West Virginia Chapter

State and District of Columbia Analyses

CHESAPEAKE BAY COMPREHENSIVE WATER RESOURCES AND RESTORATION PLAN

STATE CHAPTER

State of West Virginia

June 2018

US Army Corps of Engineers®

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SECTION 1

INTRODUCTION

1.1 Introduction

The goal of the Chesapeake Bay Comprehensive Water Resources and Restoration Plan (CBCP) is to provide a single, comprehensive and integrated restoration plan that would assist with implementation of the 2014 Chesapeake Bay Watershed Agreement (2014 Bay Agreement). The CBCP provides a "roadmap" of implementation actions that protect, restore, and preserve the Chesapeake Bay and actions that adopt and align with what organizations are doing without duplicating ongoing or planned actions. Additionally, the CBCP maximizes the use of existing information and identifies projects that can be implemented, in each jurisdiction in the Chesapeake Bay Watershed.

The CBCP aligns with the vision established in the 2014 Bay Agreement:

"We envision an environmentally and economically sustainable [and resilient] Chesapeake Bay Watershed with clean water, abundant life, conserved lands and access to the water, a vibrant cultural heritage, and a diversity of engaged citizens and stakeholders."

To identify implementation actions to protect, restore, and preserve the Chesapeake Bay, geospatial analyses were conducted at a 1) baywide, 2) jurisdiction or state, and 3) watershed scale. The baywide analysis characterized problems, needs, and opportunities at a hydrologic unit code 10 (HUC 10) scale, hereafter referred to as subwatershed. CBCP analyses were based on a core set of questions formulated from the 2014 Bay Agreement goals and outcomes as well as stakeholder input. The baywide analysis resulted in a set of recommended implementation strategies that included locations (subwatersheds), potential management measures, a range of potential costs, benefits, potential project implementation agencies, and any sequencing or dependences that could affect implementation. The full results of the baywide analysis are described in the CBCP Main Report. The CBCP state analyses are the result of the baywide analysis "clipped" per each jurisdiction in the Chesapeake Bay Watershed (New York, Pennsylvania, West Virginia, Virginia, Maryland, Delaware, and the District of Columbia). The results of State of West Virginia Analysis are described in this section of the report. The portion of the Chesapeake Bay Watershed within West Virginia is referred to as West Virginia throughout this chapter.

The CBCP state-selected watershed analysis contains a more detailed investigation in each jurisdiction, with the goal of identifying more site-specific project-scale opportunities (with priorities defined by each jurisdiction) for implementation. The Opequon Creek Watershed was identified as the state-selected Watershed by the State of West Virginia for technical services and potential design-build opportunities with a focus on green infrastructure, source water protection planning, and public sewer in karst areas. A number of agencies have identified the Opequon Creek Watershed as a priority including the National Fish and Wildlife Foundation (NFWF), The Nature Conservancy (TNC), and the U.S. Fish and Wildlife Service (USFWS). Additionally, the Eastern Panhandle Regional Planning and Development Council 2017 Hazard

Mitigation Plan (available at: http://www.region9wv.com/plans---studies.html) is a strategic plan previously developed that identified the Opequon Creek Watershed as a priority.

The following are reference maps displaying the boundaries, name (Figure 1), and number (Figure 2) of each HUC 10 subwatershed in West Virginia. Table 1 (all tables are provided following the report content) provides the number, name, size (acres), and other drainage states of each West Virginia HUC 10 subwatershed. Hereafter, HUC 10 subwatersheds are referred to simply as subwatersheds.

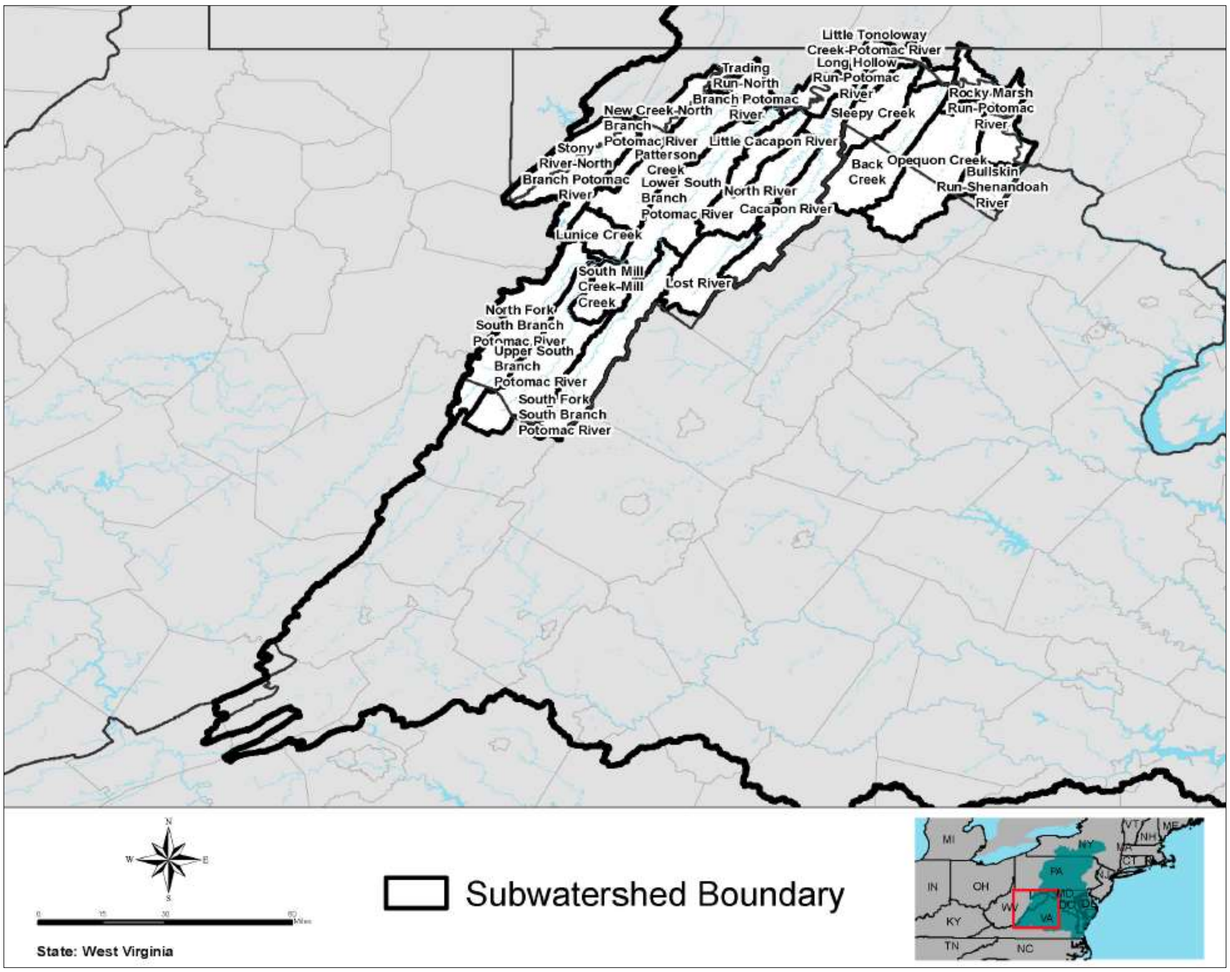

Figure 1. Hydrologic unit code (HUC) 10 subwatershed names for West Virginia

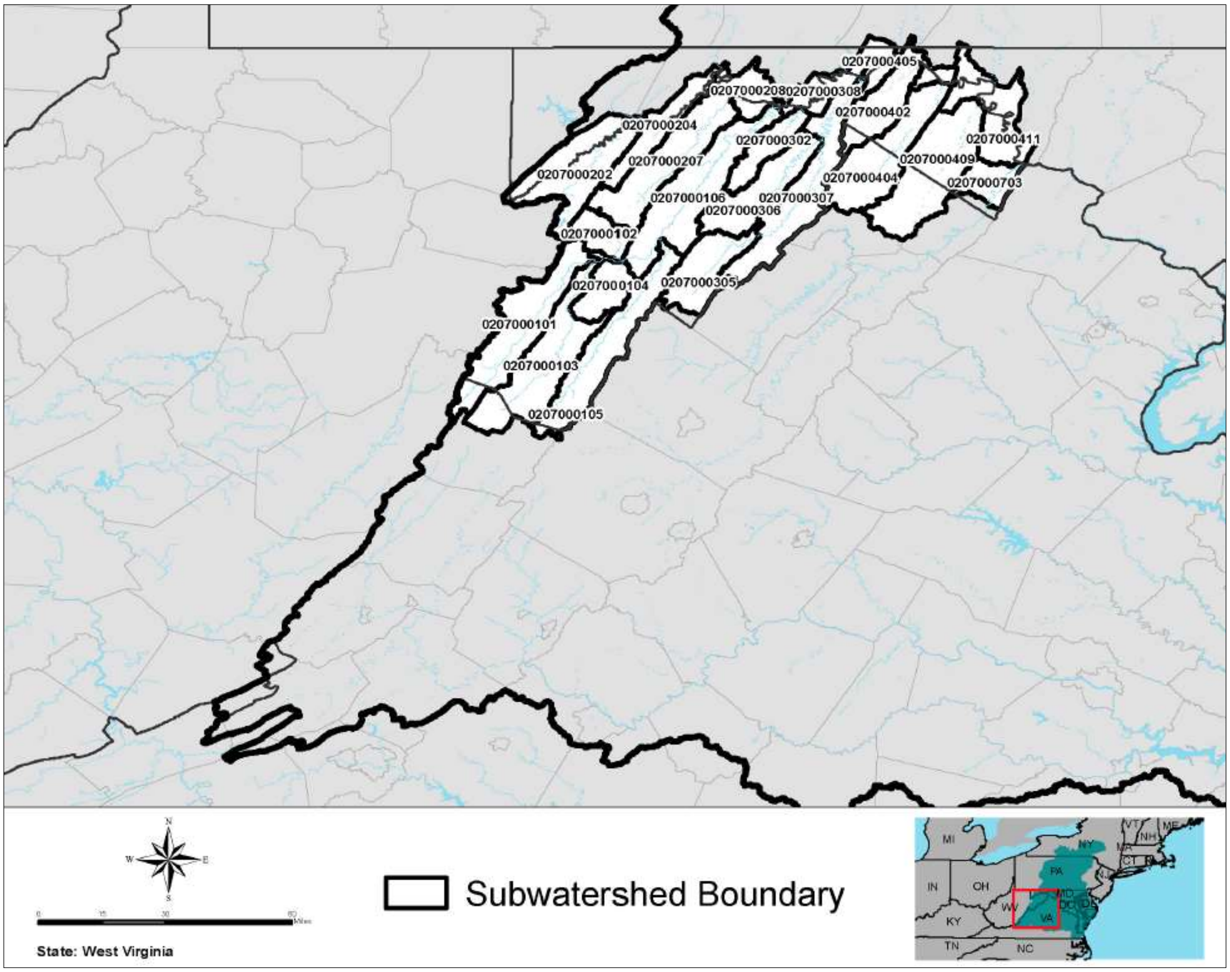

Figure 2. Hydrologic unit code (HUC) 10 subwatershed numbers for West Virginia

1.2 Watershed Stressors

The Watershed Stressors Analysis evaluated the presence of stressors in each subwatershed based on six metrics listed below. See the Planning Analyses Appendix for more details on the data used.

- *Percent impervious cover* (Chesapeake Conservancy 2016)
- *Percent forest cover* (Chesapeake Conservancy 2016)
- *Percent of stream network with forested riparian buffers* (Environmental Protection Agency (EPA) 2010)
- *303(d) impaired waterways list* (EPA)
- *Benthic Index of Biotic Integrity (B-IBI)* (Chesapeake Bay Program (CBP))
- *Nitrogen and phosphorous yields* (as predicted by Spatially Referenced Regressions on Watershed (SPARROW) modeling)

Results of the Watershed Stressors Analysis for each subwatershed in West Virginia is shown on Figure 3 and listed in Table 2. Subwatersheds that contain the least amount of watershed stressors resulted in a high watershed stressor score, and subwatersheds that contain the most amount of watershed stressors resulted in a low watershed stressor score. The healthiest watersheds are areas that, if not already protected, would be good candidates for protection. The areas that are less healthy indicate areas that may benefit from restoration actions aimed at increasing the overall health of the subwatersheds. In general, the pattern of watershed stressors typically follows that of development, with the greater the amount of development and industrial activities in an area, the more stressed the watershed.

In general, the subwatersheds in West Virginia had high scores indicating healthy subwatersheds. The healthiest subwatersheds are located along the southeastern portion of the West Virginia panhandle. There is one subwatershed in poor health, HUC 0207000411 (Rocky Marsh Run-Potomac River), which is shared by West Virginia and Maryland.

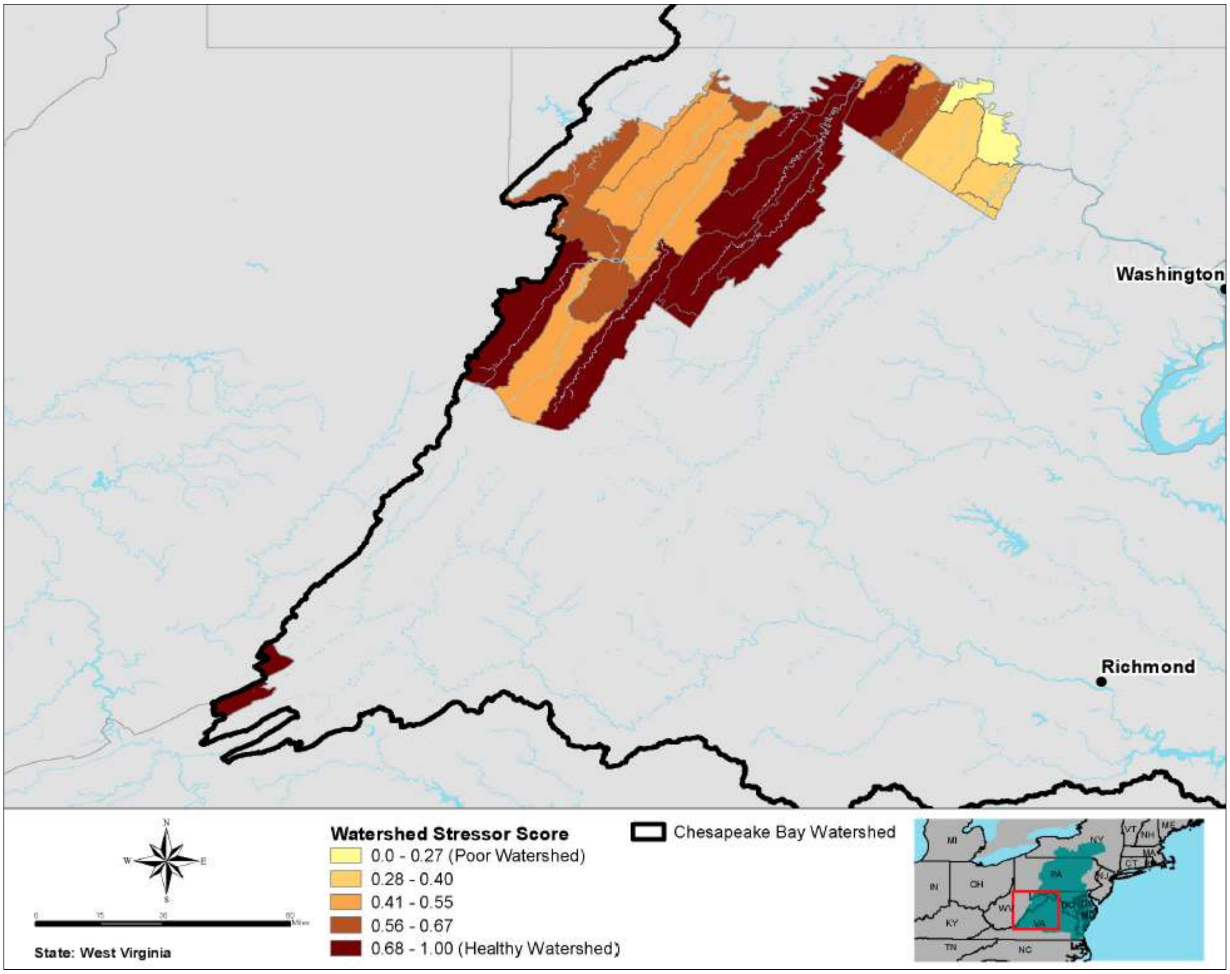

Figure 3. Watershed Stressor Analysis for West Virginia

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SECTION 2

Restoration Efforts Contributing to Watershed Wide Priorities

Opportunities for action were identified throughout the Chesapeake Bay Watershed by the baywide geospatial analyses. The *Opportunities Assessment* identifies subwatersheds with the greatest potential, need, or impairment, depending on the nature of the evaluation. The following sections discuss the *Opportunities Assessment* findings in West Virginia and presents *Opportunity* maps that highlight subwatersheds holding the greatest potential to address the need investigated in each map. Shaded cells in the tables and darker-colored subwatersheds in the figures represent subwatersheds with the highest amount of *Opportunities*.

2.1 Vital Habitats Goal

"Restore, enhance and protect a network of land and water habitats to support fish and wildlife and to afford other public benefits, including water quality, recreation uses and scenic value across the watershed."

2.1.1 Outcome: Black Duck

"By 2025, restore, enhance and preserve wetland habitat to support a wintering population of 100,000 black ducks. Refine population targets through 2025 based on best available science."

The CBP black duck focus areas were overlaid on the CBCP wetland restoration and enhancement maps to identify the subwatersheds that provide wetland restoration and enhancement opportunities with the potential to benefit black duck populations during the nonbreeding, over-wintering season.

Results of this analysis identified subwatersheds in which to focus wetland restoration and enhancement to benefit black duck populations during the nonbreeding, over-wintering season. These subwatersheds lie within the tidally influenced wetland areas of the Chesapeake Bay Mainstem and near the mouths of bay tributaries as these areas are the most important over-wintering habitats utilized by the black duck.

The analysis identified no priority areas for over-wintering black duck populations in West Virginia.

2.1.2 Outcome: Brook Trout

"Restore and sustain naturally reproducing brook trout in the Chesapeake Bay's headwater steams, with an eight percent increase in occupied habitat by 2025."

Geospatial data and analyses regarding brook trout have been provided by the CBP and Trout Unlimited, and are embedded in the Fish Passage, Riparian Forest Buffer, and Stream Restoration Analyses below.

2.1.3 Outcome: Fish Passage

"Continually increase habitat to support sustainable migratory fish populations in the Chesapeake Bay Watershed's freshwater rivers and streams. By 2025, restore historical fish migration routes by opening 1,000 additional stream miles to fish passage. Restoration success will be indicated by the consistent presence of alewife, blueback herring, American shad, hickory shad, American eel and brook trout, to be monitored in accordance with available agency resources and collaboratively developed methods."

Fish passage within the Chesapeake Bay Watershed is limited by a significant number of blockages that range from large hydroelectric power-generating dams to historical mill dams to road culverts and utility pipes that have been exposed by erosion. The intent of the CBCP's Fish Passage Blockages Opportunities Assessment was to build upon the work of the CBP's Fish Passage Workgroup to identify where high prioritized blockages are co-located with *Opportunities* for stream restoration. The following data were used in the Fish Passage Blockages Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used).

- *High prioritized fish passage blockages* (CBP Fish Passage Workgroup)
- *Stream Restoration Analysis results* (CBCP)

One of the limitations of the CBCP analyses was availability of data. The data used for fish passage blockages did not include information on reported blockages in West Virginia. Because of this constraint, results were not able to be generated for West Virginia. Even so, the probability of having fish passage blockages is high as every state within the watershed that has a fish passage blockage inventory has high priority fish passage blockages. This can be inferred by reviewing the Fish Passage Blockages Opportunities Assessment in the Planning Analyses Appendix.

2.1.4 Outcome: Riparian Forest Buffers

"Continually increase the capacity of forest buffers to provide water quality and habitat benefits throughout the Chesapeake Bay Watershed. Restore 900 miles of riparian forest buffers per year and conserve existing buffers until at least 70 percent of riparian areas in the watershed are forested."

The purpose of the Riparian Forest Buffer Opportunities Assessment was to identify subwatersheds to focus riparian buffer restoration. Riparian buffer restoration can provide numerous benefits while targeting various impairments. This analysis identified subwatersheds where riparian buffer restoration opportunities exist to:

- Address watershed stressors (high-yielding nitrogen and phosphorous subwatersheds)
- Improve brook trout habitat
- Support improving stream habitat for resident fish and migratory species

The following data layers were used in the Riparian Forest Buffer Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used):

- *Area of existing riparian buffers* (acres) (forested and non-forested) (CBP from Chesapeake Conservancy 2016)
- *Nitrogen and phosphorous yields* (as predicted by Spatially Referenced Regressions on Watershed (SPARROW) modeling)
- *Brook Trout Watersheds* (U.S. Geological Survey (USGS) National Hydrography Dataset plus catchments identified as potentially supporting brook trout based on the Eastern Brook Trout Joint Venture Salmonid Catchment Assessment and Habitat Patch Layers)
- *National Fish Habitat Assessment* (National Fish Habitat Partnership (NFHAP))
- *Eastern Brook Trout Conservation Portfolio, Range-wide Habitat Integrity and Future Security Assessment, and Focal Area Risk and Opportunity Analysis* (Trout Unlimited, Fessenmeyer et al. 2017)

Results of the Riparian Forest Buffer Opportunities Assessment for each subwatershed in West Virginia are shown in Figure 4 and listed in Table 3. In general, there are broad riparian buffer opportunities throughout the Chesapeake Bay Watershed, especially in West Virginia. Most of the subwatersheds in West Virginia have extensive acreages of riparian buffers, with one subwatershed having approximately 92 percent forest coverage within a 30-meter stream buffer. Additionally, many of the subwatersheds in West Virginia with high riparian buffer acreages are also areas where streams contain resident fish and brook trout populations.

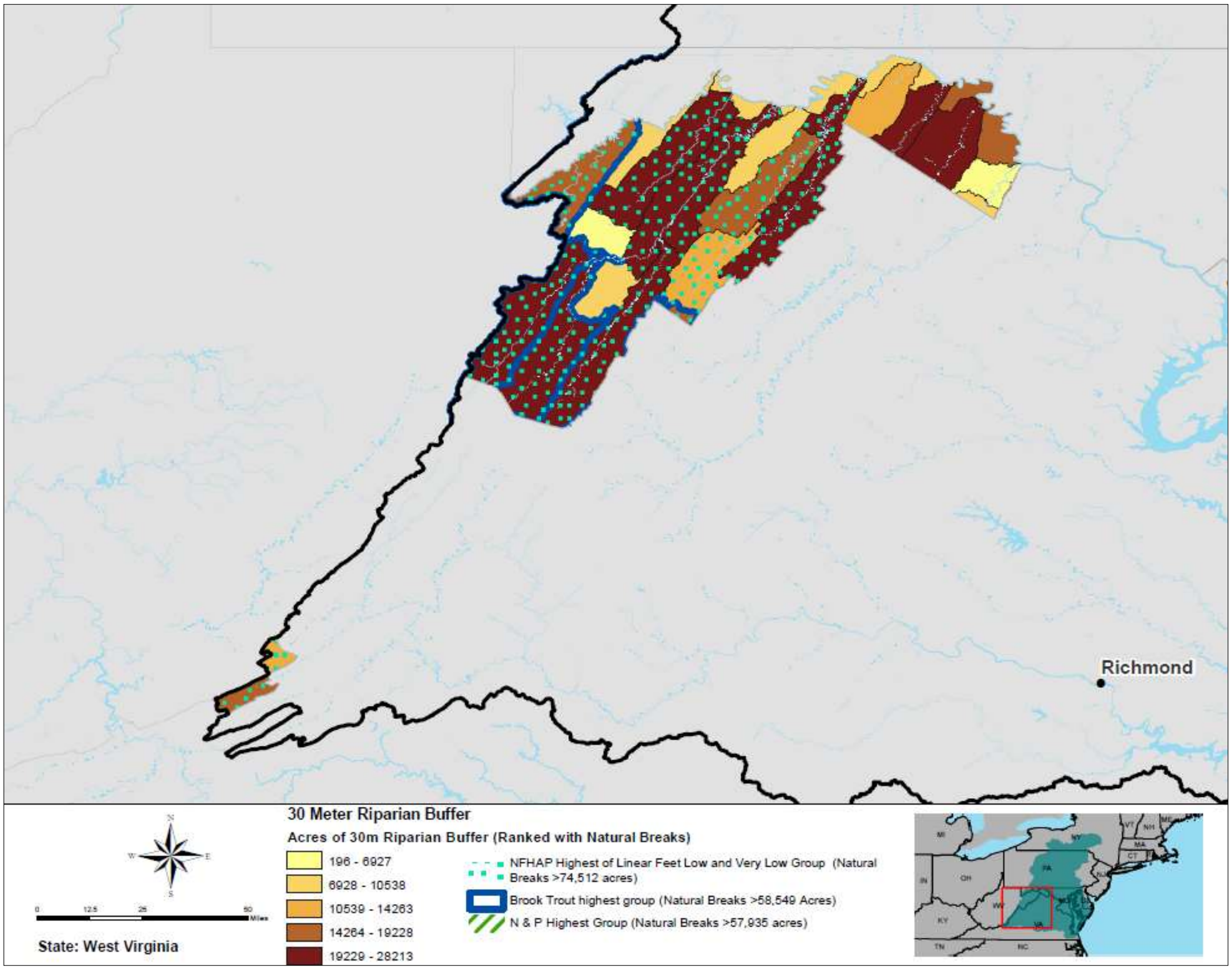

Figure 4. Riparian Forest Buffer Opportunities Assessment for West Virginia

2.1.5 Outcome: Stream Health

"Continually improve stream health and function throughout the Chesapeake Bay Watershed. Improve the health and function of ten percent of stream miles above the 2008 baseline."

The purpose of this analysis was to identify subwatersheds to focus stream restoration efforts to benefit resident fish, brook trout, and anadromous fish. The following data was used in the Stream Restoration Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used):

- *Watershed Stressor Analysis* (CBCP)
- *National Fish Habitat Assessment* (NFHAP)
- *Brook Trout Watersheds* (USGS)
- *Extent of anadromous fish habitat* (CBP)
- *Conservation Strategies for Brook Trout* (Trout Unlimited)

Results of the Stream Restoration Opportunities Assessment for each subwatershed in West Virginia is shown in Figure 5 and listed in Table 4. The subwatersheds with high watershed stressor scores (healthier watersheds) and opportunities to benefit both resident fish and brook trout are HUC 0207000101 (North Fork South Branch Potomac River) and HUC 0207000202 (Stony River-North Branch Potomac River), which are in the westernmost portion of the panhandle of West Virginia. Additionally, moderately healthy (0.5 to 0.6 stressor score) subwatersheds with available fish habitat or high B-IBI scores could potentially benefit from stream restoration. It is recommended that stressors are addressed prior to or in conjunction with stream restoration efforts in these subwatersheds to develop habitat benefits.

There are Trout Unlimited Brook Trout Conservation Strategies identified for catchments within opportunity subwatersheds for brook trout in the western portion of the bay watershed in West Virginia (see Figure 6). This information has the potential for siting projects on a smaller scale by follow-up investigations (see Planning Analyses Appendix).

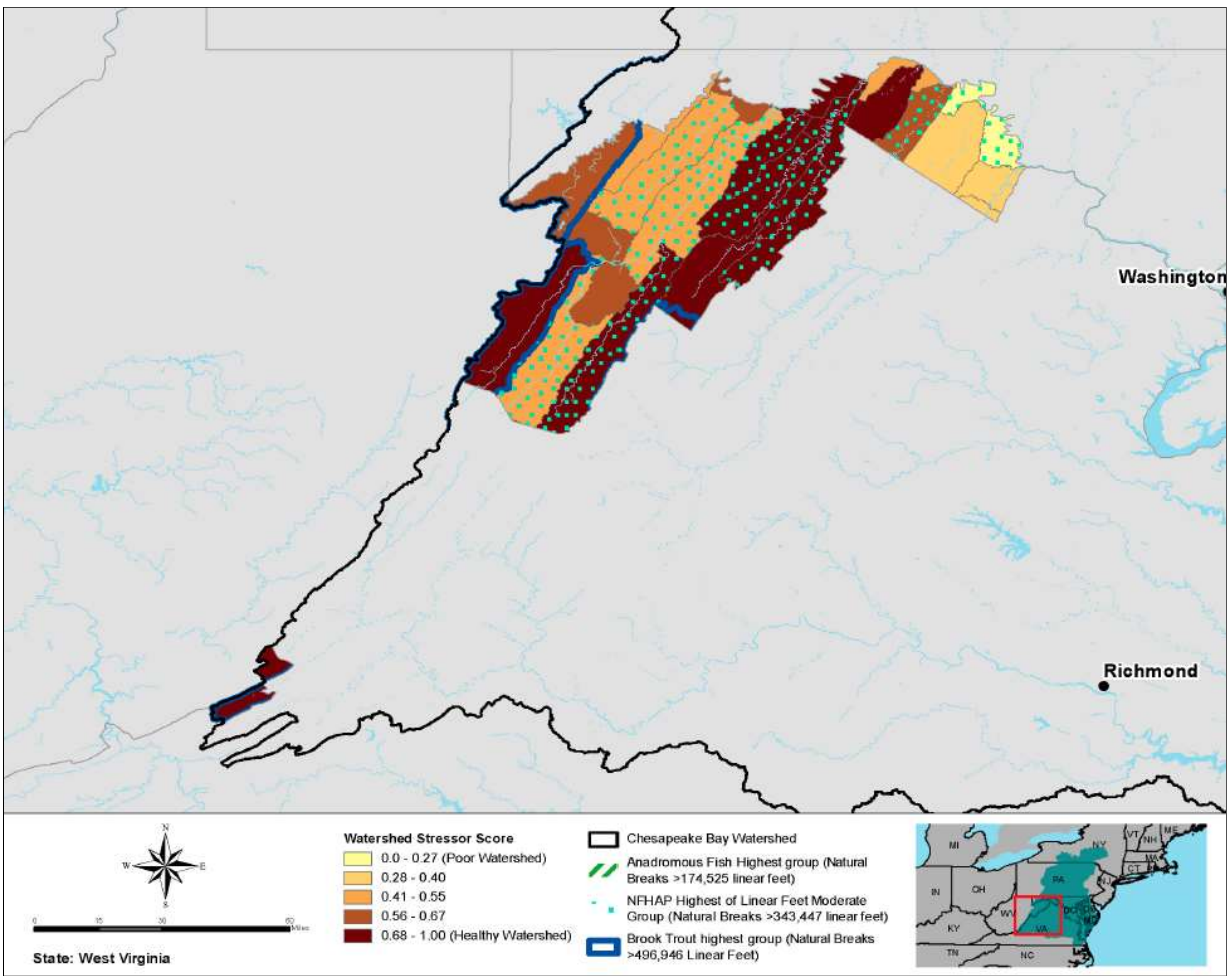

Figure 5. Stream Restoration Opportunities Assessment for West Virginia

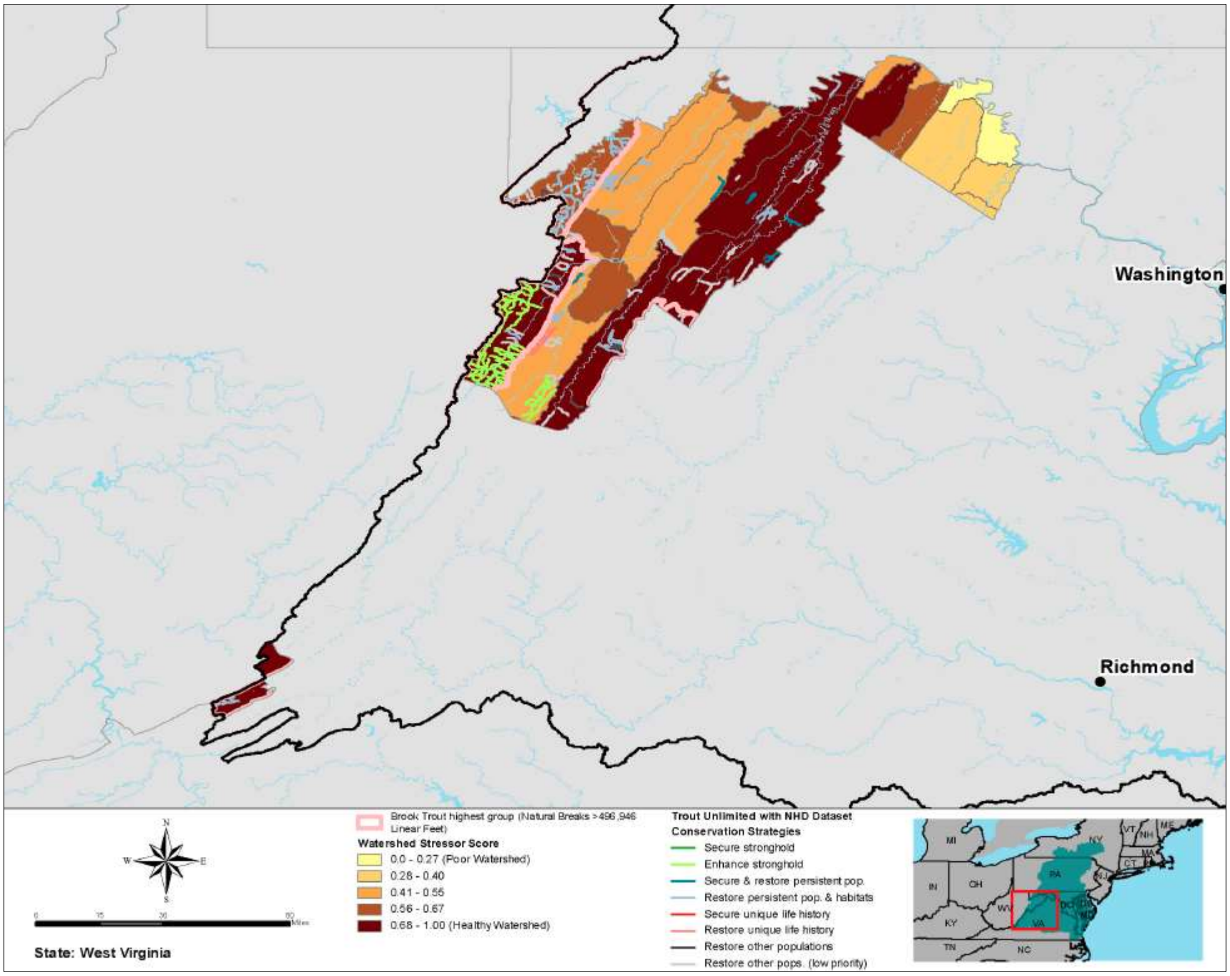

Figure 6. Stream restoration *Opportunities* to benefit brook trout based on Trout Unlimited conservation strategies and watershed stress in West Virginia

2.1.6 Outcome: Wetlands

"Continually increase the capacity of wetlands to provide water quality and habitat benefits `throughout the Chesapeake Bay Watershed. Create or reestablish 85,000 acres of tidal and nontidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025. These activities may occur in any land use (including urban), but should primarily occur in agricultural or natural landscapes."

2.1.6.1 Identify Wetland Enhancement Opportunities:

The Wetlands Enhancement Opportunities Assessment (nontidal and tidal) for West Virginia identified areas where wetlands exist and may provide enhancement opportunities to increase their ecological value. The following data was used in the Wetlands Enhancement Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used):

- *High Resolution Land Cover Data* (collected in 2016 by the Chesapeake Bay Conservancy and provided by NFWF)
- *Hydric Soils Dataset* (CBP)

Results of the Wetlands Enhancement Opportunities Assessment for each subwatershed in West Virginia is shown in Figure 7 and listed in Table 5. Although existing nontidal wetlands were identified for West Virginia, due to the scale, it is not evident on the map. When compared to the rest of the Chesapeake Bay Watershed, West Virginia has small acreages of existing wetlands; thus, the map appears to show an overall lack of wetlands in West Virginia. For example, HUC 0207000202 (Stony River-North Branch Potomac River) in the northwestern most subwatershed, has an estimated 1,294 acres of wetlands, though this acreage is not large enough to differentiate this subwatershed from other subwatersheds with less acres of existing wetlands. There are several subwatersheds in West Virginia that have hundreds of acres of wetlands.

The existing datasets do not evaluate the function and value of the existing wetlands; therefore, additional field analyses would be necessary to determine the existing wetland areas in need of enhancements and to identify the specific type of enhancement necessary.

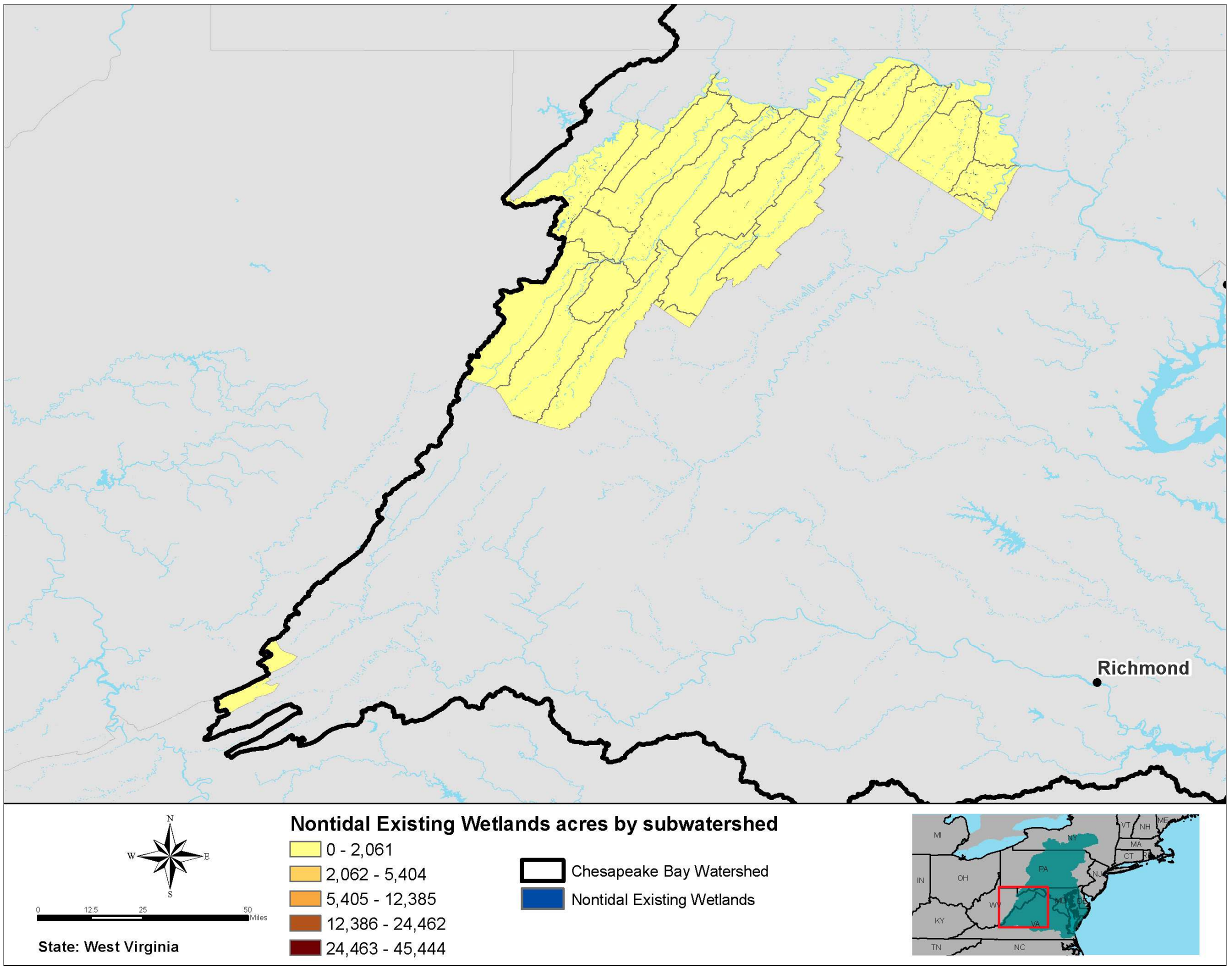

Figure 7. Existing nontidal wetlands in West Virginia

2.1.6.2 Identify Wetland Restoration Opportunities:

The Wetlands Restoration Opportunities Assessment identified opportunities for wetland restoration in West Virginia. The following data was used in the Wetlands Restoration Opportunities Assessment (see the Planning Analyses Appendix for more details on each layer):

- *Wetlands Enhancement Opportunities Assessment Results* (CBCP)
- *Digital Elevation Model* (USGS)

Results of the Wetland Restoration Opportunities Assessment (nontidal) are shown in Figure 8 and listed in Table 6. The analysis showed that there are nontidal wetland restoration opportunities in HUC 0207000409 (Opequon Creek), HUC 0207000411 (Rocky Marsh Run-Potomac River), HUC 0207000103 (Upper South Branch Potomac River) and HUC 0207000106 (Lower South Branch Potomac River).

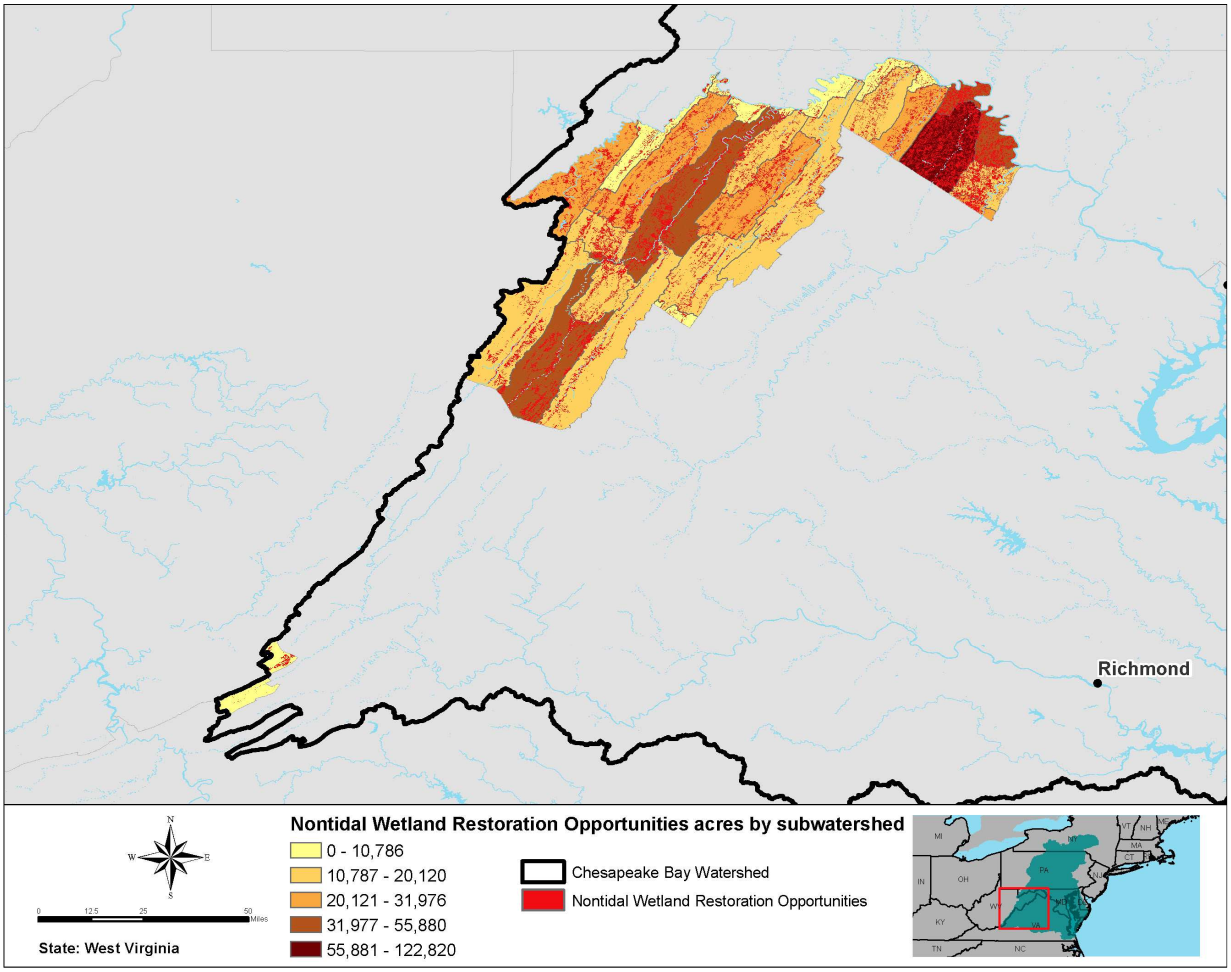

Figure 8. Nontidal wetland restoration opportunities in West Virginia

2.1.6.3 Identify Wetland Restoration Opportunities to Benefit Avian Wildlife

The purpose of this analysis was to identify the wetland restoration *Opportunities* that have the potential to benefit avian wildlife by determining where *Opportunities* overlap with Audubon Important Bird Areas. The following data was used in this analysis (see the Planning Analyses Appendix for more details on the data used):

- *Wetlands Restoration Opportunities Assessment Results* (CBCP)
- *Nesting locations for wading birds and waterbirds* (Center for Conservation Biology)
- *Black Duck Focus Areas* (CBP)
- *Audubon Important Bird Areas*

Results of this analysis for subwatersheds in West Virginia are shown on Figure 9 and listed in Table 7. The analysis showed that there are no subwatersheds in West Virginia that contained nesting areas for wading birds or identified as CBP black duck focus areas. However, HUC 0207000411 (Rocky Marsh Run-Potomac River) and HUC 0207000103 (Upper South Branch

Potomac River) contain thousands of acres of nontidal wetland restoration opportunities that overlap Audubon Important Bird Areas.

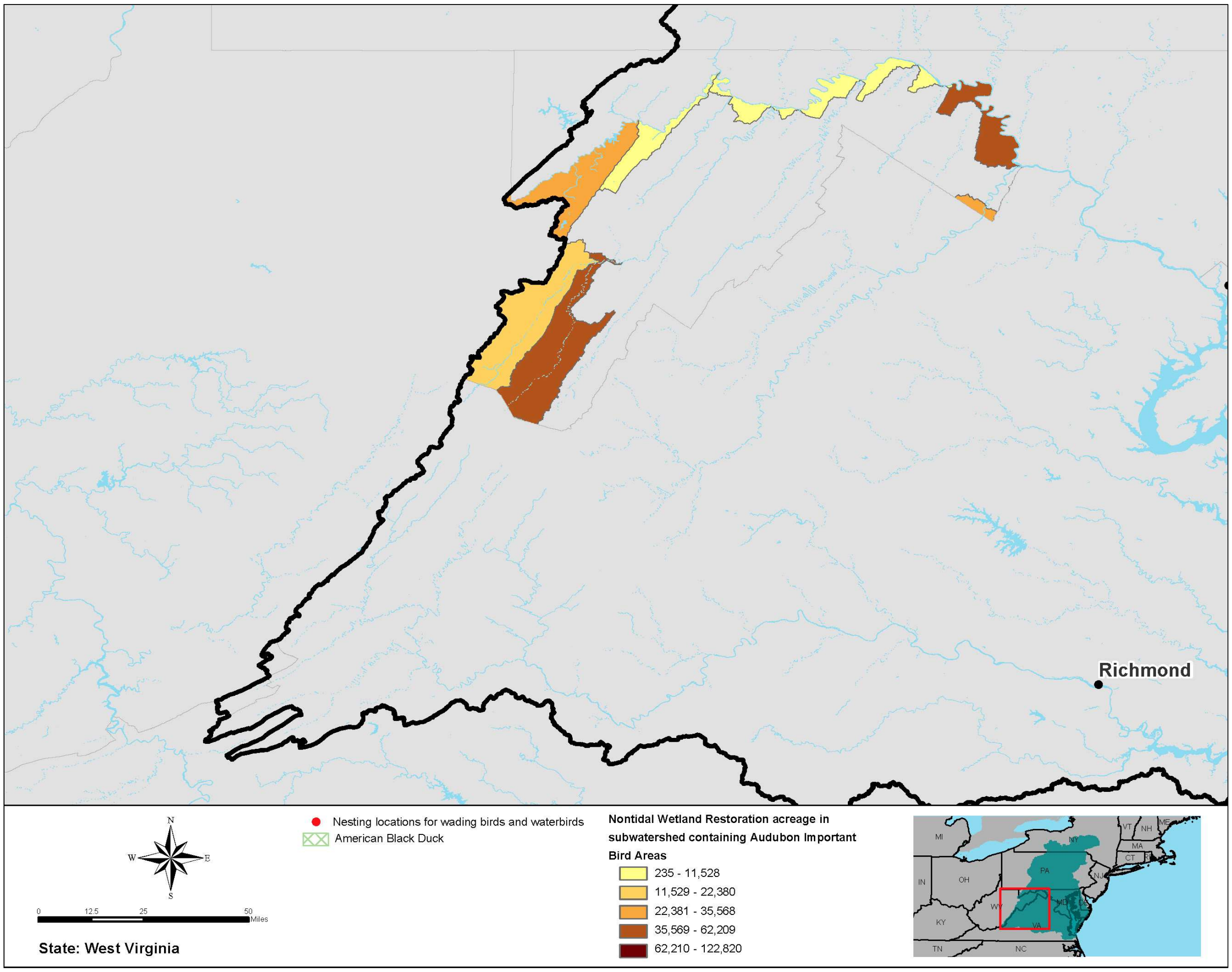

Figure 9. Nontidal wetland restoration opportunities with avian benefits in West Virginia

2.1.6.4 Identify Wetland Restoration Opportunities that are Important Habitats for Imperiled Species (Rare, Threatened, and Endangered):

The purpose of this analysis was to identify wetland restoration *Opportunities* that are important habitats for rare, threatened and endangered (RTE) species. The following data was used in this analysis (see the Planning Analyses Appendix for more details on the data used):

- *Wetlands Restoration Opportunities Assessment Results* (CBCP)
- *Nature's Network Imperiled Species Dataset* (identifies important, moderately important, and less important habitat for imperiled species)

Results of this analysis (nontidal) are shown in Figure 10. In West Virginia, there are nontidal wetland restoration *Opportunities* that could potentially benefit imperiled species. These *Opportunities* are located in the Upper South Branch-Potomac River (HUC 0207000103) and the Lower South Branch-Potomac River (HUC 0207000106) Subwatersheds. These areas are identified as core habitat for imperiled species and co-located with acreages of nontidal wetland restoration *Opportunities*.

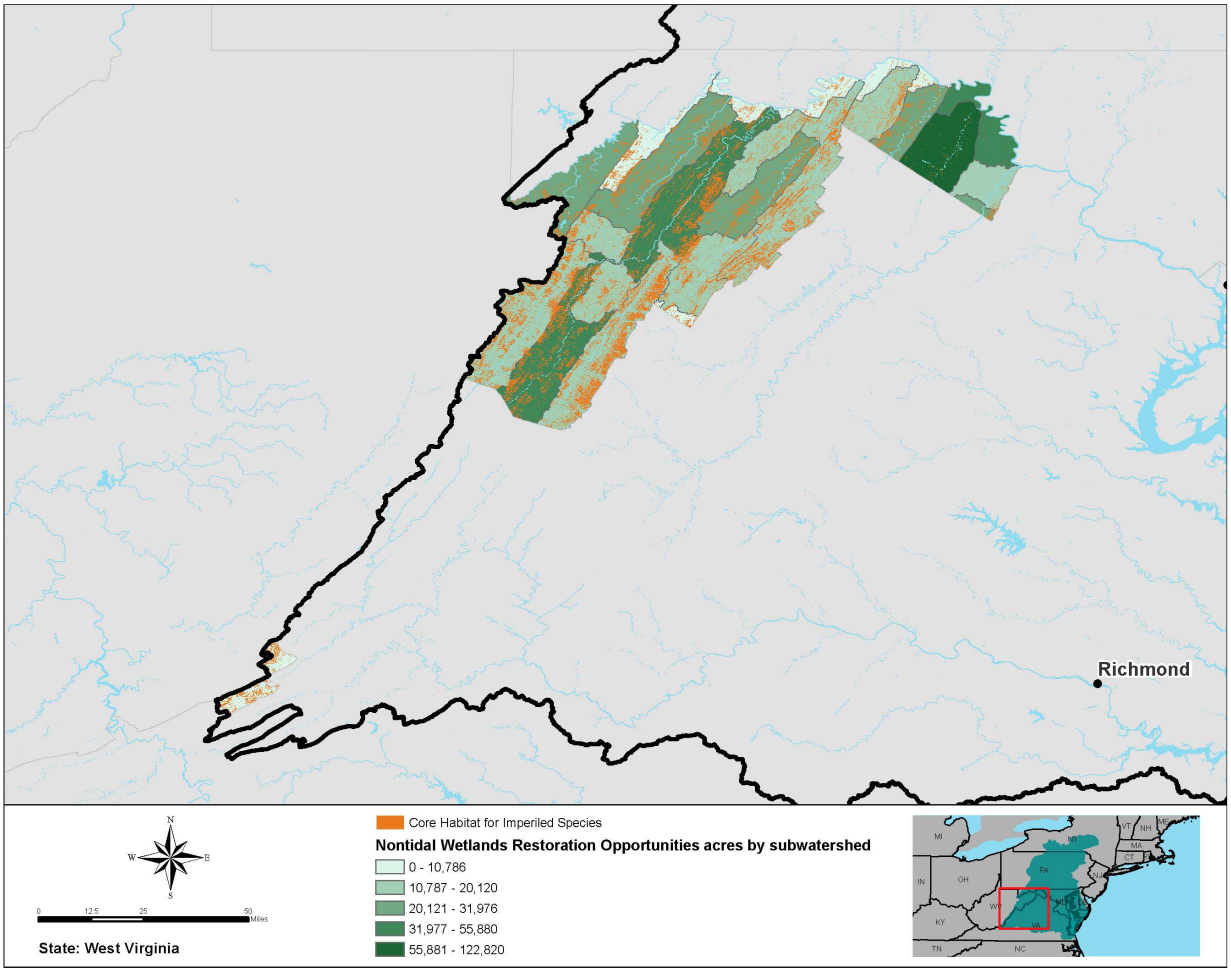

Figure 10. Core habitat for imperiled species in relation to nontidal wetland restoration *Opportunities* in West Virginia

2.1.6.5 Wetlands Threats Opportunities Assessment

The Wetlands Threats Opportunities Assessment investigated whether wetland restoration *Opportunities* are at risk to climate change, anticipated increases in flooding and coastal storms, and projected development in the Chesapeake Bay Watershed. This analysis incorporated the results of the CBCP Threats Analysis with the CBCP Wetlands Restoration Opportunities Assessment and the Wetlands Enhancement Opportunities Assessment to understand habitats that may be lost or impaired by future threats.

Results of the Wetlands Threats Opportunities Assessment (nontidal) for each subwatershed located in West Virginia is shown in Figures 11 and 12 and listed in Table 8. The wetland enhancement and restoration opportunities most likely to be affected by future threats are located on the easternmost portion of West Virginia's panhandle. These areas correspond to areas where the watershed is currently less healthy and under more stress. Stressors are expected to continue to impact these subwatersheds in the future; thus, posing a threat to potential enhancement and restoration opportunities also located in the subwatershed.

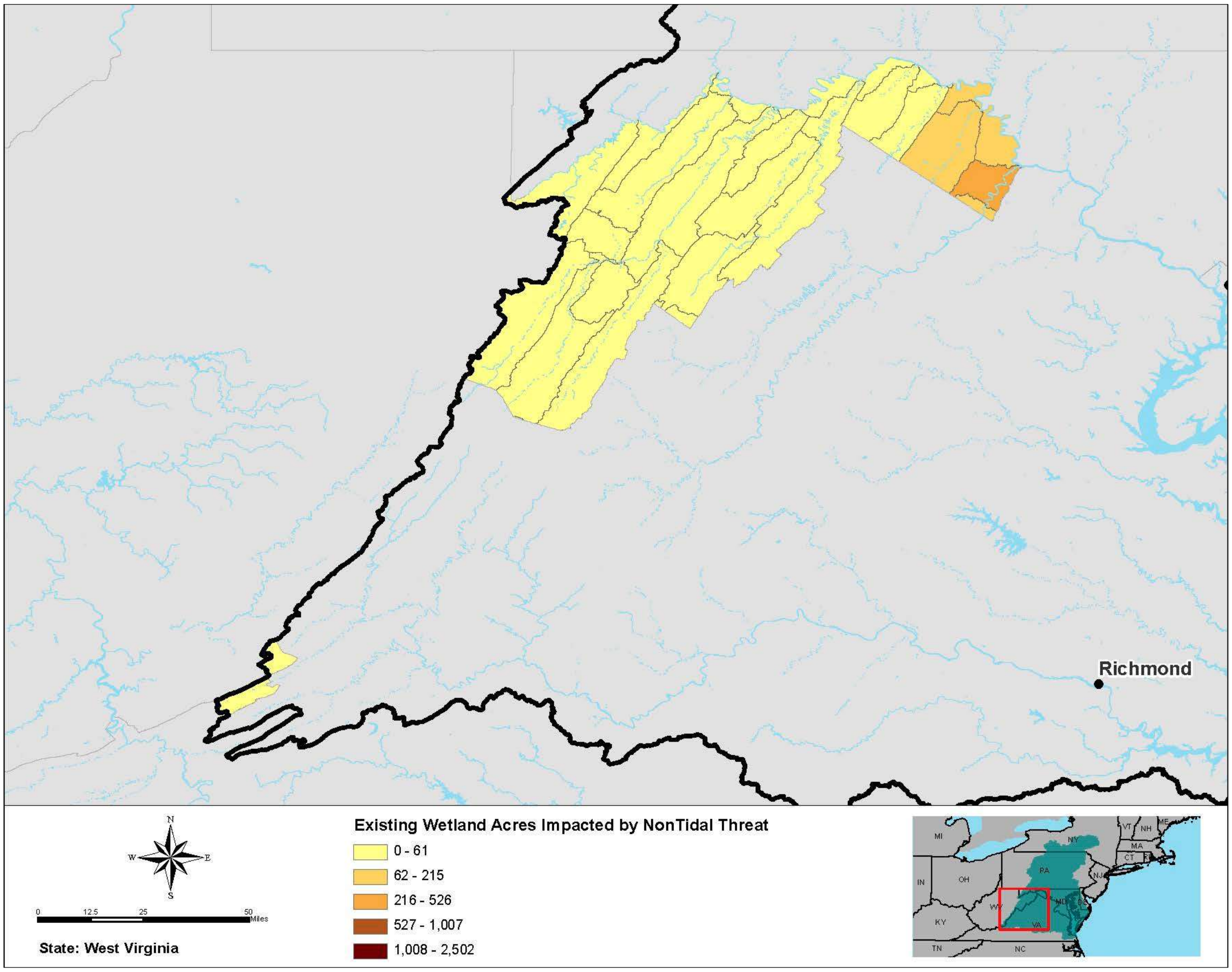

Figure 11. Wetland enhancement opportunities at risk to nontidal threats in West Virginia

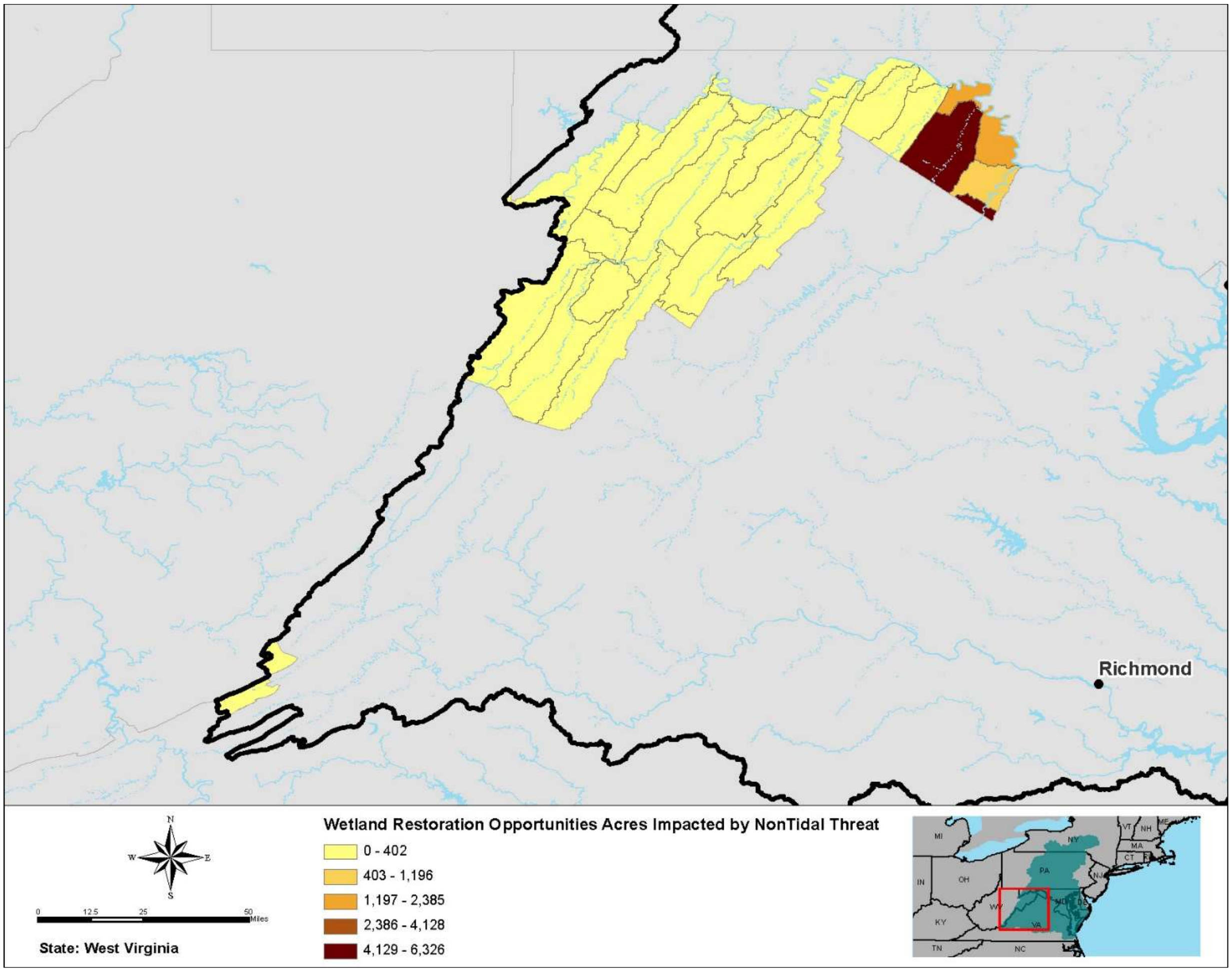

Figure 12. Wetland restoration opportunities at risk to nontidal threats in West Virginia

2.2 Toxic Contaminants Goal

"Ensure the Chesapeake Bay and its rivers are free of the effects of toxic contaminants on living resources and human health."

2.2.1 Outcome: Toxic Contaminants Research

"Continually increase our understanding of the impacts and mitigation of toxic contaminants. Develop a research agenda and further characterize the occurrence, concentrations, sources and effects of mercury, polychlorinated biphenyls (PCBs) and other contaminants of emerging and widespread concern. In addition, identify which best management practices might provide the multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways."

2.2.2 Outcome: Toxic Contaminants Policy and Prevention

"Continually improve practices and controls that prevent or reduce the effects of toxic contaminants on aquatic systems and humans. Build on existing programs to reduce the amount and effects of polychlorinated biphenyls (PCBs) in the Chesapeake Bay Watershed. Use research findings to evaluate the implementation of additional policies, programs and practices for other contaminants that need to be further reduced or eliminated."

The following data was used in the Toxic Contaminants Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used):

- *National Priorities List (NPL) Sites (Superfund Sites) (*downloaded from https://toxmap-classic.nlm.nih.gov/toxmap/superfund/identifyAll.do and cross referenced with EPA for accuracy)

Results of the Toxic Contaminants Opportunities Assessment for West Virginia is shown on Figure 13. There are three Superfund sites within subwatersheds shared between West Virginia, Virginia, and Maryland. Of the Superfund sites in West Virginia subwatersheds, two have been 'deleted' from the NPL list, HUC 0207000404 (Back Creek) and HUC 0207000409 (Opequon Creek), which is defined as:

> "[a] site deleted from the NPL by the EPA (with state concurrence) because site cleanup goals have been met and no further response is necessary at the site" (U.S. Department of Health & Human Services [USDH&HS] 2017).

One site, located in HUC 0207000204 (New Creek-North Branch Potomac River), is listed as 'final,' which is defined as:

> "[a] site determined to pose a real or potential threat to human health and the environment after completion of [Hazard Ranking System] HRS screening and public solicitation of comments about the proposed site" (USDH&HS 2017).

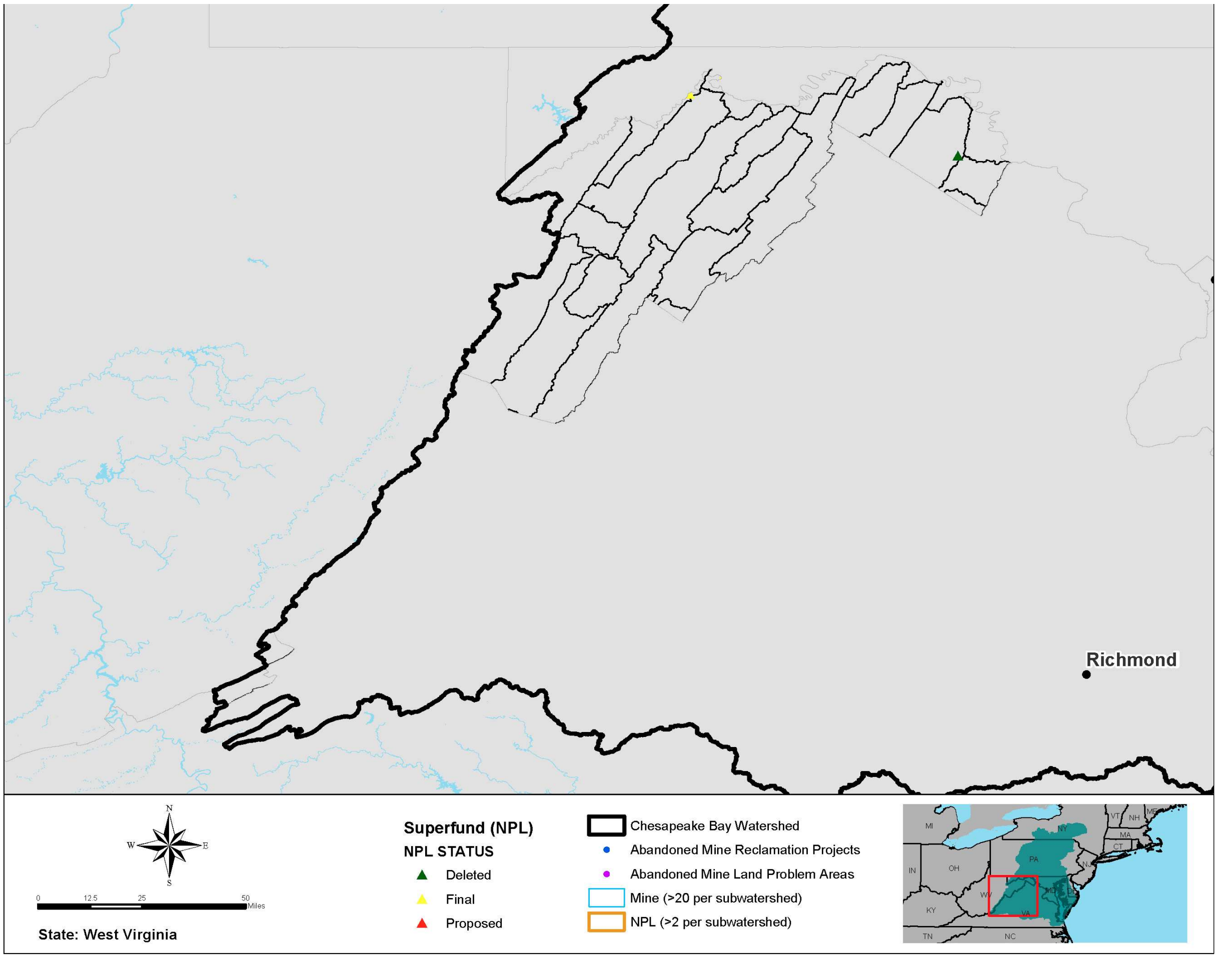

Figure 13. Toxic Contaminants Opportunities Assessment for West Virginia

2.3 Healthy Watersheds Goal

"Sustain state-identified healthy waters and watersheds, recognized for their high quality and/or high ecological value."

2.3.1 Outcome: Healthy Watersheds

"Ensure 100 percent of state-identified currently healthy waters and watersheds remain healthy."

The Healthy/High Value Habitats Opportunities Assessment identifies areas in West Virginia that have the healthiest habitats. The following data was used in the Healthy/High Value Habitats Opportunities Assessment (see Planning Analyses Appendix for more details on the data used):

- *State-identified Healthy Watersheds* (based on state-derived definitions and classifications of healthy waters and watersheds)
- *Subwatersheds identified as brook trout catchments (*National Hydrography Dataset plus catchments identified as potentially supporting brook trout based on the Eastern Brook Trout Joint Venture Salmonid Catchment Assessment)
- *Black Duck Focus Areas* (CBP)

- *Audubon Important Bird Areas*
- *Index of Ecological Integrity (IEI)*
- *Nature's Network Core and Connector Habitat*

Results of the Healthy/High Value Habitats Opportunities Assessment for West Virginia are shown in Figure 14 and listed in Table 9. Based on the results from the Healthy/High Value Habitats Opportunities Assessment, the subwatersheds with the highest acreage of healthy/high value habitats are in two of the westernmost subwatersheds in West Virginia, HUC 207000101 (North Fork South Branch Potomac River) and HUC 02070002020 (Stony River-North Branch Potomac River). These subwatersheds have thousands of acres identified as having healthy ecosystems and habitats, which indicates a high ecological value of an area. Actions to maintain existing health and conservation efforts are recommended in the subwatersheds identified as *Opportunities.*

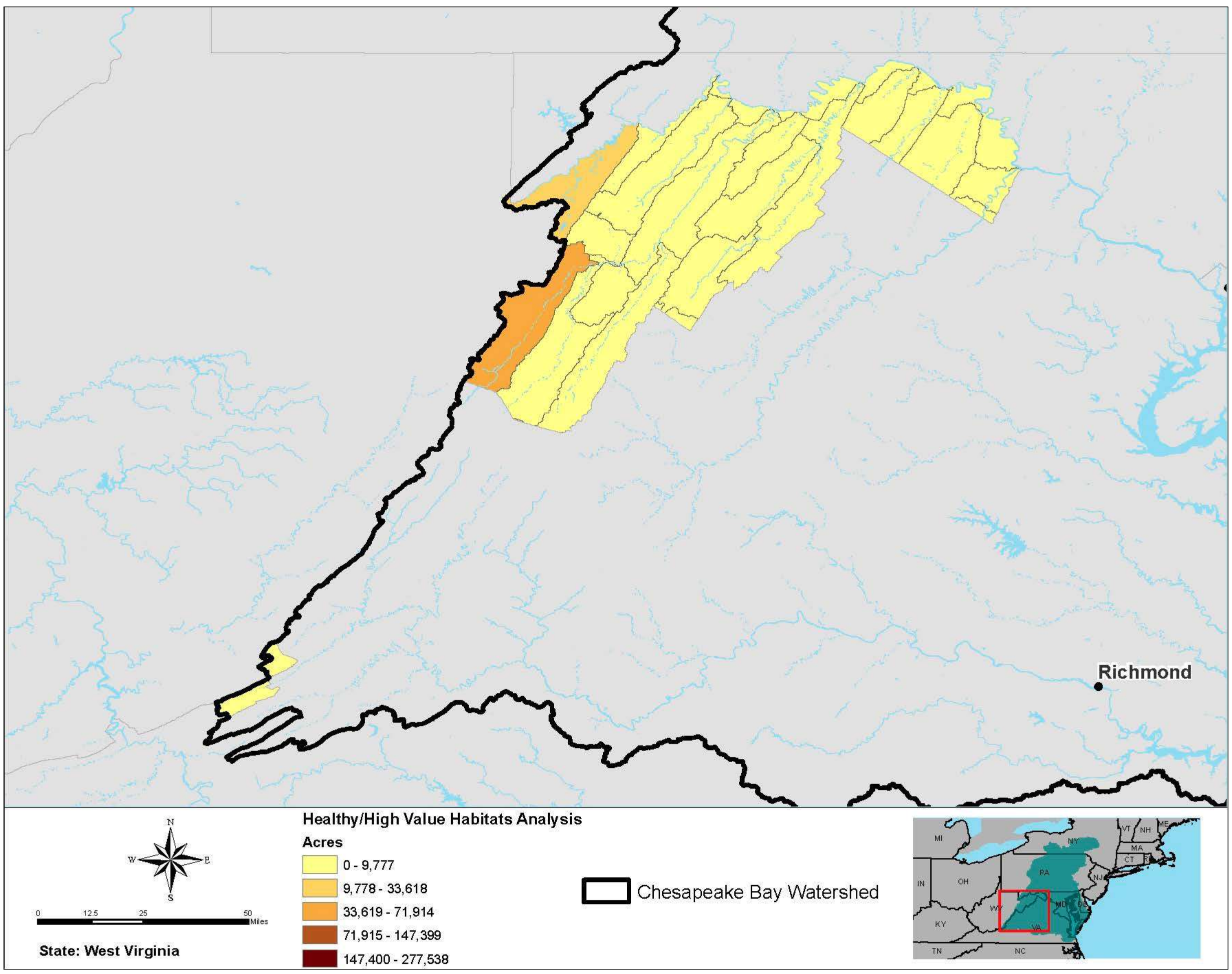

Figure 14. Healthy/high value habitats in West Virginia

2.4 Land Conservation Goal

"Conserve landscapes treasured by citizens in order to maintain water quality and habitat; sustain working forests, farms and maritime communities; and conserve lands of cultural, indigenous and community value."

2.4.1 Outcome: Protected Lands

"By 2025, protect an additional two million acres of lands throughout the watershed – currently identified as high-conservation priorities at the federal, state or local level – including 225,000 acres of wetlands and 695,000 acres of forestland of highest value for maintaining water quality."

The purpose of the Conservation Opportunities Assessment was to identify habitats in need of potential conservation. Areas in potential need of conservation consist of healthy/high value habitats that are currently not conserved and potential habitat enhancement and restoration areas that align with conservation initiatives.

The following data was used in the Conservation Opportunities Assessment (see the Planning Analyses Appendix for more details on the data used):

- *Healthy/High Value Habitats Opportunities Assessment Results* (CBCP)
- *Protected Lands Dataset* (CBP)

Results of the Conservation Opportunities Assessment for West Virginia is shown in Figure 15 and in Table 10.

The Healthy/High Value Habitats Opportunities Assessment was then overlaid with the following layers to identify those prime habitat enhancement and restoration opportunities that align with conservation initiatives:

- *Habitat Restoration Compilation including the Stream Restoration Riparian Buffer Restoration Opportunities Assessment Results* (CBCP)
- *Wetlands Restoration and Enhancement Compiled Opportunities Assessment Results* (CBCP)

Results of this analysis for West Virginia are shown in Figures 16 and 17 and Table 10.

In general, the greatest opportunities to conserve unprotected, healthy/high value habitats are concentrated in the westernmost subwatersheds in West Virginia. HUC 0207000202 (Stony River-North Branch Potomac River) and HUC 0207000101 (North Fork South Branch Potomac River) have 3,085 and 2,510 acres of conservation opportunities, respectively. These two subwatersheds along with HUC 0207000204 (New Creek-North Branch Potomac River) and HUC 0207000103 (Upper South Branch Potomac River) make up the majority of conservation opportunities in West Virginia. Because there are existing conserved state and federal lands in West Virginia, opportunities for conservation are effectively reduced.

Additionally, the habitat restoration compilation intersects with all existing and restorable wetland areas except for HUC 0207000703 (Bullskin Run-Shenandoah River).

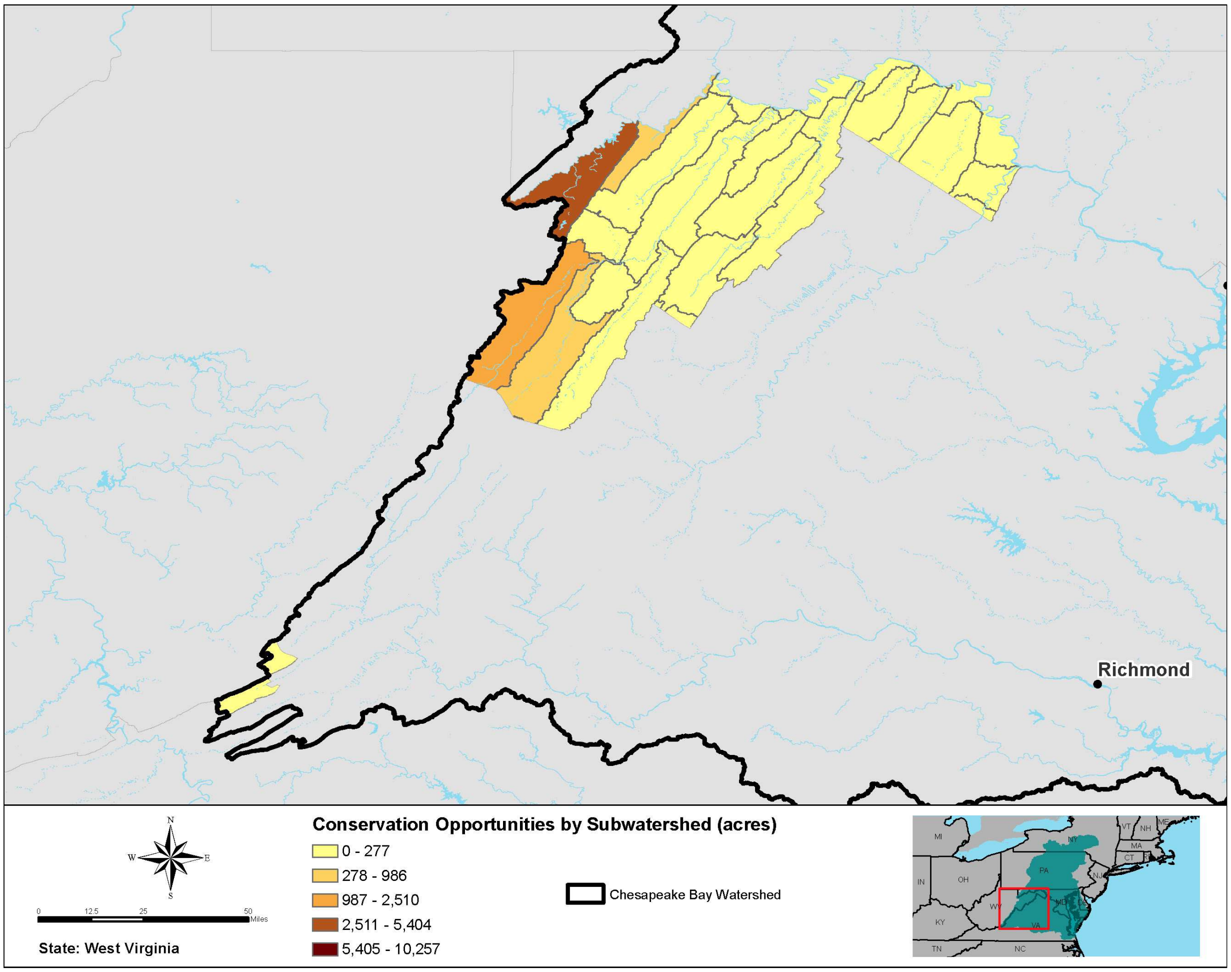

Figure 15. Conservation opportunities within West Virginia

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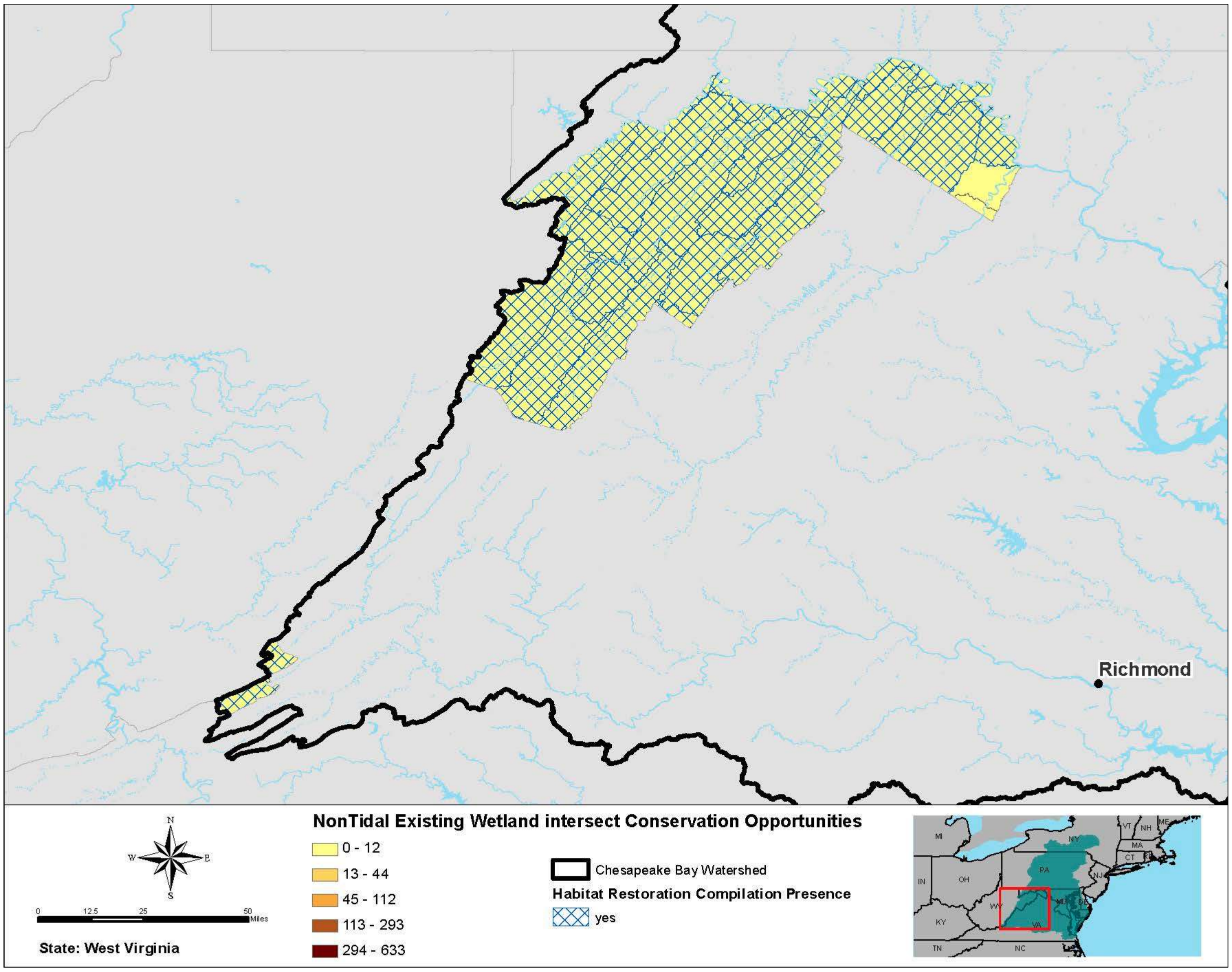

Figure 16. Nontidal wetland enhancement and conservation opportunities that intersect with areas included in the Habitat Restoration Compilation (blue hatched lines) in West Virginia

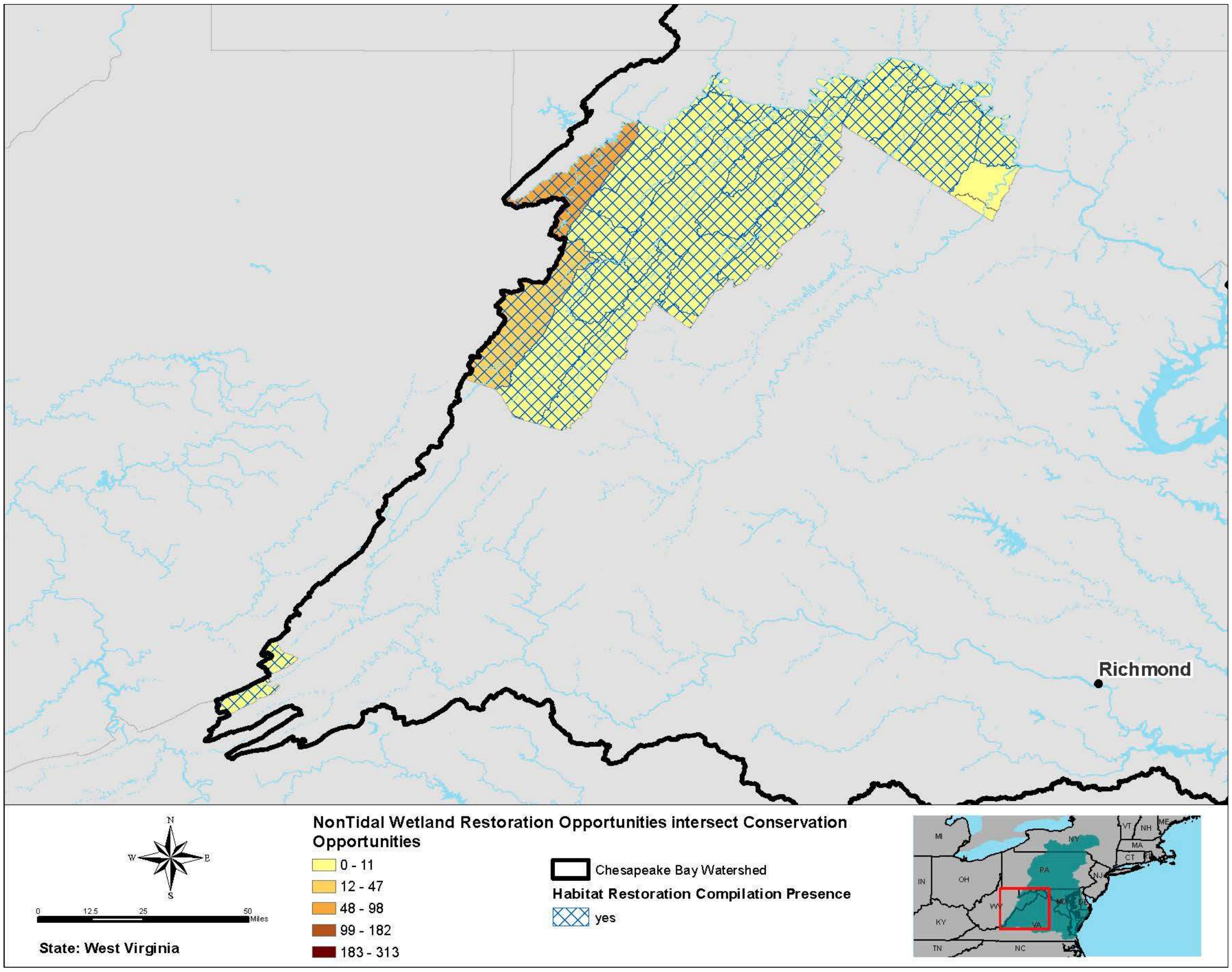

Figure 17. Nontidal wetland restoration and conservation opportunities that intersect with areas included in the habitat restoration compilation (blue hatched lines) in West Virginia

2.5 Public Access Goal

"Expand public access to the Chesapeake Bay and its tributaries through existing and new local, state, and federal parks, refuges, reserves, trails and partner sites."

2.5.1 Outcome: Public Access Site Development

"By 2025, add 300 new public access sites to the Chesapeake Bay Watershed, with a strong emphasis on providing opportunities for boating, swimming and fishing, where feasible."

This Socioeconomic Analysis synthesizes information that reflects societal use of resources within the Chesapeake Bay Watershed. The compilation characterizes the locations in the watershed that are important for recreation and public access, water supply, and source water protection and those areas where underserved populations are located.

The following data was used in the Socioeconomic Analysis (see the Planning Analysis Appendix for more details on the data used):

- *Locations of national, state, and local parks*
- *Public access points* (Nationally designated trails, existing and proposed public access sites compiled by the CBP)
- *Underserved populations* (Minority and low-income populations provided by the CBP)
- *National Inventory of Dams* (Congressionally authorized database documenting dams in the U.S. and its territories; maintained and published by the USACE)

Results of the Socioeconomic Analysis for the subwatersheds in West Virginia are shown on Figure 18 and listed in Table 11.

To determine where conservation may provide societal benefits to the public, the following data were overlaid:

- *Conservation Opportunities Assessment Results* (CBCP)
- *Socioeconomic Analysis Results* (CBCP)

The results of this analysis are depicted in Figure 19 and listed in Table 11.

The Socioeconomic Analysis for West Virginia demonstrates that there are substantive areas in the state that consist of underserved, low-income populations. Many subwatersheds have public access sites and recreational parks adjacent to communities characterized as low income. HUC 207000204 (New Creek-North Branch Potomac River) has 19 public access sites and a relatively large area classified as underserved, low income. However, the largest low-income and minority population communities are not located near areas where there are available public access sites or recreational parks. This helps to identify areas where stewardship opportunities can be identified to aide underserved communities in connecting with the natural environment. HUC 0207000204 (New Creek-North Branch Potomac River) has 397 acres and HUC 0207000101

(North Fork South Branch Potomac River) has 360 acres of conservation opportunities that may add societal benefits (i.e., facilitating environmental stewardship by connecting people to the environment).

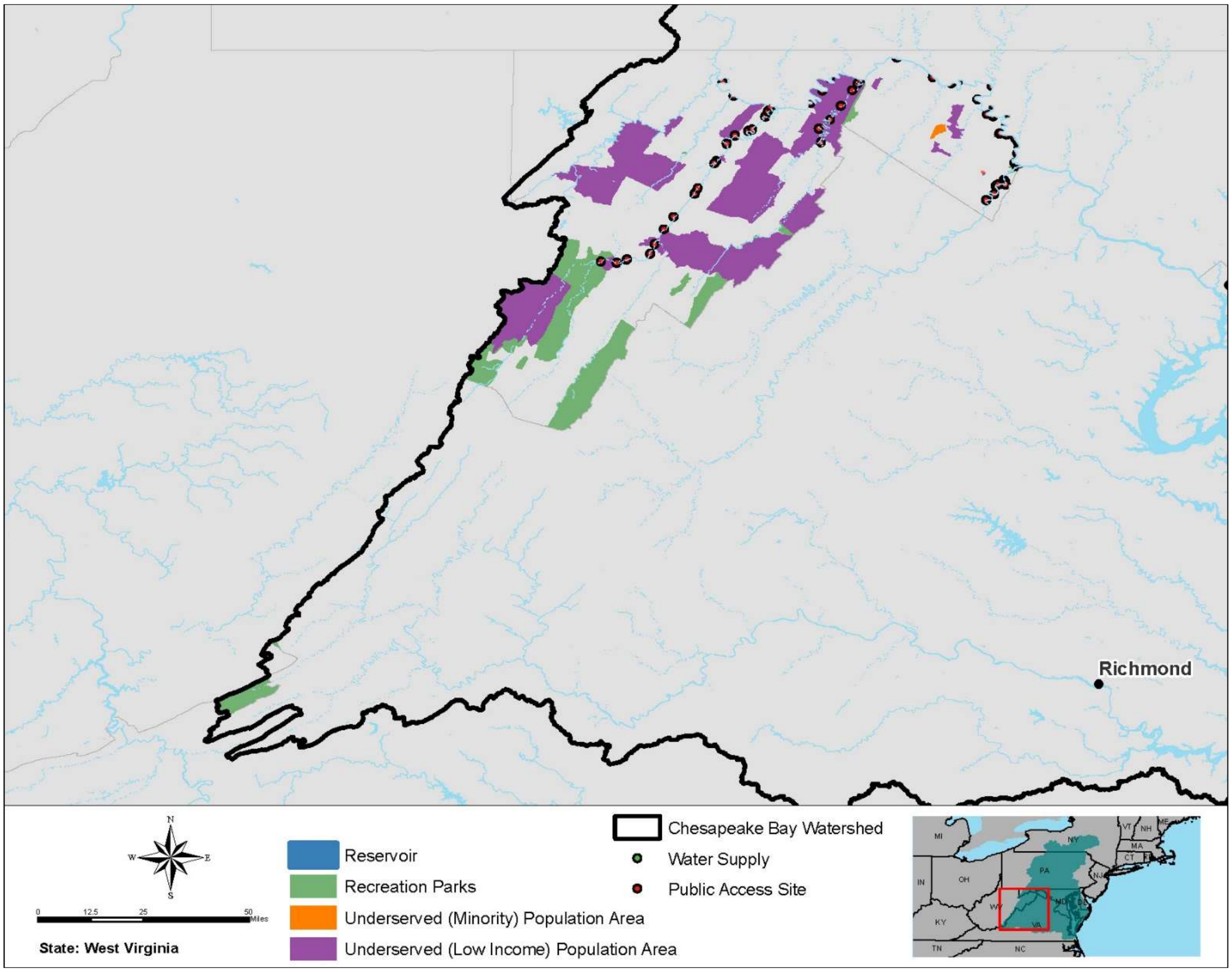

Figure 18. Socioeconomic Analysis for West Virginia

US Army Corps of Engineers

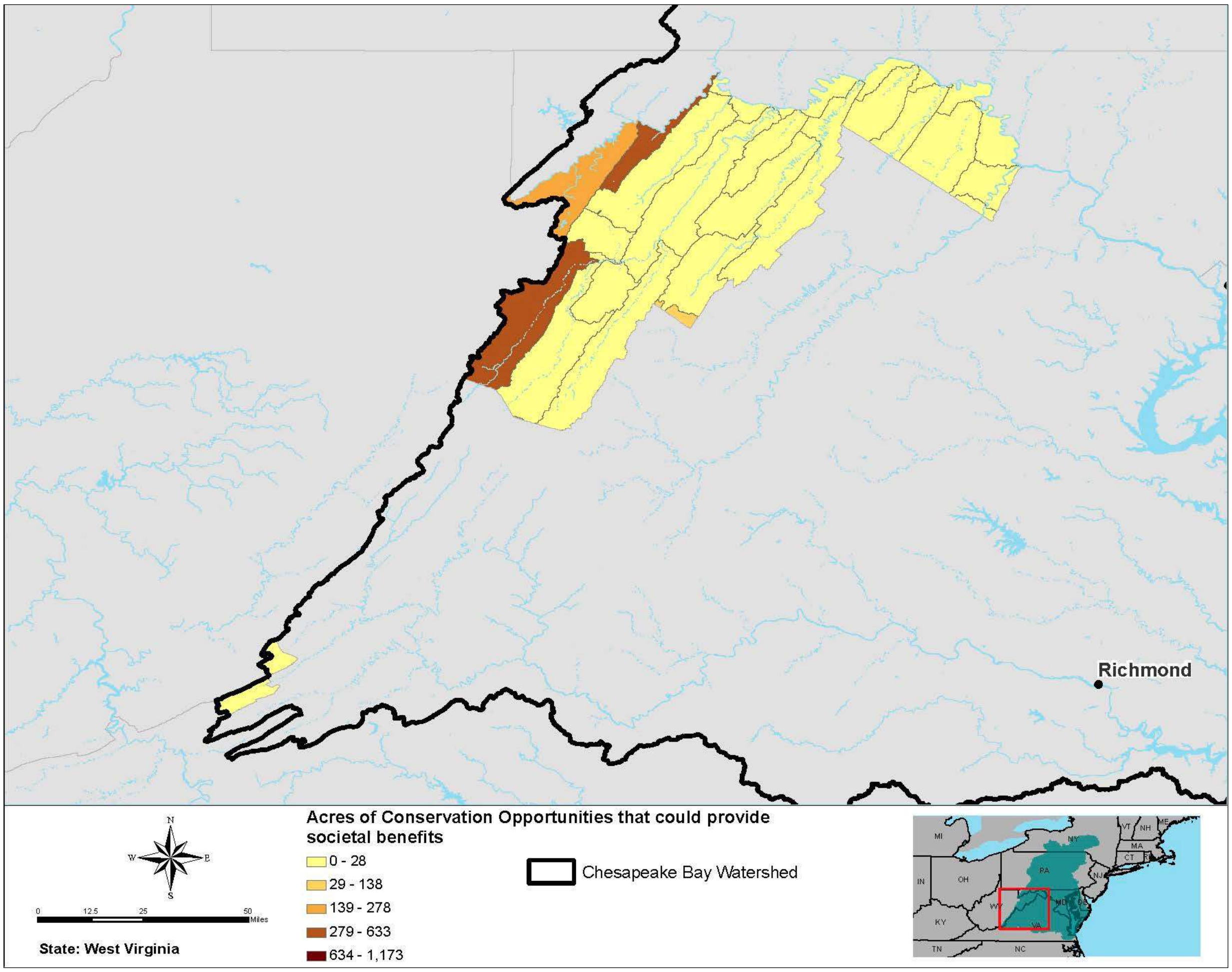

Figure 19. Conservation opportunities that may add societal benefits in West Virginia

2.6 Climate Resiliency Goal

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

2.6.1 Outcome: Climate Adaptation

"Continually pursue, design and construct restoration and protection projects to enhance the resiliency of the Chesapeake Bay and its aquatic ecosystems against the impacts of coastal storm erosion, coastal flooding, more intense and more frequent storms, and sea level rise."

The Threats Analysis identifies areas in West Virginia that are threatened by urbanization and climate change, as well as areas prone to increased/persistent future flooding.

The following data was used in the Nontidal Threats Analysis (see Planning Analyses Appendix for more details on the data used):

- *Nontidal flooding* (USGS)
- *Future projected development* (USACE North Atlantic Coast Comprehensive Study (NACCS))
- National Fish Habitat Assessment (NFHAP)

Results of the Nontidal Watershed Threats Analysis are shown in Figure 20 and listed in Table 12. Generally, West Virginia is at low risk to potential future threats; however, there is one subwatershed that stands out among the subwatersheds in West Virginia; HUC 0207000409 (Opequon Creek), which is shared with Virginia, has 11,812 acres of threatened lands. This acreage far outnumbers the other subwatersheds in West Virginia and falls in the top tier for nontidal threatened areas in the entire Chesapeake Bay Watershed.

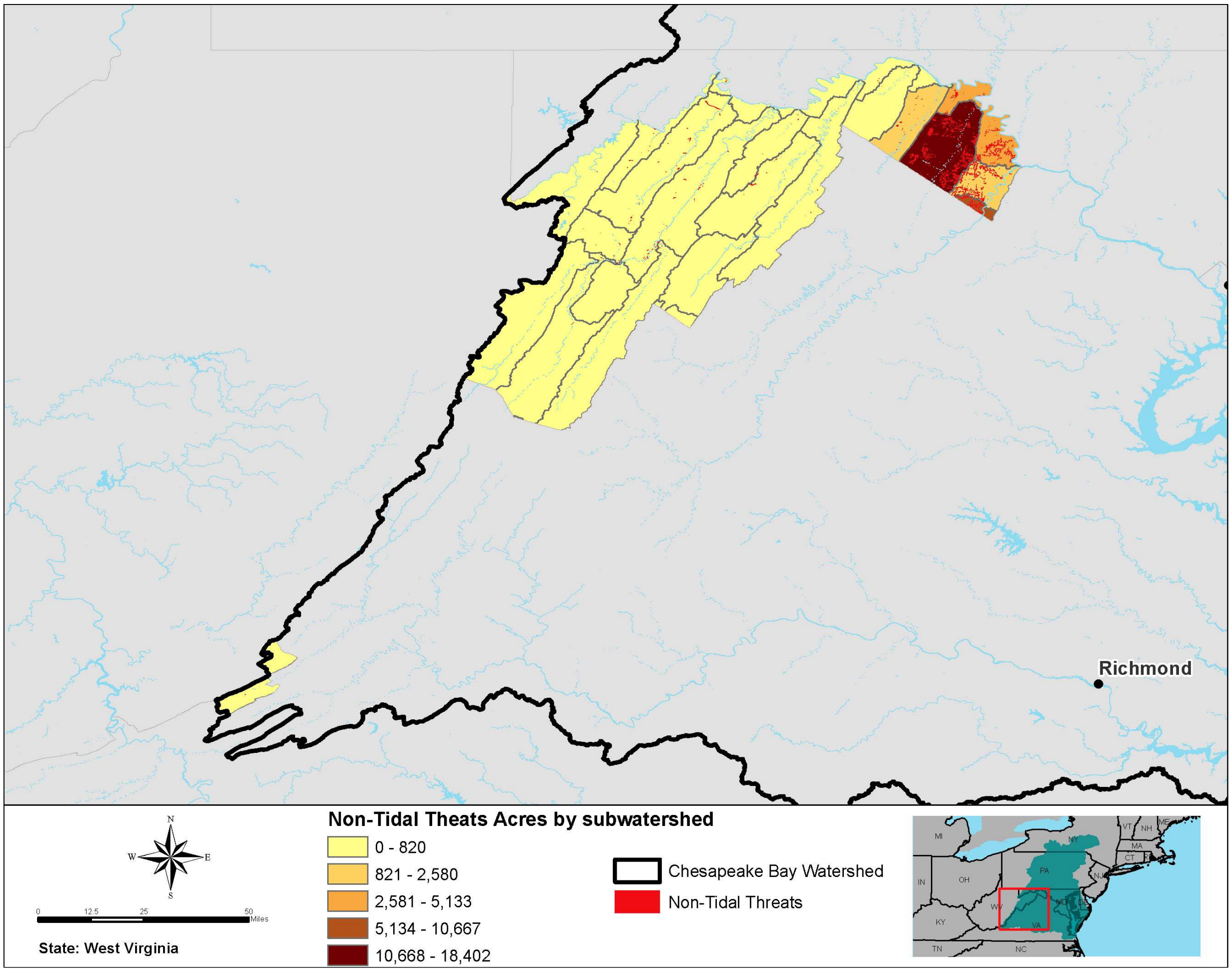

Figure 20. Nontidal Watershed Threats Analysis for West Virginia

SECTION 3

Watershed Planning Considerations outside the 2014 Bay Agreement

3.1 Rare, Threatened, and Endangered Species and U.S. Fish and Wildlife Service (USFWS) Species of Concern

The following maps (Figures 21 through 23) display areas in West Virginia that have federally listed threatened and endangered species as well as species identified as critical by the USFWS. The species have been placed into the following categories based on their primary habitat needs—aquatic, beach, stream, and wetland dependent. The following maps display the number of species per subwatershed that fall into the aquatic, stream, or wetland categories and whether they are federally listed, critical, or both.

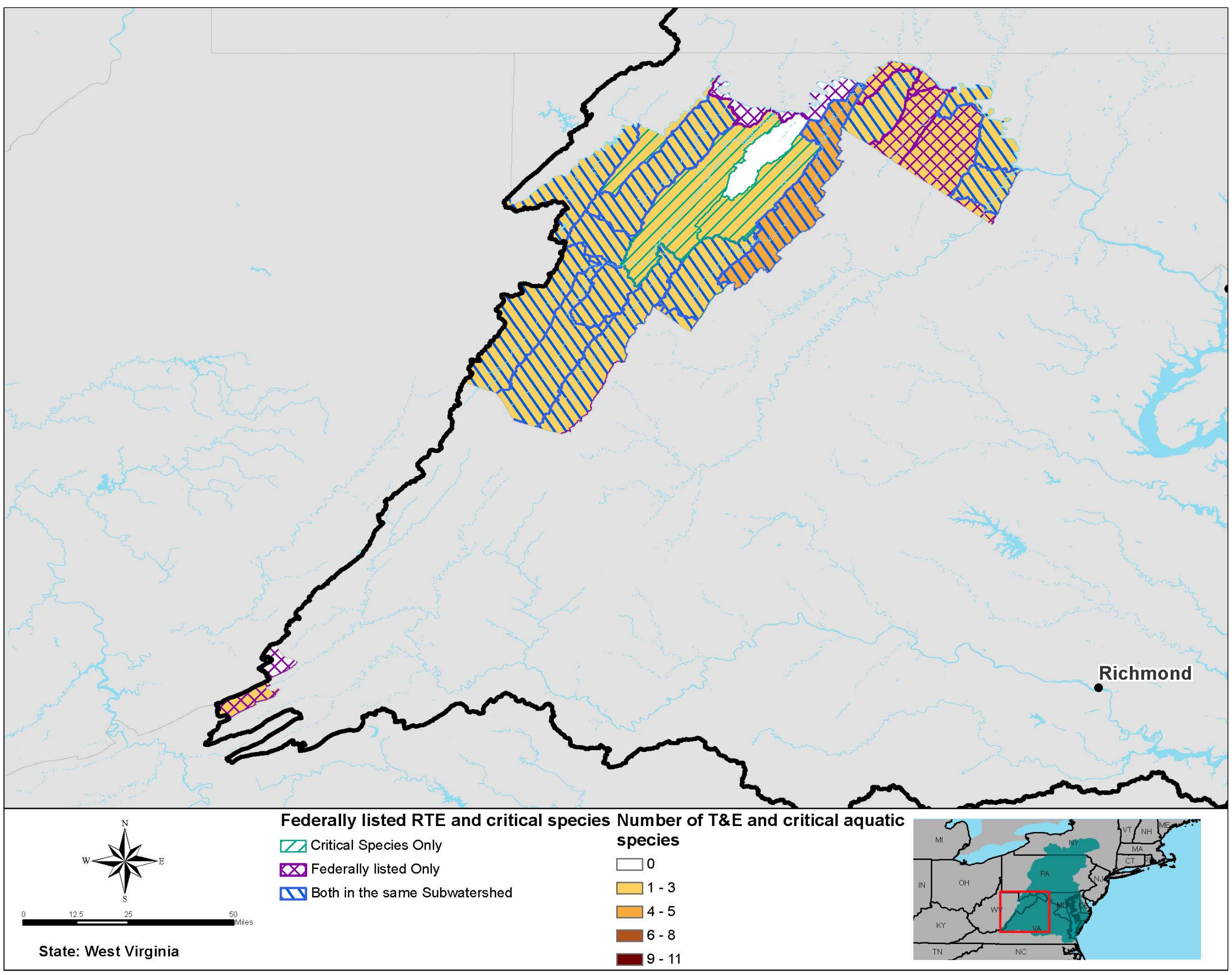

Figure 21. Occurrence of rare, threatened, and endangered and U.S. Fish and Wildlife Service critical aquatic species in West Virginia

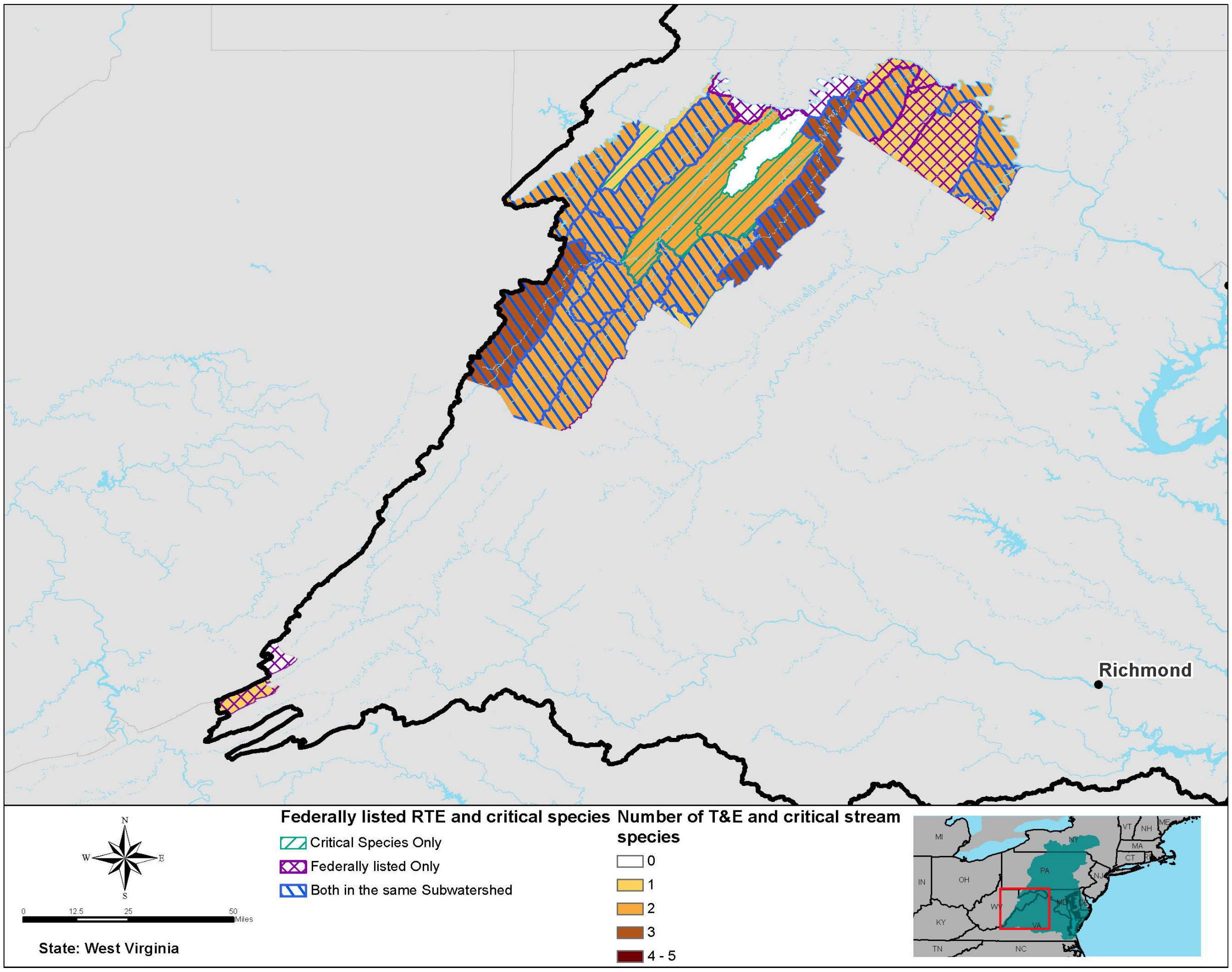

Figure 22. Occurrence of rare, threatened, and endangered and U.S. Fish and Wildlife Service critical stream species in West Virginia

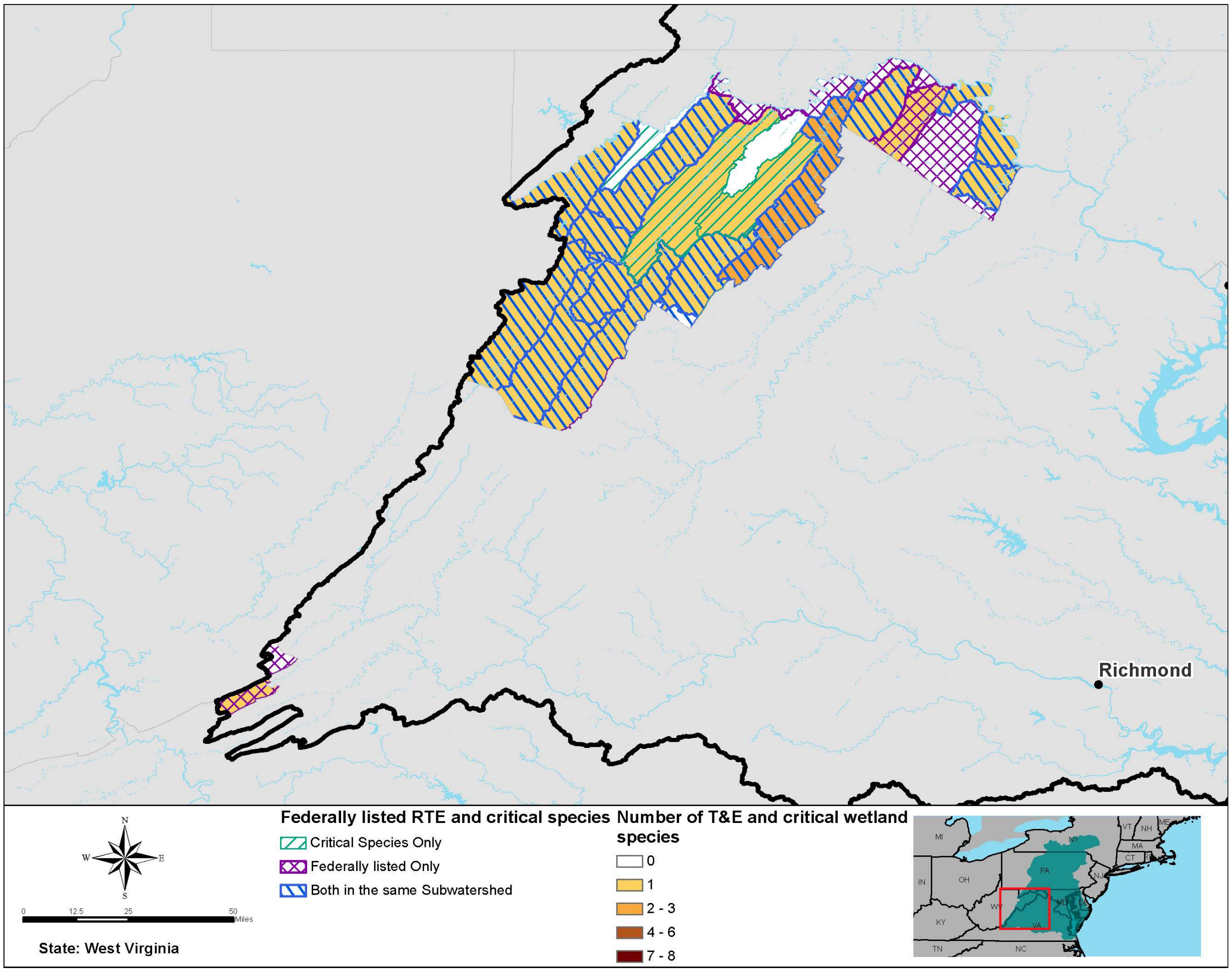

Figure 23. Occurrence of rare, threatened, and endangered and U.S. Fish and Wildlife Service critical wetland species in West Virginia

3.2 Shale Gas Development

There are two major shale plays that fall within the Chesapeake Bay Watershed, the Marcellus and Utica shale plays. The Marcellus shale play area extends from Ohio, north to New York, and includes extensive areas in West Virginia, Pennsylvania, and New York, as well as marginal areas in Maryland and Virginia. The Utica shale play covers much of the same area as Marcellus shale but extends further west and north than the Marcellus shale play. In the West Virginia portion of the watershed, which is approximately 3,570 square miles (West Virginia CBP 2018), the Utica and Marcellus shale plays cover approximately 430 and 3,199 square miles, respectively (7).

The extraction of shale gas led to West Virginia becoming the eighth-largest natural gas producing state in the U.S., and due to expansion in the development of Marcellus shale gas, shale wells now account for three quarters of the state's natural gas production (West Virginia Department of Energy 2016). On November 9, 2017, China Energy Investment Corporation Limited announced a plan to invest $83.7 billion in shale gas development and chemical manufacturing products in West Virginia, and a memorandum of understanding was signed by the West Virginia Secretary of Commerce and a representative from China Energy (West Virginia

Department of Commerce [WVDOC] 2017). The planning phase of projects focused on power generation chemical manufacturing, and underground storage of natural gas liquids and derivatives will occur throughout the next 20 years (WVDOC 2017).

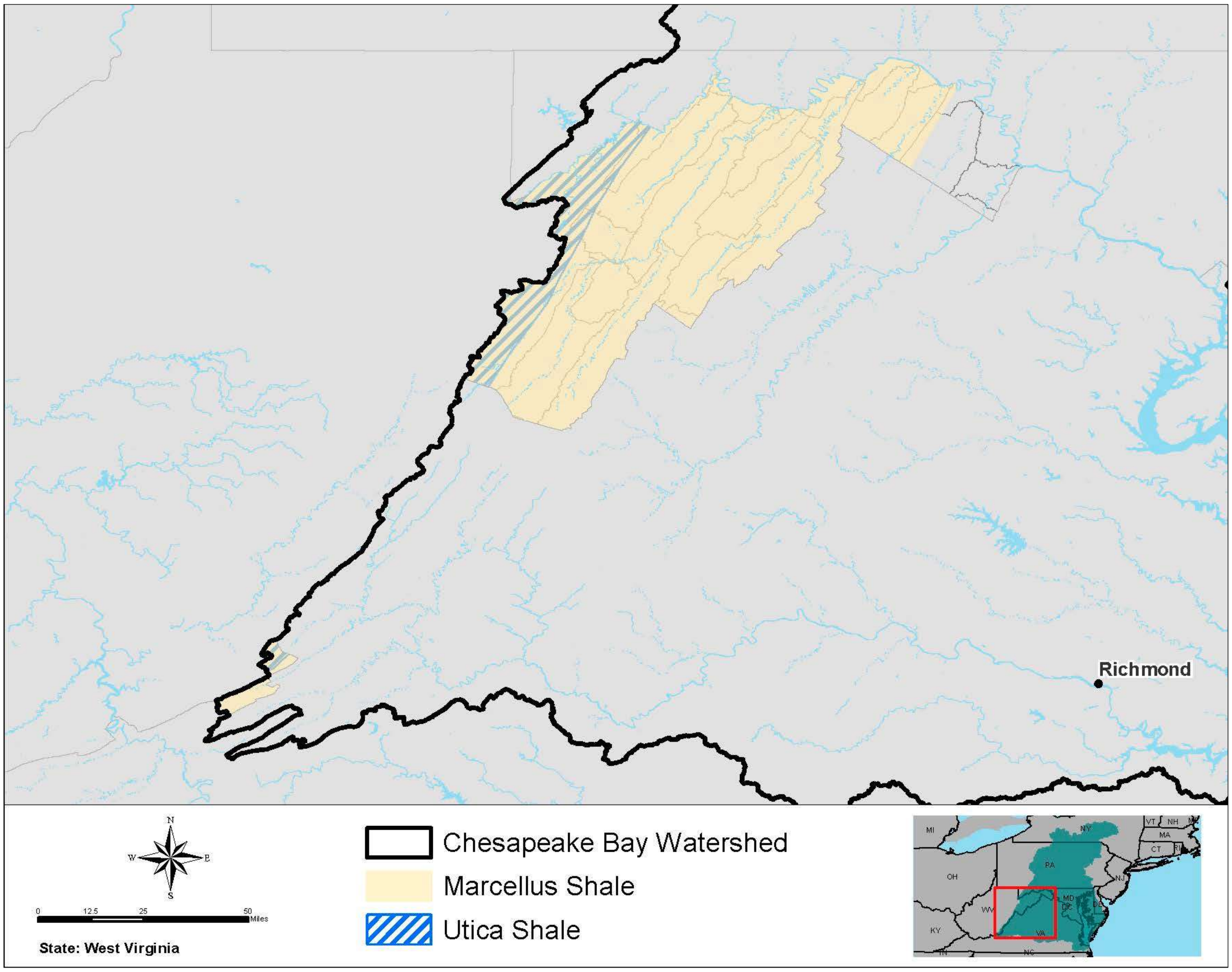

Figure 24. Extent of the Marcellus and Utica shale in West Virginia

3.3 Regional Flow and Connectivity

Nature's Network developed data that characterizes the ability of flora and fauna to move across the landscape. This regional flow data characterizes areas within a range of constrained flow to high diffuse flow (Figure 25 and Table 13) (see the Planning Analyses Appendix for definitions of each category.) The purpose of this analysis is to discern where there are important areas of regional flow, as determined by the Nature Conservancy (2016), which could benefit from tidal and/or nontidal wetland restoration. By aligning areas for potential wetland restoration with regional flow, opportunities to improve connectivity and ease of passage are identified. To investigate this concept, the CBCP overlaid the combined wetland restoration opportunities with the regional flow data. The acreage that is identified by Nature's Network as being a regional flow corridor of any degree was summed within each subwatershed. The total acreage of restoration opportunity was classified into 5 groups utilizing the Jenks (Natural Breaks) method in ArcGIS.

The top 2 groups of watersheds based on acreage of opportunity are identified as *Opportunity* subwatersheds. The subwatersheds with the greatest overlap between wetland restoration opportunity (acres) and regional flow data include HUC 0207000207 (Patterson Creek), HUC 0207000202 (Stony River-North Branch Potomac River) and HUC 0207000103 (Upper South Branch Potomac River).

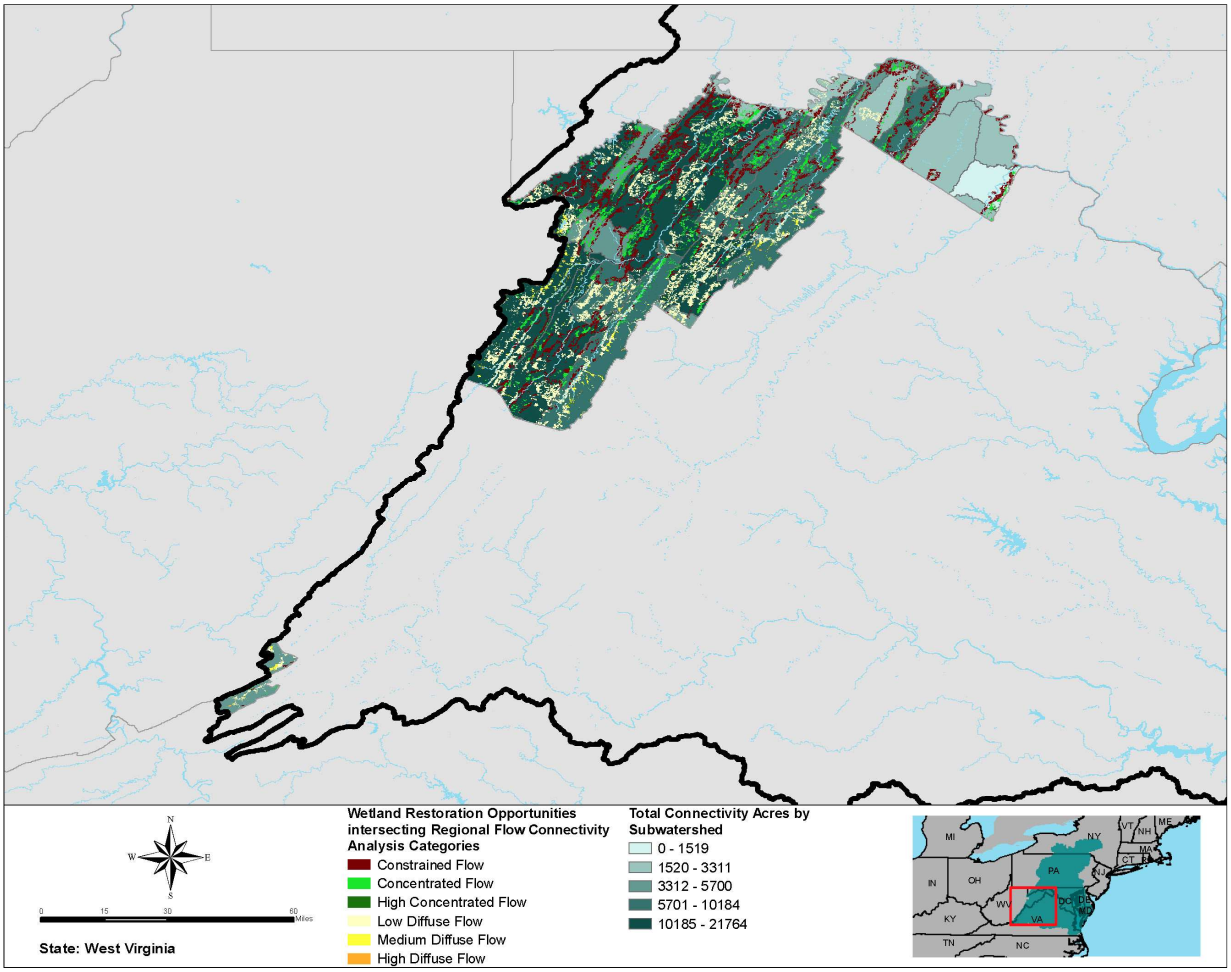

Figure 25. Wetland restoration opportunities that could beneficially impact regional flow in West Virginia

3.4 Road-Stream Crossings

A number of human activities can disrupt the continuity of river and stream ecosystems. The most familiar human-caused barriers are dams. Fish passage projects and dam removals have been a focus of the Chesapeake Bay Fish Passage Workgroup (FPWG) since 1989, and many dams and fish passage structures have been installed, opening thousands of miles of potential fish habitat. In recent years, there is growing concern about the role of road-stream crossings, especially culverts, in altering habitats, disrupting river and stream continuity, and blocking fish passage. Over 160,000 road-stream crossings exist in the Chesapeake Bay Watershed. In West Virginia there are 9,382 road-stream crossings. However, few culverts in the Chesapeake Bay Watershed have been assessed for fish passage. Of those in West Virginia, 132 culverts have been surveyed.

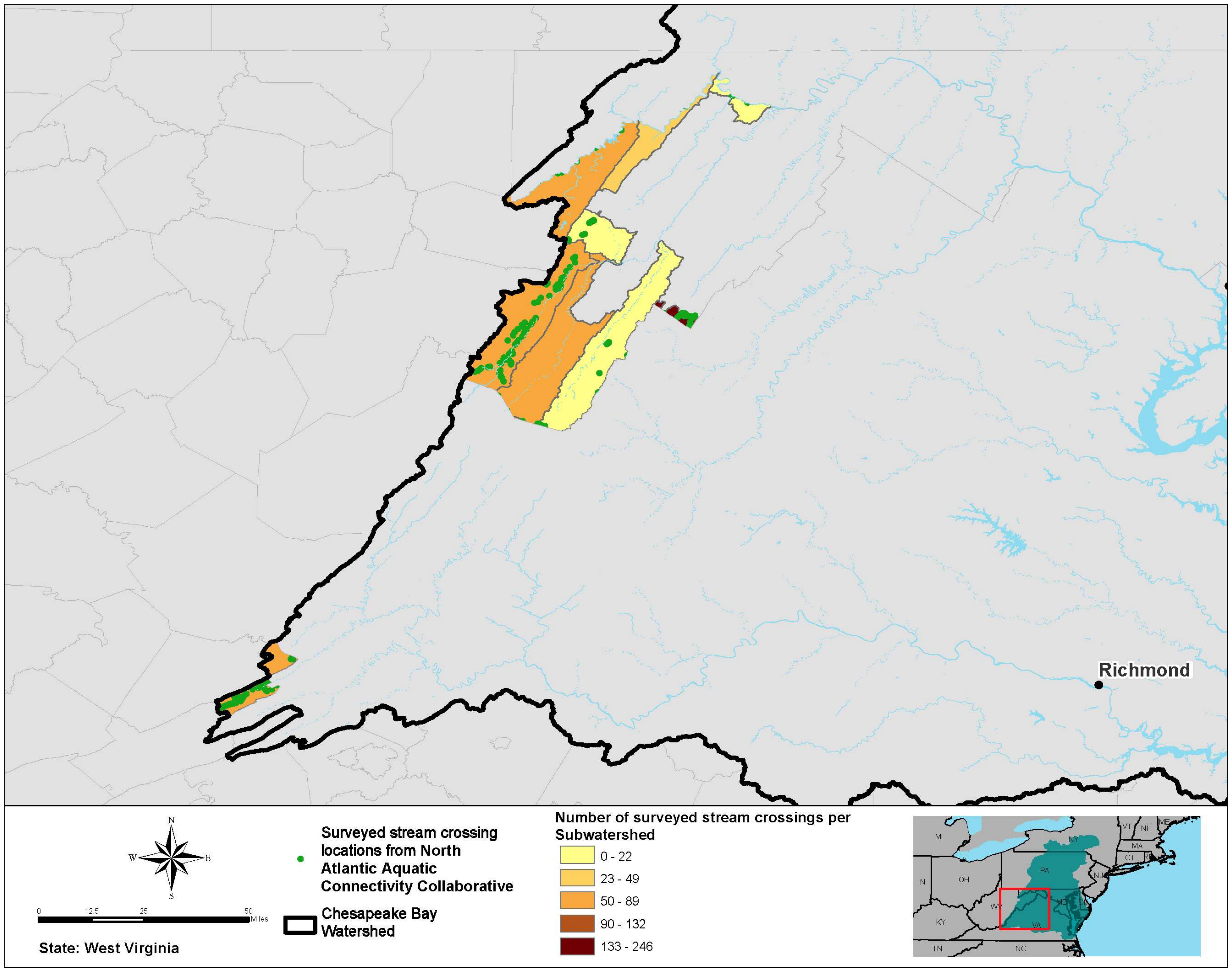

Figure 26. Surveyed stream crossings in West Virginia

SECTION 4

Integration Analysis

The *Opportunity* maps can guide various stakeholders and focus efforts. The purpose of the Integration Analysis was to evaluate the results of the individual Opportunity Assessments to identify where multiple 2014 Bay Agreement goals and outcomes or co-benefits that could be achieved. The resulting *Restoration Roadmap* is a compilation of the *Opportunity Assessments* which highlights co-benefits and the potential to address multiple problems with an integrated water resources management approach.

In West Virginia, the following *Opportunities Assessments* identified subwatersheds with opportunities aligning with the 2014 Bay Agreement goals and outcomes:

- Nontidal wetlands restoration
- Wetlands restoration to benefit avian wildlife
- Connectivity – regional flow
- Riparian forest buffers
- Stream restoration
- Healthy/High Value Habitats at risk to nontidal threats (policy)
- Conservation
- Watershed stressor (water quality improvements)

Due to the fact that there are a number of analyses that occur only in estuarine or tidal areas (oyster restoration, SAV, etc.), these data were separated and included in scoring only in those subwatersheds where 2014 Bay Agreement goals and outcomes have the potential to occur, eliminating bias towards tidal/estuarine areas at the mouth of the watershed when compared to the basin states further from the mainstem of the Chesapeake Bay. This allows for consistency between all analyses where subwatersheds were placed in disparate categories.

The subwatersheds in West Virginia with the highest potential to achieve the most 2014 Bay Agreement goals are HUC 0207000411 (Rocky Marsh Run-Potomac River) and HUC 0207000409 (Opequon Creek).

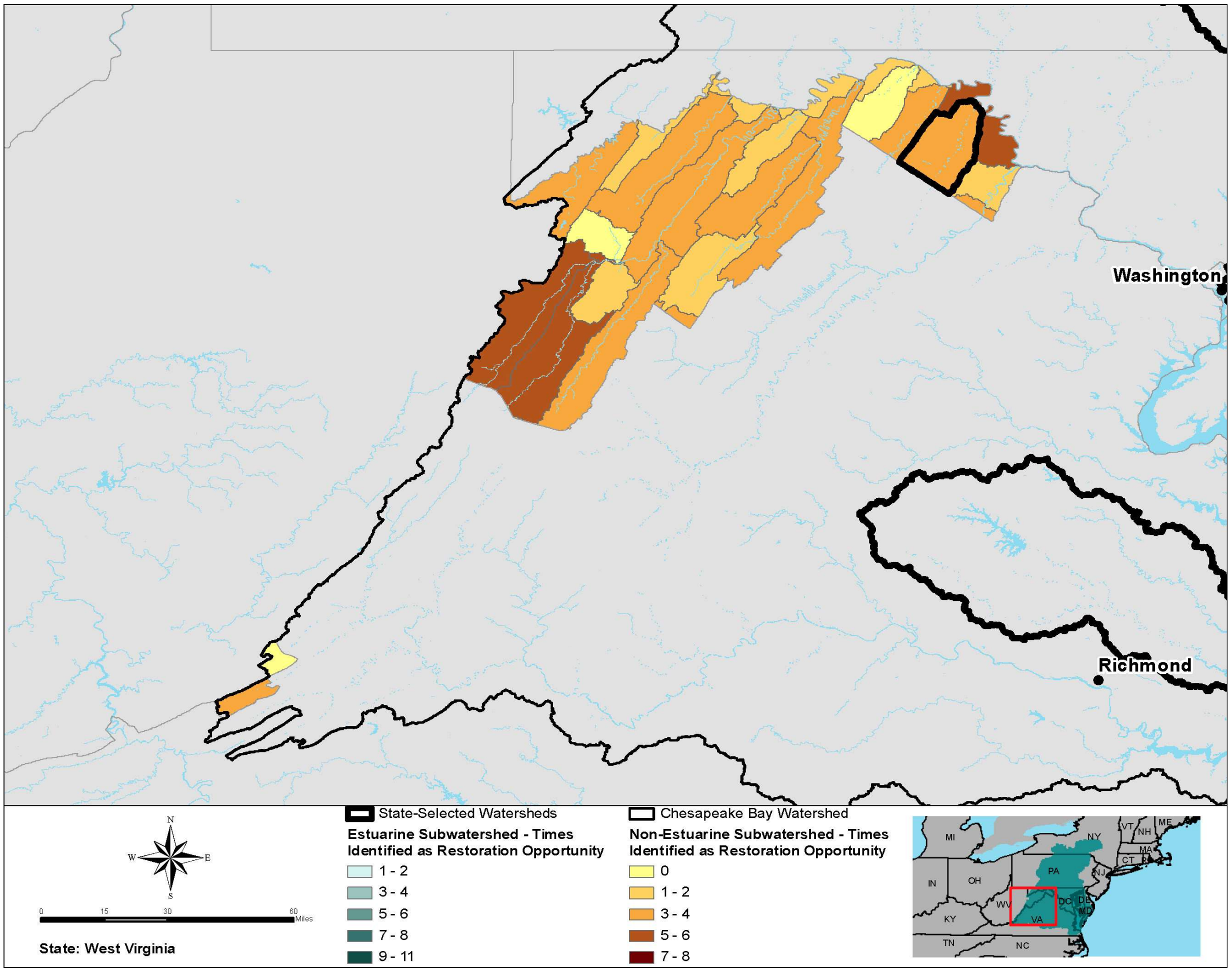

Figure 27. *Restoration Roadmap* for West Virginia

Table 1a. *Restoration Roadmap* for West Virginia*:* Compilation of Opportunity Assessments (1 = yes; 0 = no)

Drainage States	HUC 10 Number	Subwatershed Name	Nontidal Wetland Restoration Opportunity	Wetland Restoration Opportunity to Benefit Avian Wildlife	Connectivity - Regional Flow Opportunity	Riparian Forest Buffer Opportunity	Stream Restoration Opportunity	Future Threats – Nontidal Opportunity	Conservation Opportunity	Watershed Stressor Analysis Opportunity	Times Identified as *Opportunity*
MD,WV	0207000411	Rocky Marsh Run-Potomac River	1	1	0	1	1	0	0	1	5
VA,WV	0207000103	Upper South Branch Potomac River	1	1	1	1	1	0	0	0	5
VA,WV	0207000101	North Fork South Branch Potomac River	0	1	1	1	1	0	1	0	5
VA,WV	0207000409	Opequon Creek	1	0	0	1	0	1	0	1	4
WV	0207000106	Lower South Branch Potomac River	1	0	1	1	1	0	0	0	4
MD,WV	0207000202	Stony River-North Branch Potomac River	0	1	1	1	1	0	0	0	4
VA,WV	0207000404	Back Creek	0	0	1	1	1	0	0	0	3
VA,WV	0207000105	South Fork South Branch Potomac River	0	0	1	1	1	0	0	0	3
WV	0207000207	Patterson Creek	0	0	1	1	1	0	0	0	3
WV	0207000306	North River	0	0	1	1	1	0	0	0	3
WV	0207000307	Cacapon River	0	0	1	1	1	0	0	0	3
MD,WV	0207000204	New Creek-North Branch Potomac River	0	1	0	0	0	0	1	0	2
WV	0207000302	Little Cacapon River	0	0	1	0	1	0	0	0	2
VA,WV	0207000305	Lost River	0	0	1	0	0	0	0	0	1
WV	0207000104	South Mill Creek-Mill Creek	0	0	1	0	0	0	0	0	1
MD,WV	0207000208	Trading Run-North Branch Potomac River	0	1	0	0	0	0	0	0	1
MD,WV	0207000308	Long Hollow Run-Potomac River	0	1	0	0	0	0	0	0	1
MD,PA,WV	0207000405	Little Tonoloway Creek-Potomac River	0	1	0	0	0	0	0	0	1
VA,WV	0207000703	Bullskin Run-Shenandoah River	0	0	0	0	0	0	0	1	1
VA,WV	0207000402	Sleepy Creek	0	0	0	0	0	0	0	0	0
WV	0207000102	Lunice Creek	0	0	0	0	0	0	0	0	0

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SECTION 5

State-Selected Watershed Action Plan Summary

The State-Selected Watershed Action Plans undertook a detailed analysis for each jurisdiction with the goal of identifying site-specific, project-scale for implementation. The watershed being evaluated in detail for West Virginia is the Opequon Creek Watershed. The full action plan for the Opequon Creek Watershed is appended to this chapter. Figure 28 depicts the results of the action plan investigation. Utilizing the results of the CBCP baywide analyses, local data, and candidate restoration projects submitted by stakeholders, 9 areas are identified as focal points for developing projects that could address multiple CBA goals and outcomes. Table 1b summarizes the potential opportunities identified in each polygon.

Table 1b. Summary of activities in proposed focus areas for project identification in the Opequon Creek Watershed

Opequon Creek Watershed Project Focus Areas									
Activity	A	B	C	D	E	F	G	H	I
Stream Restoration	X	X	X	X	X	X	X	X	X
Riparian Buffer Restoration		X	X	X	X	X	X	X	X
Riparian Buffer Conservation	X		X	X	X	X	X	X	X
Wetland Restoration		X	X	X	X	X	X	X	X
Wetland Conservation			X	X	X	X	X	X	X
Stakeholder-Submitted Candidate Project		X	X						

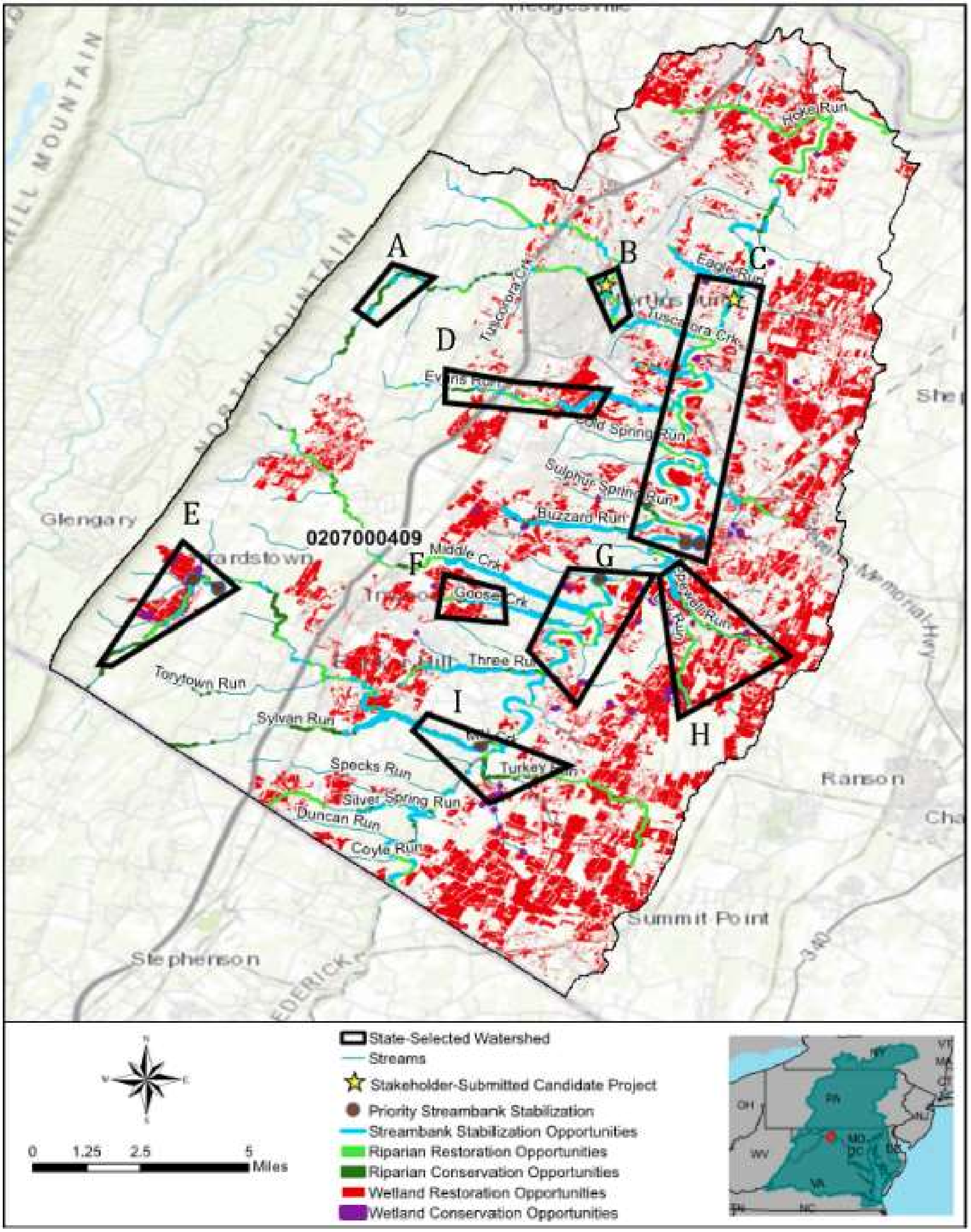

Figure 28. Proposed focus areas for project identification in the Opequon Creek Watershed

SECTION 6

Funding and Implementation Strategy

The Federal Leadership Committee for the Chesapeake Bay, including EPA and the Departments of Agriculture, Commerce, Defense, and the Interior, invested more than $536 million in watershed restoration in fiscal year 2016. Funding is directed to state and local governments, educational institutions, nonprofit organizations, and territorial and tribal agencies. These groups often provide additional funding—cash or in-kind—to further facilitate restoration efforts.

This section details a summary of federal, state, and nongovernmental programs and organizations that could be pursued for assistance in implementation efforts.

6.1 Federal Funding

The *Catalog of Federal Funding Sources for Watershed Protection* is a searchable online database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of projects. The database may be searched by:

- Key word (e.g., wetlands, infrastructure, education, forestry);
- Type of organization (e.g., nonprofit groups, state, tribal, educational institution);
- Match requirement (yes or no); and
- Federal agency.

A search of all criteria provided programmatic information by agency that may be useful for different needs and opportunities identified in the CBCP. This information is available in the CBCP Existing Watershed Conditions and Threats Report in Table 39 of Section 12.3. Each program is linked to a web page that details the most current information regarding the funding source, including program overview, current and past funding levels, lowest/median/highest awards, match requirements, contact information, and eligible organizations.

6.2 Non-Governmental Resources

Outreach and public engagement, advocacy, volunteer and community support, monitoring, and research are examples of activities that many nongovernmental and nonprofit groups do as part of their mission. These groups often are more nimble than larger governmental agencies. They are on the ground and aware of opportunities and constraints at the parcel scale. Networking with community groups can bring much needed resources to the aid of communities with the capacity to facilitate restoration efforts. Tables 40 and 41 in Sections 12.4 and 12.5 of the CBCP Existing Watershed Conditions and Threats Report catalogs a list of groups that support habitat conservation, management, and restoration efforts that are complementary to Chesapeake Bay goals.

6.3 Public-Private-Partnerships

A public-private partnership is typically a contractual agreement between a state or locality and a private organization or nongovernmental organization that commits them to provide an environmental or recreational service. Public/Private partnerships will be an essential component for implementation of various CBCP measures, including those associated with restoration, water quality, recreation, stewardship, and conservation. For example, public-private partnerships have become a popular and effective method to achieve stringent water quality standards required to meet stormwater initiatives in the Chesapeake Bay Watershed. Another successful and viable example of a public-private partnership approach is the execution of voluntary, long-term real estate protections by local citizens in the Chesapeake Bay Watershed. Other successful partnerships that have been implemented in the watershed are citizen water quality monitoring programs and programs where students grow oyster spat for reef restoration projects. Other public-private partnerships exist in which schools grow vegetation that they then plant at local restoration sites, providing a viable function for the school and promoting stewardship and interpretation throughout the watershed. Overall, the implementation of public-private partnerships will be an essential component to ensure successful implementation of the CBCP.

SECTION 7

References

Source information for all geospatial data is provided in Annex 3 of the Planning Analyses Appendix.

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US Army Corps of Engineers

Attachment A

State of West Virginia –

Data Tables Supporting Geospatial Analyses and Outputs from Opportunity Assessments

Table A1. Summary of each hydrologic unit code (HUC) 10 subwatersheds in West Virginia

HUC 10 Number	Subwatershed Name	Acres	Drainage States
0207000204	New Creek-North Branch Potomac River	88,639	MD,WV
0207000103	Upper South Branch Potomac River	189,626	VA,WV
0207000105	South Fork South Branch Potomac River	160,134	VA,WV
0207000305	Lost River	99,573	VA,WV
0207000402	Sleepy Creek	56,485	VA,WV
0207000404	Back Creek	162,936	VA,WV
0207000409	Opequon Creek	185,005	VA,WV
0207000102	Lunice Creek	56,945	WV
0207000104	South Mill Creek-Mill Creek	66,730	WV
0207000106	Lower South Branch Potomac River	219,594	WV
0207000207	Patterson Creek	180,703	WV
0207000302	Little Cacapon River	69,822	WV
0207000306	North River	131,593	WV
0207000411	Rocky Marsh Run-Potomac River	138,327	MD,WV
0207000202	Stony River-North Branch Potomac River	186,717	MD,WV
0207000208	Trading Run-North Branch Potomac River	59,929	MD,WV
0207000308	Long Hollow Run-Potomac River	59,169	MD,WV
0207000405	Little Tonoloway Creek-Potomac River	71,983	MD,PA,WV
0207000703	Bullskin Run-Shenandoah River	41,813	VA,WV
0207000101	North Fork South Branch Potomac River	186,309	VA,WV
0207000307	Cacapon River	189,803	WV

Table A2. Watershed Stressors Analysis for West Virginia

HUC 10 Number	Subwatershed Name	Watershed Stressor Score
0207000411	Rocky Marsh Run-Potomac River	0.2222
0207000409	Opequon Creek	0.3333
0207000703	Bullskin Run-Shenandoah River	0.3889
0207000103	Upper South Branch Potomac River	0.5556
0207000106	Lower South Branch Potomac River	0.5556
0207000204	New Creek-North Branch Potomac River	0.5556
0207000207	Patterson Creek	0.5556
0207000405	Little Tonoloway Creek-Potomac River	0.5556
0207000102	Lunice Creek	0.6111
0207000202	Stony River-North Branch Potomac River	0.6111
0207000208	Trading Run-North Branch Potomac River	0.6111
0207000104	South Mill Creek-Mill Creek	0.6667
0207000404	Back Creek	0.6667
0207000101	North Fork South Branch Potomac River	0.7222
0207000105	South Fork South Branch Potomac River	0.7222
0207000305	Lost River	0.7222
0207000306	North River	0.7222
0207000308	Long Hollow Run-Potomac River	0.7222
0207000302	Little Cacapon River	0.7778
0207000307	Cacapon River	0.7778
0207000402	Sleepy Creek	0.7778

Table A3. Riparian Forest Buffer Opportunities Assessment for West Virginia

HUC 10 Number	Subwatershed Name	30 Meter Riparian Buffer (Acres)	Resident Fish (Acres)	Brook Trout (Acres)	Nitrogen and Phosphorous (Acres)	Percent Forested Buffer
0207000106	Lower South Branch Potomac River	28213	133969	7341	23991	92.8%
0207000409	Opequon Creek	26935	0	36	33956	90.1%
0207000103	Upper South Branch Potomac River	25227	100527	75423	735	89.0%
0207000105	South Fork South Branch Potomac River	24768	114696	32975	3014	88.5%
0207000101	North Fork South Branch Potomac River	22952	173685	139798	6	87.2%
0207000207	Patterson Creek	22513	79505	7206	3067	85.7%
0207000307	Cacapon River	22199	148086	31648	2684	85.2%
0207000404	Back Creek	21682	67244	0	769	84.7%
0207000202	Stony River-North Branch Potomac River	17142	133053	89836	2260	72.4%
0207000306	North River	16051	87908	1527	0	68.9%
0207000411	Rocky Marsh Run-Potomac River	15080	12666	0	45024	62.4%
0207000305	Lost River	13562	98732	24031	232	55.5%

Table A4. Stream Restoration Opportunities Assessment for West Virginia

HUC 10 Number	Subwatershed Name	Watershed Stressor Score	Brook Trout (Linear Feet)	National Fish Habitat Assessment (Linear Feet)	Index of Biological Integrity Scores
208011103	Rocky Marsh Run-Potomac River	0.22	0	353731	Fair
0207000103	Upper South Branch Potomac River	0.56	496945	624296	Good
0207000106	Lower South Branch Potomac River	0.56	105638	761129	Fair
0207000204	New Creek-North Branch Potomac River	0.56	91272	264571	Poor
0207000207	Patterson Creek	0.56	57381	757969	Fair
0207000405	Little Tonoloway Creek-Potomac River	0.56	0	290989	Good
0207000202	Stony River-North Branch Potomac River	0.61	741746	336294	
0207000102	Lunice Creek	0.61	41483	234844	
0207000208	Trading Run-North Branch Potomac River	0.61	0	188045	Fair
0207000104	South Mill Creek-Mill Creek	0.67	0	146633	Fair
0207000404	Back Creek	0.67	0	754506	Fair
0207000101	North Fork South Branch Potomac River	0.72	1276369	271150	Good
0207000105	South Fork South Branch Potomac River	0.72	213873	363160	Good
0207000305	Lost River	0.72	130759	124162	Good
0207000308	Long Hollow Run-Potomac River	0.72	27350	131154	Fair
0207000306	North River	0.72	22604	394574	Fair
0207000307	Cacapon River	0.78	239382	413286	Fair
0207000402	Sleepy Creek	0.78	30154	343446	Good
0207000302	Little Cacapon River	0.78	6251	345150	Fair

Table A4. Stream Restoration Opportunities Assessment for West Virginia (continued)

HUC 10 Number	Subwatershed Name	Enhance Stronghold (Linear Feet)	Restore Other Populations (Low Priority) (Linear Feet)	Restore Other Populations (Linear Feet)	Restore Persistent Populations and Habitats (Linear Feet)	Restore Unique Life History (Linear Feet)	Secure and Restore Persistent Populations (Linear Feet)
208011103	Rocky Marsh Run-Potomac River	0	0	0	0	0	0
0207000103	Upper South Branch Potomac River	199161	152484	0	41534	85591	17865
0207000106	Lower South Branch Potomac River	0	70742	0	0	0	34742
0207000204	New Creek-North Branch Potomac River	0	18284	0	80558	0	0
0207000207	Patterson Creek	0	0	0	57566	0	0
0207000405	Little Tonoloway Creek-Potomac River	0	0	0	0	0	0
0207000202	Stony River-North Branch Potomac River	0	131511	22257	733245	0	0
0207000102	Lunice Creek	0	13512	0	28104	0	0
0207000208	Trading Run-North Branch Potomac River	0	0	0	0	0	0
0207000104	South Mill Creek-Mill Creek	0	0	0	0	0	0
0207000404	Back Creek	0	0	0	0	0	0
0207000101	North Fork South Branch Potomac River	1074881	112964	11902	78118	0	0
0207000105	South Fork South Branch Potomac River	0	76338	36974	100554	0	0
0207000305	Lost River	0	130696	0	0	0	0
0207000308	Long Hollow Run-Potomac River	0	0	0	27358	0	0
0207000306	North River	0	0	0	0	0	22805
0207000307	Cacapon River	0	105292	6995	70763	0	56321
0207000402	Sleepy Creek	0	0	0	29743	0	0
0207000302	Little Cacapon River	0	6350	0	0	0	0

Table A5. Wetland enhancement opportunities in West Virginia

HUC 10 Number	Subwatershed Name	Existing Nontidal Wetlands (Acres)
0207000202	Stony River-North Branch Potomac River	1,294
0207000409	Opequon Creek	603
0207000411	Rocky Marsh Run-Potomac River	532
0207000703	Bullskin Run-Shenandoah River	454
0207000106	Lower South Branch Potomac River	312
0207000207	Patterson Creek	279
0207000404	Back Creek	265
0207000204	New Creek-North Branch Potomac River	169
0207000101	North Fork South Branch Potomac River	162
0207000306	North River	144
0207000307	Cacapon River	139
0207000402	Sleepy Creek	138
0207000208	Trading Run-North Branch Potomac River	115
0207000103	Upper South Branch Potomac River	112
0207000105	South Fork South Branch Potomac River	107
0207000405	Little Tonoloway Creek-Potomac River	101
0207000308	Long Hollow Run-Potomac River	56
0207000102	Lunice Creek	47
0207000305	Lost River	41
0207000104	South Mill Creek-Mill Creek	15
0207000302	Little Cacapon River	12

Table A6. Wetland restoration opportunities in West Virginia

HUC 10 Number	Subwatershed Name	Nontidal Wetland Restoration Opportunities (Acres)
0207000409	Opequon Creek	89,949
0207000411	Rocky Marsh Run-Potomac River	45,364
0207000103	Upper South Branch Potomac River	41,941
0207000106	Lower South Branch Potomac River	33,358
0207000207	Patterson Creek	31,976
0207000404	Back Creek	29,258
0207000202	Stony River-North Branch Potomac River	27,414
0207000306	North River	21,668
0207000703	Bullskin Run-Shenandoah River	20,120
0207000101	North Fork South Branch Potomac River	16,877
0207000307	Cacapon River	15,158
0207000105	South Fork South Branch Potomac River	14,863
0207000102	Lunice Creek	14,172
0207000305	Lost River	12,749
0207000402	Sleepy Creek	11,790
0207000302	Little Cacapon River	11,658
0207000104	South Mill Creek-Mill Creek	11,367
0207000405	Little Tonoloway Creek-Potomac River	10,290
0207000204	New Creek-North Branch Potomac River	8,803
0207000208	Trading Run-North Branch Potomac River	6,452
0207000308	Long Hollow Run-Potomac River	3,178

Table A7. Nontidal wetland restoration opportunities with avian benefits in West Virginia

HUC 10 Number	Subwatershed Name	Presence of Black Duck	Presence of Audubon Important Bird Areas	Presence of Nesting for Wading Birds and Waterbirds	Nontidal Wetland Restoration Opportunities (Acres)
0207000409	Opequon Creek	no	no	no	89,949
0207000411	Rocky Marsh Run-Potomac River	no	yes	no	45,364
0207000103	Upper South Branch Potomac River	no	yes	no	41,941
0207000106	Lower South Branch Potomac River	no	no	no	33,358
0207000207	Patterson Creek	no	no	no	31,976
0207000404	Back Creek	no	no	no	29,258
0207000202	Stony River-North Branch Potomac River	no	yes	no	27,414
0207000306	North River	no	no	no	21,668
0207000703	Bullskin Run-Shenandoah River	no	no	no	20,120
0207000101	North Fork South Branch Potomac River	no	yes	no	16,877
0207000307	Cacapon River	no	no	no	15,158
0207000105	South Fork South Branch Potomac River	no	no	no	14,863
0207000102	Lunice Creek	no	no	no	14,172
0207000305	Lost River	no	no	no	12,749
0207000402	Sleepy Creek	no	no	no	11,790
0207000302	Little Cacapon River	no	no	no	11,658
0207000104	South Mill Creek-Mill Creek	no	no	no	11,367
0207000405	Little Tonoloway Creek-Potomac River	no	yes	no	10,290
0207000204	New Creek-North Branch Potomac River	no	yes	no	8,803
0207000208	Trading Run-North Branch Potomac River	no	yes	no	6,452
0207000308	Long Hollow Run-Potomac River	no	yes	no	3,178

Table A8. Wetland enhancement and restoration opportunities at risk to nontidal threats in West Virginia

HUC 10 Number	Subwatershed Name	Existing Wetlands at Risk to Nontidal Threat (Acres)	Wetland Restoration Opportunities at Risk to Nontidal Threats (Acres)
0207000409	Opequon Creek	125	5,442
0207000411	Rocky Marsh Run-Potomac River	95	1,510
0207000703	Bullskin Run-Shenandoah River	253	995
0207000404	Back Creek	7	348
0207000207	Patterson Creek	5	70
0207000106	Lower South Branch Potomac River	9	46
0207000306	North River	0	37
0207000204	New Creek-North Branch Potomac River	4	15
0207000208	Trading Run-North Branch Potomac River	5	4
0207000405	Little Tonoloway Creek-Potomac River	0	4
0207000102	Lunice Creek	5	2
0207000307	Cacapon River	0	2
0207000302	Little Cacapon River	0	1
0207000103	Upper South Branch Potomac River	5	1
0207000105	South Fork South Branch Potomac River	4	1
0207000305	Lost River	0	0
0207000101	North Fork South Branch Potomac River	0	0
0207000402	Sleepy Creek	0	0
0207000202	Stony River-North Branch Potomac River	0	0
0207000104	South Mill Creek-Mill Creek	0	0
0207000308	Long Hollow Run-Potomac River	0	0

Table A9. Healthy/high value habitats in West Virginia

HUC 10 Number	Subwatershed Name	Healthy/High Value Habitat (Acres)
0207000101	North Fork South Branch Potomac River	65,205.28
0207000202	Stony River-North Branch Potomac River	20,125.46
0207000103	Upper South Branch Potomac River	7,714.76
0207000204	New Creek-North Branch Potomac River	4,150.85
0207000308	Long Hollow Run-Potomac River	856.75
0207000307	Cacapon River	67.84
0207000102	Lunice Creek	6.17
0207000411	Rocky Marsh Run-Potomac River	5.98
0207000208	Trading Run-North Branch Potomac River	5.28
0207000207	Patterson Creek	4.73
0207000105	South Fork South Branch Potomac River	3.03
0207000703	Bullskin Run-Shenandoah River	0.11

Table A10. Conservation Opportunities Assessment for West Virginia

HUC 10 Number	Subwatershed Name	Existing Wetlands (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Stream Restoration Presence	Riparian Buffer Presence	Habitat Restoration Compilation	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Enhancement Opportunities that Intersect with Conservation Opportunities (Acres)
0207000202	Stony River-North Branch Potomac River	1,294	27,414	3,085	yes	yes	yes	56	10
0207000101	North Fork South Branch Potomac River	162	16,877	2,510	yes	yes	yes	37	0
0207000204	New Creek-North Branch Potomac River	169	8,803	664	yes	no	yes	2	0
0207000103	Upper South Branch Potomac River	112	41,941	596	yes	yes	yes	2	0
0207000308	Long Hollow Run-Potomac River	56	3,178	158	yes	no	yes	0	0
0207000207	Patterson Creek	279	31,976	1	yes	yes	yes	0	0
0207000102	Lunice Creek	47	14,172	1	yes	no	yes	0	0
0207000411	Rocky Marsh Run-Potomac River	532	45,364	0	yes	yes	yes	0	0
0207000208	Trading Run-North Branch Potomac River	115	6,452	0	yes	no	yes	0	0
0207000105	South Fork South Branch Potomac River	107	14,863	0	yes	yes	yes	0	0
0207000307	Cacapon River	139	15,158	0	yes	yes	yes	0	0
0207000104	South Mill Creek-Mill Creek	15	11,367	0	yes	no	yes	0	0
0207000106	Lower South Branch Potomac River	312	33,358	0	yes	yes	yes	0	0
0207000302	Little Cacapon River	12	11,658	0	yes	no	yes	0	0
0207000305	Lost River	41	12,749	0	yes	yes	yes	0	0
0207000306	North River	144	21,668	0	yes	yes	yes	0	0
0207000402	Sleepy Creek	138	11,790	0	yes	no	yes	0	0
0207000404	Back Creek	265	29,258	0	yes	yes	yes	0	0
0207000405	Little Tonoloway Creek-Potomac River	101	10,290	0	yes	no	yes	0	0
0207000409	Opequon Creek	603	89,949	0	no	yes	yes	0	0
0207000703	Bullskin Run-Shenandoah River	454	20,120	0	no	no	no	0	0

Table A11. Socioeconomic Analysis for West Virginia

HUC 10 Number	Subwatershed Name	Recreation Parks (Acres)	Underserved (Minority) Population (Acres)	Underserved (Low Income) Population (Acres)	Public Access Sites Counts	Water Supply Counts	National Inventory Dams Counts	Conservation Opportunities that May Add Societal Benefits (Acres)
0207000409	Opequon Creek	401	6,739	12,417	0	16	13	0
0207000208	Trading Run-North Branch Potomac River	63	4,278	7,147	2	0	1	0
0207000106	Lower South Branch Potomac River	0	920	29,123	19	0	1	0
0207000204	New Creek-North Branch Potomac River	0	802	41,494	0	0	11	397
0207000411	Rocky Marsh Run-Potomac River	5,978	295	1,042	25	0	7	0
0207000703	Bullskin Run-Shenandoah River	906	269	140	9	0	4	0
0207000105	South Fork South Branch Potomac River	89,340	225	6,472	0	0	23	0
0207000103	Upper South Branch Potomac River	57,916	0	1,115	2	4	0	1
0207000305	Lost River	28,655	0	40,248	0	1	4	0
0207000402	Sleepy Creek	3,654	0	88	0	0	5	0
0207000404	Back Creek	0	0	1,217	0	18	32	0
0207000102	Lunice Creek	2,974	0	486	0	0	3	0
0207000104	South Mill Creek-Mill Creek	10,365	0	2,657	0	0	4	0
0207000207	Patterson Creek	121	0	40,891	0	0	32	1
0207000302	Little Cacapon River	0	0	39,895	0	0	1	0
0207000306	North River	0	0	71,090	0	0	1	0
0207000202	Stony River-North Branch Potomac River	6,113	0	46,528	0	0	6	278
0207000308	Long Hollow Run-Potomac River	18,844	0	25,684	2	0	1	0
0207000405	Little Tonoloway Creek-Potomac River	3,883	0	1,430	1	0	16	0
0207000101	North Fork South Branch Potomac River	155,432	0	90,198	0	0	0	360
0207000307	Cacapon River	53,570	0	117,776	8	1	4	0

Table A12. Nontidal Watershed Threats Analysis for West Virginia

HUC 10 Number	Subwatershed Name	Nontidal Threats (Acres)
0207000409	Opequon Creek	11812
0207000411	Rocky Marsh Run-Potomac River	3588
0207000703	Bullskin Run-Shenandoah River	2326
0207000404	Back Creek	878
0207000207	Patterson Creek	274
0207000204	New Creek-North Branch Potomac River	145
0207000106	Lower South Branch Potomac River	142
0207000208	Trading Run-North Branch Potomac River	114
0207000306	North River	84
0207000405	Little Tonoloway Creek-Potomac River	61
0207000103	Upper South Branch Potomac River	33
0207000105	South Fork South Branch Potomac River	30
0207000302	Little Cacapon River	19
0207000102	Lunice Creek	17
0207000307	Cacapon River	16
0207000202	Stony River-North Branch Potomac River	12
0207000402	Sleepy Creek	3
0207000305	Lost River	3
0207000308	Long Hollow Run-Potomac River	1
0207000101	North Fork South Branch Potomac River	1
0207000104	South Mill Creek-Mill Creek	0

Table A13. Wetland restoration opportunities that could beneficially impact regional flow in West Virginia

HUC 10 Number	Subwatershed Name	Wetland Restoration Opportunities Intersecting Regional Flow Acres
0207000207	Patterson Creek	16,725
0207000202	Stony River-North Branch Potomac River	15,711
0207000103	Upper South Branch Potomac River	15,462
0207000106	Lower South Branch Potomac River	13,393
0207000101	North Fork South Branch Potomac River	12,678
0207000305	Lost River	10,754
0207000105	South Fork South Branch Potomac River	9,268
0207000404	Back Creek	8,887
0207000307	Cacapon River	8,822
0207000306	North River	8,767
0207000302	Little Cacapon River	6,148
0207000104	South Mill Creek-Mill Creek	5,848
0207000405	Little Tonoloway Creek-Potomac River	4,958
0207000204	New Creek-North Branch Potomac River	3,902
0207000102	Lunice Creek	3,420
0207000208	Trading Run-North Branch Potomac River	3,311
0207000402	Sleepy Creek	2,786
0207000411	Rocky Marsh Run-Potomac River	2,741
0207000308	Long Hollow Run-Potomac River	1,898
0207000409	Opequon Creek	1,595
0207000703	Bullskin Run-Shenandoah River	1,056

West Virginia State-Selected Watershed Action Plan

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Section 1

Introduction

As part of the Chesapeake Bay Comprehensive Water Resources and Restoration Plan (CBCP) watershed assessment, a multi-scalar geospatial analysis approach was completed. As part of the scoping effort to develop this approach, each state initially identified a watershed in which geospatial analyses would be completed at the local watershed scale to further define ecological problems, needs, and opportunities. For West Virginia, the state-selected watershed for the smaller scale analyses was the Opequon Creek watershed. The purpose of this refined, smaller scale geospatial analysis was to evaluate the unique problems and opportunities within the Opequon Creek watershed and ultimately guide the implementation of future projects at a smaller scale.

This report builds upon the CBCP baywide and statewide analyses, which corroborated the Opequon Creek watershed for selection as part of the CBCP smaller scale watershed analyses. The analysis findings are rooted in the geospatial analysis conducted with available data as well as feedback and collaboration from local, state, and federal agencies and NGOs. Feedback was solicited through interactive webinars and stakeholder reviews of draft deliverable products. Additionally, the summary of the analysis findings presents potential projects to pursue within the Opequon Creek watershed at a conceptual level of detail, and does not present detailed designs, detailed costs, or National Environmental Policy Act documentation. Projects selected for advancement are recommended to be evaluated further with follow-on studies to develop additional details and confirm feasibility as well as to avoid duplication of ongoing or planned actions by other federal, state, and local agencies and nongovernmental organizations (NGOs). Although this analysis aims to identify projects that may be implemented by the U.S. Army Corps of Engineers (USACE), maximizing value added by USACE expertise and resources, it also identifies actions or projects that may be generated by other agencies.

The Opequon Creek watershed in eastern West Virginia encompasses parts of Berkeley and Jefferson counties.

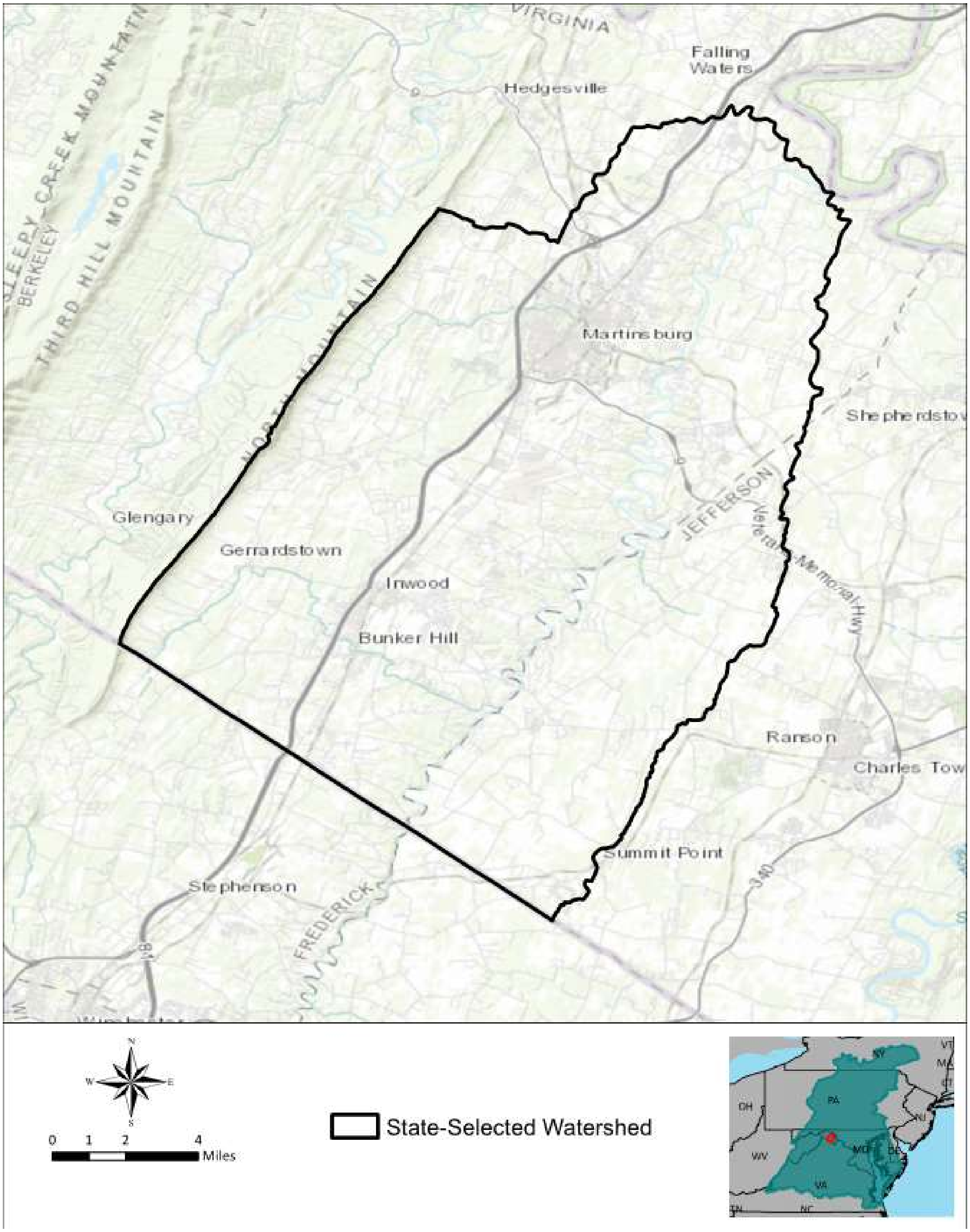

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Figure 1 illustrates the extent of the Opequon Creek watershed in West Virginia. **Figure 2** illustrates the counties and incorporated areas within the Opequon Creek watershed. The headwaters of the watershed extend into Clarke and Frederick counties in Virginia. The focus of this study is on the West Virginia portion of the watershed, which is 193 square miles. An additional 344 square miles fall within Virginia, which was not captured in this analysis. Further coordination across states should be considered as efforts progress toward project implementation.

The Opequon Creek watershed comprises the Opequon Creek hydrologic unit code (HUC) 0207000409 area, or HUC 10 (subwatershed). The Opequon Creek watershed is a part of the larger Potomac HUC 6 area. The Opequon Creek watershed includes drainage areas to the Middle Creek, Tuscarora Creek, Evans Run, Hoke Run, Sulphur Spring Run, Abrams Creek, Redbud Run, Turkey Run, Mill Creek, and other small brooks and streams. There are 195.1 miles of streams in the Opequon Creek watershed (United States Geological Survey [USGS] no date [n.d.])

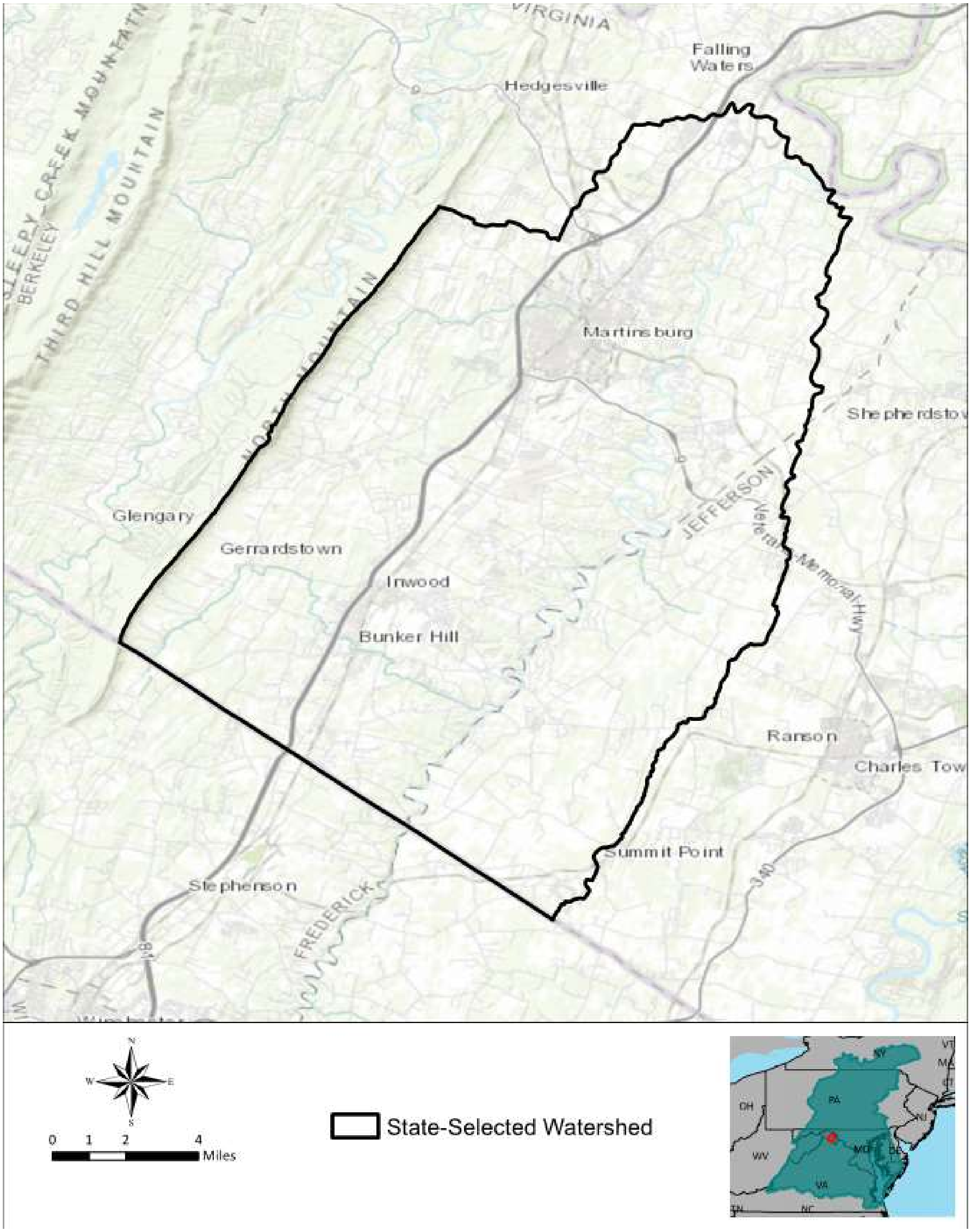

Figure 1. West Virginia watershed – Opequon Creek watershed

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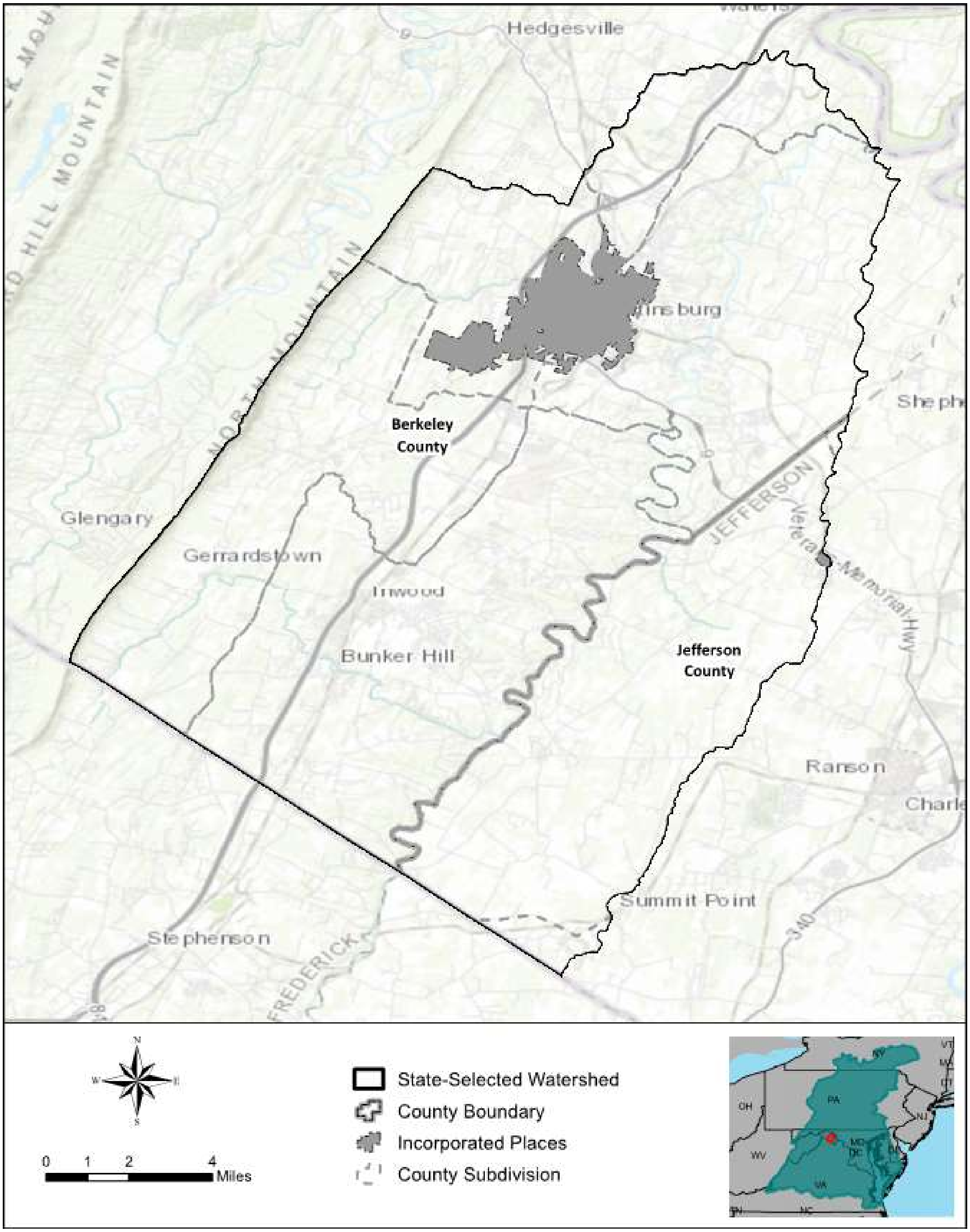
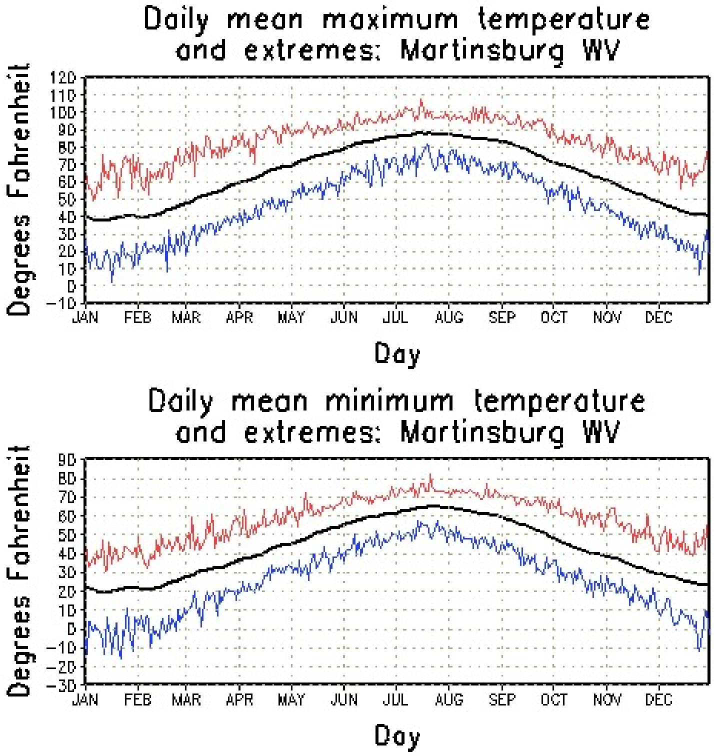


Figure 2. Municipalities within the Opequon Creek watershed

Climate within the region experiences annual mean precipitation of 37.5 inches, with 26.7 inches of mean annual snowfall, based on gage data from Martinsburg, West Virginia (National Oceanic and Atmospheric Administration [NOAA] Earth System Research Laboratory [ESRL], no date



[n.d.]).

Figure illustrates the variability in mean daily maximum and minimum temperature at the Martinsburg, WV gage based on data from 1961 through 1990.

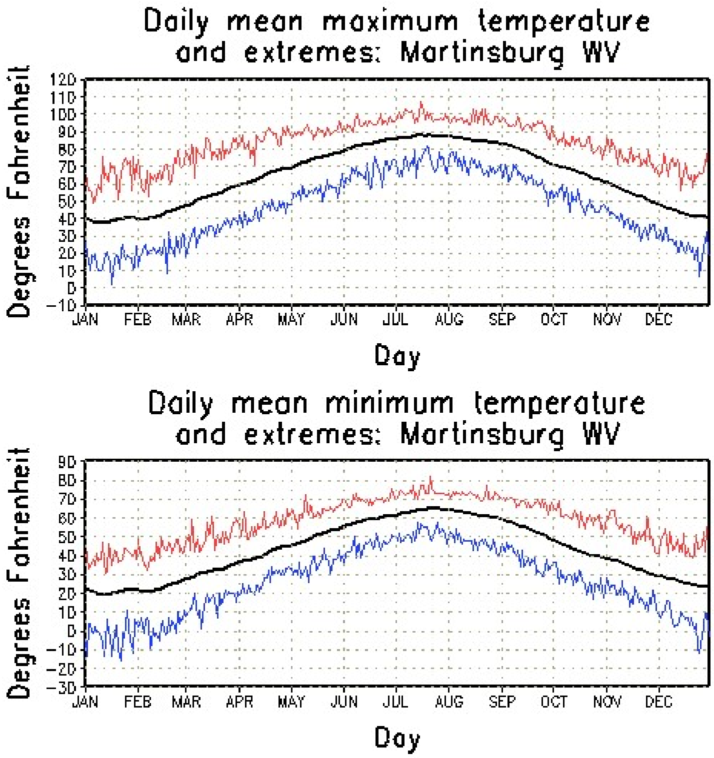


Figure 3. Mean maximum and minimum temperatures at Martinsburg, WV (NOAA ESRL n.d.)

Soils within the Opequon Creek watershed are predominantly Alfisols, with areas in the center portion of the watershed and along the western ridge comprised of Ultisols and Inceptisols. Soils along streams and tributaries are Mollisols.

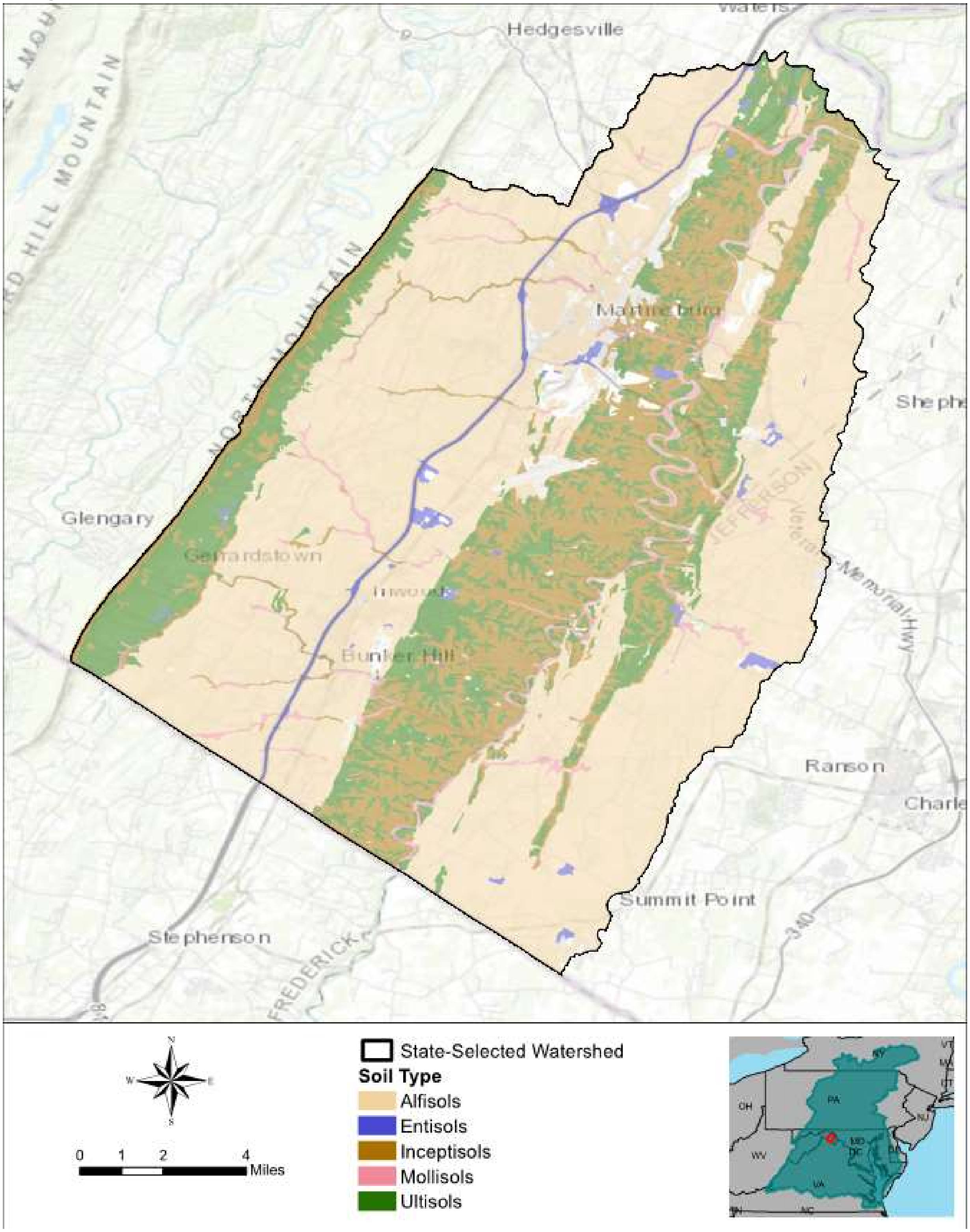


Figure shows the variability of soil type within the Opequon Creek watershed. **Figure** shows the topography in the Opequon Creek watershed, illustrating significant topographic relief in the westernmost portion of the watershed along the eastern ridge of North Mountain and along the streambanks within the watershed.

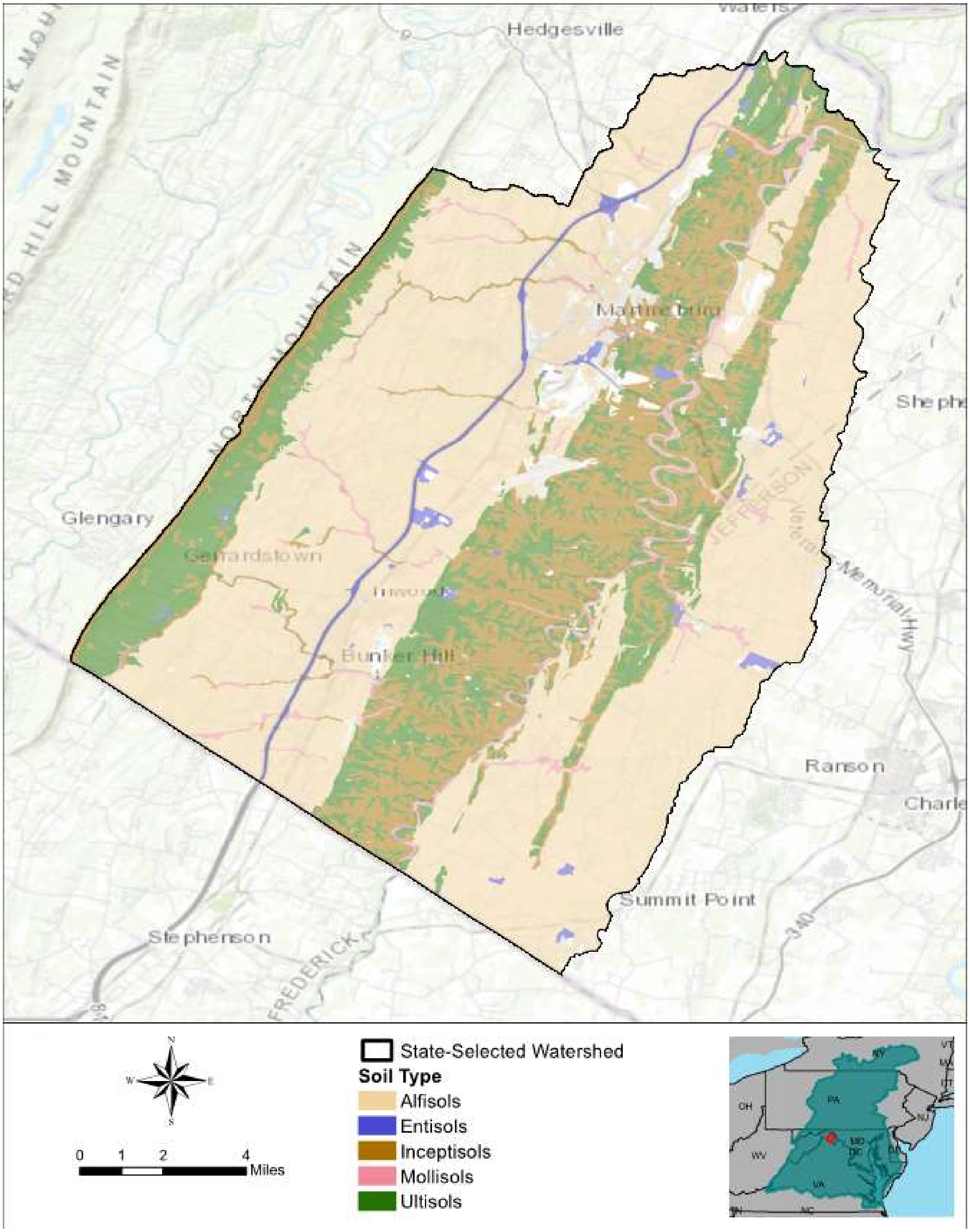


Figure 4. Soil types within the Opequon Creek watershed (U.S. Department of Agriculture [USDA] Natural Resources Conservation Service [NRCS] n.d.). Note: Soil type data for highly developed areas were not included in the source dataset

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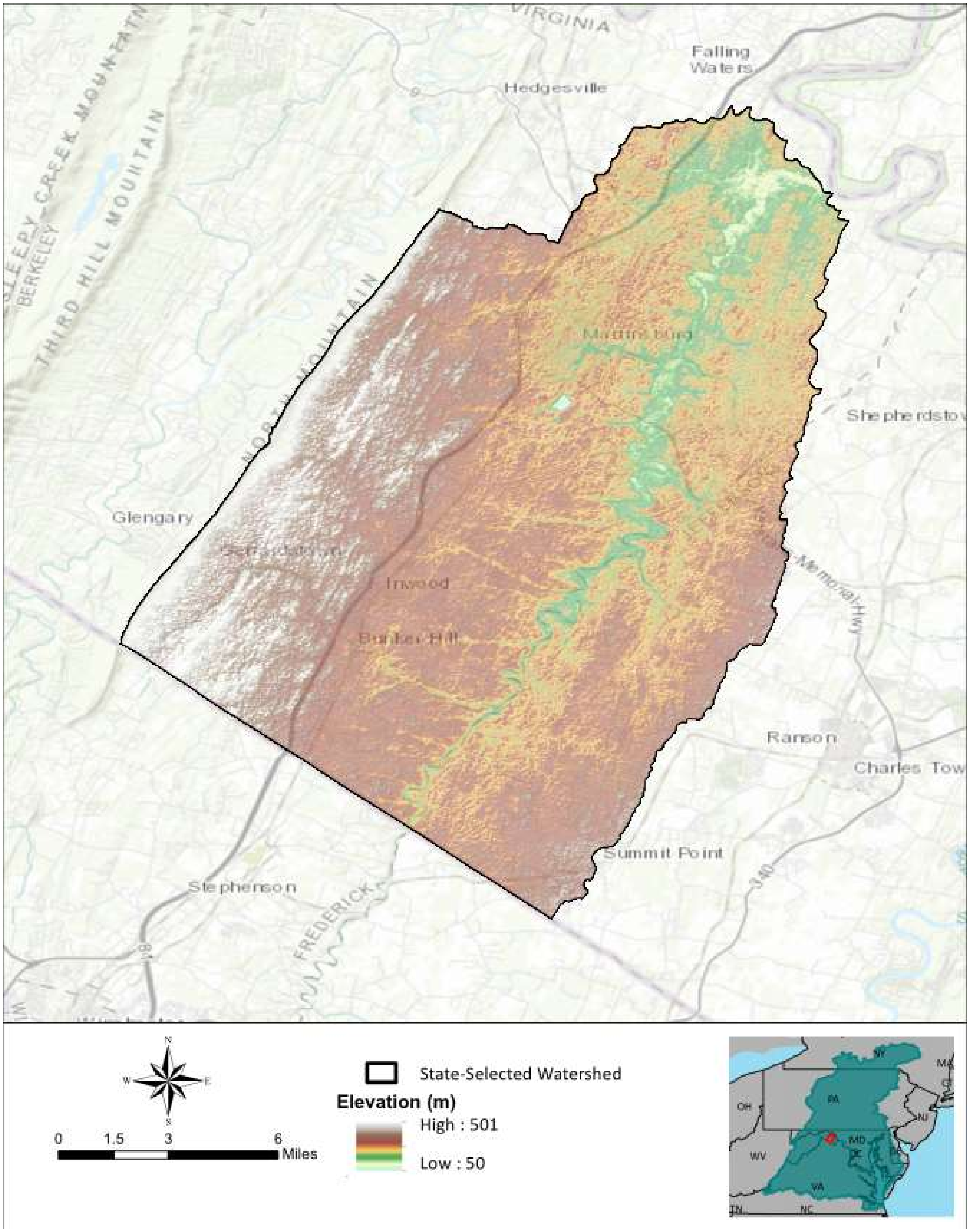

Figure 5. Opequon Creek watershed topography (Advanced Spaceborne Thermal Emission and Reflection Radiometer 2009)

The Opequon Creek watershed contains several major highways, rail, dams, fire stations, law enforcement offices, hospitals, and several wastewater treatment facilities. These critical facilities are highlighted on

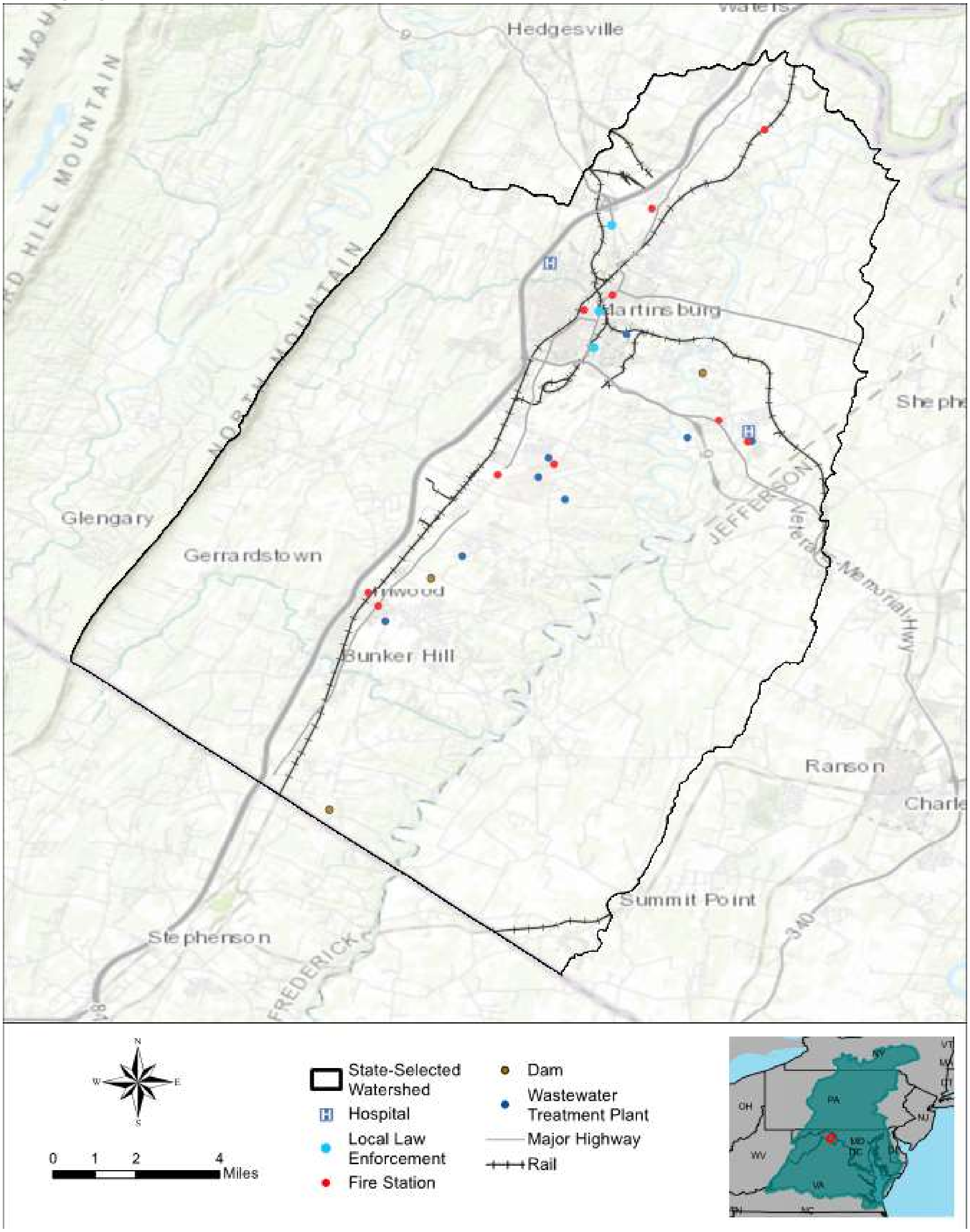

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Figure . Much of the critical infrastructure in the Opequon Creek watershed aligns with population hubs, such as Martinsburg. The population density throughout the Opequon Creek watershed is shown on

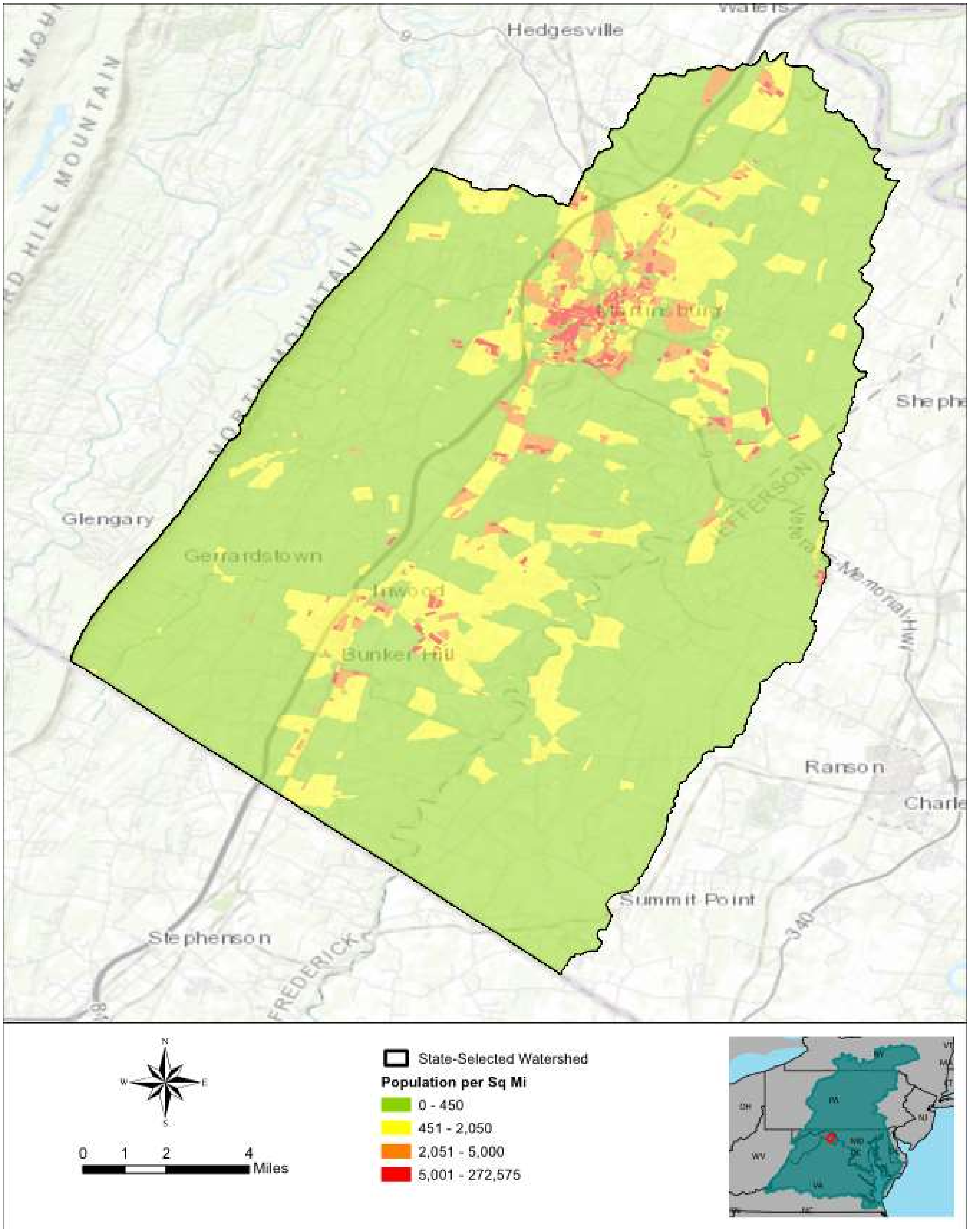

Figure . The population in the Opequon Creek watershed is predominantly white and middle aged as illustrated on **Figure** and **Figure** . The median household income of Opequon Creek watershed residents is $34,000 to $90,000 as illustrated on

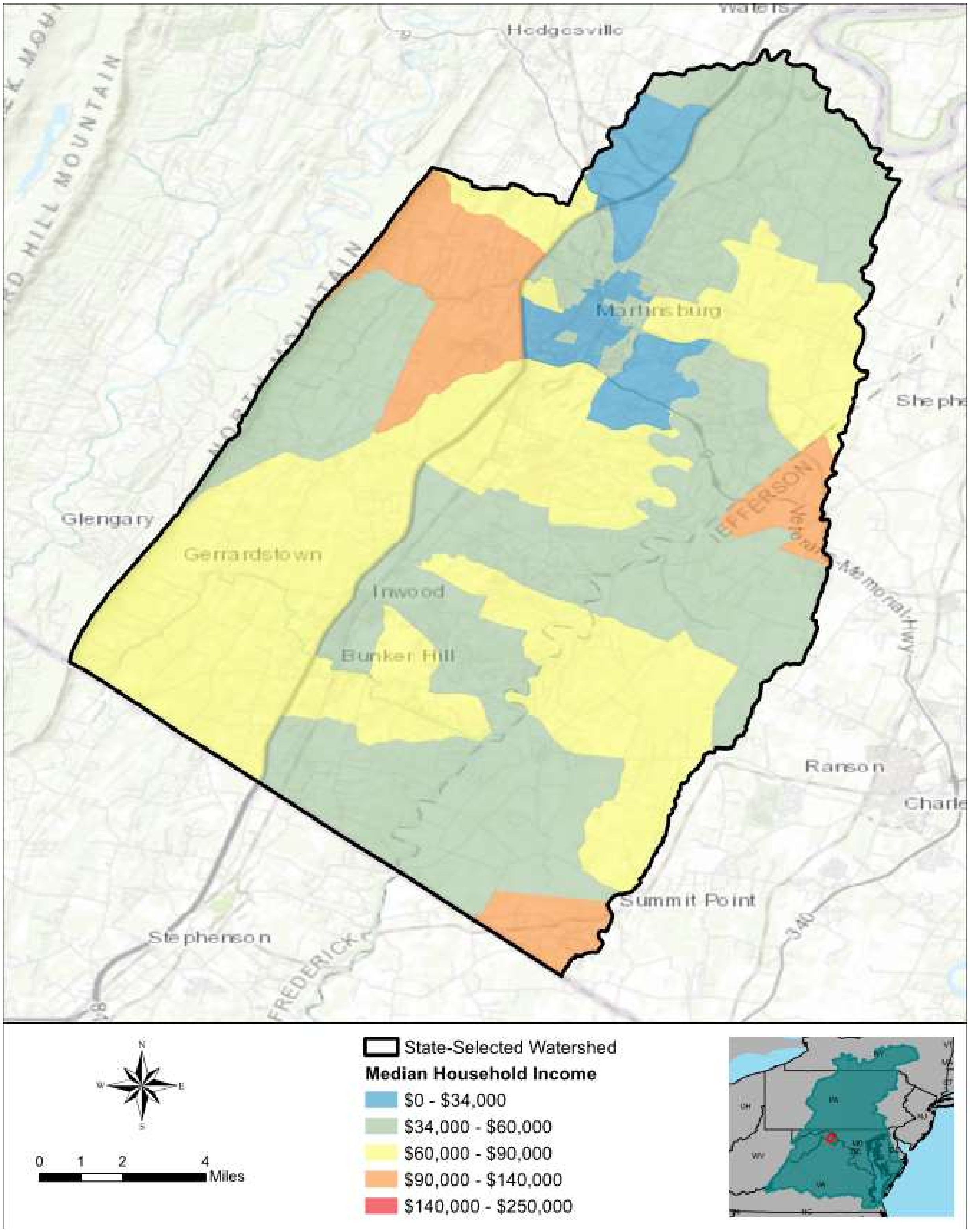

Figure .

This plan addresses the problems and risks to the Opequon Creek watershed and identifies restoration opportunities for consideration to improve the overall ecological health of the watershed.

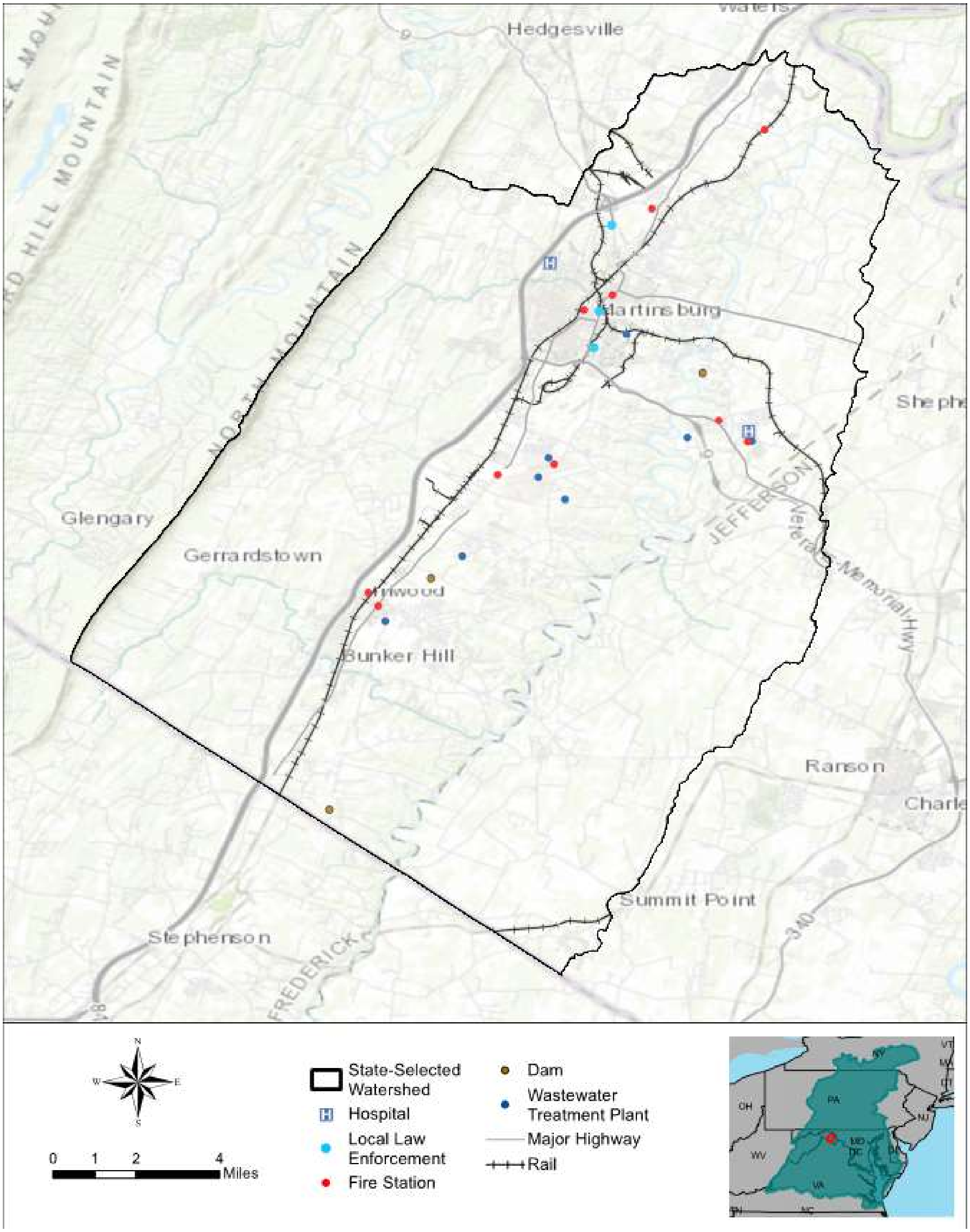

Figure 6. Critical infrastructure in the Opequon Creek watershed (U.S. Department of Homeland Security 2016)

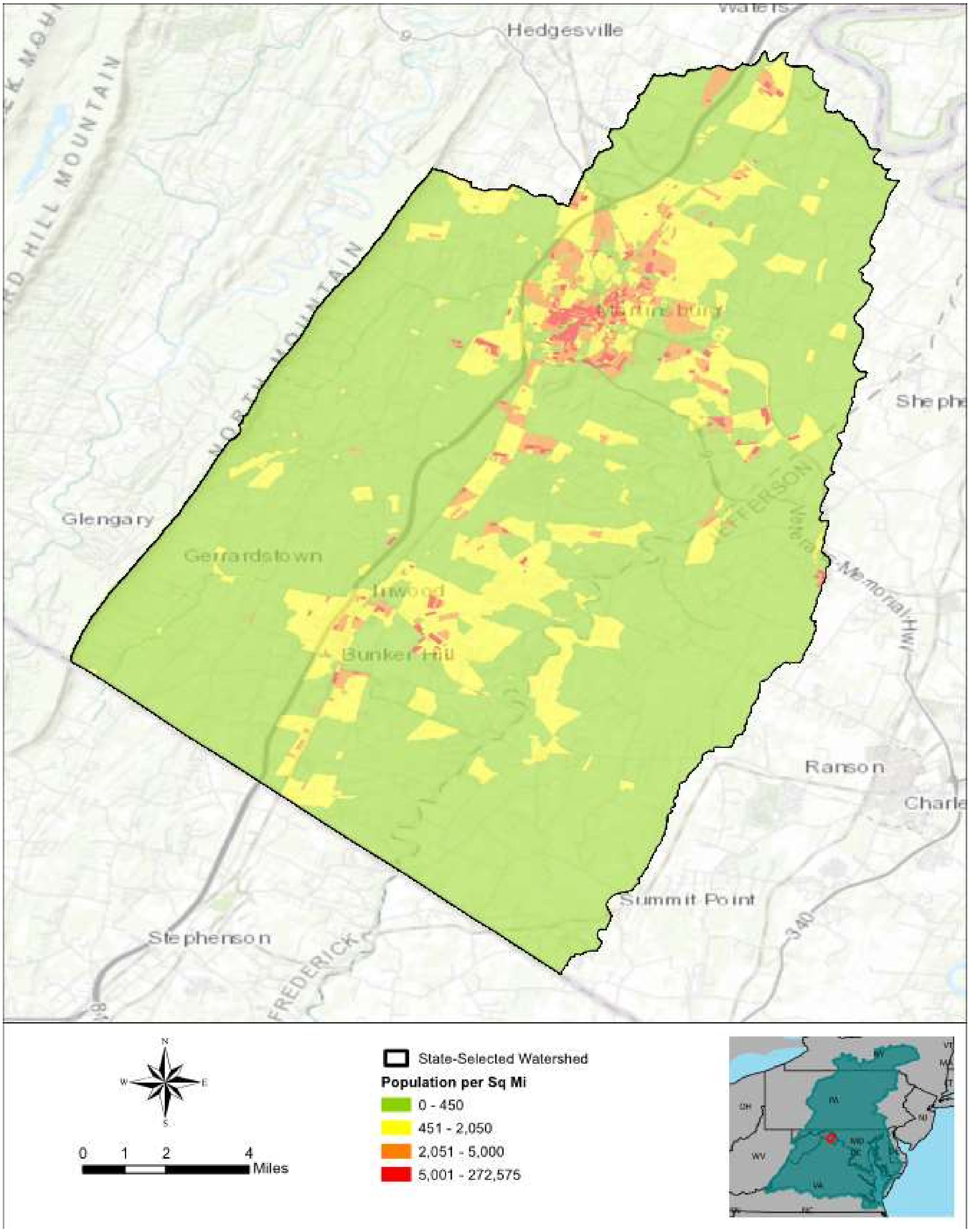

Figure 7. Opequon Creek watershed population density (U.S. Census Bureau 2010)

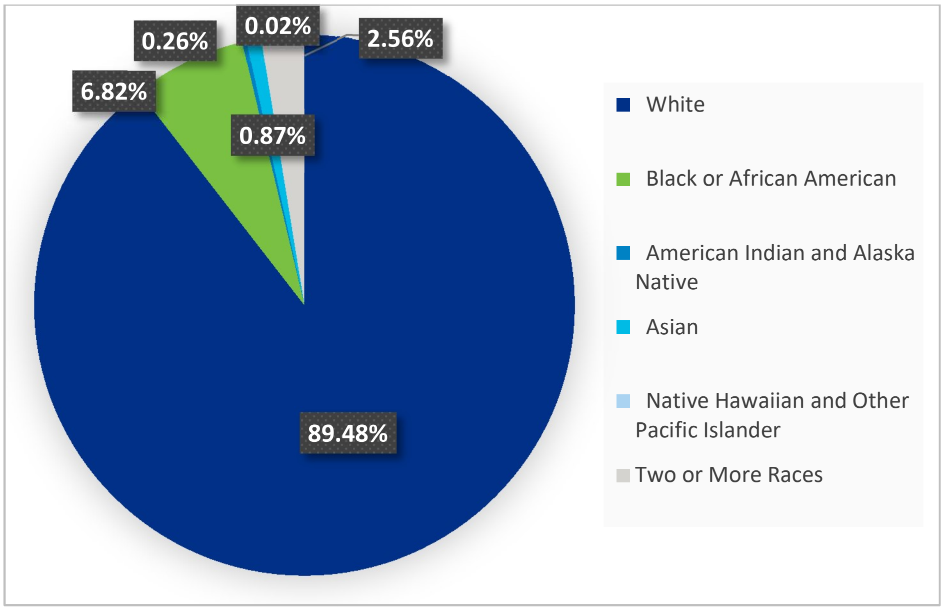

Figure 8. Opequon Creek watershed population demographics (U.S. Census Bureau 2010)

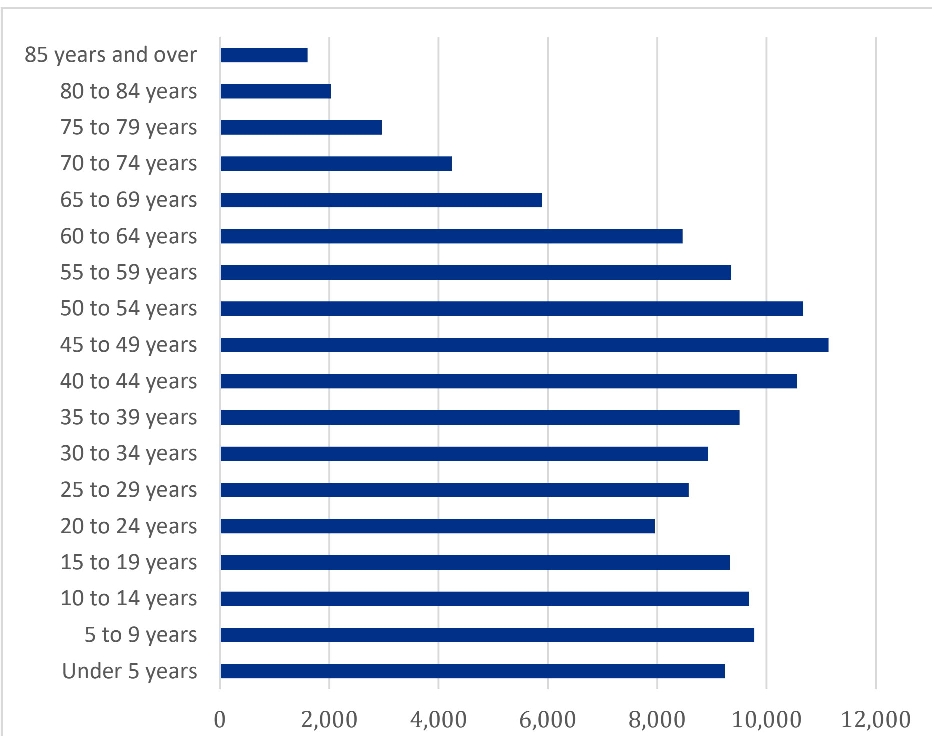

Figure 9. Opequon Creek watershed age demographics (U.S. Census Bureau 2010)

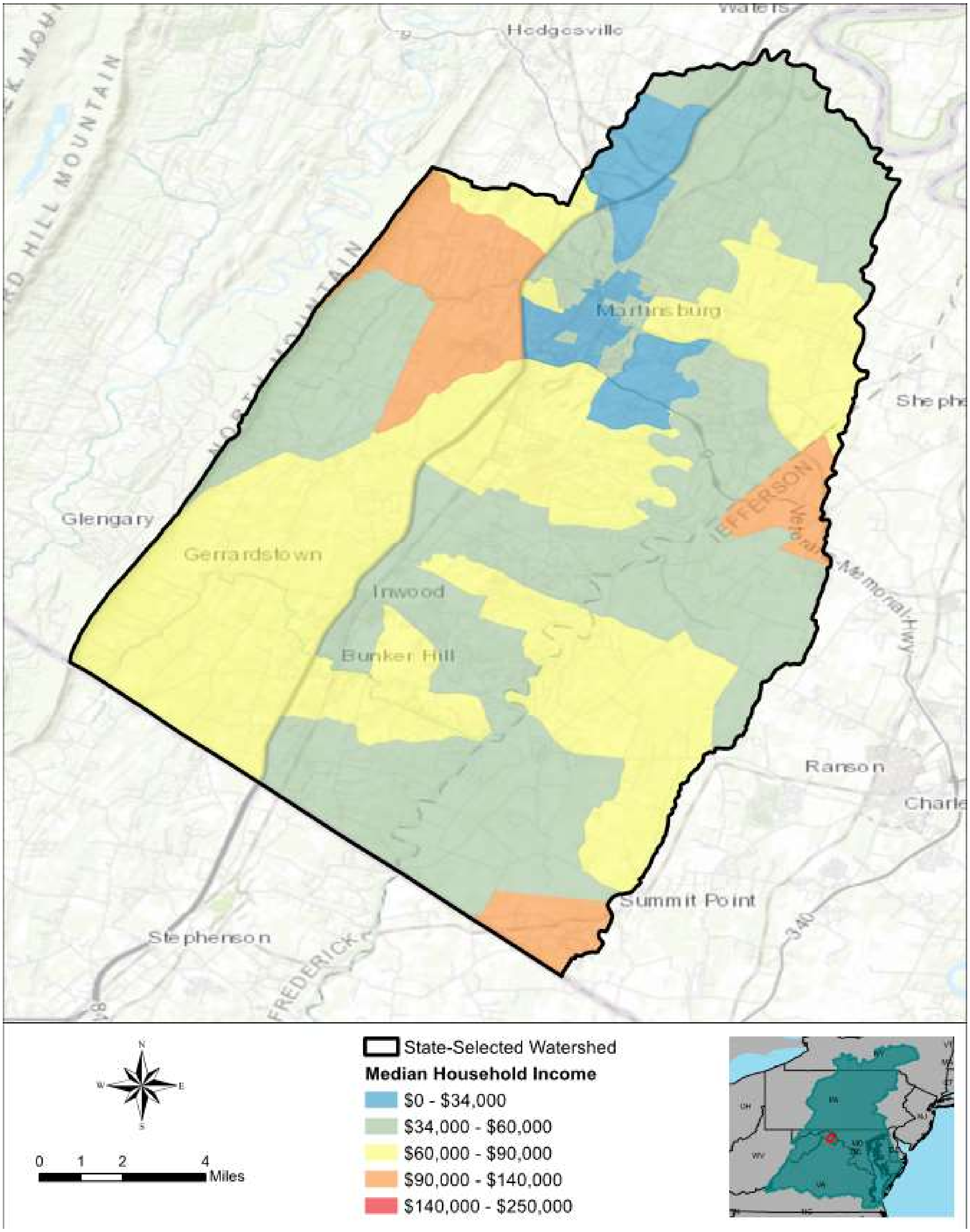

Figure 10. Median household income in the Opequon Creek watershed (U.S. Census Bureau 2010)

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Section 2

Baywide and Statewide Analyses Results Summary for the Opequon Creek Watershed

2.1 Problems and Needs

The Chesapeake Bay baywide analysis was conducted to evaluate future problems, needs, and opportunities in the Chesapeake Bay watershed through geospatial analysis. The problems identified in the Chesapeake Bay baywide and statewide analyses are refined at the Opequon Creek watershed scale, which are discussed further in Section 3. This section summarizes the problems and needs identified for the Opequon Creek watershed from the baywide analysis. For more information on the Chesapeake Bay baywide analysis, see the Chesapeake Bay Comprehensive Water Resources and Restoration Plan (CBCP) Main Report and Planning Analyses Appendix**.**

Several problems and needs were identified within the Opequon Creek watershed from the Chesapeake Bay baywide analysis. West Virginia State Chapter **Figure 3** highlights the areas of relative watershed stress throughout the Chesapeake Bay on a subwatershed scale. This analysis illustrates that the subwatershed that contains the Opequon Creek watershed is a stressed area. A low percentage of forest cover, high modeled nitrogen and phosphorous loadings, limited riparian buffer areas, moderate imperviousness, impaired stream sections based on the 303(d) impaired waterways list, and moderate scoring based on the index of biotic integrity (Chesapeake Bay Program 2012) are responsible for the watershed being stressed.

Poor habitat connectivity was identified from the Chesapeake Bay baywide analysis in the Opequon Creek watershed based on the Nature's Network core and connector habitat data (North Atlantic Landscape Conservation Cooperative 2016; see Chesapeake Bay Comprehensive Water Resources and Restoration Plan Planning Analyses Appendix **Figure 9**). The Madison Cave isopod (*Antrolana Lira*) is the only federally threatened species found in Jefferson and Berkeley counties within the Opequon Creek watershed (U.S. Fish and Wildlife Service 2017).

Although this section summarizes the findings from the Chesapeake Bay baywide analysis, further discussion of the problems and needs within the Opequon Creek watershed, explored through more localized datasets, can be found in Section 3.

2.2 Opportunities

Several restoration opportunities were identified in the baywide analysis to address the problems and needs identified in Section 2.1. The types of restoration opportunities considered in the baywide analysis include:

- Riparian buffer development and restoration
- Wetland restoration

- Stream restoration and streambank stabilization
- Conservation

Although not exhaustive, these restoration opportunities address several of the problems and needs identified in the baywide analysis. Additional restoration opportunities for the Opequon Creek watershed will be explored and discussed in Section 3.

As shown on West Virginia State Chapter **Figures 5** and **9**, the Opequon Creek watershed was considered a medium priority area for restoration and conservation based on engagement from several agencies in the area. The greatest engagement within the watershed is in the central portion of the watershed where Opequon Creek drains into the Potomac River and subsequently into Chesapeake Bay. There is high engagement and interest from stakeholders to work toward restoration and conservation in the subbasins that drain to Opequon Creek, including Tuscarora Creek (West Virginia Department of Environmental Protection [WVDEP] et al. 2008) and Mill Creek (WVDEP et al. 2013).

As illustrated on the CBCP Planning Analyses Appendix **Figure 18,** the Opequon Creek watershed is an area of high nitrogen and phosphorous loadings based on Spatially Referenced Regression on Watershed Attributes (SPARROW) modeling conducted at the baywide scale. The data were coupled with data highlighting the forested land within a 30 meter buffer of the streams and rivers as illustrated on West Virginia State Chapter **Figure 4**. This figure highlights the opportunities to restore riparian buffers and increase forested areas to progress toward the goal of 70 percent forested riparian buffer to help reduce nitrogen and phosphorous loading and stress within the watershed.

Wetland restoration (nontidal) was highlighted as an opportunity within the Opequon Creek watershed based on the Chesapeake Bay baywide analysis. This is illustrated on West Virginia State Chapter **Figure 9**, which shows the opportunities for wetland restoration within the Opequon Creek watershed are widespread. Restored wetlands can help trap polluted runoff, improving downstream water quality; create habitat for fish, birds, mammals, and invertebrates; provide hazard mitigation; and improve soil retention.

Other restoration opportunities and more detailed delineation of these restoration opportunities will be discussed further in Section 3.

2.3 Summary of Baywide Analysis Results in the Opequon Creek Watershed

In summary, the baywide analysis identified the following problems and needs within the Opequon Creek watershed:

- The Opequon Creek watershed is one of the highest stressed areas of Chesapeake Bay based on the following considerations:
  - Nitrogen and phosphorous loading
  - Extent of riparian buffers

  - 303(d) impaired waterways
  - Benthic index of biotic integrity
- There is poor habitat connectivity within the Opequon Creek watershed.
- The Opequon Creek watershed is vulnerable to nontidal threats such as:
  - Frequent flooding
  - Future development
  - Fish habitat degradation

Opportunities to address the problems and needs identified in the Chesapeake Bay baywide analysis include:

- Opportunities to implement riparian buffers to reduce nitrogen and phosphorous loading to Opequon Creek watershed
- Opportunities for wetland restoration to improve water quality and restore habitat
- Opportunities for stream restoration and streambank stabilization to reduce sediment loads, restore fish passages, and improve hydraulics adding flood risk reduction

Each of these opportunities will be discussed and explored further in the more detailed watershed analysis in Section 3.

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Section 3

Opequon Creek, WV Watershed Analysis

3.1 Opequon Creek Watershed Problems and Needs

Building upon the findings of the Chesapeake Bay baywide and statewide analyses, this section utilizes localized geospatial datasets, where available, to execute a refined analysis to identify problems, needs, and opportunities within the Opequon Creek watershed. This section also leverages existing reports, studies, projects, and stakeholder information specific to the Opequon Creek watershed to inform the findings and analysis.

Stakeholders were engaged to help define the known problems, needs, and opportunities within their watershed. In addition, collaborators working to connect various agencies operating in Chesapeake Bay were engaged to ensure consistency and information sharing. **Attachment A** to this report includes a list of the stakeholders contacted to support the development of this analysis.

In recent decades, there has been a decline in ecological health, including poor water quality, benthic macroinvertebrate community health, and habitat condition in the Opequon Creek watershed (WVDEP 2005). Habitats are negatively impacted by anthropogenic influences such as continued population growth and urbanization developments (WVDEP 2005). The water quality in the Opequon Creek watershed is significantly impaired by nutrients and fecal coliform bacteria originating from livestock and failure of onsite septic systems, compounded by karstic drainage patterns, heavy agricultural activities, and intensive urbanization (WVDEP 2005). Excessive nitrogen and phosphorous in the watershed's water column has resulted in increased algal growth and an in the increase of macroinvertebrates known as "grazers" (WVDEP 2005).

Land cover within the Opequon Creek watershed is dominated by cultivated agricultural land.

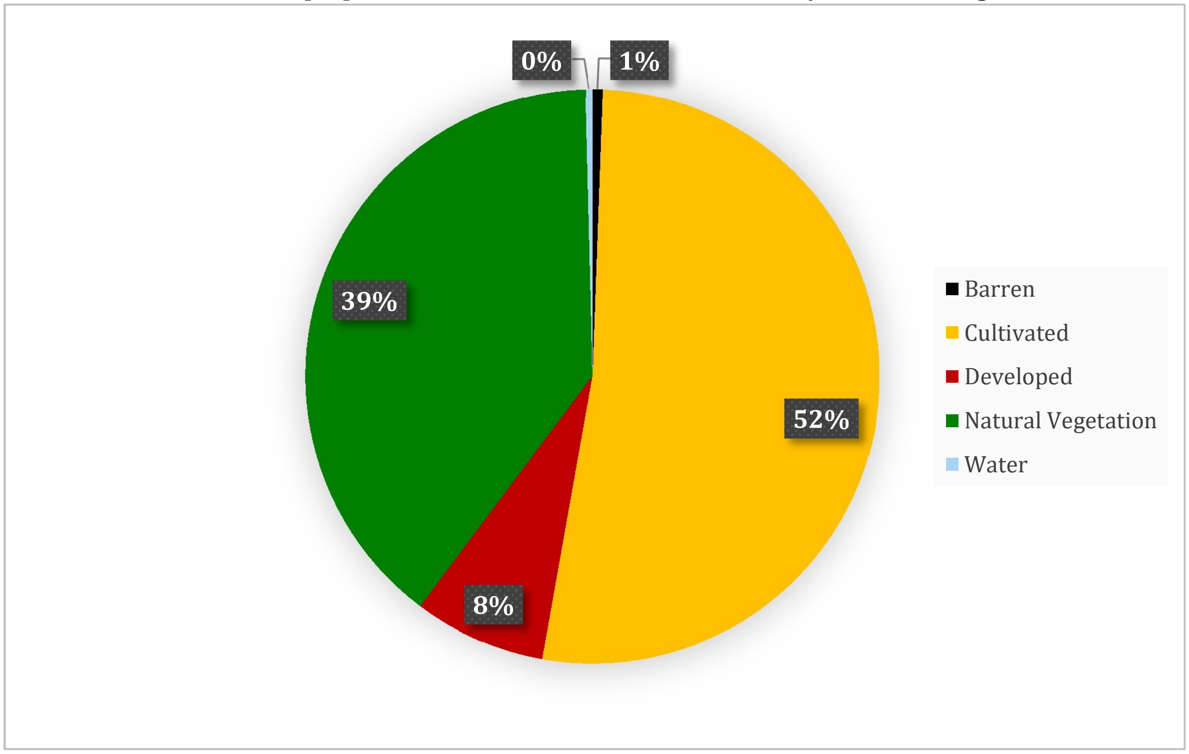

Figure 2 shows the breakdown of land cover by area within the Opequon Creek watershed based on the high-resolution land cover data from the Chesapeake Conservancy (2016) that were developed for the Chesapeake Bay Program.

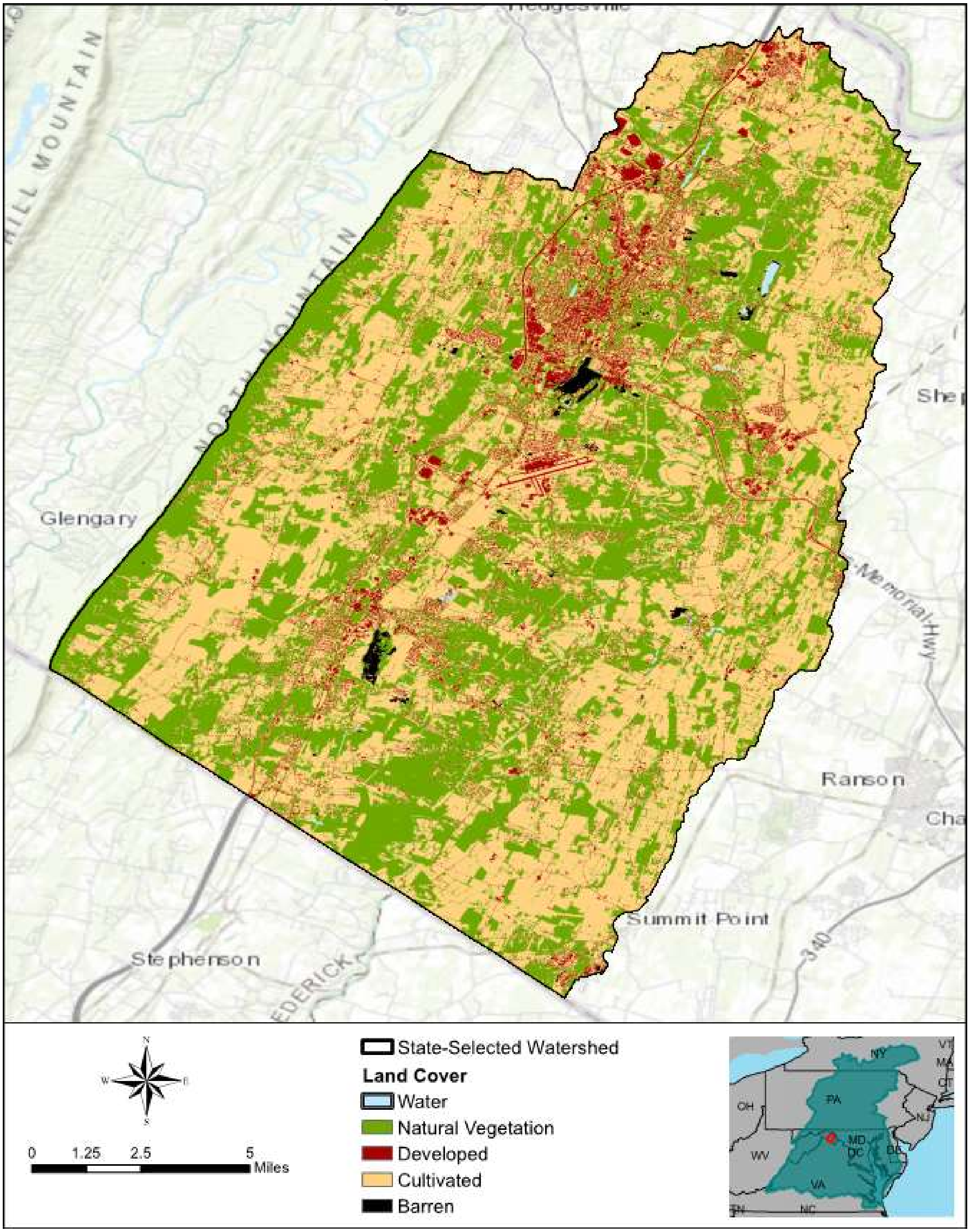

Figure 3 illustrates a map of land cover within the Opequon Creek watershed.

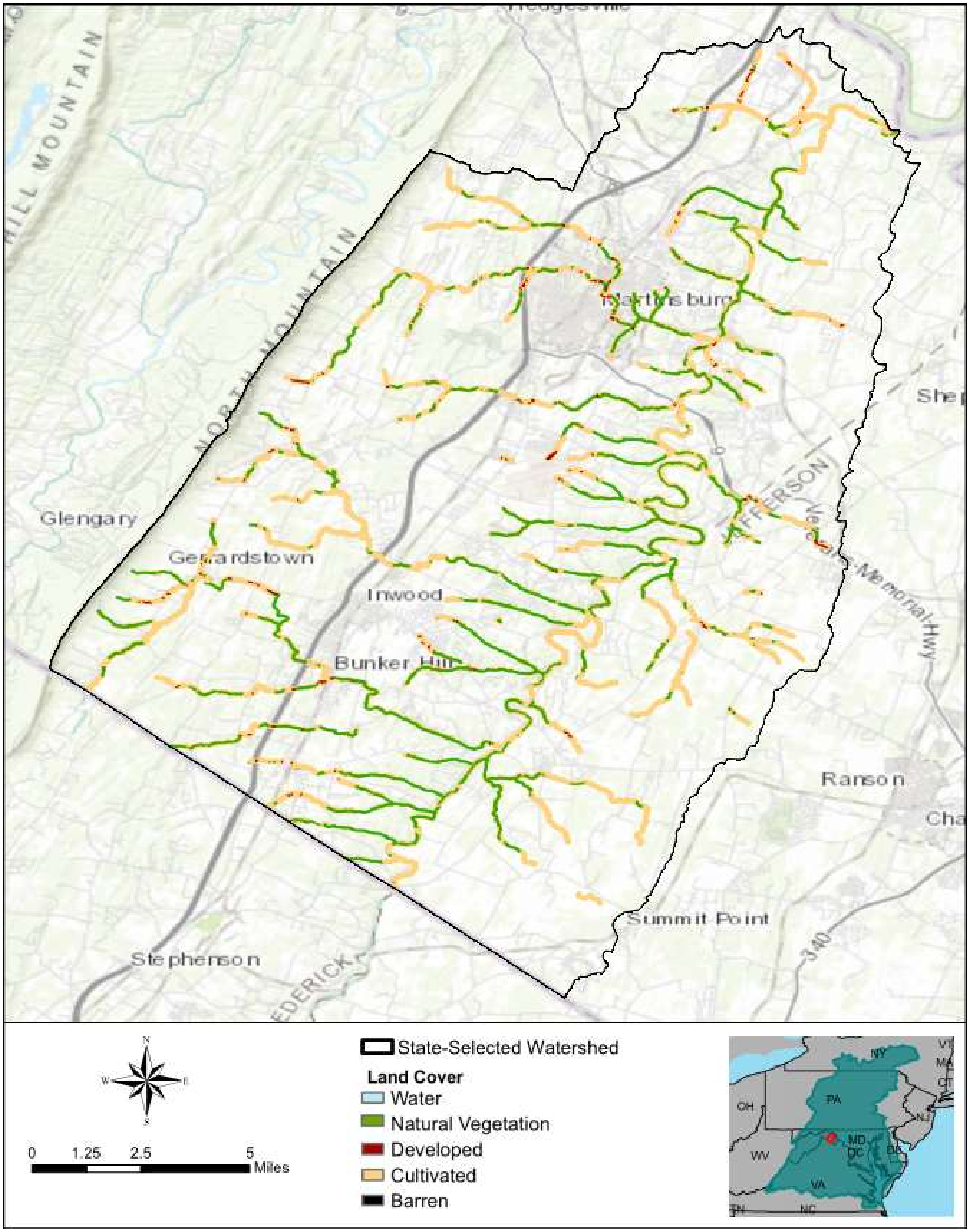

Figure 4 illustrates the land cover along streams within the Opequon Creek watershed. The data were obtained by creating a 30 meter buffer of the stream centerlines and determining the land cover within that buffer (Chesapeake Conservancy 2016). For visualization purposes, the buffer land cover data were consolidated into four groups: (1) commercial, residential, or paved; (2) forest or scrub-shrub; (3) agriculture; and (4) grass and barren land cover. Stream miles of each land cover classification were computed using the USA Contiguous Albers Equal Area Conic U.S. Geological Survey projection to ensure that miles were not skewed by the projection of the dataset. The full breakdown of land cover along the streams of the Opequon Creek watershed is summarized on

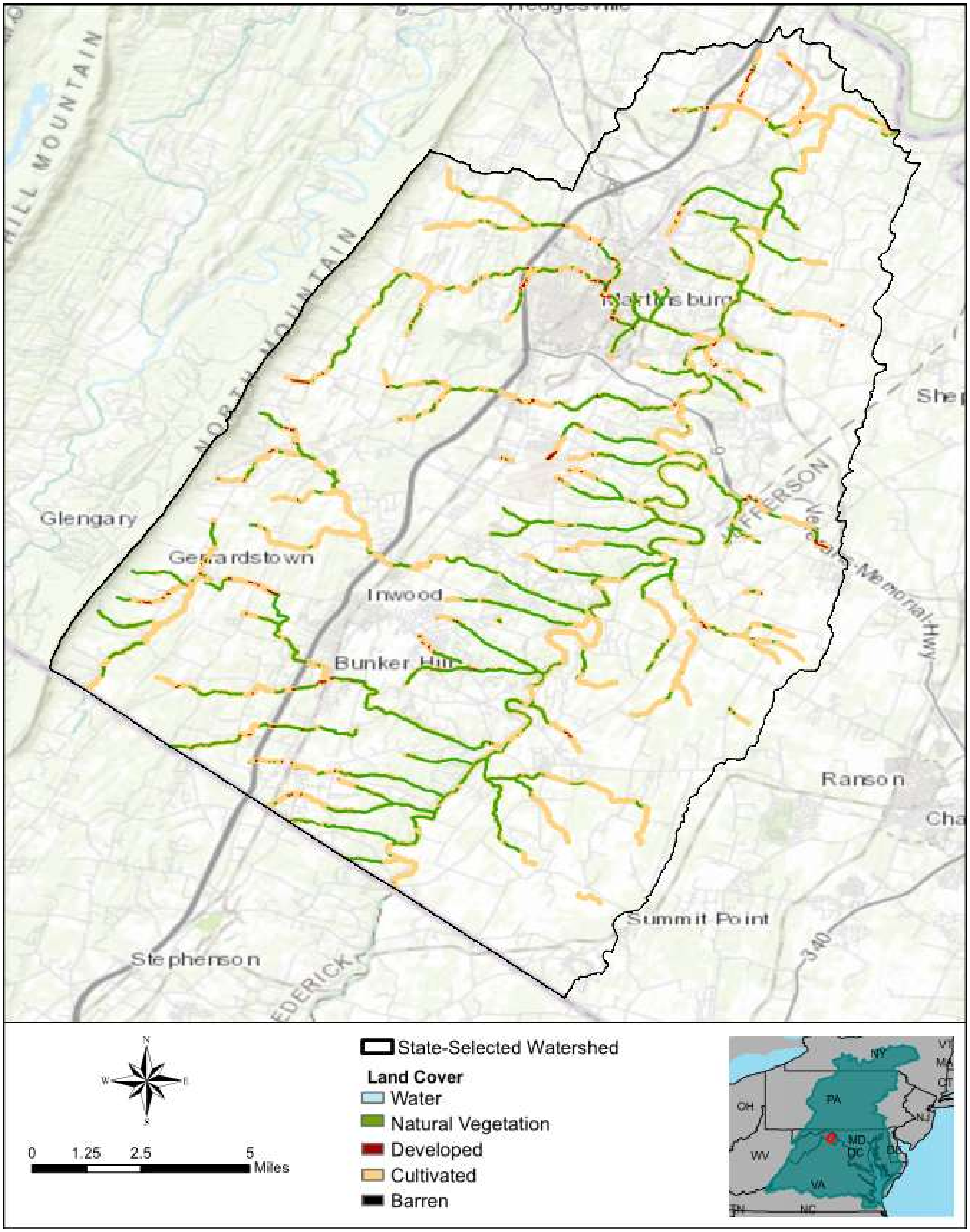

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Figure 4. This analysis reveals that only 58 percent of the total riparian area is forested. Agricultural lands comprise a large percentage of the land along the streambanks of Opequon Creek.

Land cover practices and natural hydrogeologic and soil conditions result in high nitrogen and phosphorous yields in this area of Chesapeake Bay (WVDEP 2005). Because a large percentage of the Opequon Creek watershed is karst, nutrients applied for agricultural purposes are easily transmitted to groundwater and emerge as contaminated surface water (WVDEP 2005). Septic systems, wastewater treatment plants, or other urban sources are also major contributors to nutrient loads. Furthermore, troglodytic (nitrogen-fixing) bacteria are likely another contributor to the nitrogen load by converting atmospheric nitrogen to water-soluble nitrate within the watershed (WVDEP 2005).

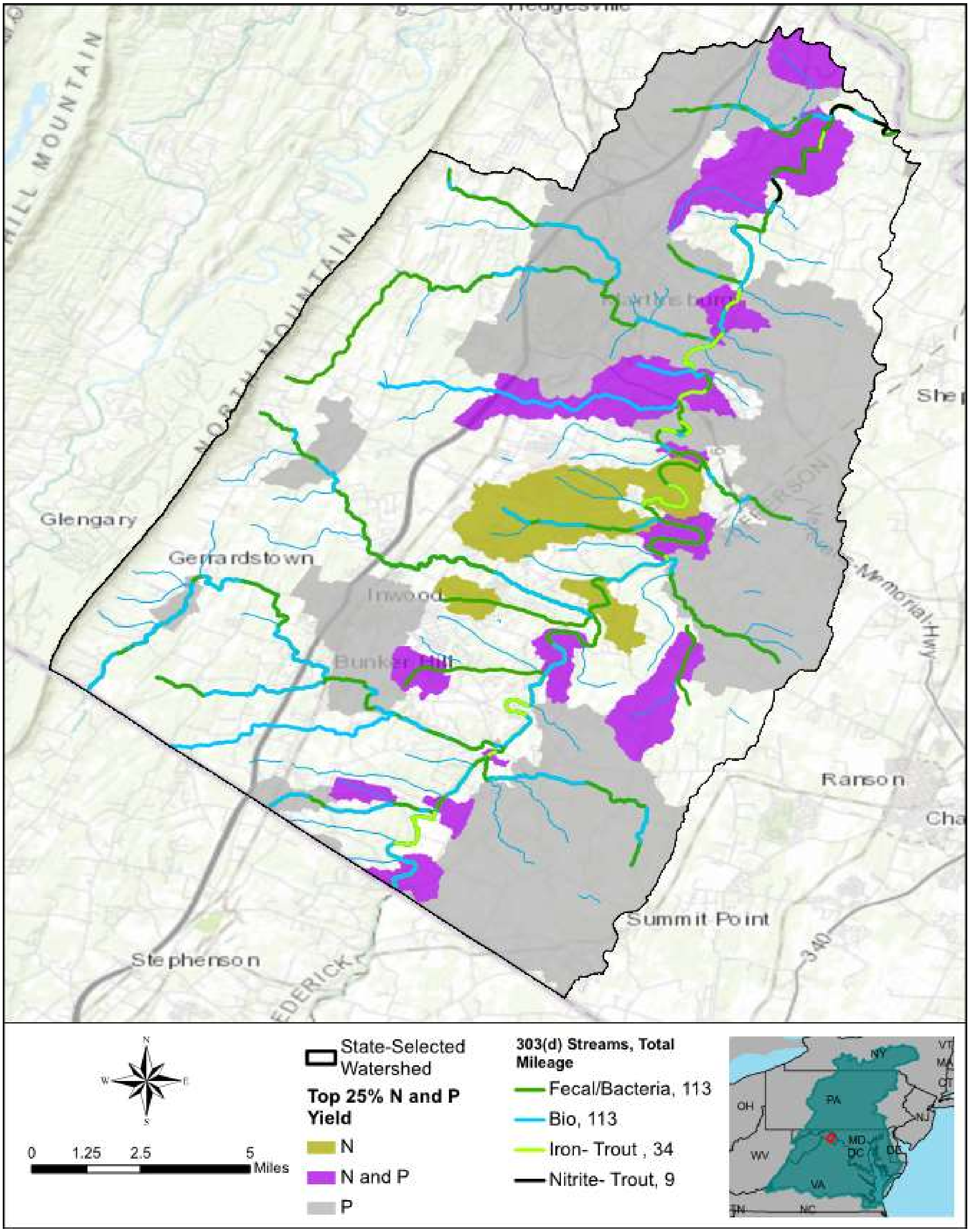

Figure 5 displays the top 25 percent nitrogen and phosphorous concentrations predicted from SPARROW output provided in the Chesapeake Bay baywide analysis (USACE 2017b).

Understanding the sources and dynamics of nitrogen and phosphorous loadings within the watershed can help identify appropriate management measures.

As illustrated on **Figure 6**, loadings of nitrogen and phosphorous in the Opequon Creek watershed have resulted in impairments for nutrients based on EPA's 303(d) list. In addition to nitrogen and phosphorous impairments, waterbodies within the Opequon Creek watershed are impaired for biological impairments, including fecal coliform, and iron (**Attachment B**). Many of these areas of impaired streams are also areas of game fisheries as listed by the West Virginia Department of Natural Resources (WVDNR) high quality streams list, which were identified based on native or stocked populations of trout and warm water streams five or more miles in length with desirable fish populations utilized by the publics (WVDNR 2004). **Figure 6** was generated by displaying data from West Virginia's 303(d) impaired waters list (WVDEP 2014, 2018a) with the information classified by data layer's detailed cause of impairment. This information was overlain with WVDNR's high quality streams list (WVDNR 2004). Therefore, **Figure 6** illustrates the locations where impaired conditions most affect aquatic and fish habitat.

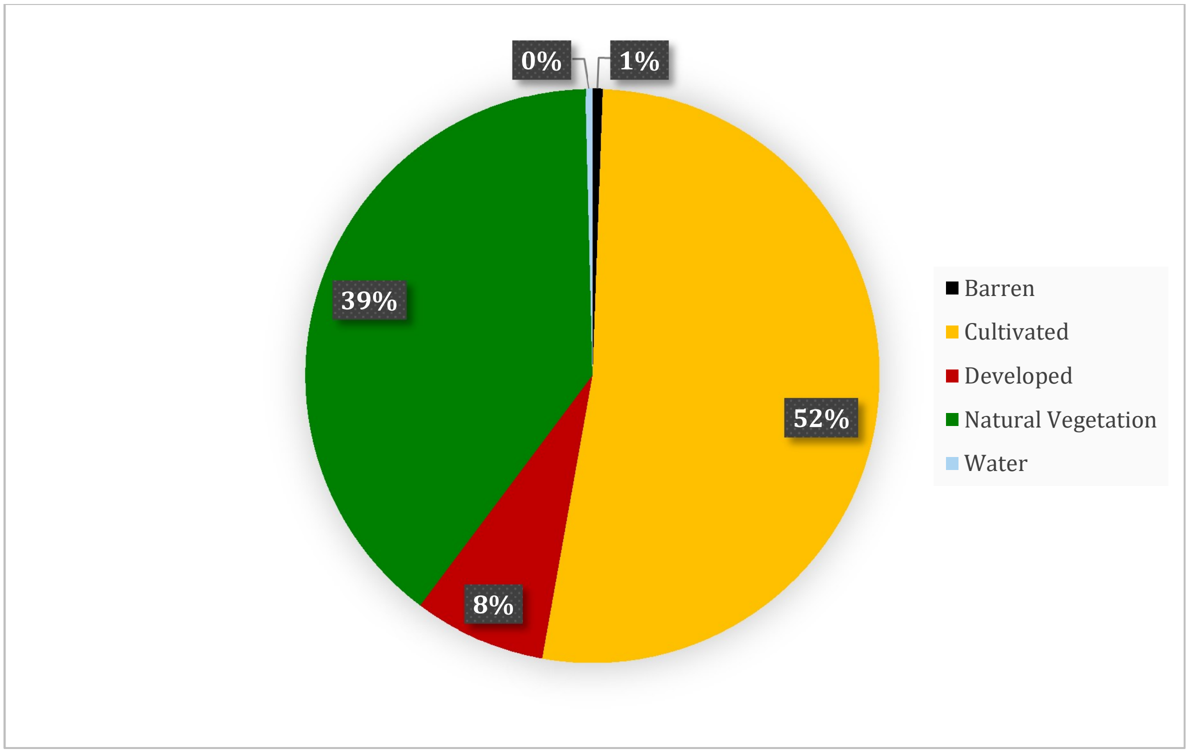

Figure 2. Opequon Creek watershed land cover (Chesapeake Conservancy 2016)

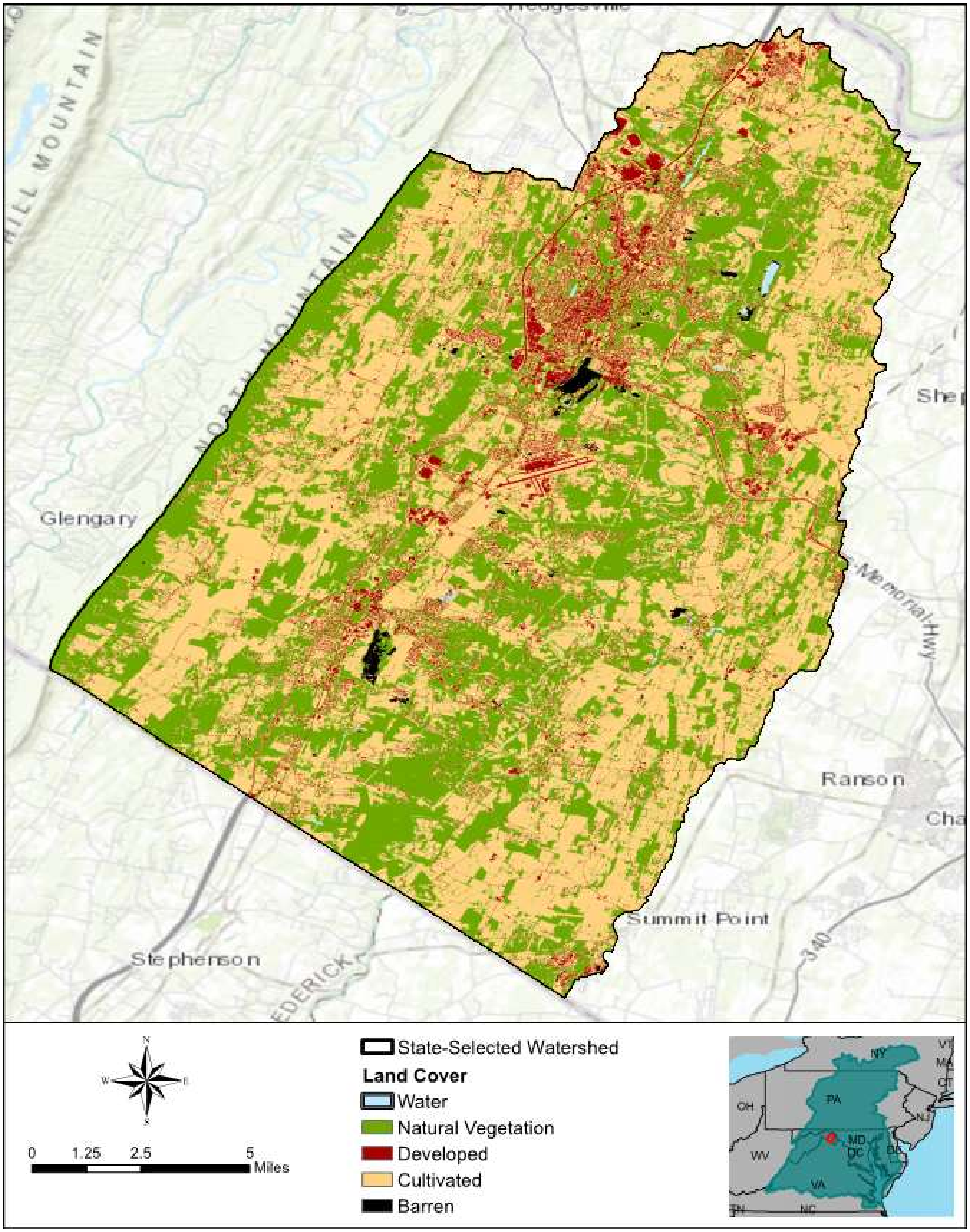

Figure 3. High resolution land cover data in the Opequon Creek watershed (Chesapeake Conservancy 2016)

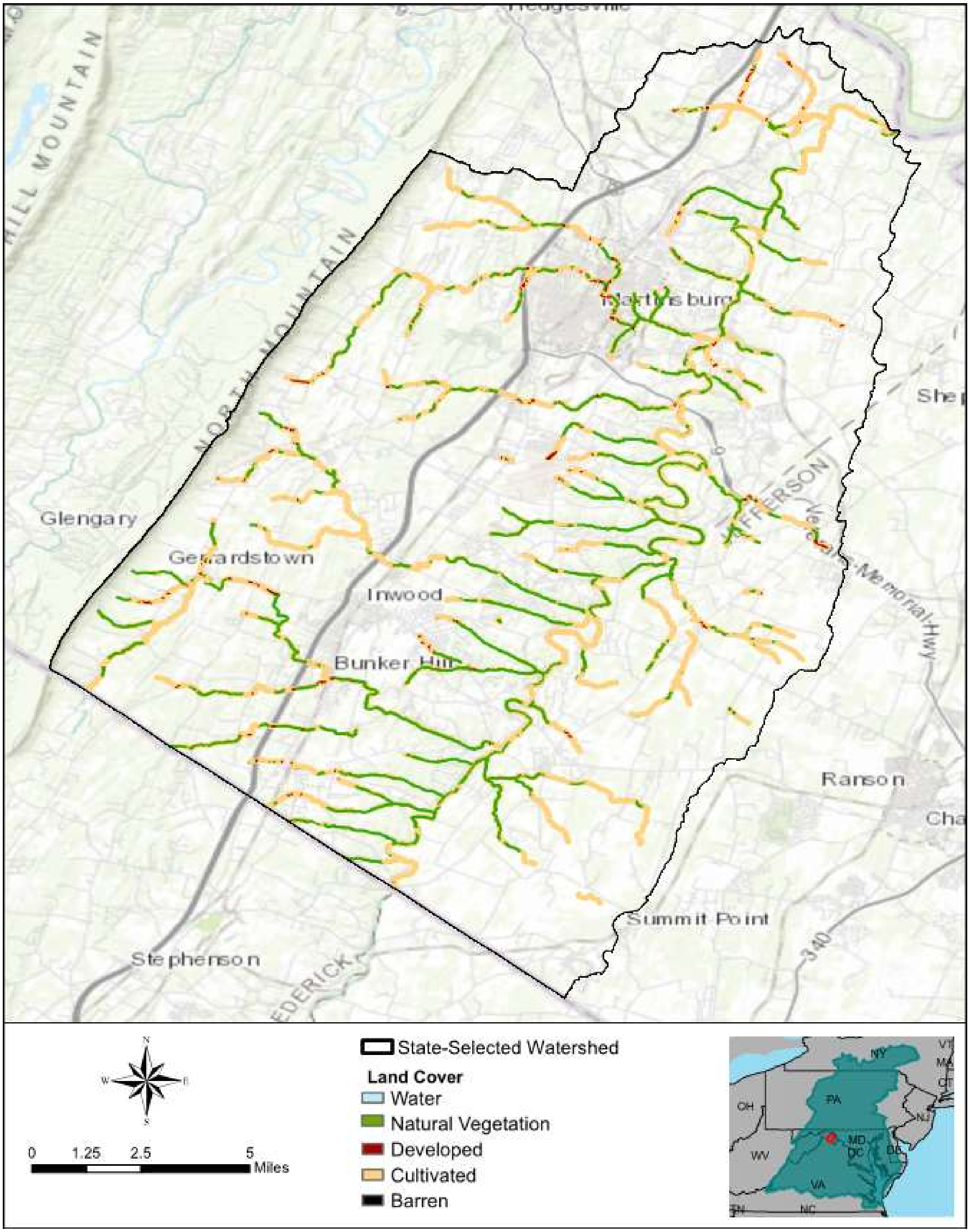

Figure 4. Riparian land cover in the Opequon Creek watershed (Chesapeake Conservancy 2016; U.S. Geological Survey [USGS] 2017)

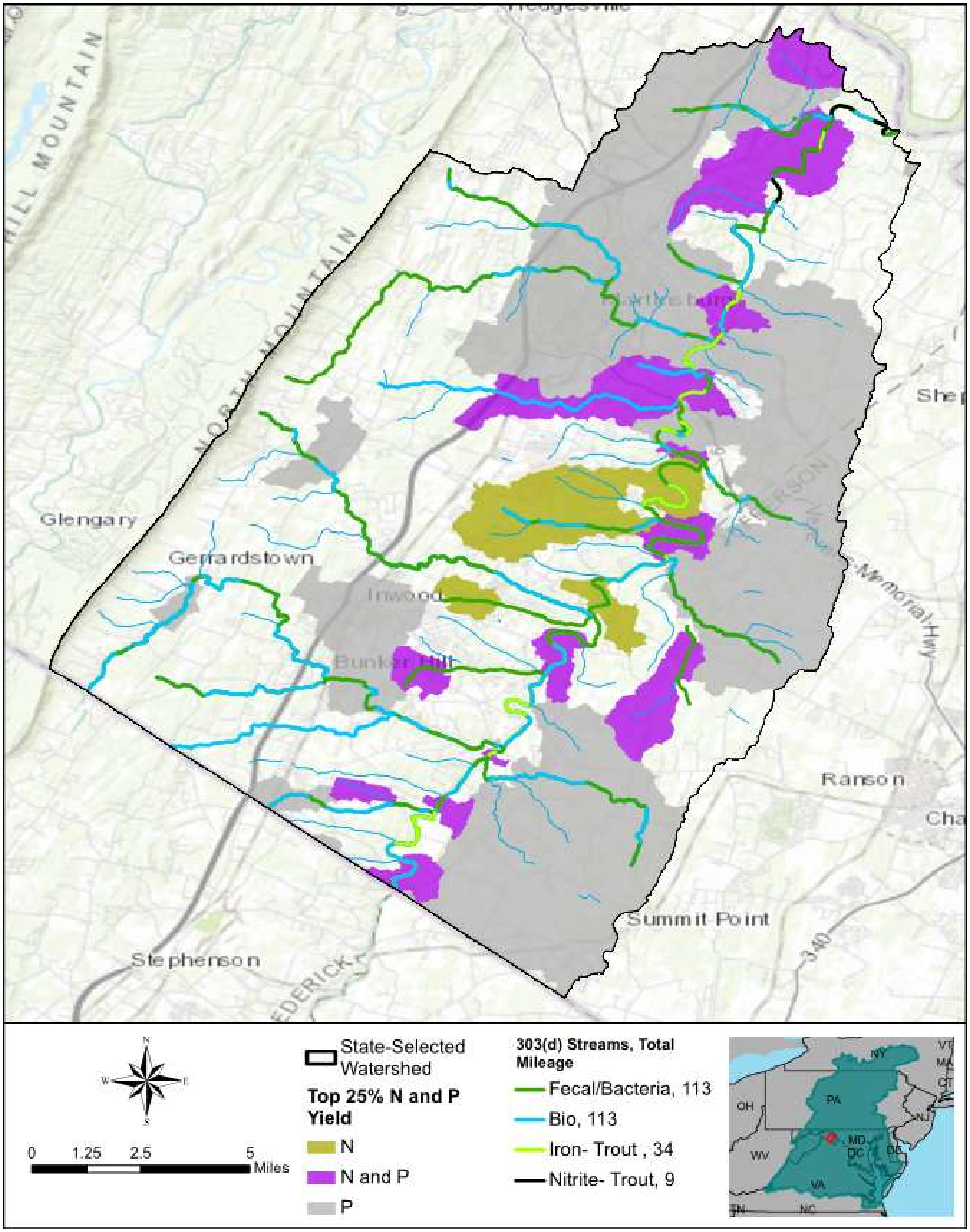

Figure 5. Total nitrogen and phosphorous yield estimates from SPARROW output with 303(d) impaired streams (USACE 2017; WVDEP 2014, 2018a)

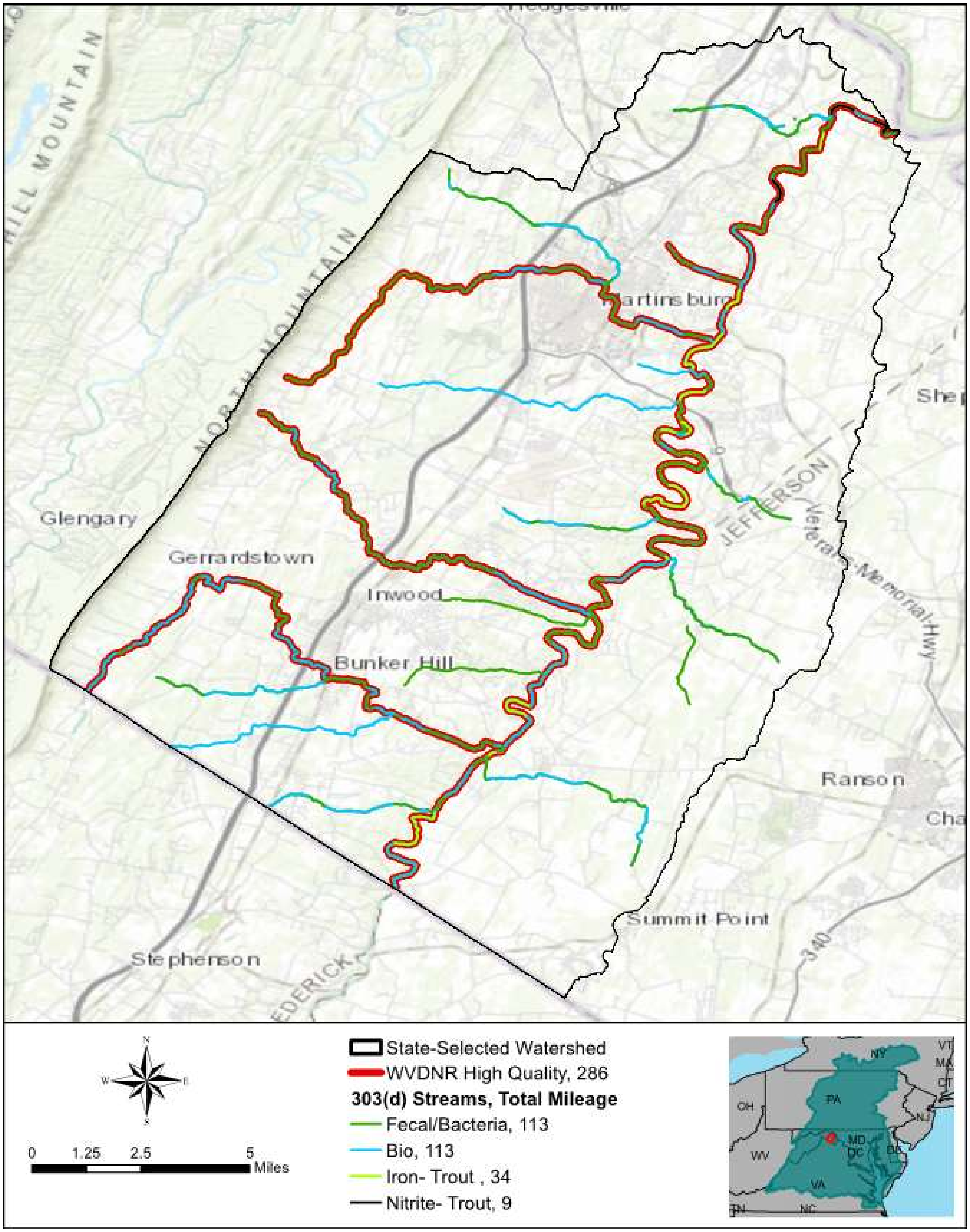

Figure 6. 303(d) impaired streams designation overlain with WVDNR high quality streams (WVDEP 2014, 2018a; WVDNR 2004)

The Chesapeake Bay baywide analysis also highlighted the Opequon Creek watershed as an area subject to nontidal threats. This includes flooding, future projected development, and areas at high risk of fish habitat degradation (USACE 2017c). These threats can have adverse impacts on wetlands, particularly when wetlands cannot build elevation at a rate to keep pace with increased flood depths and frequency. Future development also contributes to increased rainfall runoff and encroaches on riparian buffer regions.

In summary, there are several problems and needs in the Opequon Creek watershed, including:

- High nutrient loading and poor water quality
- Stream impairments for biological, fecal coliform, nutrients, and metals
- Loss of wetlands
- Lack of riparian buffers

Several projects have been completed or are planned to address some of these problems and needs within the watershed.

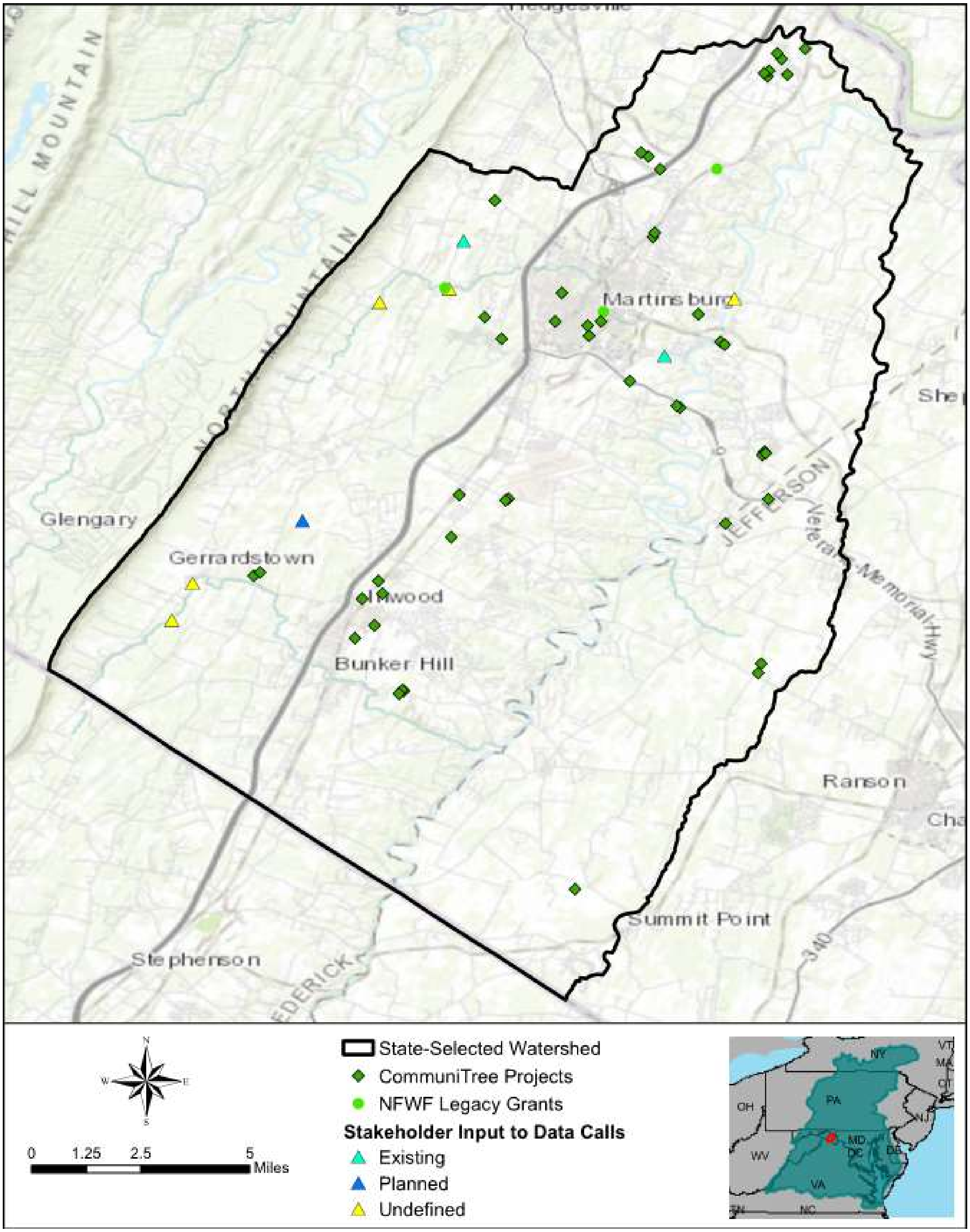

Figure 7 shows the existing, ongoing, or planned projects along with National Fish and Wildlife Foundation (NFWF) grants within the Opequon Creek watershed. Additionally, the Carla Hardy West Virginia Project CommuniTree is a volunteer-based project that has conducted many plantings within the Opequon Creek watershed shown in **Figure 16.** This analysis of the Opequon Creek watershed will avoid the duplication of ongoing efforts and activities within the watershed.

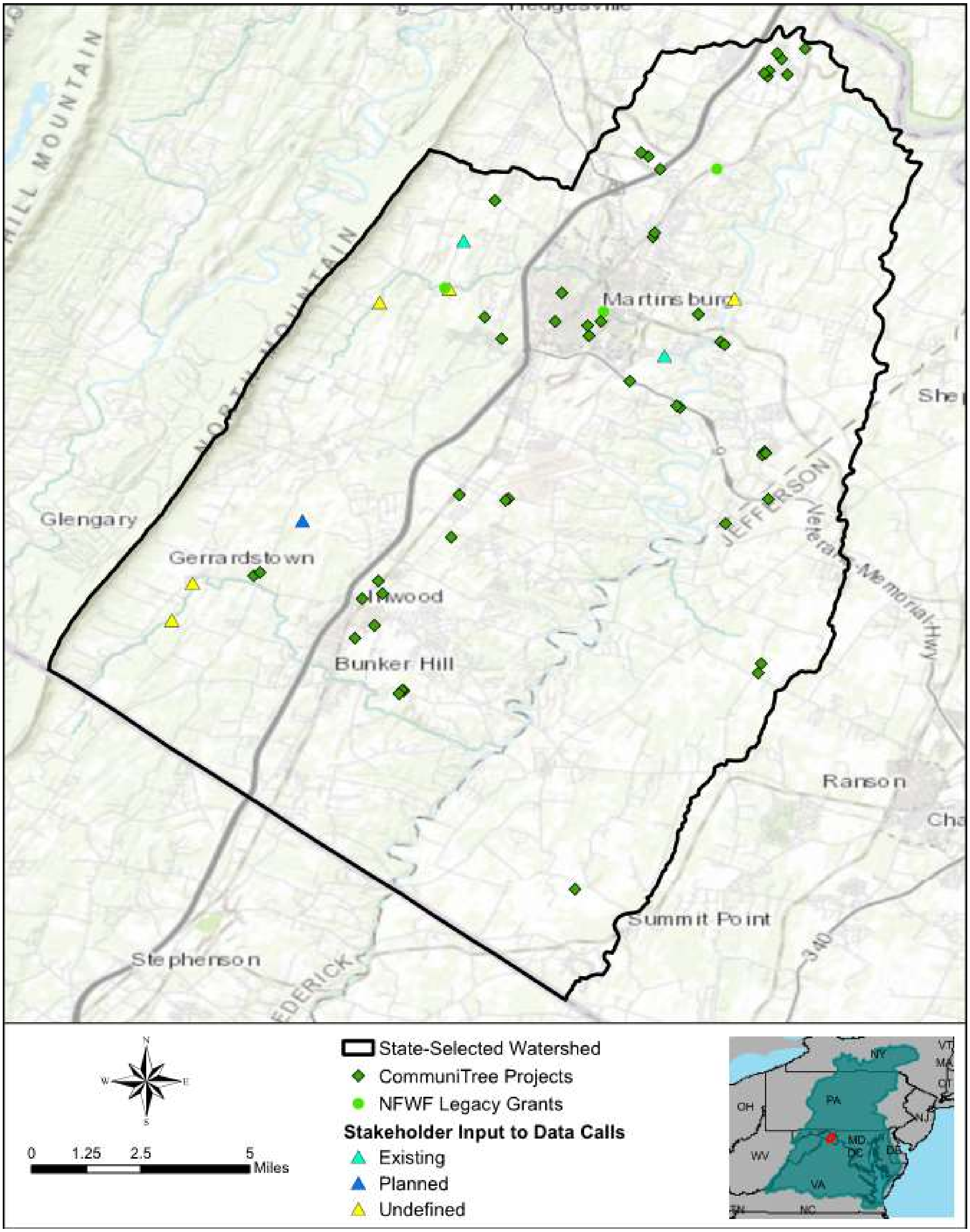

Figure 7. Existing and ongoing projects in the Opequon Creek watershed

3.2 Opequon Creek Watershed Opportunities

There are several measures that can be implemented to restore ecosystems and address problems and needs within the watershed. Several activities are underway by state and federal agencies to improve ecosystem health within the Opequon Creek watershed. This section discusses some restoration activities to consider for future investigation and planning. Information is provided for each restoration measure based on available data, including existing projects, ongoing studies, or completed projects within the watershed.

3.2.1 Riparian Buffers

3.2.1.1 Summary of the Riparian Buffer Need

Riparian buffers can provide water quality and habitat benefits throughout the watershed. Riparian buffers can help clean water by preventing pollutants, nutrients, and sediment loads from entering waterbodies and assist with stabilizing streambanks (USACE 2015). In addition to providing habitat restoration benefits, restored riparian buffers can also serve flood risk management benefits (USACE 2015). The 2014 Chesapeake Bay Watershed Agreement goals target restoration of 900 miles per year of riparian forest buffer and conservation of existing buffers in the Chesapeake Bay until 70 percent of the riparian areas in the watershed are forested (USACE 2015). Based on the high-resolution land cover data (Chesapeake Conservancy 2016) evaluating the main stem of the Opequon Creek, only 58 percent of the riparian buffers are forested, with another 28 percent classified as planted/cultivated. Of the 28 percent of planted/cultivate lands, approximately 12 percent is grass/pasture land presenting some opportunity to restore forested riparian buffers.

Due to high agricultural land cover within the Opequon Creek watershed,

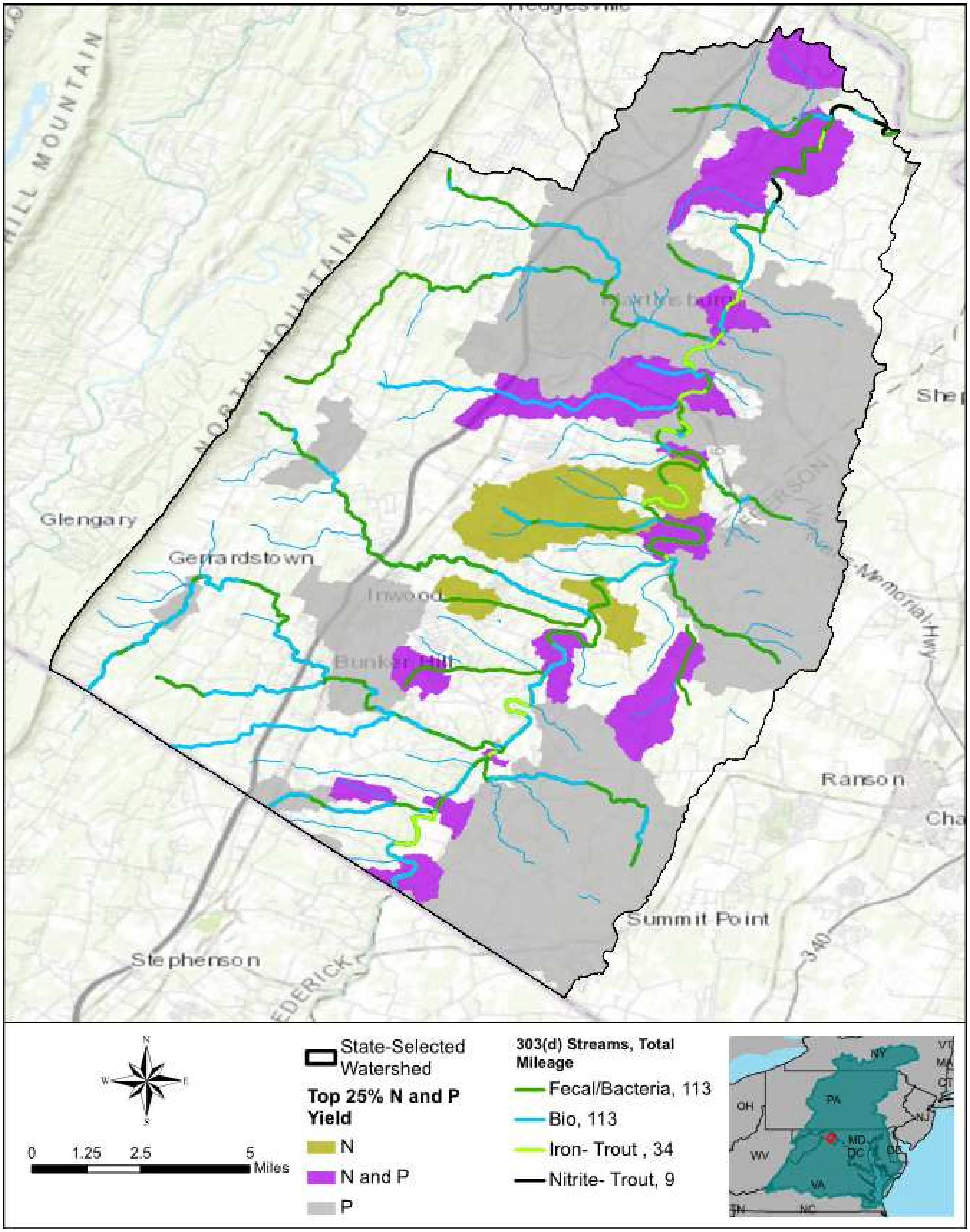

Figure 5 highlights the high nutrient loading within the Opequon Creek watershed. Riparian buffers may help manage nutrient and other pollutant loadings to the receiving waters of the Opequon Creek.

3.2.1.2 Existing and Ongoing Riparian Buffer Projects

Based on correspondence with stakeholders, numerous riparian buffer restoration efforts have been conducted along the mainstem of Opequon Creek and its tributaries. Several CommuniTree project areas are illustrated on

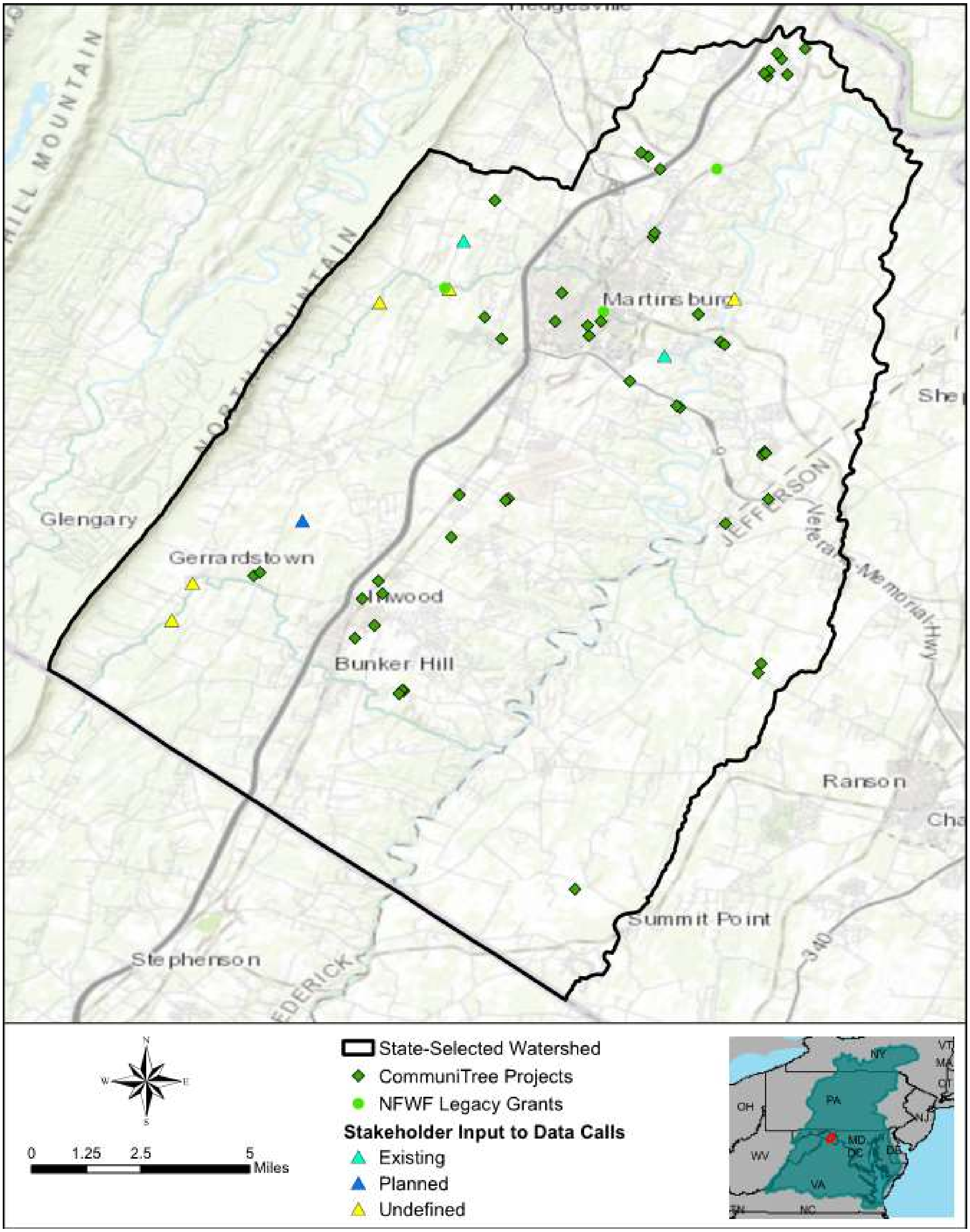

Figure 7.

3.2.1.3 Riparian Buffer Restoration Opportunities

With only 58 percent forested riparian buffer areas in the watershed and several stream impairments for nutrients, biological impairments, and metals, there are opportunities for restoring riparian buffers along Opequon Creek and its tributaries.

Using the land cover classification map, combined with the predicted top 25 percent nitrogen and phosphorus loadings, areas with grass, scrub, and agriculture were identified for riparian buffer restoration. Restoring riparian buffers in these categories of land cover along the streambanks makes up an additional 11 percent of the watershed. Conversion of these categories of land cover would nearly meet the 70 percent forested recommended goal. Executing riparian buffer restoration in residential, developed, and agricultural areas likely would be more challenging.

3.2.1.4 Riparian Buffer Restoration Costs

There is a wide range of potential riparian buffer vegetation restoration costs. The U.S. Forest Service has revegetated riparian buffers for as low as $800 per acre (2017 U.S. dollars), whereas the *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers* (Palone and Todd 1997) cost estimates can be up to $6,200 per acre in 2017 U.S. dollars. This higher estimate includes site preparation, tree seedlings, maintenance and additional plantings, shelters, fencing, herbicide treatment, and mowing.

Assuming a 30 meter buffer along the Opequon Creek, the cost to restore 818 acres of riparian buffers in the areas currently designated as scrub, grass, or agriculture within the predicted top 25 percent nitrogen and phosphorus areas could cost between $950,000 and $31.7 million U.S. 2017 dollars.

3.2.1.5 Riparian Buffer Implementation Barriers

Land ownership is a significant implementation barrier. For cultivated land, getting acceptance from farmers to forest a 30 meter buffer around a river may be a challenge. Installation of riparian buffers on public lands may be easier than on private land.

There also may be geomorphic limitations to the installation of riparian buffers. For steep streambanks, additional streambank stabilization measures or stream restoration measures may be required to reconnect a stream or river to its floodplain and restore its banks to be able to support the added vegetation.

Funding can be a major implementation barrier to restoring riparian buffers, especially given the wide range of cost to restore areas. Federal assistance programs for these types of projects may be limited or inflexible.

3.2.2 Wetland Restoration

3.2.2.1 Summary of the Wetland Restoration Needs

Wetlands provide water quality and habitat benefits within a watershed (USACE 2015). The 2014 Chesapeake Bay Watershed Agreement goals highlight reestablishing 85,000 acres of tidal and nontidal wetlands and enhancing the function of an additional 150,000 acres of degraded wetlands by 2025 (USACE 2015). As part of the 2014 Chesapeake Bay Watershed Agreement goals, wetlands were also areas targeted for additional land conservation by 2025 (USACE 2015).

Wetlands provide habitat to fish, birds, mammals, and invertebrates. Wetlands also can provide flood risk reduction benefits and help with soil retention.

Within the Opequon Creek watershed, 82 percent of the land cover is natural vegetation, with most of the land cover being cultivated agricultural land (see

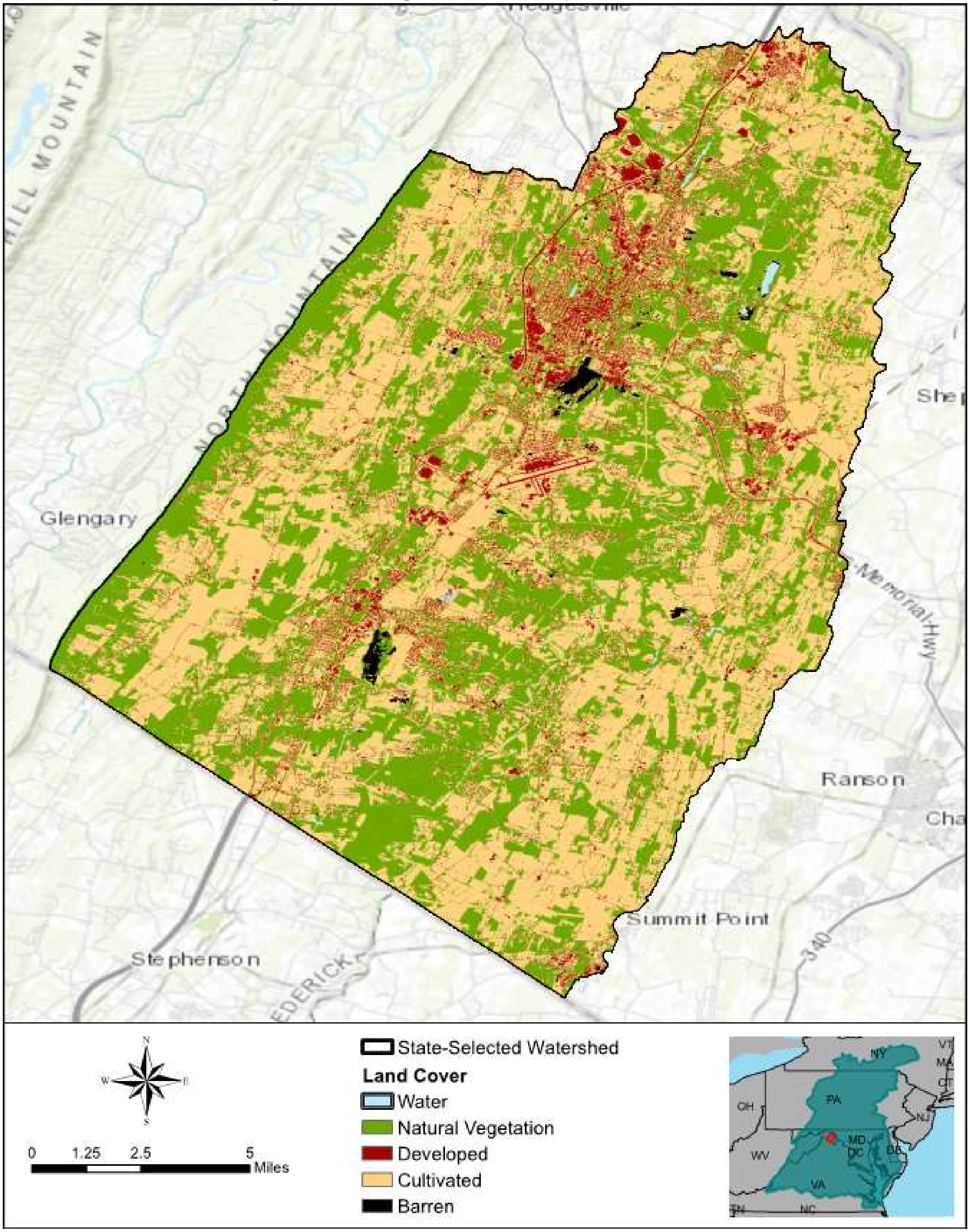

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Figure 3). There has been a decline in wetland areas in the Opequon Creek watershed likely due to increased nutrients and development.

3.2.2.2 Existing and Ongoing Wetland Restoration

Although wetland restoration may be taking place as part of stream restoration projects, there are no known independent wetland restoration efforts in the Opequon Creek watershed.

3.2.2.3 Wetland Restoration Opportunities

The USACE Non-Tidal Wetland Restoration Opportunities (USACE 2017a) data layer was refined to identify wetland restoration opportunity areas within the Opequon Creek watershed, as illustrated on

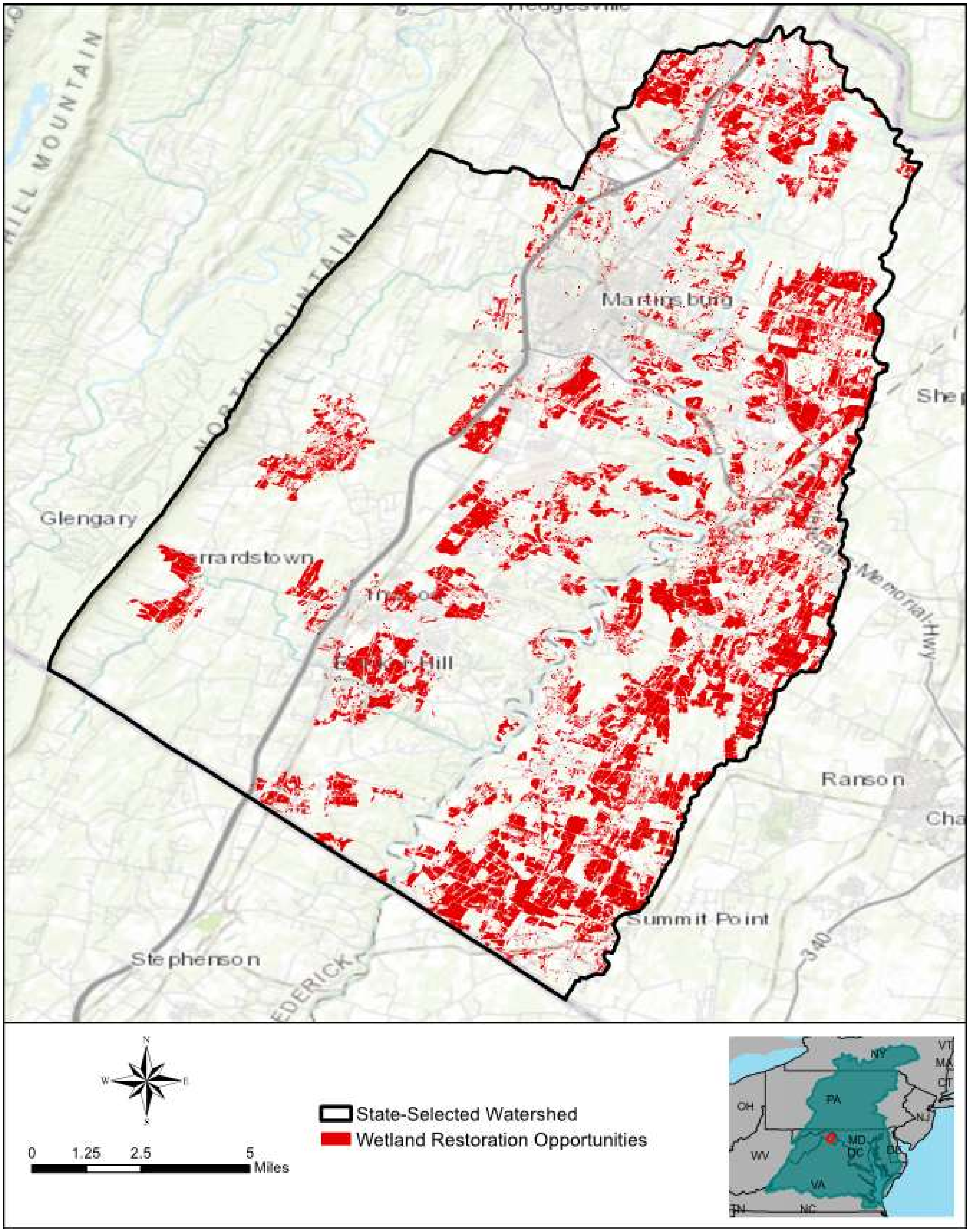

Figure 8. The Wetland Opportunities data layer was generated considering land cover, hydrology, and soil characteristics to identify potential wetland restoration areas. The Chesapeake

Conservancy high resolution land cover dataset (2016) was used to refine the wetland opportunities data layer by removing any impervious area from consideration as an area for restoration. Areas of development also were eliminated from consideration as defined by the USDA national cropland dataset (USDA 2017). The ecological network model from the Landscape Ecological Assessment of the Chesapeake Bay Watershed (Chesapeake Bay Resource Land Assessment [RLA] 2004) was used to remove ecological hubs and corridors from the wetland opportunities layer to further refine potential wetland restoration areas. Ecological hubs contain one or more terrestrial or aquatic hub areas and are bounded by major roads or an anthropogenic land cover classification of greater than 100 meters (RLA 2004). Ecological corridors represent the best ecological connection between hubs (RLA 2004). Gaps in ecological hubs or corridors represent areas that could be targeted for potential wetland restoration. This geospatial analysis resulted in an identified 23,753 acres of land within the Opequon Creek watershed. Additional restoration efforts may be required in areas where invasive species exist.

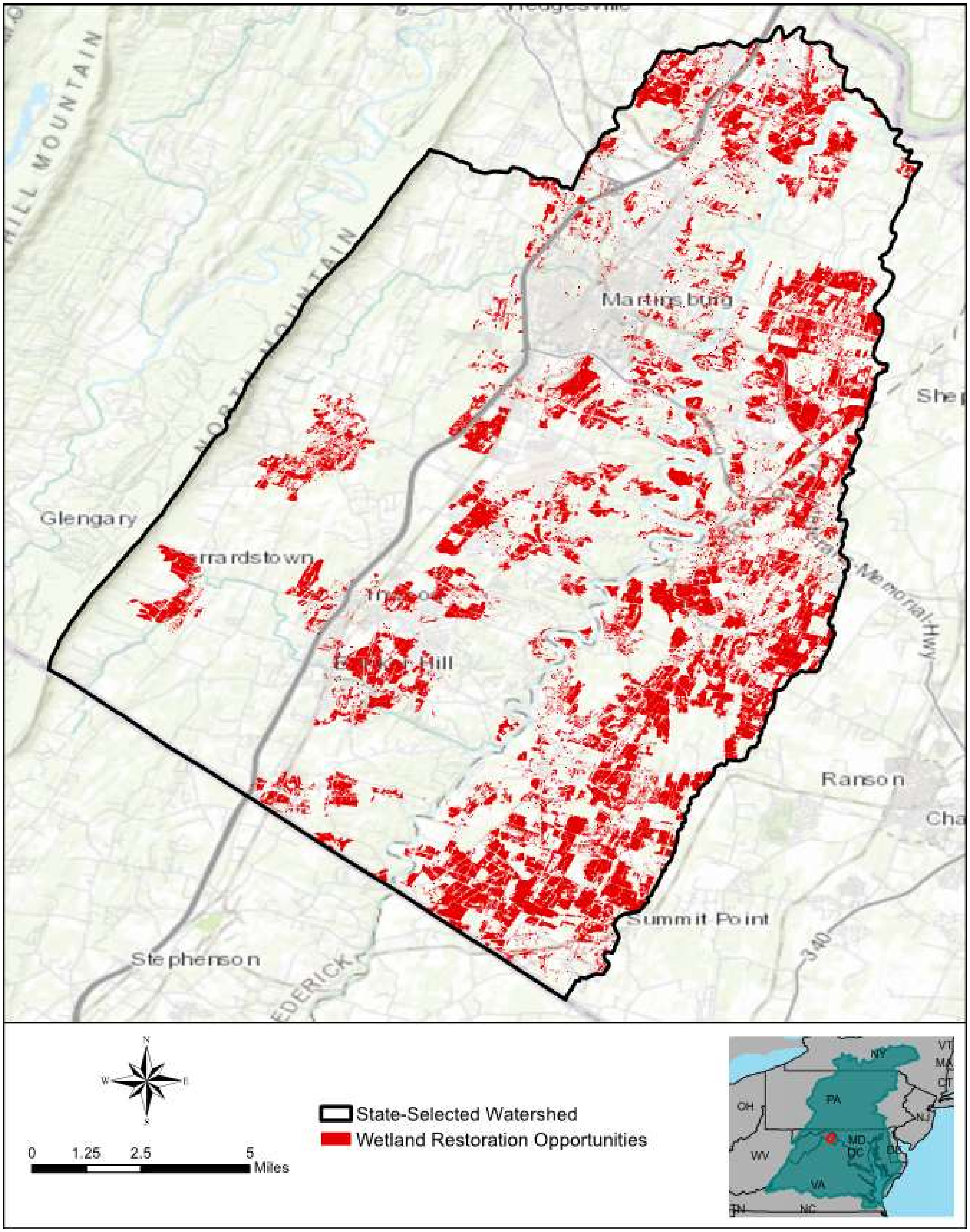

Figure 8. Wetland restoration opportunities (RLA 2004; USACE 2017; and USDA 2017)

3.2.2.4 Wetland Restoration Costs

There is a broad range of potential costs for wetland restoration. Wetland restoration costs can range from approximately $16,000 to $178,000 per acre in U.S. 2017 dollars. Based on the total 23,753 acres of potential restoration area identified, wetland restoration could cost between $380 million and $4.3 billion in U.S. 2017 dollars. Additional analysis and feasibility studies would need to be conducted to better define wetland restoration opportunities and priorities and to consider implementation barriers.

3.2.2.5 Wetland Restoration Implementation Barriers

Implementation barriers to wetland restoration include development in potential wetland migration areas, land ownership, accessibility, and invasive species. Accessibility becomes important for monitoring and maintenance as well as restoration implementation. Funding is another limitation for wetland restoration projects, with several agencies that may be available as potential partners.

3.2.3 Stream Restoration and Streambank Stabilization

3.2.3.1 Summary of the Stream Restoration and Streambank Stabilization

Streambanks within the Opequon Creek watershed have been subject to historic erosion (WVDEP 2005; WVDEP et al. 2008, 2013).

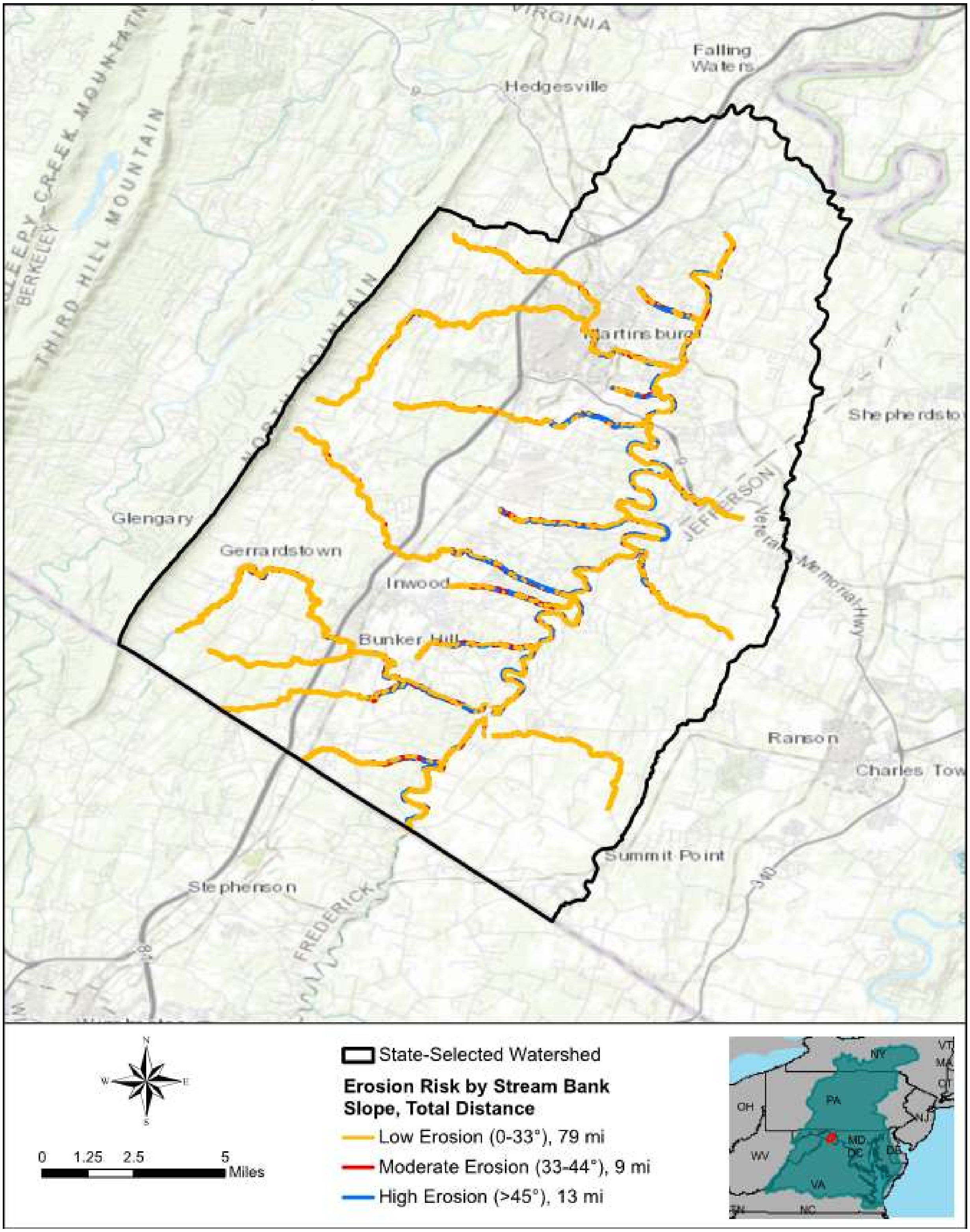

Figure 9 displays the streambank erosion risk based on streambank angle. This figure was created by evaluating the streambank angle from a 3 meter digital elevation model (DEM) within a 40 meter buffer of the stream centerline (USGS 2017).

The long history of conversion of the landscape to support agriculture to support agriculture, urban and suburban development, and use of the waterways for commerce and hydropower have resulted in fish passage blockages, eroding stream banks, the trapping of large quantities of sediment behind dams, and the disconnection of streams from their floodplains.

Although no fish blockages were present in the Opequon Creek watershed from the Chesapeake Bay baywide data. Additional assessment is necessary to identify fish passage issues. The *Watershed Based Plan for Mill Creek* (WVDEP et al. 2008) identifies the need for culvert improvements and dam removal. Furthermore, several streams in the watershed are classified as high-quality streams for fish habitat (WVDNR 2004).

3.2.3.2 Existing and Ongoing Stream Restoration and Streambank Stabilization Projects

Within the Opequon Creek watershed, the WVDEP, the Canaan Valley Institute (CVI), and the Opequon Creek Project Team have supported stream restoration and streambank stabilization projects. A dam removal project was completed on Tuscarora Creek (CVI 2016), and a streambank stabilization project was completed on Mill Creek (CVI 2009).

3.2.3.3 Stream Restoration and Streambank Stabilization Opportunities

Within the Opequon Creek watershed, opportunities exist for stream restoration to reduce sediment loads and restore fish passage, including dam removal and culvert improvements. However, a thorough stream restoration feasibility study is needed to fully identify and prioritize stream restoration opportunities within the watershed.

Analysis identified 13 miles of streambanks as high erosion areas where streambank stabilization may be a viable mitigation measure. As highlighted on

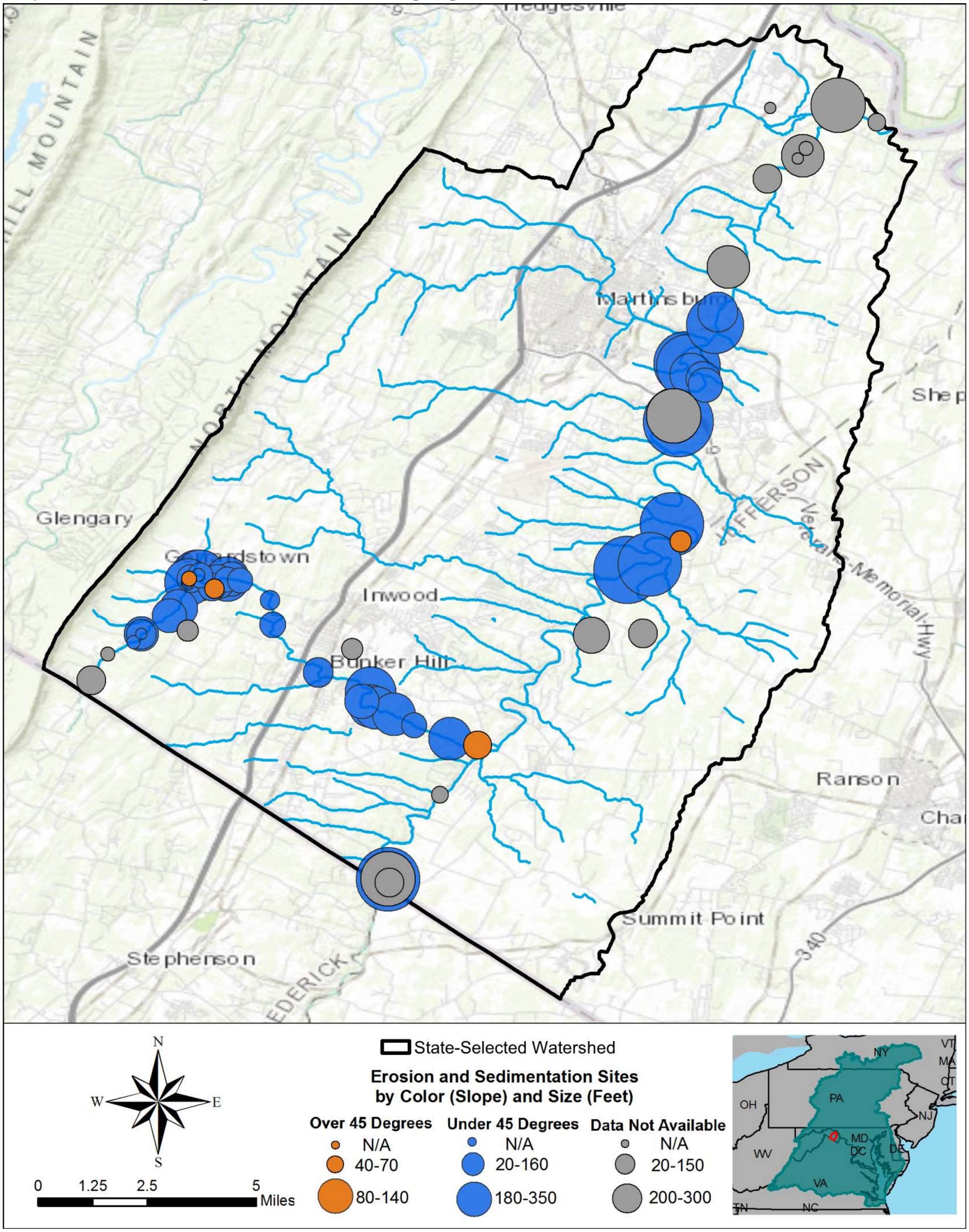

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Figure 10 and based on provided site visits and field surveys, 410 feet of streambanks are the highest priority. Further investigation would be required to confirm the most appropriate solutions in each of these areas. Streambank stabilization projects also help provide habitat for fish and other wildlife. Control of aggressive bank erosion within the Opequon Creek watershed can help improve water quality and may provide improved recreational space and opportunities.

3.2.3.4 Stream Restoration and Streambank Stabilization Costs

Stream stabilization costs are estimated at approximately $600 to $1,600 per linear foot. Using this estimate, restoration of the 410 feet of priority streambanks would cost approximately $246,000 to $656,000, and the 13 miles of high erosion areas would cost approximately $41 million to $110 million in U.S. 2017 dollars.

3.2.3.5 Stream Restoration and Streambank Stabilization Implementation Barriers

Funding is a major implementation barrier to implementing stream restoration and streambank stabilization. Land access and acquisition may be necessary in some instances to develop stream restoration and streambank stabilization projects, presenting a significant implementation barrier.

There are several implementation barriers to removing dam blockages, including willingness of the dam or blockage owner, funding, transportation and infrastructure limitations, potential for contaminated sediments, climate change risks, flood risk management impacts, and potential downstream impacts. However, there are opportunities to partner with state and local jurisdictions to remove fish blockages within the Opequon Creek watershed.

For improving stream crossings, there are similar implementation barriers, such as funding, disruption to traffic patterns, flood risk impacts, and potential downstream impacts. Similarly, there are opportunities to partner with other organizations to help receive funding and support restoration of streams through improvements of stream crossings and blockages.

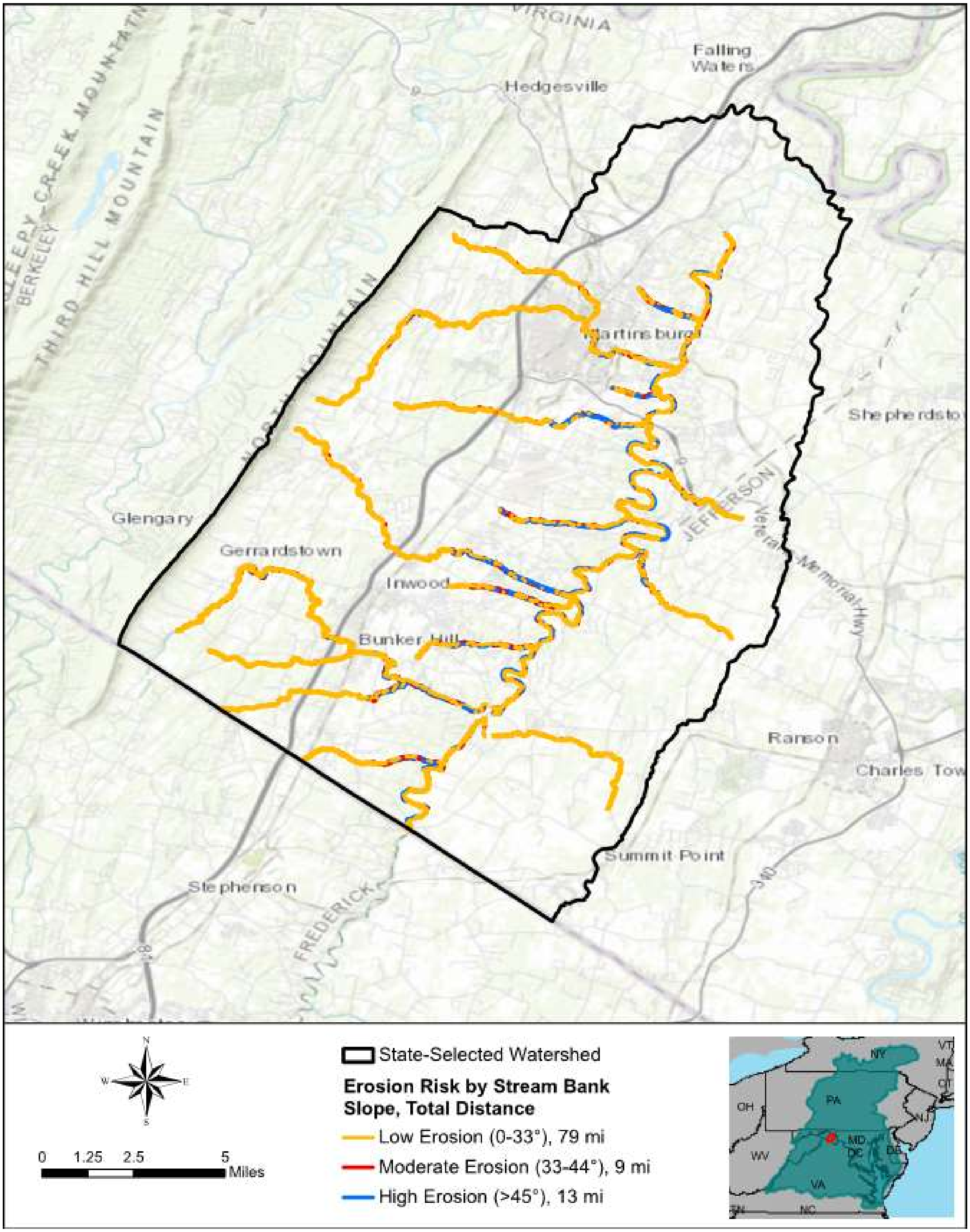

Figure 9. Erosion risk by streambank slope (USGS 2003, 2017).

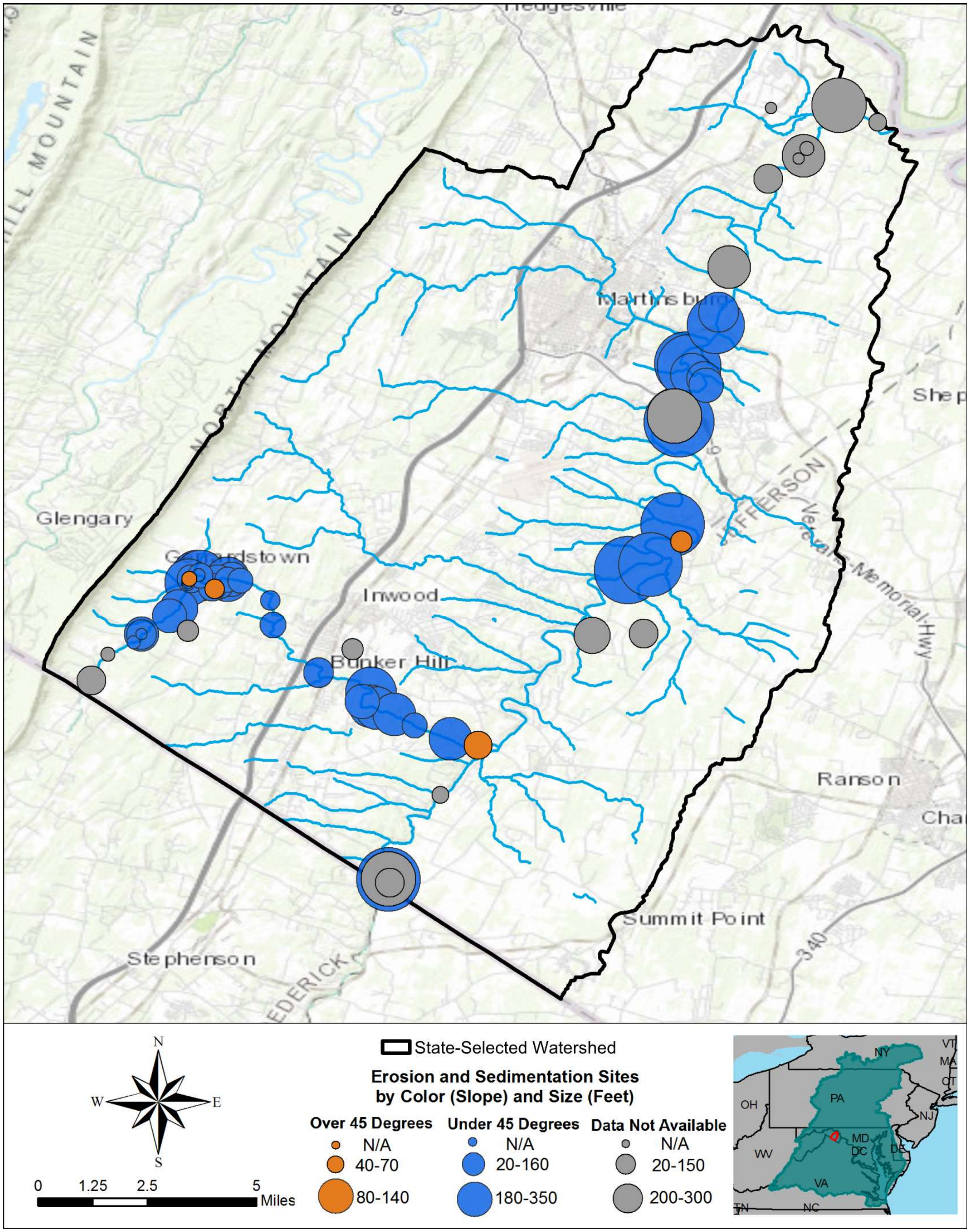

Figure 10. Erosion risk at assessed field sites (USGS 2003, 2017; WVDEP 2018b)

For stream stabilization projects, upland land cover and drainage patterns may be an implementation barrier to successful streambank stabilization. Additionally, climate change or varying streamflow patterns due to upland development may be barriers to successful streambank stabilization efforts.

3.2.4 Conservation Opportunities

As shown on **Figure** , this analysis identified riparian buffer and wetland conservation opportunities. The riparian buffer conservation areas are derived from the forested areas with a 30 meter buffer of streams in the watershed overlain with the most intact areas from the *Important Habitats Component of Nature's Network* dataset (North Atlantic Landscape Conservation Cooperative [NALCC] 2017). The wetland conservation areas are derived from wetland restoration areas (

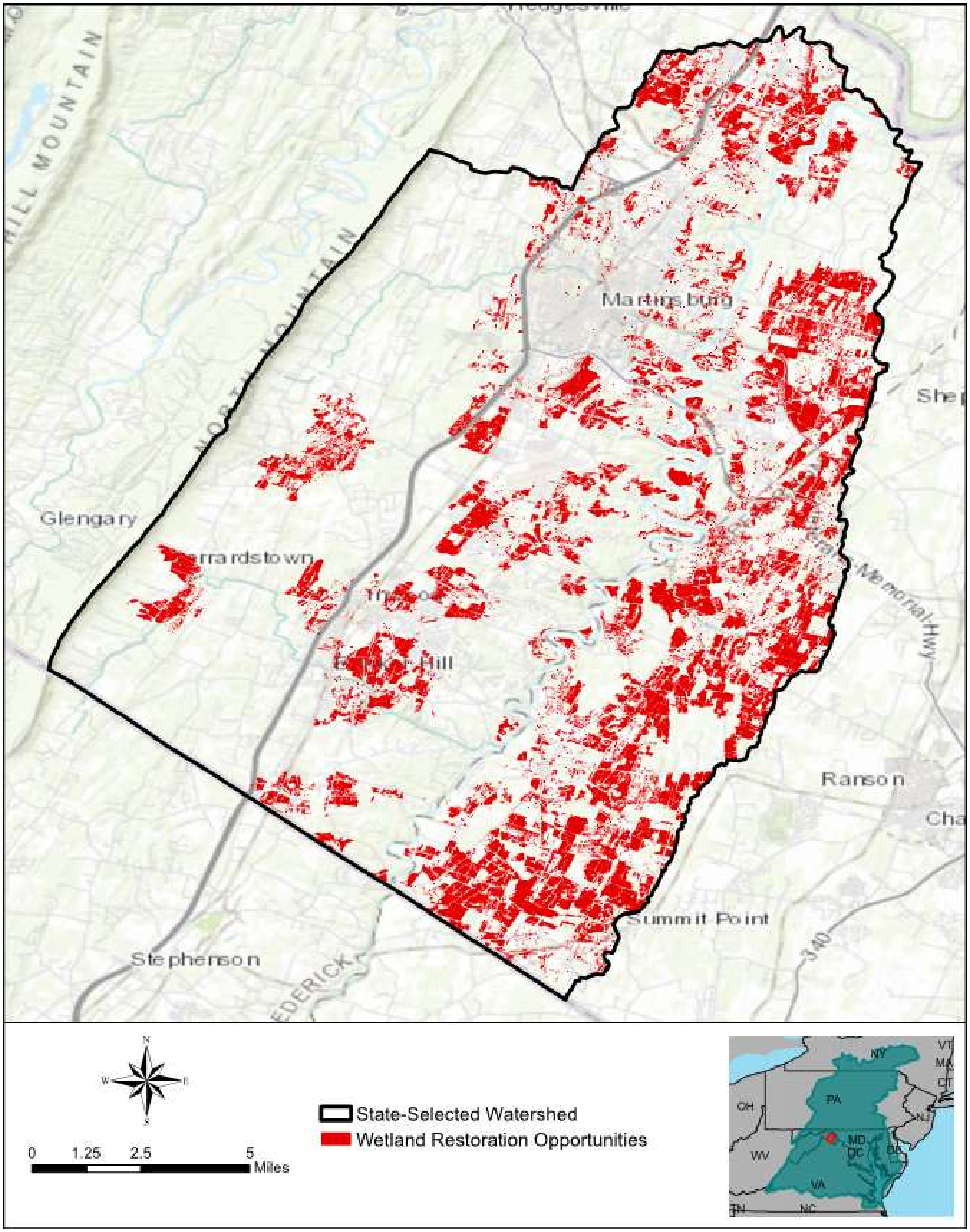

Figure 8) overlain with the most intact areas from the *Important Habitats Component of Nature's Network* (NALCC 2017).

The West Virginia Conservation Reserve Enhancement Program (CREP) has helped landowners plant streamside buffers, establish buffers, protect eroding lands, and create wildlife habitat. This program would be a source of support for future conservation opportunities. CREP, administered through WVDNR, authorizes the state to purchase easements to establish conservation areas for protecting natural resources and improving water quality (WVDNR 2007).

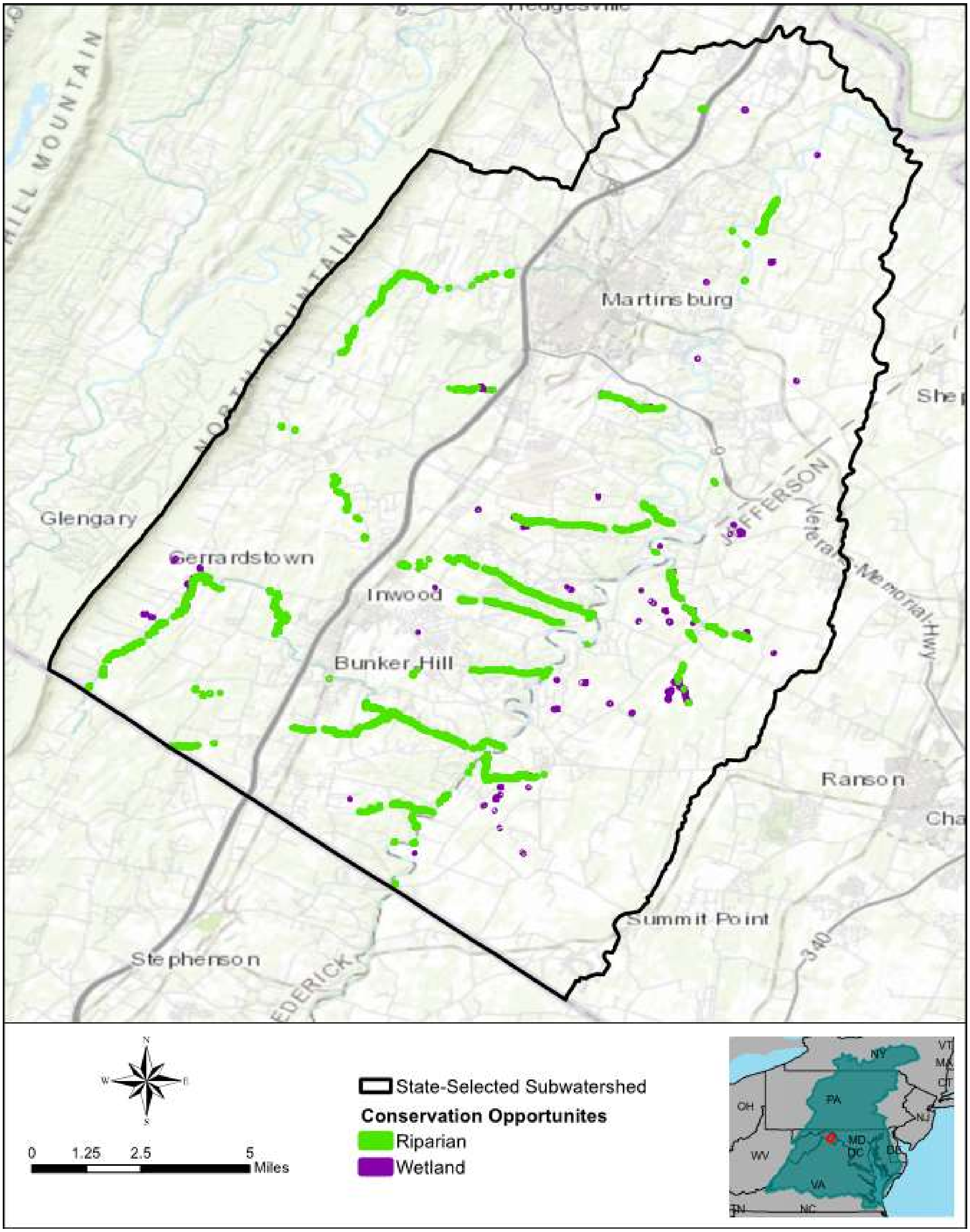

Figure 20. Conservation opportunities (NALCC 2017; USACE 2017; USDA 2017; USGS 2017)

3.2.5 Other Restoration Opportunities

Additional restoration opportunities include agricultural best management practices (BMPs) to help reduce nutrient loading to receiving waters. Some types of BMPs include cover crops, enhanced nutrient management, soil conservation, water control structures, manure transport, and waste management for the agricultural sector. With such a large portion of the Opequon Creek watershed's land cover in the agricultural sector and the high loading of nutrients into Opequon Creek and its tributaries, as illustrated on

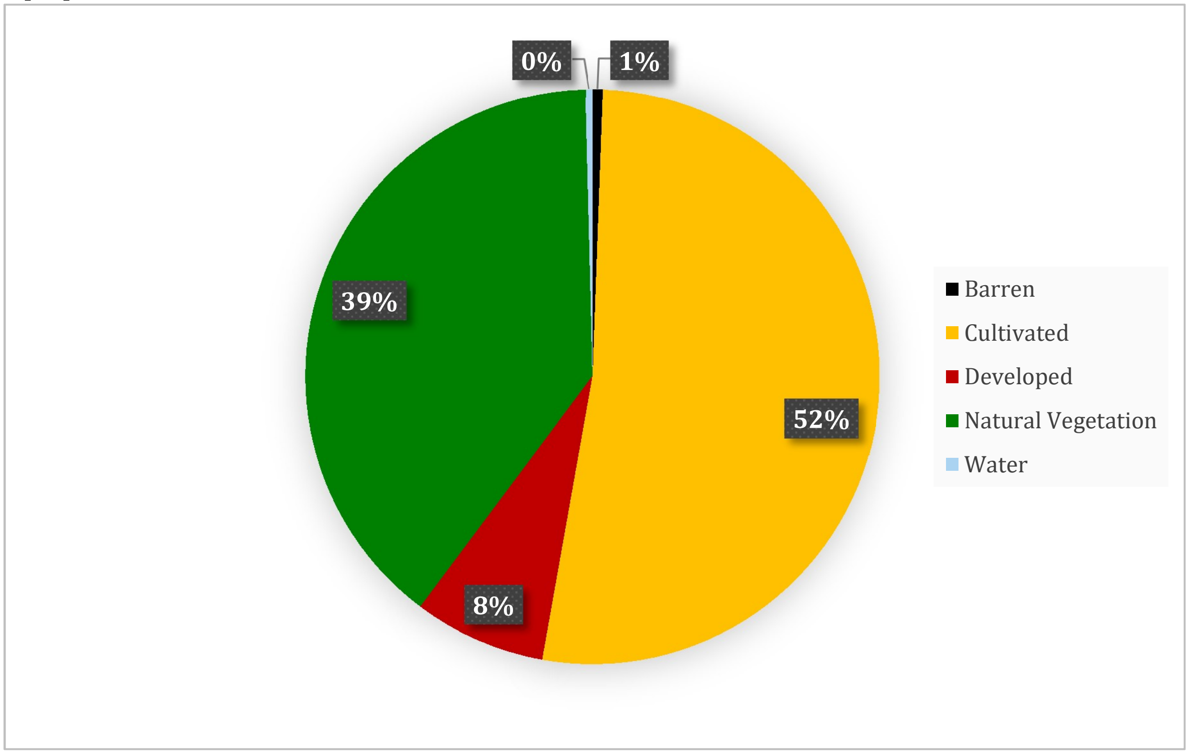

Figure 2 and

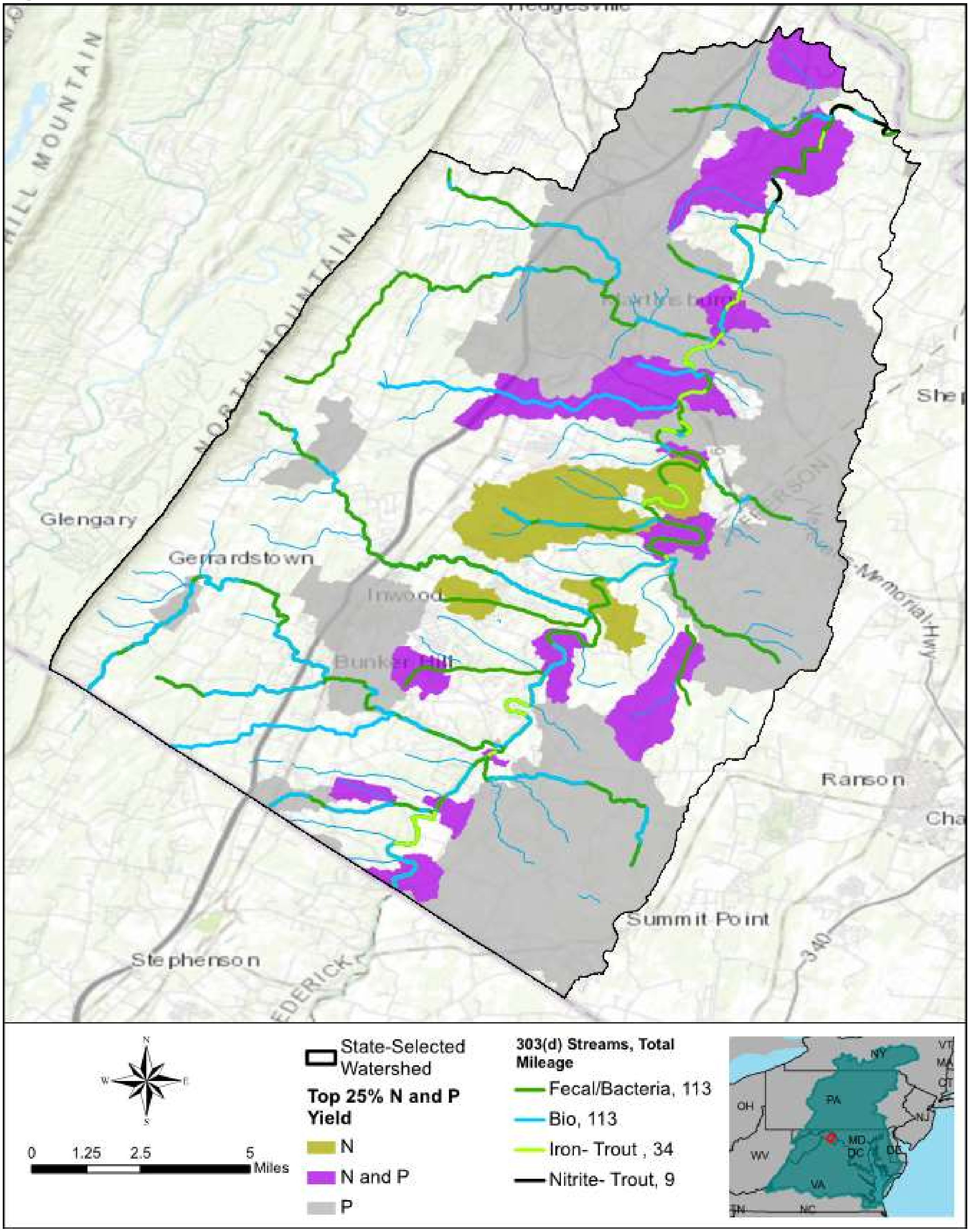

Figure 5, agricultural BMPs are an important restoration activity for the Opequon Creek watershed.

Furthermore, restoration opportunities exist for reducing pollutant loads from failing septic systems in the Opequon Creek watershed. These septic systems have been shown to fail vertically, carrying nutrients and other pollutants to the water table below and ultimately to the waterbodies of the watershed. Wastewater treatment plant capacity currently exists to treat additional wastewater; however, engineering planning and design support is needed to develop the infrastructure to convey wastewater to the treatment plants.

Finally, based on stakeholder input, restoration opportunities exist for green infrastructure projects in developing areas of the Opequon Creek watershed, especially within the Interstate (I)-81 corridor. Existing municipal separate storm sewer system (MS4) programs may be able to provide additional details on current or potential project sites and partnership opportunities. Green infrastructure projects could be designed to provide habitat restoration and connectivity in addition to rainfall runoff reduction and water quality treatment capacity.

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Section 4

Summary

The Opequon Creek watershed, located in the West Virginia portion of the Chesapeake Bay watershed, contains valuable ecological resources and fish habitat and is of interest because of high nutrient loads. These loads originate from multiple sources such as failing septic systems, agricultural land use, and urban development. The watershed is largely agricultural in land cover but has seen expanding development in the I-81 corridor near Martinsburg. This analysis and study focused on the portions of the Opequon Creek watershed within West Virginia.

The Opequon Creek watershed has experienced ecosystem problems, including loss of wetland habitat. The banks of the Opequon Creek have experienced areas of high erosion. These problems stem from several sources, including high nutrient loading from runoff and groundwater sources, land use patterns, stream impoundments and stream crossings that inhibit habitat movement, development, and increased temperatures.

Several measures have been identified to help restore the Opequon Creek watershed, with many efforts currently underway.

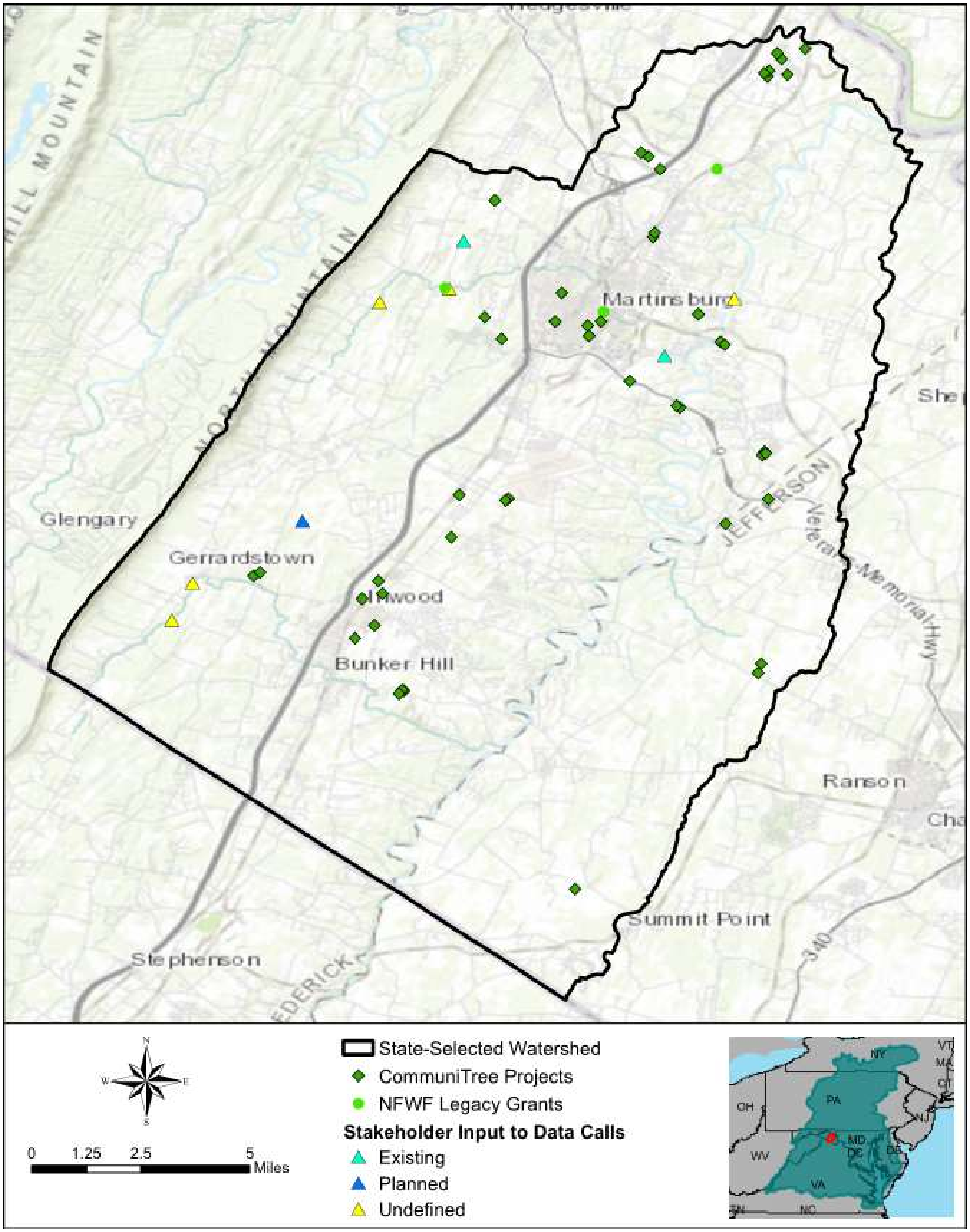

Figure 7 summarizes many of the restoration activities completed or ongoing within the watershed to restore ecosystems and improve ecological health within the Opequon Creek watershed.

Additional restoration opportunities identified within the Opequon Creek watershed include streambank stabilization, re-establishment of riparian buffers, wetland restoration, removal of stream barriers and blockages, agricultural BMPs, green infrastructure, and wastewater system improvements. In addition to these restoration activities, areas prioritized for conservation have been identified within the watershed, with many local and state programs in place to help fund and support the conservation such as WVDNR's CREP. **Figure 11** summarizes the restoration and conservation opportunities identified within the Opequon Creek watershed. The priority streambank stabilization markers designate surveyed erosion and sedimentation field sites with streambank angles greater than 45 degrees (**Figure 19**). The streambank stabilization opportunities represent reaches where the estimated streambank angle is greater the 45 degrees within a 40-meter buffer of the stream based on the USGS 3-meter DEM as described in Section 3.2.3.1. **Table 1** lists conservation and restoration activities and their recommended prioritization, highlighting any limitations or conditions required for success. All opportunities are located within the Opequon Creek subwatershed (0207000409).

The sequencing of these restoration and conservation activities is important. Some of the wetland stressors may need to be addressed and mitigated prior to the design and implementation of additional restoration activities. Addressing the nutrient loads from agriculture and wastewater management systems via agricultural BMPs and design-build projects would benefit the design of wetland restoration and riparian buffer restoration toward water quality improvement.

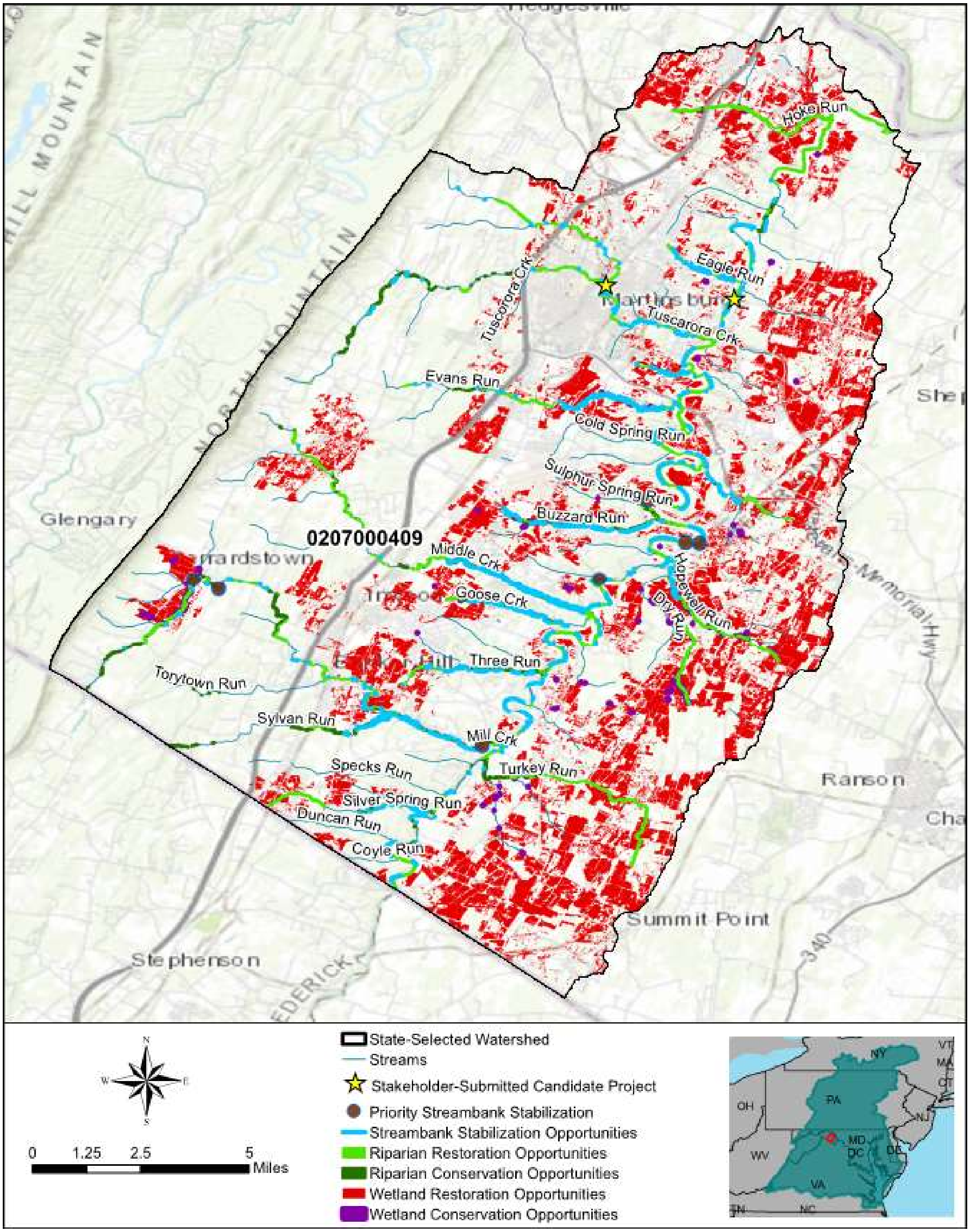

Figure 11. Restoration and conservation opportunities in the Opequon Creek watershed

Table 1. Summary of Opequon Creek restoration and conservation activities

Suggested Prioritization	Activity	Quantity	Details
1	Agricultural BMPs	Not computed	Implementation of agricultural BMPs will help realize improvements in ecosystem health throughout the watershed, which will aid in restoration of vegetation and habitat throughout the watershed. Agricultural nutrients contribute to stressors in the watershed, and addressing these stressors will be critical prior to taking on other restoration opportunities.
2	Wastewater Management Systems Improvements	Not Computed	Improvements to failing septic systems and expanding wastewater conveyance systems will help realize improvements in ecosystem health throughout the watershed. Wastewater nutrients and biological contaminants contribute to stressors in the watershed, and addressing these stressors is critical to restoring the habitats in the watershed.
3	Conservation	443 acres	Several potential conservation areas have been identified within the Opequon Creek watershed. Further investigation is needed to identify conservation areas with programs like WVDNR's CREP available to support the conservation of these areas.
4	Stream Restoration	13 miles	Streambank stabilization and restoration projects were identified as a need within the Opequon Creek watershed from geospatial analysis and stakeholder input. Areas of high erosion along Opequon Creek and its tributaries could be targeted for streambank stabilization and restoration. A thorough stream restoration feasibility study is needed to fully identify and prioritize stream restoration opportunities within the watershed. Restoration efforts would help retain soil and restore functionality of the stream for habitat and wildlife.
5	Riparian Buffer Restoration	25 Miles	Riparian buffers provide multiple benefits in the watershed, including shoreline stabilization and habitat creation, and provide water quality benefits to adjacent streams by preventing pollution from entering the waterways. Several riparian buffer opportunities were identified within the Opequon Creek watershed, on the mainstem, and along tributaries. The highest priority areas are located along the mainstem of Opequon Creek, those many areas have steep banks, posing a challenge to successfully implementing riparian buffer restoration.
6	Fish Passage	Not Computed	No prioritization was available for removal or redesign of culverts, crossings, and dams within the Opequon Creek watershed. A thorough prioritization of these structures is needed to determine the impact of removal or redesign to ecosystems and habitat. Projects may provide improved ecosystem connectivity, expanded available habitat to aquatic habitat, and improved stream functionality and stream health.
7	Wetland Restoration	21,425 acres	Several areas were identified for wetland restoration or migration. Wetlands trap polluted rainfall runoff and improve receiving water quality in addition to providing fish habitat.

To reduce the stressors in the Opequon Creek watershed, ongoing work to conserve habitat and implementation of agricultural BMPs should continue throughout the Opequon Creek watershed. Addressing the wastewater management system issues within the watershed is critical toward improving the watershed ecology. Riparian buffer restoration would aid in reducing pollutant loadings to receiving tributaries of Opequon Creek, helping to improved overall water quality within the Opequon Creek watershed. Upstream areas with known culverts identified as being potential barriers to aquatic habitat should be prioritized for potential removal or replacement to promote increased habitat connectivity in the upper sections of the watershed.

In concert with the conservation and restoration efforts to reduce watershed stressors in the Opequon Creek watershed, there are several co-benefit restoration opportunities that can be undertaken as highlighted by the focus areas in **Figure 22**. **Table 2** summarizes the activities proposed in the focus areas. Following public input, at least one project will be developed further for presentation in the final report.Focus areas were identified that contain concentrations of co-located opportunities where co-benefits could be achieved. These focus areas were identified to assist with identifying a project to pursue for implementation. Focus is recommended in Opequon Creek tributaries of Buzzard Run, Duncan Run, Eagle Run, Evans Run, Goose Creek, Hopewell Run, Middle Creek, Mill Creek, Shaw Run, Three Run, and Tuscarora Creek where some streambank stabilization activities are already ongoing. Banks along these streams have been identified with a potential for high erosion, and opportunities exist to stabilize the streambanks and create additional habitat. Stream restoration and streambank stabilization projects can provide flood reduction benefit by reconnecting streams to floodplains. Restoring wetlands, preparing for wetland migration, and restoring riparian buffers in these areas will help promote improved water quality, provide additional habitat, and in turn, promote more favorable aquatic conditions. Areas with co-benefit projects including streambank stabilization, riparian buffer restoration, and/or wetland conservation are identified with black polygons in **Figure 22**. The entire watershed is recommended for future feasibility studies to develop a more comprehensive restoration plan for stream restoration and other restoration activities in this area.

Table 2. Summary of activities in proposed focus areas for project identification in Opequon Creek watershed

Opequon Creek Watershed Project Focus Areas									
Activity	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Stream Restoration	X	X	X	X	X	X	X	X	X
Riparian Buffer Restoration		X	X	X	X	X	X	X	X
Riparian Buffer Conservation	X		X	X	X	X	X	X	X
Wetland Restoration		X	X	X	X	X	X	X	X
Wetland Conservation			X	X	X	X	X	X	X
Stakeholder-Submitted Candidate Project		X	X						

To continue progress toward a restored Opequon Creek watershed, further feasibility studies should be conducted to understand applicability of these restoration measures at a finer scale. The feasibility study also should consider the sequencing of these measures to ensure their success. Collaboration will be a key component of progressing restoration. Several

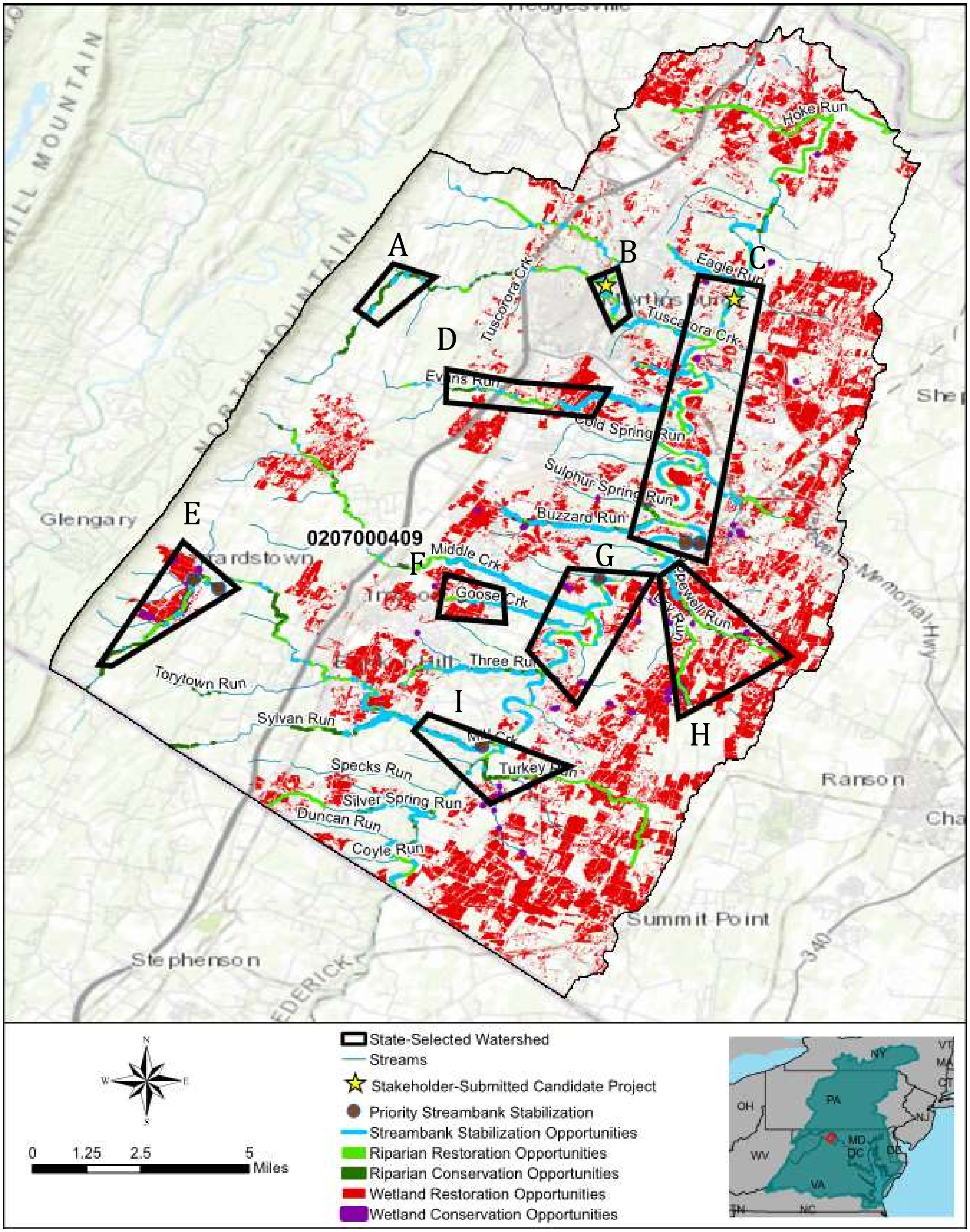

Figure 22. Proposed focus areas identified for project identification in the Opequon Creek watershed

Table 3. Summary of USACE Program Support

Program Support	Brief Description
Continuing Authorities Program (CAP)	Under this authority, USACE can plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. CAP authorities cover a range of mission areas from ecosystem restoration to navigation to improvements to past USACE projects. A feasibility study must be performed prior to implementation. Implementation is conducted with a 50/50 cost share between USACE and non-federal sponsor. The Continuing Authorities Programs are: • Section 14: Flood Control Act of 1946 amended for emergency streambank and shoreline erosion protection for public facilities and services • Section 103: River and Harbor Act of 1962 authorizes participation in the cost of protecting the shores of publicly owned property from hurricane and storm damage • Section 107: River and Harbor Act of 1960 amended for navigation • Section 111: River and Harbor Act of 1968 amended for mitigation of shoreline erosion damage caused by Federal navigation projects • Section 145: Water Resources Development Act of 1976 amended for placement of dredged material on beaches • Section 204: Water Resources Development Act of 1992 amended for Beneficial Uses of Dredged Material • Section 205: Flood Control Act of 1948 amended for flood control • Section 206: Water Resources Development Act of 1996 amended for Aquatic Ecosystem Restoration • Section 208: Flood Control Act of 1954 amended for snagging and clearing for flood control • Section 1135: Water Resources Development Act of 1986 amended for project modifications for Improvement of the Environment.
General Investigation Studies	Projects under this authority address flood risk management, navigation, water supply, recreation, and other needs and opportunities, which, as authorized by Congress, anticipate a greater federal commitment than CAP studies. These projects must be in federal interest and of major need to be economically justified and must be environmentally acceptable.
Section 510	This program provides design and/or construction assistance to non-federal interests for environmental projects that support the restoration and protection of the Chesapeake Bay estuary. Design and construction costs are cost-shared at 75 percent federal and 25 percent non-federal. Implementation of projects under this authority is dependent only on the extent that funds are separately budgeted or specifically appropriated for such work.
USACE Technical Services	This is the primary authorization and technical services program that USACE has available to states and local communities. It contains both the Planning Assistance for States Program (PAS) and the Floodplain Management Services (FPMS). • PAS – gives USACE authorization to use technical expertise in water and related land resources management to provide states, public entities within states, and Native American tribes planning assistance with water resources problems and needs. Types of projects may include all flood-related studies, GIS mapping, stormwater assessments, sanitary sewer studies, water supply and demand, water system vulnerability assessments, surface and groundwater quality, environmental restoration, wetland delineations, and watershed planning. There are two types of Planning Assistance offered through PAS: ○ Comprehensive Plans – including planning for the development, utilization, and conservation of the water and related resources of drainage basins, watersheds, or ecosystems located within the boundaries of the state or across states if both agree.

Program Support	Brief Description
	Typical water resource problems included in a comprehensive water resource plan include flood risk management, water supply, water conservation, environmental restoration, water quality, hydropower, erosion, navigation, fish and wildlife, cultural resources, and environmental resources. However, design and implementation are not covered under this authority. ○ Technical Assistance Supporting State Water Resources Management Plans – support of planning efforts to manage state water resources including provision and analysis of hydrologic, economic, or environmental data and analysis for water resource management and land resource development plans. This authority may not be used for design or construction. • Floodplain Management Services (FPMS) authorizes USACE to conduct technical studies using either all federal funding or in combination with a voluntary contribution from a non-federal sponsor. The FPMS authority provides for technical assistance and does not have a provision for construction. Detailed plans, specifications, and construction would have to be accomplished under other civil works authorities or by non-federal sponsors.
Section 729	This is a watershed planning authority to assess the water resource needs of river basis and watersheds within the U.S. relating to: • Ecosystem protection and restoration • Navigation and ports • Flood risk management • Watershed protection • Water supply • Drought Preparedness. These studies require an initial federally funded (<$100,000) watershed assessment (reconnaissance phase). These projects must be implemented with a 75% federal and 25% non-federal cost share agreement.
Section 571 – Central WV Environmental Infrastructure Program	This program provides design and construction assistance for environmental infrastructure and resource protection and development, including projects for wastewater treatment, water supply, and surface water protection and development. The USACE and West Virginia Infrastructure and Jobs Development Council (WVIJDC) administer the application process for project selection and implementation.

implementation barriers exist to execute the restoration activities outlined in this report. Collaboration across agencies and state boundaries will help minimize these barriers.

USACE has several programs and authorities to support the implementation of these projects. **Table** provides a summary of some of the USACE authorities that could support implementation of these identified project opportunities.

Within the area highlighted in **Figure 11** in the Opequon Creek watershed, opportunities may exist for partnership with USACE and non-federal sponsors to utilize the CAP Authority to implement streambank stabilization to mitigate erosion damages and provide flood risk management, and to support wetland restoration. Section 510 funding may be available to support erosion and sediment control of highly eroded streambanks as well as low impact development (LID).

Within the upper reaches of the watershed where co-benefit project opportunities were identified as shown in **Figure 22**, riparian buffer restoration and removal of fish passage blockages were identified with conservation activities. The CAP Authority Section 206 may be appropriate for supporting the modification of removal of barriers to fish passage. Additional studies may be conducted to refine the location of riparian buffer opportunities as well, utilizing the Planning Assistance for States Authority.

Based on correspondence with stakeholders, there is a widespread need throughout the Opequon Creek watershed for expansion and improvements of wastewater management systems to replace existing septic systems thus reducing a significant nutrient load source. While wastewater treatment plants that serve the Opequon Creek watershed have been upgraded and expanded in recent years, wastewater infrastructure remains sparse throughout much of the area. Section 571 funding may be available to support the design and construction wastewater conveyance systems.

These opportunities were identified based on the information available at the time of study. It is not an exhaustive identification of potential projects or opportunities. Additional opportunities will likely present themselves as more studies are conducted, data are collected, and collaboration continues. These additional opportunities should be considered in the support of a restored Opequon Creek watershed and Chesapeake Bay.

Section 5

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Attachment A - Opequon Creek watershed Stakeholders

The following stakeholders were engaged in the development of the Opequon Creek watershed analysis:

- Kristin Saunders – Cross Program Coordinator for the Chesapeake Bay Program and University of Maryland Center for Environmental Science, Chesapeake Bay Program Office
- Jennifer Pauer – Environmental Resources Specialist Supervisor, West Virginia Department of Environmental Protection, Division of Water and Waste Management Watershed Improvement Branch
- Alana Hartman – Environmental Resources Analyst, West Virginia Department of Environmental Protection, Division of Water and Waste Management, Watershed Improvement Branch
- Chad Thompson – Stormwater Specialist, West Virginia Department of Environmental Protection, Watershed Improvement Branch
- Sebastian Donner – Stormwater Specialist, West Virginia Department of Environmental Protection, Watershed Improvement Branch
- Matthew Pennington – Environmental Program Coordinator, Eastern Panhandle Regional Planning and Development Council (Region 9)
- Herb Peddicord –West Virginia Division of Forestry

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Attachment B – Opequon Creek Watershed Updated 303(d) Imperiled Streams List

FINAL CONSOLIDATED REACH FILE					
Master Code	Master Name	Cause	Size	Impaired Reach	Table Type
WVP-4	Opequon Creek	Bio	30.7	Entire length	TMDL table
WVP-4	Opequon Creek	Fecal Coliform	30.7	Entire length	TMDL table
WVP-4	Opequon Creek	Iron (trout)	30.7	Entire length	List table
WVP-4-A	Hoke Run	Bio	3.3	Entire length	TMDL table
WVP-4-A	Hoke Run	Fecal Coliform	3.3	Entire length	TMDL table
WVP-4-B	Eagle Run	Bio	1.2	Entire length	TMDL table
WVP-4-B	Eagle Run	Fecal Coliform	1.2	Entire length	TMDL table
WVP-4-C	Tuscarora Creek	Bio	7	Mouth to RM 7.0	TMDL table
WVP-4-C	Tuscarora Creek	Fecal Coliform	11.6	Entire length	TMDL table
WVP-4-C.4	UNT/Opequon Creek RM 10.21	Bio	1	Entire length	List table
WVP-4-C-1	Dry Run	Bio	4.6	Entire length	TMDL table
WVP-4-C-1	Dry Run	Fecal Coliform	4.6	Entire length	TMDL table
WVP-4-D	Evans Run	Bio	5.8	Entire length	TMDL table
WVP-4-F	Shaw Run	Bio	2.2	Entire length	TMDL table
WVP-4-F	Shaw Run	Fecal Coliform	2.2	Entire length	TMDL table
WVP-4-H	Buzzard Run	Bio	2.6	Entire length	List table
WVP-4-H	Buzzard Run	Fecal Coliform	2.6	Entire length	TMDL table
WVP-4-I	Hopewell Run	Bio	3.5	Entire length	TMDL table
WVP-4-I	Hopewell Run	Fecal Coliform	3.5	Entire length	TMDL table
WVP-4-I-2	UNT/Hopewell Run RM 1.85 (South Branch)	Fecal Coliform	2.6	Entire length	TMDL table
WVP-4-J	Middle Creek	Bio	11.7	Entire length	TMDL table
WVP-4-J	Middle Creek	Fecal Coliform	11.7	Entire length	TMDL table

FINAL CONSOLIDATED REACH FILE					
Master Code	Master Name	Cause	Size	Impaired Reach	Table Type
WVP-4-J-1	Goose Creek	Fecal Coliform	3	Entire length	TMDL table
WVP-4-L	Three Run	Fecal Coliform	2.2	Entire length	TMDL table
WVP-4-M	Mill Creek	Bio	11.4	Entire length	TMDL table
WVP-4-M	Mill Creek	Fecal Coliform	11.4	Entire length	TMDL table
WVP-4-M-1	Sylvan Run	Bio	4.5	Entire length	TMDL table
WVP-4-M-2	Torytown Run	Bio	2.4	Entire length	TMDL table
WVP-4-M-2	Torytown Run	Fecal Coliform	2.4	Entire length	TMDL table
WVP-4-N	Turkey Run	Bio	5.1	Entire length	TMDL table
WVP-4-N	Turkey Run	Fecal Coliform	5.1	Entire length	TMDL table
WVP-4-P	Silver Spring Run	Bio	3.2	Entire length	TMDL table
WVP-4-P	Silver Spring Run	Fecal Coliform	3.2	Entire length	TMDL table