to water quality standard exceedances in the Chesapeake Bay. The EPA documented that adjustments to sediment and associated nutrient load reduction obligations would be needed if monitoring showed the trapping capacity of the dam was reduced (US EPA, 2010, Appendix T).

On January 31, 2019 the CBP Principals' Staff Committee (PSC) finalized a framework for developing the CWIP (CBP, 2019a, Appendix C), and the CWIP Steering Committee more recently identified nitrogen load reductions (CBP, 2019b) as the primary goal since most of the jurisdictions within the Chesapeake Bay watershed are projected to exceed their phosphorus goals. Central to this CBP partnership framework is the premise that additional Conowingo load reductions are not allocated or subdivided among each jurisdiction, but rather will be achieved collectively by the jurisdictions working together through a flexible, adaptive, and innovative CWIP approach.

The purpose of this draft CWIP is to present a set of BMP implementation scenarios for review and evaluation by the CBP partnership and the public and to articulate the programmatic commitments needed to implement the BMPs. It also outlines the process by which climate change impacts will be addressed. The BMP types, geographic extent, nitrogen reductions achieved, and total cost of each scenario are presented so that the PSC can compare and select the most appropriate path forward for CWIP implementation. The outreach strategy presented in the draft CWIP will be further refined once a final implementation strategy is agreed upon. The implementation strategies presented here are not place-based, and CWIP implementation will rely upon a phased and cooperative multi-jurisdictional effort that includes field assessments to identify the specific locations for and types of BMPs. The Programmatic and Numeric Implementation Commitments section of this draft describes potential approaches to implement the CWIP given available resources, current programs, and a market-driven approach. The Financing Strategy in this draft contains a placeholder to be completed when the financing strategy to implement the CWIP is available in 2021.

Background

The Conowingo Reservoir is located in the lower portion of the Susquehanna River basin. The Susquehanna River basin has a 27,500 square mile drainage area that is largely (77%) in Pennsylvania with 22% of its area in New York and 1% (281 square miles) in Maryland. The Susquehanna River itself is 444 miles long, originating in Cooperstown, New York, and flowing through Pennsylvania and Maryland before emptying into the Chesapeake Bay near Havre De Grace, Maryland. The reservoir was constructed in 1928 and is owned and operated by Exelon Corporation with a design capacity of 30,000 acre-feet. It is the most downstream of the four hydroelectric dams and their reservoirs located on the lower Susquehanna River (Figure 1).

The dams in the lower Susquehanna River have historically trapped and stored sediment and associated nutrients transported from the watershed, preventing these pollutants from reaching the Chesapeake Bay. Decades prior to the establishment of the 2010 Chesapeake Bay TMDL, scientists had concern over impacts to the Chesapeake Bay from the lower Susquehanna River dams filling, reaching their capacity. In 1995, it was determined that two of the three reservoirs, Safe Harbor and Holtwood, had reached their sediment trapping capacity. The 2010 Chesapeake Bay TMDL (EPA, 2010, Appendix T) also recognized that TMDL allocations may need to be reevaluated with Conowingo Reservoir infill. Comparison of bathymetric data from the Conowingo Reservoir (1996 to 2011) showed a 33% decrease in reservoir sedimentation equating to a 10% increase in sediment load to the Chesapeake Bay from 20.3 – 22.3 million tons (USACE & MDE, 2015). The inability of these reservoirs to trap sediment results in sediment being transported downstream where the nutrients associated with the sediments adversely impact DO levels in the Chesapeake Bay.

Analyses of the sources of sediment being transported from the lower Susquehanna reservoirs finds that most of the load entering the Chesapeake Bay during storm events originates from the watershed, with smaller contributions from reservoir scour (USACE & MDE, 2015). Analyses find the three reservoirs are no longer trapping sediment and associated nutrients over the long term, and accumulated sediment is being released episodically during high-flow storm events. USACE & MDE (2015) concluded that the dams have reached a state of dynamic equilibrium where there is no appreciable change in sediment transport through the Conowingo Reservoir over the periods of years to decades; rather, there are periodic releases of sediment during high flow events temporarily increasing the capacity of the reservoir, which subsequently continues to accumulate sediment until the next high flow event.

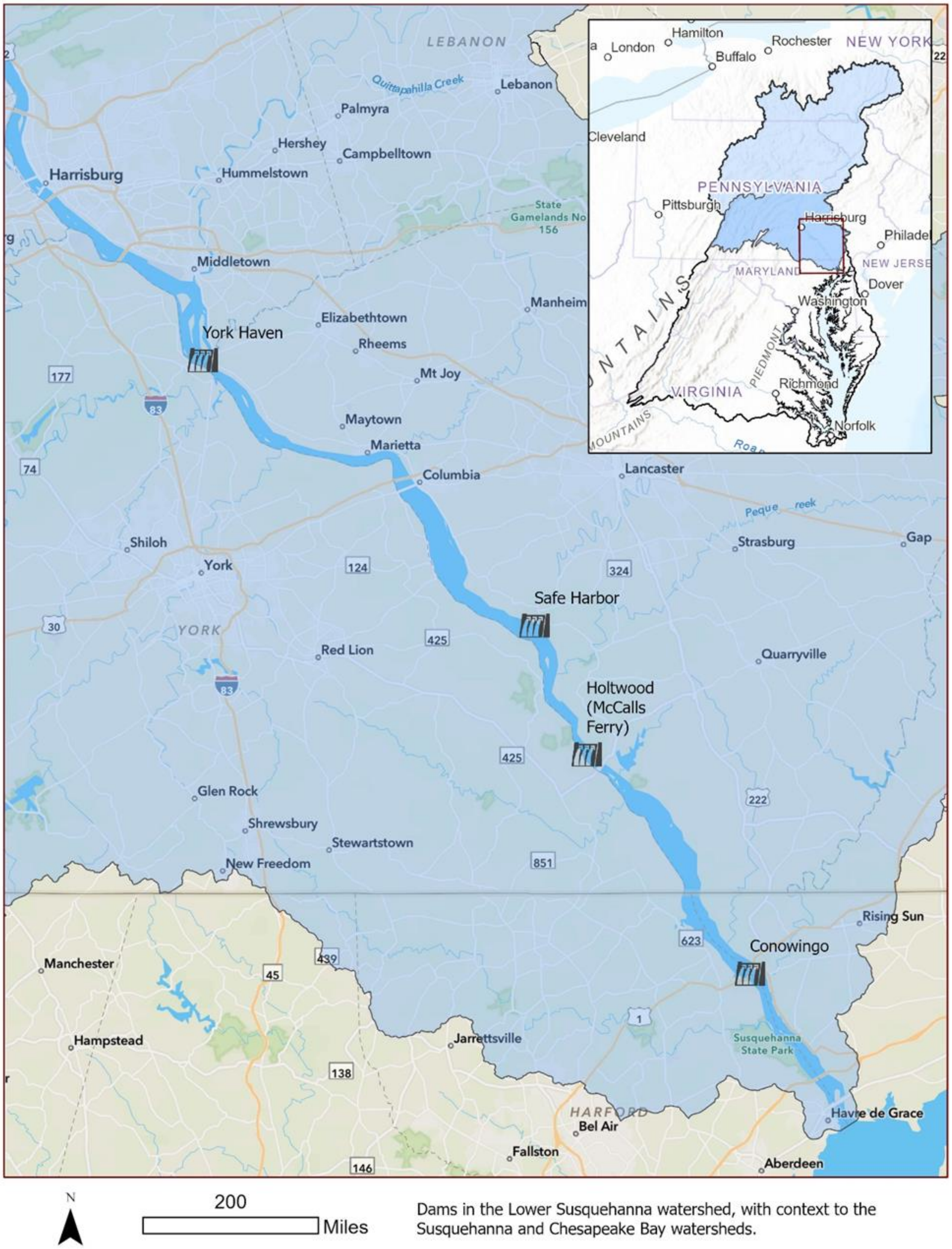

Figure 1. Geographic extent of the Conowingo Reservoir within the Lower Susquehanna River Basin.

The CBP partnership estimates that, after fully implementing the Chesapeake Bay TMDL and the Phase III WIPs, an additional reduction of 6 million pounds of nitrogen and 0.26 million pounds of phosphorus is needed in order to mitigate the water quality impacts of Conowingo Reservoir infill (Appendix C). The CWIP framework states that pollutant reductions to meet the Conowingo targets should come from the most effective areas within Bay watershed jurisdictions—that is, the geographic areas with the greatest influence on Chesapeake Bay water quality. If implementation were directed watershed-wide, or not targeted in the most-effective sub-basins, the total pollution reduction needed would increase. For example, it is estimated using the Phase 6 suite of modeling tools, that 7.28 million pounds of nitrogen would need to be reduced if implementation was distributed watershed-wide, rather than in the most effective areas (US EPA, 2018). Table 2 presents each jurisdiction's nitrogen and phosphorus load reduction responsibility if distributed watershed-wide, based on the CBP-partnership-approved methodology to calculate load reductions equitably.

Table 2. Additional nitrogen and phosphorus load reductions required for Conowingo Dam infill using the Phase 6 Suite of modeling tools.*

Jurisdiction	Nitrogen Load Reductions (million lbs/year)	Phosphorus Load Reductions (million lbs/year)
New York	0.32	0.011
Pennsylvania	3.31	0.113
Maryland	1.76	0.091
West Virginia	0.19	0.015
District of Columbia	0.00	0.001
Delaware	0.32	0.005
Virginia	1.38	0.155
Basin-wide	7.28	0.392

* Table reproduced from letter from the US EPA Region 3 Regional Administrator to the Principal's Staff Committee Members, October 26, 2018 (US EPA, 2018).

The decision by the PSC to develop a CWIP is based on the studies indicating that conditions in the watershed have changed since 2010, and that additional load reductions of nutrients are now needed to mitigate the water quality impacts of the Conowingo Dam infill on the Chesapeake Bay (USACE & MDE, 2015; Easton et al., 2017). This decision by the PSC was reached based on the following:

- At the December 2017 PSC Meeting, the PSC agreed to assign the total pollutant reductions attributed to the Conowingo Dam infill to a separate Conowingo Planning Target and to collectively develop a separate CWIP (US EPA, 2018).

- At the December 2017 PSC Meeting, all PSC jurisdictional members agreed to pool resources and to identify a process to fund and implement the CWIP (e.g., the allocation of future EPA Chesapeake Bay Implementation and Regulatory and Accountability Program grant funding to the seven Bay watershed jurisdictions; US EPA, 2018).
- At the March 2018 PSC Meeting, the PSC agreed with EPA's request that the agency not have a member on the CWIP Steering Committee due to EPA's oversight role for the implementation of all the jurisdictions' WIPs, including the CWIP (US EPA, 2018).
- At the January 31, 2019 PSC Meeting, the PSC approved final revisions to a Framework for developing the CWIP (CBP, 2019a). The Framework is included as Appendix C.

Conowingo WIP Framework

The CWIP is not a jurisdictional WIP, unlike the State WIPs in support of the Chesapeake Bay TMDL. The CWIP presents an opportunity to build on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. The CWIP encompasses an adaptive management approach consistent with other jurisdictional WIPs that represents the collective agreement amongst the CBP partnership and a transparent, fair, and equitable process for all stakeholders. The CWIP is based on the best available information and supporting analyses to achieve the designated nutrient reductions. The CWIP acknowledges the need to adapt its approach as new information becomes available throughout the implementation phase, while putting in place a process to monitor outcomes, transparently assess progress, and reallocate and redirect resources as necessary. As such, the CWIP will be updated as needed in recognition that programmatic and/or numeric commitments may need to be modified as part of the adaptive management process during the WIP timeframe through their two-year water quality milestone reporting process.

The framework represents an agreement amongst all Chesapeake Bay jurisdictions that recognizes:

A. Trapping of pollutants by the Conowingo reservoir over the past 80+ years has benefited the water quality of the Bay, and it has also benefitted jurisdictions to varying degrees by lessening load reduction responsibilities. However, those benefits are greatly diminished.
B. No reservoir maintenance to restore trapping capacity has occurred over the life of the dam and the reservoir is now near full capacity.
C. The most cost-effective approach to mitigate current adverse water quality impacts of the

Conowingo reservoir in a state of dynamic equilibrium are realized by pooling resources to pay for pollutant reduction practices in the most effective locations (i.e., the locations with the most influence on Bay water quality). Pollutant reduction practices placed in the most effective areas will limit the overall load reductions needed.

Geography of the Conowingo WIP

The CWIP framework document (Appendix C) identifies four geographic options for assigning pollutant load reduction responsibilities. After considering these options, the CWIP Steering Committee agreed at its September 23, 2019 meeting to use the "Susquehanna + Most Effective Basins" option as the basis for the CWIP (CBP, 2109b). However, this draft presents a series of BMP scenarios for evaluation that also consider alternate geographies to address issues of cost and equity. The BMP scenarios presented here cover multiple geographic scales, which are described further in the Programmatic and Numeric Implementation Commitments section of this draft.

A common theme across all the geographic scales is that BMP implementation is targeted to the most effective sub-basins (referred to as Land-River Segments, LRSs) of the watershed to achieve an additional reduction of six million pounds of nitrogen and 0.26 million pounds of phosphorus to mitigate the water quality impacts of Conowingo Reservoir infill on the Chesapeake Bay. The methodology used to identify the relative effectiveness of each LRS was developed by the CBP partnership and applied as part of the original TMDL allocations in 2010. The resulting maps of relative effectiveness for nitrogen and phosphorus were updated using the Phase 6 Chesapeake Bay Watershed Model, which reflects the condition of dynamic equilibrium of the Conowingo. These relative effectiveness maps represent the increase in DO that occurs in the deep water/deep channel areas of the Chesapeake Bay (i.e., the areas where achievement of water quality standards is most difficult) per pound of nutrient reduced in each local LRS. The relative effectiveness accounts for the amount of nutrients produced locally, and the transport of these nutrients through the watershed into the tidal areas, then from the tidal areas to the Bay, results in multiple watershed and estuary delivery factors affecting DO levels in the Chesapeake Bay. Therefore, the most-effective LRSs are not necessarily the areas within the upland drainage of the Conowingo Dam, nor closest to the Chesapeake Bay given the effect of local watershed characteristics on travel time, to include the impact of dams and impoundments. Further, delivery to the Bay from the estuary considers the Bay's circulation and bathymetry (depth), as well as other factors. Figure 2A and Figure 2B present the relative effectiveness maps for nitrogen and phosphorus, respectively, for the entire Bay watershed.

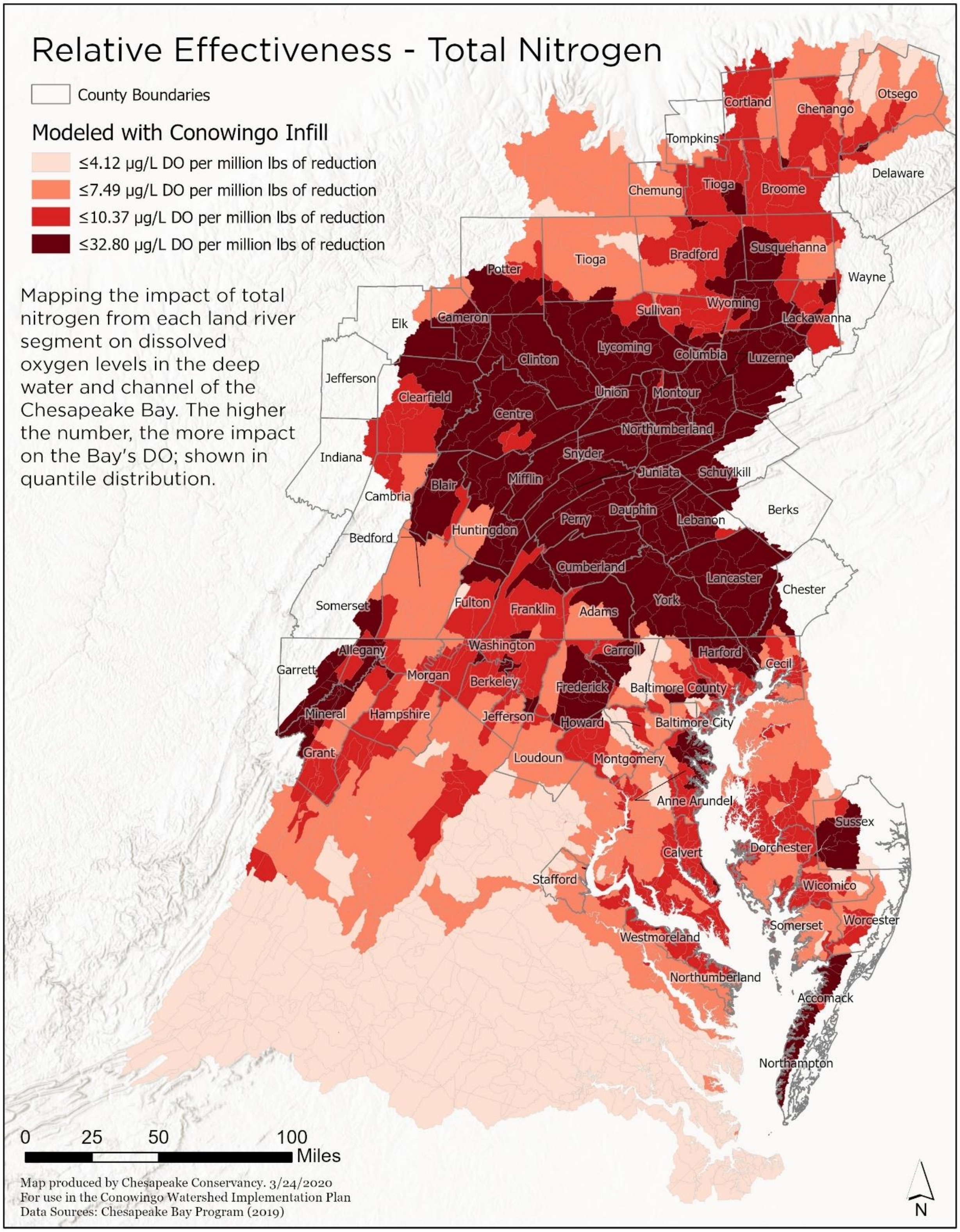

Figure 2A. Relative effectiveness of reducing nitrogen in each Chesapeake Bay land-river segment (LRS) on improving dissolved oxygen (DO) in the Chesapeake Bay.

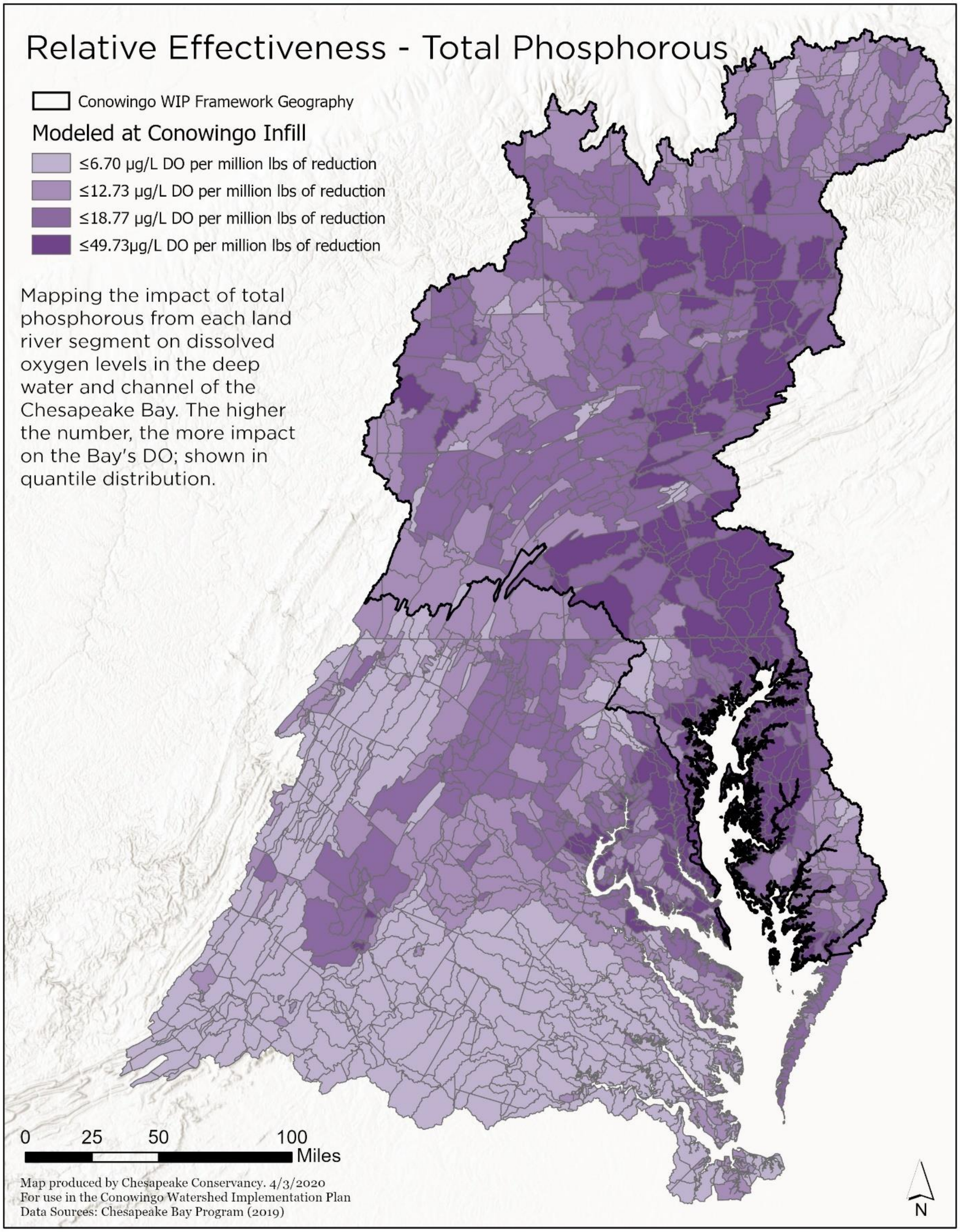

Figure 2B. Relative effectiveness of reducing phosphorus in each Chesapeake Bay land -river segment (LRS) on improving dissolved oxygen (DO) in the Chesapeake Bay.

Roles and Responsibilities

The CWIP was developed through the guidance and recommendations of a CWIP Steering Committee, a subcommittee of the PSC. This committee is composed of a representative from each Bay jurisdiction and the Chesapeake Bay Commission (CBC). The membership of this committee is provided in Appendix A. The EPA is not a formal member of this committee due to its oversight role as part of the Chesapeake Bay TMDL accountability framework. The decisions of the committee follow a list of guiding principles identified in Appendix A of the CWIP Framework document (Appendix C).

The roles and responsibilities of the EPA, CWIP Steering Committee, PSC, and third-party grantees are defined in the Framework document (Appendix C) and the Cooperative Agreement between EPA and the third-party grantees. Each of their roles as it pertains to the development and implementation of the CWIP are summarized below.

EPA will:

a. Evaluate the draft and final CWIP and provide biennial evaluations of the progress toward attaining the goals in the CWIP. EPA's evaluations, in consultation with the PSC, and any needed improvement will be used to determine if corrections or adjustments are necessary to attain the goals of the CWIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).
b. Issue a Request for Applications (RFA) for the third-party and administer the subsequently awarded grant. Because EPA will be issuing the RFA, it cannot act as a third party.
c. Provide technical staff and contractor support such as modeling or GIS analysis to the CWIP Steering Committee.

Guiding Principles

Fairness Principle: Strive for fairness, equity, and feasibility among state, local, and federal and other partners participating in the CWIP regarding level of effort, financing, tracking, resource sharing, and third -party access.

Governance Principle: Operate as an Action Team as defined in the document "Governance and Management Framework for the Chesapeake Bay Program Partnership". Strive for consensus using the Chesapeake Bay Program Partnership Consensus Continuum as described in the document. When consensus cannot be reached, the issue will be deferred to the PSC with a summary of the issue and the different options and opinions expressed by the members.

Consistency Principle: Ensure consistency with the EPA Phase III WIP expectations and CWIP framework documents.

Transparency Principle: Establish clear tracking, accountability and verification consistent with expectations for jurisdictions and to transparently demonstrate which practices are planned for, implemented and maintained in the CWIP vs state WIPs in order to avoid double-counting.

Efficiency in Innovation Principle: Implement the CWIP building on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. At the same time, strive for innovation, leverage new technologies, and, where appropriate, develop new implementation approaches.

**From the "Framework for the Conowingo Watershed Implementation Plan Appendix A. 10/12/2018 Final"*

The CWIP Steering Committee will:

a. Consist of a representative from each jurisdiction and the Chesapeake Bay Commission (CBC). Each Bay jurisdiction and the CBC may also solicit comments on the CWIP Framework from key stakeholders.
b. Develop the CWIP with EPA staff and grantee support.
c. Guide the development of a financing strategy and implementation of the CWIP, working with the third party.

The PSC will:

a. Approve the final draft CWIP for submittal to EPA and the CBP partnership for review and comment.
b. Approve the final CWIP before posting on the CBP partnership website.
c. Review the progress of the CWIP Steering Committee in the development and implementation of the CWIP on a regular basis.

The third-party grantee, herein referred to as the CWIP Implementation Team will, pursuant to EPA Cooperative Agreements:

a. Work with the CWIP Steering Committee to establish a timeline to implement the CWIP.
b. Develop draft and final CWIP documents, to include two-year milestones every two years, following the release of the final CWIP, that will articulate the programmatic, implementation, and numeric commitments to achieve the necessary load reductions due to the Conowingo Dam infill.
c. Document approaches and strategies to select and implement BMPs to cost-effectively and efficiently achieve the necessary load reductions and create a BMP Opportunity Analysis that identifies catchment-scale locations of high-priority opportunities for the load reductions.
d. Facilitate the implementation of projects funded specifically in pursuit of CWIP goals or as identified through the financing framework.
e. Develop and implement tracking, verifying, and reporting protocols and tools to readily track, verify, and report creditable practices for the CWIP.
f. Work with the jurisdictions to develop and implement engagement strategies with local communities in the priority geographies to advise the CWIP Steering Committee on locally relevant and actionable load reduction strategies.

> The BMP Opportunity Analysis will guide outreach and accelerate CWIP Milestone planning by identifying project-scale opportunities for BMP implementation.
>
> This opportunity analysis will utilize best available data and innovative GIS-based methods for remote identification of suitable locations for specific BMP implementation efforts.

g. Develop a draft and final financial strategy to provide the administrative and financial resources to implement load reduction strategies.

> The CWIP Implementation Management Team is currently divided into three EPA funded activities:
>
> **Activity #1:** Develop and implement the CWIP (Center for Watershed Protection lead)
> **Activity #2:** Develop a Conowingo implementation financing strategy (Chesapeake Bay Trust lead)
> **Activity #3**: Track, verify, and report progress made in the implementation of the CWIP and report to EPA on an annual basis (Chesapeake Conservancy lead)

Accounting for the Impacts of Climate Change

According to the CBP partnership, the CWIP will be assigned additional load reductions due to the impacts of climate change. Recognizing that these additional loads will impede progress towards improving the health of the Chesapeake Bay, the PSC agreed to a three-part approach for addressing climate change impacts in the Phase III WIPs and future two-year milestones. This approach is also applicable to the CWIP and includes the following commitments:

1. Incorporate climate change in the WIPs by including a narrative strategy that describes the state and local jurisdictions' current action plans and strategies to address climate change.
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.
3. Incorporate climate change into two-year milestones by no later than 2022–2023, start to account for additional nutrient and sediment pollutant loads due to 2025 climate change, and determine how climate change will impact the BMPs included in the WIPs and address these vulnerabilities. The PSC also acknowledged that jurisdictions could address additional nutrient and sediment pollutant loads due to 2025 climate change in the WIPs.

At the time that the additional loads are assigned, the two-year milestone periods will be used to adjust the scale and scope of the load reduction strategies for those jurisdictions that have not previously addressed the additional loads. At the time of the release of this draft CWIP, the methods to address climate change and the WIPs following the Water Quality Goal Implementation Meeting February 10–11, 2020 are pending PSC approval. If additional reductions are assigned, they will be incorporated into the two-year milestone periods for the CWIP. An expanded list of creditable and reportable BMPs may be considered that provide an effective means to mitigate the effects of climate change.

A central tenet of the CWIP is to significantly scale up implementation of BMP implementation in the most effective areas to reduce nitrogen loads to the Bay. Some of these BMPs (i.e., wetlands and reforestation) can reduce the vulnerability of communities to the effects of climate change, making communities more resilient, healthier, and less susceptible to urban heat island effects while helping restore water quality and ecosystem functions.

Some of the key features of green infrastructure practices are that: 1) they provide enhanced storage capacity for flood mitigation of more intense and larger precipitation events, 2), they reduce emissions of greenhouse gases through carbon sequestration, and, 3) they lower temperatures through shading and evapotranspiration. Focusing CWIP resources and funding to these practices may stimulate the development of versatile designs that provide multiple benefits to local communities.

As project implementation moves forward, two-year milestones and investment decisions on individual projects will be refined using the most up to date and available climate modeling data and assessment framework. The CWIP will function in concert with the overall jurisdictions' WIPs, which allows CWIP implementation to adjust to the impacts of climate change as the science evolves and advances.

Accounting for the Impacts of Growth

The geography of the CWIP extends across both local and state political lines. As a result, there is no organized or centralized entity responsible for growth management. Consequently, it is expected that the change in load reductions due to growth will be accounted for through the jurisdiction-specific Phase III WIPs' accounting processes.

Comprehensive Local, Regional, and Federal Engagement Strategies and Commitments

Since Implementation of the Conowingo WIP is not the responsibility of any one state, a Conowingo Implementation Team (CIT) will be established to begin the implementation process. The CIT will perform outreach tasks as well as technical tasks, which will be discussed in further detail in subsequent sections. However, standalone references to the CIT refers to the team overseeing both outreach and technical tasks in support of implementation of the CWIP. During the initial milestone process, the CIT will facilitate the cooperative approach to implementation of programs and practices with the available resources. The CIT will report to and consult with:

- EPA representative(s)
- CWIP Steering Committee or specific designees
- Finance partners/representatives

Consistent with the Framework for the CWIP, the engagement strategy adopts a Bay-wide effort to ensure that additional nutrient and sediment load reductions needed for a healthy Chesapeake Bay are achieved. The CWIP does not require the development of plans specific to local or priority geographies, rather an aggregation of targeted, priority implementation of practices, that together will achieve the necessary load reductions. The success of the CWIP requires participation from all six States and the District of Columbia to ensure accountability that all actions needed are taken within the agreed upon timeline, and that they are consistent with the guiding principles. The engagement strategy will be carried out in concert with the CBP partnership and jurisdictions' governments and will engage with federal agencies, regional and local governments, quasi- and non-governmental organizations, private sector for-profits, and individual citizens. Overall, the strategies identified in the CWIP build upon the efforts by the Bay jurisdictions to develop the jurisdiction-specific Phase III WIPs. This ensures consistency in messaging and efficiency in the delivery of important communications to a variety of stakeholders. For example, a draft of Frequently Asked Questions (FAQ) document has been completed and provided in Appendix B. While the aforementioned approach is necessary for the successful implementation of this collaborative WIP, the specific locations for stakeholder outreach will be determined to some extent by the targeted geographies in the final CAST scenario selected by the PSC.

There are four phases for local and regional stakeholder outreach developed by the CIT. Consistent with the adaptive management approach, there will be a review and evaluation of the strategies and their effectiveness to achieve the desired level of engagement with the completion of each phase.

- Phase 1 (2019 – 2020): Planning phase for stakeholder outreach, development of general materials, and web-based outreach to solicit input on the draft CWIP.

- Phase 2 (2020 – 2021): Outreach will focus on delivering the CWIP, collecting data on specific projects that will be implemented to achieve the two-year milestones, and providing training to local stakeholders on the data tools produced as part of the CWIP to support project planning for implementation.

- Phases 3 – 4 (2021 – 2025): These phases include Years 3 through 6 where outreach will focus on reconvening stakeholders annually to review and evaluate progress and make recommendations on the next two-year milestones. The development of additional training and guidance documents may be pursued based on feedback from stakeholders to include input from the CWIP Steering Committee.

Federal and CBP partnership engagement will be achieved through the continuation of the CWIP Steering Committee. The success of CWIP implementation will require continuous input from CWIP Steering Committee members to provide guidance on adaptive management strategies and adjust strategies to reflect future changes in standards, policy, and Phase III WIP strategies. CWIP Steering Committee meetings may occur quarterly or monthly based on the needs of the CWIP.

Engagement and Communication Goals

The success of the CWIP requires fulfillment of the EPA expectation for all WIPs to include a comprehensive strategy to engage local, regional, and federal partners in WIP implementation. The measures taken to adopt and implement nutrient load reduction strategies need to be representative of the available local capacity, technical, and financial resources to achieve the desired outcomes. This requires broad-based local community support that is guided and coordinated by jurisdictional agencies.

Conowingo Implementation Team - Outreach

The CIT will work with the third-party grantees will provide outreach support for the Conowingo WIP. The CIT will work with EPA, state agencies, local governments, and implementation partners to provide information and resources related to implementing water quality improvement measures in the CWIP. The CIT will work with local communities and state agencies to provide tools, resources, and information that facilitate the implementation of the CWIP recommendations and help to identify locally relevant and actionable steps. As such, a central goal of the CWIP is to sustain communication and engagement of federal, state, and local stakeholders involved in the development phase throughout its implementation. This will include both the public and private sector. A second goal is to effectively communicate and provide timely information about financing options to implement nutrient reducing strategies. A third goal is to develop broad-based support for implementation by addressing the needs and capacity of specific sectors, communities and organizations that are directly involved in implementation, tracking, and reporting.

Currently, web-based strategies have been developed for the entire watershed and in-person outreach strategies are developed for priority geographies of Pennsylvania and Maryland. In-person strategies outlined below will be refined geographically after the final CWIP scenario and geography is determined.

Strategies

Web-based

To communicate and interact with stakeholders and partners in all the Bay jurisdictions, the CIT will utilize web-based strategies including webcasts and online meetings. These web-based platforms provide the ability to communicate with stakeholders and partners spread across a large geographic area and the flexibility to communicate when in-person meetings are otherwise not possible.

Draft CWIP Phase

A series of three (3) webcasts will be delivered during the public comment period of the draft CWIP. These webcasts will focus on the background need for the CWIP, the process of developing the draft CWIP, the priority watersheds, the implementation goals, and will also provide opportunity for questions and comments. The first two webcasts will focus on implementation in Pennsylvania and Maryland, respectively, because of the higher levels of implementation expected in those states. The third webcast will focus on implementation in New York, Delaware, Virginia, and West Virginia where little or no implementation is planned.

Additionally, during the draft CWIP public comment period, the CIT will utilize online meeting platforms and conference calls to solicit feedback and engage in discussions with key partners and stakeholders such as state and local agency representatives, Countywide Action Plan (CAP) coordinators and team members, and others currently involved in BMP implementation. This technology can support presentations as well as data and document sharing, providing a reasonable alternative if in-person meetings are not possible.

Final CWIP Phase

After the final CWIP is approved, the CIT will deliver at least one annual webcast to provide information on progress, strategy modifications and refinements, funding levels and priorities, milestone updates, available tools and resources, and success stories. The CIT will also develop a condensed presentation for integration as a component to other partner online presentations or webcasts, which could be delivered when requested.

Pennsylvania

The Pennsylvania Department of Environmental Protection (PA DEP) developed a phased approach[1] to implement the Phase III WIP through their CAPs. The CAPs assign each of the 43 counties within the Chesapeake Bay watershed into one of four tiers (Tiers 1 – 4), where each tier represents 25% of the pollutant load reduction for the Phase III WIP (Table 3). Four counties (Lancaster, York, Franklin, and Adams) participated in a pilot CAP process with plans completed in 2019. The engagement strategy for the Pennsylvania portion of the CWIP aligns development of the CAPs for the Phase III with the CWIP outreach. The ongoing CAP process allows the CIT to interact directly with local stakeholders and state agency staff in the development of integrated strategies.

[1]This phased approach to implementing Pennsylvania's Phase III WIP is described at: https://www.dep.pa.gov/Business/Water/Pennsylvania's%20Chesapeake%20Bay%20Program%20Office/WIP3/GetInvolved/Pages/Local-Government.aspx

This will allow the CIT to integrate the engagement strategy into the Phase III WIP strategy, creating efficiencies for all participants and ensuring consistent communication and fostering collaboration. Together, the CIT and PA DEP will use the Phase III WIP two-year milestone process to align the CAP for Tiers 3 and 4 with the CWIP timeline in the identified priority geographies. Table 4 identifies the two-year milestone period and the schedule for counties identified by PA DEP to initiate their CAP process within that time period.

Table 3. Pennsylvania counties and their tiers for CAPs. Counties with an asterisk (*) next to them were part of the initial PA DEP pilot for CAP development.

Tier 1	Tier 2	Tier 3		Tier 4	
Lancaster* York*	Franklin* Lebanon Cumberland Center Bedford	Adams* Northumberland Perry Snyder Huntingdon Columbia Mifflin Lycoming	Schuylkill Bradford Juniata Clinton Tioga Susquehanna Clearfield Fulton	Union Chester Dauphin Berks Blair Lackawanna Luzerne Montour Cambria Sullivan	Potter Somerset Wyoming Elk Indiana Cameron Wayne McKean Jefferson Carbon

Table 4. PA DEP proposed draft alignment of CAP development and the CWIP and two-year water quality milestones (milestone periods are based on July 1 – June 30).

Two-Year Milestone Period	Proposed Time Period to Develop CAPs and Integrate CWIP
2018 – 2020	Jan/Feb 2020: Center, Bedford, Cumberland, Lebanon
2020 – 2022	Late Fall 2020: Blair, Northumberland/ Montour, Lycoming, Union/Snyder, Luzerne

Audience (for stakeholder engagement workshops)

Emphasis will be placed on reaching out to targeted groups currently working on and/or familiar with local CAP development and implementation. This includes agriculture representatives, Cooperative Extensions, the United States Department of Agriculture (USDA), Conservations Districts, county and municipal staff, land trusts, environmental and engineering consultants, watershed groups, state agencies, water authorities, and local community leaders. These groups of people are specifically identified in the Community Clean Water Planning Guide[2] and will: 1) have relevant specialized knowledge, 2) be able to speak on behalf of impacted landowners and industries, 3) have connections to relevant groups, and 4) have shown a willingness to

[2] https://www.ccpa.net/DocumentCenter/View/35039/WIP3-Community-Clean-Water-Guide

engage. These groups will also be engaged during future outreach activities to share feedback on milestones and BMPs.

Communications and Timing

The CIT, specifically the Chesapeake Conservancy with assistance from the Center for Watershed Protection, will lead the CWIP local area engagement in Pennsylvania. Information will be provided to PA DEP to share with local stakeholders as part of the County Clean Water Technical Toolbox[3] for the CAPs. The CIT will join PA DEP staff at select CAP meetings beginning in January 2020 to discuss the complementarity of CWIP with Phase III Chesapeake Bay WIP.

The CAP process will continue beyond the delivery of the final CWIP; therefore, the CIT will coordinate with PA DEP to conduct web-based outreach during the CWIP public comment period.

Active CAP Counties

Beginning January 2020: The CIT will integrate outreach to Tier 2 Counties through the CAP process by coordinating with PA DEP and participating in CAP meetings and phone calls with CAP Coordinators.

Other Counties

Beginning April 2020: CIT outreach to counties who are not currently going through the CAP process with PA DEP will focus on providing the stakeholders with an understanding of how the CWIP is structured and how the development of CWIP two-year milestones will integrate with the CAP process. Outreach in these locations will include webcasts, participating in regional partnership meetings as well as phone calls and in-person meetings with key stakeholders.

CWIP Milestone Planning in Pennsylvania

The CIT will coordinate milestone planning efforts with PA DEP as part of the engagement process, inclusive of the CAP process. Schedules for CWIP milestone draft and final delivery are to align with jurisdictional two-year milestone targets.

Maryland

A Maryland-specific outreach strategy has been developed in recognition that Maryland has completed county-based strategies as part of the Maryland Phase III WIP. The outreach strategy for the priority geographies in Maryland follows a process similar to the strategy developed for the Phase III WIPs. The CIT will communicate with Maryland Department of Environment (MDE) and Maryland Department of Agriculture (MDA) to ensure that communication efforts regarding CWIP and the Phase III WIP complement each other. The primary stakeholders identified for Maryland WIP and

[3] http://files.dep.state.pa.us/Water/ChesapeakeBayOffice/WIPIII/FinalPlan/County-Specific%20Clean%20Water%20Technical%20Toolbox.pdf

CWIP engagement strategies are the same and includes organizations that have a central role in project implementation. The organizations include county, municipal, federal, and soil conservation district staff associated with source-sector specific organizations to include stormwater, agriculture, wastewater, septic and federal facilities.

Audience (for stakeholder engagement workshops)

Emphasis will be placed on reaching out to targeted groups currently working on and/or familiar with local WIP implementation. For the first round of stakeholder engagement workshops, invitees will be organizations and local government agencies actively working on WIP-related projects in the watersheds identified in the CWIP. These groups were selected because they have been or are currently engaged in WIP projects and reporting and because they have area strong understanding of the watersheds. These groups will also be engaged during future outreach activities to share feedback on milestones and BMPs. Invitees are to include:

- County Conservation District and USDA Natural Resources Conservation Service (NRCS), MDA, Department of Public Works, and Planning staff currently doing WIP work.
- Key Maryland Department of Natural Resources (MD DNR) staff that deal with land management or are doing WIP work.
- Local and regional watershed groups that are actively doing projects in cooperation with counties to meet WIP goals such as, Octoraro Watershed Association, Friends of the Bohemia, Elk & North East River Watershed Association, and ShoreRivers.

Although the meetings will be open to the public, the goal is to get feedback from those familiar with WIPs related to the draft CWIP strategy. It is anticipated that the meeting format will be the same for all three initial stakeholder workshops in Maryland. The anticipated format is:

- The CIT, led by the Harry R. Hughes Center and MD Sea Grant Extension in partnership with the Center for Watershed Protection, Inc. (CWP) with support from the Chesapeake Conservancy will start with introductory remarks, the history of and need for a Conowingo WIP, the identification of selected watersheds, and workshop objectives.
- CWP and the Chesapeake Conservancy will provide a technical overview regarding the BMP identification and selection process and the implementation opportunity maps that resulted from this process.
- The Harry R. Hughes Center and MD Sea Grant Extension will facilitate breakout sessions for attendees' geography (e.g. county, watershed, other jurisdiction) and get feedback on initial concerns, potential for proposed BMPs, areas that are missing, constraints, and ongoing activities, which will be used to inform revisions to the next iteration of the draft CWIP.

- The Harry R. Hughes Center and MD Sea Grant will compile feedback from all three workshops and provide to the CWIP Steering Committee through CWP.

Individuals, organizations, and grantees working on CWIP financing strategies and tracking and reporting tools will be invited to present at the webcasts/workshops and share status updates on their respective activities.

Communications

The CIT members will utilize its *Constant Contact* database it developed during the Phase III WIP process to send out initial workshop notices and can include the ability for respondents to ask questions that can be passed along to the CIT.

December 2019 – September 2020

During this timeframe, the CIT will focus on identifying project opportunities to reduce loads associated with the CWIP.

December 2019 – **January 2020:** Front-load ***Constant Contact*** email addresses.
January 2020: Select three locations for Maryland Stakeholder Engagement Workshops (on hold due to COVID-19 and instead will be web-based)
July – August 2020: Hold three (3) web-based workshops.
August – September 2020: Provide workshop feedback to EPA and the CWIP Steering Committee

November 2020 – February 2021

Upon finalizing the CWIP and draft two-year milestones, the CIT will focus on delivering the CWIP and collecting data on specific projects that will be implemented to achieve the two-year milestones. The CIT, led by the Harry R. Hughes Center, also organizes regular statewide WIP meetings and will allow for alignment of WIP III and CWIP meetings.

November – December 2020: Conduct a webinar to share the Final CWIP.
December 2020 – May 2021: In-person regional engagement meetings to solicit input on two-year milestones due November 2021.
February 2021: Roll out of the BMP opportunity blueprint with support to local stakeholders on the data tools produced to support planning of projects to implement the CWIP.

Years 3 – 6

During this timeframe, the CIT will focus on providing technical assistance to local stakeholders to support implementation and the tracking, verifying, and reporting of projects toward meeting the two-year milestones by providing access to partner-led and external training opportunities. The CIT will also reconvene local stakeholders in eight communities at the conclusion of each two-year milestone deadline to evaluate progress and make recommendations on the next set of two-year milestones.

New York, Delaware, Virginia, and West Virginia

The initial outreach strategy for New York, Delaware, Virginia and West Virginia has been developed in recognition that these states, depending on the scenario, have little or no CWIP implementation planned. If included in one or more of the Scenarios (described later in this draft), these states have very specific and limited targeted areas and/or limited BMP implementation levels.

Audience

The primary stakeholders identified in these states include state agency staff and those that have a central role in project implementation in the specific watersheds identified in the final CWIP (e.g. conservation district staff).

Communications

Because implementation (if any) is limited and highly targeted in these states, the CIT will focus primarily on direct communication with the audience via conference calls and web-meetings.

Programmatic and Numeric Implementation Commitments

Conowingo Implementation Program Structure

The Conowingo Implementation Program is structured to dovetail and work in tandem with financing institution and existing state or grant programs to deploy implementation funds in the most efficient way possible while providing thorough review and oversight of project offers and contracts.

Implementation of projects funded for the purpose of reducing nutrient loads associated with the CWIP could occur through three primary pathways:

1. Existing cost-share programs
2. Directly through Pay-for-Performance (or similar contracts)
3. In partnership with foundations/grant-making organizations

Existing State Cost-Share Programs

To prevent the development of duplicative or redundant programs, implementation of the CWIP could take advantage of implementation programs identified in the jurisdictions' WIPs. The jurisdictional WIPs provide a complete list of programs currently in place with information on what areas of implementation the program covers. Each Bay jurisdiction has a network of programs that could be utilized based on the selected BMP strategy, while this document only focuses on a few key programs in each jurisdiction that are in-line with the Conowingo WIP implementation goals.

Pennsylvania

Conservation Excellence Program: The Conservation Excellence Program is a grant program administered by the State Conservation Commission and provides technical assistance and project funding through a mix of grants, low-interest loans, and tax credits to help farmers and landowners implement conservation BMPs.

Environmental Stewardship Fund: The Environmental Stewardship Fund is a dedicated fund used for environmental restoration and conservation and community revitalization projects. Funds from the Environmental Steward Fund are directed to the Department of Agriculture, the Department of Environmental Protection, the Department of Conservation and Natural Resources, and PennVEST for water and wastewater treatment facilities, and grants to local governments and nonprofits.

Maryland

Maryland Agricultural Water Quality Cost-Share (MACS) Program: The MACS program is administered by the Maryland Department of Agriculture (MDA) and provides farmers with grants to cover up to 87.5% of the cost to install BMPs on their farms to prevent soil erosion, manage nutrients, and safeguard water quality in streams, rivers, and the Chesapeake Bay. The MACS program provides implementation cost-share funding and support for more than 30 BMPs currently, such as grassed waterways, streamside buffers, and animal manure management systems.

Virginia

Agricultural BMP Cost-Share (VACS) Program: The VACS program supports the use of various practices in conservation planning to treat cropland, pastureland, hay land, and forested land. Some are paid for at a flat rate or straight per-acre rate. Others are cost-shared on a percentage basis up to 100%. In some cases, the United States Department of Agriculture (USDA) also pays a percentage. All practices in the program have been included because of their ability to improve or protect water quality.

Virginia Conservation Assistance Program (VCAP): The VCAP program is an urban cost-share program that provides financial incentives and technical and educational assistance to property owners installing eligible BMPs in Virginia's Chesapeake Bay Watershed. Qualified sites include residential, commercial, or recreational lands with a proposed practice that addresses a water quality need.

Delaware

Delaware Chesapeake Bay Implementation Grant Program: This is a grant funding program for BMP implementation projects that reduce nutrient and sediment loads. The available funding is used to assist with implementation of BMP projects identified in Delaware's Chesapeake Bay WIP. The program prioritizes projects that demonstrate cost-effective approaches to measurable water quality improvements and targets cost-effective BMPs (e.g., forest buffers, water control structures, tree plantings, grass buffers, cover crops, and wetland restoration). Eligible applicants include: State agencies, county or municipal governments, conservation districts, not-for-profit organizations representing local governments, watershed organizations, community organizations, and/or homeowners' associations within the State of Delaware's portion of the Chesapeake Bay watershed.

New York

New York Agricultural Non-Point Source Abatement and Control Program: This is a cost-share grant program that provides funding to address and prevent potential water quality issues that stem from farming activities. Financial and technical assistance supports the planning and implementation of on-farm projects with the goal of improving water quality in New York's waterways. The program seeks to support New York's efforts to implement BMP systems that improve water quality and environmental stewardship. The program prioritizes water quality protection projects including nutrient management through manure storage, vegetative buffers along streams, and conservation cover crops. The program is a competitive grant program, with funds applied for and awarded through county Soil and Water Conservation Districts.

West Virginia

West Virginia Agricultural Enhancement Program: This program is administered by the West Virginia Conservation Districts with assistance from the West Virginia Conservation Agency. The program has been developed to assist the agricultural cooperators of West Virginia Conservation Districts with the voluntary implementation of BMPs on West Virginia agricultural lands in order to conserve and improve land and water quality. The program offers technical and financial assistance to implement priority BMPs. A primary objective of the program includes the reduction of nutrients and sediment from entering the States' waters.

Program Support

Most of the jurisdictional implementation programs utilize conservation districts, local governments, and or local partners to deliver technical support and/or funding. As a result, the local programs have the technical and administrative ability to implement, track, and verify BMPs and management plans in a manner that is consistent with CBP partnership requirements and specifications. While the technical and administrative ability to implement these BMPs are, for the most part, already in place to implement projects, the capital and human resources to increase the rate of implementation to meet CWIP goals are not in place. Based on discussions with State agency staff, a ramp up of implementation above WIP III goals will require additional communication, outreach, and/or incentives to allow implementation to move forward.

Since the CWIP requires additional implementation beyond WIP III, costs associated with outreach and education will likely increase since the landowners who are currently or likely to be cooperators have already been integrated into WIP goal-setting and increasing implementation will require working with landowners that, to date, have not expressed significant interested in adopting some of the BMPs needed to achieve the WIP III goals.

The cost of the CWIP implementation ramp up will likely vary across Bay jurisdictions and BMP types. However, based on discussions with State agency staff, it is estimated that local programs will need at least 8%–15% of the BMP implementation costs to support the additional technical and administrative needs. This cost can be refined based on the selected implementation strategy.

Financing Strategy

A financing strategy to address the funding requirements to implement BMPs identified in the CWIP a financing strategy is being developed by third-party grantees. The economic development component of the financing strategy is dependent on the final CWIP geography, BMPs, and implementation schedule. As a result, the CWIP financing strategy will be finalized after completion of the Plan.

Pay-for-Performance

The CWIP Implementation can also address the PSC's Efficiency in Innovation Principle by using Pay for Performance (PFP) solicitations and contracts to deploy implementation funding directly to the highest performing projects. These types of contract mechanisms align the incentives of permittees and implementers to cost-effectively produce and sustain pollutant load reductions that achieve water quality goals and could focus funding to large-scale conservation practices with desirable co-benefits. This implementation approach would link payments to pollutant load reductions, rather than, or in addition to, reimbursing expenses typical of grant-based funding programs, and minimizes risk of funding ineffective projects that do not deliver intended results (Praul, n.d.). The success of this approach for project implementation has been demonstrated by several jurisdictions and agencies in the Chesapeake Bay Watershed including programs administered by Anne Arundel County, Maryland, the Maryland Department of Transportation's State Highway Administration, and Pennsylvania's Department of Transportation. This project delivery strategy leverages existing programs and private sector capacity by providing access to CWIP funds through a future contracting process that will have well-defined metrics and goals. Further, PFP contracts can be structured to lessen the financial burden of public funds as project offerors seek practices to achieve measurable CWIP outcomes that are most nitrogen cost-effective and dovetail with the Chesapeake Bay load reduction outcomes. These contract solicitations can also be developed to account for secondary and co-benefits (habitat, flood control, etc.).

The PFP strategy can be utilized to incentivize the private sector to develop and demonstrate new implementation approaches that achieve additional efficiencies by assigning risk and adjustment factors to a variety of project opportunities. To allow for this flexibility and innovation, funding decisions would be informed through the use of "Project Tiers" to evaluate a level of risk associated with a variety of specific BMPs. This tier-based system allows stakeholders and project offerors the flexibility to innovate, optimize, and incorporate efficiencies into a variety of restoration strategies that are proven to offer nitrogen load reduction performance while taking risk factors into consideration. Figure 3 shows how specific BMPs are categorized into these project tiers.

Tier I: Low Relative Risk

Tier I projects are considered priority BMPs in the CWIP that are mostly land-based, and therefore easier to track and verify over time. They have established and approved CBP partnership protocols and credit calculations. They are currently being widely implemented and likely have habitat and other co-benefits. These projects offer the lowest relative risk due to the ability to provide clear guidance on project specifications and credit and ease of tracking and verifying.

Tier II: Moderate Relative Risk

Tier II projects are either not land-based or more difficult to track, verify, and credit. They have or will soon have an approved CBP partnership protocols and credit calculations. Currently, some are not widely implemented or the technical and site-specific requirements to identify and develop load reduction estimates for a specific project in the CWIP are not feasible at this time. These projects offer a moderate level of risk due to the ability to provide clear guidance on project specifications and credit but are more difficult to track and verify.

Tier III: High Relative Risk

Tier III is designed to provide a pathway for innovation and may or may not be land-based BMPs but do not have an approved CBP partnership protocol or credit at the time of this draft. However, these practices may be approved at some future point based on current research (STAC workshop recommendations) or an activity under study such as dredging. These practices may have significant potential for load reduction, but additional research and development will be required to document water quality improvement metrics and these practices would not receive credit towards the planning targets without additional evaluation by the CBP partnership. These projects offer the highest risk because there are no specifications or credit at this time, but pilot projects (such as the Maryland Dredging Pilot Project) could generate data to support a specification and credit in the future.

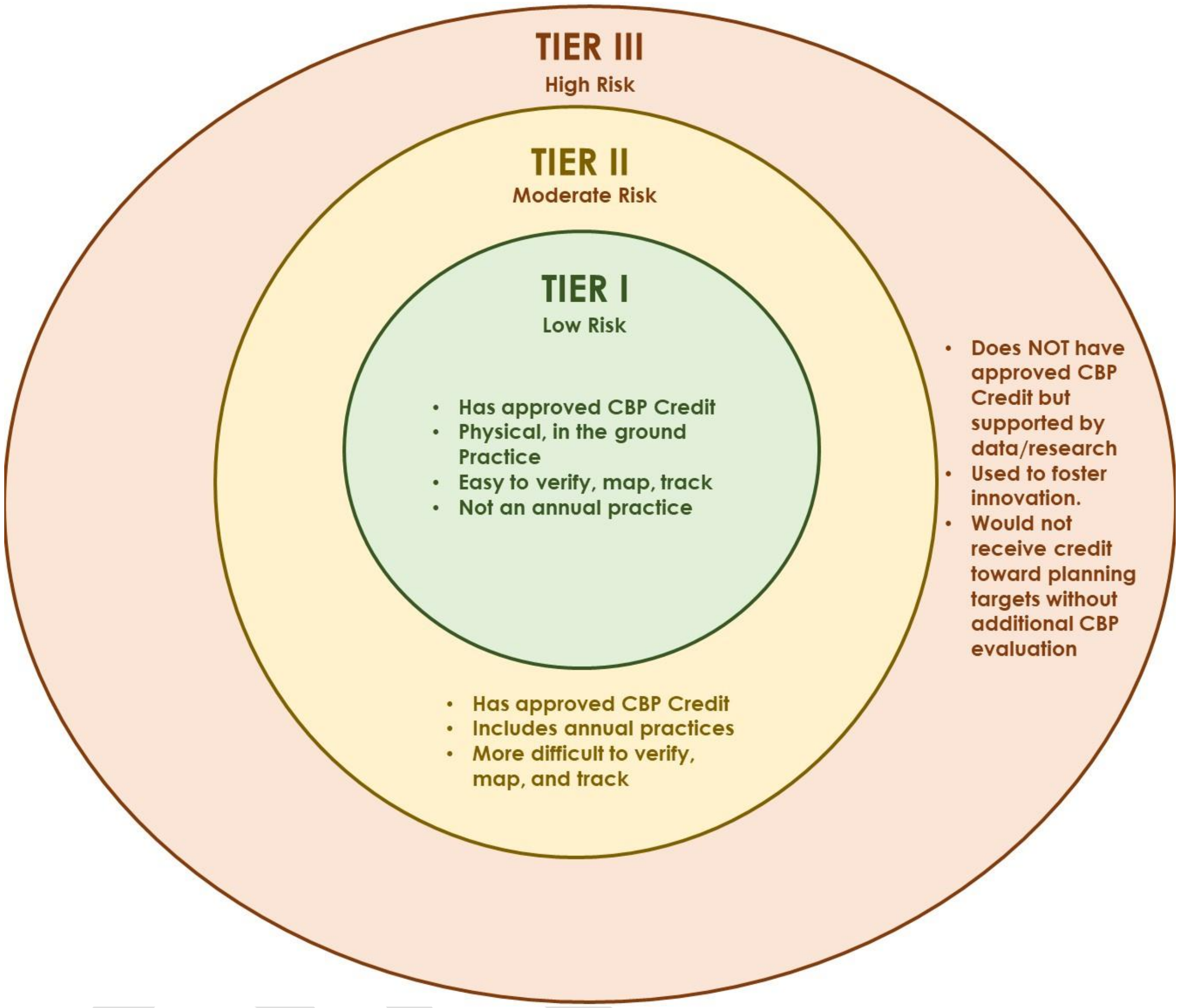

Figure 3. BMP project tiers matrix

Conowingo Implementation Team- Technical Review

In addition to the CIT outreach efforts, the CIT will assist EPA, the states, and engaged financial institutions by assisting with technical review of proposed projects that implement approved BMPs at scale or innovative approaches to BMP implementation that utilize detailed credit calculations. The technical review process will ensure that only technical sound projects with clear and accurate credit calculations will be considered for funding. To accomplish this, the CIT will work with the CBP partnership to:

- Evaluate project offers on a technical basis;
- Evaluate project offers on a cost basis;
- Confirm, verify, and track completed contracted projects; and,

- Ensure the practices funded by the contract are tracked as CWIP projects and are not double counted.

The CIT will work with stakeholders, landowners, local jurisdictions, and the private sector to:

- Provide information and education to increase the awareness of the CWIP Implementation Program and the technical requirements of the PFP contract solicitation including the review process for priority practices that are eligible, metrics for evaluating project offers, and the process for including Tier II or Tier III practices in project offers;
- Provide GIS resources and information to help interested parties identify the most nitrogen cost-effective locations, through the BMP Opportunity Analysis (Appendix D);
- Provide case-study examples of successful projects (when available); and,
- Ensure coordination of CWIP implementation with WIP III implementation at the local and jurisdictional level.

The CIT will be created and tasked with review and tracking for project investments at all stages of implementation with staff resources focusing on managing the program as opposed to managing the implementation of individual projects. The technical leads for the CIT are the Center for Watershed Protection (CWP) and the Chesapeake Conservancy. As technical leads, these organizations provide direct support to stakeholders working to identify and implement CWIP projects. This may include the following:

- Assisting the understanding of contract solicitation requirements;
- Educating interested parties on uncertainty, edge of tide, and exchange ratios when developing responses;
- Conducting site visits to review and document current conditions of specific sites; and,
- Providing GIS products to facilitate project identification, review, verification and calculation of CWIP credit.

The CIT would consist of members that can fulfill the following roles and responsibilities:

Conowingo Implementation Program Manager: Oversee and manage the CIT technical and outreach efforts, participate in the technical review, act as a point of contact with the CWIP Steering committee and CBP partnership, identify and contract with additional experts (as needed) to evaluate innovative project ideas, act as point of contact with project offerors, and oversee project verification and documentation *(the Center for Watershed Protection will function in this role)*.

Civil Engineer: Participate in the technical review by reviewing and commenting on the project approach, design, location, feasibility, and potential co-benefits.

Engineers are licensed or otherwise qualified experts with a demonstrated track record (*the Center for Watershed Protection with contractor support will function in this role)*.

GIS Specialists: Participate in the technical review by using available data and tools to review specific solicitation responses for potential primary and secondary benefits and develop tools to help stakeholder and interested parties identify and assess nitrogen cost-effective opportunities *(the Chesapeake Conservancy will function in this role)*.

Modeler: Participate in the technical review by reviewing and double-checking modeled load reduction estimates provided in specific solicitation responses *(the Center for Watershed Protection with support from EPA and/or contractors will function in this role)*.

Pay-for-Performance Contract Expert/Procurement Professional: Participate in the contract development and execution process, develop contract solicitation language and PFP contract language (*a qualified contractor will function in this role)*.

Funder Representative: Participate in the contract development and execution process, develops contract solicitation language, develops PFP contract language, processes requests for payments, and distributes funds *(this role will need to be further defined based on the financing strategy)*.

Outreach Specialists: Participate in outreach and education events developed for local stakeholders, landowners, and the private sector and provide information on contract solicitations and responses, CWIP tools and resources, and updates on progress or changes in the program *(the Chesapeake Conservancy, Center for Watershed Protection, University of Maryland Sea Grant Extension, and Harry R. Hughes Center will function in this role)*.

The technical review process will require support from qualified contractors who have specific knowledge and skills in key areas. The CIT Program Manager will identify potential contractors for each role using a request for qualification process to identify candidates that possess the required skills. The selection criteria will ensure there are no conflicts of interest by disqualifying any reviewers from consideration if they are part of a project offer in that cycle. Once qualified, potential contractors will provide hourly rate costs, which will be used as the basis for competitive selection. The CIT Program Manager will provide a roster to EPA and the CWIP Steering Committee of all selected contractors with a brief resume for approval. Approved contractors will be compensated based on their approved hourly rate and a predetermined number of hours to participate in the review process.

Conowingo Implementation Program Process

The CIT Program Manager will solicit contracts once per year with payment terms tied directly to the CWIP nitrogen load reduction goals. The contract solicitation will require that project offers utilize CBP partnership protocols and specifications in the responses and FieldDoc as part of the submittal process which will be evaluated for technical merit. Through the use of FieldDoc, project bids will document the location of the project which will allow the CWIP credit calculation to apply Edge of Tide and/or the Exchange ratios.

> Exchange ratio is the adjustment factor applied to all projects located outside of the Susquehanna watershed to compensate for the adjusted level of effort required to achieve comparable results in the Susquehanna watershed.
>
> Edge-of-Tide ratio is the adjustment factor applied to all projects to normalize loads based on delivery to the mainstem of the Chesapeake Bay. The appropriate factor shall be calculated using assessment tools consistent with the CBP partnership modeling tools and accepted by the CBP partnership (Davis-Martin, 2017).

All project offers will be thoroughly evaluated by the CIT for technical merit and will take into account project location when evaluating the credit. The technical review approach will be similar to the Maryland Water Quality Trading Program, which utilizes uncertainty ratios and Edge-of-Tide ratios to adjust for specific project types and locations. This analysis—which is consistent with methods used to define the priority basins—provides stakeholders and interested parties the ability to identify project locations within the selected CWIP geography that have the capacity to deliver the largest nitrogen reductions.

This approach supports the PSC's stated goal of developing a process by which preferred practices, targeted geographic locations, and implementation projects will be selected and deployed. It also supports the PSC's Transparency Principle by providing a contracting mechanism for project implementation that can transparently document practices that are funded by and implemented for credit towards achieving CWIP goals.

Pay-For-Performance Project Selection Process

The CIT will develop an implementation process that is transparent and identifies cost-effective projects for implementation to make progress towards the CWIP load reduction of 6 million pounds of nitrogen. A six-step process is proposed from contract solicitation and technical review to project acceptance and verification (Figure 4). Each of these steps is described below.

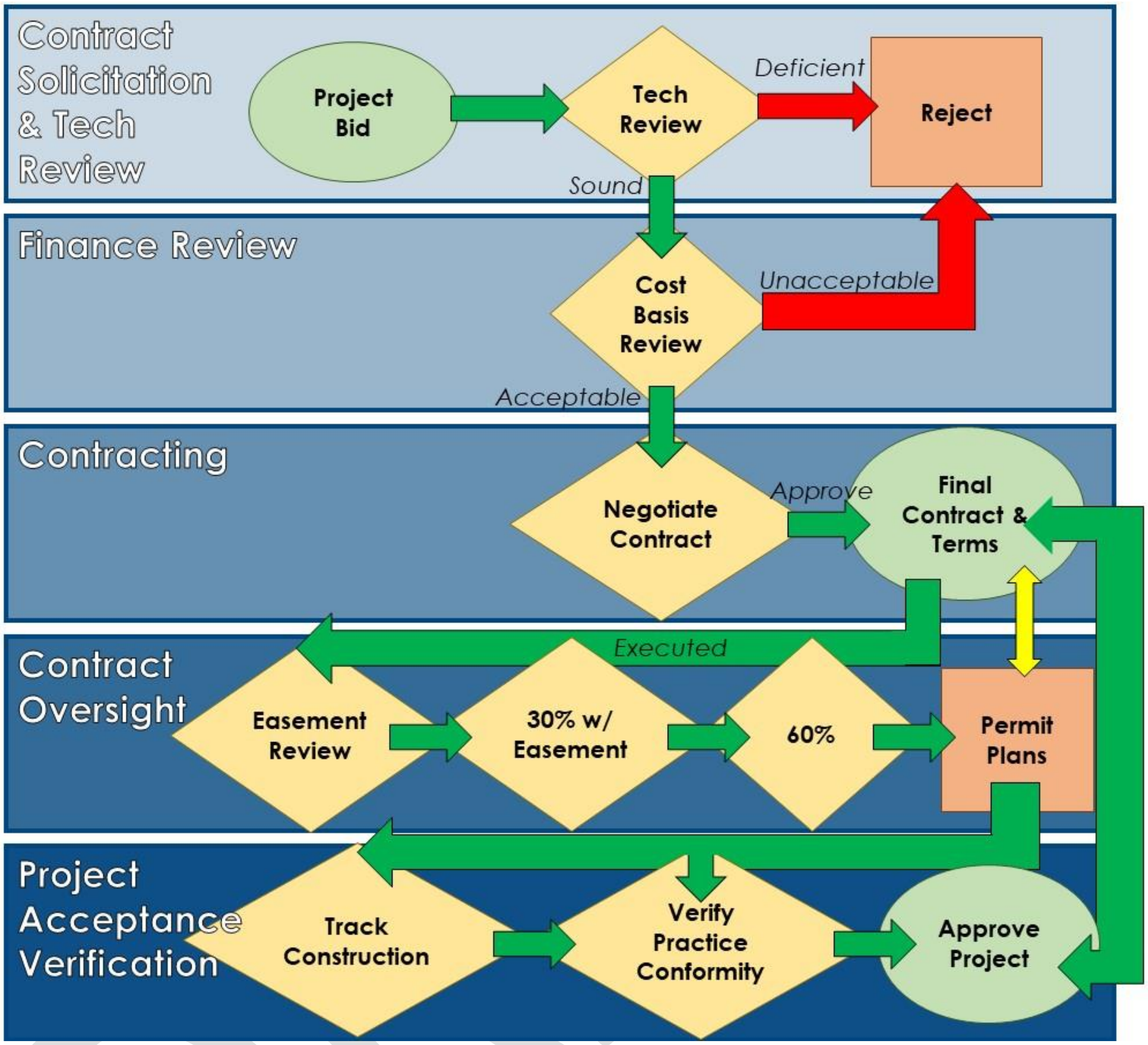

Figure 4. Pay-for-Performance project selection and verification process.

Solicitation Outreach

Once per year, the CIT in conjunction with project funders will release a solicitation for project offers using the PFP approach. The solicitation will clearly outline the practices that are eligible as Tier I and the process to bring in Tier II projects, that total nitrogen is the target/goal, and the methods and metrics for calculating load reductions. Tier III projects, such as dredging and benefited recuse, are innovative projects that could produce cost-effective nutrient reductions but are not currently credited, as such these project opportunities would be evaluated separately and would include requirements for performance monitoring. The solicitation will also include key contract language and provisions. The CIT will utilize existing Pennsylvania County Action Team meetings, regional partnership meetings, WIP III meetings, other appropriate meeting venues, and webcasts to raise awareness of the Conowingo Implementation Program and the PFP solicitation details and requirements.

Project Offer Review

The CIT will review all submitted project offers. Project offers will be required to provide sufficient design detail and documentation consistent with CBP partnership standards and protocols to determine if the design approach is sound, feasible, and creditable. This process will begin with a technical review which will evaluate the technical details of all projects including project location, BMP practice(s), design, credit calculation, feasibility, risk, co-benefits (if applicable) and easements/agreements. The process may include site visits to confirm and evaluate conditions at the proposed site. Any project deemed technically deficient in any area will be removed from consideration; projects deemed technically sound will move to the cost basis review. Based on the amount of funding available, the CIT will award contracts to the lowest responsive and responsible bidder (the bidder with the lowest cost who also meets all the required qualifications and submittal requirements) who proposes the BMP to reduce the most nitrogen from the Chesapeake Bay in the most cost-effective manner.

Contract Negotiation

The process of negotiating and establishing contracts for implementation of load reduction practices will be determined once the financing strategy is completed. However, it is envisioned that the contract will use nitrogen reduction as the primary metric of concern. Co-benefits as supplemental could also be integrated into the performance metric if desired. Contract language will need to be developed to address payment terms, transfer of lability, performance standards, etc. Additionally, provisions could be included in contracts allowing the nitrogen reduction credit to increase with documented monitoring supporting the increases (e.g., stream restoration) and allowing for adjustments in payment based on the documented increased performance metrics.

Contract Oversight

The CIT will provide administrative oversight of the contracts to ensure adherence to the contract terms and timely delivery. Oversight would occur at specific phases of the contract work plan. This oversight would focus primarily on ensuring protocols and specifications are being followed to generate the contracted performance metrics.

Project Acceptance Verification

Once operational, the CIT will conduct site visits to verify that the contracted project has been implemented in manner consistent with the contract and the established standards and specifications. Once all project elements are verified, the project will be accepted for payment. Projects will be re-verified on a periodic basis to ensure credit generation throughout the length of the contract.

Coarse BMP Opportunity Analysis

As this CWIP serves as a starting point for outreach and coordination with local stakeholders, the CIT developed a Coarse BMP Opportunity Analysis that identifies the potential implementation opportunities associated with in-the-ground BMPs for the Conowingo Shell geography identified in Scenarios 1 and 2. The Coarse BMP Opportunity Analysis will be updated for the final CWIP based on the final geography and CAST scenario chosen by the PSC. The specific location and type of BMPs will be further refined in the BMP Opportunity Analysis, which will be completed in subsequent phases of CWIP implementation as described in the Programmatic and Numeric Implementation Commitments section. The BMPs considered in this initial analysis were selected in consultation with the CWIP Steering Committee, as they address both developed and agricultural load sources, are accepted BMPs by the CBP partnership and data is available to map the extent of available area for future implementation. The BMPs included: wetland restoration, forested buffers, and living shorelines. The BMP opportunities analysis included the identification of areas within the Susquehanna + Most Effective Basins geography identified in the PSC Framework document where there is: 1) suitable watershed and land cover characteristics to implement wetlands, forested buffers, and living shoreline BMPs within the counties, 2) area within a specific landscape for the BMPs to have the greatest corresponding load reductions in the Chesapeake Bay, and 3) additional opportunities for nitrogen load reductions over and above the jurisdictions' Phase IIII WIP goals as estimated from the difference between the "E3" and Phase III WIP scenarios. The data sources and methods used to derive the BMP opportunities are included in Appendix C.

Figure 5, Figure 6, and Figure 7 illustrate the extent to which four of these BMPs may be implemented.

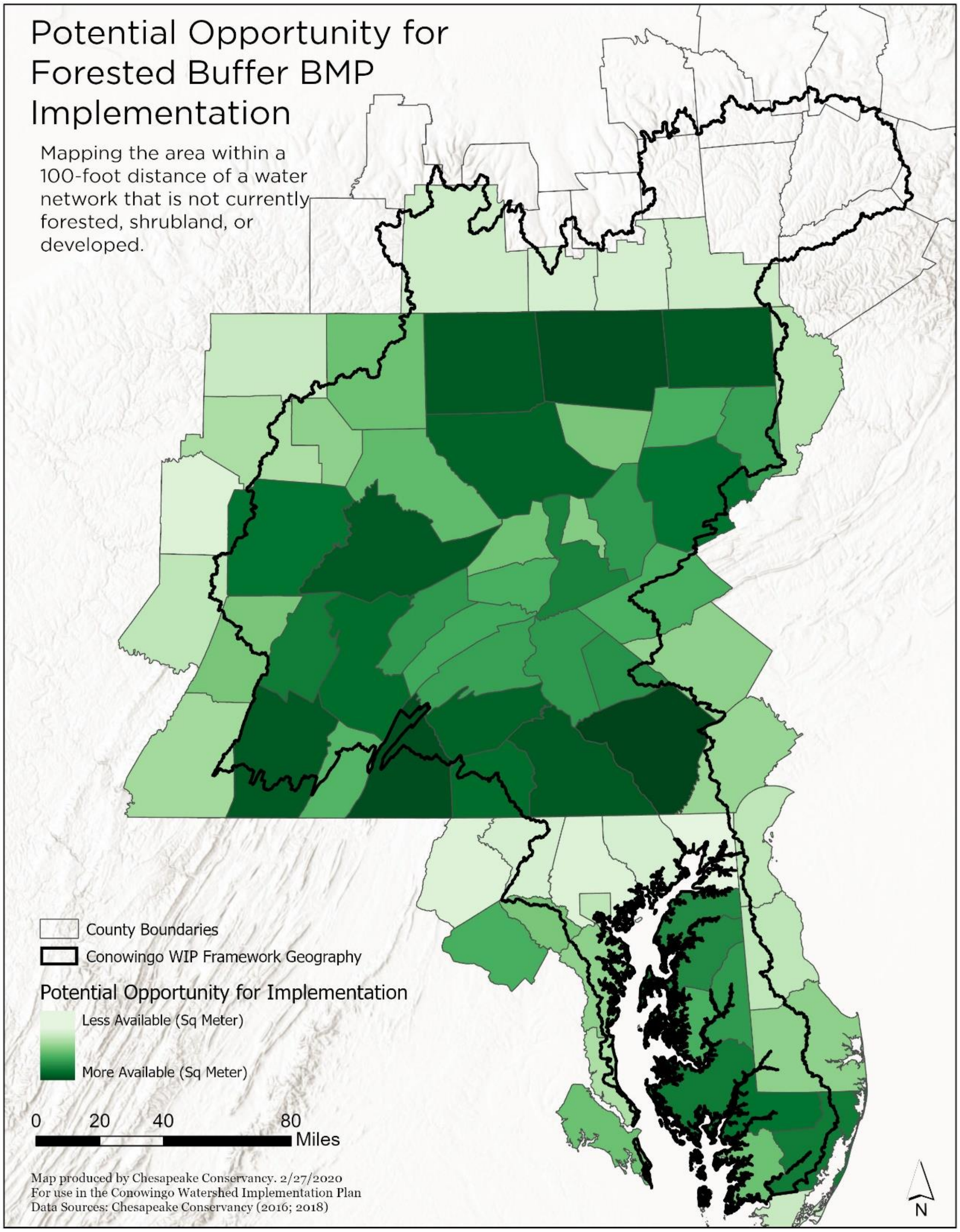

Figure 5. Opportunity to implement forest buffers within the Susquehanna + Most Effective Basins

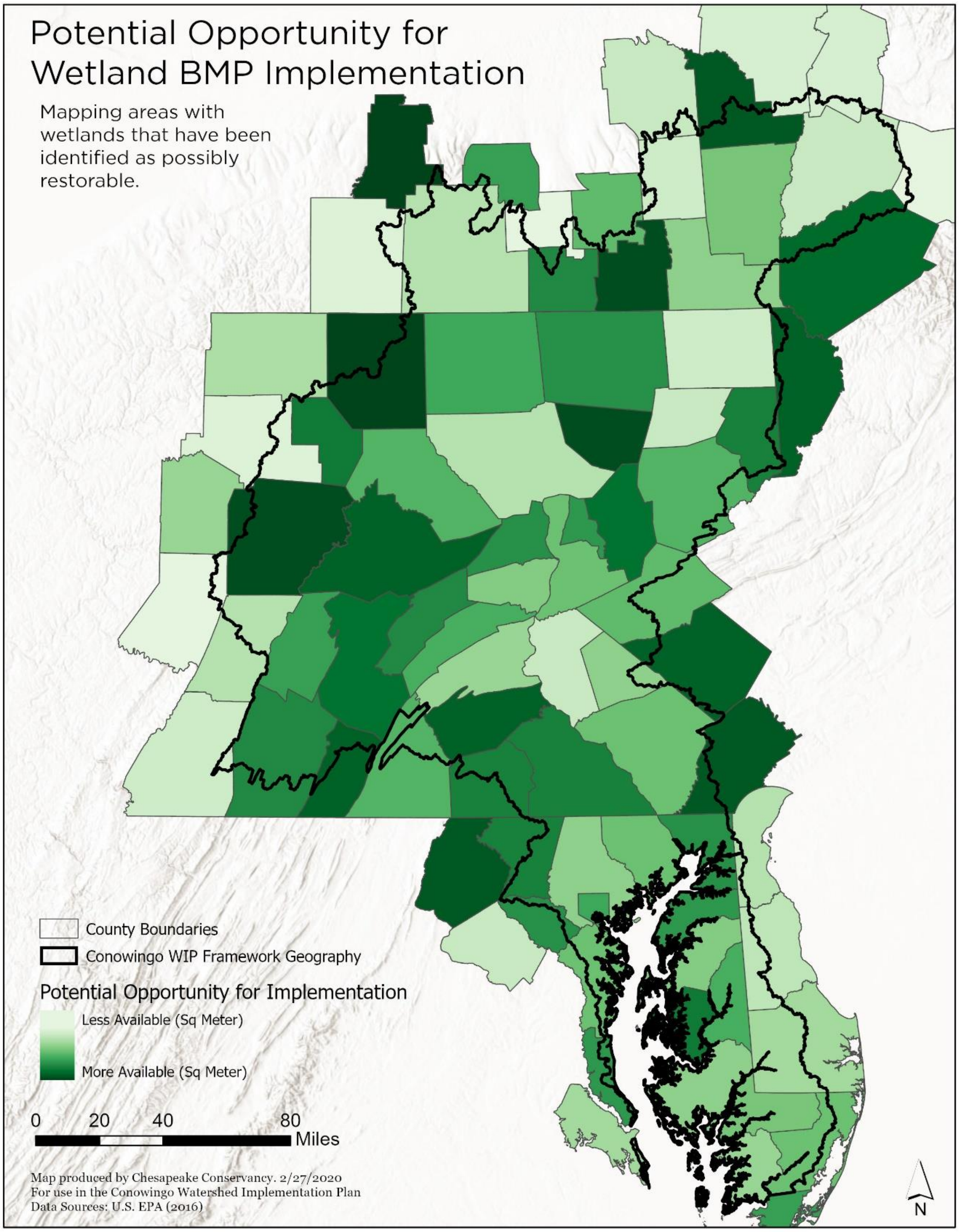

Figure 6. Opportunity to implement wetland restoration within the Susquehanna + Most Effective Basins

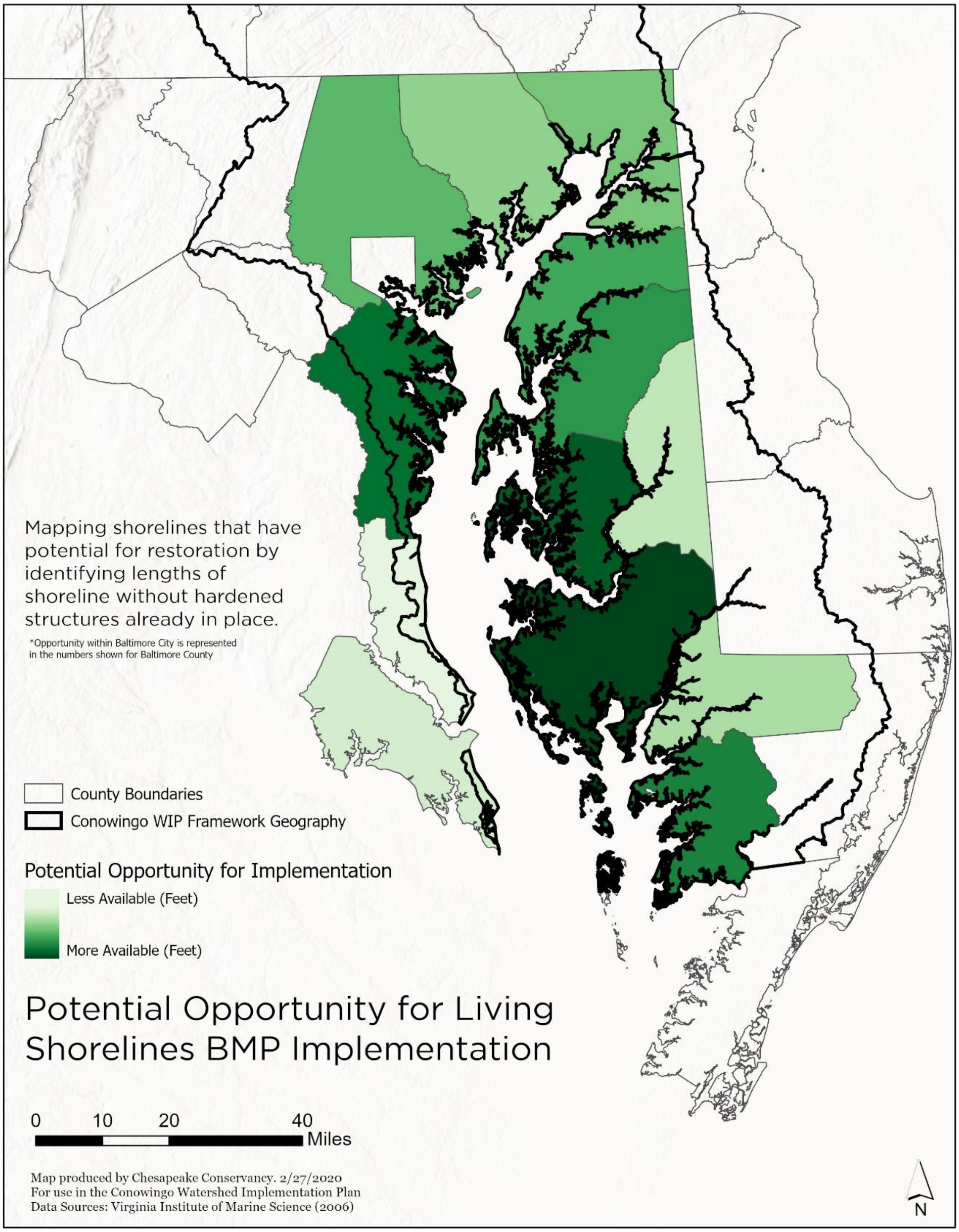

Figure 7. Opportunity to implement living shorelines within the Susquehanna + Most Effective Basins

CAST Scenarios: Part 1

The draft CWIP provides 11 different implementation scenarios developed in CAST that results in the required reduction of 6 million pounds of nitrogen, all of which are summarized in the table below. All of the scenarios are presented in this document for review and consideration by the CWIP Steering committee and the PSC. Scenarios 1 through 5 were developed to provide a variety of approaches to achieving the required load reductions and the associated estimated costs. Scenarios 6.1 through 11 were developed specifically to enable a more consistent analysis between scenarios based on changes in geography or BMP selection.

Overview of all CAST scenarios, including geographic extent ("Geography"), BMP categories ("BMPs"), the total nitrogen reduction ("Total N Reduction (lbs/year)"), the total annualized cost ("Total Annualized Cost"), the cost effectiveness for nitrogen removal ("Cost Effectiveness ($/lbs)"), the name and affiliation of the person who ran the scenario ("Developer"), and additional notes for context and clarification ("Description & Notes").

Scenario	Attributes						
	Geography	**BMPs**	**Total N Reduction (lbs/year)**	**Total Annualized Cost ($/Year)**	**Cost Effectiveness ($/lbs)**	**Developer**	**Description & Notes**
1	Conowingo Shell > All counties in PA & MD > Drains to Chesapeake Bay > Excluded Phase I jurisdictions*	Agricultural + Urban	6.0 Million	$369 Million	$61	CWP	This is the only scenario that is aggregated by county; everything else is by land-river segment (LRS). This scenario uses the WIP3 baseline.
2	Susquehanna watershed > Added Q1 N-effective[1] LRS outside of the Susquehanna	Agricultural + Urban	6.1 Million	$236 Million	$39	CWP	This scenario uses the WIP3 baseline.
3	Only Q1 N-Effective[2] LRS within Bay Watershed	Agricultural	6.4 Million	$51 Million	$8	EPA CBP	Uses modified WIP 3 baseline; Scenario 10 is a modification of this scenario that uses the same BMPs, with a different focus geography
4	Only Q2 N-effective LRS within the Susquehanna watershed[3]	Agricultural	6.6 Million	$51 Million	$8	EPA CBP	
5	Only Q2 N-effective LRS within the Susquehanna watershed	Agricultural + Urban	6.6 Million	$51 Million	$8	CWP	The BMPs in this scenario are the same as Scenario 4, but it also includes urban forestry and urban buffer practices.
6	Conowingo Shell	Agricultural + Urban	6.2 Million	$124 Million	$20	CWP	Cost-Effective Ag Practices plus Urban Forestry and Bioswales

Overview of all CAST scenarios, including geographic extent ("Geography"), BMP categories ("BMPs"), the total nitrogen reduction ("Total N Reduction (lbs/year)"), the total annualized cost ("Total Annualized Cost"), the cost effectiveness for nitrogen removal ("Cost Effectiveness ($/lbs)"), the name and affiliation of the person who ran the scenario ("Developer"), and additional notes for context and clarification ("Description & Notes").

Scenario	Attributes						
	Geography	**BMPs**	**Total N Reduction (lbs/year)**	**Total Annualized Cost ($/Year)**	**Cost Effectiveness ($/lbs)**	**Developer**	**Description & Notes**
6.1	Conowingo Shell	Agricultural + Urban	6.2 Million	$90 Million	$14	CWP	This is a modification to Scenario 6 that incorporates BMP implementation levels and Urban BMPS (bioswale and infiltration) consistent with other final scenarios.
7	Conowingo Shell	Agricultural	6.0 Million	$67 Million	$11	CWP	Same as Scenario 6.1, but without urban BMPs
8	Only Q2 N-effective LRS within the Conowingo Shell	Agricultural + Urban	6.3 Million	$96 Million	$15	EPA CBP	Uses the same BMPs as Scenario 6.1 but focuses on the upper quartile LRSs. Uses modified WIP3 Baseline.
9	Only Q2 N-effective LRS within the Conowingo Shell	Agricultural	6.0 Million	$50 Million	$8	EPA CBP	Same BMPs as Scenario 8, but without urban BMPs
10	Susquehanna watershed > Added Q1 N-effective[1] Bay-Wide LRS outside of the Susquehanna	Agricultural + Urban	6.2 Million	$82 Million	$14	CWP	Same BMPs as Scenarios 6.1 and 8
11	Susquehanna watershed > Added Q1 N-effective[1] Bay-Wide LRS outside of the Susquehanna	Agricultural	6.1 Million	$66 Million	$11	CWP	Same as Scenario 10 but without Urban BMPs

* If a county drains to the Chesapeake Bay and is partially within the Conowingo shell, then the whole county was included in the scenario output. Then, Phase I jurisdictions were removed (already heavily regulated and in less effective areas).

[1]Q1 Nitrogen (N)-Effective: Most effective land-river segments (LRS) for nitrogen reduction delineated by the upper quartile.

[2]Q2 Nitrogen (N)-Effective: Most effective land-river segments (LRS) for nitrogen reduction delineated by the median.

[3]This scenario uses 1995 CAST data.

Red Font Indicates Scenarios recommended to present to the PSC. Includes three geographies and Urban/Ag or Ag BMP options.

Scenario 1: Constrained

This scenario refines the BMP scenario from the previous CWIP draft by removing bioreactors, since it is not a CBP-partnership-approved BMP, and by increasing forest buffers as a replacement for the bioreactors.

Scenario 1. Constrained	
Geographic Extent	Susquehanna River Basin (PA) + Western and Eastern Shore (MD) Geobasins
Primary BMPs	Forest Buffers, Wetland Restoration, Stream Restoration, Living Shorelines, Bioswales
States Included	Maryland, Pennsylvania
N Reduction	6,000,026 pounds/year
Total Annualized Cost	$367,838,818
Cost Per Pound	$61.31

Scenario 1 Geography

This geographic option, presented in the CWIP Framework as the "Susquehanna + Most Effective Basins," represents the entire Susquehanna Basin along with the major State basins that are most effective for improving DO in the Chesapeake Bay based on reducing phosphorus in the watershed. The top six most effective basins for phosphorus represent a statistical break in the data and when combined with the three Susquehanna basins provide a simple, consolidated boundary within which to target the CWIP. Figure 8 illustrates this geography, which includes the Susquehanna, Western Shore, and Eastern Shore (Upper, Middle, and Lower) geobasins. This boundary was selected by the PSC as the geographic focus for the CWIP and was used to develop the initial CWIP BMP scenario. This scenario focuses BMP implementation on counties whose entire land area is fully contained within the boundary. This scenario excludes jurisdictions in New York and Delaware due to low effectiveness, and MS4 jurisdictions in Maryland outside the Susquehanna basin due to the amount of regulated land.

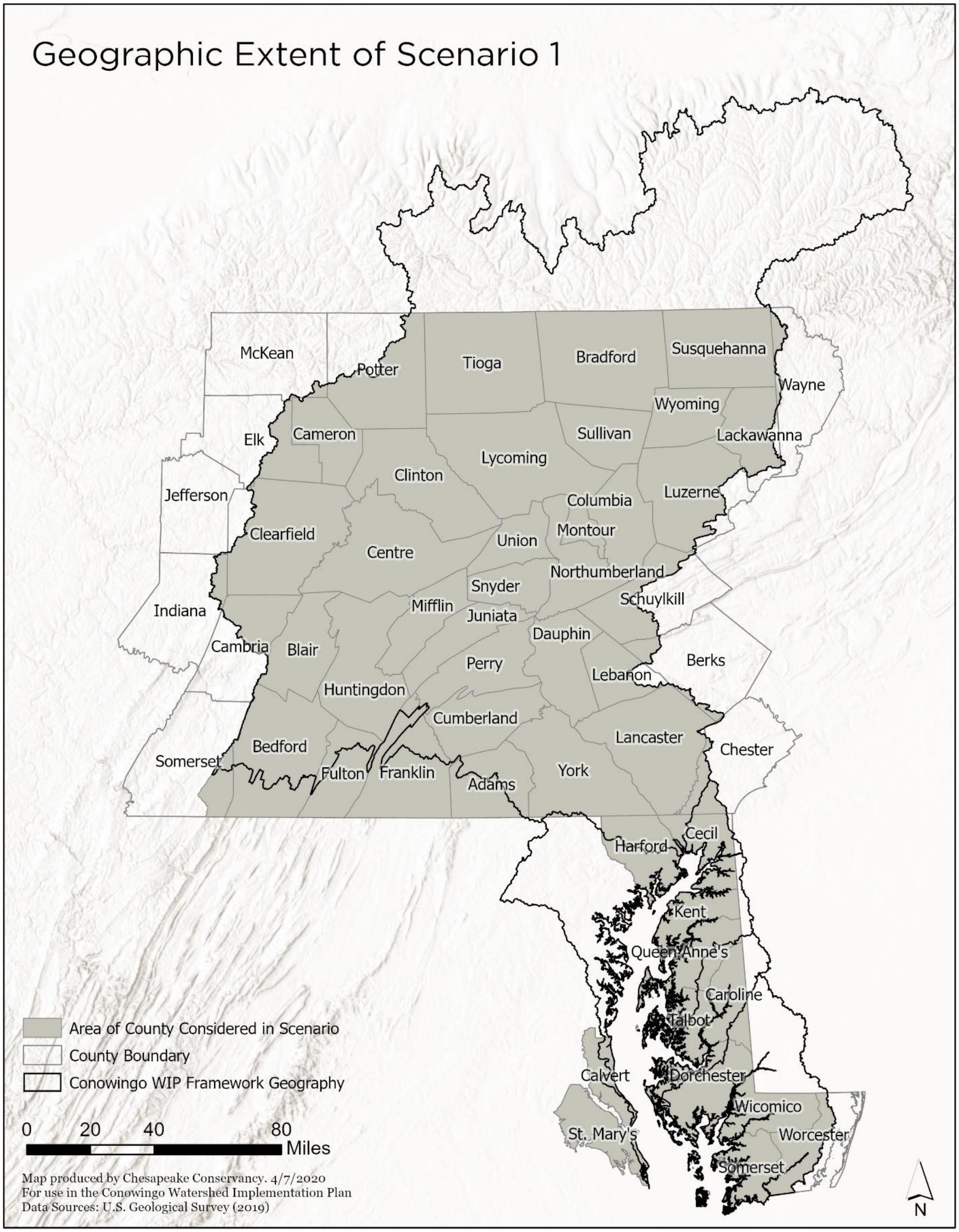

Figure 8. Scenario 1 geographic extent

Scenario 1 BMPs

This implementation scenario was developed to demonstrate the modeled nitrogen load reduction to the Bay based on BMPs that were selected collectively by the CWIP Steering Committee. Further, the BMPs address both developed and agricultural load sources, are accepted BMPs by the CBP partnership and data is available to map the extent of available area for future implementation (Table 5).

Table 5. Summary of acres of BMP implementation for Scenario 1

Proposed BMPs in Scenario 1: Constrained				
Practice	**Unit**	**Maryland**	**Pennsylvania**	**Total**
Agricultural Practices				
Forest Buffers on Fenced Pasture Corridor	Acres in Buffers	8,580	95,804	104,384
Forest Buffers	Acres in Buffers	16,111	44,960	61,071
Wetland Restoration	Acres	6,586	34,326	40,912
Non-Urban Stream Restoration	Feet	419,995	2,959,918	3,379,913
Non-Urban Shoreline Management	Feet	773,022	-	773,022
Urban Practices				
Bioswale	Feet	2,415	12,137	14,552
Urban Stream Restoration	Acres	324,384	1,358,957	1,683,341

Scenario 1 Loads Results

The data sources and methods used to quantify the load reductions are included in Appendix E. This initial BMP implementation strategy achieves the required reduction of 6 million pounds annually (Table 6).

Table 6. Summary of Scenario 1 nitrogen load reductions

NITROGEN LOADS FOR SCENARIO 1: CONSTRAINED				
STATE	**Sector**	**Baseline**	**Scenario 1**	**N Reduction**
MD	Agriculture	13,840,672	12,989,629	851,043
	Developed	7,684,437	7,674,370	10,067
	Natural	6,271,233	6,089,006	182,227
	Septic	2,545,801	2,545,801	-
	MD Total	**30,342,143**	**29,298,806**	**1,043,337**
PA	Agriculture	39,428,949	35,123,923	4,305,026
	Developed	14,874,103	14,798,709	75,394
	Natural	17,459,042	16,882,773	576,269
	Septic	1,985,752	1,985,752	-
	PA Total	73,747,846	68,791,157	4,956,689
TOTAL		**104,089,990**	**98,089,964**	**6,000,026**

Scenario 1 Cost

Table 7 provides an overview of the costs associated with implementation of the BMP scenario identified in Table 6. The annualized costs are derived from the CBP partnership's Chesapeake Assessment Scenario Tool (CAST). This scenario is the least cost-effective option, largely because many agricultural practices were not incorporated, and due to efforts to restrict the loss of cropland.

Table 7. Summary of costs for BMPs Implemented in Scenario 1

Annualized Costs by State and Sector for Scenario 1. Constrained				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$7,127,298	$ 2,388,661	$ 55,299,681	$ 64,815,641
PA	$ 73,290,317	$ 12,003,399	$ 217,729,462	$ 303,023,178
Total	$ 80,417,615	$ 14,392,061	$ 273,029,143	$ 367,838,819

These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. As stated in the Pennsylvania Phase III WIP, there are other important sources of cost variability, including:

• Changes in technology, protocols, and/or credit inputs for BMPs. The cost structure to inputs for many of these practices has changed and continues to change as protocols are updated and the costs for raw materials, transportation, labor, etc. evolve.

- Design and scale can significantly drive cost estimate variation by several orders of magnitude. The use of full delivery contracts—where a contractor or project offeror seeks out and acquires suitable property for the project, then integrates the design, construction, and post-construction operation and maintenance for CWIP implementation—can drive the private sector to find efficiencies through design and create scalable implementation opportunities.

- Variation in local costs. Although CAST includes Maryland and Pennsylvania default costs the CWIP priority geographies are spread across as large geographic area and local economic conditions as well access to labor and materials.

- Operations & Maintenance (O&M) assumptions and real costs. Each BMP has an estimated cost associated with O&M. However, design, location, materials, implementation methods, and weather are just a few factors that can impact both short- and long-term O&M costs.

These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Scenario 2: Enhanced WIP Implementation

This scenario considers that there may be additional opportunity to implement WIP III BMPs, which can be credited towards the CWIP. The scenario assumes a 25% increase in implementation of BMPs at the WIP III level of implementation within the geographic areas defined below.

Scenario 2. Enhanced WIP Implementation	
Geographic Extent	Susquehanna Basin Plus N-Effective LRSs outside the Susquehanna.
Primary BMPs	All BMPs at the WIP3 Implementation Level
States Included	Maryland, Pennsylvania, Delaware, New York, Virginia, West Virginia
N Reduction	6,098,728 pounds/year
Total Annualized Cost	$235,908,443
Cost Per Pound	$38.68

Scenario 2 Geography

This geography includes the entire Susquehanna River basin, along with additional Land River Segments (LRSs) in the top quartile for relative effectiveness (based on nitrogen reduction) in the Chesapeake Bay Watershed. The dark areas in

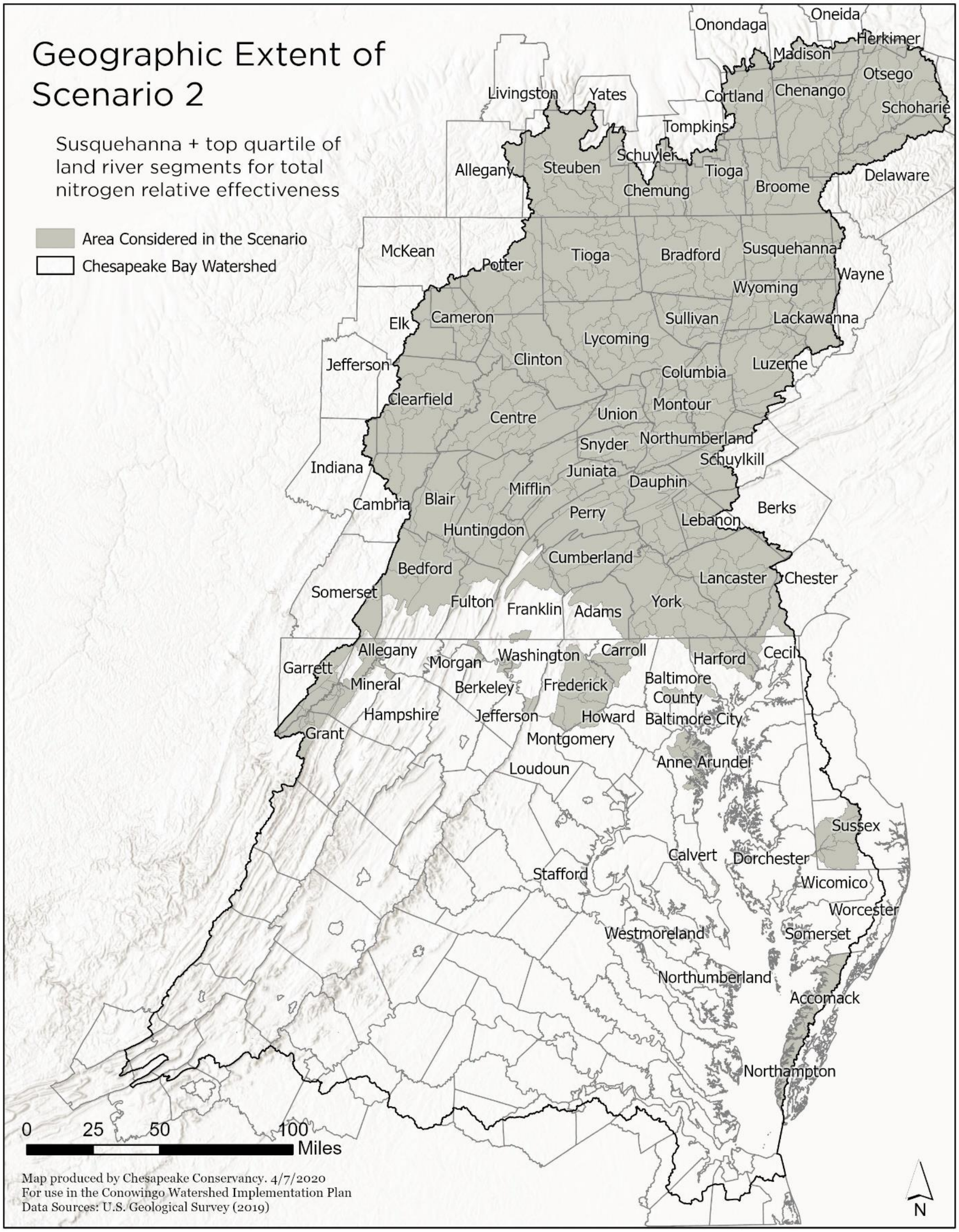

Figure 9 highlight the upper quartile segments.

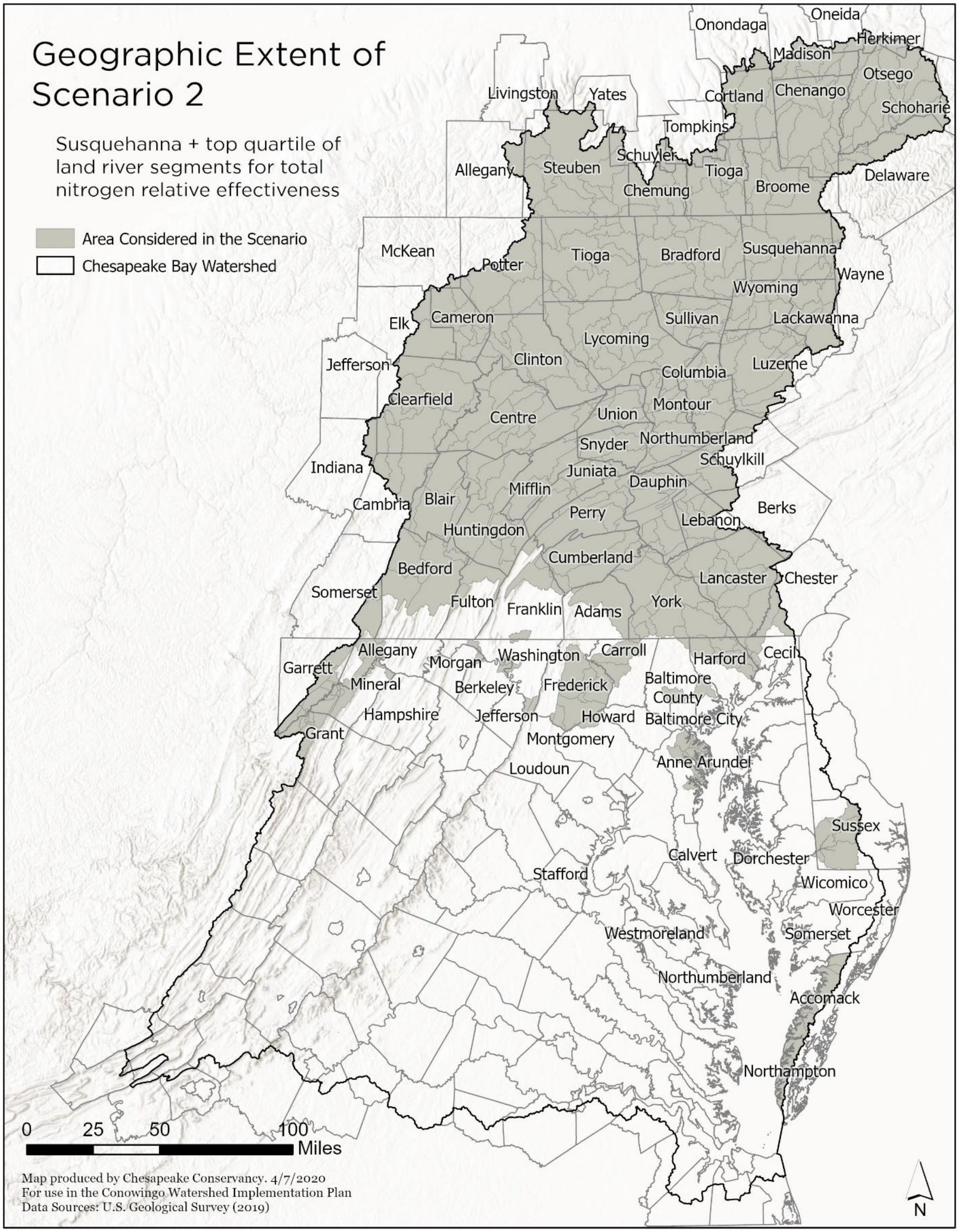

Figure 9. Scenario 2 geographic extent

Scenario 2 BMPs

This implementation scenario was developed to demonstrate the modeled nitrogen load reduction to the Chesapeake Bay based on BMPs that were selected by the jurisdictions as part of their WIP III strategies. These BMPs address both developed and agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation. This scenario is used to illustrate the ability to achieve the needed load reductions by increasing the scale, scope, or number of projects. Additionally, this scenario could integrate with a strategy that involves participation in a trading program where load reduction credits are available from WIP III projects that exceed their individual project goals and produce additional tradable credit. The BMPs included in this scenario include those in the jurisdictions' WIPs, as well as others implemented prior to the WIP[4], and are provided in Appendix H.

Scenario 2 Loads Results

This BMP implementation strategy, as shown in

[4] The full suite of BMPs included in this scenario can be refined to reflect a narrower range of practices.

Table 8, achieves the required reduction of slightly over 6 million pounds annually.

Table 8. Summary of Scenario 2 nitrogen load reductions

N LOADS FOR SCENARIO 2: ENHANCED WIP IMPLEMENTATION				
STATE	**Sector**	**Baseline**	**Scenario 2**	**N Reduction**
DE	Agriculture	1,206,209	1,075,719	130,489
	Developed	264,208	250,857	13,352
	Natural	176,331	173,131	3,199
	Septic	56,121	53,468	2,653
	DE Total	**1,799,438**	**1,649,745**	**149,694**
MD	Agriculture	3,571,216	3,233,321	337,895
	Developed	2,147,369	2,099,466	47,903
	Natural	1,557,861	1,533,448	24,412
	Septic	837,096	825,800	11,296
	MD Total	**8,874,894**	**8,453,387**	**421,507**
NY	Agriculture	4,918,504	4,654,984	263,520
	Developed	1,398,622	1,248,440	150,182
	Natural	2,844,262	2,814,968	29,295
	Septic	176,675	176,675	-
	NY Total	**11,432,120**	**10,989,124**	**442,996**
PA	Agriculture	35,795,450	31,291,008	4,504,443
	Developed	14,064,630	13,847,623	217,007
	Natural	16,487,560	16,284,325	203,235
	Septic	1,767,113	1,722,399	44,714
	PA Total	**76,100,989**	**71,131,590**	**4,969,399**
VA	Agriculture	590,902	512,982	77,920
	Developed	132,627	125,614	7,012
	Natural	198,344	192,908	5,436
	Septic	28,758	27,046	1,712
	VA Total	**968,785**	**876,704**	**92,081**
WV	Agriculture	219,951	208,491	11,460
	Developed	148,966	148,234	732
	Natural	282,158	280,795	1,363
	Septic	27,776	27,279	497
	WV Total	**813,682**	**799,630**	**14,052**
TOTAL	***99,989,907.74***	***99,989,907***	***93,900,179***	***6,089,728***
1: The loads reported in this table are adjusted to equate to nitrogen reductions from the Susquehanna, using the methods described in Appendix E.				

Scenario 2 Cost

Table 9 provides an overview of the costs associated with implementation of the BMP scenario identified in

Table 8. The annualized costs are derived from CAST. This option is more cost-effective than Scenario 1, but it has not been optimized to select the most cost-effective options.

Table 9. Summary of costs for BMPs implemented in Scenario 2

Annualized Costs by State and Sector for Scenario 2: Enhanced WIP Implementation					
	Agriculture	**Developed**	**Natural**	**Septic**	**Total**
DE	$2,635,272	$2,063,607	$1,644,871	$1,405,222	**$7,748,972**
MD	$4,160,624	$11,394,309	$11,247,559	$4,177,592	**$30,980,084**
NY	$14,736,078	$57,419,493	$288,990	-	**$72,444,561**
PA	$41,749,277	$45,334,120	$22,519,019	$6,211,214	**$115,813,630**
VA	$1,824,054	$3,931,166	$1,585,852	$1,046,643	**$8,387,715**
WV	$180,534	$286,337	$15,115	$51,495	**$533,481**
Total	***$65,285,839***	***$120,429,032***	***$37,301,407***	***$12,892,165***	***$235,908,443***

These costs should be considered as initial estimates only and may change significantly on a per-unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Scenario 3: Nitrogen-Effective, Bay-wide

This scenario includes only the most cost-effective BMPs for nitrogen reduction, all of which are applied on agricultural lands within targeted geographic areas of the Chesapeake Bay watershed described below.

Scenario 3. Nitrogen-Effective, Bay-wide	
Geographic Extent	Nitrogen-Effective Segments Throughout the Bay Watershed
Primary BMPs	• Nutrient Application Management Core Nitrogen, Rate, Placement, and Timing • Conservation, High-Residue, and Low-Residue Tillage • Prescribed Grazing • Grass and Forest Buffers • Wetland Restoration • Soil and Water Conservation Plan • Manure Incorporation • Barnyard Runoff Controls
States Involved	Maryland, Pennsylvania, Delaware, Virginia, West Virginia
N Reduction	6,376,678 pounds/year
Total Annualized Cost	$50,989,853
Cost Per Pound	$7.99

Scenario 3 Geography[5]

This geographic option targets LRSs in the top quartile for relative effectiveness (based on nitrogen reduction) across the entire Bay watershed (Figure 10).

[5] The relative effectiveness of LRS in this scenario was based on CAST modeling assumptions used to develop the TMDL, which assume the Conowingo dam is trapping sediment and associated nutrients. Use of these "1995 conditions" resulted in only minor differences in which LSRs are most effective. If selected by the PSC, the scenario will be refined to reflect the Conowingo infill condition.

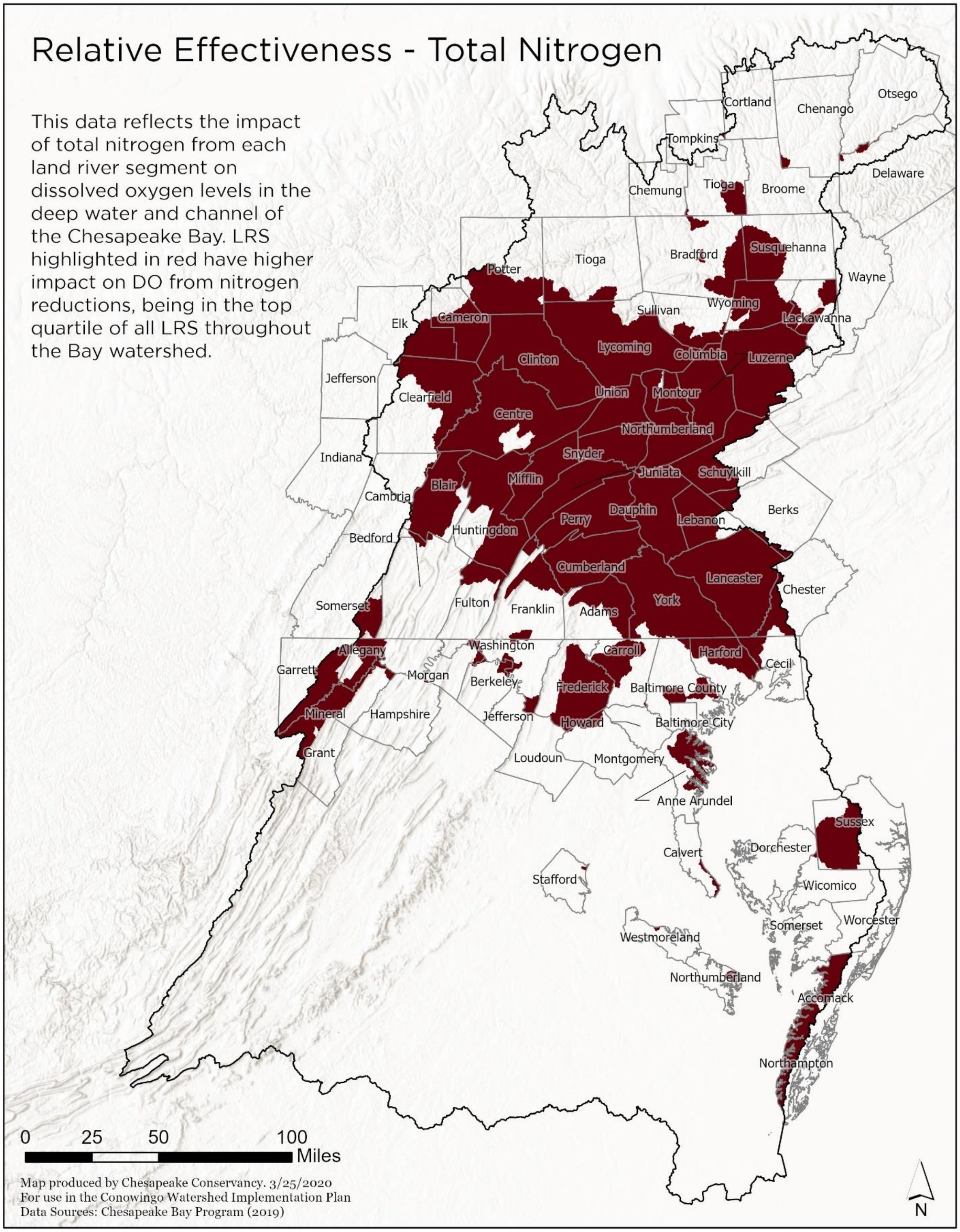

Figure 10. Scenario 3 geographic extent

Scenario 3 BMPs

This implementation scenario was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen. These BMPs only address agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation (Table 10). This scenario is used to an illustrate an approach that optimizes cost-effectiveness of BMP implementation.

Table 10. Summary of acres of BMP implementation for Scenario 3

BMPs Implemented in Scenario 3. Nitrogen-Effective, Bay-wide			
Practice	**Duration**	**Unit**	**Amount**
Nutrient Application Management Core Nitrogen	annual	Acres	497,108
Nutrient Application Management Rate Nitrogen	annual	Acres	680,286
Nutrient Application Management Placement Nitrogen	annual	Acres	230,891
Nutrient Application Management Timing Nitrogen	annual	Acres	644,867
Conservation Tillage	annual	Acres	160,978
High Residue Tillage	annual	Acres	63,263
Low Residue Tillage	annual	Acres	81,069
Prescribed Grazing	cumulative	Acres	127,102
Forest Buffers	cumulative	Acres in Buffers	11,882
Wetland Restoration	cumulative	Acres	14,480
Grass Buffers	cumulative	Acres in Buffers	46,762
Soil and Water Conservation Plan	cumulative	Acres	432,625
Manure Incorporation	annual	Acres	166,857
Barnyard Runoff Control	cumulative	Acres	1,309

Scenario 3 Loads Results

This BMP implementation strategy, as shown in Table 11, achieves the required reduction of 6 million pounds of nitrogen annually. Reductions are achieved almost entirely within the agricultural sector, as these practices are overall the most cost-effective and represent a large percent of the area being considered.

Table 11. Summary of Scenario 3 nitrogen load reductions

Nitrogen Load Reductions for Scenario 3: Nitrogen-Effective, Bay-wide[1]				
STATE	**Sector**	**Baseline**	**Scenario 3**	**N Reduction**
DE	Agriculture	2,104,913	2,104,332	581
	Developed	427,933	427,933	-
	Natural	316,614	316,589	25
	Septic	114,768	114,768	-
	DE Total	**2,964,228**	**2,963,622**	**606**
MD	Agriculture	14,379,353	13,080,247	1,299,106
	Developed	7,620,554	7,620,554	-
	Natural	6,230,638	6,184,525	46,113
	Septic	2,551,945	2,551,945	-
	MD Total	**30,782,491**	**29,437,272**	**1,345,219**
PA	Agriculture	42,335,501	37,608,018	4,727,483
	Developed	14,878,339	14,878,339	-
	Natural	17,575,268	17,410,473	164,795
	Septic	1,985,768	1,985,768	-
	PA Total	**76,774,876**	**71,882,598**	**4,892,278**
VA	Agriculture	7,619,879	7,496,459	123,420
	Developed	4,351,743	4,351,743	-
	Natural	5,013,391	5,008,026	5,365
	Septic	1,063,019	1,063,019	-
	VA Total	**18,048,032**	**17,919,247**	**128,785**
WV	Agriculture	2,407,593	2,398,867	8,726
	Developed	1,008,137	1,008,137	-
	Natural	2,176,604	2,175,540	1,064
	Septic	284,212	284,212	-
	WV Total	**5,876,547**	**5,866,757**	**9,790**
TOTAL		***134,446,174***	***128,069,495***	***6,376,678***
1: The loads reported in this table are adjusted to equate to nitrogen reductions from the Susquehanna, using the methods described in Appendix E.				

Scenario 3 Cost

Table 12 provides an overview of the costs associated with implementation of the BMP scenario identified in Table 11. The annualized costs are derived from CAST. Default costs for Pennsylvania, Maryland, Delaware, Virginia, and West Virginia within CAST were used to develop the cost estimates. A summary of the assumptions used to generate this estimate is provided in Appendix G.

Table 12. Summary of costs for BMPs implemented in Scenario 3

Annualized Costs by State and Sector for Scenario 3: Bay-Wide Cost-Effective Agriculture	
	Agriculture
DE	--
MD	$6,241,295
NY	--
PA	$44,385,635
VA	$169,432
WV	$193,491
Total	**$50,989,853**

BMP implementation in Delaware is minimal and the BMPs used in this scenario reduce overall costs so are listed as zero. These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Scenario 4: Nitrogen-Effective, Susquehanna

This scenario is similar to Scenario 3 in that it includes only the most cost-effective BMPs for nitrogen reduction, applied on agricultural lands. However, this scenario only applies BMPs within targeted geographic areas of the Susquehanna River Basin, as described below.

Scenario 4. Nitrogen-Effective, Susquehanna	
Geographic Extent	N-Effective Land River Segments (LRSs) Within the Susquehanna Watershed
Primary BMPs	• Nutrient Application Management Core Nitrogen, Rate, Placement, and Timing • Conservation, High-Residue, and Low-Residue Tillage • Prescribed Grazing • Grass and Forest Buffers • Wetland Restoration • Soil and Water Conservation Plan • Manure Incorporation • Barnyard Runoff Controls
States Involved	Maryland, Pennsylvania, New York
N Reduction	6,615,658 pounds/year
Total Annualized Cost	$51,032,822
Cost Per Pound	$7.71

Scenario 4 Geography[6]

This geographic option targets those LRSs in the top quartile for relative effectiveness (based on nitrogen reduction) within the Susquehanna River Basin only (Figure 11).

PLACEHOLDER NOTE: Figure 11 is in production.

Figure 11. Scenario 4 geographic extent

Scenario 4 BMPs

This implementation scenario was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen (Table 13). These BMPs only address agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation. This scenario is used to an illustrate an approach that looks primarily at reducing the cost per pound of nitrogen reduced but is limited to the Susquehanna River Basin, which has the greatest relative influence on DO in the Bay.

[6] The scenario presented was based on 1995 Modeling and will be refined to reflect the Conowingo Infill N-effective basins reflected in Figure 2.

Table 13. Summary of acres of BMP implementation for Scenario 4

BMPs Implemented in Scenario 4: Nitrogen-Effective, Susquehanna			
Practice	**Duration**	**Unit**	**Amount**
Nutrient Application Management Core Nitrogen	annual	Acres	305,137
Nutrient Application Management Rate Nitrogen	annual	Acres	668,563
Nutrient Application Management Placement Nitrogen	annual	Acres	227,905
Nutrient Application Management Timing Nitrogen	annual	Acres	673,548
Conservation Tillage	annual	Acres	214,027
High Residue Tillage	annual	Acres	45,579
Low Residue Tillage	annual	Acres	9,616
Prescribed Grazing	cumulative	Acres	94,269
Forest Buffers	cumulative	Acres in Buffers	22,729
Wetland Restoration	cumulative	Acres	12,479
Grass Buffers	cumulative	Acres in Buffers	24,117
Soil and Water Conservation Plan	cumulative	Acres	204,016
Manure Incorporation	annual	Acres	200,029
Barnyard Runoff Control	cumulative	Acres	755

Scenario 4 Loads Results

This BMP implementation strategy, as shown in Table 14, exceeds the required nitrogen reduction of 6 million pounds per year, reaching almost 6.6 million.

Table 14. Summary of Scenario 4 nitrogen load reductions

N LOADS FOR SCENARIO 4: NITROGEN-EFFECTIVE, SUSQUEHANNA				
STATE	**Sector**	**Baseline**	**Scenario 4**	**N Reduction**
MD	Agriculture	783,258	628,688	154,569
	Developed	338,577	338,577	-
	Natural	261,156	254,545	6,610
	Septic	198,843	198,843	-
	MD TOTAL	**1,581,834**	**1,420,654**	**161,180**
NY	Agriculture	5,980,815	5,832,273	148,541
	Developed	1,398,622	1,398,622	-
	Natural	2,922,999	2,915,574	7,425
	Septic	176,675	176,675	-
	NY Total	**10,479,111**	**10,323,144**	**155,966**
PA	Agriculture	38,269,615	32,142,759	6,126,856
	Developed	13,936,730	13,936,730	-
	Natural	16,439,618	16,268,052	171,566
	Septic	1,724,857	1,724,857	-
	PA Total	**70,370,820**	**64,072,398**	**6,298,422**
	TOTAL	***82,431,764***	***75,816,196***	***6,615,658***

Scenario 4 Cost

Table 15 provides an overview of the costs associated with implementation the BMP scenario identified in Table 14. The annualized costs are derived from CAST using a Chesapeake Bay cost basis, which is the average of unit cost estimates for all states. This option is also very cost-effective.

Table 15. Summary of costs for BMPs implemented in Scenario 4

Annualized Costs by State and Sector for Scenario 4: Cost-Effective Agriculture in the Susquehanna Basin				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,073,475.53	$3,813	-	$1,073,475
NY	$1,742,223.20	$65,371	-	$1,742,223
PA	$48,216,777.10	$5,133,682	$348	$48,217,124
Total	**$51,032,475.83**	***$5,202,867***	***$348***	***$51,032,822***

These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Scenario 5: Susquehanna, Nitrogen-Effective + Urban Equity

This scenario is the same as Scenario 4 except that it includes implementation of the most cost-effective urban BMPs for nitrogen removal.

Scenario 5. Susquehanna, Nitrogen-Effective + Urban Equity	
Geographic Extent	Nitrogen-Effective Land River Segments (LRSs) Within the Susquehanna Watershed
Primary BMPs	Agricultural • Nutrient Application Management Core Nitrogen, Rate, Placement, and Timing • Conservation, High-Residue, and Low-Residue Tillage • Prescribed Grazing • Grass and Forest Buffers • Wetland Restoration • Soil and Water Conservation Plan • Manure Incorporation • Barnyard Runoff Controls Urban • Forest Planting • Forest Buffers
States Involved	Maryland, Pennsylvania, New York
N Reduction	6,601,250 pounds/year
Total Annualized Cost	$51,298,783
Cost Per Pound	$7.77

Scenario 5 Geography[7]

This geographic option is the same as for Scenario 4, targeting those LRSs in the top quartile for relative effectiveness (based on nitrogen reduction) within the Susquehanna watershed (Figure 12).

PLACEHOLDER NOTE: Figure 12 is in production.

Figure 12. Scenario 5 geographic extent

Scenario 5 BMPs

This implementation scenario was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen. These BMPs address both developed and agricultural load sources, are accepted BMPs by the CBP partnership and data is available to map the extent of available area for future implementation (Table 16). Similar to Scenario 4, this scenario is used to illustrate an approach that looks primarily at reducing the cost per pound of nitrogen reduced limited to the Susquehanna watershed, but it adds in cost-effective urban practices to

[7] The scenario presented was based on 1995 Modeling and will be refined to reflect the Conowingo Infill N-effective basins reflected in Figure 2.

be more equitable in how the reductions are distributed across sectors. The Urban BMP scenario includes very aggressive use of urban forest planting and urban forest buffers, and it can be expanded to include a broader suite of urban BMPs. However, urban land, and in particular urban land that is not regulated by the MS4 program, represents a very small fraction of the total area of consideration.

Table 16. Summary of acres of BMP implementation for Scenario 5

BMPs Implemented in Scenario 5: Cost-Effective Agriculture + Urban Equity			
Practice	**Duration**	**Unit**	**Amount**
Agricultural Practices			
Nutrient Application Management Core Nitrogen	annual	Acres	305,137
Nutrient Application Management Rate Nitrogen	annual	Acres	668,563
Nutrient Application Management Placement Nitrogen	annual	Acres	227,905
Nutrient Application Management Timing Nitrogen	annual	Acres	673,548
Conservation Tillage	annual	Acres	214,027
High Residue Tillage	annual	Acres	45,579
Low Residue Tillage	annual	Acres	9,616
Prescribed Grazing	cumulative	Acres	94,269
Forest Buffers	cumulative	Acres in Buffers	22,729
Wetland Restoration	cumulative	Acres	12,479
Grass Buffers	cumulative	Acres in Buffers	24,117
Soil and Water Conservation Plan	cumulative	Acres	204,016
Manure Incorporation	annual	Acres	200,029
Barnyard Runoff Control	cumulative	Acres	755
Urban Practices			
Urban Forest Planting	cumulative	Acres	17,148
Urban Forest Buffers	cumulative	Acres	48,858

Scenario Loads Results

This scenario exceeds the Nitrogen target by over 600,000 pounds (Table 17). The agricultural BMP implementation was reduced by 5% to account for urban BMP implementation.

Table 17. Summary of Scenario 5 nitrogen load reductions

N LOADS FOR SCENARIO 5: SUSQUEHANNA COST-EFFECTIVE AG + URBAN EQUITY				
STATE	**Sector**	**Baseline**	**Scenario 5**	**N Reduction**
MD	Agriculture	783,258	640,063	143,195
	Developed	338,577	337,807	770
	Natural	261,156	255,091	6,065
	Septic	198,843	198,843	-
	MD TOTAL	**1,581,834**	**1,431,804**	**150,030**
NY	Agriculture	5,980,815	5,839,376	141,438
	Developed	1,398,622	1,393,111	5,510
	Natural	2,922,999	2,916,291	6,708
	Septic	176,675	176,675	-
	NY Total	**10,479,111**	**10,325,454**	**153,657**
PA	Agriculture	38,269,615	32,704,182	5,565,433
	Developed	13,936,730	13,299,229	637,501
	Natural	16,439,618	16,344,989	94,629
	Septic	1,724,857	1,724,857	-
	PA Total	**70,370,820**	**64,073,256**	**6,297,563**
	TOTAL	***82,431,764***	***75,830,514***	***6,601,250***

Scenario 5 Cost

Table 18 provides an overview of the costs associated with implementation of the BMP scenario identified in Table 16. The annualized costs are derived from CAST. This option was also very cost-effective, relying on the most cost-effective options in both the agricultural and urban sectors.

Table 18. Summary of costs for BMPs implemented in Scenario 5

Annualized Costs by State and Sector for Scenario 5: Susquehanna, Nitrogen-Effective + Urban Equity				
	Agriculture	**Developed**	**Natural**	**Total**
MD	968,173	3,813	-	971,986
NY	1,613,846.37	65,371	-	1,679,217
PA	43,513,566	5,133,682	330	48,647,578
Total	***46,095,585***	***5,202,867***	***330***	***51,298,783***

These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented.

CAST Scenarios: Part 2

Based on feedback from the CWIP Steering Committee, the project team developed a second set of scenarios that were designed to more clearly compare across BMP options and geographies. The six scenarios described below include two broad BMP types and three geographies. Further, these scenarios rely primarily on the most cost-effective BMP options available, particularly in the agricultural sector. Finally, while the original scenarios used a highly variable degree of BMP implementation and choice of BMPs between scenarios, these attempt to be more consistent. These scenarios are highlighted in red text in Table 1 of this report.

Geographies

Three separate geographies were used among the six new scenarios, with targeting based on nitrogen-effectiveness at the Land River Segment (LRS) scale: 1) the entire Conowingo geography, 2) the upper median within the Conowingo geography, and 3) the Susquehanna plus upper quartile effective segments in the Chesapeake Bay watershed. Figure 13 and

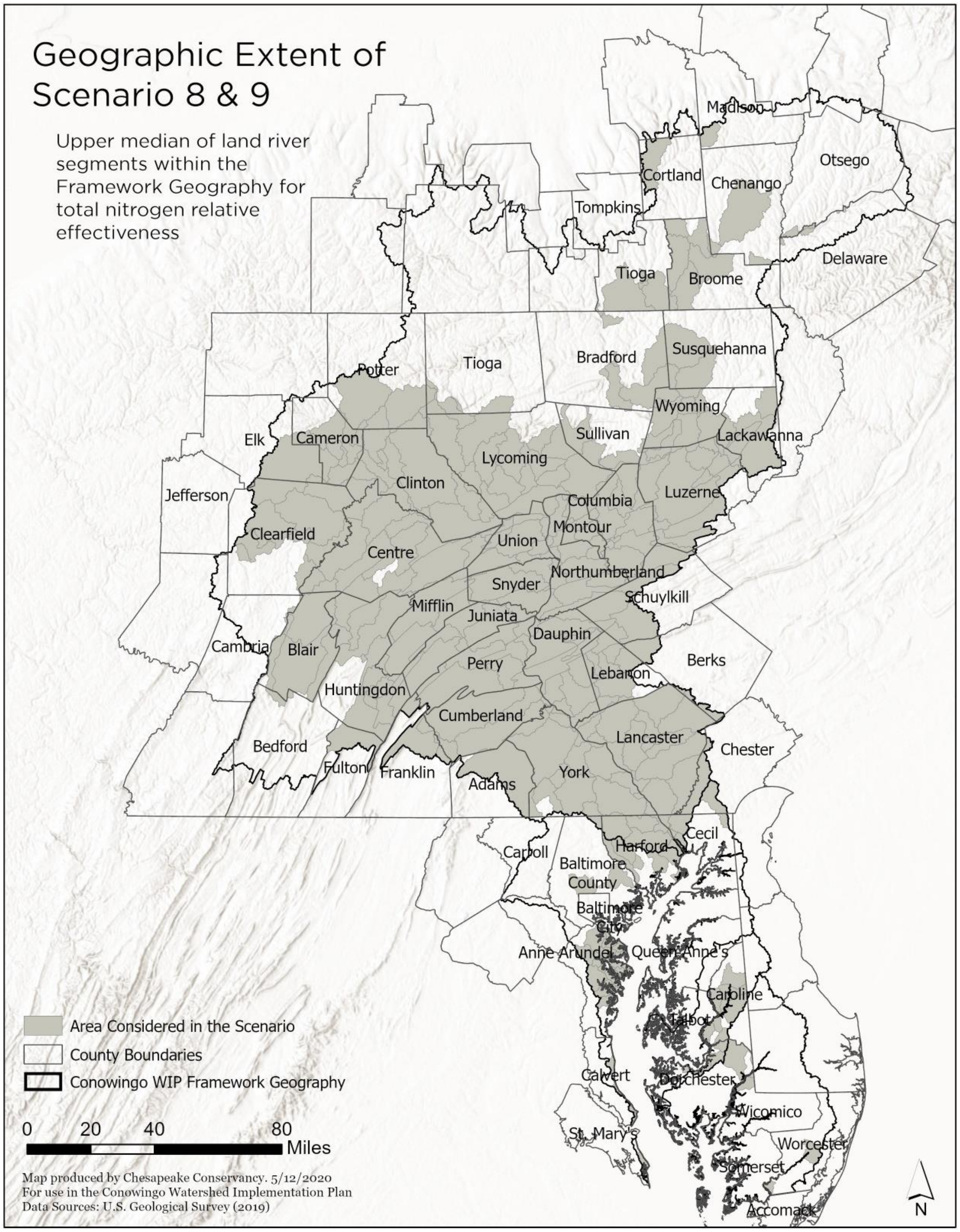

Figure *14* in the scenario descriptions illustrate each of these geographies.

BMP Choice and Implementation Level

Overall, the scenarios considered to BMP implementation strategies: Agricultural BMPs Only and Agricultural BMPs + Urban BMPs. To strive for consistency between the scenarios, a maximum implementation level was selected for each scenario based on the maximum implementation level that a state had reported for any segment in the WIP3 strategies. As a result of this method, Delaware was not included in any scenario, since the state's WIP 3 plan uses a single level of implementation across the entire state (See Appendix H). For each scenario, BMPs were implemented at the maximum level, but implementation levels for wetland restoration were later reduced in Scenarios 6.1, 7, 8, and 9. In Scenarios 6.1 and 7, the implementation level was reduced by 50% to reduce costs and nitrogen reduction targets. In Scenarios 8 and 9, these practices were targeted toward a smaller and more effective list of LRSs.

The agricultural BMPs included nutrient management, tillage operations, buffers, prescribed grazing, Soil and Water Conservation Plans, and wetland restoration. Most of these BMPs are an ongoing (annual or short-term), programmatic application, with the exception of prescribed grazing, buffers and wetland restoration. Two relatively cost-effective urban BMPs were chosen to represent the developed sector: bioswales and infiltration BMPs.

Baseline and Differences between Scenarios

While the scenarios are very similar in their assumptions and development, there are some differences between Scenarios 8 and 9, which were developed by the Chesapeake Bay Program, and Scenarios 6.1, 7, 10 and 11, which were developed by the Center for Watershed Protection. These differences relate primarily to differences in the baseline condition, as well as some slight differences in the method for accounting for the maximum levels of implementation. While these differences change the BMP composition slightly, they do not appear to have a major impact on any scenario's cost-effectiveness.

Scenario 6.1: Conowingo Geography, Agriculture + Urban

Scenario 6.1: Conowingo Geography, Agriculture + Urban	
Geographic Extent	Entire Conowingo geography
Primary BMPs	Cost-Effective Agricultural BMPs + Urban BMPs (Infiltration and Bioswales)
States Included	Maryland, New York, Pennsylvania
N Reduction	6.2 million pounds/year
Total Annualized Cost	$90 million
Cost Per Pound	$14

Scenario 6.1 and 7 Geography

Scenarios 6.1 and 7 use the entire Conowingo geography (Figure 13). All of the cost-effective agricultural BMPS are implemented at their maximum level, defined by WIPs, with the exception of wetland restoration, which was reduced by 50% to lower the overall nutrient reduction and cost.

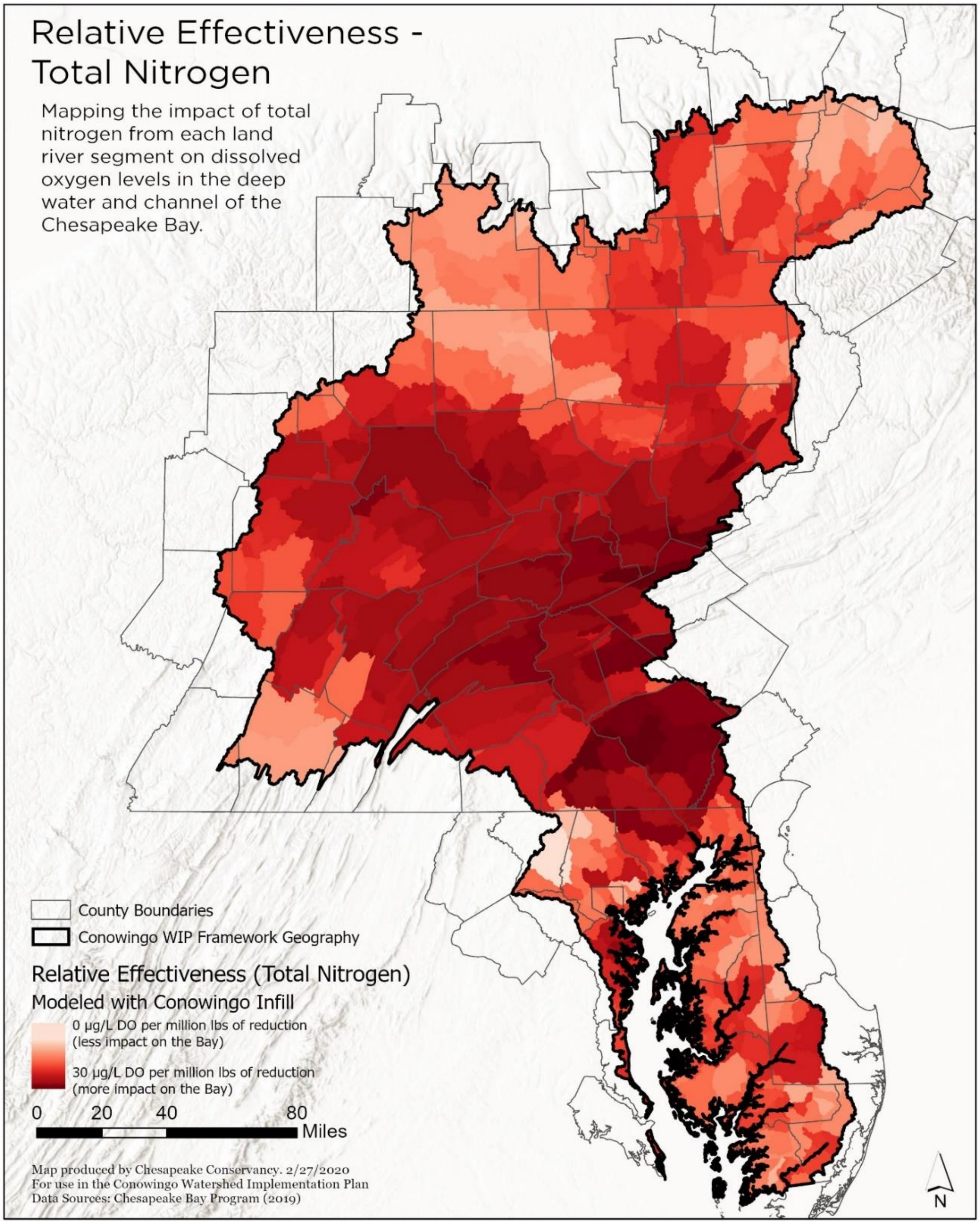

Figure 13. Scenario 6.1 and 7 geographic extent

Scenario 6.1 BMPs

Scenario 6.1 relies on a suite of cost-effective agricultural BMPs (Table 19), along with two urban BMPs, infiltration and bioswales.

Table 19. Summary of acres of BMP implementation for Scenario 6

BMPs Implemented in Scenario 6: Conowingo Geography, Agriculture + Urban						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	30,242	22,174	373,437	425,854
Nutrient Application Management Rate Nitrogen	annual	Acres	31,025	22,174	913,312	966,511
Nutrient Application Management Placement Nitrogen	annual	Acres	8,645	22,174	298,619	329,438
Nutrient Application Management Timing Nitrogen	annual	Acres	8,864	22,174	868,420	899,458
Conservation Tillage	annual	Acres	101,738	72,747	203,809	378,294
High Residue Tillage	annual	Acres	-21,516*	23,731	110,095	112,310
Low Residue Tillage	annual	Acres	--	20,401	-236*	20,165
Prescribed Grazing	cumulative	Acres	27,894	65,535	138,762	232,190
Wetland Restoration	cumulative	Acres	24,264	--	1,400	25,664
Grass Buffers	cumulative	Acres in Buffers	32,577	1,160	32,823	66,560
Soil and Water Conservation Plan	cumulative	Acres	129,605	524,166	279,875	933,646
Manure Incorporation	annual	Acres	72,647	--	14,720	87,367
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	670	391	1,051	2,112
Urban Practices						
Infiltration Practices	cumulative	Acres	1,300	10,302	92	11,694
Bioswale	cumulative	Acres	6,415	--	1,011	7,426
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Scenario 6.1 Loads Results

Scenario 6 reduces Loads by 6.2 Million Pounds Per year, with 64% of the load reduction from Pennsylvania, 28% from Maryland and the remainder from New York. The bulk of the load reduction is from the agricultural sector.

Table 20. Summary of Scenario 6 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 6: CONOWINGO GEOGRAPHY AGRICULTURE PUS URBAN				
STATE	**Sector**	**Baseline**	**Scenario 6**	**N Reduction**
MD	Agriculture	13.88	12.25	1.62
	Developed	7.57	7.54	0.03
	Natural	6.20	6.15	0.05
	MD Total	**27.65**	**25.94**	**1.71**
NY	Agriculture	5.94	5.49	0.45
	Developed	1.40	1.35	0.05
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.73**	**0.54**
PA	Agriculture	39.43	35.66	3.77
	Developed	14.87	14.87	0.01
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.82**	**3.94**
	TOTAL	***109.68***	***103.49***	***6.19***

Scenario 6.1 Cost

The total cost for this scenario is approximately $90 million/year. Although urban BMPS represent only a small fraction (< 2%) of the total load, approximately 25% of the costs are in the developed sector.

Table 21. Summary of costs for BMPs Implemented in Scenario 6.1

Annualized Costs by State and Sector for Scenario 6. Conowingo Geography Agriculture + Urban				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$11,471,478	$7,969,215	--	**$19,440,693**
NY	$4,144,222	$12,866,150	--	**$17,010,373**
PA	$52,117,345	$1,115,020	--	**$53,232,366**
Total	***$67,733,046***	***$21,950,386***	**--**	***$89,683,431***

Scenario 7: Conowingo Geography, Agriculture Only

Scenario 7. Conowingo Geography, Agriculture Only	
Geographic Extent	Conowingo Geography
Primary BMPs	Cost-Effective Agricultural BMPs
States Included	Maryland, New York, Pennsylvania
N Reduction	6.0 million pounds/year
Total Annualized Cost	$68 million
Cost Per Pound	$11

Scenario 7 Geography

Scenario 7 uses the same geography as Scenario 6 (Figure 13), which comprises the entire Conowingo Geography.

Scenario 7 BMPs

This scenario relies entirely on cost-effective agricultural BMPs (Table 22).

Table 22. Summary of acres of BMP implementation for Scenario 7

BMPs Implemented in Scenario 7: Conowingo Geography, Agriculture Only						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	30,242	22,174	373,437	425,854
Nutrient Application Management Rate Nitrogen	annual	Acres	31,025	22,174	913,312	966,511
Nutrient Application Management Placement Nitrogen	annual	Acres	8,645	22,174	298,619	329,438
Nutrient Application Management Timing Nitrogen	annual	Acres	8,864	22,174	868,420	899,458
Conservation Tillage	annual	Acres	101,738	72,747	203,809	378,294
High Residue Tillage	annual	Acres	-21,516*	23,731	110,095	112,310
Low Residue Tillage	annual	Acres	--	20,401	-236*	20,165
Prescribed Grazing	cumulative	Acres	27,894	65,535	138,762	232,190
Wetland Restoration	cumulative	Acres	24,264	--	1,400	25,664
Grass Buffers	cumulative	Acres in Buffers	32,577	1,160	32,823	66,560
Soil and Water Conservation Plan	cumulative	Acres	129,605	524,166	279,875	933,646
Manure Incorporation	annual	Acres	72,647	--	14,720	87,367
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	670	391	1,051	2,112
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Scenario 7 Loads Results

This scenario reduces loads by 6.1 million pounds per year, with the reductions coming almost entirely from the agricultural sector. Additionally, 65% of the load reduction comes from Pennsylvania, 27% from Maryland, and the remainder from New York.

Table 23. Summary of Scenario 7 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 7: CONOWINGO GEOGRAPHY, AGRICULTURE ONLY				
STATE	**Sector**	**Baseline**	**Scenario 7**	**N Reduction**
MD	Agriculture	13.88	12.25	1.62
	Developed	7.57	7.57	--
	Natural	6.20	6.16	0.05
	MD Total	**27.65**	**25.98**	**1.67**
NY	Agriculture	5.94	5.49	0.45
	Developed	1.40	1.40	--
	Natural	2.92	2.89	0.03
	NY Total	**10.26**	**9.78**	**0.48**
PA	Agriculture	39.43	35.66	3.77
	Developed	14.87	14.87	--
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.83**	**3.93**
	TOTAL	***109.68***	***103.59***	***6.09***

Scenario 7 Cost

The total cost for this scenario is $68 Million/year, with all of the costs in the agricultural sector, and approximately 77% of the costs in Pennsylvania.

Table 24. Summary of costs for BMPs Implemented in Scenario 7

Annualized Costs by State and Sector for Scenario 7. Conowingo Geography, Agriculture Only				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$11,471,478	--	--	**$11,471,478**
NY	$4,144,223	--	--	**$4,144,223**
PA	$52,117,345	--	--	**$52,117,345**
Total	***$67,733,046***	**--**	**--**	***$67,733,046***

Scenario 8: Conowingo, Cost-Effective LRSs, Agriculture + Urban

Scenario 8. Conowingo, Cost-Effective LRSs, Agriculture + Urban	
Geographic Extent	Upper Median Segments in the Conowingo Geography
Primary BMPs	Cost-Effective Agricultural BMPs plus Infiltration and Bioswales
States Included	Maryland, New York, Pennsylvania
N Reduction	$6.3 million pounds/year
Total Annualized Cost	$96 million/year
Cost Per Pound	$15/pound

Scenario 8 and 9 Geography

Scenarios 8 and 9 are implemented within the upper median segments within the Conowingo Geography (

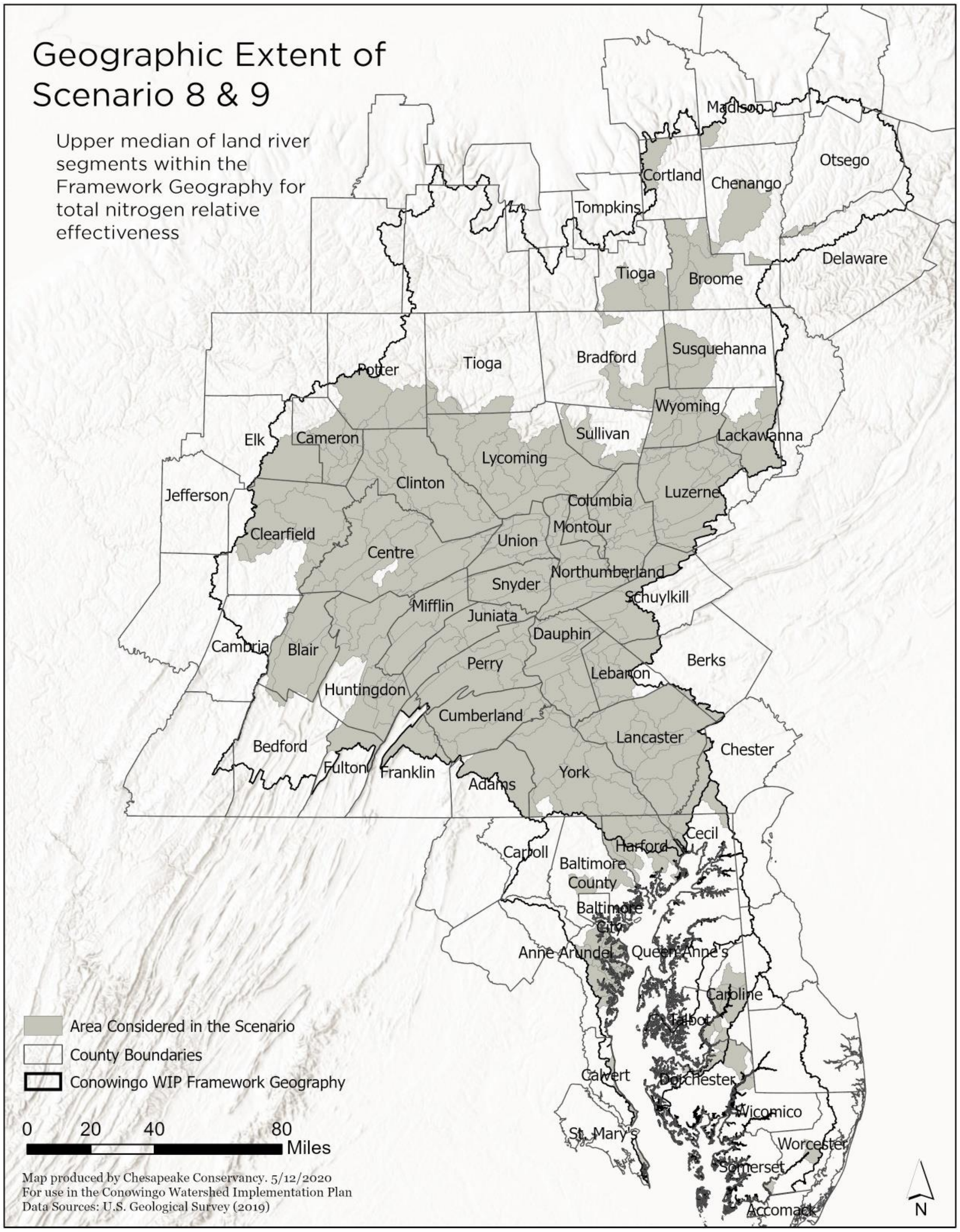

Figure 14), with the exception of wetland restoration, which was concentrated in the upper quartile segments.

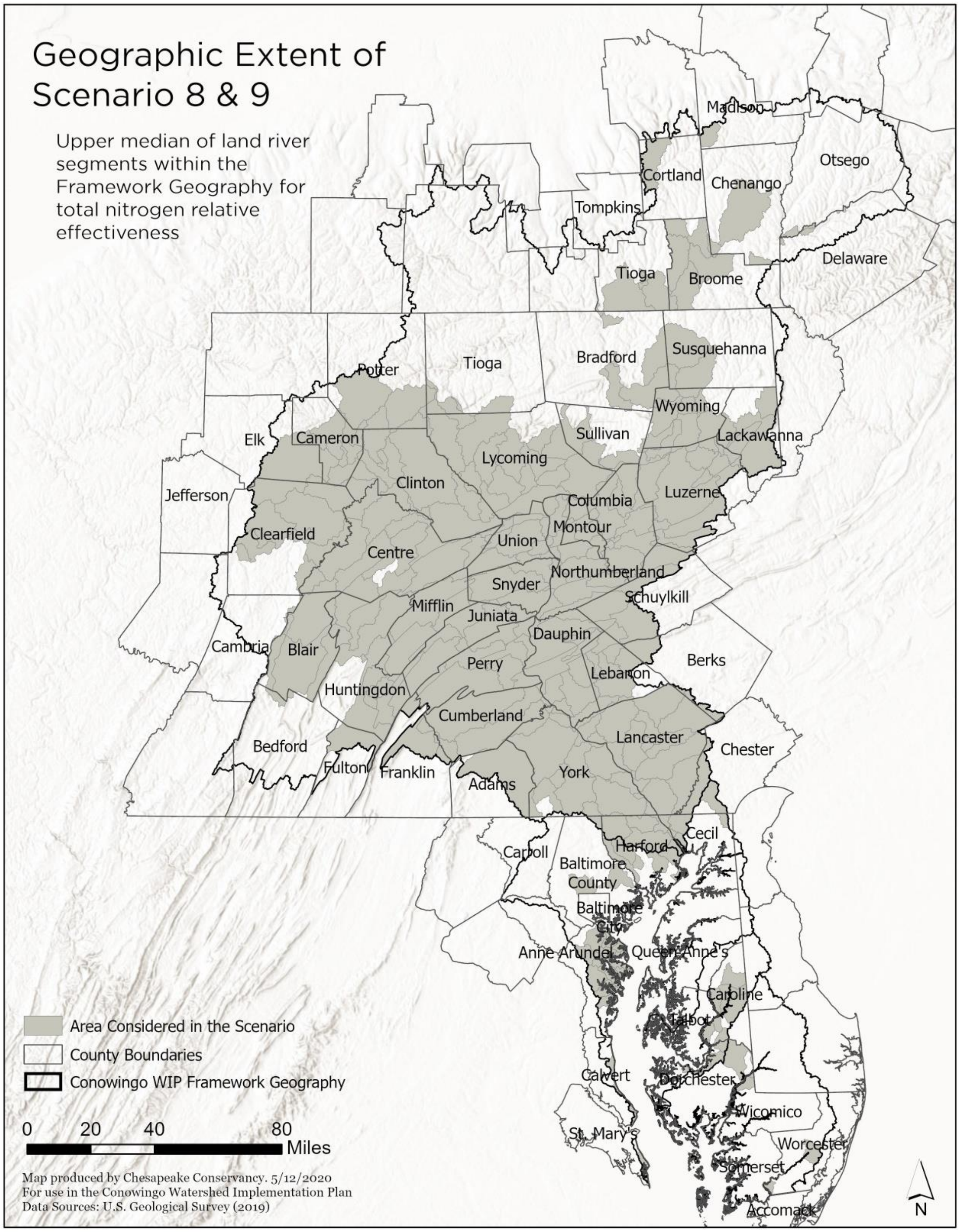

Figure 14. Scenario 8 and 9 geographic extent

Scenario 8 BMPs

Scenario 8 relies entirely on cost-effective urban and agricultural BMPs, similar to Scenarios 6 and 10. This scenario is slightly different, in that it does include some forest buffers.

Table 25. Summary of acres of BMP implementation for Scenario 8

BMPs Implemented in Scenario 8: Conowingo, Cost-Effective LRSs, Agriculture + Urban						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	-105*	2,479	414,788	417,161
Nutrient Application Management Rate Nitrogen	annual	Acres	4,634	2,479	687,206	694,319
Nutrient Application Management Placement Nitrogen	annual	Acres	-30*	2,479	275,790	278,239
Nutrient Application Management Timing Nitrogen	annual	Acres	1,324	2,479	682,045	685,847
Conservation Tillage	annual	Acres	17,775	12,791	146,485	177,052
High Residue Tillage	annual	Acres	-13,397*	12,508	56,479	55,590
Low Residue Tillage	annual	Acres	--	5,970	93,685	99,655
Prescribed Grazing	cumulative	Acres	8,358	4,942	100,484	113,784
Forest Buffers	cumulative	Acres in Buffers	1,571	1,042	20,362	22,974
Wetland Restoration	cumulative	Acres	3,063	--	3,560	6,623
Grass Buffers	cumulative	Acres in Buffers	7,376	385	24,081	31,843
Soil and Water Conservation Plan	cumulative	Acres	30,139	55,609	295,182	380,931
Manure Incorporation	annual	Acres	12,842	--	123,234	136,076
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	169	47	972	1,187
Urban Practices						
Infiltration Practices	cumulative	Acres	8,976	3,673	1,037	13,686
Bioswale	cumulative	Acres	9,911	--	20,006	29,916
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Scenario 8 Loads Results

Scenario 8 achieves 6.3 million pounds of nitrogen reduction, with 86% of the total reduction from Pennsylvania, and approximately 95% of the load reduction from the agricultural sector.

Table 26. Summary of Scenario 8 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 8: CONOWINGO, COST-EFFECTIVE LRSS, AGRICULTURE + URBAN				
STATE	**Sector**	**Baseline**	**Scenario 8**	**N Reduction**
MD	Agriculture	14.31	13.74	0.57

	Developed	7.62	7.50	0.13
	Natural	6.23	6.20	0.03
	MD Total	**28.16**	**27.44**	**0.72**
NY	Agriculture	5.98	5.87	0.11
	Developed	1.41	1.39	0.02
	Natural	2.92	2.92	0.01
	NY Total	**10.31**	**10.17**	**0.14**
PA	Agriculture	42.34	37.22	5.12
	Developed	14.88	14.73	0.15
	Natural	17.58	17.39	0.18
	PA Total	**74.79**	**69.34**	**5.45**
TOTAL		***113.26***	***106.96***	***6.31***

Scenario 8 Cost

The total cost ($96 million) is distributed almost evenly between the agricultural and developed sectors.

Table 27. Summary of costs for BMPs Implemented in Scenario 8

Annualized Costs by State and Sector for Scenario 8. Conowingo, Cost-Effective LRSs, Agriculture + Urban				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,787,421	$21,010,811	--	**$22,798,232**
NY	$529,289	$4,586,840	--	**$5,116,128**
PA	$47,219,212	$21,084,433	--	**$68,303,645**
Total	***$49,535,921***	***$46,682,085***	**--**	***$96,218,005***

Scenario 9: Conowingo, Cost-Effective LRSs, Agriculture

Scenario 9. Susquehanna + Chesapeake, Effective LRSs, Agriculture	
Geographic Extent	Upper Median Segments in the Conowingo Geography
Primary BMPs	Cost-Effective Agricultural BMPs
States Included	Maryland, New York, Pennsylvania
N Reduction	6.0 million pounds/year
Total Annualized Cost	$50 million
Cost Per Pound	$8

Scenario 9 Geography

Scenario 9 uses the same geography as Scenario 8 (

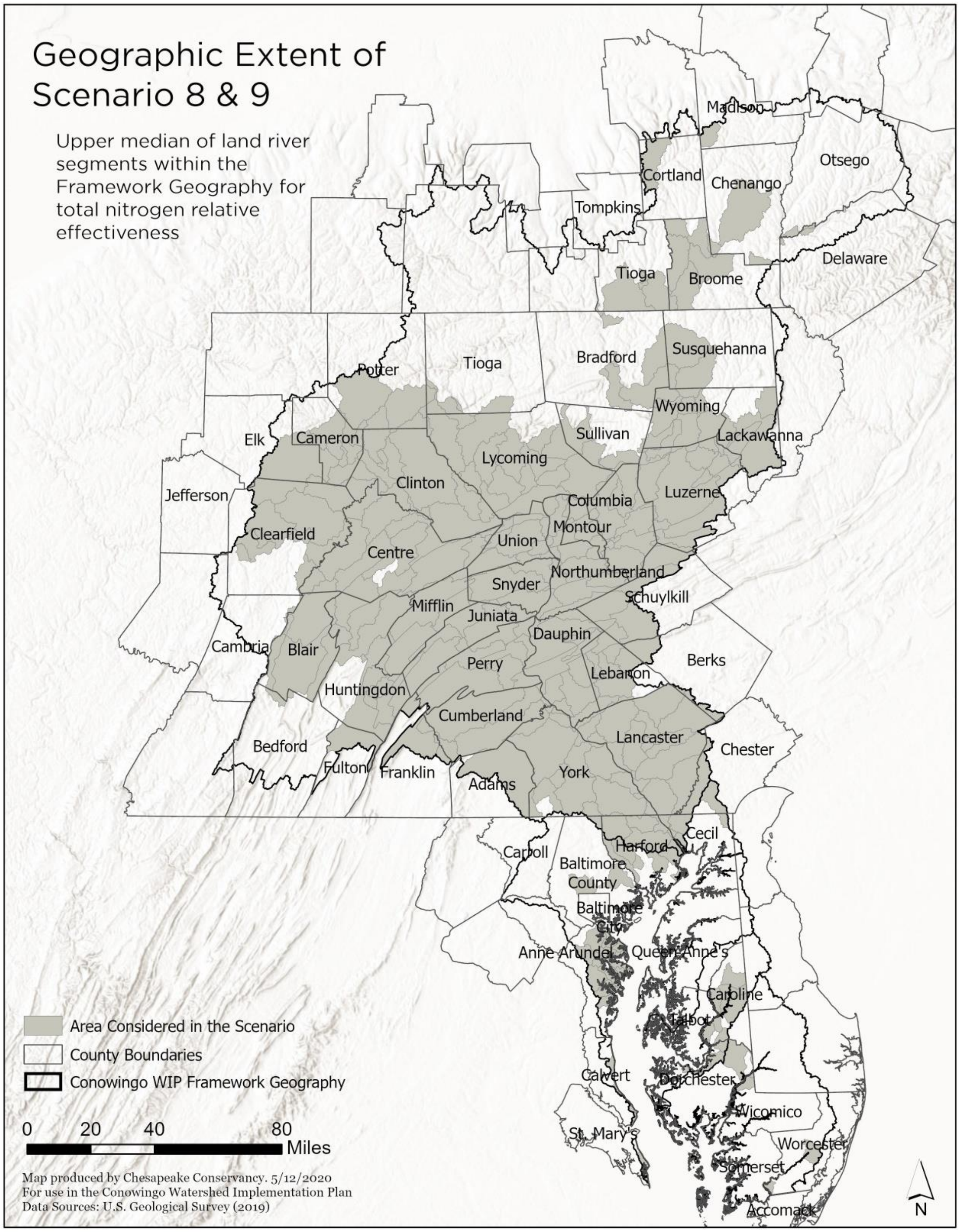

Figure 14).

Scenario 9 BMPs

Scenario 9 relies entirely on agricultural BMPs (Table 28).

Table 28. Summary of acres of BMP implementation for Scenario 9

BMPs Implemented in Scenario 9: Susquehanna + Chesapeake, Effective LRSs, Agriculture + Urban						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	-105*	2,479	414,788	417,161
Nutrient Application Management Rate Nitrogen	annual	Acres	4,634	2,479	687,206	694,319
Nutrient Application Management Placement Nitrogen	annual	Acres	-30*	2,479	275,790	278,239
Nutrient Application Management Timing Nitrogen	annual	Acres	1,324	2,479	682,045	685,847
Conservation Tillage	annual	Acres	17,775	12,791	146,485	177,052
High Residue Tillage	annual	Acres	-13,397*	12,508	56,479	55,590
Low Residue Tillage	annual	Acres	--	5,970	93,685	99,655
Prescribed Grazing	cumulative	Acres	8,358	4,942	100,484	113,784
Forest Buffers	cumulative	Acres in Buffers	1,571	1,042	20,362	22,974
Wetland Restoration	cumulative	Acres	3,063	--	3,560	6,623
Grass Buffers	cumulative	Acres in Buffers	7,376	385	24,081	31,843
Soil and Water Conservation Plan	cumulative	Acres	30,139	55,609	295,182	380,931
Manure Incorporation	annual	Acres	12,842	--	123,234	136,076
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	169	47	972	1,187
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Scenario 9 Loads Results

Scenario 9 results in a 6.0-million-pound reduction in nitrogen loads, with 88% of the reduction coming from Pennsylvania.

Table 29. Summary of Scenario 9 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 9: SUSQUEHANNA + CHESAPEAKE, EFFECTIVE LRSS, AGRICULTURE + URBAN				
STATE	**Sector**	**Baseline**	**Scenario 9**	**N Reduction**
MD	Agriculture	14.31	13.74	0.57
	Developed	7.62	7.62	--
	Natural	6.23	6.21	0.02
	MD Total	**28.16**	**27.58**	**0.59**
NY	Agriculture	5.98	5.87	0.11

	Developed	1.41	1.41	--
	Natural	2.92	2.92	0.01
	NY Total	**10.31**	**10.19**	**0.12**
PA	Agriculture	42.34	37.22	5.12
	Developed	14.88	14.88	--
	Natural	17.58	17.40	0.18
	PA Total	**74.79**	**69.50**	**5.29**
	TOTAL	***113.26***	***107.26***	***6.00***

Scenario 9 Cost

The total cost ($50 million) is among the least expensive, and it is spent entirely in the agricultural sector.

Table 30. Summary of costs for BMPs Implemented in Scenario 9

Annualized Costs by State and Sector for Scenario 9. Susquehanna + Chesapeake, Effective LRSs, Agriculture + Urban				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,787,421	--	--	**$1,787,421**
NY	$529,289	--	--	**$529,289**
PA	$47,219,212	--	--	**$47,219,212**
Total	***$49,535,921***	**--**	**--**	***$49,535,921***

Scenario 10: Susquehanna, Cost-Effective LRSs, Agriculture + Urban

Scenario 10. Susquehanna, Cost-Effective LRSs, Agriculture + Urban	
Geographic Extent	Susquehanna Watershed, plus Additional LRSs in the upper Quartile of the Chesapeake Watershed
Primary BMPs	Cost-Effective Agriculture plus Urban BMPs
States Included	Maryland, New York, Pennsylvania, Virginia, West Virginia
N Reduction	6.2 million pounds/year
Total Annualized Cost	$82 million
Cost Per Pound	$13

Scenario 10 – 11 Geography

This scenario uses the same geography as Scenario 2, which includes the entire Susquehanna watershed, plus additional LRSs in the upper quartile of the Chesapeake Bay (Figure 15).

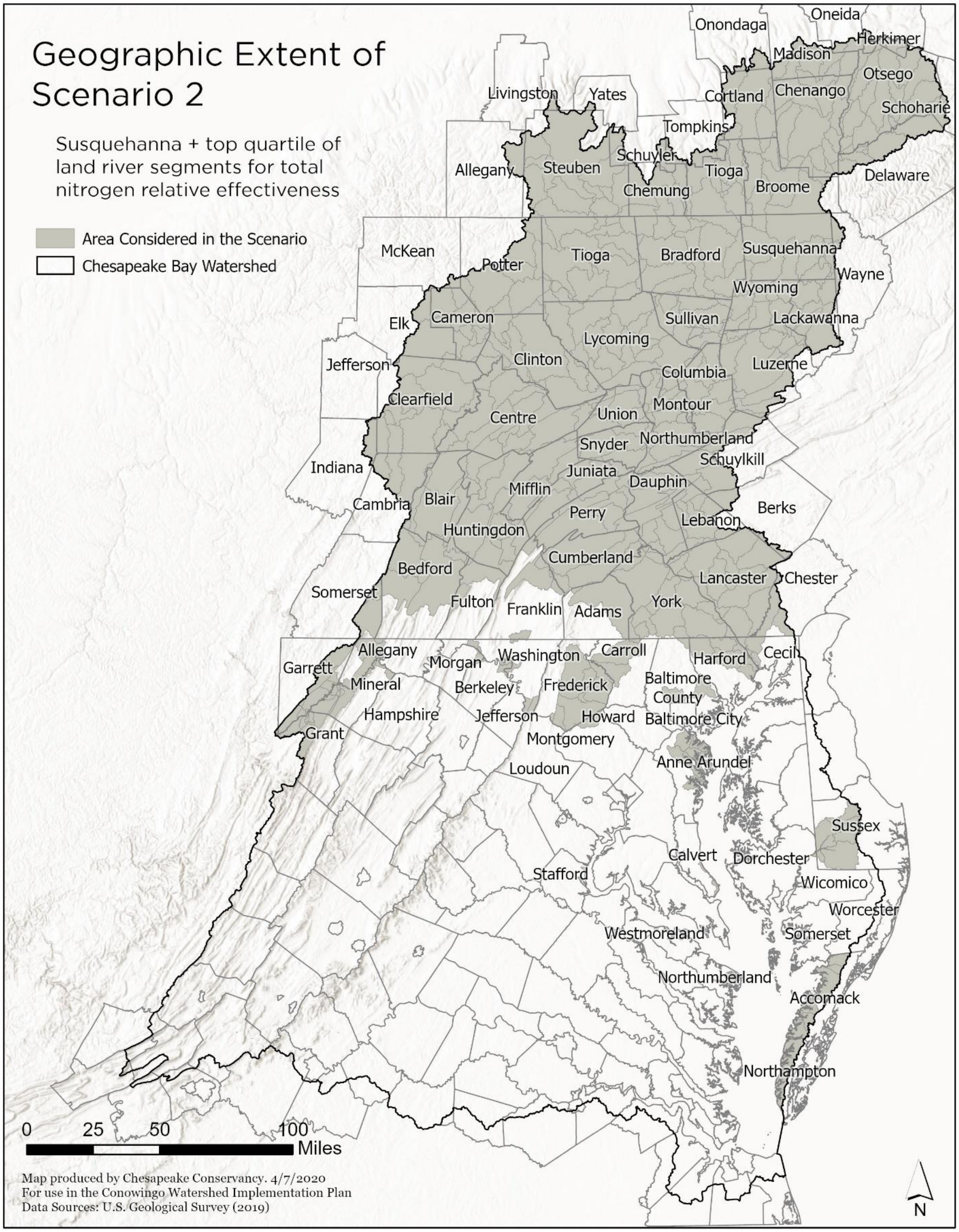

Figure 15. Scenarios 10 and 11 geographic extent

Scenario 10 BMPs

This scenario relies on both urban and agricultural BMPs, with a similar mix of practices to scenarios 6.1 and 8.

Table 31. Summary of acres of BMP implementation for Scenario 10

BMPs Implemented in Scenario 10: Susquehanna, Cost-Effective LRSs, Agriculture + Urban								
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**VA**	**WV**	**Total**
Agricultural Practices								
Nutrient Application Management Core Nitrogen	annual	Acres	22,936	22,174	371,547	710	1,175	416,657
Nutrient Application Management Rate Nitrogen	annual	Acres	30,086	22,174	918,015	568	--	970,276
Nutrient Application Management Placement Nitrogen	annual	Acres	6,599	22,174	301,246	900	--	330,019
Nutrient Application Management Timing Nitrogen	annual	Acres	8,596	22,174	873,365	900	--	904,135
Conservation Tillage	annual	Acres	18,325	72,747	202,770	2,343	48	293,843
High Residue Tillage	annual	Acres	2,592	23,731	108,625	74	--	134,949
Low Residue Tillage	annual	Acres	--	20,401	-297*	--	--	20,105
Prescribed Grazing	cumulative	Acres	20,305	69,806	153,505	436	3,298	243,616
Wetland Restoration	cumulative	Acres	20,591	--	6,597	163	0	27,188
Grass Buffers	cumulative	Acres in Buffers	16,274	1,160	33,160	1,373	22	50,594
Soil and Water Conservation Plan	cumulative	Acres	63,696	566,544	315,725	2,599	3	945,965
Manure Incorporation	annual	Acres	39,148	--	14,673	--	--	53,821
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	12	416	1,269	19	5	1,698
Urban Practices								
Infiltration Practices	cumulative	Acres Treated	794	10,302	92	63	43	11,187
Bioswale	cumulative	Acres Treated	699	--	1,011	3	--	1,710
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).								

Scenario 10 Loads Results

Although this scenario includes segments outside of the Susquehanna, the majority of the load reduction comes from Pennsylvania (67%), with only very small amount from

Virginia and West Virginia. This scenario has the greatest reduction from New York, since the entire Susquehanna watershed is included.

Table 32. Summary of Scenario 10 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 10: SUSQUEHANNA, COST-EFFECTIVE LRSS, AGRICULTURE + URBAN				
STATE	**Sector**	**Baseline**	**Scenario 10**	**N Reduction**
MD	Agriculture	13.88	12.53	1.35
	Developed	7.57	7.56	0.01
	Natural	6.20	6.17	0.04
	MD Total	**27.65**	**26.26**	**1.39**
NY	Agriculture	5.94	5.47	0.47
	Developed	1.40	1.35	0.05
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.70**	**0.56**
PA	Agriculture	39.43	35.44	3.99
	Developed	14.87	14.87	0.01
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.60**	**4.17**
VA	Agriculture	7.32	7.25	0.06
	Developed	4.26	4.26	0.00
	Natural	4.97	4.97	0.00
	VA Total	**16.55**	**16.48**	**0.07**
WV	Agriculture	2.39	2.39	0.00
	Developed	1.01	1.01	0.00
	Natural	2.17	2.17	0.00
	WV Total	**5.57**	**5.57**	**0.00**
	TOTAL	***131.80***	***125.61***	***6.19***

Scenario 10 Cost

This scenario costs approximately $82 million, with most of the cost (80%) in the agricultural sector.

Table 33. Summary of costs for BMPs Implemented in Scenario 10

Annualized Costs by State and Sector for Scenario 10. Susquehanna, Cost-Effective LRSs, Agriculture + Urban				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$8,538,540	$1,682,443	--	**$10,220,983**
NY	$4,320,831	$12,866,150	--	**$17,186,981**
PA	$53,290,516	$1,115,020	--	**$54,405,536**
VA	$32,923	$81,318	--	**$114,241**
WV	$85,035	$53,223	--	**$138,257**
Total	***$66,267,844***	***$15,798,155***	**--**	***$81,927,742***

Scenario 11: Susquehanna, Cost-Effective LRSs, Agricultural Only

Scenario 11. Susquehanna, Cost-Effective LRSs, Agricultural Only	
Geographic Extent	Entire Susquehanna Watershed, plus upper quartile LRSs within the entire Chesapeake Bay.
Primary BMPs	Cost-Effective Agricultural BMPs
States Included	Maryland, New York, Pennsylvania, Virginia, West Virginia
N Reduction	6.1 million pounds/year
Total Annualized Cost	$66 million
Cost Per Pound	$11

Scenario 10 – 11 Geography

Scenario 10 uses the same geography as Scenario 10 (Figure 15).

Scenario 11 BMPs

Scenario 11 uses agricultural BMPs only.

Table 34. Summary of acres of BMP implementation for Scenario 11

BMPs Implemented in Scenario 11: Susquehanna, Cost-Effective LRSs, Agricultural Only								
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**VA**	**WV**	**Total**
Agricultural Practices								
Nutrient Application Management Core Nitrogen	annual	Acres	22,936	22,174	371,547	710	1,175	418,542
Nutrient Application Management Rate Nitrogen	annual	Acres	30,086	22,174	918,015	568	--	970,844
Nutrient Application Management Placement Nitrogen	annual	Acres	6,599	22,174	301,246	900	--	330,919
Nutrient Application Management Timing Nitrogen	annual	Acres	8,596	22,174	873,365	900	--	905,035
Conservation Tillage	annual	Acres	18,325	72,747	202,770	2,343	48	296,234
High Residue Tillage	annual	Acres	2,592	23,731	108,625	74	--	135,022
Low Residue Tillage	annual	Acres	--	20,401	-297*	--	--	20,105
Prescribed Grazing	cumulative	Acres	20,305	69,806	153,505	436	3,298	247,350
Wetland Restoration	cumulative	Acres	20,591	--	6,597	163	--	27,352
Grass Buffers	cumulative	Acres in Buffers	16,274	1,160	33,160	1,373	22	51,989
Soil and Water Conservation Plan	cumulative	Acres	63,696	566,544	315,725	2,599	3	948,568
Manure Incorporation	annual	Acres	39,148	--	14,673	--	--	53,821

BMPs Implemented in Scenario 11: Susquehanna, Cost-Effective LRSs, Agricultural Only								
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**VA**	**WV**	**Total**
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	12	416	1,269	19	5	1,721
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).								

Scenario 11 Loads Results

scenario 11 results in a 6.1-million-pound reduction in nitrogen loads, with the majority of the load reduction (68%) coming from Pennsylvania.

Table 35. Summary of Scenario 11 nitrogen load reductions (values in millions of pounds).

NITROGEN LOADS (MILLIONS OF POUNDS) FOR SCENARIO 11: SUSQUEHANNA, COST-EFFECTIVE LRSS, AGRICULTURAL ONLY				
STATE	**Sector**	**Baseline**	**Scenario 11**	**N Reduction**
MD	Agriculture	13.88	12.53	1.35
	Developed	7.57	7.57	0.00
	Natural	6.20	6.17	0.04
	MD Total	**27.65**	**26.27**	**1.38**
NY	Agriculture	5.94	5.47	0.47
	Developed	1.40	1.40	0.00
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.75**	**0.51**
PA	Agriculture	39.43	35.44	3.99
	Developed	14.87	14.87	0.00
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.60**	**4.16**
VA	Agriculture	7.32	7.25	0.06
	Developed	4.26	4.26	0.00
	Natural	4.97	4.97	0.00
	VA Total	**16.55**	**16.48**	**0.07**
WV	Agriculture	2.39	2.39	0.00
	Developed	1.01	1.01	0.00
	Natural	2.17	2.17	0.00
	WV Total	**5.57**	**5.57**	**0.00**
	TOTAL	***131.80***	***125.68***	***6.12***

Scenario 11 Cost

This scenario costs approximately $66 million, with the approximately $53 million in Pennsylvania.

Table 36. Summary of costs for BMPs Implemented in Scenario 11

Annualized Costs by State and Sector for Scenario 11. Susquehanna, Cost-Effective LRSs, Agricultural Only				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$8,538,540	--	--	**$8,538,540**
NY	$4,320,831	--	--	**$4,320,831**
PA	$53,290,516	--	--	**$53,290,516**
VA	$32,923	--	--	**$32,923**
WV	$85,035	--	--	**$85,035**
Total	***$66,267,844***	**--**	**--**	***$66,267,844***

Financing Strategy

The Chesapeake Bay restoration effort overall is considered a test model for coordinating and implementing large-scale ecosystem restoration efforts. However, while a significant amount of resources has been applied to studying the impacts of eutrophication in the Bay and BMPs necessary to restore water quality, relatively little has been done to coordinate and advance innovative approaches for financing and implementing aggressive restoration programs. Specifically, there has been little effort to engage private industries and financing experts on how best to develop incentives for fostering more effective corporate stewardship, leveraging carbon markets, and accessing other private capital and financial markets. Given the increased loads associated with Conowingo infill and other restoration challenges on the horizon such as climate change, industries and industry leaders must be engaged in a substantive way to sustain restoration progress into the future.

This problem is not unique to any one Bay state or jurisdiction. All of the Bay jurisdictions could benefit from a codified, institutional approach to engaging leaders in finance and the key Bay industry sectors. There have been some regional efforts to engage financing experts on Bay Restoration. One noteworthy effort was the October 2004 report issued by the Chesapeake Bay Watershed Blue Ribbon Finance Panel established by the Chesapeake Executive Council in Directive 03-02 in December 2003. The Panel, comprised of distinguished and knowledgeable citizens from throughout the watershed, provided a comprehensive analysis of the sources of impairments to the Bay's water quality and living resources, the costs to remove those impairments and a series of recommendations to finance those costs. The principal recommendation was to establish a regional Chesapeake Bay Financing Authority to close an estimated $15 billion gap in public funds for the cleanup. It was further recommended to seek a $12 billion commitment from the federal government, to be funded over six years, with the remaining $3 billion in new funds to come from the Bay jurisdictions. The Report also included over twenty additional recommendations on potential funding sources and program actions to be taken by the Bay partners. Unfortunately, in the effort to respond to the primary recommendation for the Financing Authority, these additional recommendations were largely overlooked. Many of the recommendations, however, are innovative and of great potential value to the jurisdictions and the CBP partnership.

Recognizing this need for innovations in financing, the PSC has directed that a key component of the CWIP implementation is to develop a financing strategy that complements jurisdictional WIPs, accelerates Bay restoration overall, and provides healthy competition in the marketplace that will stimulate innovation and science while lowering costs. Due to CIT and jurisdictional workload and funding, a draft financing strategy is scheduled for public review approximately one year after this CWIP will be finalized.

The Chesapeake Bay Trust is leading the effort to develop the CWIP financing strategy, which will be provided as a separate document when completed in March 2021. Recognizing that the CWIP BMP implementation strategy will need to evolve with time and the completion of a comprehensive financing strategy, adjustments may need to be considered to better align with the innovative financing tools and ideas contained within the financing strategy.

Contingency Plans and Opportunities

A contingency plan for the CWIP provides safeguards to ensure the nitrogen load reductions are achieved if the selected BMP implementation strategy is not sufficient to meet the stated goals in advance of the WIP timeline. The CIT will work with the CWIP Steering Committee to evaluate actions needed given the options described in this CWIP. The annual reports on jurisdiction-specific and Conowingo load reductions, the two-year milestones reporting on progress, along with the adaptive management approach, provide the necessary checks and balances throughout CWIP implementation to evaluate if alternative actions need to be taken. Any relevant future outcomes from Maryland's 401 Water Quality Certification for Conowingo Dam will be considered in this process, as appropriate.

The CWIP is developed with the option to introduce full delivery/pay-for-performance strategies to provide the opportunity for private capital to cover initial project implementation costs. This strategy maximizes CWIP resource flexibility by allowing investments in the most cost-effective projects and provide an opportunity for innovative projects while requiring the project offeror to demonstrate the amount of nitrogen load reductions achieved towards CWIP goals.

<u>Alternative 1. Implementation Efforts Do Not Meet Load Reduction Targets</u>

1A. Re-evaluate Priority Watersheds. The CWIP focuses implementation on priority watersheds within the Chesapeake Bay basin based on their relative influence on Bay water quality as well as efforts to align with existing jurisdictional planning and implementation. A BMP Opportunity Blueprint will identify the extent of implementation for the priority BMPs in each of these areas (and will be used to evaluate project offers). If the market to support implementation does not achieve the required level of implementation, or capacity of the current priority watersheds cannot meet the demand for implementation, the CIT will work with the CWIP Steering Committee, PSC, and EPA to identify additional effective sub-basins following the process outlined in the Framework.

1B. Other BMPs. The CIT may utilize an extended list of BMPs that meet the CBP partnership requirements as creditable and reportable practices. Additional BMPs may be desired given the response or direction indicated by a market-driven approach, or if there is greater capacity for other BMPs given site-specific geographies.

1C. Dredging. While modeling results from the USACE & MDE (2015) study notes that increasing or recovering the storage volume of the Reservoir provides limited and short-lived ecosystem benefits to the Chesapeake Bay at a high cost of dredging, MDE is funding a study and pilot project to evaluate this action further with results expected in late Summer/early Fall 2020. The results of this study will evaluate the beneficial reuse of sediments as a result of dredging and help the CWIP Steering Committee to evaluate the cost-effectiveness of this activity. The CWIP can be adjusted to incorporate feasible, cost-effective, creditable, and trackable load reduction measures identified in the study.

1D. Reassigning Loads. EPA could decide to assign the required Conowingo reduction back to each of the jurisdictions if the CWIP is not effective at reducing loads. As stated in the October 2018 letter from the EPA to the PSC, "Pursuant to its role and authority under the Bay TMDL's Accountability Framework, EOA can assign the necessary Conowingo load reductions among the seven Bay Watershed jurisdictions" (EPA, 2018).

At the time of CWIP development, the protocols for stream restoration were under review by the CBP partnership and consequently provided uncertainty to quantify the benefits of practice implementation in the BMP scenario geographies. The stream restoration protocols have been recently updated to provide clarifications on how to apply the protocols, information needed to be eligible for, and quantify the credit, and changes to the protocols to include a new, eligible practice (Protocol 5, Outfall Stabilization). The CIT may explore methods to account for the benefits of this practice. This would require the CIT to propose generalized site conditions to quantify the nitrogen load reductions, along with input from the engagement process to understand the capacity to adopt this practice. Utilization of full delivery/pay-for-performance strategies would incentivize project offerors to identify, calculate, and provide site specific stream restoration data. Further, the focus of CWIP on nitrogen reduction will drive private sector stream restoration design to incorporate features that promote nitrogen processing.

Accountability, Tracking, Crediting

The CIT will work with the jurisdictions, the CBP partnership and the CWIP Steering Committee to track, verify, and report practices implemented and their associated load reductions for the CWIP. The intent is to use the existing reporting and tracking tools to create efficiencies and reduce redundancy or unnecessary bureaucracies given the well-established and familiar protocols available to the CBP partnership and restoration practitioners (e.g., project implementers). The protocols provide assurance and accountability that load reductions associated with practices implemented in the selected geographies are credited towards the CWIP while the tools will help streamline the process across multiple geographic scales that align with the Chesapeake Bay TMDL.

There are three levels, or tiers, for reporting to track practice implementation from the site specific-scale of implementation to the Chesapeake Bay-wide modeling scale. The tools used for each tier include Chesapeake Commons' FieldDoc, jurisdiction-specific databases, and the National Environmental Information Exchange Network (NEIEN). Each of these reporting tools will include common fields or metrics to track and report projects that meet CBP partnership requirements and are credited towards the CWIP, rather than Phase III WIPs. The CIT is responsible for reviewing the accuracy and validity of the information given the steps described in the Quality Assurance Project Plan (QAPP), annually. Reports may also be provided to the jurisdictions based on their progress.

When a practitioner implements a project that will be tracked towards CWIP progress, they will be required to report the project through Chesapeake Commons' FieldDoc platform. This web-based tracking platform will allow the user to track practice implementation and assign it to both the CWIP program and other funding programs for reporting purposes. When a practitioner is done editing the project details and metrics, there will be a submission allowing them to report their practice to all attached programs. For a practice to be considered complete for CWIP reporting, a set of required metrics must be completed, including the information needed for a practice to be reported to NEIEN, as well as a spatial footprint of the practice and a photograph of the project. These data will be utilized for a data validation check as outlined by the Activity 3 Team in a QAPP and approved by EPA. An intermediate step may be taken at the jurisdictional level, where projects reported in FieldDocs are input to a jurisdiction-specific database that is then uploaded to NEIEN. The team may work with the various agencies to ensure the projects designated for the Conowingo are translated effectively.

Adaptive Management, Milestones, and Progress Reporting

The EPA will evaluate the draft and final CWIP and provide biennial evaluations of the progress toward attaining the goals in the CWIP. The EPA's evaluations, in consultation with the PSC, will be used to determine if corrections or adjustments are necessary to attain the goals of the CWIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).

Development of the 2020-2021 set of two-year milestones will be based on anticipated levels of funding both prior to and after the implementation of the Conowingo financing strategy. Two-year milestone goals can be developed with additional information from the CBP partnership related to anticipated funding levels for CWIP implementation prior to the implementation of the financing framework and may be integrated into future drafts of this plan and/or future two-year milestones. However, the results of the financing strategy will largely determine the rate and scale of annual implementation.

For the initial set of two-year milestones, the CIT will work with the relevant jurisdictions to submit draft milestones to EPA by November 2021 and a final version by January 15, 2022. The milestone reporting is contingent upon funding available through the financing strategy or other sources to support implementation efforts.

An intermediate step may be taken at the jurisdictional level, where projects reported in FieldDoc are input to a jurisdiction-specific database that are then uploaded to NEIEN. In this case, the CIT will work with the jurisdictions to ensure the projects designated for the Conowingo are translated effectively. This process will be done in a timely manner to ensure adequate time for review and submission by the jurisdictions before December 1 of each year. A unique identifier in NEIEN will denote the project is credited towards the CWIP, rather than the jurisdictions' Phase III WIPs, to ensure that proper crediting can be completed.

Timeline and Next Steps

The development of the CWIP is arranged to occur in stages with the Plan completed in November 2020, followed by a financing strategy in March 2021. The timeline is established to dovetail with the Phase III WIPs where the CWIP identifies priority BMPs in focal geographies to achieve the required nitrogen load reductions to ensure the health of the Chesapeake Bay remains on track. The implementation of the CWIP is dependent on funding being available. For example, implementation may begin as early as 2021 pending the availably of funding prior to the completion and implementation of the of the Conowingo financing strategy. Annual CWIP implementation funding levels will impact the overall CWIP timeline and could result in implementation occurring after 2025 if funding is limited or delayed. The timeline shown in Table 37 identifies key periods of CWIP development and its implementation.

Table 37. CWIP development and implementation timeline

Year	Key Decisions and Outcomes
2018	• October 28, 2018, the Chesapeake Bay Program (CBP) Principals' Staff Committee (PSC) approved a Framework for developing the CWIP. • Formation of the Steering Committee
2019	• Begin development of the CWIP (September) • Begin Phase 1 Stakeholder Outreach
2020	• WIP approved with updated timeline • Conowingo Reservoir dredging analysis complete (June/July)

Year	Key Decisions and Outcomes
	• Finalized tracking and reporting protocols and tools (March/April) • Begin Phase 2 Stakeholder Outreach • Draft financing framework • Begin design of the financing framework
2021	• Submit draft two-year milestones for 2022–2023 November 1 • Begin Phase 3 Stakeholder Outreach • Financial strategy complete • Economic development investment plan complete • Draft plan for the financing framework • Project-specific BMP opportunity blueprint for priority geographies
2022	• Submit final two-year milestones for 2022–2023 incorporating climate change by January 15 • Begin Phase 4 Stakeholder Outreach • Launch the financing framework • Implementation of investment activities (Winter)
2023	• Continued implementation of investment activities • Submit two-year milestone for 2024–2025 by November 1
2024 – 2025	• Continued implementation of investment activities • Submit two-year milestone 2024–2025 by January 15

References

Chesapeake Bay Program (CBP). 2018. Framework for the Conowingo Watershed Implementation Plan. October 12, 2018 Final version.

Chesapeake Bay Program (CBP). (2019a, January 31). *Chesapeake Bay Program Principals' Staff Committee Meeting, Final Actions and Decisions*. Retrieved from: https://www.chesapeakebay.net/channel_files/36881/psc_actions-decisions_01-31-19_final.pdf

Chesapeake Bay Program (CBP). (2019b, September 23). *Conowingo WIP Steering Committee Meeting, Face to Face*. Retrieved from: https://www.chesapeakebay.net/channel_files/39794/conowingo_wip_actions_and_decisions_23.9.19_(1).pdf

Chesapeake Bay Program (CBP). (2019c, August 12). *Chesapeake Bay Program Principals' Staff Committee Conference Call, Final Actions and Decisions*. Retrieved from: https://www.chesapeakebay.net/channel_files/40423/i._psc_actions-decisions_8-12-19_final.pdf

Chesapeake Bay Program (CBP). (2020, January 24). *Chesapeake Bay Program Principals' Staff Committee, Program Update*. Retrieved from: https://www.chesapeakebay.net/what/event/principals_staff_committee_meeting_january_2020

Davis-Martin, J. (2017, December 4). Chesapeake Bay 2017 Midpoint Assessment – Policy Issues for Partnership Decisions: Water Quality Goal Implementation Team Meeting, December 4–5, 2017. Retrieved from: https://www.chesapeakebay.net/channel_files/25782/wqgit_dec_4-5_2017_mpa_policy_decisions_briefing_presentation_story_board-12.3.17_jsadd.pdf

Easton, Z., Scavia, D., Alexander, R., Band, L., Boomer, K., Kleinman, P., Martin, J., Miller, A., Pizzuto, J., Smith, D., & C. Welty. 2017. Scientific and Technical Advisory Committee Review of the Phase 6 Chesapeake Bay Watershed Model. STAC Publication Number 17-007. Edgewater, MD. Retrieved from: http://www.chesapeake.org/pubs/379_Easton2017.pdf

Praul, C. (n.d.). Technical Brief: Pay for Performance Contract Mechanisms for Stormwater Management. Prepared by: Environmental Incentives, LLC. South Lake Tahoe, CA. Retrieved from: https://www.enviroaccounting.com/payforperformance/FileResource/GetFileResourceForProgram/8c4d7d33-faba-4481-a642-49fba7ff83eb

U.S. Army Corps of Engineers, Baltimore District (USACE), & Maryland Department of the Environment (MDE). 2015. Lower Susquehanna River Watershed Assessment, Maryland

and Pennsylvania. Prepared for: U.S. Geological Survey (USGS), Maryland Department of Natural Resources (MD DNR), the Susquehanna River Basin Commission (SRBC), USACE's Engineer Research & Development Center, U.S. Environmental Protection Agency (US EPA), & the Nature Conservancy.

U.S. Environmental Protection Agency (US EPA). 2010. Chesapeake Bay TMDL. Appendix T: Sediments Behind the Susquehanna Dams Technical Documentation – Assessment of the Susquehanna River Reservoir Trapping Capacity and the Potential Effect on the Chesapeake Bay. Prepared by: Tetra Tech, Inc.

U.S. Environmental Protection Agency (US EPA). (2018, October 26). *Letter from United States Environmental Protection Agency, Region III, to the Principals' Staff Committee*.

Appendix A. Membership of the Conowingo WIP Steering Committee

JURISDICTIONAL REPRESENTATIVE	JURISDICTION/AFFILIATION
John Maleri/Katherine Antos	District of Columbia
Marcia Fox/Brittany Sturgis (Alternate)	Delaware
Matthew Rowe*/Dave Goshorn	Maryland
Ken Kosinski/Lauren Townley	New York
Jill Whitcomb*	Pennsylvania
Ann Jennings	Virginia
Teresa Koon	West Virginia
Mark Hoffman/Ann Swanson (Alternate)	Chesapeake Bay Commission
***Co-chair**	

Appendix B. Conowingo Watershed Implementation Plan Steering Committee Meeting Draft Conowingo WIP Outreach FAQ Document

November 21, 2019

Activity 1 Handout: Draft Conowingo WIP Outreach FAQ Document

Why do we Need to Reduce Pollution in the Chesapeake Bay?

The Chesapeake Bay is in poor health due to pollution from a variety of sources – including stormwater runoff, air emissions, wastewater, agriculture, development, and more. For many years, pollution that flowed into the streams and rivers of the Chesapeake Bay was not managed to meet water quality standards. At the same time the population in the 64,000-square mile watershed increased significantly – rising 43 percent between 1980 and 2017, from 12.7 million people to 18.2 million people. All of this has harmed water quality in the watershed.

In 2010, the U.S. Environmental Protection Agency (EPA) established the Chesapeake Bay Total Maximum Daily Load (TMDL), which set nitrogen, phosphorous, and sediment reduction goals so that the Bay would meet clean water standards by 2025. Sediment can smother aquatic life and pollutants such as nitrogen and phosphorus cause algae to grow in local waterways and the Chesapeake Bay that rob the waters of oxygen. To meet these goals the seven jurisdictions (Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia) that drain to the Bay developed Watershed Implementation Plans to help guide their Chesapeake Bay clean-up efforts

How Does a Watershed Implementation Plan Work?

Watershed Implementation Plans (WIPs) identify pollutant sources and methods to address those pollutants. This is done across three general tracks: first, they identify local pollution sources by category (such as urban, agriculture, forests, wastewater treatment plants, and septic systems); second, they identify the partners and resources that can help reduce pollution; and third, they identify the best strategies to reduce pollution to meet the 2025 goals.

Why is this WIP Focusing on the Conowingo Dam?

Jurisdictions throughout the Chesapeake Bay watershed have made progress cleaning up the Bay since the TMDL was established in 2010. However, recent scientific studies have shown that the dam's reservoir is nearing "dynamic equilibrium" which means it will no longer serves as a sufficient sink for sediment and other pollutants and what flows in above the dam will eventually flow out. The Chesapeake Bay TMDL WIPs did not account for the Conowingo Dam's reduced ability to trap upstream pollution. To address this problem the EPA-Chesapeake Bay Program, and the Bay jurisdictions have been working since [2017] to develop a WIP specific to the Conowingo Dam.

Is the Conowingo WIP Independent from WIPs Currently in Development in Other States?
Yes. When complete, the Conowingo WIP will be its own plan, independent of the individual WIPs currently being developed by each of the Bay jurisdictions.

How Will the Conowingo Dam WIP be Created?

To assist in the development of the Conowingo WIP, the most up-to-date data, modeling, and technology will be used to target and track restoration practices where they will have the most strategic impact. The Environmental Protection Agency contracted with the Center for Watershed Protection, the Chesapeake Bay Trust, and the Chesapeake Conservancy to assist in overseeing various tasks including coordination, project identification, and developing a financing strategy to reduce the total amount of Nitrogen delivered to the Chesapeake Bay.

Who Will Pay for the Practices in the Conowingo WIP?

New financing methods are being developed that will be designed to help expedite progress toward restoration of the Chesapeake Bay.

How Much Nitrogen Will Need to be Reduced as Part of the Watershed Implementation Plan?

Current estimates are that six million pounds of nitrogen need to be reduced as part of the Conowingo WIP. To meet this target, the Chesapeake Bay Program and partner jurisdictions are utilizing an approach called "most effective basins" that involve implementing projects on lands located both upstream and downstream of the dam. Based on the amount of pollutant load being delivered to the Bay and planned restoration efforts some watersheds downstream of the dam could offer restoration opportunities that deliver benefits to the Chesapeake Bay comparable to restoration opportunities located upstream of the dam. These cost-effective downstream restoration opportunities could also be included in the Watershed Implementation Plan if the cost per pound of nitrogen reduced is similar or better than reductions associated with projects upstream of the dam.

If you would like more information about the Conowingo WIP visit ***insert website address here***.

Bay Watershed Facts (for a call-out box):

Rivers and streams from Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia drain to the Chesapeake Bay.

The largest river that flows into the Chesapeake Bay is the Susquehanna River, which starts near Cooperstown, New York.

The land draining into the Chesapeake Bay is 64,000 square miles in size.

More than 100,000 streams, creeks, and rivers drain into the Chesapeake Bay.

Maps needed for the fact sheet:

Map of the overall Bay Watershed

Map of the most effective basins

Appendix C. Framework for the Conowingo Watershed Implementation Plan

October 12, 2018 Final

Framework for the Conowingo Watershed Implementation Plan

Objective: To document PSC approval on the Framework for developing the Conowingo Watershed Implementation Plan.

Background: When the TMDL was established in 2010, it was estimated that Conowingo Dam would be trapping sediment and associated nutrients through 2025. New research has determined this is not the case, and that the reservoir behind Conowingo Dam has now reached dynamic equilibrium. As a result, more sediment, nitrogen, and phosphorus are now entering the Chesapeake Bay than were estimated when the TMDL was established. Even with full implementation of the seven Bay jurisdictions' WIPs, this additional pollutant loading from Conowingo reservoir reaching dynamic equilibrium will cause or contribute to water quality standards exceedances in the upper Bay. This additional pollutant load must be addressed if the Bay's water quality standards, as they are currently written and implemented, are to be met. The Chesapeake Bay Program (CBP) partnership estimates that, after fully implementing the Bay TMDL and Phase I/II WIPs, an additional reduction of 6 million pounds of nitrogen and 0.26 million pounds of phosphorus is needed in order to mitigate the water quality impacts of Conowingo Reservoir infill. Although further analysis may alter the total nitrogen and phosphorus loads needing to be reduced, these current estimates are also based on reductions occurring in the most effective sub-basins of the watershed – that is, the geographic areas with the greatest influence on Chesapeake Bay water quality. If implementation were directed watershed-wide, including less effective areas, the total pollution reduction needed would increase.

It is also important to recognize that the Conowingo Dam, a hydroelectric facility owned and operated by Exelon, is currently undergoing a Federal Energy Regulatory Commission relicensing which requires a water quality certification from the state of Maryland pursuant to Section 401 of the Clean Water Act. Maryland has indicated that it is going to review the May 2017 application from Exelon for consistency with all applicable state water quality standards. Public comments received on the application signal a need for Exelon to be a key partner in addressing the downstream water quality impacts.

The CBP Partnership has identified four options for assigning pollutant load reduction responsibility among the Bay jurisdictions and has also signaled that Exelon should be held responsible for some portion of the reduction. The four geographic options under discussion are listed below and do not yet include an assignment to Exelon, which could be impacted by the outcome of Maryland's 401 Water Quality Certification. The four options are:

1. Susquehanna Basin Only – This option includes the area within the states of New York, Pennsylvania and Maryland that are in the Susquehanna River Basin that drain directly into the Conowingo Reservoir.
2. Susquehanna Basin + Most Effective Basins – This option includes the Susquehanna Basin (i.e. Option 1 above) plus those other basins within the Chesapeake Bay watershed within which best management practices are most effective at improving Chesapeake Bay water quality.

3. Susquehanna Basin + All of Maryland and Virginia – This option adds the Partnership states that benefitted most from the original calculation of the TMDL in 2010.
4. The Entire Chesapeake Bay Watershed – This option includes all seven jurisdictions in the Bay watershed.

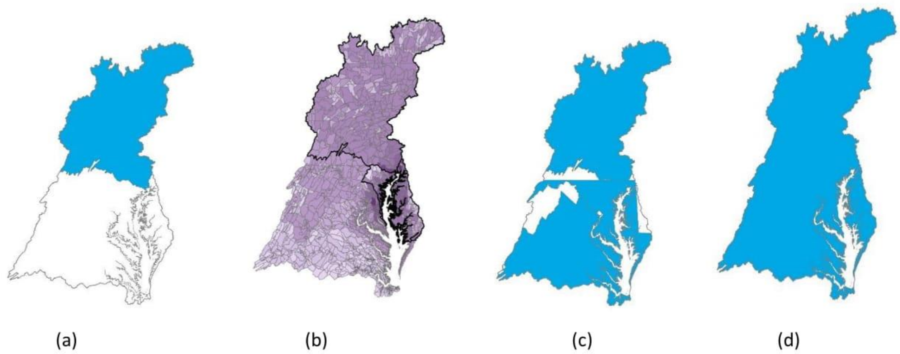

Figure 1 – Four options currently under consideration by the Bay Partnership for assigning responsibility for the additional reduction needed as a result of Conowingo infill. a) Susquehanna Basin, b) Susquehanna Basin + Most–Effective Basins (darker shades of purple = more effective basins within the watershed), c) Susquehanna Basin + All of Maryland and Virginia and d) Entire Chesapeake Bay Watershed.

There are also three options with respect to timing to account for these additional load reductions:

1. Now – The loading is incorporated now into the Phase 3 WIP and must be addressed by 2025.
2. Beyond 2025 – The loading is recognized as something that must begin to be addressed now, but the actual implementation will continue beyond 2025.
3. Post-2025 – The loading is not something that can be addressed now and will be re-visited once implementation of the Phase 3 WIPs is assessed post 2025.

After careful and extensive discussion of these options, the following conceptual approach was offered and agreed to by the CBP Partnership's Principals' Staff Committee (PSC) at its December 2017 meeting.

<u>Conceptual Approach</u>: Develop a separate and collaborative Conowingo Watershed Implementation Plan that provides details on how to reduce adverse water quality impacts to the Chesapeake Bay resulting from Conowingo Reservoir infill and provides a timeline at which it can be accomplished.

The recommended approach is in response to the recognition by all Bay jurisdictions that:

A. Trapping of pollutants by the Conowingo reservoir over the past 80+ years has benefited the water quality of the Bay, and it has also benefitted states to varying degrees by lessening load reduction responsibilities, but now those benefits are greatly diminished; and,
B. No reservoir maintenance to restore trapping capacity has occurred over the life of the dam and the reservoir is now near full capacity; and
C. The most cost-effective approach to mitigate current adverse water quality impacts, of the Conowingo reservoir at dynamic equilibrium, are realized by pooling resources to pay for pollutant reduction practices in the most effective locations (i.e., the locations with the most influence on Bay water quality). Pollutant reduction practices placed in the most effective areas (Figure 2) will limit the overall load reductions needed.

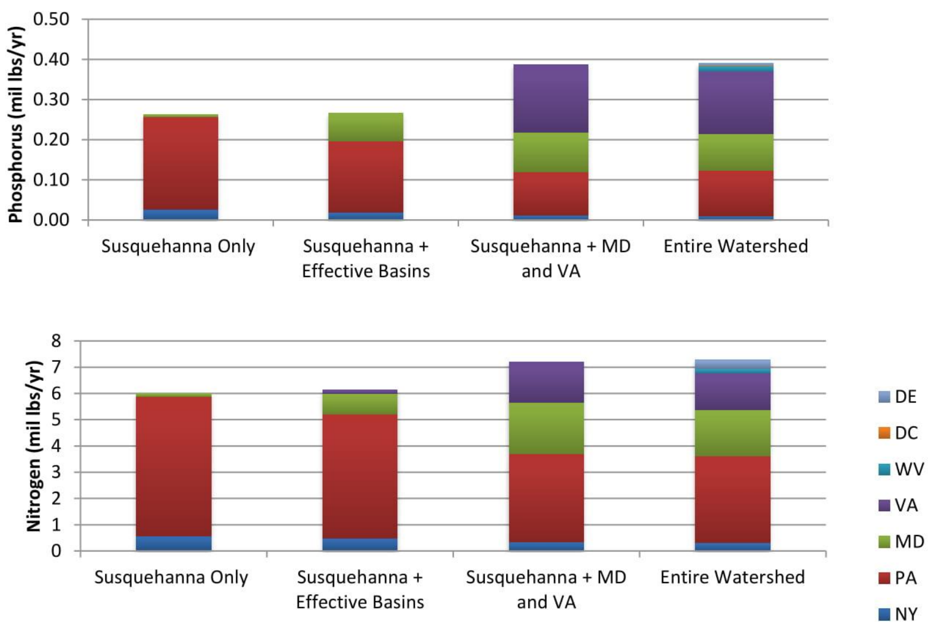

Figure 2 – Basinwide Conowingo targets developed using four different allocation options.

The Conowingo Watershed Implementation Plan (WIP) would include consideration of the following innovative components:

1. Establishing the Conowingo WIP Steering Committee as a subcommittee of the PSC. The

Conowingo WIP Steering Committee is composed of a representative from each Bay jurisdiction and the Chesapeake Bay Commission (CBC). This committee is responsible for developing and implementing the Conowingo WIP with assistance from a third party. The membership of this committee is in Appendix A. A list of guiding principles under which this Action Team will operate is included in Appendix C.

2. Creating a fund that members of the Conowingo WIP Steering Committee can use to work with the third-party awardee and install the most cost-effective practices in the most effective locations.
3. Incorporating the outcome of the Exelon CWA S. 401 water quality certification.
4. Developing a financing strategy to support development and implementation of the Conowingo WIP.
5. Developing a process by which preferred practices, targeted geographic locations and implementation projects will be selected and deployed.
6. Managing reservoir sediment through dredging and innovative and/or beneficial re-use based upon information from the Maryland pilot project.
7. Determining achievability and in what timeframe the needed load reductions will occur.

Although there are many specifics to this approach that remain to be discussed and agreed-upon, the PSC requested that more detail be provided on the following:

1. **<u>Pollutant Load Targets</u>: The total pollutant load targets attributed to Conowingo Reservoir infill would be assigned to a separate Conowingo Planning Target which all Bay jurisdictions would work collaboratively to achieve.**

   For the reasons described above, rather than adding those individual pollutant reduction targets to jurisdictions' existing Phase III planning targets, the recommendation is that the total pollutant reduction targets for nitrogen and phosphorus be assigned to the Conowingo WIP Steering Committee (i.e., the CBP Partnership will now have eight Targets: the seven Bay jurisdictions + Conowingo) with the latter to be achieved collaboratively by all relevant parties in a separate WIP. In other words, although the PSC may expect that reductions to meet the Conowingo pollutant reduction targets will come from the most effective areas in a subset of Bay jurisdictions, all Bay jurisdictions recognize the benefits of Conowingo's past pollutant trapping and, therefore, all agree to work together in implementing the agreed upon plan.

2. **<u>Funding options</u>: Partners would agree to contribute resources (e.g. funding, technical assistance, in-kind services, etc) into a pool to be managed collaboratively to achieve the necessary pollutant load reductions.**
   The unique and critical component to this proposed Conowingo WIP is pooling resources and the collaborative application of those pooled resources in the most cost-effective manners possible. Pooled resources would be phased in over a period of time. Key sources of initial funding are anticipated to be realized through the Exelon Water Quality Certification (anticipated May 2018) and additional federal funding sources (e.g., USDA , CWA 117 Innovative Nutrient and Sediment and Small Watershed Grants, Army Corps, USFW, NFWF Chesapeake Stewardship Fund, etc.) that can supplement current state WIP efforts. A financial strategy will be developed by the third party awardee and Steering Committee that identifies these initial sources of funding, as well as medium

and longer range funding sources that can be phased in over time as necessary to achieve the Conowingo pollution reduction targets. The strategy will consider leveraging state, local and private dollars and in-kind services or technical resources as well as reallocation of existing federal funds to the jurisdictions (e.g., CBIG, CBRAP, 319, WIP assistance funds) for Chesapeake Bay restoration. EPA will work with the partnership to help ensure that any reallocation of federal funds will not adversely impact state WIP efforts. The Conowingo WIP Steering Committee will also work with a third party (see below) to enlist other federal and non-federal funding sources or voluntary partnerships as well as define associated roles and responsibilities, including consideration of "pay for success" approaches.

3. **Implementing the Plan: Pooled resources would be managed by a third party, following RFP issuance by EPA's CBP Office, with guidance from the WIP Steering Committee to implement pollutant reducing practices in the most cost-effective manners possible independent of jurisdictional boundaries.**
   A third party would be charged with applying the pooled resources in the most cost-effective and pollutant load reduction-efficient locations in order to achieve the required Conowingo pollutant load reductions for the least cost. Reductions would come from existing CBP partnership-approved BMPs and other innovative components such as those listed above. Geographic targeting of BMP locations would be consistent with CBP partnership-approved models and watershed loading rates. Additionally, the third party would be charged with verifying and tracking all reductions following CBP partnership-approved protocols and pursuing or leveraging additional funding sources to implement the Conowingo WIP.

4. **Crediting Implementation**
   Practices funded with pooled dollars are credited to the Conowingo WIP pollutant reduction targets, regardless of where the practices were implemented or where the funding originated. The Conowingo WIP Steering Committee, with technical support from EPA's CBP and the third party, will develop a Conowingo credit calculation and tracking protocol that simultaneously considers opportunities to advance other state WIP efforts.

5. **Plan Development Schedule**
   The schedule is in Appendix B and subject to change. The Conowingo WIP Steering Committee will submit changes to this schedule to the PSC for approval.

6. **Roles and Responsibilities**

   I. EPA will:
      a. Evaluate the Conowingo WIP and provide biennial evaluations of the progress toward attaining the goals in the Conowingo WIP. EPA's evaluations, in consultation with the PSC, and any needed improvement will be used to determine if corrections or adjustments are necessary to attain the goals of the Conowingo WIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).
      b. Issue a Request for Proposal (RFP) for the third party and administer the subsequently awarded contract, grant or cooperative agreement. Because EPA will be issuing the RFP, it cannot act as a third party.

   c. Provide technical staff and contractor support such as modeling or GIS analysis to the Conowingo WIP Steering Committee.

II. The Conowingo WIP Steering Committee will:
   a. Consist of a representative from each jurisdiction and the Chesapeake Bay Commission (CBC). Each Bay jurisdiction and the CBC may also solicit comments on the Conowingo WIP framework from key stakeholders. EPA will not participate on this committee due to its oversight role as part of the Bay TMDL accountability framework
   b. Develop the Conowingo WIP with EPA staff and contractor support.
   c. Guide the development of a financing strategy and implementation of the Conowingo WIP, working with the third party.

III. The Third Party will:
   a. Provide facilitation, programmatic and technical assistance to the Conowingo WIP Steering Committee in the implementation of the Conowingo WIP.
   b. Develop a financing strategy with guidance from the Steering Committee and act as a fund manager, either using the shared dollars directly and/or awarding the funding to other parties to implement cost-effective pollution reduction technologies in areas having the most impact on Chesapeake Bay's water quality.
   c. Track/ verify progress made in the implementation of the Conowingo WIP and report to EPA on an annual basis.
   d. Pursue additional funding sources to sustain the Conowingo WIP and help meet associated pollution reduction targets.

IV. The PSC will:
   a. Approve the final draft Conowingo WIP for submittal to EPA and the Partnership for review and comment.
   b. Approve the final Conowingo WIP before posting on the CBP Partnership website in June 2019.
   c. Review the progress of the Conowingo WIP Steering Committee in the development and implementation of the Conowingo WIP on a regular basis.

APPENDIX A
Draft Conowingo WIP Guiding Principles for PSC Review
Prepared by: The Conowingo WIP Steering Committee
10/12/18 Version

1. **Fairness Principle**: Strive for fairness, equity, and feasibility among state, local, and federal and other partners participating in the Conowingo WIP regarding level of effort, financing, tracking, resource sharing, and third party access.

2. **Governance Principle**: Operate as an Action Team as defined in the document "Governance and Management Framework for the Chesapeake Bay Program Partnership". Strive for consensus using the Chesapeake Bay Program Partnership Consensus Continuum as described in the document. When consensus cannot be reached, the issue will be deferred to the PSC with a summary of the issue and the different options and opinions expressed by the members.

3. **Consistency Principle**: Ensure consistency with the EPA Phase 3 WIP expectations and Conowingo WIP framework documents.

4. **Transparency Principle**: Establish clear tracking, accountability and verification consistent with expectations for jurisdictions and to transparently demonstrate which practices are planned for, implemented and maintained in the Conowingo WIP vs state WIPs in order to avoid double-counting.

5. **Efficiency in Innovation Principle**: Implement the Conowingo WIP building on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. At the same time, strive for innovation, leverage new technologies, and, where appropriate, develop new implementation approaches.

APPENDIX B – Schedule for Development
Conowingo Phase 3 Watershed Implementation Plan (WIP)

OPTION 1 --- CONCURRENT SUBMITTAL

December 2017	Received PSC Approval on Conowingo WIP framework and the first cut of the Conowingo pollutant reduction targets to address this additional load.
March 2018 - March 2019	The Conowingo WIP Steering Committee, including a representative from each jurisdiction and the Chesapeake Bay Commission work collaboratively to begin development of the Conowingo WIP to include: 1) finalizing the Conowingo WIP framework, pollution reduction target(s), and resource sharing commitments; and, 2) working with EPA, other federal partners, and the third party to develop a financing strategy that leverages technical assistance, in-kind services, and federal, state, local and potential private sector funding sources.
September 2018	EPA prepares a draft RFP for an award of a cooperative agreement or contract to manage and oversee the pooled resources and to facilitate the development and implementation of the Conowingo WIP, as guided by the Conowingo WIP Steering Committee.
Sept. 2018 – March 2019	EPA selects the RFP awardee and, building on the decisions made to date, the Conowingo WIP Steering Committee continues drafting the Conowingo WIP with support of the awardee to include a finance strategy for the Conowingo WIP, additional local government and public engagement strategies, identifying specific reduction practices and a timeline, funding sources, the methodology for addressing any identified gaps and provisions for contingencies.
April 1, 2019	The Conowingo WIP Steering Committee submits a draft Conowingo WIP to the PSC for review and comment.
April 8, 2019	The PSC submits comments to the Conowingo WIP Steering Committee.
April 12, 2019	**States will post their Draft Phase III WIPs on their respective websites for Partnership review and comment.**
April 12, 2019	DRAFT Conowingo WIP posted on the CBP website for a 30-day public comment period ending May 13, 2019.
June 7, 2019	**Partnership Comments Due on States' Draft Phase III WIPs.**
July 5, 2019	The Conowingo WIP Steering Committee addresses all comments and submits a final draft to the PSC for final review and comment.

July 19, 2019	The PSC submits any final comments to the Conowingo WIP Steering Committee.
August 9, 2019	**States will post their FINAL Phase III WIPs on their respective websites.**
August 9, 2019	**The CBP partnership will post the FINAL Conowingo WIP on its website**
October 1, 2019	The Conowingo Steering Committee and the third party will begin full plan implementation utilizing funding allocated to the plan for federal FY 2020.
??	Determine the role of Exelon in the implementation of the Conowingo WIP based on the outcome of Maryland's decisions regarding 401 certification and the resultant court cases.
Biennially	EPA to evaluate the effectiveness and progress of the Conowingo WIP, pursue additional funding sources to help with implementation, identify additional mitigation options and recommend options to the PSC, as necessary.
Summer 2023	The PSC will reevaluate and make any necessary corrections based on EPA's biennial evaluations of the Conowingo WIP implementation, recommendations from the Conowingo WIP Steering Committee and any other factors.
2025	Consistent with the 2014 Watershed Agreement and the 2010 TMDL, a goal will be to have all practices in place to achieve the necessary nutrient and sediment reductions by 2025.

Appendix D. BMP Opportunities Analysis

Map name	Brief Description	Map units	Datasets referenced	Methods used
Buffer Restoration opportunities	Total area of land suitable for buffer restoration within 100 ft. of water network.	Square Meters	• Land Cover: 1-meter land cover data classified using 2013 NAIP imagery; Chesapeake Conservancy & University of Vermont; 2016 • Water network (MD/PA): Lidar-derived water network combined with 2013 1-meter land cover data; Chesapeake Conservancy; 2018	Pixels from the high-resolution land cover dataset within 100 ft. distances of the water network were considered in the buffer analysis. Pixels classified as low vegetation, wetlands, or barren were considered buffer restoration opportunities. Area of buffer restoration opportunity is summed by county.
Living Shorelines opportunities	Total length of shoreline not already obstructed by the presence of a structure	Feet	• Maryland Shoreline Inventory: Shoreline Situation Report, Comprehensive Coastal Inventory Program, Virginia Institute of Marine Science, College of William and Mary; 2006	Line-of-sight assessment that describes the presence of shoreline structures for shore protection and recreational purposes. Unclassified shorelines identified as areas with potential opportunity for implementation. Length of opportunity is summed by county.
Wetland restoration opportunities	Lands currently in agriculture that naturally accumulate water due to topography and have historically had poorly draining soils	Square Meters	• Potentially Restorable Wetlands; U.S. EPA; 2016	Total land area identified as potential wetland restoration opportunities on agricultural land summed by county.
Urban BMP opportunities	Urban land outside of MS4 boundaries	Square Meters	• Urban Areas/Urban Clusters. U.S. Census Bureau. 2010 • Municipal Separate Storm Sewer System (MS4) Boundaries. Chesapeake Bay Program. 2019.	Area of urban land that falls outside of MS4 boundaries summed by county. These are potential locations for urban BMP implementation that is not already considered under current permitting processes.
Total nitrogen relative effectiveness	Change in dissolved oxygen (DO) that occurs in the Bay per pound of nutrient changed locally in the watershed	µg/L DO per million lbs of reduction	• Relative Effectiveness; Chesapeake Bay Program. 2019.	See Emily Trentacoste, Gary Shenk, or Jeff Sweeney at the Chesapeake Bay Program.

CAST analysis on Nitrogen loads	Theoretical opportunities for additional nitrogen reductions beyond projected Phase III WIP implementation	Pounds of Nitrogen delivered to edge of stream/year	• CAST Phase III WIP Final Scenario Report; Chesapeake Bay Program. 2019.
			  ○ Projected nitrogen delivery to edge-of-stream after full implementation of Phase III WIPs.
			• CAST 2010 E3 Scenario Report; Chesapeake Bay Program. 2017.
			  ○ E3 - Everything by everyone everywhere, e.g. BMPs implemented to theoretical maximum extent resulting in the lowest possible loads that could be delivered to local streams
				WIP 3 load - E3 load = theoretical nitrogen load available for reduction through CWIP implementation. Outputs for this layer are summed by LRS.

Appendix E. Data and Methods to Quantify the Nitrogen Load Reduction from BMP Implementation-Scenario 1

The Chesapeake Assessment Scenario Tool (CAST) was used to model pollutant load reductions all BMPs.

The initial CWIP analysis included CAST runs by land-river segment (LRS) for the priority geography areas only. However, the limited geography achieved only achieved one third of the 6-million-pound nitrogen load reduction. To enhance the nitrogen load reduction potential, increase the time efficiency of modelling, and to benefit the financing strategy to implement the BMPs, the geography of interest was expanded to the county scale.

The current analysis began with examining the full opportunity of implementing forest buffers, forest buffer-streamside with exclusion fencing, wetland restoration – floodplain, wetland restoration – headwater, urban stream restoration, nonurban stream restoration from WIP3 to E3. That analysis yielded a 9.3-million-pound nitrogen reduction. Therefore, best professional judgement was used to scale back the implementation of forest buffers to 65%, wetlands to 65%, and stream restoration to 90%. With this reduced implementation, the nitrogen reduction was reduced to 6.2-million-pounds.

The analysis herein, was developed to that 6-million-pounds of nitrogen reduction could be achieved in the area of interest. The analysis is not a definitive commitment but rather a planning document that shows the reductions are possible but may require implementation of different strategies, such as dredging, to accomplish the pollution reduction goals. Final BMPs will determined once a financing strategy is complete.

Determining opportunity

- An analysis of the Amount Credited in WIP3 subtracted from the Amount Credited in E3 was performed for the following practices in the Conowingo geography:
    - Forest Buffers
    - Forest Buffer – Narrow
    - Forest Buffer-Streamside with Exclusion Fencing
    - Forest Buffer-Narrow with Exclusion Fencing
    - Grass Buffers
    - Grass Buffer – Narrow

- Grass Buffer-Streamside with Exclusion Fencing
- Grass Buffer-Narrow with Exclusion Fencing
- Wetland Restoration – Floodplain
- Wetland Restoration – Headwater
- Urban Stream Restoration
- Nonurban Stream Restoration

- To determine the area that bioswales could be applied to, analysis of each of the load sources classified as Nonregulated Developed land use was performed for each County within the Conowingo Geography.
    - 1% of that land acreage was calculated from these load source groups as a responsible assumption for this analysis. The 1% was based upon best professional judgement and…
        - Non-Regulated Buildings and Other
        - Non-Regulated Roads
        - Non-Regulated Tree Canopy over Impervious
        - Non-Regulated Tree Canopy over Turf Grass
        - Non-Regulated Turf Grass
- An analysis of the opportunity for non-urban shoreline management was performed by the Chesapeake Conservancy using Shoreline Inventory for Maryland from the Virginia Institute of Marine Science (VIMS). This data includes visual assessments of the shorelines which occurred in a locality-based series from 2002 to 2006.
    - Analysis was performed on the following counties in Maryland:
        - Cecil
        - Dorchester
        - Harford
        - Kent
        - Queen Anne's
        - Somerset

  - St. Mary's
  - Talbot
  - Caroline
  - Wicomico

Determining practices and areas for the input deck

- Acres (or feet for stream restoration) within the Conowingo Shell for WIP3 were subtracted from E3 for each of the practices excluding bioswales
  - This was done by county, practice, and load source using the Amount Credited values
- Any practice for which there were positive acres between the E3 – WIP3 analysis were kept
  - This removed all categories of grass buffers, forest buffer – narrow, and forest buffer – narrow with exclusion fencing from the analysis as there were no positive acres or feet available from E3 – WIP3.
  - The rest of the practices were kept
  - The available acres (or feet for stream restoration) for each practice by county by load source group were calculated

Creating the Model Runs

- An input deck was created using 100% of the available opportunity from the following:
  - Forest buffers
  - Forest Buffer-Streamside with Exclusion Fencing
  - Wetland Restoration – Floodplain
  - Wetland Restoration – Headwater
  - Urban Stream Restoration
  - Nonurban Stream Restoration
- Further, bioswales were entered to treat 1% of the Nonregulated Developed land use was performed for each County within the Conowingo Shell.

- Non-Urban Shoreline Management was entered based off of opportunity analysis that was performed by the Chesapeake Conservancy
    - To account for the age of the data and qualifying conditions for Living Shorelines the opportunity lengths were reduced by 50%.
    - Implementation assumed 10% of the adjusted opportunity that was determined by the Chesapeake Conservancy using VIMS data and entered as total feet into the input deck.
- The input deck was run in CAST along with the predetermined WIP3 Final deck available through the CAST administrator

Reports Generated

- Inputs were placed into the CAST model
- The CAST model determined that no BMPs in the input deck were invalid
- Reports for loads, and BMPs submitted versus credited were created for both the CWIP plus WIP3 and WIP3 runs individually

Quality Control

- Analysis of the BMPs Submitted versus Credited report was generated for both the WIP3 and the CWIP (plus WIP3) model runs. The CWIP (plus WIP3) Amount Credited values were subtracted from the WIP3 values.
- The difference in Amount Credited was compared to the values that were entered into the input deck.
- A small number of BMPs acres were not credited, primarily forest buffers. It was determined that the number of these acres were considered as insignificant.

Bioreactors

- An analysis of the opportunity for bioreactors was performed by the Center for Watershed Protection using USGS NHDPlus HR, USDA NRCS Soils, and MD Dept of Planning 2010 Land Use Land Cover data.
- The analysis extracted Depth to Water Table from NRCS soil survey then intersected the canals/ditches from NHD within the Conowingo Geography with the depth to water table and MDP land use data.
- Results were filtered to include only canals/ditches with a depth to water table <= 12" and within agricultural land.

- The average loading from the load sources categorized as Cropland were determined by summing the acres and EOT loads individually and then dividing the load by acres for the following:
    - Double Cropped Land
    - Full Season Soybeans
    - Grain with Manure
    - Grain without Manure
    - Other Agronomic Crops
    - Silage with Manure
    - Silage without Manure
    - Small Grains and Grains
    - Specialty Crop High
    - Specialty Crop Low
- This provided an EOT calculation of the reduction

Stream Restoration

- CAST currently applies a default rate of 0.075 pound of nitrogen per linear foot of stream restoration per the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" (pg. 14). However, the default rate was doubled to provide an estimate of the total nitrogen reduction. This was deemed reasonable given the update to the Stream Restoration Protocols and a new protocol that is under review by the Urban Stormwater Workgroup for Outfall Stabilization (Protocol 5).

Reducing from Full Opportunity

- Once the model results were generated, stream restoration doubled, and the reductions from bioreactors were included, there was approximately 9.3M pounds of nitrogen reduction calculated.
- An analysis was performed to reduce the suite of practices down from 100% of the opportunity from E3 – WIP3 down to a level that achieved closer to the 6M pound nitrogen goal.

- The following practices were reduced in acreage by 35% (65% of full opportunity)
    - Forest buffers
    - Forest Buffer-Streamside with Exclusion Fencing
    - Wetland Restoration – Floodplain
    - Wetland Restoration – Headwater
- The following stream restoration practices were reduced in feet by 10% (90% of full opportunity)
    - Urban Stream Restoration
    - Nonurban Stream Restoration
- The rest of the practices were unchanged.
- This resulted in the achieving a nitrogen goal of approximately 6 M pound.

Susquehanna Nitrogen Exchange Ratios

Nitrogen from the Susquehanna basin has a greater impact on dissolved oxygen in the Bay than the same nitrogen load from many other basins in the Chesapeake Bay. Table E1 summarizes the unit change in DO per million pounds of N for each of the basins considered in this study, along with the "Exchange Ratio" applied to equate loading from the Susquehanna and the geographies where each ratio is applied.

Basin	Unit Change per 1,000,000 pounds of N	Exchange Ratio (to Susquehanna N Load)	Geographies where Applied
Susquehanna	16.325	1.00	All PA Counties
Upper Eastern Shore	10.709	0.66	Kent, Queen Anne's and Cecil Counties in MD
Lower Eastern Shore	9.782	0.60	Somerset, Wicomico and Worchester Counties in MD

Middle Eastern Shore	11.244	0.69	All other MD Counties

Table E1: Change in Dissolved Oxygen per million pounds of Nitrogen

These ratios were applied to loads and load reductions included in this report. a "Susquehanna Equivalent N Load" would be calculated using the following equation:

L_{susq}=LxER

Where:

L_{susq} = Susquehanna Equivalent Nitrogen Load (pound/acre/year or pound/year)

L= Estimated Edge of Tide Load (pound/acre/year or pound/year)

ER=Exchange Ratio (From Table XX).

For example, if the loading rate for a particular land use in the Lower Eastern Shore is 10 pound/acre/year, the equivalent Susquehanna Equivalent N Load would be calculated as:

L_{susq}=10 pound/acre/yearx0.6, or   6.0 pound/acre/year

Appendix F. Summary of analysis to develop nitrogen load reductions for the BMP implementation strategy.

This information will be added following selection of the CAST scenario.

Appendix G. A summary of assumptions used to provide the cost estimates for the CWIP implementation strategy.

Cost Assumption were developed using data found with in CAST and summarized below (https://cast.chesapeakebay.net/Documentation/CostProfiles).

Stream restoration

- MD
  - Urban & Non-Urban Stream Restoration Protocols
    - $408.24/ft
    - O&M: $51.03/ft/yr
    - Total annualized cost per unit: $145.32
- PA
  - Urban & Non-Urban Stream Restoration Protocols
    - $408.24/ft
    - O&M: $51.03/ft/yr
    - Total annualized cost per unit: $145.32
- Stream Restoration Averaged
  - Urban & Non-Urban Stream Restoration Protocols
    - $408.24/ft
    - O&M: $51.03/ft/yr
    - Total annualized cost per unit: $145.32

Living shorelines

- MD
  - Urban Shoreline Management
    - $435.07/ft
    - O&M: $21.75/ft/yr
    - Total annualized cost per unit: $50.05
  - Non-Urban Shoreline Management
    - $85.23/ft
    - O&M: $0/ft/yr
    - Total annualized cost per unit: $6.84
  - Urban Shoreline Erosion Control Non-Vegetated
    - $856.33/ft
    - O&M: $42.82/ft/yr
    - Total annualized cost per unit: $98.53
  - Urban Shoreline Erosion Control Vegetated
    - $82.87/ft
    - O&M: $4.14/ft/yr
    - Total annualized cost per unit: $9.53

- Non-Urban Shoreline Erosion Control Non-Vegetated
  - $117.19/ft
  - O&M: $5.86/ft/yr
  - Total annualized cost per unit: $15.26
- Non-Urban Shoreline Erosion Control Vegetated
  - $15.20/ft
  - O&M: $0.76/ft/yr
  - Total annualized cost per unit: $1.98

▪ PA
- Urban Shoreline Management
  - $435.07/ft
  - O&M: $21.75/ft/yr
  - Total annualized cost per unit: $50.05
- Non-Urban Shoreline Management
  - $63.56/ft
  - O&M: $0/ft/yr
  - Total annualized cost per unit: $5.10
- Urban Shoreline Erosion Control Non-Vegetated
  - $856.33/ft
  - O&M: $42.82/ft/yr
  - Total annualized cost per unit: $98.53
- Urban Shoreline Erosion Control Vegetated
  - $82.87/ft
  - O&M: $4.14/ft/yr
  - Total annualized cost per unit: $9.53
- Non-Urban Shoreline Erosion Control Non-Vegetated
  - $139.66/ft
  - O&M: $6.98/ft/yr
  - Total annualized cost per unit: $18.19
- Non-Urban Shoreline Erosion Control Vegetated
  - $30.54/ft
  - O&M: $1.53/ft/yr
  - Total annualized cost per unit: $3.98

▪ Living Shorelines Averaged
- Urban Shoreline Management
  - $435.07/ft
  - O&M: $21.75/ft/yr
  - Total annualized cost per unit: $50.05
- Non-Urban Shoreline Management
  - $74.40/ft
  - O&M: $0/ft/yr

    - Total annualized cost per unit: $5.97
- Urban Shoreline Erosion Control Non-Vegetated
    - $856.33/ft
    - O&M: $42.82/ft/yr
    - Total annualized cost per unit: $98.53
- Urban Shoreline Erosion Control Vegetated
    - $82.87/ft
    - O&M: $4.14/ft/yr
    - Total annualized cost per unit: $9.53
- Non-Urban Shoreline Erosion Control Non-Vegetated
    - $128.43/ft
    - O&M: $6.42/ft/yr
    - Total annualized cost per unit: $16.73
- Non-Urban Shoreline Erosion Control Vegetated
    - $22.87/ft
    - O&M: $1.15/ft/yr
    - Total annualized cost per unit: $2.98

Buffers

- MD
    - Agriculture
        - Grass Buffer
            - $250.55/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $40.97
        - Grass Buffer, Narrow
            - $250.55/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $40.97
        - Grass Buffer, Streamside with Exclusion Fencing
            - $1,550.52/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $261.32
        - Grass Buffer, Narrow with Exclusion Fencing
            - $4,152.49/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $702.37
        - Forest Buffer
            - $1,756.64/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $100.33
        - Forest Buffer, Narrow

            - $1,756.64/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $100.33
        - Forest Buffer, Streamside with Exclusion Fencing
            - $11,506.45/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $652.70
        - Forest Buffer, Narrow with Exclusion Fencing
            - $31,021.16/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $1,758.31
        - Saturated Buffer
            - $4,676.50/ac
            - O&M: $78.06/ac/yr
            - Total annualized cost per unit: $453.32
    - Developed
        - Forest Buffer
            - $1,790.67/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $91.90
        - Grass Buffer
            - $430.51/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $55.75
- PA
    - Agriculture
        - Grass Buffer
            - $385.86/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $56.95
        - Grass Buffer, Narrow
            - $385.86/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $56.95
        - Grass Buffer, Streamside with Exclusion Fencing
            - $1,685.83/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $277.30
        - Grass Buffer, Narrow with Exclusion Fencing
            - $4,287.79/ac
            - O&M: $156.08/ac/yr

                - Total annualized cost per unit: $718.35
        - Forest Buffer
            - $2,929.92/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $157.35
        - Forest Buffer, Narrow
            - $2,929.92/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $157.35
        - Forest Buffer, Streamside with Exclusion Fencing
            - $12,679.72/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $709.73
        - Forest Buffer, Narrow with Exclusion Fencing
            - $32,194.44/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $1,815.33
        - Saturated Buffer
            - $4,660.61/ac
            - O&M: $78.06/ac/yr
            - Total annualized cost per unit: $452.04
    - Developed
        - Forest Buffer
            - $2,986.67/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $153.28
        - Grass Buffer
            - $524.44/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $67.92
- **Buffers Averaged**
    - Agriculture
        - Grass Buffer
            - $318.21/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $48.96
        - Grass Buffer, Narrow
            - $318.21/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $48.96
        - Grass Buffer, Streamside with Exclusion Fencing

        - $1,618.18/ac
        - O&M: $52/ac/yr
        - Total annualized cost per unit: $269.31
    - Grass Buffer, Narrow with Exclusion Fencing
        - $4,220.14/ac
        - O&M: $156.08/ac/yr
        - Total annualized cost per unit: $710.36
    - Forest Buffer
        - $2,343.28/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $128.84
    - Forest Buffer, Narrow
        - $2,343.28/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $128.84
    - Forest Buffer, Streamside with Exclusion Fencing
        - $12,093.09/ac
        - O&M: $52/ac/yr
        - Total annualized cost per unit: $681.22
    - Forest Buffer, Narrow with Exclusion Fencing
        - $31,607.80/ac
        - O&M: $156.08/ac/yr
        - Total annualized cost per unit: $1,786.82
    - Saturated Buffer
        - $4,668.56/ac
        - O&M: $78.06/ac/yr
        - Total annualized cost per unit: $452.68
- Developed
    - Forest Buffer
        - $2,388.67/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $122.59
    - Grass Buffer
        - $477.48/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $61.84

<u>Wetlands</u>

- MD
    - Agriculture
        - Wetland Restoration, Floodplain
            - $403.64/ac

        - O&M: $44.65/ac/yr
        - Total annualized cost per unit: $93.71
    - Wetland Restoration, Headwater
        - $3,000/ac
        - O&M: $44.65/ac/yr
        - Total annualized cost per unit: $343.85
    - Wetland Creation, Floodplain
        - $3,228/ac
        - O&M: $44.65/ac/yr
        - Total annualized cost per unit: $365.82
    - Wetland Creation, Headwater
        - $3,228/ac
        - O&M: $44.65/ac/yr
        - Total annualized cost per unit: $365.82
- Developed
    - Wet Ponds and Wetlands
        - $4,411.42/acre treated
        - O&M: $62.92/acre treated
        - Total annualized cost per unit: $329.91
    - Floating Treatment Wetland, 10% Coverage of Pond
        - $3,707/ac
        - O&M: $185/ac/yr
        - Total annualized cost per unit: $1,546.24
    - Floating Treatment Wetland, 20% Coverage of Pond
        - $7,415/ac
        - O&M: $371/ac/yr
        - Total annualized cost per unit: $3,093.85
    - Floating Treatment Wetland, 30% Coverage of Pond
        - $11,122/ac
        - O&M: $556/ac/yr
        - Total annualized cost per unit: $4,640.09
    - Floating Treatment Wetland, 40% Coverage of Pond
        - $14,829/ac
        - O&M: $741/ac/yr
        - Total annualized cost per unit: $6,186.34
    - Floating Treatment Wetland, 50% Coverage of Pond
        - $18,536/ac
        - O&M: $927/ac/yr
        - Total annualized cost per unit: $7,733.58
- Natural
    - Wetland Enhancement

            - $726.45/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $124.81
        - Wetland Rehabilitation
            - $2,545.85/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $300.10
- PA
    - Agriculture
        - Wetland Restoration, Floodplain
            - $466.56/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $96.58
        - Wetland Restoration, Headwater
            - $2,781.64/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $319.62
        - Wetland Creation, Floodplain
            - $2,776.65/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $318.72
        - Wetland Creation, Headwater
            - $2,907.81/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $331.78
    - Developed
        - Wet Ponds and Wetlands
            - $4,418.64/acre treated
            - O&M: $63.02/acre treated
            - Total annualized cost per unit: $330.44
        - Floating Treatment Wetland, 10% Coverage of Pond
            - $3,707/ac
            - O&M: $185/ac/yr
            - Total annualized cost per unit: $1,546.24
        - Floating Treatment Wetland, 20% Coverage of Pond
            - $7,415/ac
            - O&M: $371/ac/yr
            - Total annualized cost per unit: $3,093.85
        - Floating Treatment Wetland, 30% Coverage of Pond
            - $11,122/ac
            - O&M: $556/ac/yr

            - Total annualized cost per unit: $4,640.09
        - Floating Treatment Wetland, 40% Coverage of Pond
            - $14,829/ac
            - O&M: $741/ac/yr
            - Total annualized cost per unit: $6,186.34
        - Floating Treatment Wetland, 50% Coverage of Pond
            - $18,536/ac
            - O&M: $927/ac/yr
            - Total annualized cost per unit: $7,733.58
    - Natural
        - Wetland Enhancement
            - $1,145.41/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $161.98
        - Wetland Rehabilitation
            - $2,781.64/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $319.62
- **Wetlands Averaged**
    - Agriculture
        - Wetland Restoration, Floodplain
            - $435.10/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $95.15
        - Wetland Restoration, Headwater
            - $2,890.82/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $331.74
        - Wetland Creation, Floodplain
            - $3,002.33/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $342.27
        - Wetland Creation, Headwater
            - $3,067.91/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $348.80
    - Developed
        - Wet Ponds and Wetlands
            - $4,415.03/acre treated
            - O&M: $62.97/acre treated
            - Total annualized cost per unit: $330.18

- Floating Treatment Wetland, 10% Coverage of Pond
  - $3,707/ac
  - O&M: $185/ac/yr
  - Total annualized cost per unit: $1,546.24
- Floating Treatment Wetland, 20% Coverage of Pond
  - $7,415/ac
  - O&M: $371/ac/yr
  - Total annualized cost per unit: $3,093.85
- Floating Treatment Wetland, 30% Coverage of Pond
  - $11,122/ac
  - O&M: $556/ac/yr
  - Total annualized cost per unit: $4,640.09
- Floating Treatment Wetland, 40% Coverage of Pond
  - $14,829/ac
  - O&M: $741/ac/yr
  - Total annualized cost per unit: $6,186.34
- Floating Treatment Wetland, 50% Coverage of Pond
  - $18,536/ac
  - O&M: $927/ac/yr
  - Total annualized cost per unit: $7,733.58

- Natural
  - Wetland Enhancement
    - $935.93/ac
    - O&M: $44.65/ac/yr
    - Total annualized cost per unit: $143.40
  - Wetland Rehabilitation
    - $2,663.75/ac
    - O&M: $44.65/ac/yr
    - Total annualized cost per unit: $309.86

Bioswales

- MD
  - Developed
    - Bioswale
      - $9,598.47/acre treated
      - O&M: $313.42/acre treated/year
      - Total annualized cost per unit: $864.54
- PA
  - Developed
    - Bioswale
      - $9,614.18/acre treated
      - O&M: $313.93/acre treated/year

            - Total annualized cost per unit: $865.95
- Bioswales Averaged
    - Bioswale
        - $9,606.33/acre treated
        - O&M: $313.68
        - Total annualized cost per unit: $915.25

Appendix H. BMPs and counties included within each CAST scenario

BMPs with respective durations and units within each CAST scenario.

Scenario	BMPs (Duration; Unit)
1	Agricultural BMPs • Forest Buffers on Fenced Pasture Corridor (Cumulative; Acres in Buffers) • Forest Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Non-Urban Stream Restoration (Cumulative Feet) • Non-Urban Shoreline Management (Cumulative; Feet) Urban BMPs • Urban Stream Restoration (Cumulative; Feet) • Bioswale (Cumulative; Feet)
2	Full Suite of BMPs implemented in the WIP 3 programs. Google drive shared with the Group includes the input files.
3,4,7,9,11	• Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres) • Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres) • Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Forest Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres)
5	Agricultural BMPs • Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres)

BMPs with respective durations and units within each CAST scenario.	
Scenario	**BMPs (Duration; Unit)**
	• Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres) • Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres) Urban BMPs • Urban Forest Buffers (Annual; Acres) • Urban Forest Planting (Annual; Acres)
6	Agricultural BMPs • Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres) • Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres) • Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres) Urban BMPs • Urban Forest Buffers (Annual; Acres)

BMPs with respective durations and units within each CAST scenario.	
Scenario	**BMPs (Duration; Unit)**
	• Urban Forest Planting (Annual; Acres) • Urban Tree Planting • Bioswales
6.1, 8, 10	Same agricultural BMPs as Scenario 6 Urban BMPs include: • Urban Infiltration • Bioswales

Maximum implementation level (%) for each state/BMP combination for Scenarios 6.11 through 11.

BMP_Short_Name	Source	MD	NY	PA	VA	WV
barnrunoffcont	feed	95	95	95	93	84
conplan	ag	95	95	95	74	21
conservetill	crop	47.4	33.2	40.4	82	64
forestbuffers	agopenspace	95	9.8	95	95	3
grassbuffers	crophay	8.7	0.6	3.6	3	1
hrtill	crop	76.	30.9	67.0	22	0
incorplowearly	crophaywithmanure	0	0	9.7	0	0
incorplowlate	crophaywithmanure	26.3	0	0	0	0
injection	crophaywithmanure	2.2	0	0	0	0
lowrestill	crop	0	15.1	8.9	0	0
nmcoren	agnoopen	69.6	21.8	95	85	23
nmplacen	agnoopen	19.9	21.8	25	63	0
nmraten	agnoopen	34.7	21.8	48.6	63	0
nmtimen	agnoopen	9.9	21.8	51.4	63	0
precrotgrazing	pasture	67.8	95	100	71	76
wetlandrestorefloodplain	ag	0	0	0.4	1	0.01701323
wetlandrestoreheadwater	ag	8.2	0	0.02	1	0
infiltration	nonregulated	6.5	18.9	0.09	5	5
bioswale	nonregulated	5.7	0	1.99	2	2

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
1	• Calvert • Carline • Cecil • Dorchester • Harford • Kent • Queen Anne's • Somerset • St. Mary's • Talbot • Wicomico • Worcester	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • McKean • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder	--	--	--

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
		• Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York			
2,10,11	• Allegany • Anne Arundel • Baltimore City • Baltimore County • Calvert • Carroll • Cecil • Dorchester • Frederick • Garrett • Harford • Howard • Montgomery • Somerset • Washington • Wicomico • Worcester <u>Delaware</u> • Sussex, Delaware	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • McKean	• Allegany • Broome • Chemung • Chenango • Cortland • Delaware • Herkimer • Livingston • Madison • Oneida • Onondaga • Otsego • Schoharie • Schuyler • Steuben • Tioga • Tompkins • Yates	• Accomack • Loudoun • Northampton • Northumberland • Stafford • Westmoreland	• Berkeley • Grant • Hampshire • Jefferson • Mineral • Morgan

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
		• Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York			
3	• Allegany • Anne Arundel • Baltimore City • Baltimore County • Calvert • Carroll • Cecil • Dorchester • Frederick • Garrett • Harford • Howard • Montgomery • Somerset • Washington • Wicomico • Worcester Delaware	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson	• Broome • Chemung • Chenango • Cortland • Delaware • Otsego • Tioga • Tompkins	• Accomack • Loudoun • Northampton • Northumberland • Stafford • Westmoreland	• Berkeley • Grant • Hampshire • Jefferson • Mineral • Morgan

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
	• Sussex, Delaware	• Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York			
4,5	• Baltimore County • Cecil • Harford	• Adams • Berks • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Franklin • Huntingdon • Juniata • Lackawanna	--	--	--

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
		• Lancaster • Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Union • York			
6.1,7	• Anne Arundel • Baltimore City • Baltimore County • Calvert • Carroll • Cecil • Dorchester • Harford • Wicomico <u>Delaware</u> • Sussex, Delaware	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna	• Broome • Chemung • Chenango • Cortland • Delaware • Otsego • Tioga • Tompkins	--	--

Counties within each CAST scenario.

Scenario	Maryland	Pennsylvania	New York	Virginia	West Virginia
		• Lancaster • Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York			
8,9	• Anne Arundel • Baltimore City • Baltimore County • Calvert • Caroline • Carroll • Cecil • Dorchester • Harford • Queen Anne's • Somerset • Talbot • Wicomico • Worcester	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton	• Broome • Chenango • Cortland • Delaware • Madison • Otsego • Tioga • Tompkins	• Accomack	--

Counties within each CAST scenario.					
Scenario	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**
		• Huntingdon • Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Sullivan • Susquehanna • Tioga • Union • Wyoming • York			