Summary of Comments – Watershed Restoration Plans

Comment (Carolann Sharpe):

I am a member of Friends of Liberty Reservoir, a boater, hiker and horseback rider on the property. My comments and suggestions are made with full knowledge that this is not a public park but a privately owned watershed. With that said, Over the past year, when learning about the decommissioned trails, and inconsistencies located in the documents related to the reservoir, it baffles me a little that there isn't more communication with the residents that neighbor this property. Overall, it seems that so many people benefit from the reservoir as a place of natural beauty and recreation that although that isn't it's the primary function, to ignore that would be myopic and miss out of opportunities of volunteerism and a core of citizens that feel invested in the health and welfare of the property.

I ask and hope that the "powers that be" can find a way to include the public, brainstorm with the public and allow the multi-use recreation that Liberty provides for them to continue. Fishing, Boating, Horsebackriding, Hiking, are all very important to this property.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to decommissioned trails, communication with neighboring residents of the reservoir, or the need for improvements to the boat docks. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (Jessica Conaway):

Good afternoon
I may have missed some detail in this lengthy proposal but I do not see any reference to plans to support fire roads currently used for hiking, biking, hunting, horseback riding, and bird watching etc. As someone who appreciates this valuable resource both for it's utilitarian use as a water

supply and as a natural resource I was dismayed to find this oversight. I have personally assisted in rescuing a hiker who was injured. Without the fire road access for emergency personnel her removal would have been impossible. These recreational uses are also an important asset of our community. Please reassess and include repair and maintenance plans for these passageways to allow safe use and to avoid the more damaging unauthorized trail blazing people will do in order to gain access.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to decommissioned trails or support of fire roads. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (Linda Doll):

Please consider the maintenance of trails or volunteer maintenance of trails, including decommissioned trails, to keep them open for public recreation. Nature restores the human soul. A hike in the woods benefits both the body and mind. I would be happy to contribute funds going directly to trail maintenance or volunteer my time to help restore trails.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to decommissioned trails or maintenance and improvement of trails. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment: (Nathan McMillan):

The boat ramp at pretty boy needs to be re-done. A set up similar to loch raven would be the best thoughts to me, gives Prettyboy another attraction having a little pier to walk out and for those bank fisher man to fish from. Also maybe some clearing on some of the trails for bank fisherman better access points.

Thank you for this opportunity!

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to improvement of trails, addition of a fishing pier, or the need for improvements to the boat docks. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (Gary Youngworth):

The boat ramps at both liberty and pretty boy are in need of repair. There is a lot of trash being left by Bank fishermen in liberty. Additional policing of these areas would be of a great help and possibly levying fines to those who keep littering.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to the need for improvements to the boat docks. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (David Tanner):

Hey Kelly! I saw the post on carrolcountymd.gov about seeking input on the restoration projects. I think I speak for all boaters on Liberty Reservoir when I say the ramps need a lot of work. They have broken away over the years, and the large potholes are almost dangerous in spots. I have witnessed a boat slide almost all the way off a trailer when pulling out from hitting a bump. It's a beautiful reservoir and incredible fishery, with devoted and loyal anglers who buy permits every year. It would be greatly appreciated if this was at least considered. I'm not sure how it would be done, if you have to plan it during a period of drought or just base it on when the water is usually lowest in the year. Either way, thanks for reading!

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Unfortunately, Carroll County Government is not the appropriate agency to address your concerns related to the need for improvements to the boat docks. These issues should be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (Inez Donmoyer):

Since, the City of Baltimore owns and maintains the water and land surrounding Liberty Reservoir, what is their Watershed Implementation Plan (WIP) for the reservoir? Will Carroll County assist the City of Baltimore (a landowner in Carroll County) in improving the water quality on Liberty Reservoir? I am a member of the Friends of Liberty Reservoir (FoLR) and want to be part of the process in improving the water quality and protecting our natural resources within Liberty Reservoir. Our property borders the reservoir and we are very willing to help maintain and participate in the process to ensure our natural resources are improved with integrity.

Response:

No email address – no response provided.

Comment (Mark Rudyak):

Since, the City of Baltimore owns and maintains the water and land surrounding Liberty Reservoir, what is their Watershed Implementation Plan (WIP) for the reservoir? Will Carroll County assist the City of Baltimore (a landowner in Carroll County) in improving the water quality on Liberty Reservoir? I am a member of the Friends of Liberty Reservoir (FoLR) and want to be part of the process in improving the water quality and protecting our natural resources within Liberty Reservoir. Our property sits right on the border of the reservoir and we are more than willing to lend assistance to help maintain trails and integrity of the watershed. Thank you.

Response:

No email address – no response provided.

Comment (Full Moon Farm):

Given that the City of Baltimore owns and maintains the water and land surrounding the Liberty Reservoir, what is the City's Watershed Implementation Plan (WIP) for the reservoir? Will

Carroll County assist the City of Baltimore (a landowner in Carroll County) in our goal improving the water quality of the Liberty Reservoir? We are members of the Friends of Liberty Reservoir (FoLR); we wish to be part of the process to improve our water quality and to protect our natural resources within Liberty Reservoir.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Questions related to the City of Baltimore Watershed Implementation Plan for the reservoir or citizen participation regarding the City's actions regarding access and monitoring should be addressed to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment (Kathleen Ostrowski) (Received after comment period closed):

Good day,

I support the efforts to maintain the area around the Liberty Reservoir. Working in conjunction with all interested parties will make the reservoir safer and enjoyable. Clean water is a valuable resource which needs the intervention of everyone.

Response:

Thank you for taking the time to provide your comments.

The County Bureau of Resource Management (BRM) released for public comment the watershed restoration plans, characterization plans, and stream corridor assessments for the Upper and Lower Monocacy, Prettyboy, Loch Raven, Double Pipe Creek, and Liberty watersheds.

The BRM is required by the Environmental Protection Agency to document proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with urban wasteload allocation (WLA). The documents released for public comment were developed to detail the County's watershed restoration efforts and progress towards meeting approved stormwater WLAs.

Questions related to the City of Baltimore Watershed Implementation Plan for the reservoir or citizen participation regarding the City's actions regarding access and monitoring should be addressed to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government. Mr. Howells can be reached at 410-396-1586 or clark.howells@baltimorecity.gov.

Again, thank you for your interest.

Comment 1 (Judy Thacher):

Since the City of Baltimore owns and maintains the water and land surrounding Liberty Reservoir, what is their WIP for the reservoir? As a civic group, the Friends of Liberty Reservoir (FoLR) has a concern for all of Carroll County natural resources in urban and rural areas. Will Carroll County assist the City of Baltimore (a landowner in Carroll County) in improving the water quality on Liberty Reservoir? The FoLR wants to be part of the process in improving the water quality and protecting our natural resources within Liberty Reservoir. FoLR additional comments from the Characterization Plan focused on the Liberty Reservoir sub-watershed area:

We know steeper slopes are more prone to soil erosion and may have a greater influence on the amount of pollutant generated. Liberty Reservoir sub watershed is almost equally divided between low, medium and high slope areas; however, it is the highest second largest percent of high slope area. What focus will be placed on maintaining the stability of this area?

Response:

The Liberty Reservoir Watershed Characterization Plan is intended to provide a background on the hydrological, biological and other natural characteristics of the watershed, including the existing topography of the watershed.

The intent of the Carroll County Restoration Plan is to reduce pollutants entering waterways from existing developed areas through the implementation of filtration, infiltration and hydraulic controlling structural BMPs that will reduce pollutant loads from urban runoff and reduce stream bank erosion from improved hydraulics and reduced velocities.

Comment 2 (Judy Thacher):

Liberty Reservoir sub watershed has the second highest percent of group B Hydrological Soil Groups. Freedom is a designated PFA (Priority Funding Area) that includes employment, social and commercial activity. As this grows, how will surface water runoff be addressed?

Response:

Surface runoff for new development in Carroll County is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

In addition to Chapter 151, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management.

Comment 3 (Judy Thacher):

Liberty Reservoir sub watershed area, contains wetland areas which is a beneficial surface water resource providing downstream flood protection. Floodplains are ideal locations for bike paths, open spaces, and wildlife conservation, which will create a more appealing community (page 15). Liberty Reservoir sub watershed contains 223 acres of floodplains, which should be utilized for bike paths, equestrian trails, open spaces and wildlife conservation to make our community more appealing. Does Carroll County plan to work with the City of Baltimore to create these recreation and flood protection areas around Liberty Reservoir?

Response:

This watershed planning initiative is to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to address the developed and approved watershed TMDL Wasteload Allocations (WLA).

The focus of Carroll County's Restoration Plan is to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County.

Comment 4 (Judy Thacher):

Liberty Reservoir sub watershed is listed as an ecologically important area, called Green Infrastructure. Using this classification, we would like to see the area improved and maintained. This can be address through programs like rural legacy or program open space. Is Carroll County actively pursuing this?

Response:

The Carroll County portion of the Liberty Watershed lies within the Upper Patapsco Rural Legacy area and encompasses 21,541 acres (25%) of the Liberty watershed.

Comment 5 (Judy Thacher):

Within the Liberty Reservoir sub watershed area, we have several build out parcels, where more developments can increase pressure on the watershed. Currently there is 214 acres of impervious surface within this subwatershed and developments will only increase this number. When this happens aquatic species begin to disappear, such as trout. Liberty Reservoir subwatershed is currently at 4.7% impervious surfaces and the DNR has noted that rates above 4% affect aquatic life. What steps is Carroll County taking to reduce impervious surfaces?

Response:

Removal of impervious surfaces is listed as a potential BMP implementation strategy in Section V. of the Restoration Plan. Annually all municipalities and County DPW reports any reduction of impervious surface to the Department that is reported to MDE.

To reduce pollutants from urban areas Carroll County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Thank you for taking the time to provide your comments. Responses have been inserted below in red.

We also recommend that your issues and concerns be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government at 410-396-1586 or clark.howells@baltimorecity.gov

Comment 1 (Friends of Liberty Reservoir):

Good Afternoon,

Below is the Friends of Liberty Reservoir (FoLR) feedback regarding the Carroll County Watershed Plan.

Since the City of Baltimore owns and maintains the water and land surrounding Liberty Reservoir, what is their WIP for the reservoir? As a civic group, the Friends of Liberty Reservoir (FoLR) has a concern for all of Carroll County natural resources in urban and rural areas. Will Carroll County assist the City of Baltimore (a landowner in Carroll County) in improving the water quality on Liberty Reservoir? The FoLR wants to be part of the process in improving the water quality and protecting our natural resources within Liberty Reservoir.

FoLR additional comments/questions from the Characterization Plan focused on the Liberty Reservoir subwatershed area:

We know steeper slopes are more prone to soil erosion and may have a greater influence on the amount of pollutant generated. Liberty Reservoir subwatershed is almost equally divided between low, medium and high slope areas; however, it is the highest second largest percent of high slope area. What focus will be placed on maintaining the stability of this area?

Response:

The Liberty Reservoir Watershed Characterization Plan is intended to provide a background on the hydrological, biological and other natural characteristics of the watershed, including the existing topography of the watershed.

The intent of the Carroll County Restoration Plan is to reduce pollutants entering waterways from existing developed areas through the implementation of filtration, infiltration and hydraulic controlling structural BMPs that will reduce pollutant loads from urban runoff and reduce stream bank erosion from improved hydraulics and reduced velocities.

Comment 2 (Friends of Liberty Reservoir):

Liberty Reservoir subwatershed has the second highest percent of group B Hydrological Soil Groups. Freedom is a designated PFA (Priority Funding Area) that includes employment, social and commercial activity. As this grows, how will surface water runoff be addressed?

Response:

Surface runoff for new development in Carroll County is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

In addition to Chapter 151, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management.

Comment 3 (Friends of Liberty Reservoir):

Liberty Reservoir subwatershed area, contains wetland areas which is a beneficial surface water resource providing downstream flood protection. Floodplains are ideal locations for bike paths, open spaces, and wildlife conservation, which will create a more appealing community (page 15). Liberty Reservoir subwatershed contains 223 acres of floodplains, which should be utilized for bike paths, equestrian trails, open spaces and wildlife conservation to make our community more appealing. Does Carroll County plan to work with the City of Baltimore to create these recreation and flood protection areas around Liberty Reservoir?

Response:

This watershed planning initiative is to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to address the developed and approved watershed TMDL Wasteload Allocations (WLA).

The focus of Carroll County's Restoration Plan is to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County.

Comment 4 (Friends of Liberty Reservoir):

Liberty Reservoir subwatershed is listed as an ecologically important area, called Green Infrastructure. Using this classification, we would like to see the area improved and maintained. This can be address through programs like rural legacy or program open space. Is Carroll County actively pursuing this?

Response:

The Carroll County portion of the Liberty Watershed lies within the Upper Patapsco Rural Legacy area and encompasses 21,541 acres (25%) of the Liberty watershed.

Comment 5 (Friends of Liberty Reservoir):

Within the Liberty Reservoir subwatershed area, we have several build out parcels, where more developments can increase pressure on the watershed. Currently there is 214 acres of impervious surface within this subwatershed and developments will only increase this number. When this happens aquatic species begin to disappear, such as trout. Liberty Reservoir subwatershed is currently at 4.7% impervious surfaces and the DNR has noted that rates above 4% affect aquatic life. What steps is Carroll County taking to reduce impervious surfaces?

Response:

Removal of impervious surfaces is listed as a potential BMP implementation strategy in Section V. of the Restoration Plan. Annually all municipalities and County DPW reports any reduction of impervious surface to the Department that is reported to MDE.

To reduce pollutants from urban areas Carroll County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.
Thank you for taking the time to provide your comments. Responses have been inserted below in red.

We also recommend that your issues and concerns be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government at 410-396-1586 or clark.howells@baltimorecity.gov

Comment 1 (Mary Cowan) (Received after comment period closed):

I am a long-standing resident of Carroll County, Maryland, and had served as a former DNR officer for almost twenty years. My property is within the Liberty Watershed, and I have been an active environmental steward and recreational user of the watershed. I had been following the Carroll County Times as they tracked the proposed changes for the Liberty Reservoir restoration and conservation planning. I want to express my concerns regarding the cause and effect that stems from the proposed plan.

In the proposed plan, from my interpretation, the words used to identify these dirt roads as “trail roads” were at one point designated as fire roads, intended for emergency access for fire fighters and appropriate responders. The proper name for those roads should be fire roads, not “trail roads”. In addition, these roads have been historically open to the general public for limited recreational utilization. This misconception has lead to confusion within the community where the generalization of the term “trail road” implies recreational use and not emergency response. The word choice of “trail road” neglects the significant role that these roads serve for safety within the watershed and for the residents located around the boundaries. By cutting off these access points without identifying new ones, there is a now a concern for how emergency responders will be able to gain access into the watershed.

Response:

As stated in Section I. A. the Carroll County proposed restoration plan presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Liberty Reservoir and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

Comment 2 (Mary Cowan) (Received after comment period closed):

The roads have been acknowledge by both the supporting organizations and residents/users of the trails as not being well maintained. The failure to maintain these roads as fire roads goes against the initial safety purposes of their initial design. This case of neglect is a critical issue that should be resolved for the safety of the watershed that we all hope to enjoy. The roads can serve as a fire road in the new plan and help to maintain by the recreational users as a mutual benefit and cost effective strategy for safety and limited public recreational space.

Response:

This watershed planning initiative is to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to address the developed and approved watershed TMDL Wasteload Allocations (WLA).

The focus of Carroll County's Restoration Plan is to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County.

Comment 3 (Mary Cowan) (Received after comment period closed):

There have been no historical fires within the watershed of late, but the roads should be maintained for safety reasons or have appropriate roads designated and maintained after a fire study evaluation has been conducted. There have been times of droughts that have jeopardized the watershed should there have been a fire and the roads, as stated in the Carroll County Times, have not been maintained for long durations. If these roads are determined to no longer be suitable for fire responders, new roads should be identified in the proposed restoration project and communicated to residents so that they are aware for safety purposes. Community knowledge could help save a life or valuable resource should someone identify a fallen tree and help clear if the Department of Public Works can not respond in a timely manner.

The proposed plans with cutting off the identified as Murray Road, Content Lane, Poole/Pouder Area, Glen Falls Road, Old Oakland Road to Wards Chapel Road, Cockeys Mill Road to Md. 140 and Ivy Mill Road appear to be based on entrances near or approximate to more significant housing developments as opposed to long-standing properties that have been within the watershed boundaries for prolonged periods. The strategic planning of the restoration and conservation initiatives do not address long term county planning of these houses that contribute to larger volumes of stormwater runoff, total suspended solids, and tree canopy removal. The plan suggested that the suggested road closings would be allowed to return to a more natural state to improve water quality. However, the broader issues are the total runoff areas from housing developments and agricultural fields that drain into the watershed.

Response:

Surface runoff for new development in Carroll County is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

In addition to Chapter 151, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management.

Comment 4 (Mary Cowan) (Received after comment period closed):

There has been little to no water quality monitoring reports or long-standing studies within the Liberty Reservoir or other surrounding watersheds that suggest the proposed roads are the most suitable for closing. Instead, the streets offered to indicate a biased section of housing developments that only have recently become established within the Carroll and Baltimore County Communities. A significant portion of runoff from large housing developments contribute to the total input of the watershed and should be a prioritization by the government and appointed organizations to educate residents as well as monitor the water that comes from their existing stormwater management practices and create new ones in these areas. By allowing existing trails to return to a tree, the buffer would only prolong inevitable contamination from runoff from these proprietaries that back up to the watershed boundaries. Additionally, no evidence suggests the water quality in these areas alone warrant the naturalization process; only indications of maintenance are addressed, which have been offered to be maintained by The Friends of Liberty Watershed.

Studies should be conducted with full public transparencies from the data collected to identify total areas of the Liberty Watershed. The studies should include all roads, developments, and farms to determine whether or not the selected routes would be the most suitable for closing. A map of restricted areas that would potentially incur fines or other criminal charges, as well as a longstanding management practice should be published at least one year before initiation. The general public with open community hearings to address residential concerns. I believe that all residents want to have a healthy and safe environment in a critical area, such as the watershed. However, the project does not help educate nor adequately address the larger picture of water quality issues in either county.

The proposed idea of creating tree buffers would greatly help the overall tree canopy, but a master list of native trees that will be planted has not been identified. Some of the trails may receive more significant runoff and sit on less permeable soil and would need to have proper plants selected to combat the issues that are present, and then identified for their ability to uptake nutrients and improve water quality. However, other practices should be evaluated and simulated in these areas such as conservation plantings that could coexist on or around those trails that would help mitigate maintenance plans from the Department of Public Works and be actively upkeep by the residents who are the primary users of such paths.

Response:

The buffer plantings identified in Section V. D. of Carroll County’s Restoration Plan have been implemented. Table 10 lists the date of each planting implementation. All planting initiatives are done using native tree stock. A sentence was added to the Restoration Plan that clarifies native stock being used for all restoration plantings.

Comment 5 (Mary Cowan) (Received after comment period closed):

For years, Liberty has been used by the public within a limited scope of a wilderness area. These rules are accepted by the residents who are the primary users. Many residents, including myself, have purchased property along the watershed for the recreational offerings that it provides. There is an overwhelming support of the watershed trails that the residents would like to have kept open. Those within the watershed are stewards in their own rights and should be engaged and called upon for their local knowledge of the area. There are other practices that could include hard engineering structures to be placed at the expense of residents within the watershed. The costs could be paid out over several years in housing taxes initiated by the newer developments that build on the boundaries of the watershed to offset the costs. This strategy would greatly benefit residents who purchase or have purchased properties that back onto the watershed. Those that do not wish to have access to the trails and other opportunities that this watershed provides, will have this information on local taxes and be able to conclude whether or not they wish to be located in that area. Such practices could include permeable surfaces that would allow for water to permeate the subsurface as opposed to pulling and creating muddy trails, for example.

Environmental stewardship, active response, and future planning are essential to the long term sustainability of the Liberty Reservoir and watersheds. I believe that the initiatives to preserve, conserve, and restore are admirable and may result in road closings in the future. However, there are no detailed studies or modelings to suggest that the proposed roads would improve water quality. Transparency and active water monitoring should be the first step in identifying practices to be put in place, followed by a response management plan with an adequate public announcement.

Response:

The Carroll County Restoration Plan does not discuss road closings within the City of Baltimore's property.

Comment 6 (Mary Cowan) (Received after comment period closed):

There are many potential management plans that could be developed that are more residentially led and supported or determined through concrete datadriven analysis, professionally mapped. I strongly urge the Department of Public Works and Watershed Management to reevaluate and conduct studies on and around all trail roads, engage the community, educate about water quality that residents impact, and produce a new data-based proposal to present to the community that highlight several different option and allow for a vote.

Response:

Carroll County performed a stream corridor assessment of the Liberty Watershed that was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation.

Priority for restoration projects were based on; the amount of impervious area in need of treatment and focused on areas that will address significant downstream erosion that reduces nutrient and sediment loadings to Liberty Reservoir.

Thank you for taking the time to provide your comments. Responses have been inserted below in red.

We also recommend that your issues and concerns be brought to the attention of Mr. Clark Howells, Watershed Section Manager, Baltimore City Government at 410-396-1586 or clark.howells@baltimorecity.gov

Double Pipe Creek Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Double Pipe Creek Watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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Double Pipe Creek Watershed Restoration Plan

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I. Introduction

The Double Pipe Creek Watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients and sediment in 1996, and again for bacteria in 2002. A TMDL for sediment was developed and approved in September of 2008, with a subsequent TMDL for phosphorus developed and approved in August of 2012. The 2003 bacteria listing was addressed with a TMDL that was developed and approved in December of 2009.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Towns of Manchester, New Windsor, and Union Bridge, the Cities of Taneytown and Westminster, as well as the Monocacy Scenic River Citizens Advisory Board.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for Double Pipe Creek and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Double Pipe Creek Watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Double Pipe Creek Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the Rural Legacy Area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Double Pipe Creek Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

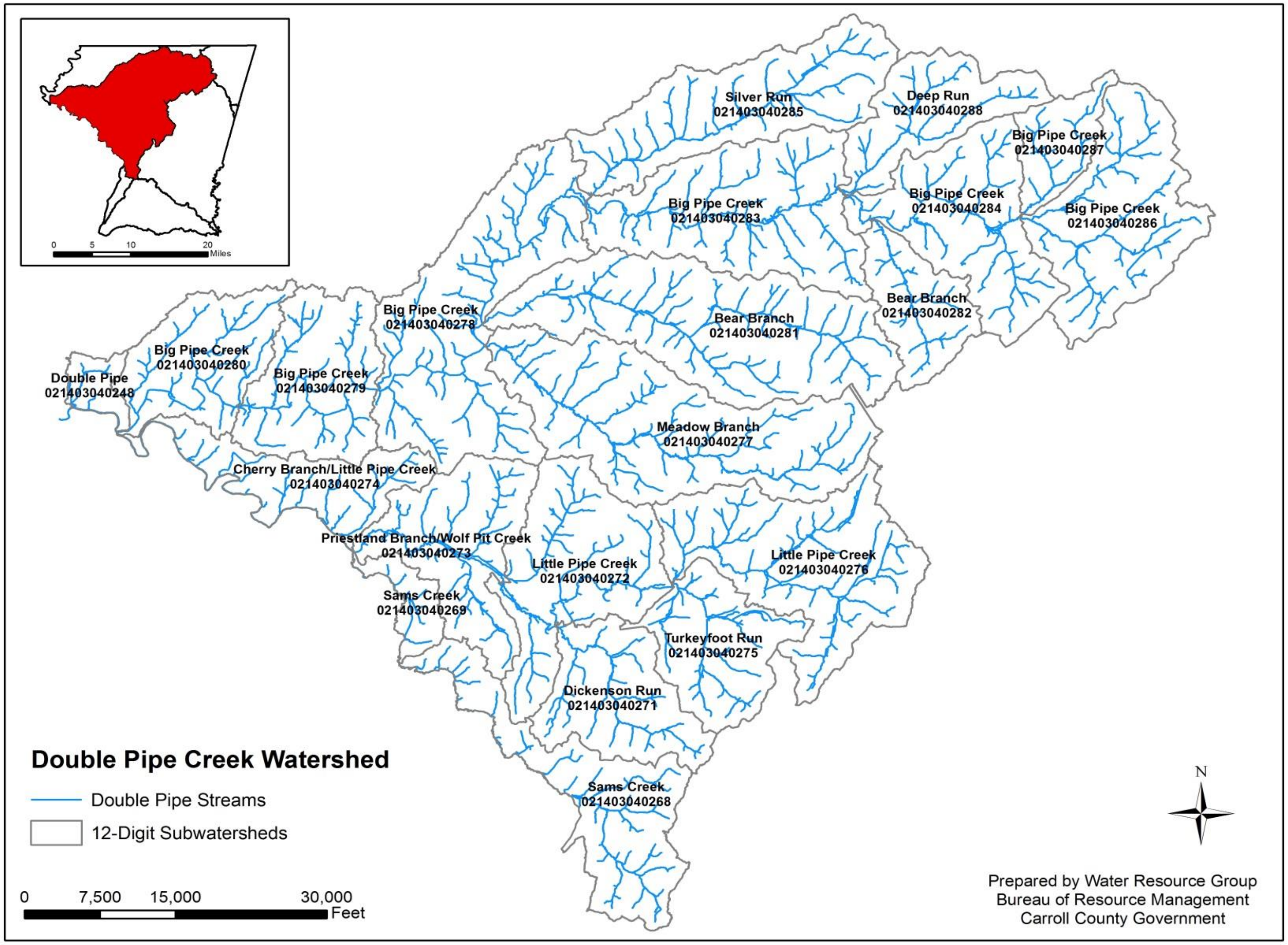

Figure 1: Double Pipe Creek Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Double Pipe Creek Water Quality Standards

The entire portion of the Double Pipe Creek Watershed within Carroll County is designated as use IV-P, Recreational Trout Waters. The use IV-P is capable of supporting adult trout for a put-and-take fishery, but may not be capable for growing and propagating trout.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQS). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the Double Pipe Creek Watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. This restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Double Pipe Creek Watershed was determined by (MDE, 2009) to be 4,423,635 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 67,365 billion MPN/year, which is a reduction of 4,356,270 billion MPN/year (98.5%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Double Pipe Creek Watershed.

Table 3: Double Pipe Creek 8-digit Watershed Bacteria TMDL

Double Pipe Creek Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	4,423,635	67,365	98.5%
Total		**67,365**	**98.5%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County was determined by (MDE, 2012) to be 16,129 lbs. /yr., the TMDL for the stormwater WLA was determined to be 4,441 lbs. /yr., which is a reduction of 11,688 lbs. /yr. (72%) from the current loading (Table 4). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2012).

Table 4: Double Pipe Creek 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs/yr)	TMDL (lbs/yr)	Percent Reduction
Carroll County	9,316	2,329	75%
Municipalities	6,813	2,112	69%
Total	**16,129**	**4,441**	**72%**

Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by (MDE, 2008) is 4,759 tons/yr., the TMDL for the stormwater WLA was determined to be 3,149 tons/yr., which is a reduction of 1,610 tons/yr. (34%) from the current loading (Table 5).

Table 5: Double Pipe Creek 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,759	3,149	34%
Total	**4,759**	**3,149**	**34%**

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Double Pipe Creek Watershed is located along the western portion of the County. The watershed is within the Potomac River Basin, which lies within the Piedmont physiographic province of Maryland. There are twenty one (21) major sub-watersheds in the County that cover a total land area of 105,457 acres. Figure 1 depicts the location of the Double Pipe Creek Watershed and its subwatersheds.

B. Baseline and Current Land Use

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Double Pipe Creek Watershed, agriculture is the dominant land cover at about 60 percent of the total land, followed by forest which accounts for 20 percent, and residential, which accounts for about 12 percent of the total land cover. Mixed urban accounts for less than 3 percent of the total land cover, which represents the relatively rural nature of the Double Pipe Creek Watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 Accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 5% increase in low-density residential land cover since 2011, which has been incorporated into Table 6.

Table 6 shows the current land cover data for the Double Pipe Creek Watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within Double Pipe Creek can be found in Figure 2.

Table 6: Double Pipe Creek Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	28	<1%	33	<1%	48	<1%	47	<1%
Low-Density Residential	7,375	7%	7,566	7%	7,636	7%	12,827	12%
Low-Density Mixed Urban	2,234	2%	2,344	2%	2,405	2%	2,405	2%
Medium-Density Mixed	385	<1%	508	<1%	591	<1%	591	<1%
High-Density Mixed Urban	64	<1%	110	<1%	129	<1%	129	<1%
Barren Land	241	<1%	276	<1%	263	<1%	260	<1%
Forest	23,894	23%	23,808	23%	23,742	23%	21,201	20%
Shrub/Scrub	1,057	1%	1,051	1%	1,091	1%	1,014	<1%
Grassland	127	<1%	193	<1%	203	<1%	189	<1%
Pasture/Hay	24,083	23%	23,630	22%	23,596	22%	22,237	21%
Cropland	44,409	42%	44,384	42%	44,192	42%	41,054	39%
Wetland	1,532	1.5%	1,526	1.5%	1,533	1.5%	1,492	1.4%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Double Pipe Creek Watershed is estimated to have 3,897 acres of total impervious within the catchment and accounts for approximately 3.7 percent of the total land area. The impervious surface area within Double Pipe, by subwatershed can be found in Table 7 and is shown in Figure 3.

Table 7: Double Pipe Creek Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0281	Bear Branch	9,158	308.81	3.4%
0282	Bear Branch	2,643	62.18	2.4%
0278	Big Pipe Creek	8,799	261.34	3.0%
0279	Big Pipe Creek	4,582	77.01	1.7%
0280	Big Pipe Creek	3,937	77.09	2.0%

0283	Big Pipe Creek	7,183	217.99	3.0%
0284	Big Pipe Creek	5,568	110.99	2.0%
0286	Big Pipe Creek	6,074	266.68	4.4%
0287	Big Pipe Creek	1,796	36.21	2.0%
0274	Cherry Branch/Ltl Pipe Creek	3,452	77.79	2.3%
0288	Deep Run	3,456	97.99	2.8%
0271	Dickenson Run	4,049	167.61	4.1%
0248	Double Pipe Creek	759	20.63	2.7%
0272	Little Pipe Creek	5,880	141.19	2.4%
0276	Little Pipe Creek	7,442	789.78	10.6%
0277	Meadow Branch	9,490	482.11	5.1%
0273	Priestland/ Wolf Pit Branch	4,760	193.33	4.1%
0268	Sams Creek	5,393	178.31	3.3%
0269	Sams Creek	991	42.25	4.3%
0285	Silver Run	6,212	156.26	2.5%
0275	Turkeyfoot Run	3,833	131.31	3.4%
Double Pipe Creek Watershed		**105,457**	**3,897**	**3.7%**

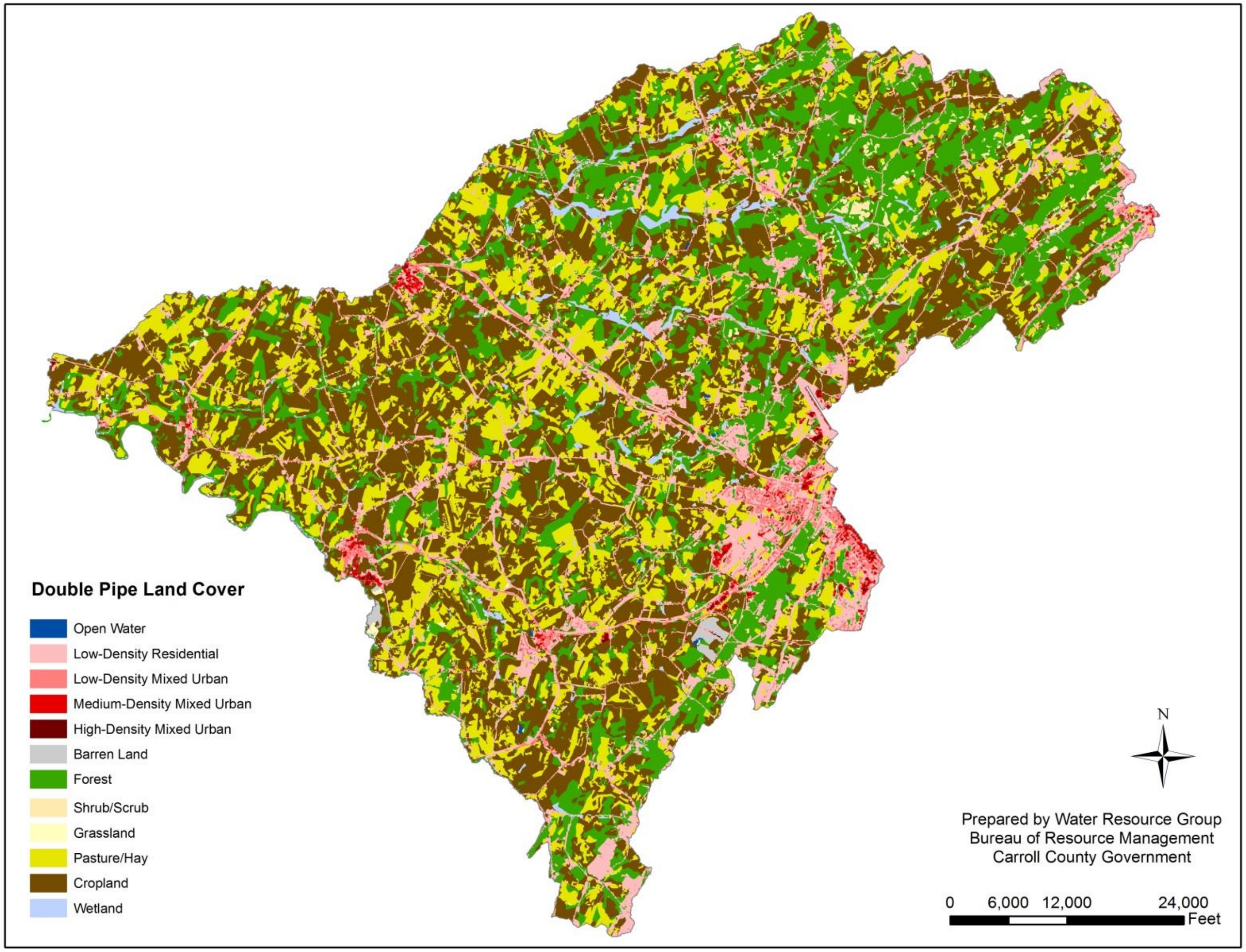

Figure 2: Double Pipe Creek Watershed Land Use/Land Cover from 2011

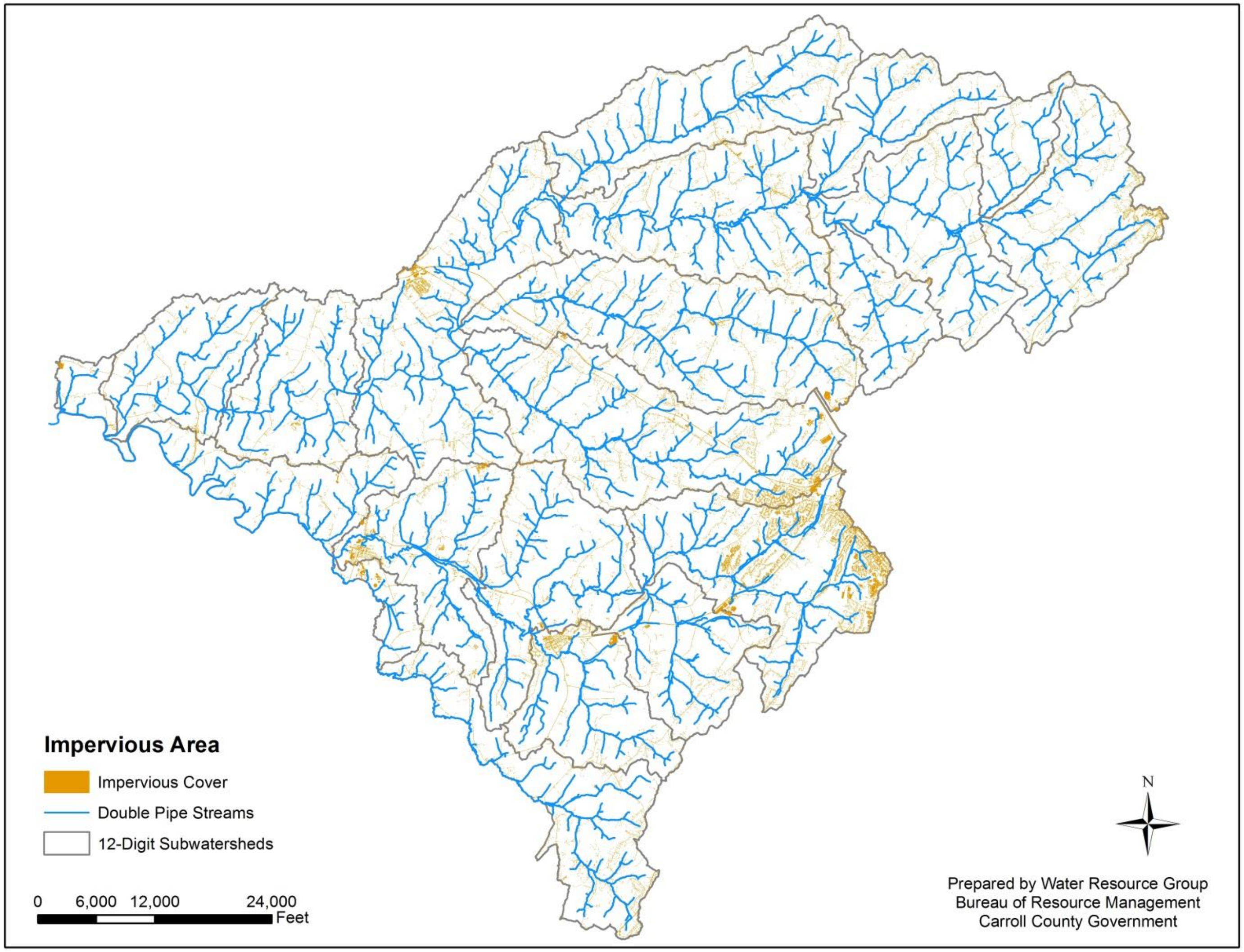

Figure 3: Double Pipe Creek Watershed Impervious Surface Area

C. Watershed Characterization

Following the Double Pipe Creek stream corridor assessment (SCA), completed in 2016, a Watershed Characterization for the Double Pipe Creek Watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Double Pipe Creek Watershed SCA will be used as the foundation for the watershed restoration plan. The Double Pipe Creek SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/DoublePipeCreek/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/DoublePipeCreek/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Double Pipe Creek Watershed, there are no sections designated as Tier II waters.

b. Ecologically Sensitive Areas

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State (imap.maryland.gov). Targeted ecological areas within the Double Pipe Creek Watershed are shown in Figure 4.

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

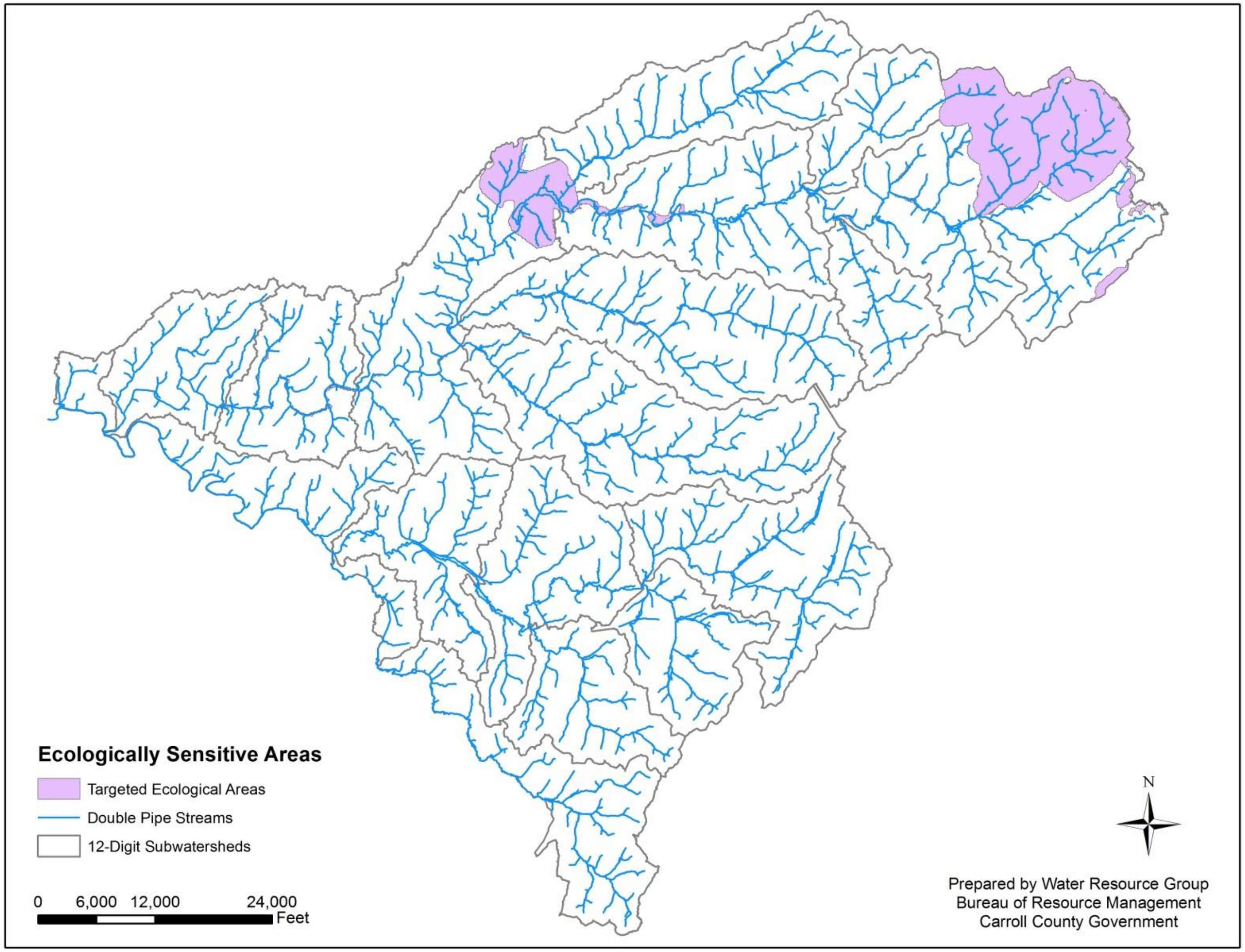

Figure 4: Targeted Ecological Areas

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Double Pipe Creek Watershed was conducted during the winter of 2016 by Carroll County Bureau of Resource Management staff. The Double Pipe Creek SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Double Pipe Creek SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/DoublePipeCreek/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along approximately 211,310 linear feet of the corridor, 23.72% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Big Pipe Creek (0286), Little Pipe Creek (0272), Meadow Branch (0277), and Little Pipe Creek (0276). A significant portion of the drainage within Little Pipe Creek (0272), Meadow Branch (0277), and Little Pipe Creek (0276) sub-watersheds originates within the corporate limits of Westminster, whereas, the Big Pipe Creek subwatershed (0286) originates within the corporate limits of Manchester. Table 8 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

Table 8: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Bear Branch (021403040281)	45.68	14.01	6,350	8.59%
Bear Branch (021403040282)	11.33	5.32	7,225	25.73%
Big Pipe Creek (021403040278)	45.71	9.10	10,250	21.34%
Big Pipe Creek (021403040279)	25.30	5.66	3,000	10.03%
Big Pipe Creek (021403040280)	20.57	8.59	10,350	22.82%
Big Pipe Creek (021403040283)	32.82	3.24	3,800	22.25%
Big Pipe Creek (021403040284)	27.25	10.82	13,720	24.01%
Big Pipe Creek (021403040286)	23.86	3.56	7,950	42.34%
Big Pipe Creek (021403040287)	10.04	0.00	N/A	N/A
Cherry Branch/Little Pipe Creek (021403040274)	22.98	7.34	8,400	21.66%
Deep Run (021403040288)	15.45	2.99	4,490	28.46%
Dickenson Run (021403040271)	18.77	8.90	10,750	22.88%
Double Pipe (021403040248)	4.84	0.99	1,300	24.89%
Little Pipe Creek (021403040272)	29.06	12.18	25,050	38.94%
Little Pipe Creek (021403040276)	33.28	19.31	30,240	29.66%
Meadow Branch (021403040277)	43.38	20.43	34,145	31.65%
Priestland Branch/Wolf Pit Creek (021403040273)	22.19	3.76	4,500	22.69%
Sams Creek (021403040268)	29.83	16.56	22,565	25.81%
Sams Creek (021403040269)	5.69	1.27	0	0.00%
Silver Run (021403040285)	27.43	3.40	1,600	8.90%
Turkeyfoot Run (021403040275)	18.47	11.30	5,625	9.43%
Total	**513.93**	**168.72**	**211,310**	**23.72%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Double Pipe Creek Watershed there are 2,695 parcels remaining with potential development on 39,244 acres for an estimated lot yield of 8,343 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 5 shows the remaining parcels in Double Pipe Creek watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

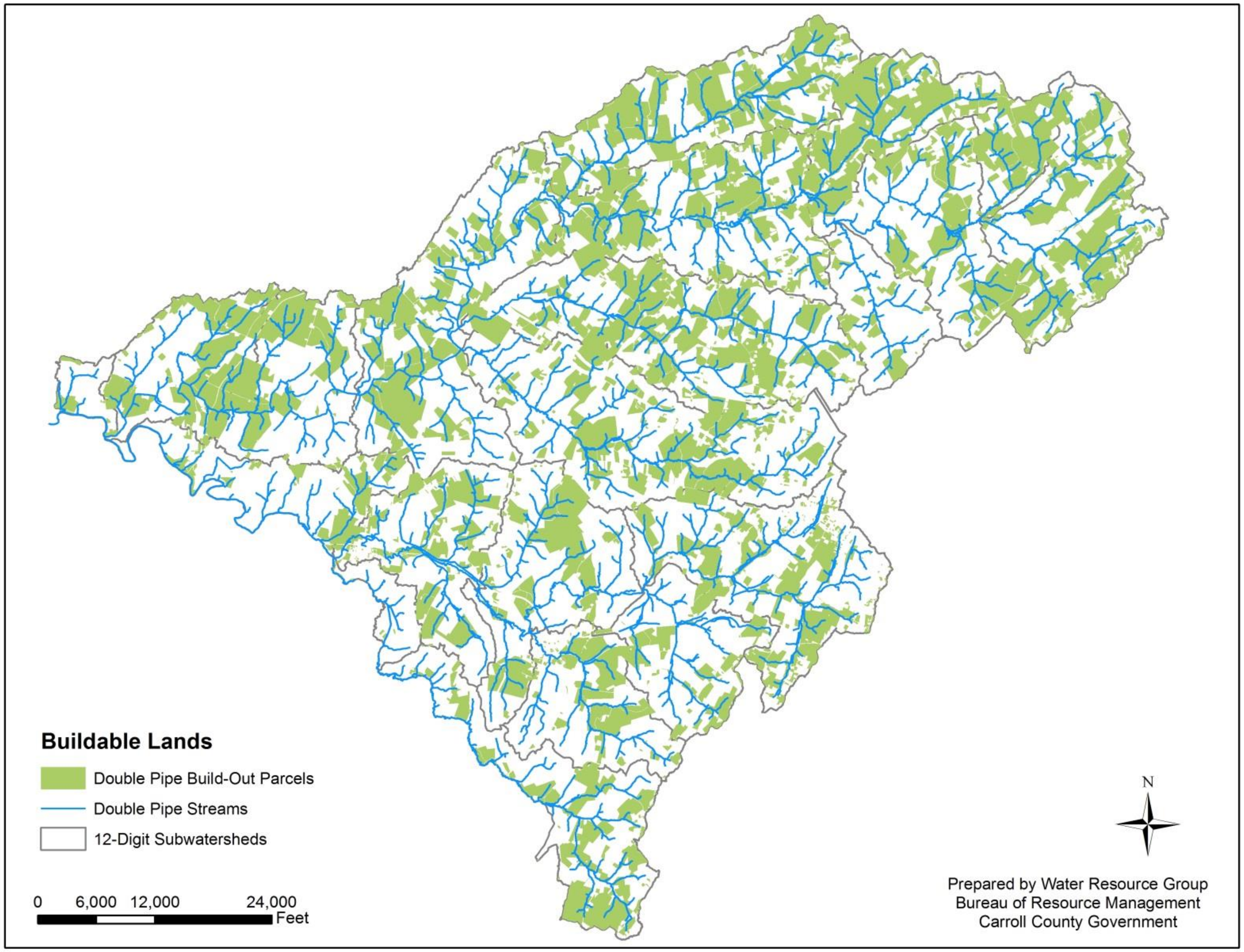

Figure 5: Double Pipe Creek Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Double Pipe Creek Watershed there are 199.89 acres of grass buffer and 98.72 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Double Pipe Creek Watershed can be found in Appendix B, and are shown in Figure 6. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Double Pipe Creek Watershed lies within the Little Pipe Creek Rural Legacy Area and encompasses 34,237 acres (32%) of the Double Pipe watershed. The extent of the Rural Legacy Area within Double Pipe can be found in Figure 7.

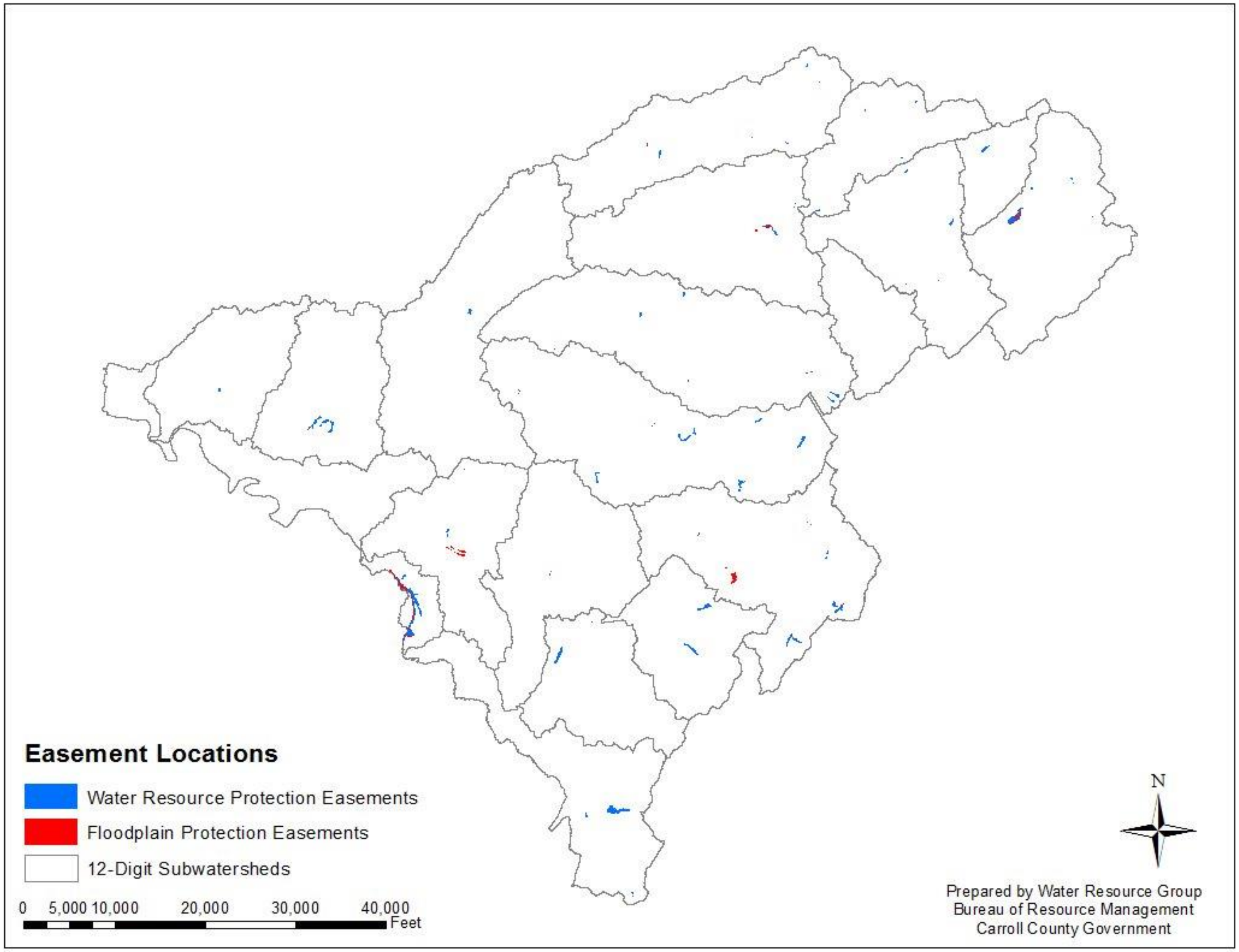

Figure 6: Water Resource and Floodplain Protection Easement Locations

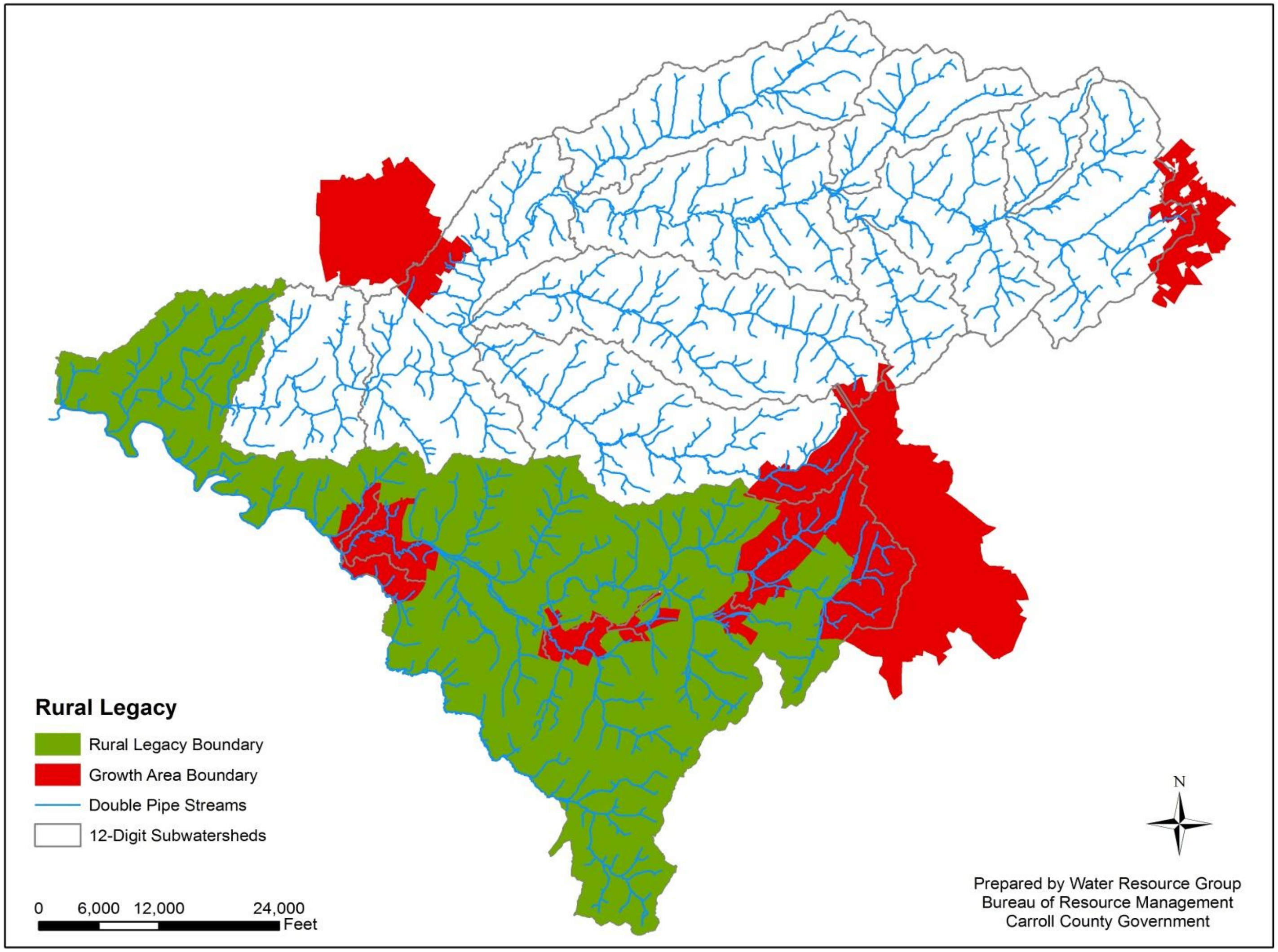

Figure 7: Little Pipe Creek Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a Memorandum of Agreement (MOA) to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff is continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts. Educational

events that County staff have participated in that are either held within the Double Pipe Creek Watershed or offered to citizens countywide can be found in Table 9.

Table 9: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Charlotte's Quest Nature Center Spring Fest	2018, 2019	Double Pipe/Prettyboy/Liberty
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide

Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide
Homeowners & Stormwater Workshop	2017	Countywide
Longwell Run Earth Day Celebration & Tree Planting	2018	Double Pipe
McDaniel Clean-up Day	2018	Double Pipe
Mid-Atlantic Car Wash Association “Wash to Save the Bay”	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
New Windsor Town Beautification Day	2018	Double Pipe
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Double Pipe Creek Watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, Maryland Department of Environment (MDE) released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design (ESD) practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Double Pipe Creek Watershed TMDL's, that have been either completed or planned in current budget, are listed in Table 10. The location of each facility can be found in Figure 8, the practice type and runoff depth treated for each facility can be found in Appendix B.

Table 10: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Sunnyside	30.2	2.69	Facility	Completed	0284
Friendship Overlook	82.01	15.88	Retrofit	Completed	0276
Farm Museum	6.44	0.45	Facility	Completed	0276
Farm Museum 1	11.61	2.3	Facility	Completed	0276
Farm Museum 2	0.09	0.05	Facility	Completed	0276
Farm Museum 3	0.79	0.06	Retrofit	Completed	0276
Farm Museum 4	0.03	0.03	Facility	Completed	0276
Farm Museum 5	0.01	0.01	Facility	Completed	0276
CC Maintenance	45.49	25.05	Retrofit	Completed	0281
Langdon	194	92.1	Facility	Under Construction	0276
Blue Ridge Manor	36.28	9.26	Retrofit	Completed	0271
Locust Wetland	35.9	11	Facility	Planned	0273
CC Health Dept.	14.77	6.72	Facility	Planned	0276
Long Valley Rd	98.32	16.64	Facility	Planned	0276
Exceptional Center	46.5	14.7	Retrofit	Completed	0276
Elmer Wolfe	9.78	4.26	Retrofit	Completed	0273
NW RR Track	34.5	15.34	Facility	Planned	0271
Avondale Run Phase 2	7.86	1.84	Retrofit	Planned	0276
CC Airport	38.4	7.4	Retrofit	Planned	0281
Greens of Westminster Sec 6 #2	38.31	12.56	Retrofit	Planned	0277
Meadow Ridge 171	22.1	5.73	Retrofit	Planned	0277
Meadow Ridge 172	18.2	5.35	Retrofit	Planned	0277
Totals:	**771.59**	**249.42**			

B. Storm Drain Outfalls

During the Double Pipe Creek Watershed SCA in 2016, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. Four elementary schools within the Double Pipe Creek Watershed have planted four gardens with a total drainage area of 1.47 Acres.

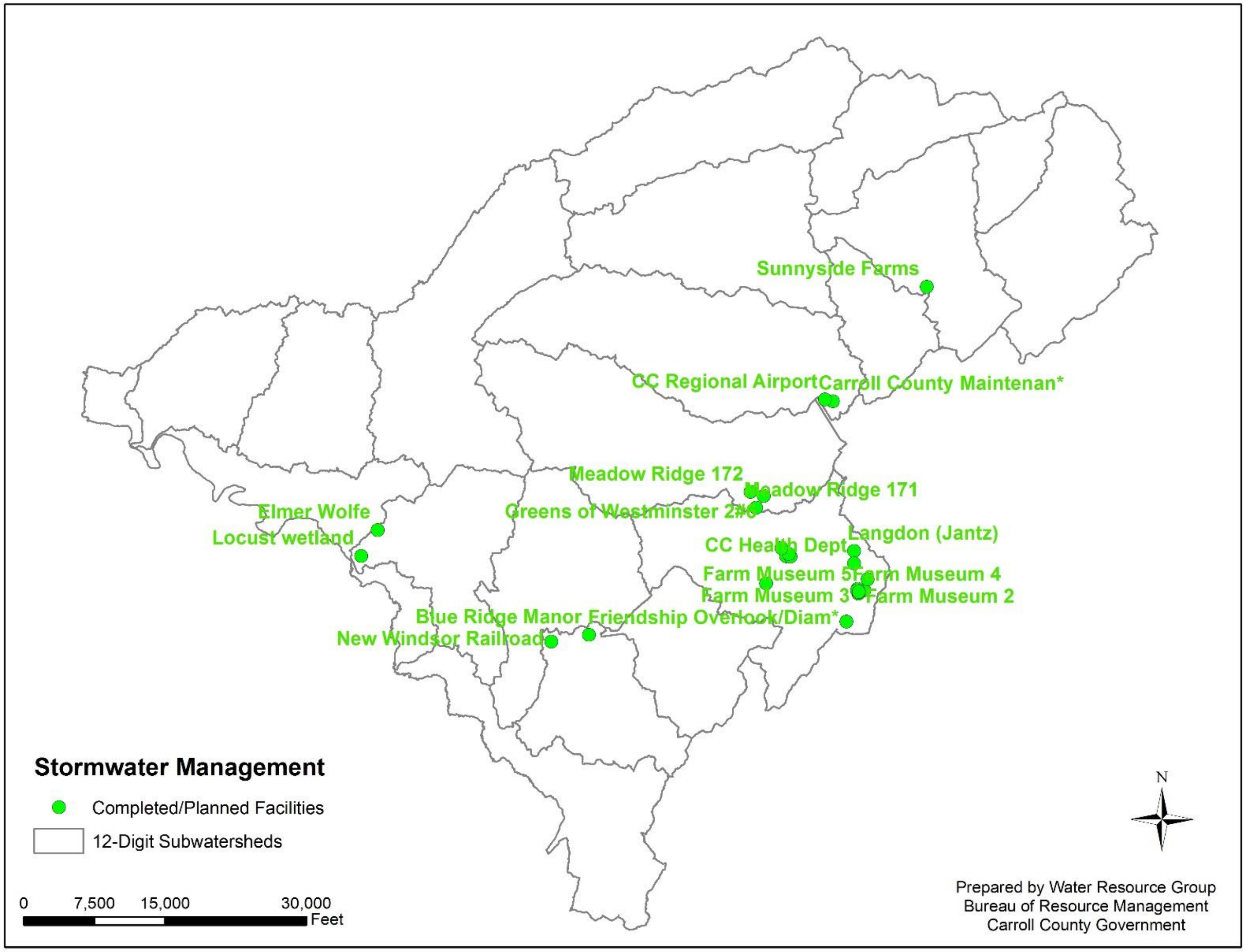

Figure 8: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

The 2016 Double Pipe Creek SCA determined that approximately twenty five (25) percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Twenty six properties participated in this initiative during the spring and fall of 2014 and 2015. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the residential buffer plantings are shown in Figure 9.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	12- Digit Subwatershed	Date Planted
Planting 1	4.13	1,115	225	0274	2013
Planting 2	10.85	4,325	125	0276	2013
Planting 3	0.2	450	20	0273	Spring 2015
Planting 4	1.4	750	50	0272	Spring 2015
Planting 5	0.5	435	30	0283	Spring 2015
Planting 6	0.3	340	40	0286	Spring 2015
Planting 7	0.65	562	50	0277	Spring 2015
Planting 8	2.3	250	200	0285	Spring 2015
Planting 9	0.4	150	50	0281	Spring 2015
Planting 10	2.25	900	50	0286	Spring 2015
Planting 11	0.2	430	10	0283	Spring 2015
Planting 12	0.62	360	50	0286	Spring 2015
Planting 13	1.8	1,600	20	0277	Spring 2015
Planting 14	0.9	310	160	0287	Spring 2015
Planting 15	0.26	200	50	0273	Fall 2015
Planting 16	3	800	300	0285	Fall 2015
Planting 17	9	800	275	0273	Fall 2015
Planting 18	0.13	220	25	0281	Fall 2015

Planting 19	0.6	1,000	20	0272	Fall 2015
Planting 20	0.2	450	25	0285	Fall 2015
Planting 21	1.25	300	50	0272	Fall 2015
Planting 22	0.45	225	75	0278	Fall 2015
Planting 23	2.2	1,150	60	0271	Fall 2015
Planting 24	1.62	200	200	0276	Fall 2015
Planting 25	4.26	1,000	125	0276	Fall 2015
Planting 26	1.8	250	150	0276	Fall 2015

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be inspected bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

2. Municipal Plantings

In addition to the implementation of residential stream buffer plantings, in 2015, the Towns of New Windsor, Union Bridge and the City of Westminster also initiated tree planting projects within the Double Pipe Creek Watershed.

The City of Westminster implemented tree planting projects at three locations that consisted of planting over 2,300 trees to reforest more than 7.5 acres. The Town of New Windsor project consisted of planting 570 trees at a stocking rate of 260 trees per acre to restore a forested buffer along 1,150 feet of stream that is currently leased as cropland. The Town of Union Bridge project involved reforesting over 1,000 feet of stream corridor with over 1,200 trees just north of town in a wellhead protection area.

The Municipal efforts are included in Table 10 above.

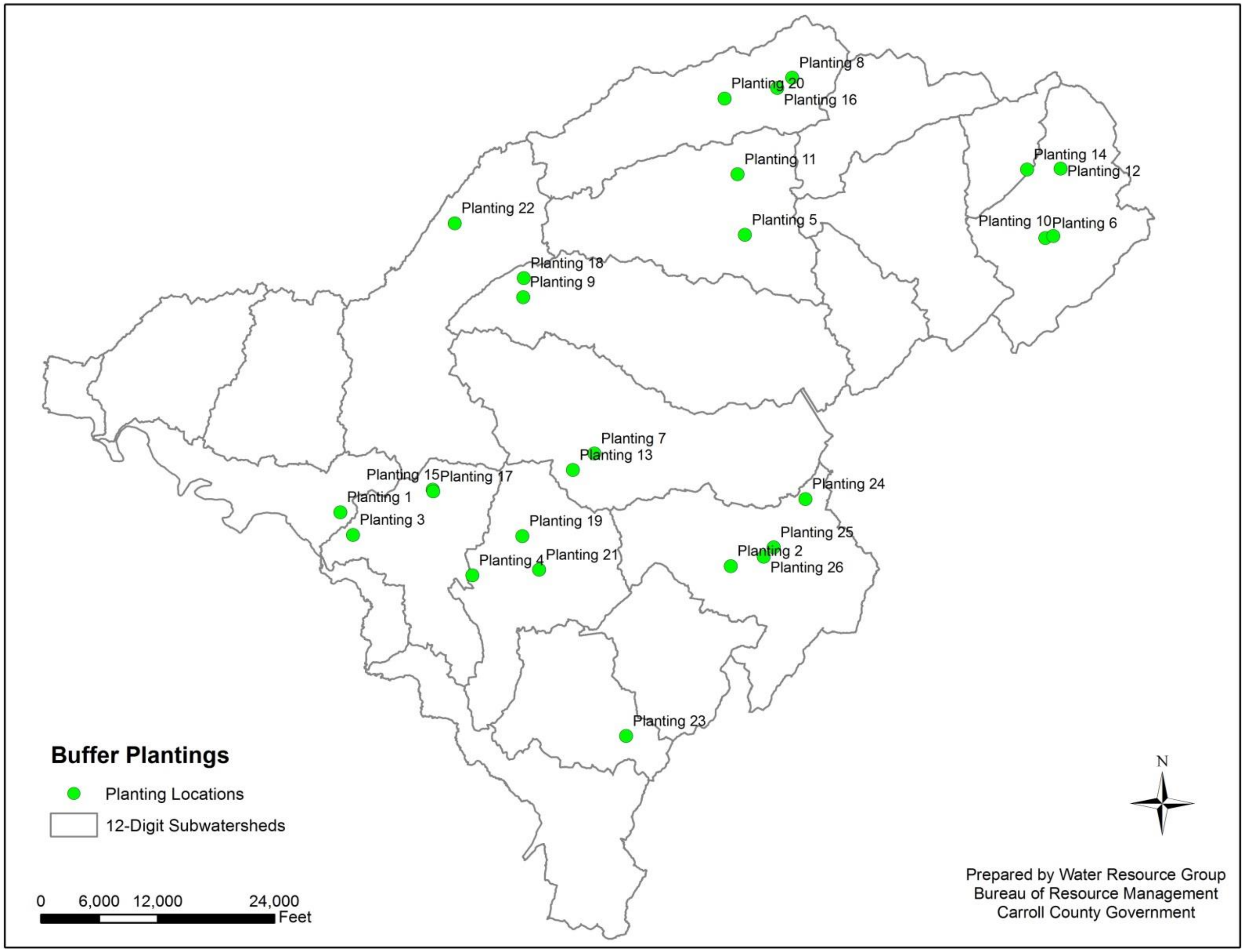

Figure 9: Stream Buffer Initiative Locations

E. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has considered the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

F. Streambank Regeneration

Accelerated streambank erosion occurs downstream of inadequately managed impervious from development. The proportion of rain water that previously infiltrated into the ground is reduced. Thus, causing immediate runoff, and increasing the total amount and velocity of flow in the receiving channel, accelerating erosion and resulting in greater sediment loads within the stream corridor.

There are two effective ways to reduce the destabilizing velocity increases in the receiving channel. The first is traditional stream restoration, increasing the plan form and bank resistance. The second is upland stormwater management, storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont, many residential, institutional, or commercial areas were developed prior to 1982 without any stormwater management or subsequently with peak flow control that matched existing conditions only, not really returning the runoff characteristics to predevelopment, as required by COMAR 26.17.02.01. Matching the existing hydrologic runoff response in these areas does not address existing streambank instability and does nothing to help restore streams or reduce current nutrient and legacy sediment export to the Bay.

Carroll County has been experimenting with the use of enlarged, enhanced, sand filters as primary stormwater management for more than 10 years. In an effort to determine the cause of these unanticipated stormwater management/quality/stream restoration benefits, we reanalyzed the design information. This showed that the Carroll County standard design reduced the two-year storm peak flow below that of an equivalent forested watershed in good condition. This has always been the goal of stormwater management, returning the hydrologic condition to that assumed to exist in pre-contact times.

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

Although streambank regeneration is not currently an approved practice in the 2014 MDE guidance document (MDE, 2014), the guidance states that innovative practices that are not approved under the Maryland Stormwater Design Manual (MDE, 2000) nor have an MDE or CBP assigned pollution removal efficiency can be used to offer jurisdictions additional options toward watershed restoration activities provided that there is proper documentation and monitoring to verify pollutant removal efficiencies acceptable to MDE. The County has developed a paired watershed approach to evaluate the effectiveness of upland stormwater management practices on stream channel protection and will begin a 3-year study in 2016 collecting the necessary data to document the sediment and nutrient reduction benefits associated with this practice. The results will inform recommendations to credit upland stormwater practices as a hydrogeomorphic stream stabilization technique for sediment reductions.

G. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Double Pipe Creek Watershed are shown in Table 12.

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Manchester	n/a		Annual
County	0.4	multiple	Annual
Union Bridge	0.44	0273	Annual
Westminster	0.49	0276/0277	Annual
Management Practice	**Bi-Weekly Mechanical Street Sweeping**		
Town	# Acres Swept	12-Digit Watershed	Date of Completion
Westminster	7.62	0276	Annual

H. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2009, twenty (43) septic systems within the Double Pipe Creek Watershed have been repaired and seventeen (35) new systems have been built utilizing Best Available Technology (BAT). Fourteen (33) of these projects have been via the Bay Restoration Fund. BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time.
Septic systems that have been built or repaired utilizing BAT within the Double Pipe Creek Watershed are listed in Appendix C.

I. Agricultural Best Management Practices (BMPs)

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix C provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix D.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Double Pipe Creek Watershed. As described in Section I, bacteria, phosphorus and TSS loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDLs suggests an urban TP load reduction of 72.5% from the 2009 baseline year and TSS load reduction of 33.8% from the 2000 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Double Pipe Creek watershed). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban TP load reductions of 72.5% and urban TSS load reductions of 33.8% of the local TMDL baseline years. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the local TP TMDL, as land cover data from 2011 was the closest available for that time period. Similarly, a baseline year of 2001 was used as a proxy for the 2000 baseline year in the local TSS TMDL. The modeled baseline scenarios did not include any BMPs and therefore represent the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TP TMDL and 2000 TSS TMDL baseline years can be counted toward load reductions necessary to meet the TMDLs, even though 2011 and 2001 were used as the baseline proxy years. For reference, the modeled baseline urban P load using the 2011 land cover was 938.00 lbs, which equates to a 72.5% reduction of 680.05 lbs. The modeled baseline urban TSS load using the 2001 land cover was 1290.91 tons, which equates to a 33.8% reduction of 432.95 tons (Table 13).

The projects completed as of December 2019 are providing 49.61 pounds of TP reduction, and 72.24 tons of TSS reduction. The planned projects would provide another 61.13 lbs. of TP reduction and another 42.22 tons of sediment (Table 14). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix C for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 10 and 11. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Double Pipe Creek TMDLs. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, MDE currently does not provide guidance on bacteria reduction efficiencies.

Table 13: Total Phosphorus and Total Suspended Sediment Load Reduction in the Double Pipe Creek Watershed in Carroll County.

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
938.00	72.5%	680.05	49.61	61.13	12%
Total Suspended Sediment Load Reduction					
Modeled Baseline Load (tons)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons)**	**Reduction from Current BMPs (tons)**	**Reduction from Planned Strategies (tons)**	**Total % Reduction Achieved**
1280.91	33.8%	432.95	72.24	42.22	9%

Table 14: Comparison of Total Phosphorus and Total Suspended Sediment Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

	Total Phosphorus Delivered Load Reductions (lbs/yr)				
Status	**Pond Retrofits**	**Buffers**	**Easements**	**Stream Restoration**	**Catch Basin/ Inlet Cleaning**
Completed	40.64	3.38	5.51		0.08
Planned	24.85			36.28	
	Total Suspended Sediment Delivered Load Reductions (tons/yr)				
Completed	47.48	3.95	20.78		0.03
Planned	33.14			9.08	

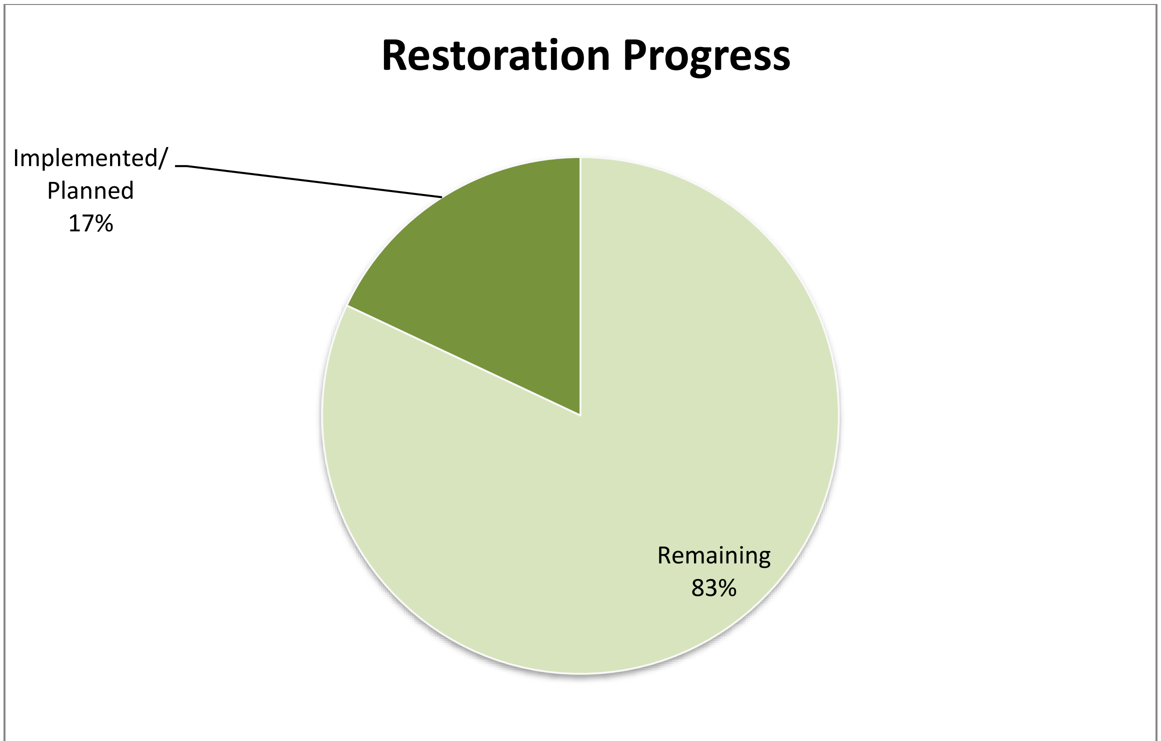

Figure 10: 2019 Restoration Progress Phosphorus

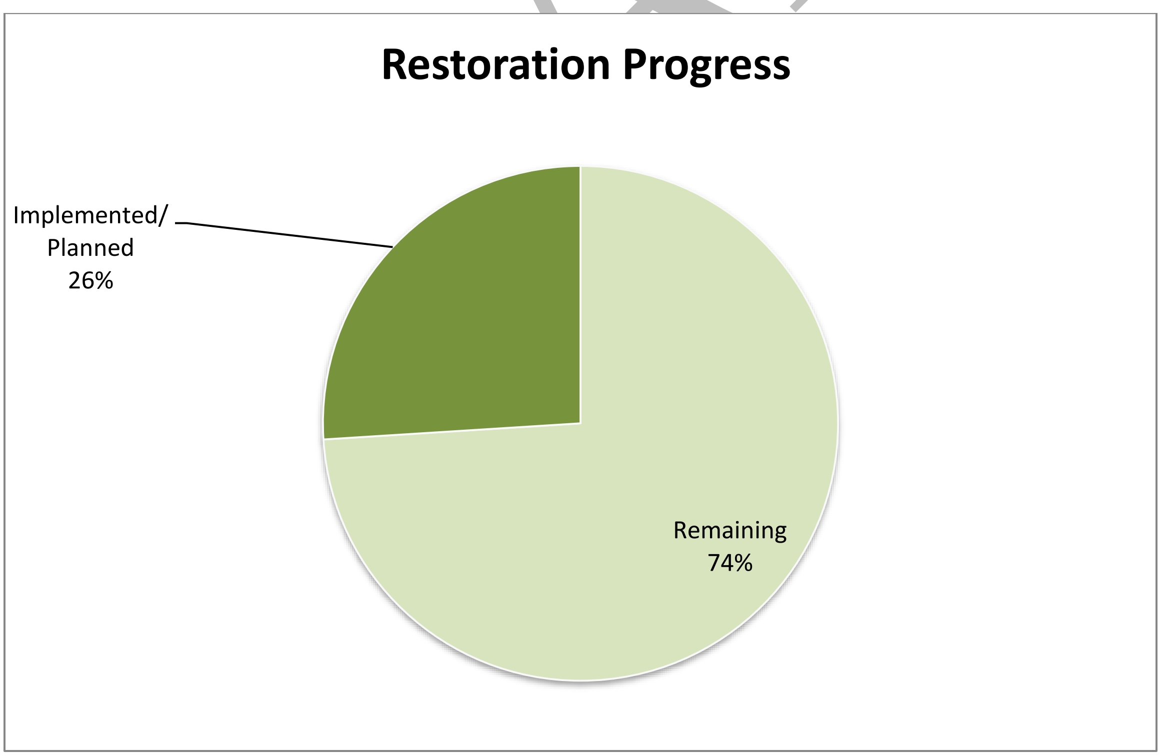

Figure 11: 2019 Restoration Progress Sediment

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Double Pipe Creek Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

Table 15 lists infrastructure related measures that have been implemented since the baseline year that would assist in reducing bacteria counts within the watershed.

Table 15: Waste Collection Infrastructure Upgrades

	County	Manchester	Westminster	Union Bridge	New Windsor
BAT Upgrades	78	0*	0*	0*	0*
Casings/Linings	n/a	TBD	TBD	TBD	TBD
Lateral line replacements	n/a	TBD	TBD	TBD	TBD
Pump Station upgrade	n/a	TBD	TBD	TBD	TBD

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County’s MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

1. Retrofit Monitoring

The BRM currently monitors two locations within the Double Pipe Creek Watershed. The Farm Museum site, shown in Figure 12 is located within the Little Pipe Creek (0276) subwatershed just outside the corporate limits of the City of Westminster. The Greens of Westminster site, shown in Figure 13 is located within the Meadow Branch (0277) subwatershed and is entirely within the corporate limits of the City of Westminster.

The Farm Museum location is a public educational facility owned by the Carroll County Commissioners, with a drainage area of 23 acres, of which 4 acres, or 17% is impervious. The Greens of Westminster location has a drainage area of approximately 41 acres, of which, 15.6 acres or 38% is impervious.

Bi-weekly monitoring at the Farm Museum site began in February of 2015, while monitoring at the Greens of Westminster location started in December of 2017. Both sites involve the collection of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for both sites can be found in Table 16.

Additional monitoring at these locations include spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 16: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00
Total Kjeldahl Nitrogen	0.5 mg/l	SM 4500-NH3 C97

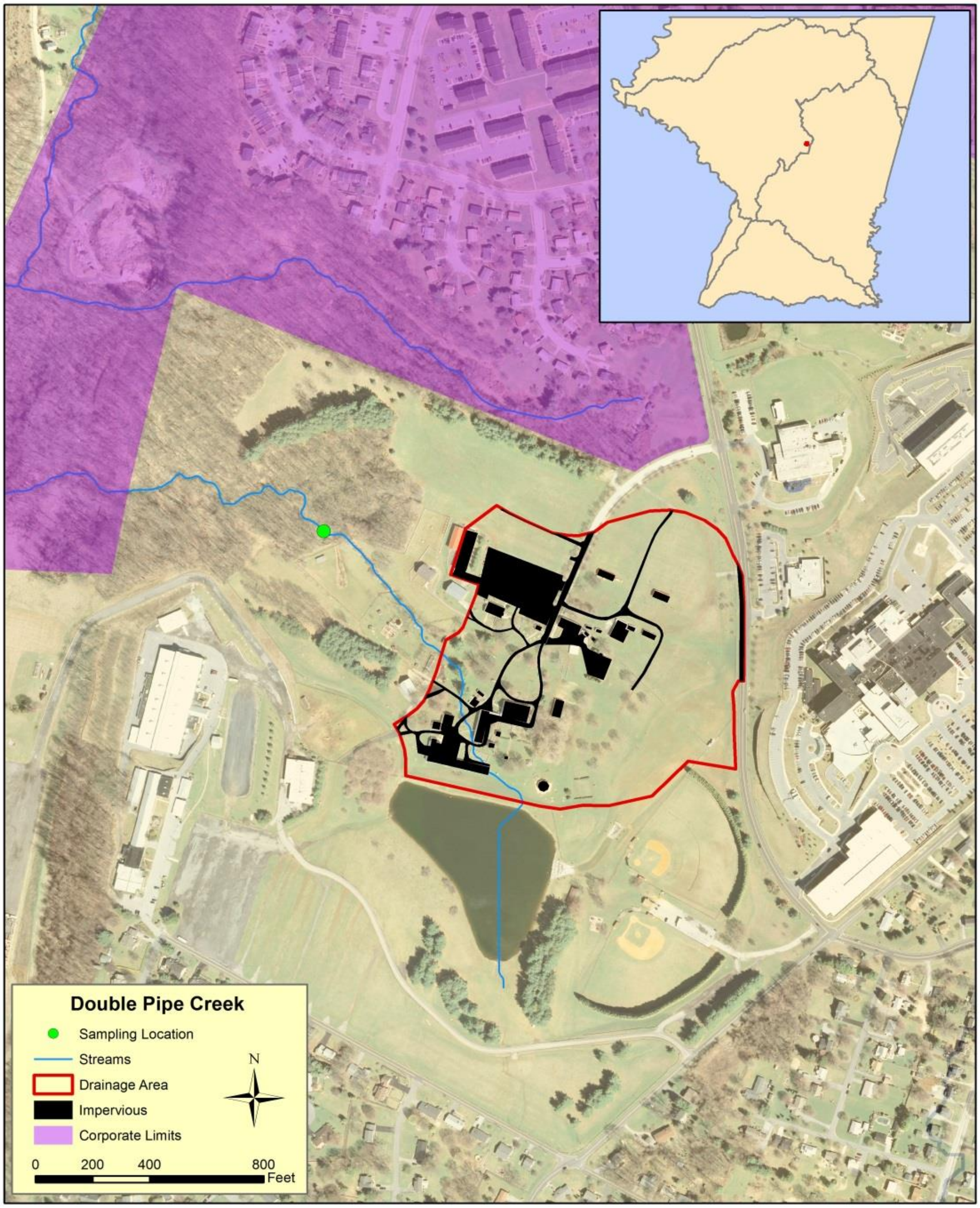

Figure 12: Farm Museum Monitoring Location

Figure 13: Greens of Westminster Monitoring Location

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Double Pipe Creek Watershed began in December of 2017 at two locations, shown in Figure 14. Monitoring was suspended during a project by the City of Westminster and will resume once concluded. Samples are collected on the 1st Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 17 shows the monitoring results for the entire year, whereas Table 18 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 17: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2017		2018	
		# Samples	MPN	# Samples	MPN
LPC03	Low	1	15	5	29
	High	0	n/a	0	n/a
	All	1	15	5	29
LPC06	Low	1	8	5	35
	High	0	n/a	0	n/a
	All	1	8	5	35

Table 18: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2017		2018	
		# Samples	MPN	# Samples	MPN
LPC03	Low	0	n/a	1	43
	High	0	n/a	0	n/a
	All	0	n/a	1	43
LPC06	Low	0	n/a	1	56
	High	0	n/a	0	n/a
	All	0	n/a	1	56

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 19 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 19: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2017		2018	
			# Samples	% Exceeded	# Samples	% Exceeded
LPC03	576	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	410	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	298	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	235	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
LPC06	576	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	410	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	298	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a
	235	Low	**1**	**0%**	**5**	**0%**
		High	n/a	n/a	n/a	n/a

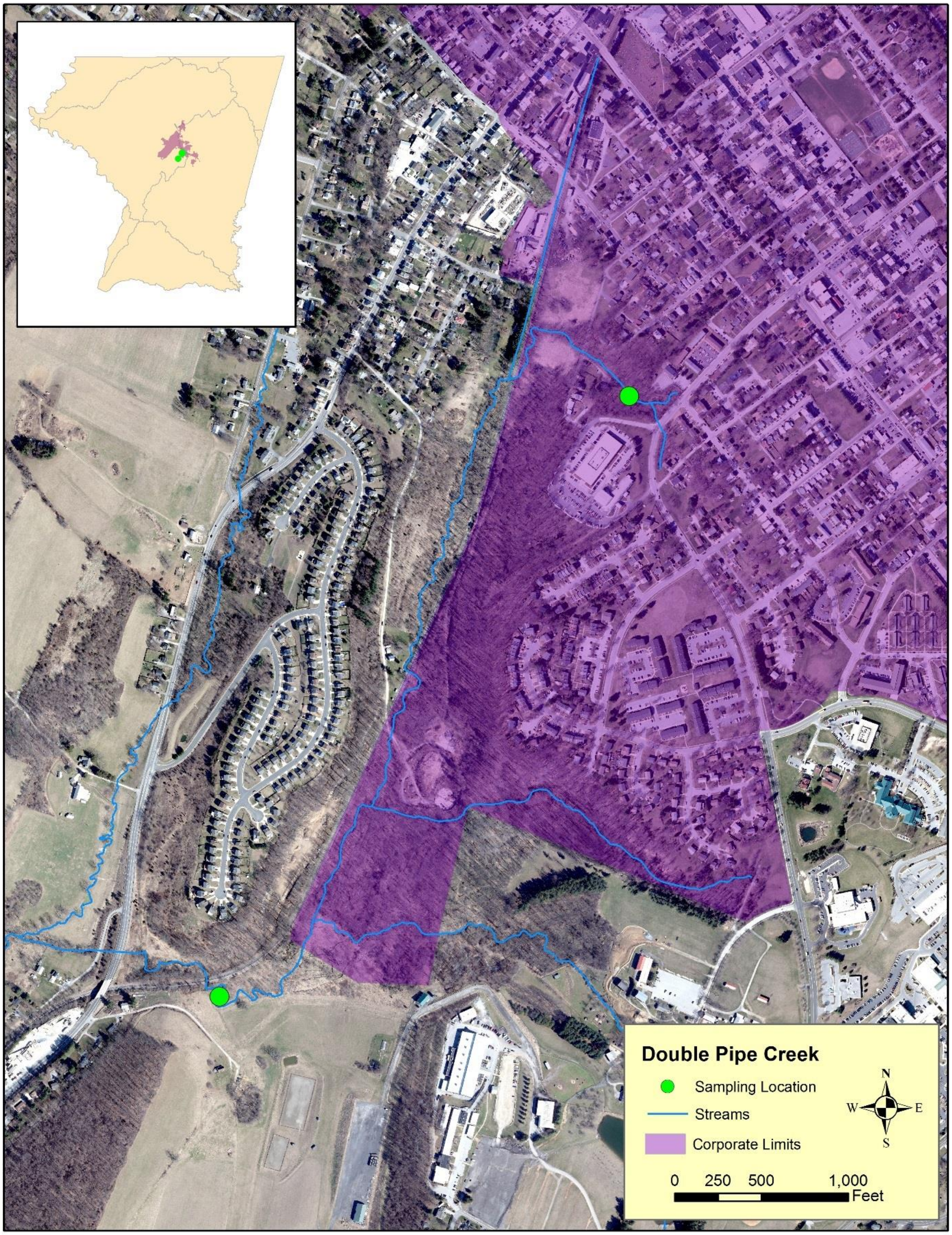

Figure 14: Bacteria Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 21). BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Double Pipe Creek Watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 20, and the tidal water designated use zones are shown in Figure 15.

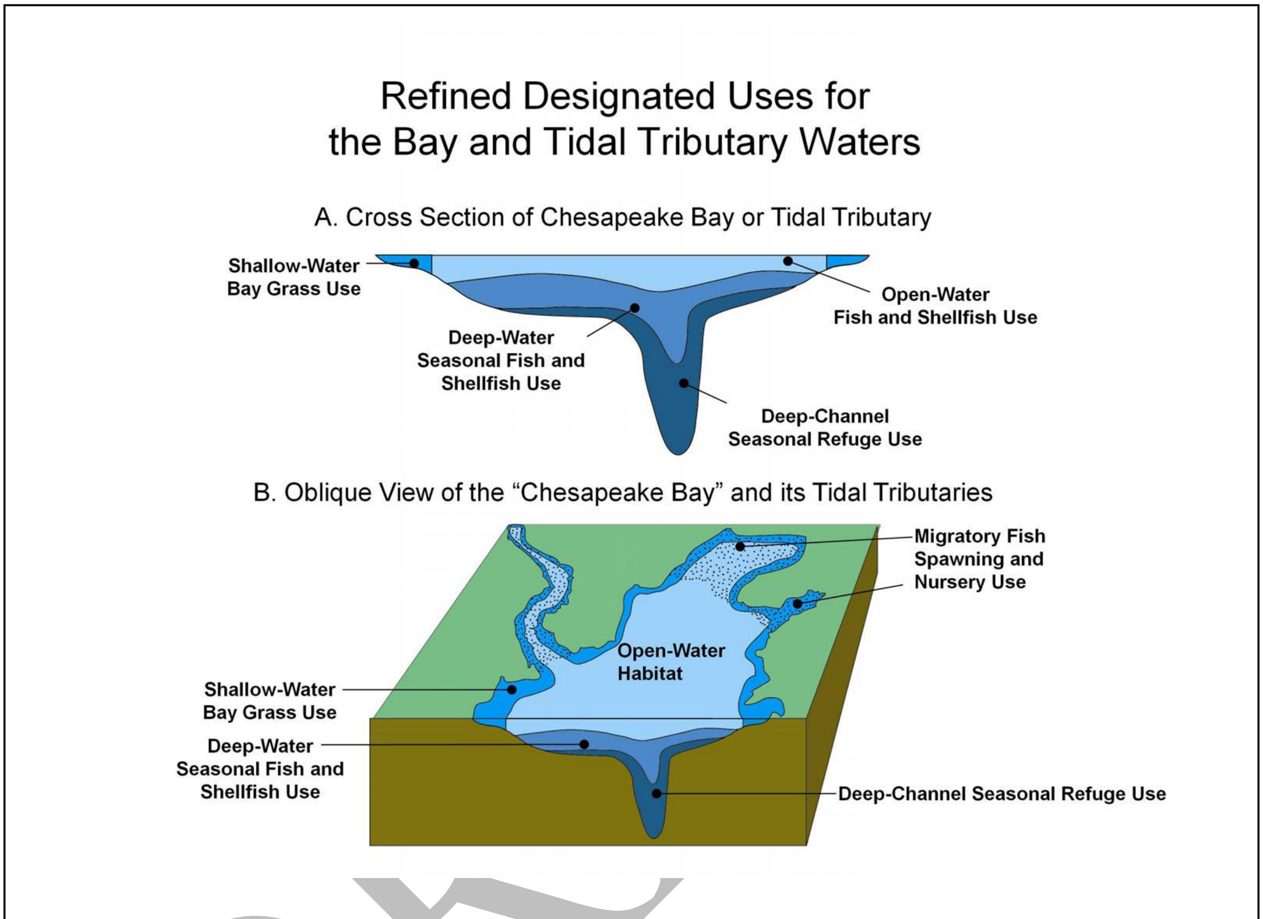

Figure 15: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 20: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Double Pipe Creek Watershed is located within the Potomac River segment of the Chesapeake Bay. The Potomac River segment within Maryland covers 1,539,973 acres, approximately 137,878 acres (9%) of this river segment is within Carroll County. The location of the Potomac River segment is shown in Figure 16.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix E) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 21. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Potomac River segment within the Double Pipe Creek Watershed are 0.47 for phosphorus and 0.65 for suspended sediment (MAST, 2016). There are three delivery ratios for nitrogen, depending on the river segment: PM1_3120_3400, PM1_3450_3400, and PM3_3040_3340, which are 0.30, 0.25, and 0.23, respectively. Essentially, if one pound of nitrogen is discharged into a tributary within the Double Pipe portion of the Potomac River segment, only 25% of that pound is reaching the Bay.

Table 20 shows the Chesapeake Bay TMDL for the Potomac land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Double Pipe Creek Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Double Pipe Creek Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the

Potomac segment shed. The Double Pipe Creek Watershed covers 76.5% of the Potomac land-river segment within Carroll County.

Table 21: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Double Pipe Creek Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
10,100.99	22.07%	2,228.95	152.95	266.16	18.80%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
110,661.46	9.25%	10,232.26	855.30	593.77	14.16%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Potomac land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Double Pipe Creek Watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix E.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 22: Carroll County Potomac River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	**Total Phosphorus (TP)[3]**			**Total Nitrogen (TN)**		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Lower Monocacy Watershed	2.11	31.83	1.5%	35.02	307.19	3.34%
Upper Monocacy Watershed	69.73	57.11	5.69%	473.39	469.79	9.22%
Double Pipe Creek Watershed	152.95	266.16	18.80%	855.30	593.77	14.16%
Total	**224.79**	**355.10**	**25.99%**	**1,363.71**	**1,370.75**	**26.72%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

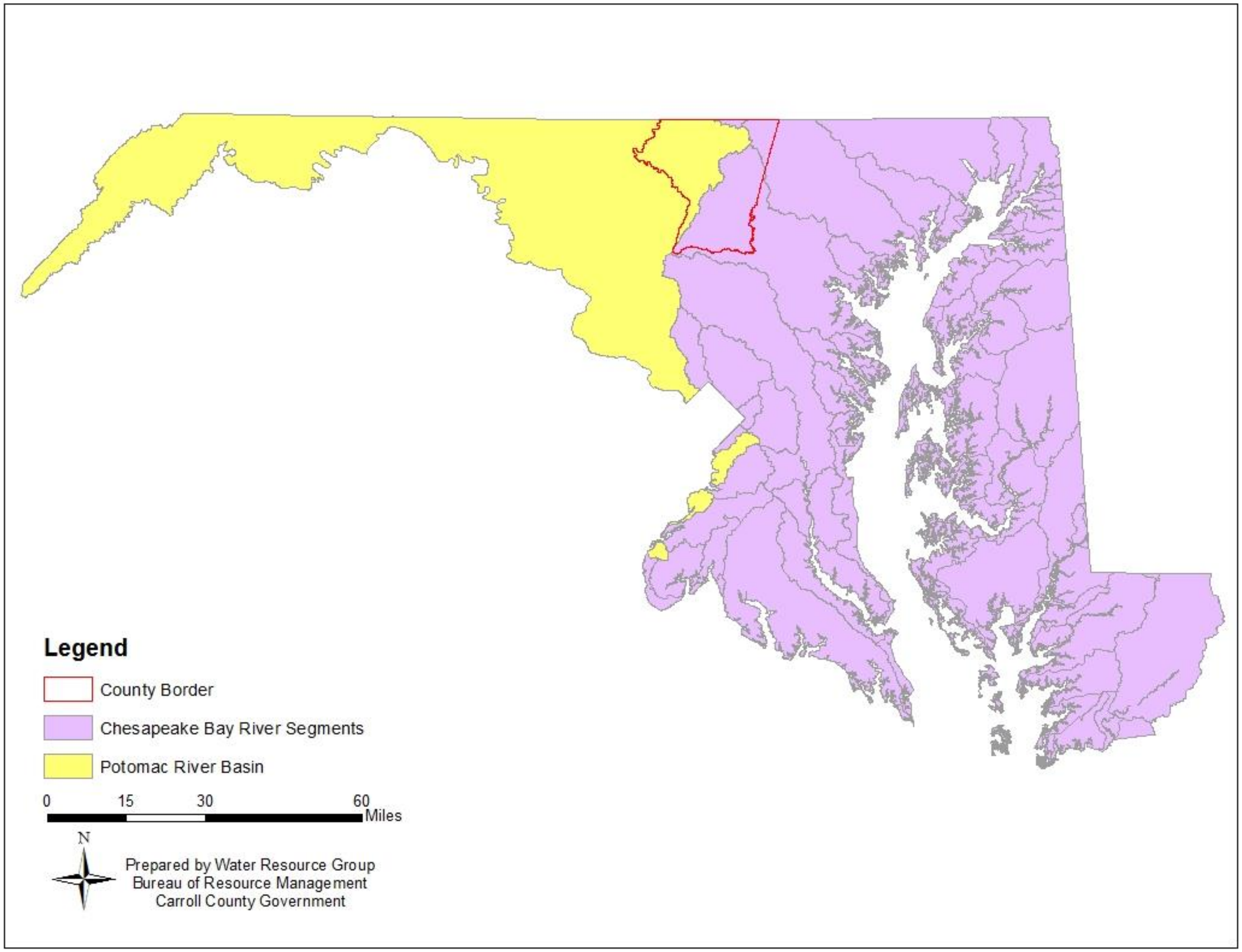

Figure 16: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 13% of the required reduction since the baseline year of 2009. Based on currently identified projects, the required reduction is expected to achieve 17% by 2025. The implementation from baseline through the current CIP is achieving approximately 1.06% reduction in the TMDL/year since the baseline.

The sediment TMDL through 2019 will have achieved 19% of the required reduction since the baseline year of 2000. Based on current projects is expected to achieve 26% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 1.04% reduction in the TMDL/year since the baseline.

If the County is able to achieve a 2.75% reduction rate per year for phosphorus and a 2.5% reduction rate per year for sediment, the sediment and phosphorus TMDLs in the Double Pipe Creek Watershed would be achieved by 2055. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 23 lists the anticipated benchmark for each nutrient TMDL within the Double Pipe Creek Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 23: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2055
Phosphorus	13%	17%	100%
Sediment	19%	26%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Upon draft completion of the Double Pipe Creek Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the Bureau's website. During the thirty day public comment period inputs from any stakeholder or the public will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost	Anticipated Completion
SWM Facilities	County	2130907	Completed	$4,318,182	Completed
Buffer Plantings	County	2130907	Completed	$455,344	Completed
Catch Basin/Inlet Cleaning	New Windsor	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Manchester	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Westminster	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Union Bridge	2130907	Completed	**	Annual
Street Sweeping	Westminster	2130907	Completed	**	Annual
Water/floodplain Easement	Watershed	2130907	Completed	N/A	Completed
SWM (Planned)*	County	2130907	Planning/Design	$5,109,885	FY19-25
TBD*	Watershed	2130907	Planning/Design	$28,000,000	TBD

***Costs for proposed Stormwater facilities are based on current FY19-FY25 project costs, which may be subject to change.**
****Project Costs not reported.**

XIII. Appendix B: Forest Buffer and Grass Buffer Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Silver Run	0.499747	2001
Meadow Branch	4.322408	2001
Meadow Branch	0.031301	2001
Meadow Branch	0.048342	2001
Meadow Branch	0.195628	2002
Meadow Branch	4.604909	2002
Greenwood Overlook	0.020146	2005
Sams Creek	0.021275	2005
Greenwood Overlook	1.5615	2005
Brilhart Property	0.004671	2005
Stone's Throw, Section 2	1.214203	2005
Stone's Throw, Section 2	0.014455	2005
Brilhart Property	0.214226	2005
Camelot Plaza	0.028655	2005
Little Pipe Creek	0.286582	2006
Heather's Land	0.000154	2006
Silver Run	0.16199	2006
Heather's Land	0.031541	2006
Walgarmyr, Section 2	0.103012	2006
Meadow Branch	3.832533	2006
Walgarmyr, Section 2	2.745445	2006
Meadow Branch	0.480212	2006
Big Pipe Creek	15.79883	2006
Hoke Property, OC #2	0.002411	2006
Hoke Property, OC #2	0.005513	2006
Hoke Property, OC #2	0.000001	2006
Heather's Land	0.00226	2006
Silver Run	0.850312	2006
Heather's Land	0.105968	2006
Meadow Branch	0.001036	2006
Hoke Property, OC #2	0.000146	2006
Hoke Property, OC #2	0.000079	2006
Bowling Brook	0.165051	2007
Bowling Brook	0.006586	2007
Bowling Brook	0.003342	2007

Bowling Brook	0.47473	2007
Bowling Brook	0.001163	2007
Bowling Brook	0.122419	2007
Bowling Brook	0.289267	2007
Bowling Brook	0.28219	2007
Arters Mill Estates	0.759966	2007
Cherry Branch/Little Pip*	0.824342	2008
Sterling Ridge Estates	0.002571	2008
Silver Run	0.798376	2008
Sterling Ridge Estates	0.656118	2008
Dutchmans' Bluff	0.537402	2008
Big Pipe Creek	0.039364	2008
Dutchmans' Bluff	1.610619	2008
Dutchmans' Bluff	0.02223	2008
Big Pipe Creek	0.14002	2008
Dutchmans' Bluff	0.000146	2008
Dutchmans' Bluff	0.000079	2008
Lehigh Cement Company	0.815991	2009
Sams Creek	0.207958	2009
Lehigh Cement Company	0.297441	2009
Priestland Branch/Wolf P*	0.770892	2009
Priestland Branch/Wolf P*	0.015621	2009
Sams Creek	0.871106	2009
Lehigh Cement Company	4.710873	2009
Priestland Branch/Wolf P*	0.001046	2009
Priestland Branch/Wolf P*	0.001046	2009
Drifting Snow	0.012816	2010
Big Pipe Creek	0.000976	2010
Drifting Snow	0.001701	2010
Greenvale Mews	0.19557	2010
Little Pipe Creek	0.000364	2010
Little Pipe Creek	2.635458	2010
Greenvale Mews	0.022979	2010
Greenvale Mews	0.232209	2010
Greenvale Mews	0.129904	2010
Meadow Branch	0.632547	2010
Cox Hillside	0.000519	2010
Deep Run	1.096886	2010
Cox Hillside	0.436183	2010
Big Pipe Creek	0.155886	2010
Big Pipe Creek	0.162486	2010

Little Pipe Creek	0.000015	2010
Greenvale Mews	0.004634	2010
Greenvale Mews	0.004634	2010
Greenvale Mews	0.000022	2010
Greenvale Mews	0.000022	2010
Meadow Branch	0.001036	2010
Nadine's Overlook	0.012495	2011
Little Pipe Creek	2.233671	2011
Nadine's Overlook	0.950734	2011
Father's Care, LLC Prope*	0.407079	2011
Little Pipe Creek	0.173619	2011
Father's Care, LLC Prope*	0.885941	2011
Bear Branch	0.158629	2011
Jordans Crossing	0.008824	2012
Jordans Crossing	0.002531	2012
Big Pipe Creek	0.214848	2012
Jordans Crossing	0.246492	2012
Jordans Crossing	0.105036	2012
Big Pipe Creek	0.006038	2012
Big Pipe Creek	0.049611	2012
Sams Creek	21.166948	2015
Sams Creek	0.02894	2015
Was-Mere Acres	0.121091	2015
Was-Mere Acres	0.656231	2015
Was-Mere Acres	0.018013	2015
Big Pipe Creek	1.270809	2015
Big Pipe Creek	0.503489	2015
Was-Mere Acres	1.303992	2015
Was-Mere Acres	1.194162	2015
Sams Creek	0.012083	2015
Sams Creek	0.012083	2015
Bear Branch	0.413334	2016
Medford Quarry Amended	9.217172	2017

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Meadow Branch	0.291417	2001
Sams Creek	1.506742	2001
Silver Run	0.195684	2001
Meadow Branch	0.356696	2002
Big Pipe Creek	4.303266	2002

Meadow Branch	0.00012	2002
Meadow Branch	2.539834	2002
Doves Crest	0.705711	2003
Doves Crest	2.43664	2003
Little Pipe Creek	0.600093	2003
Doves Crest	0.000831	2003
Doves Crest	0.000716	2003
Sunny View Acres	0.062616	2005
Camelot Plaza	0.59231	2005
Camelot Plaza	12.540144	2005
Naomi's Delight	0.241606	2005
Stone's Throw, Section 2	0.918153	2005
Brilhart Property	0.008496	2005
Greenwood Overlook	0.002037	2005
Snavely Forest	0.022865	2005
Little Pipe Creek	0.444514	2005
Meadow Branch	2.656235	2005
Sams Creek	0.001253	2005
Naomi's Delight	2.342045	2005
Brilhart Property	0.104149	2005
Greenwood Overlook	0.648749	2005
Turkeyfoot Run	4.257514	2005
Snavely Forest	7.397423	2005
Hoke Property, OC #2	3.243872	2006
Walgarmyr, Section 2	0.155932	2006
Walgarmyr, Section 2	0.003029	2006
Meadow Branch	0.731093	2006
Meadow Branch	1.031899	2006
Big Pipe Creek	0.707324	2006
Big Pipe Creek	0.110829	2006
Meadow Branch	0.33284	2006
Big Pipe Creek	5.399041	2006
Walgarmyr, Section 2	2.60639	2006
Walgarmyr, Section 2	0.597048	2006
Hoke Property, OC #2	10.53242	2006
Hoke Property, OC #2	0.004648	2006
Hoke Property, OC #2	0.001288	2006
Hoke Property, OC #2	0.000134	2006
Bowling Brook	0.00185	2007
Bowling Brook	0.000684	2007
Bowling Brook	0.686132	2007

Arters Mill Estates	0.364396	2007
Bear Branch	0.418759	2007
Big Pipe Creek	0.590873	2007
Bowling Brook	0.160364	2007
Bowling Brook	2.032802	2007
Dutchmans' Bluff	4.327792	2008
Big Pipe Creek	0.561355	2008
Big Pipe Creek	0.31053	2008
Cherry Branch/Little Pip*	0.107477	2008
Dickenson Run	0.406619	2008
Dutchmans' Bluff	1.487281	2008
Dutchmans' Bluff	0.865191	2008
Dutchmans' Bluff	0.001288	2008
Dutchmans' Bluff	0.000134	2008
Uniontown Bible Church	1.103603	2009
Uniontown Bible Church	0.552112	2009
Uniontown Bible Church	5.992726	2009
Uniontown Bible Church	3.560872	2009
Lehigh Cement Company	0.674208	2009
Priestland Branch/Wolf P*	0.076308	2009
Priestland Branch/Wolf P*	0.087143	2009
Sams Creek	8.513259	2009
Sams Creek	21.65962	2009
Lehigh Cement Company	1.562524	2009
Silver Run Estates - Lo*	0.802246	2010
Drifting Snow	0.054724	2010
Schatzie's Choice, Secti*	0.046963	2010
Bixler Hangover Parcel	0.039258	2010
Krom's Keep	0.002427	2010
Cox Hillside	0.043399	2010
Greenvale Mews	0.440083	2010
Greenvale Mews	0.072271	2010
Big Pipe Creek	0.024401	2010
Big Pipe Creek	2.081584	2010
Big Pipe Creek	0.300847	2010
Meadow Branch	0.425908	2010
Bear Branch	2.517975	2010
Greenvale Mews	0.010387	2010
Greenvale Mews	0.698816	2010
Greenvale Mews	0.023069	2010
Greenvale Mews	0.029469	2010

Deep Run	0.2606	2010
Little Pipe Creek	1.670127	2010
Little Pipe Creek	0.734495	2010
Drifting Snow	0.782751	2010
Bixler Hangover Parcel	1.186291	2010
Krom's Keep	0.031625	2010
Cox Hillside	0.206525	2010
Little Pipe Creek	0.00983	2010
Greenvale Mews	0.020095	2010
Greenvale Mews	0.020095	2010
Nadine's Overlook	0.662134	2011
Nadine's Overlook	0.079099	2011
Father's Care, LLC Prope*	0.00398	2011
Little Pipe Creek	1.23704	2011
Little Pipe Creek	0.411898	2011
Nadine's Overlook	0.004953	2011
Bear Branch	9.402464	2011
Nadine's Overlook	0.000001	2011
Nadine's Overlook	2.748509	2011
Nadine's Overlook	0.675002	2011
Nadine's Overlook	0.14752	2011
Father's Care, LLC Prope*	0.439079	2011
Little Pipe Creek	0.285468	2011
Nadine's Overlook	0.077379	2011
Nadine's Overlook	0.000831	2011
Nadine's Overlook	0.000716	2011
Nadine's Overlook	0.000007	2011
Nadine's Overlook	0.000007	2011
Jordans Crossing	0.005556	2012
Jordans Crossing	0.006565	2012
Bedford Falls Farm	0.217965	2012
Big Pipe Creek	3.90744	2012
Big Pipe Creek	0.426711	2012
Jordans Crossing	0.250612	2012
Jordans Crossing	0.071328	2012
Bedford Falls Farm	1.477757	2012
Jacob's Ridge 2	0.088561	2013
Jacob's Ridge 3	0.013881	2013
Meadow Branch	0.051278	2013
Meadow Branch	0.05071	2013
Jacob's Ridge 2	5.107377	2013

Jacob's Ridge 3	0.037209	2013
Jacob's Ridge 3	3.243542	2013
Meadow Branch	0.311167	2013
Jacob's Ridge 2	0.000007	2013
Jacob's Ridge 3	0.000007	2013
Jacob's Ridge 3	0.000061	2013
Jacob's Ridge 3	0.000061	2013
Was-Mere Acres	1.404828	2015
Was-Mere Acres	3.809993	2015
Was-Mere Acres	0.23423	2015
Sams Creek	1.56634	2015
Sams Creek	0.078326	2015
Dickenson Run	13.210574	2015
Big Pipe Creek	0.594202	2015
Big Pipe Creek	0.29763	2015
Was-Mere Acres	0.325963	2015
Was-Mere Acres	0.935911	2015
Sams Creek	0.025074	2015
Sams Creek	0.025074	2015
Bear Branch	0.715206	2016
McNemar Property OC #1	0.902456	2017
Wakefield Solar	1.594496	2018
Snader's Summit	0.784605	2019
Snader's Summit	2.658072	2019

XIV. Appendix C: Double Pipe Creek BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2008-2019
0281	Bear Branch	Septic Repair	0	0	0	0	0	0	0	2	2	0	1	1	0
		New Construction	0	0	0	0	0	1	1	1	1	0	0	0	4
0282	Bear Branch	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	1	0	0	0	1
0278	Big Pipe Creek	Septic Repair	1	1	0	0	1	0	0	2	2	0	0	0	7
		New Construction	0	0	0	0	0	0	0	0	2	0	0	0	2
0279	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	2	0	0	0	3
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0280	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	1	0	1	2
		New Construction	0	0	0	0	0	0	0	1	0	0	0	0	1
0283	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	1	3	0	0	5
		New Construction	0	0	0	0	0	0	0	1	1	0	0	0	2
0284	Big Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0286	Big Pipe Creek	Septic Repair	0	1	0	0	0	0	0	1	0	1	0	0	3
		New Construction	0	0	0	0	0	0	0	0	2	0	0	0	2
0287	Big Pipe Creek	Septic Repair	0	1	0	0	0	0	1	0	0	0	0	0	2
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0274	Cherry Branch / Little Pipe Creek	Septic Repair	0	0	0	0	0	0	0	1	1	0	0	0	2
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0

0288	Deep Run	Septic Repair	0	0	0	1	0	0	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	1	0	0	0	1
0271	Dickenson Run	Septic Repair	0	0	0	0	0	0	0	1	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0248	Double Pipe Creek	Septic Repair	0	0	0	1	0	0	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0272	Little Pipe Creek	Septic Repair	0	0	0	0	0	1	0	0	0	0	0	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0276	Little Pipe Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	2	1	0	0	4	0	0	0	7
0277	Meadow Branch	Septic Repair	0	0	0	0	0	0	0	0	2	0	1	0	3
		New Construction	0	0	0	0	0	0	2	2	1	0	0	1	6
0273	Priestland / Wolf Pit Branch	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	2	0	0	0	0	2
0268	Sams Creek	Septic Repair	0	0	0	0	0	0	0	1	0	0	1	0	2
		New Construction	0	0	0	0	0	0	0	1	2	0	2	0	5
0269	Sams Creek	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0	0
0285	Silver Run	Septic Repair	0	0	0	0	0	0	0	0	0	1	0	0	1
		New Construction	0	0	0	0	0	1	0	0	0	0	0	0	1
0275	Turkeyfoot Run	Septic Repair	0	0	0	0	0	0	0	1	1	0	1	0	3
		New Construction	0	0	0	0	0	0	0	1	0	0	0	0	1

XV. Appendix D: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

SWM Facilities

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Sunnyside	Facility	30.2	2.69	ST	1.91	0.09449%	39	5.0928	0.15831%	61	1.4849	0.2173%	78	3.07
Friendship Overlook	Retrofit	82.01	15.88	ST	1.68	0.2539%	39	13.68	0.4251%	61	3.99	0.5836%	77	8.24
CC Farm Museum	Facility	6.44	0.45	RR	1.40	0.0333%	64	1.79	0.0414%	75	0.39	0.0478%	80	0.68
Farm Museum 1	Facility	11.61	2.3	RR	1.44	0.0602%	65	3.25	0.0750%	76	0.70	0.0866%	81	1.22
Farm Museum 2	Facility	0.09	0.05	RR	1.00	0.0015%	60	0.08	0.0013%	70	0.01	0.0007%	75	0.01
Farm Museum 3	Facility	0.79	0.06	RR	1.00	0.0038%	60	0.20	0.0047%	70	0.04	0.0055%	75	0.08
Farm Museum 4	Facility	0.03	0.03	RR	1.00	0.0005%	60	0.03	0.0004%	70	0.00	0.0002%	75	0.00
Farm Museum 5	Facility	0.01	0.01	RR	1.00	0.0002%	60	0.01	0.0001%	70	0.00	0.0001%	75	0.00
CC Maintenance	Retrofit	45.49	25.05	ST	2.50	0.4879%	39	26.29	0.5670%	62	5.32	0.3746%	79	5.29
Blue Ridge Manor	Retrofit	36.28	9.26	RR	1.86	0.1940%	67	10.45	0.2416%	78	2.27	0.2790%	83	3.94
Exceptional Center	Retrofit	46.5	14.7	ST	1.51	0.4826%	38	26.01	0.5590%	60	5.24	0.3697%	76	5.22
Langdon	Facility	194	92.1	ST	1.00	1.8495%	35	99.69	2.1422%	55	20.09	1.4169%	70	20.00
Elmer Wolfe	Facility	9.78	4.26	ST	1.40	0.1111%	38	5.32	0.1270%	59	1.07	0.0824%	75	1.06
Locust Wetland	Facility	35.9	11	ST	1.00	0.34%	35%	18.45	0.40%	55%	3.72	0.2622%	70%	3.70

CC Health Dept	Facility	14.77	6.72	RR	2.50	0.27%	68%	14.70	0.23%	79%	2.20	0.1306%	85%	1.84
Long Valley Rd	Facility	98.32	16.64	RR	2.50	0.53%	68%	28.80	0.66%	79%	6.22	0.7679%	85%	10.84
Greens of Westminster Sec6 #2	Retrofit	38.31	12.56	ST	2.11	0.41%	39%	22.03	0.47%	62%	4.45	0.3135%	78%	4.43
New Windsor Railroad Track	Facility	34.5	15.34	ST	1.00	0.33%	35%	17.73	0.38%	55%	3.57	0.2520%	70%	3.56
Avondale Run Phase 2	Retrofit	7.86	1.84	RR	2.50	0.04%	68%	2.30	0.05%	79%	0.50	0.0614%	85%	0.87
Carroll County Airport	Retrofit	38.4	7.4	RR	2.50	0.21%	68%	11.25	0.26%	79%	2.43	0.2999%	85%	4.23
Meadow Ridge 171	Retrofit	22.1	5.73	ST	1.00	0.06%	35%	3.34	0.10%	55%	0.97	0.1425%	70%	2.01
Meadow Ridge 172	Retrofit	18.2	5.35	ST	1.00	0.05%	35%	2.75	0.09%	55%	0.80	0.1174%	70%	1.66

Streambank Regeneration[1]

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Blue Ridge Manor	220	0.03%	1.47	0.14%	1.28	0.016%	441.06	0.22
Total:		**0.03%**	**1.47**	**0.14%**	**1.28**	**0.016%**	**441.06**	**0.22**

[1]A study is currently underway by the County to evaluate streambank regeneration as an innovative practice following the guideline in MDE (2014). In the interim, the default stream restoration credit is combined with equivalent impervious area, as suggested in the 2014 MDE guidance, is used here to estimate nutrient and sediment reductions from this practice. Also see BMP Assumptions in Appendix D.

Floodplain Reconnect

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Mayberry Gun Club	6,000	0.74%	40.05	3.73%	35.00	0.426%	12028.89	6.01
Total:		**0.74%**	**40.05**	**3.73%**	**35.00**	**0.426%**	**12028.89**	**6.01**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Union Bridge	0.44	3.5	1.54 [0.06]	1.4	0.616 [0.02]	420	184.8 [21.58]	0.0107 [0.01]
County	0.4	3.5	1.40 [0.06]	1.4	0.56 [0.02]	420	168.0 [19.62]	0.084 [0.01]
Westminster	0.49	3.5	1.715 [0.07]	1.4	0.686 [0.03]	420	205.8 [24.03]	0.1029 [0.01]
		Total:	**4.655 [0.19]**		**1.862 [0.07]**		**558.6 [65.23]**	**0.1976 [0.03]**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced [delivered] (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced [delivered] (Tons)
Westminster	7.62	11.7	89.154	4	3.56616 [0.14]	0.68	5.1816	4	0.207264 [0.01]	0.18	1.3716	10	0.13716 [0.01]
		Total:	**89.1540**		**3.5662 [0.14]**		**5.1816**		**0.2073 [0.01]**		**1.3716**		**0.1372 [0.01]**

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	4.13	0.0219%	66	1.179	0.0272%	77	0.255	0.0233%	57	0.298
Planting 2	10.85	0.0575%	66	3.099	0.0715%	77	0.670	0.0611%	57	0.783
Planting 3	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 4	1.4	0.0074%	66	0.40	0.0092%	77	0.09	0.0079%	57	0.10
Planting 5	0.5	0.0026%	66	0.14	0.0033%	77	0.03	0.0028%	57	0.04
Planting 6	0.3	0.0016%	66	0.09	0.0020%	77	0.02	0.0017%	57	0.02
Planting 7	0.65	0.0034%	66	0.19	0.0043%	77	0.04	0.0037%	57	0.05
Planting 8	2.3	0.0122%	66	0.66	0.0151%	77	0.14	0.0130%	57	0.17
Planting 9	0.4	0.0021%	66	0.11	0.0026%	77	0.02	0.0023%	57	0.03
Planting 10	2.25	0.0119%	66	0.64	0.0148%	77	0.14	0.0127%	57	0.16
Planting 11	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 12	0.62	0.0033%	66	0.18	0.0041%	77	0.04	0.0035%	57	0.04
Planting 13	1.8	0.0095%	66	0.51	0.0119%	77	0.11	0.0101%	57	0.13
Planting 14	0.9	0.0048%	66	0.26	0.0059%	77	0.06	0.0051%	57	0.06
Planting 15	0.26	0.0014%	66	0.07	0.0017%	77	0.02	0.0015%	57	0.02
Planting 16	3	0.0159%	66	0.86	0.0198%	77	0.19	0.0169%	57	0.22
Planting 17	9	0.0477%	66	2.57	0.0593%	77	0.56	0.0507%	57	0.65
Planting 18	0.13	0.0007%	66	0.04	0.0009%	77	0.01	0.0007%	57	0.01

Planting 19	0.6	0.0032%	66	0.17	0.0040%	77	0.04	0.0034%	57	0.04
Planting 20	0.2	0.0011%	66	0.06	0.0013%	77	0.01	0.0011%	57	0.01
Planting 21	1.25	0.0066%	66	0.36	0.0082%	77	0.08	0.0070%	57	0.09
Planting 22	0.45	0.0024%	66	0.13	0.0030%	77	0.03	0.0025%	57	0.03
Planting 23	2.2	0.0117%	66	0.63	0.0145%	77	0.14	0.0124%	57	0.16
Planting 24	1.62	0.0086%	66	0.46	0.0107%	77	0.10	0.0091%	57	0.12
Planting 25	4.26	0.0226%	66	1.22	0.0281%	77	0.26	0.0240%	57	0.31
Planting 26	1.8	0.0095%	66	0.51	0.0119%	77	0.11	0.0101%	57	0.13
Planting 27	2.05	0.0109%	66	0.59	0.0135%	77	0.13	0.0108%	57	0.15
Planting 28	0.59	0.0031%	66	0.17	0.0039%	77	0.04	0.0031%	57	0.04
Planting 29	0.44	0.0023%	66	0.13	0.0029%	77	0.03	0.0023%	57	0.03
Planting 30	0.17	0.0009%	66	0.05	0.0011%	77	0.01	0.0009%	57	0.01
Planting 31	0.22	0.0012%	66	0.06	0.0014%	77	0.01	0.0012%	57	0.02
Total:	**54.74**									

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 2000-2008	82.960	2000-2008	0.2235%	30	10.69	0.3114%	40	2.62	0.4508%	55	5.77
Grass Buffer 2009-Current	116.930	2009 - current	0.3150%	30	15.07	0.4390%	40	3.69	0.6353%	55	8.14
Total:	**199.89**		**0.5385%**		**25.76**	**0.7504%**		**6.31**	**1.0861%**		**13.91**

Forest Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 2000-2008	43.930	2000-2008	0.1775%	45	8.49	0.1649%	40	1.39	0.2387%	55	3.06
Forest Buffer 2009-Current	54.790	2009 - current	0.2214%	45	10.59	0.2057%	40	1.73	0.2977%	55	3.81
Total:	**98.72**		**0.3989%**		**19.08**	**0.3706%**		**3.12**	**0.5364%**		**6.87**

XVI. Appendix E: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Double Pipe Creek watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2001 and 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table D-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table D-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest
Shrub/Scrub	Open Land

Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table D-2 below and were based on literature and professional judgement.

Table D-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.52	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.52	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation	Imp. (Pervious) values	Imp. (Pervious) values	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.
LD Mixed	2.8 (0.8)	1.21 (0.19)		
MD Mixed	6.2 (0.8)	2.66 (0.30)		
HD Mixed	2.8 (0.8)	2.66 (0.30)		
LD Residential	2.5 (1.3)	1.21 (0.19)		

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was based on dominant watershed parameters

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following

MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table D-3 for the Double Pipe Creek watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table D-3 based on professional judgement.

Table D-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
			2011	2011	2001
LD Mixed	15	>5 to <30	0.43	0.08	253.09
MD Mixed	52	>=30 to <70	1.47	0.19	287.00
HD Mixed	87	>=70	1.53	0.20	288.84
LD Residential	15	>5 to <30	0.43	0.08	253.03

The local TP TMDL baseline year is 2009 and the local TSS TMDL baseline year is 2000, which means any retrofitted water quality BMPs installed since these years can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table D-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Double Pipe Creek watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.041, 0.040, and 0.106, respectively. Note the TSS delivery ratio is based on 2001 land use. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XVII. Appendix F: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Sunnyside	Facility	30.2	2.69	ST	1.91	15.3	41.1570	39%	16.0402	1.69	4.5461	61%	2.7862	0.44	1.1836	78%	0.9230
Friendship Overlook	Retrofit	82.01	15.88	ST	1.68	15.3	242.9640	39%	93.6804	1.69	26.8372	61%	16.2656	0.44	6.9872	77%	5.3891
CC Farm Museum	Facility	6.44	0.45	RR	1.40	15.3	6.8850	64%	4.4280	1.69	0.7605	75%	0.5720	0.44	0.1980	81%	0.1597
Farm Museum 1	Facility	11.61	2.3	RR	1.44	15.3	35.1900	65%	22.7374	1.69	3.8870	76%	2.9367	0.44	1.0120	81%	0.8198
Farm Museum 2	Facility	0.09	0.05	RR	1.00	15.3	0.7650	60%	0.4571	1.69	0.0845	70%	0.0591	0.44	0.0220	75%	0.0165
Farm Museum 3	Facility	0.79	0.06	RR	1.00	15.3	0.9180	60%	0.5485	1.69	0.1014	70%	0.0709	0.44	0.0264	75%	0.0198
Farm Museum 4	Facility	0.03	0.03	RR	1.00	15.3	0.4590	60%	0.2743	1.69	0.0507	70%	0.0354	0.44	0.0132	75%	0.0099
Farm Museum 5	Facility	0.01	0.01	RR	1.00	15.3	0.1530	60%	0.0914	1.69	0.0169	70%	0.0118	0.44	0.0044	75%	0.0033
CC Maintenance	Retrofit	45.49	25.05	ST	2.50	15.3	383.2650	39%	150.6806	1.69	42.3345	62%	26.2462	0.44	11.0220	79%	8.6866
Blue Ridge Manor	Retrofit	36.28	9.26	RR	1.86	15.3	141.6780	67%	94.3535	1.69	15.6494	78%	12.1825	0.44	4.0744	84%	3.4041
Exceptional Center	Retrofit	46.5	14.7	ST	1.51	15.3	224.9100	38%	85.5642	1.69	24.8430	60%	14.8537	0.44	6.4680	76%	4.9216
Langdon	Facility	194	92.1	ST	1.00	15.3	1409.1300	35%	492.4909	1.69	155.6490	55%	85.4824	0.44	40.5240	70%	28.3263
Elmer Wolfe	Facility	9.78	4.26	ST	1.40	15.3	65.1780	38%	24.5094	1.69	7.1994	59%	4.2545	0.44	1.8744	75%	1.4097

Locust Wetland	Facility	35.9	11	ST	1.00	15.3	168.3000	35%	58.8209	1.69	18.5900	55%	10.2096	0.44	4.8400	70%	3.3832
CC Health Dept	Facility	14.77	6.72	RR	2.50	15.3	102.8160	68%	69.6064	1.69	11.3568	79%	8.9505	0.44	2.9568	85%	2.5103
Long Valley Rd	Facility	98.32	16.64	RR	2.50	15.3	254.5920	68%	172.3588	1.69	28.1216	79%	22.1632	0.44	7.3216	85%	6.2159
Greens of Westminster Sec6 #2	Retrofit	38.31	12.56	ST	2.11	15.3	192.1680	39%	75.1774	1.69	21.2264	62%	13.0666	0.44	5.5264	78%	4.3278
New Windsor Railroad Track	Facility	34.5	15.34	ST	1.00	15.3	234.7020	35%	82.0283	1.69	25.9246	55%	14.2378	0.44	6.7496	70%	4.7180
Avondale Run Phase 2	Retrofit	7.86	1.84	RR	2.50	15.3	28.1520	68%	19.0589	1.69	3.1096	79%	2.4507	0.44	0.8096	85%	0.6873
Carroll County Airport	Retrofit	38.4	7.4	RR	2.50	15.3	113.2200	68%	76.6499	1.69	12.5060	79%	9.8562	0.44	3.2560	85%	2.7643
Meadow Ridge 171	Retrofit	22.1	5.73	ST	1.00	15.3	87.6690	35%	30.6403	1.69	9.6837	55%	5.3183	0.44	2.5212	70%	1.7623
Meadow Ridge 172	Retrofit	18.2	5.35	ST	1.00	15.3	81.8550	35%	28.6083	1.69	9.0415	55%	4.9656	0.44	2.3540	70%	1.6454
Total:		**771.59**	**249.42**				**3816.1260**		**1598.8055**		**421.5198**		**256.9755**		**109.7448**		**82.1038**

SWM Facilities

Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Sunnyside	Facility	30.2	27.51	ST	1.91	10.8	297.1080	39%	115.7926	0.43	11.8293	61%	7.2500	0.07	1.9257	78%	1.5017
Friendship Overlook	Retrofit	82.01	66.13	ST	1.68	10.8	714.2040	39%	275.3779	0.43	28.4359	61%	17.2345	0.07	4.6291	77%	3.5704

Farm Museum	Facility	6.44	5.99	RR	1.40	10.8	64.6920	64%	41.6061	0.43	2.5757	75%	1.9372	0.07	0.4193	81%	0.3381
Farm Museum 1	Facility	11.61	9.31	RR	1.44	10.8	100.5480	65%	64.9674	0.43	4.0033	76%	3.0246	0.07	0.6517	81%	0.5279
Farm Museum 2	Facility	0.09	0.04	RR	1.00	10.8	0.4320	60%	0.2581	0.43	0.0172	70%	0.0120	0.07	0.0028	75%	0.0021
Farm Museum 3	Facility	0.79	0.73	RR	1.00	10.8	7.8840	60%	4.7107	0.43	0.3139	70%	0.2194	0.07	0.0511	75%	0.0383
Farm Museum 4	Facility	0.03	0	RR	1.00	10.8	0.0000	60%	0.0000	0.43	0.0000	70%	0.0000	0.07	0.0000	75%	0.0000
Farm Museum 5	Facility	0.01	0	RR	1.00	10.8	0.0000	60%	0.0000	0.43	0.0000	70%	0.0000	0.07	0.0000	75%	0.0000
CC Maintenance	Retrofit	45.49	20.44	ST	2.50	10.8	220.7520	39%	86.7886	0.43	8.7892	62%	5.4491	0.07	1.4308	79%	1.1276
Blue Ridge Manor	Retrofit	36.28	27.02	RR	1.86	10.8	291.8160	67%	194.3412	0.43	11.6186	78%	9.0447	0.07	1.8914	84%	1.5802
Exceptional Center	Retrofit	46.5	31.8	ST	1.51	10.8	343.4400	38%	130.6575	0.43	13.6740	60%	8.1757	0.07	2.2260	76%	1.6938
Langdon	Facility	194	101.9	ST	1.00	10.8	1100.5200	35%	384.6317	0.43	43.8170	55%	24.0643	0.07	7.1330	70%	4.9860
Elmer Wolfe	Facility	9.78	5.52	ST	1.40	10.8	59.6160	38%	22.4179	0.43	2.3736	59%	1.4027	0.07	0.3864	75%	0.2906
Locust Wetland	Facility	35.9	24.9	ST	1.00	10.8	268.9200	35%	93.9875	0.43	10.7070	55%	5.8803	0.07	1.7430	70%	1.2184
CC Health Dept	Facility	14.77	8.05	RR	2.50	10.8	86.9400	68%	58.8584	0.43	3.4615	79%	2.7281	0.07	0.5635	85%	0.4784
Long Valley Rd	Facility	98.32	81.68	RR	2.50	10.8	882.1440	68%	597.2115	0.43	35.1224	79%	27.6806	0.07	5.7176	85%	4.8541
Greens of Westminster Sec6 #2	Retrofit	38.31	25.75	ST	2.11	10.8	278.1000	39%	108.7946	0.43	11.0725	62%	6.8160	0.07	1.8025	78%	1.4116
New Windsor Railroad Track	Facility	34.5	19.16	ST	1.00	10.8	206.9280	35%	72.3213	0.43	8.2388	55%	4.5247	0.07	1.3412	70%	0.9375
Avondale Run Phase 2	Retrofit	7.86	6.02	RR	2.50	10.8	65.0160	68%	44.0158	0.43	2.5886	79%	2.0401	0.07	0.4214	85%	0.3578
Carroll County Airport	Retrofit	38.4	31	RR	2.50	10.8	334.8000	68%	226.6596	0.43	13.3300	79%	10.5056	0.07	2.1700	85%	1.8423
Meadow Ridge 171	Retrofit	22.1	16.37	ST	1.00	10.8	176.7960	35%	61.7902	0.43	7.0391	55%	3.8659	0.07	1.1459	70%	0.8010

Meadow Ridge 172	Retrofit	18.2	12.85	ST	1.00	10.8	138.7800	35%	48.5036	0.43	5.5255	55%	3.0346	0.07	0.8995	70%	0.6288
	Total:	**771.59**	**522.17**				**5639.4360**		**2633.6925**		**224.5331**		**144.8901**		**36.5519**		**28.1865**

Catch Basin/inlet Cleaning

Location	Tons*	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Manchester		3.5	0.000	1.4	0.000	420	0	0.000
New Windsor		3.5	0.000	1.4	0.000	420	0	0.000
Union Bridge	0.44	3.5	1.540	1.4	0.616	420	184.8	0.092
County	0.4	3.5	1.400	1.4	0.560	420	168	0.084
Westminster	0.49	3.5	1.715	1.4	0.686	420	205.8	0.103
		Total:	**4.6550**		**1.8620**		**559**	**0.279**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Westminster	7.62	11.7	89.154	4	3.56616	0.68	5.1816	4	0.207264	0.18	1.3716	10	0.13716
		Total:	**89.1540**		**3.5662**		**5.1816**		**0.2073**		**1.3716**		**0.1372**

Streambank Regeneration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Blue Ridge Manor	220	0.075	16.500	0.068	14.960	44.8	9856	4.928
		Total:	**16.5000**		**14.9600**		**9,856**	**4.928**

Floodplain Reconnect

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Mayberry Gun Club	6,255.00	0.075	469.125	0.068	425.340	44.8	280224	140.112
		Total:	**469.1250**		**425.3400**		**280,224**	**140.112**

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	4.13	10.8	44.6040	66	29.4386	0.43	1.7759	77	1.3674	0.07	0.2891	57	0.1648
Planting 2	10.85	10.8	117.1800	66	77.3388	0.43	4.6655	77	3.5924	0.07	0.7595	57	0.4329
Planting 3	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 4	1.4	10.8	15.1200	66	9.9792	0.43	0.6020	77	0.4635	0.07	0.0980	57	0.0559
Planting 5	0.5	10.8	5.4000	66	3.5640	0.43	0.2150	77	0.1656	0.07	0.0350	57	0.0200

Planting 6	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 7	0.65	10.8	7.0200	66	4.6332	0.43	0.2795	77	0.2152	0.07	0.0455	57	0.0259
Planting 8	2.3	10.8	24.8400	66	16.3944	0.43	0.9890	77	0.7615	0.07	0.1610	57	0.0918
Planting 9	0.4	10.8	4.3200	66	2.8512	0.43	0.1720	77	0.1324	0.07	0.0280	57	0.0160
Planting 10	2.25	10.8	24.3000	66	16.0380	0.43	0.9675	77	0.7450	0.07	0.1575	57	0.0898
Planting 11	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 12	0.62	10.8	6.6960	66	4.4194	0.43	0.2666	77	0.2053	0.07	0.0434	57	0.0247
Planting 13	1.8	10.8	19.4400	66	12.8304	0.43	0.7740	77	0.5960	0.07	0.1260	57	0.0718
Planting 14	0.9	10.8	9.7200	66	6.4152	0.43	0.3870	77	0.2980	0.07	0.0630	57	0.0359
Planting 15	0.26	10.8	2.8080	66	1.8533	0.43	0.1118	77	0.0861	0.07	0.0182	57	0.0104
Planting 16	3	10.8	32.4000	66	21.3840	0.43	1.2900	77	0.9933	0.07	0.2100	57	0.1197
Planting 17	9	10.8	97.2000	66	64.1520	0.43	3.8700	77	2.9799	0.07	0.6300	57	0.3591
Planting 18	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Planting 19	0.6	10.8	6.4800	66	4.2768	0.43	0.2580	77	0.1987	0.07	0.0420	57	0.0239
Planting 20	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 21	1.25	10.8	13.5000	66	8.9100	0.43	0.5375	77	0.4139	0.07	0.0875	57	0.0499
Planting 22	0.45	10.8	4.8600	66	3.2076	0.43	0.1935	77	0.1490	0.07	0.0315	57	0.0180
Planting 23	2.2	10.8	23.7600	66	15.6816	0.43	0.9460	77	0.7284	0.07	0.1540	57	0.0878
Planting 24	1.62	10.8	17.4960	66	11.5474	0.43	0.6966	77	0.5364	0.07	0.1134	57	0.0646
Planting 25	4.26	10.8	46.0080	66	30.3653	0.43	1.8318	77	1.4105	0.07	0.2982	57	0.1700
Planting 26	1.8	10.8	19.4400	66	12.8304	0.43	0.7740	77	0.5960	0.07	0.1260	57	0.0718
Planting 27	2.05	10.8	22.1400	66	14.6124	0.43	0.8815	77	0.6788	0.07	0.1435	57	0.0818
Planting 28	0.59	10.8	6.3720	66	4.2055	0.43	0.2537	77	0.1953	0.07	0.0413	57	0.0235

Planting 29	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 30	0.17	10.8	1.8360	66	1.2118	0.43	0.0731	77	0.0563	0.07	0.0119	57	0.0068
Planting 31	0.22	10.8	2.3760	66	1.5682	0.43	0.0946	77	0.0728	0.07	0.0154	57	0.0088
Total:	**54.74**		**591.1920**		**390.1867**		**23.5382**		**18.1244**		**3.8318**		**2.1841**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficie
Grass Buffer 2000-2008	82.960	2000-2008	11.7	970.6320	30	291.18960	0.68	56.4128	40	22.5651	0.18	14.9328	55
Grass Buffer 2009-Current	116.930	2009 -current	11.7	1368.0810	30	410.42430	0.68	79.5124	40	31.8050	0.18	21.0474	55
	199.890		**Total:**	**2338.7130**		**701.61390**		**135.9252**		**54.3701**		**35.9802**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficie
Forest Buffer 2000-2008	43.930	2000-2008	11.7	513.9810	45	231.2915	0.68	29.8724	40	11.9490	0.18	7.9074	55
Forest Buffer 2009-Current	54.790	2009 -current	11.7	641.0430	45	288.4694	0.68	37.2572	40	14.9029	0.18	9.8622	55
	98.720		**Total:**	**1155.0240**		**519.76080**		**67.1296**		**26.8518**		**17.7696**	

Liberty Reservoir Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Liberty Watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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I. Introduction

The Liberty Reservoir Watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for bacteria in 2002; a TMDL for bacteria was developed and approved in December of 2009. The Maryland Department of the Environment (MDE) identified Liberty Reservoir on the State's 2010 Integrated Report as impaired by sediments - sedimentation/siltation (1996), nutrients - phosphorus (1996). A Total Maximum Daily Load (TMDL) for phosphorus and sediment was developed and approved in May of 2014.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Towns of Manchester, Westminster and Hampstead, and the Patapsco Chapter of Trout Unlimited.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Liberty Reservoir and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Liberty Watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Liberty Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the Rural Legacy Area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Liberty Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

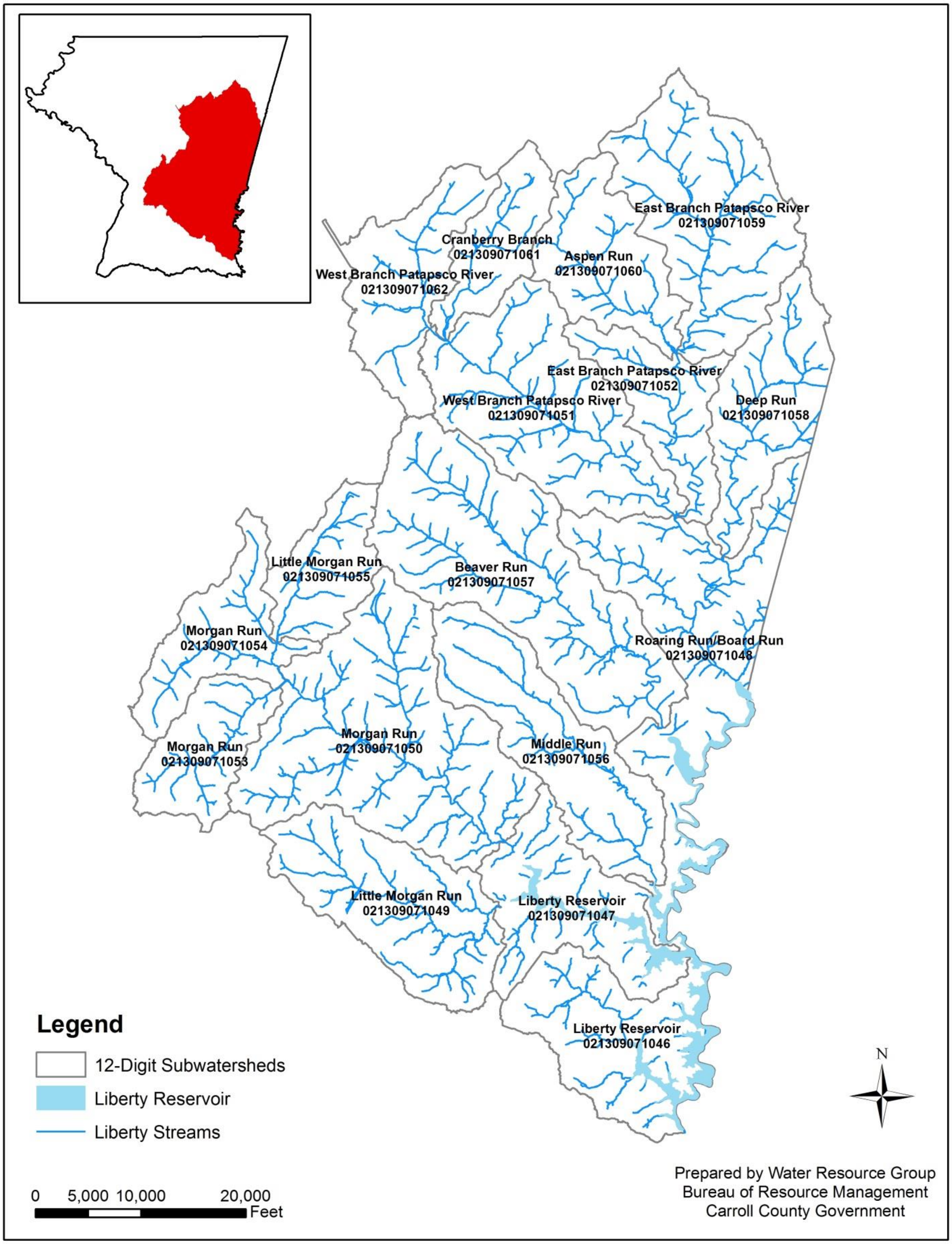


Figure 1: Liberty Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

Designated Uses	Use Classes							
	I	I-P	II	II-P	III	III-P	IV	IV-P
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Liberty Watershed Water Quality Standards

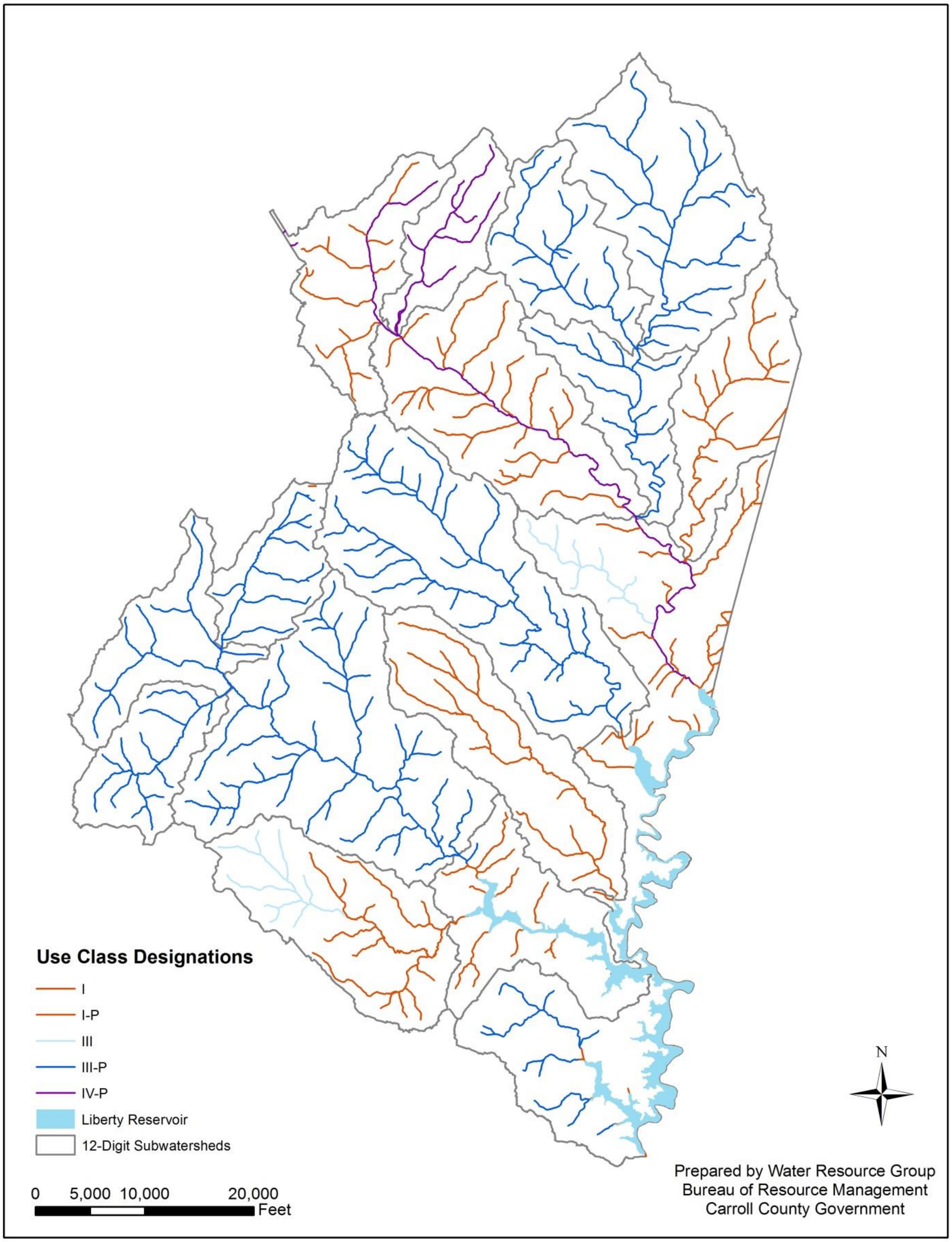
The Liberty Watershed within Carroll County has multiple designated uses throughout the watershed and range from use I; non-tidal warm water to use IV-P; recreational trout waters and public water supply. The use III-P is capable of growing and propagating trout, but may not be capable of supporting adult trout for a put-and-take fishery. The designated use for each stream segment within the Liberty Watershed as determined by MDE can be found in Figure 2.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576



Source: MDE

Figure 2: Liberty Watershed Designated Uses

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQS). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the Liberty Watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. This restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Liberty Reservoir Watershed was determined by (MDE, 2009) to be 86,352 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 9,326 billion MPN/year, which is a reduction of 77,026 billion MPN/year (89.2%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Liberty Reservoir Watershed.

Table 3: Liberty Reservoir 8-digit Watershed Bacteria TMDL

Liberty Reservoir Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	67,250	7,263	89.2%
Hampstead	4,241	458	89.2%
Manchester	2,250	243	89.2%
Westminster	12,611	1,362	89.2%
Total	**86,352**	**9,326**	**89.2%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 13,889 lbs. /yr., the TMDL for the stormwater WLA was determined to be 6,995 lbs. /yr., which is a reduction of 6,934 lbs. /yr. (50%) from the current loading (Table 4). The baseline loads for the County and Towns were derived from the TMDL Data Center. These baseline loads were combined and compared to the combined allocations for the County and Towns to derive the total percent reduction required. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2012).

Table 4: Liberty 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	12,204	6,102	50%
Municipalities	1,685	893	47%
Total	**13,889**	**6,995**	**50%**

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Liberty Reservoir. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

c. Sediment

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 4,630 tons/yr., the TMDL for the stormwater WLA was determined to be 2,880 tons/yr., which is a reduction of 1,750 tons/yr. (38%) from the current loading (Table 5).

Table 5: Liberty 8-digit Watershed Sediment TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	4,016	2,530	37%
Municipalities	614	350	43%
Total	**4,630**	**2,880**	**38%**

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Liberty Watershed is located along the Eastern portion of the County. The watershed is within the Patapsco River Basin, which lies within the Piedmont physiographic province of Maryland. There are seventeen (17) major sub-watersheds in the County that cover a total land area of 87,249 acres. Figure 1 depicts the location of the Liberty Watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Liberty Watershed, agriculture is the dominant land cover at about 37 percent of the total land, followed by forest which accounts for 31 percent, and residential, which accounts for about 22 percent of the total land cover. Mixed urban accounts for less than 5 percent of the total land cover, which represents the relatively rural nature of the Liberty Watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 Accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 8% increase in low-density residential land cover since 2011, which has been incorporated into Table 5.

Table 6 shows the current land cover data for the Liberty Watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Liberty Watershed can be found in Figure 3.

Table 6: Liberty Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	1,097	1%	1,284	1%	1,290	1%	1,289	1%
Low-Density Residential	11,711	13%	11,733	13%	11,904	14%	19,080	22%
Low-Density Mixed Urban	2,684	3%	2,720	3%	2,795	3%	2,795	3%
Medium-Density Mixed Urban	1,067	1%	1,205	1%	1,323	1.5%	1,323	1.5%
High-Density Mixed Urban	284	<1%	371	<1%	412	<1%	412	<1%
Barren Land	246	<1%	228	<1%	201	<1%	197	<1%
Forest	27,748	32%	27,606	32%	27,616	32%	26,804	31%
Shrub/Scrub	1,796	2%	1,774	2%	1,786	2%	1,476	1.7%
Grassland	177	<1%	289	<1%	276	<1%	224	<1%
Pasture/Hay	14,686	17%	14,277	16%	14,195	16%	12,078	14%
Cropland	24,275	28%	24,427	28%	24,116	28%	20,323	23%
Wetland	1,453	2%	1,309	1.5%	1,308	1.5%	1,286	1.5%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Liberty Watershed is estimated to have 5,770 acres of total impervious within the catchment and accounts for approximately 6.6 percent of the total land area. The impervious surface area within Liberty, by subwatershed can be found in Table 7 and is shown in Figure 4.

Table 7: Liberty Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
1060	Aspen Run	3,668	128	3.5
1057	Beaver Run	9,322	752	8.0
1061	Cranberry Branch	2,337	165	7.1
1058	Deep Run	4,154	220	5.3
1052	East Branch Patapsco	2,937	124	4.2
1059	East Branch Patapsco	6,781	468	6.9
1046	Snowden's Run	5,142	564	11.0
1047	Liberty Reservoir	4,509	214	4.7
1049	Little Morgan Run	5,529	395	7.1
1055	Little Morgan Run	2,406	95	3.9
1056	Middle Run	5,472	266	4.9
1053	Morgan Run	2,698	95	3.5
1054	Morgan Run	3,169	103	3.3
1050	Morgan Run	10,153	415	4.1
1048	Roaring Run	8,085	489	6.0
1051	West Branch Patapsco	7,065	442	6.3
1062	West Branch Patapsco	3,822	835	21.8
Liberty Watershed		**87,249**	**5,770**	**6.6**

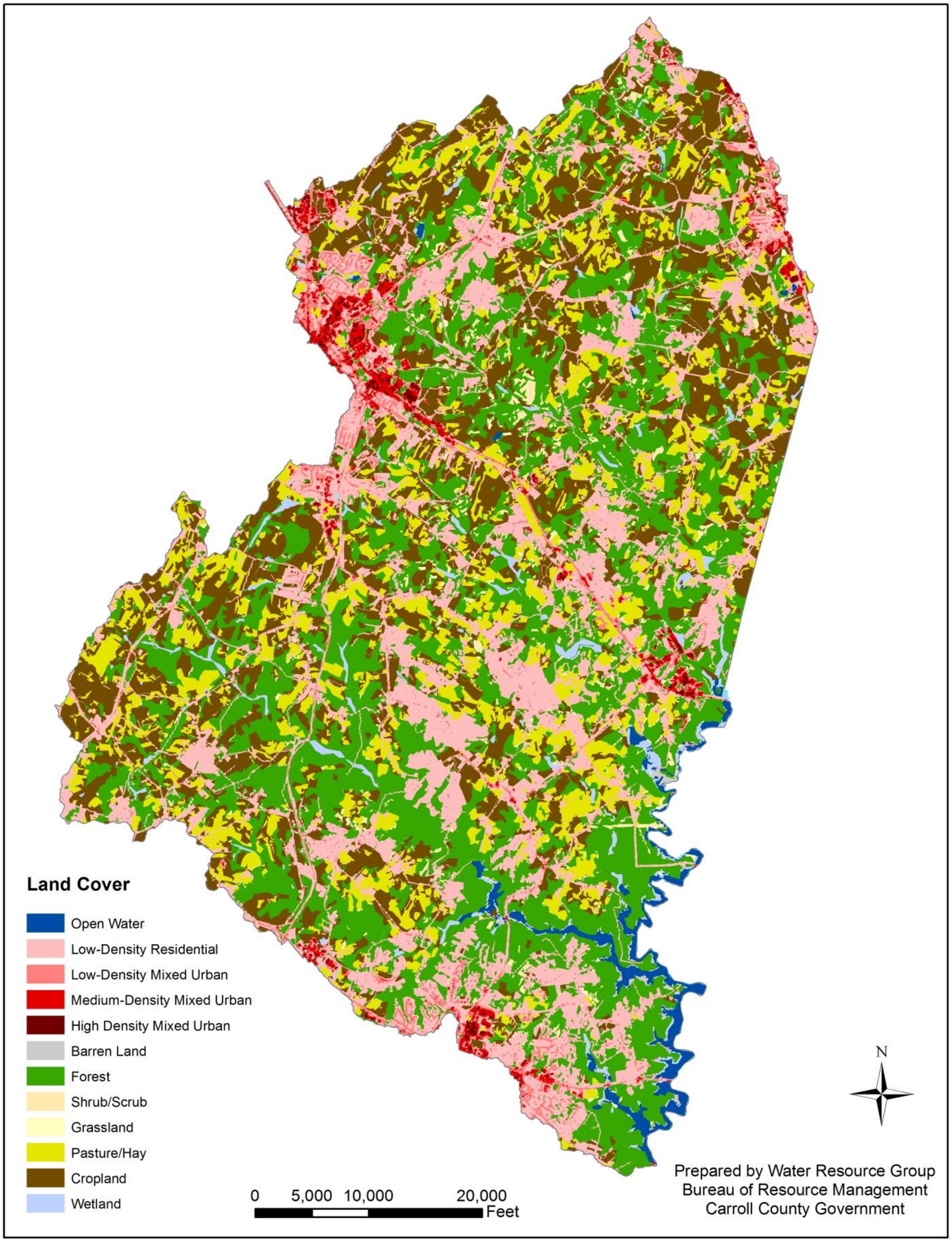


Figure 3: Liberty Watershed Land Use/Land Cover

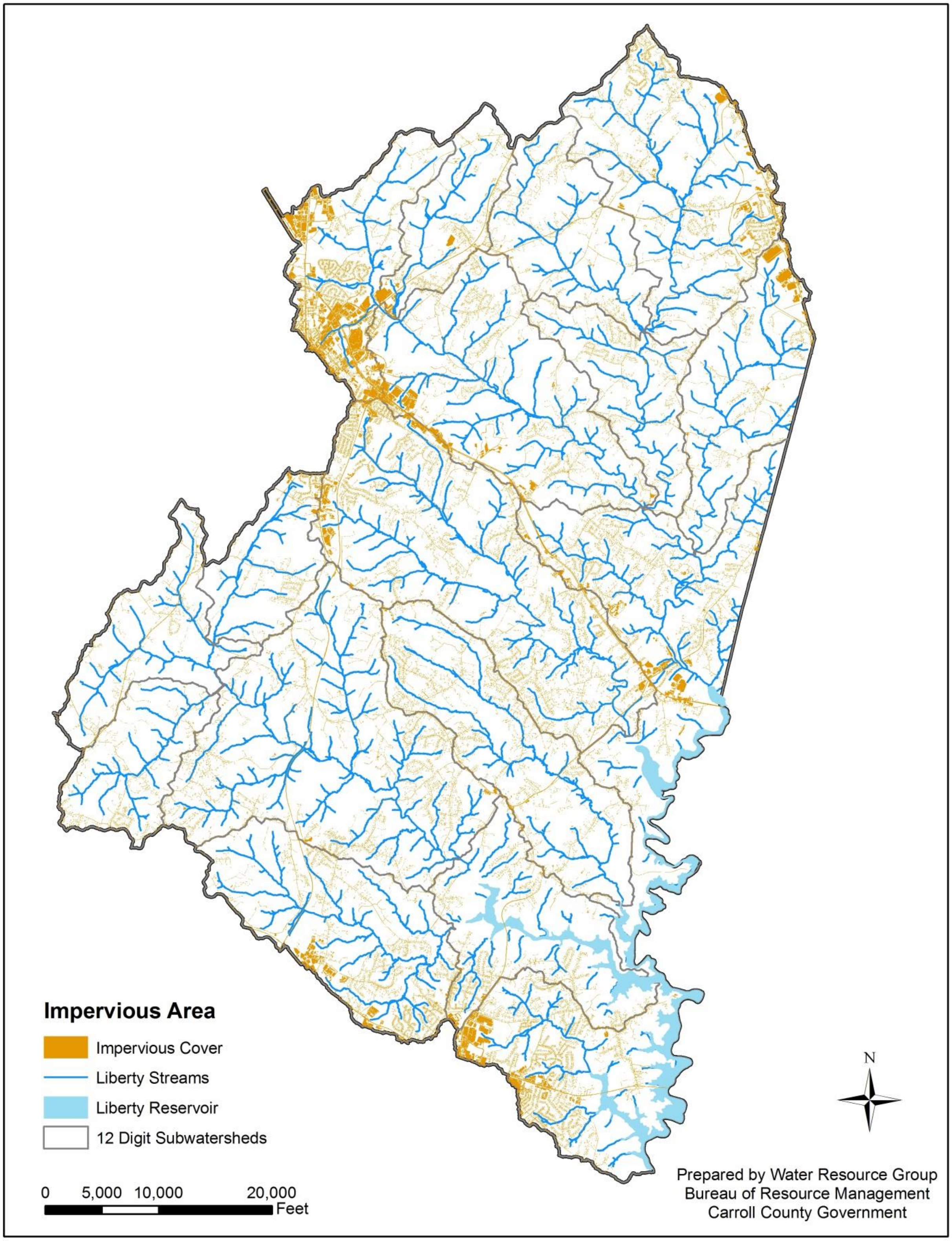


Figure 4: Liberty Watershed Impervious Surface Area

C. Watershed Characterization

Following the Liberty stream corridor assessment (SCA), completed in 2012, a Watershed Characterization for the Liberty Watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Liberty Watershed SCA will be used as the foundation for the watershed restoration plan. The Liberty SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/Liberty/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/Liberty/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Liberty Watershed, sections of Roaring Run, Beaver Run, Middle Run, Morgan Run, and Little Morgan Run are listed as Tier II waters. Tier II designated stream segments for the Liberty Watershed can be found in Figure 5.

b. Ecologically Sensitive Areas

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State (imap.maryland.gov). Targeted ecological areas within the Liberty Watershed are shown in Figure 6.

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

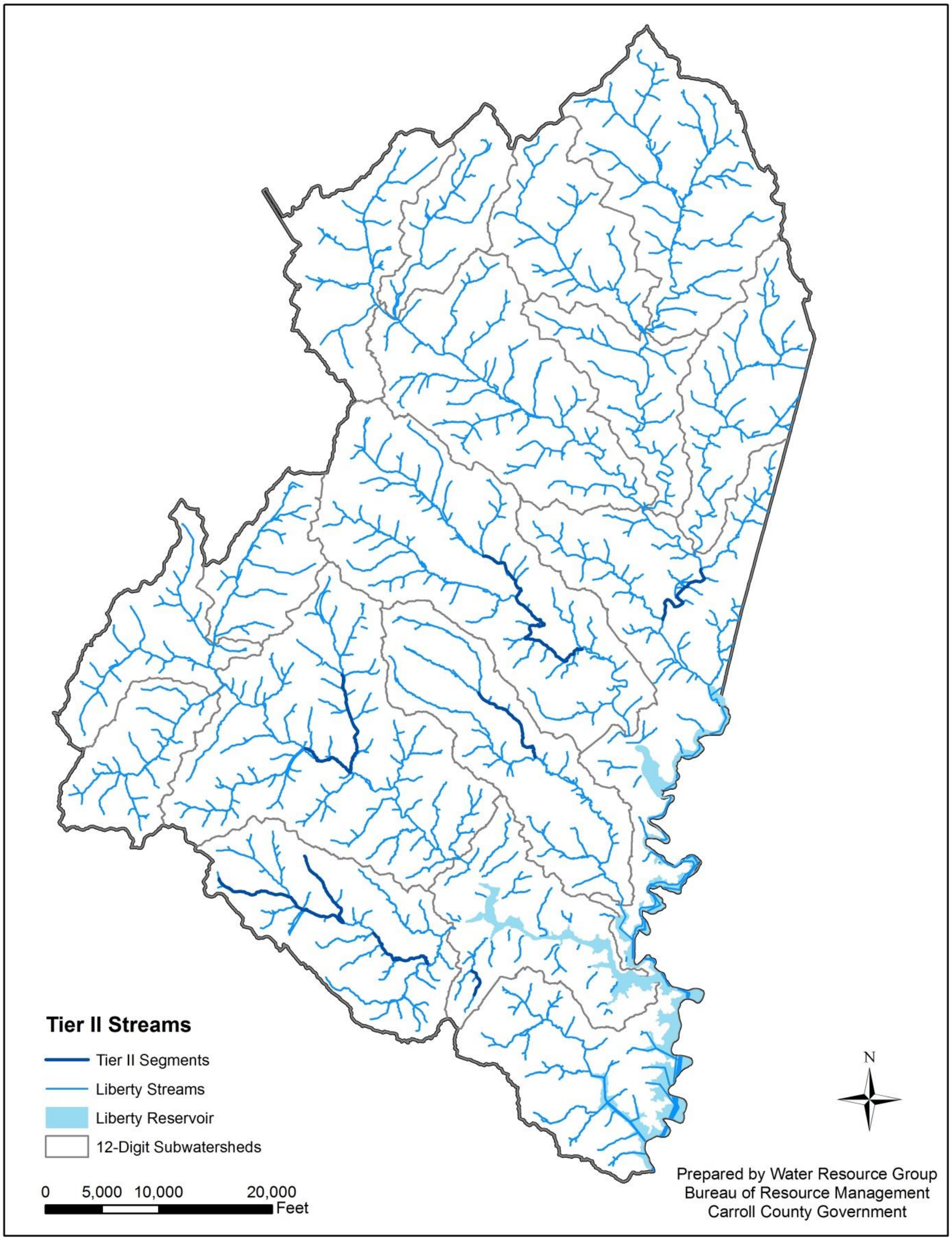


Figure 5: Tier II Waters

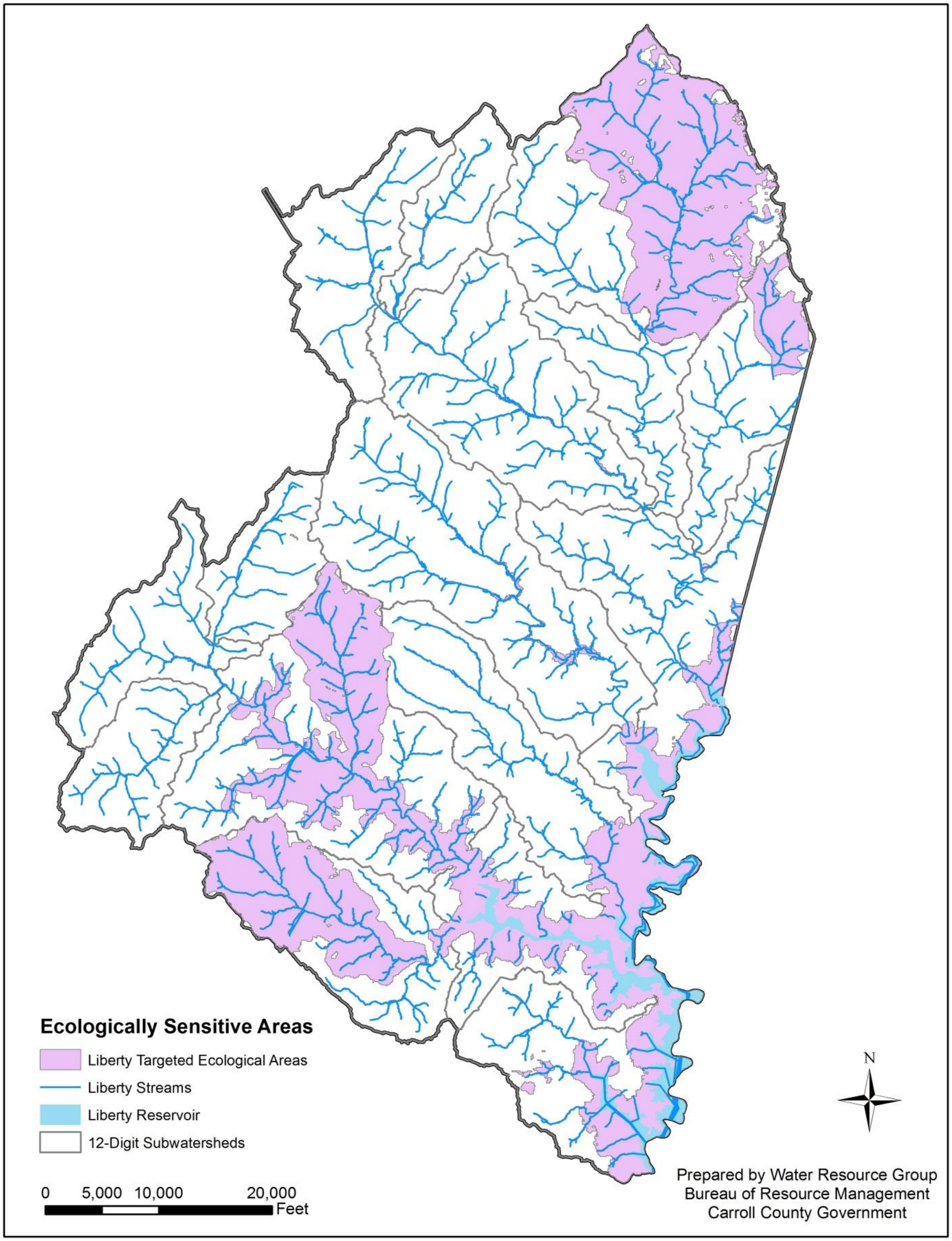


Figure 6: Targeted Ecological Areas

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Liberty Watershed was conducted during the winter of 2012 by Carroll County Bureau of Resource Management staff. The Liberty SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Liberty SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/Liberty/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along approximately 81,000 linear feet of the corridor, 4.95% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Little Morgan Run (1049) and East Branch Patapsco (1059). A significant portion of the drainage within the East Branch Patapsco (1059) sub-watershed originates within the corporate limits of Manchester and Hampstead. The Little Morgan Run watershed has the fourth highest impervious percentage of all the subwatersheds within Liberty and sixty nine percent (69%) of the watershed is located within the Freedom Growth Area Boundary (GAB). Table 8 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

Table 8: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Aspen Run (021309071060)	15.37	7.12	1,500	3.99%
Beaver Run (021309071057)	45.23	23.51	7,825	6.30%
Cranberry Branch (021309071061)	10.35	6.43	1,950	5.74%
Deep Run (021309071058)	21.56	13.87	2,060	2.81%
East Branch Patapsco (021309071052)	14.22	6.43	70	0.21%
East Branch Patapsco (021309071059)	33.25	20.60	11,975	11.01%
Snowden's Run (021309071046)	16.74	0.00	0	0.00%
Liberty Reservoir (021309071047)	13.83	11.29	2,570	4.31%
Little Morgan Run (021309071049)	29.50	17.25	10,460	11.48%
Little Morgan Run (021309071055)	11.37	7.23	1,410	3.69%
Middle Run (021309071056)	25.05	0.24	0	0.00%
Morgan Run (021309071053)	13.17	9.10	1,340	2.79%
Morgan Run (021309071054)	14.21	8.26	1,050	2.41%
Morgan Run (021309071050)	56.09	43.42	20,720	9.04%
Roaring Run (021309071048)	34.87	33.72	3,521	1.98%
West Branch Patapsco	36.01	20.09	9,332	8.80%
West Branch Patapsco	13.15	10.35	5,200	9.51%
Total	**403.97**	**238.93**	**80,983**	**4.95%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Liberty Watershed there are 2,965 parcels remaining with potential development on 32,448 acres for an estimated lot yield of 9,975 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 7 shows the remaining parcels in Liberty Watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

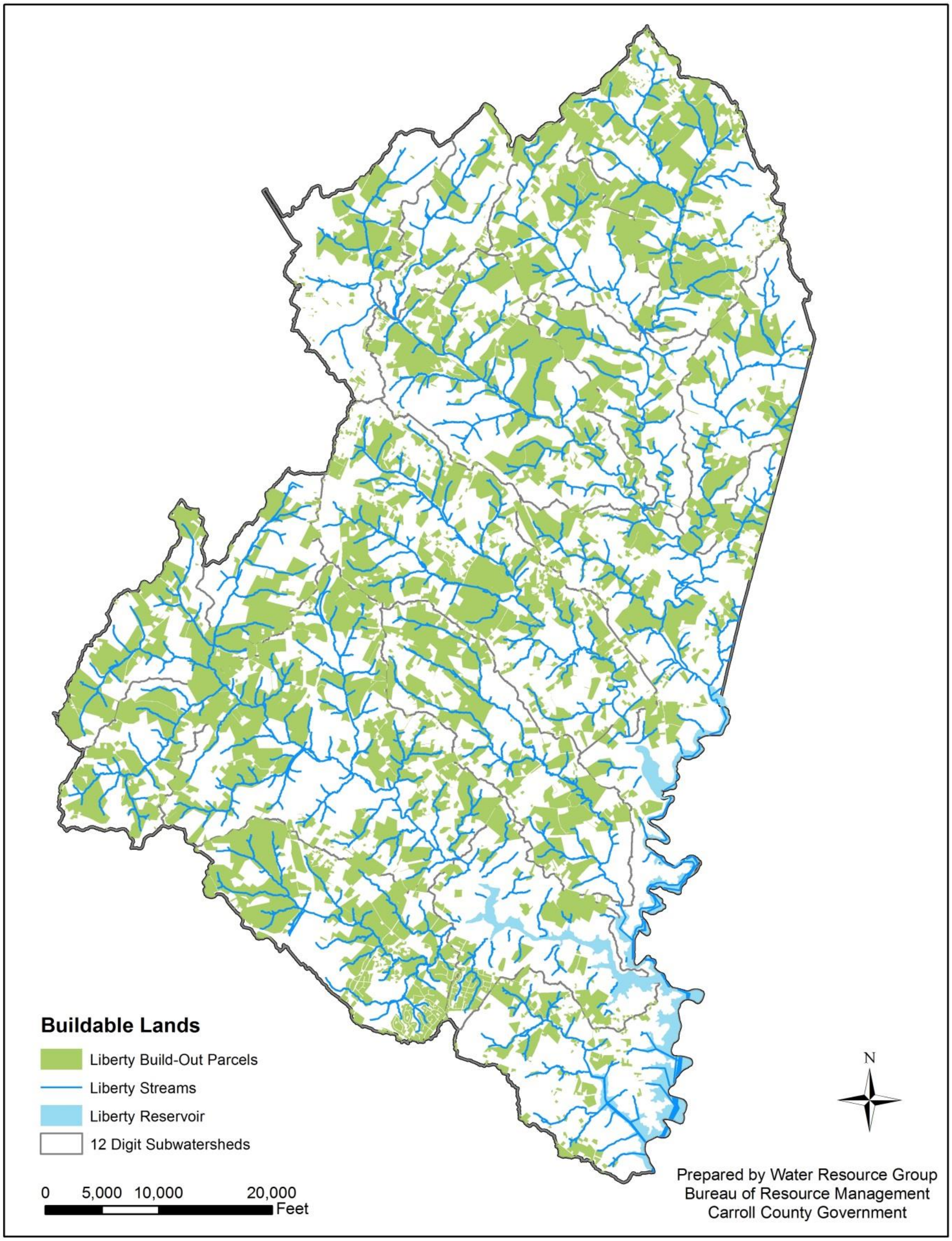


Figure 7: Liberty Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Liberty Reservoir Watershed there are 215.47 acres of grass buffer and 273.49 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Liberty Reservoir Watershed can be found in Appendix B, and are shown in Figure 8. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Liberty Watershed lies within the Upper Patapsco Rural Legacy area and encompasses 21,541 acres (25%) of the Liberty watershed. The extent of the Rural Legacy Area within Liberty can be found in Figure 9.

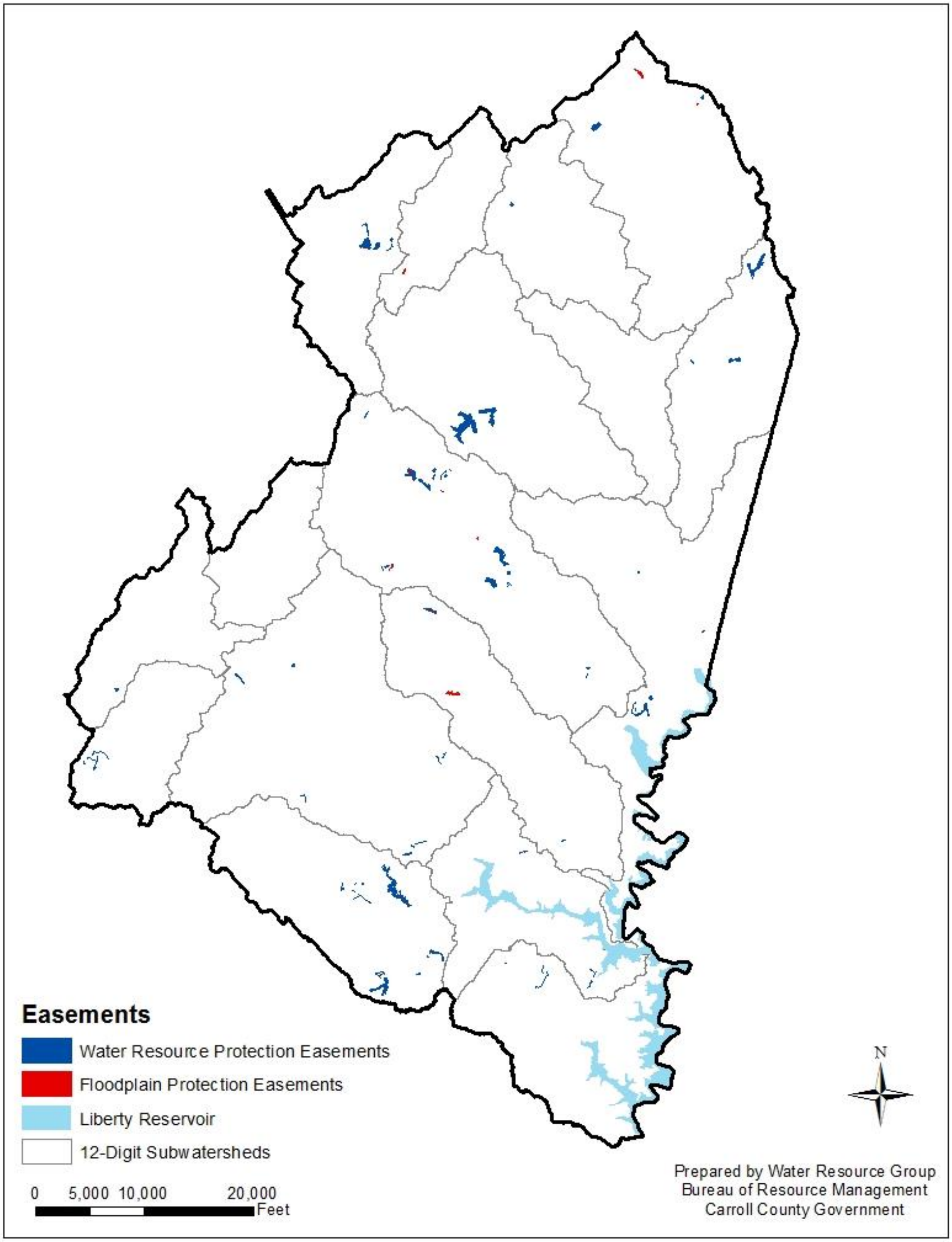


Figure 8: Water Resource and Floodplain Protection Easement Locations

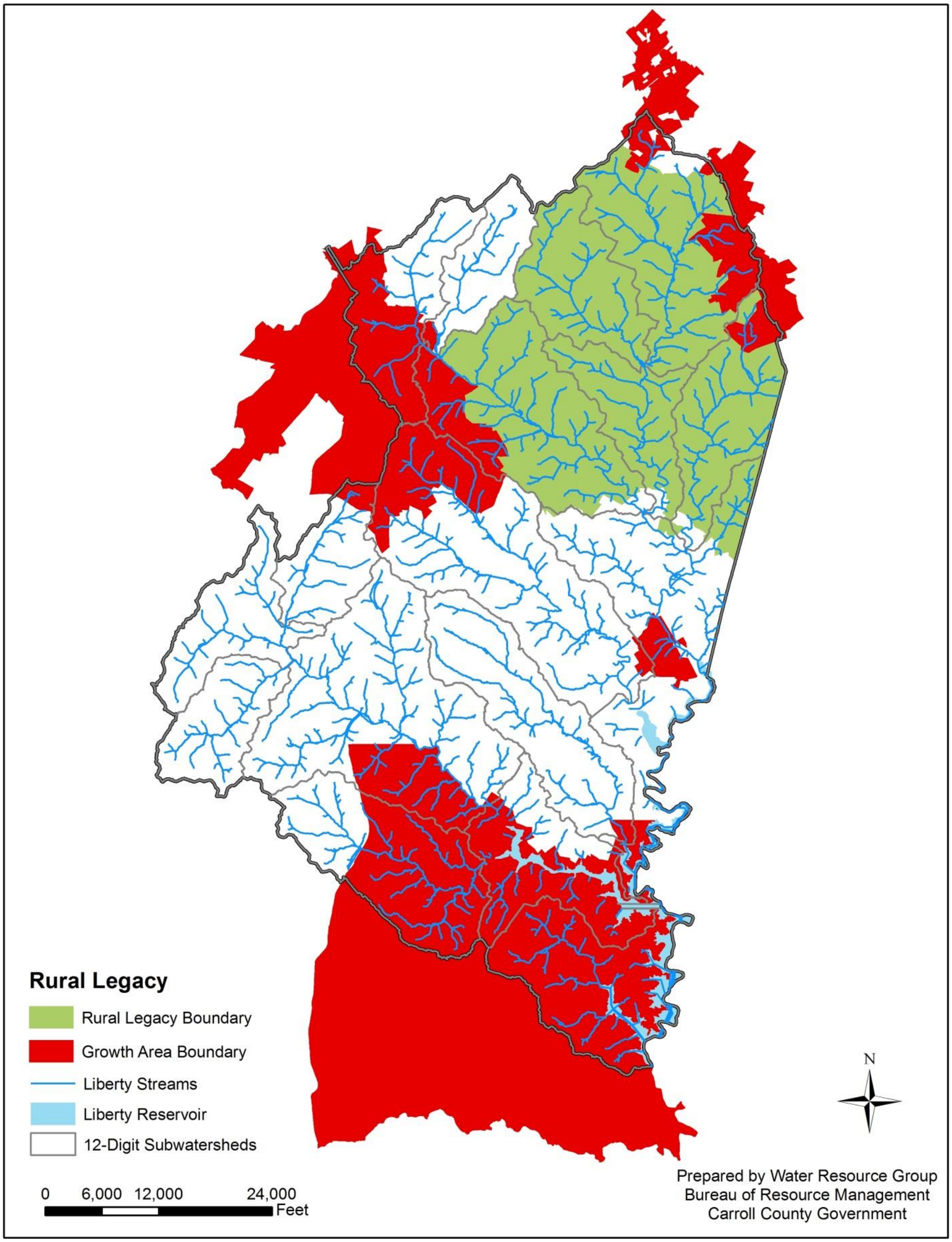


Figure 9: Upper Patapsco Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a Memorandum of Agreement (MOA) to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff is continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts. Educational

events that County staff have participated in that are either held within the Liberty Reservoir Watershed or offered to citizens countywide can be found in Table 9.

Table 9: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Charlotte's Quest Nature Center Spring Fest	2018, 2019	Double Pipe/Prettyboy/Liberty
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide

Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide
Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association “Wash to Save the Bay”	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Liberty Watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, Maryland Department of Environment (MDE) released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design (ESD) practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Liberty Watershed TMDL's, that have been either completed or planned, are listed in Table 10. The location of each facility can be found in Figure 10, the practice type and runoff depth treated for each facility can be found in Appendix C.

Table 10: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Marriot Wood 1 Facility #1	2.5	0.56	Retrofit	C	1046
Hickory Ridge	23.75	4.8	Retrofit	C	1051
Bateman SW Pond	47.25	4.52	Facility	C	1051
Marriot Wood 1 Facility #2	7.12	2.04	Retrofit	C	1046
Marriot Wood II	7.51	1.38	Retrofit	C	1046
Elderwood Village	7.64	2.47	Retrofit	C	1046
Westminster Airport Pond	204.84	85	Retrofit	C	1062
Oklahoma II Foothills	23.72	6.06	Retrofit	C	1046
Oklahoma Phase I	24.44	7.27	Retrofit	C	1046
Edgewood	38	12.12	Retrofit	C	1049
Upper Patapsco Phse 1	24.6	10.1	Facility	C	1051
Upper Patapsco Phase 2	101.8	2.98	Facility	C	1051
Quail Meadows	111.97	23.25	Retrofit	C	1046
Heritage Heights	21.38	4.1	Retrofit	C	1046
Westminster High School	117.25	32.59	Retrofit	C	1057
Westminster Comm. Pond	250.22	63.89	Facility	C	1062
Diamond Hills Section 5	51.8	12.94	Retrofit	C	1055
Wilda Drive	6.75	1.6	Facility	C	1050
Collins Estates	16.34	3.18	Retrofit	C	1049
High Point	4.7	0.91	Retrofit	C	1046
Randomhouse	41.8	16.38	Retrofit	C	1061
Aspen Run	14.4	1.7	Retrofit	C	1052

Eldersburg Business Center	97.98	52.7	Retrofit	C	1046
Finksburg Industrial Park	67.8	22.12	Retrofit	C	1048
Elderwood village Parcel	144	61	Retrofit	C	1046
Oklahoma 4	56.93	14.52	Retrofit	C	1046
Miller/Watts	39.65	25.63	Retrofit	C	1048
Central MD (Wet)	92.72	25.83	Retrofit	C	1049
Feeser Property	4.38	1.72	Facility	C	1062
Shiloh Middle	83.83	25.64	Retrofit	UC	1059
Willow Pond	601	72.75	Retrofit	UC	1062
Central MD (Dry)	63.35	45	Retrofit	UC	1049
Stone Manor	17.81	3.97	Retrofit	P	1047
Winters St. Pond	79.4	36.01	Retrofit	P	1062
Black and Decker	160.31	50.33	Facility	P	1058
Linton Springs	53.43	25.8	Retrofit	P	1049
W. Branch Trade Center	58.75	19.77	Retrofit	P	1062
Squires	36.8	10	Retrofit	P	1046
Hampstead Regional	350	85	Facility	P	1059
Solo Cup	64	34.44	Retrofit	P	1058
Brynwood	95.5	21.7	Facility	P	1049
Springmount Estaes	60	20	Retrofit	P	1046
Winters Mill High School	58.3	21.8	Retrofit	P	1062
East Middle School Wetland	10.18	10.18	Retrofit	P	1062
Eldersburg Marketplace	54.78	35.16	Retrofit	P	1046
Westminster Marketplace	52.07	40.4	Retrofit	P	1051
Town Mall of Westminster	172.66	65.82	Retrofit	P	1062
Totals:	**3,725.41**	**1,127.13**			

B. Storm Drain Outfalls

During the Liberty Watershed SCA in 2012, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. Nine elementary schools within the Liberty Watershed have planted ten gardens with a total drainage area of 2.66 acres.

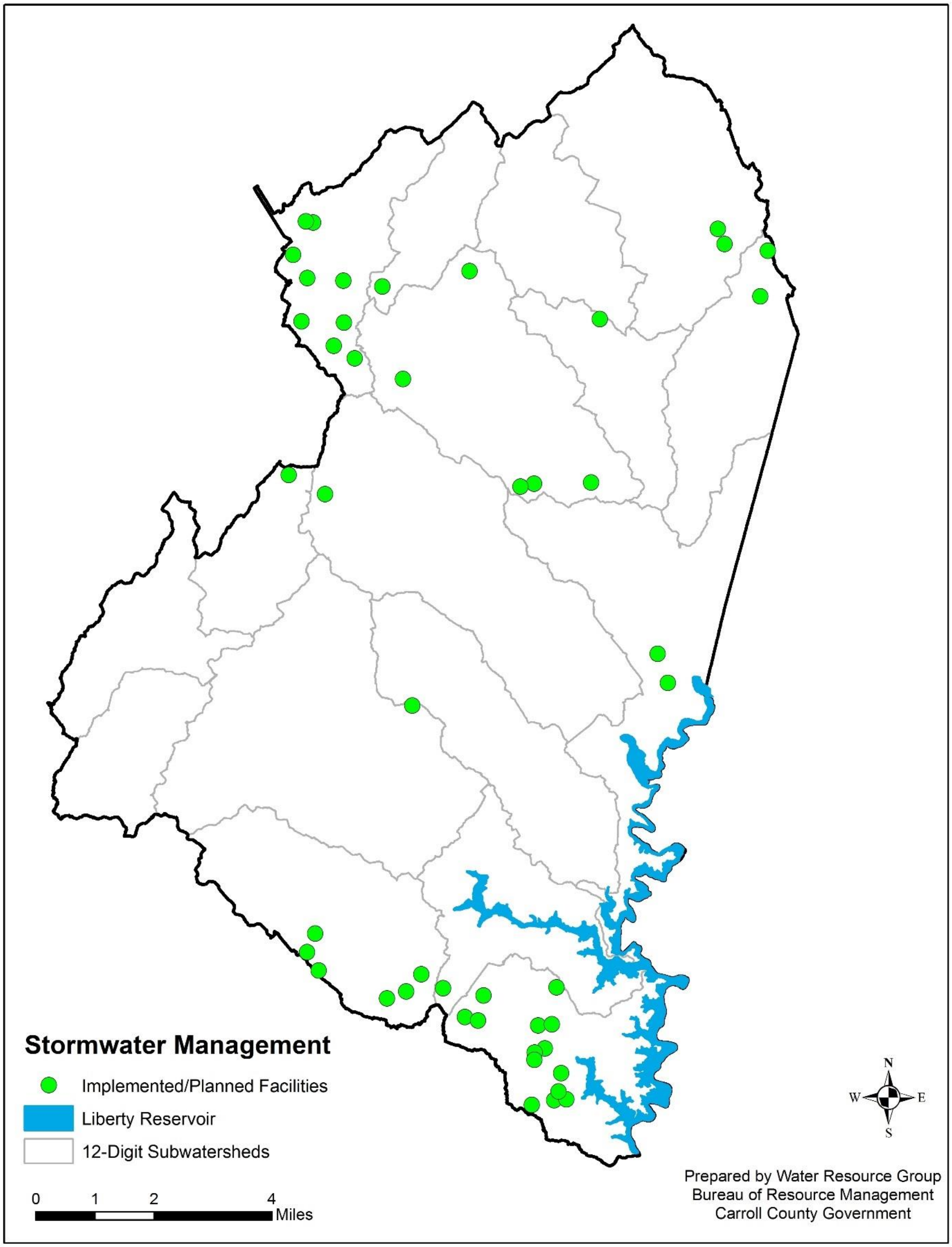


Figure 10: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

The 2012 Liberty SCA determined that approximately 25 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Thirteen properties participated in this initiative during the spring and fall of 2014. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the residential buffer plantings are shown in Figure 11.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	12- Digit Subwatershed	Date Planted
Planting 1	0.14	125	45	1050	Spring 2014
Planting 2	1.43	400	210	1059	Spring 2014
Planting 3	1.19	380	100	1053	Spring 2014
Planting 4	0.6	485	50	1050	Spring 2014
Planting 5	0.32	180	80	1057	Spring 2014
Planting 6	0.31	280	40	1048	Spring 2014
Planting 7	0.3	285	40	1049	Spring 2014
Planting 8	0.16	155	45	1054	Spring 2014
Planting 9	1.02	560	60	1061	Spring 2014
Planting 10	0.84	500	80	1062	Fall 2014
Planting 11	3.18	600	200	1062	Fall 2014
Planting 12	2.92	650	150	1059	Fall 2014
Planting 13	1.15	400	115	1059	Fall 2014
Planting 14	0.24	170	60	1049	Fall 2017
Planting 15	0.52	200	65	1051	Fall 2017
Planting 16	1.41	650	55	1048	Spring 2017
Planting 17	0.1	140	10	1049	Fall 2017
Planting 18	4.06	1,000	200	1057	Fall 2017

Planting 19	1.22	400	150	1046	Fall 2017
Planting 20	0.21	360	40	1058	Fall 2017
Planting 21	0.87	250	160	1057	Fall 2017
Planting 22	0.1	90	60	1049	Fall 2017
Planting 23	0.76	460	70	1059	Fall 2017
Planting 24	0.44	250	80	1056	Fall 2017
Planting 25	0.38	250	50	1049	Fall 2017
Planting 26	0.3	250	45	1047	Fall 2017
Planting 27	0.16	180	40	1049	Fall 2017
Planting 28	0.2	140	60	1058	Fall 2017
Planting 29	0.9	700	60	1057	Fall 2017
Planting 30	0.38	360	40	1058	Fall 2017
Planting 31	0.11	150	20	1048	Fall 2017
Planting 32	2.07	950	50	1053	Fall 2018
Planting 33	0.38	150	100	1050	Fall 2018
Planting 34	4	250	400	1050	Fall 2018
Planting 35	1.88	480	125	1057	Fall 2018
Planting 36	0.54	150	80	1048	Fall 2018

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be inspected bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

2. Municipal Plantings

In addition to the implementation of residential stream buffer plantings, the Westminster Rescue Mission, as well as the Town of Manchester and City of Westminster initiated tree planting projects within the Liberty Watershed during 2014.

The Westminster Rescue Mission project consisted of planting 960 trees at a stocking rate of 302 trees per acre to restore a forested buffer along 600 feet of stream that was previously mowed as lawn. The City of Westminster project is immediately adjacent to the Rescue Mission property and consisted of planting 253 trees at the same 302 trees per acre stocking rate. The Manchester project planted over 1,200 trees to establish a forested stream buffer for approximately 1,000 feet within the Manchester Farms subdivision.

The Municipal efforts are included in Table 11 above.

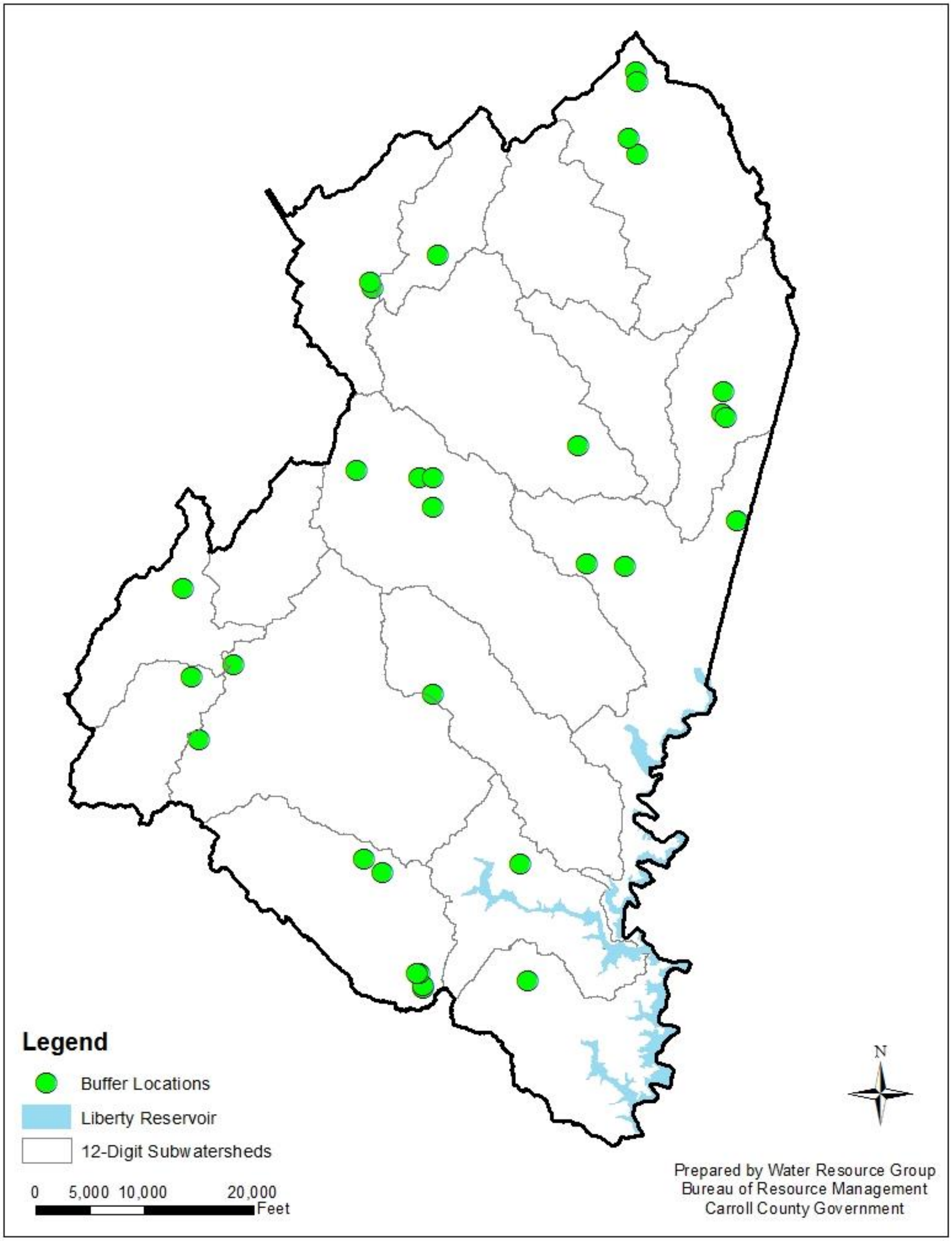


Figure 11: Stream Buffer Initiative Locations

E. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has identified the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

F. Streambank Regeneration

Accelerated streambank erosion occurs downstream of inadequately managed impervious from development. The proportion of rain water that previously infiltrated into the ground is reduced. Thus, causing immediate runoff, and increasing the total amount and velocity of flow in the receiving channel, accelerating erosion and resulting in greater sediment loads within the stream corridor.

There are two effective ways to reduce the destabilizing velocity increases in the receiving channel. The first is traditional stream restoration, increasing the plan form and bank resistance. The second is upland stormwater management, storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont, many residential, institutional, or commercial areas were developed prior to 1982 without any stormwater management or subsequently with peak flow control that matched existing conditions only, not really returning the runoff characteristics to predevelopment, as required by COMAR 26.17.02.01. Matching the existing hydrologic runoff response in these areas does not address existing streambank instability and does nothing to help restore streams or reduce current nutrient and legacy sediment export to the Bay.

Carroll County has been experimenting with the use of enlarged, enhanced, sand filters as primary stormwater management for more than 10 years. In an effort to determine the cause of these unanticipated stormwater management/quality/stream restoration benefits, we reanalyzed the design information. This showed that the Carroll County standard design reduced the two-year storm peak flow below that of an equivalent forested watershed in good condition. This has always been the goal of stormwater management, returning the hydrologic condition to that assumed to exist in pre-contact times.

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

Although streambank regeneration is not currently an approved practice in the 2014 MDE guidance document (MDE, 2014), the guidance states that innovative practices that are not approved under the Maryland Stormwater Design Manual (MDE, 2000) nor have an MDE or CBP assigned pollution removal efficiency can be used to offer jurisdictions additional options toward watershed restoration activities, provided that there is proper documentation and monitoring to verify pollutant removal efficiencies acceptable to MDE. The County has developed a paired watershed approach to evaluate the effectiveness of upland stormwater management practices on stream channel protection protection and will begin a 3-year study in 2016 collecting the necessary data to document the sediment and nutrient reduction benefits associated with this practice. The results will inform recommendations to credit upland stormwater practices as a hydrogeomorphic stream stabilization technique for sediment reductions.

Interim nutrient reductions associated with streambank regeneration are included in Appendix C in anticipation of the study results and are derived from the default stream restoration credit included in the 2014 MDE guidance.

G. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Liberty Watershed, and their associated reduction values are shown in Table 12.

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Hampstead	8.64	1058/1059	Annual
Manchester	0.674	1059	Annual
Westminster	0.49	1051/1057/1062	Annual
Management Practice	**Bi-Weekly Mechanical Street Sweeping**		
Town	# Acres Swept	12-Digit Watershed	Date of Completion
Westminster	5.28	1062	Annual

H. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2009, seventy two (72) septic systems within the Liberty Watershed have been repaired and eighty (175) new systems have been built utilizing Best Available Technology (BAT). Seventy (70) of these projects have been via the Bay Restoration Fund. BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Liberty Reservoir Watershed are listed in Appendix C.

I. Agricultural Best Management Practices (BMPs)

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix C provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix D.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Liberty Watershed. As described in Section I, phosphorus sediment, and bacteria loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014.

The local TMDL suggests an urban P load reduction of 50% and TSS load reduction of 38% from the 2009 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Liberty Reservoir). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reductions from the baseline year. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the TMDL, as land cover data from 2011 was the closest available for that time period. The modeled 2011 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2011 was used as the baseline proxy year. For reference, the modeled baseline urban P load using the 2011 land cover was 1,793.45 lbs, which equates to a 50% reduction of 896.72 lbs and the modeled TSS load was 3,415 tons, which equates to a 37% reduction of 1,298 tons (Table 13).

The projects completed as of December, 2019 are providing 305.05 pounds of TP reduction, and 520.08 tons of TSS reduction. The planned projects, would provide another 158.41 lbs of TP reduction and 227.22 tons of sediment reduction (Table 14). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 12 and 13. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Liberty TMDL. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, currently MDE does not provide guidance on bacteria reduction efficiencies.

Table 13: Total Phosphorus and Total Suspended Sediment Load Reduction in the Liberty Watershed in Carroll County.

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
1,793.45	50%	896.72	305.05	158.41	26%
Total Suspended Sediment Load Reduction					
Modeled Baseline Load (tons)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons)**	**Reduction from Current BMPs (tons)**	**Reduction from Planned Strategies (tons)**	**Total % Reduction Achieved**
3,415.0	37%	1,263.6	520.08	227.22	22%

Table 14: Comparison of Total Phosphorus and Total Suspended Sediment Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

Total Phosphorus Delivered Load Reductions (lbs/yr)					
Status	**Pond Retrofits**	**Buffers**	**Stream Restoration**	**Catch Basin/ Inlet Cleaning**	**Easements**
Completed	263.22	2.60	19.69	0.56	18.97
Planned	150.54		7.87		
Total Suspended Sediment Delivered Load Reductions (tons/yr)					
Completed	457.03	4.09	3.25	0.28	55.43
Planned	225.93		1.30		

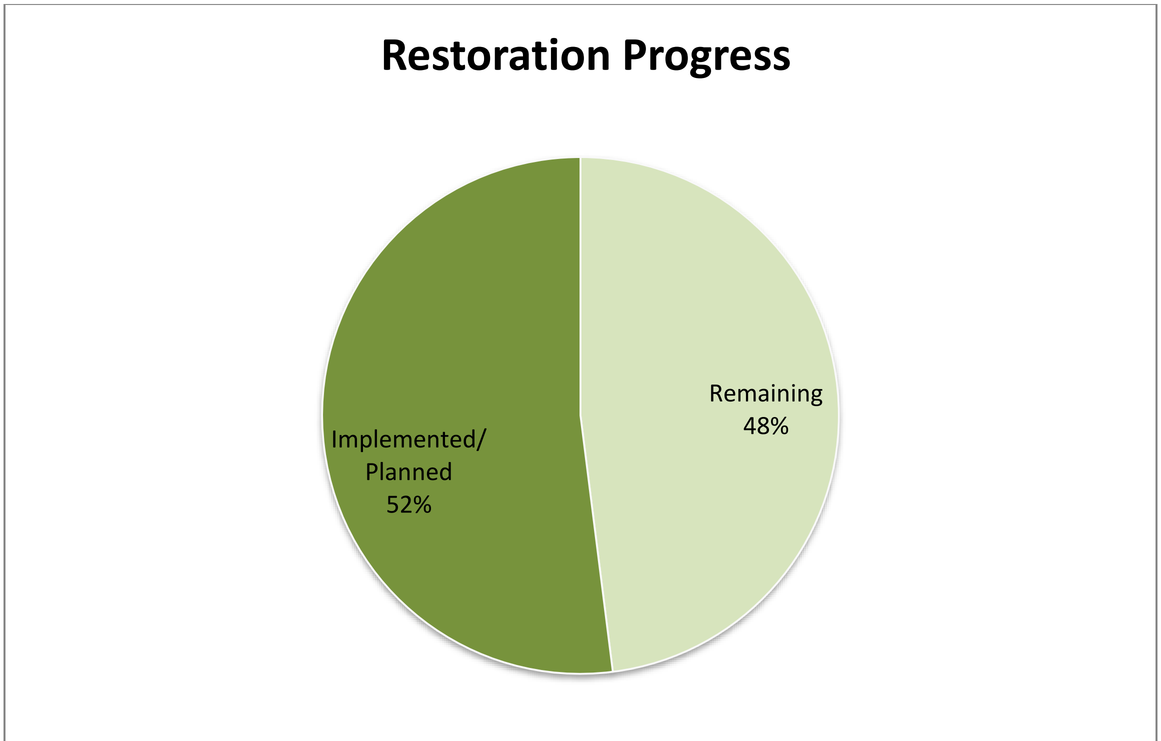


Figure 12: 2019 Restoration Progress-Phosphorus

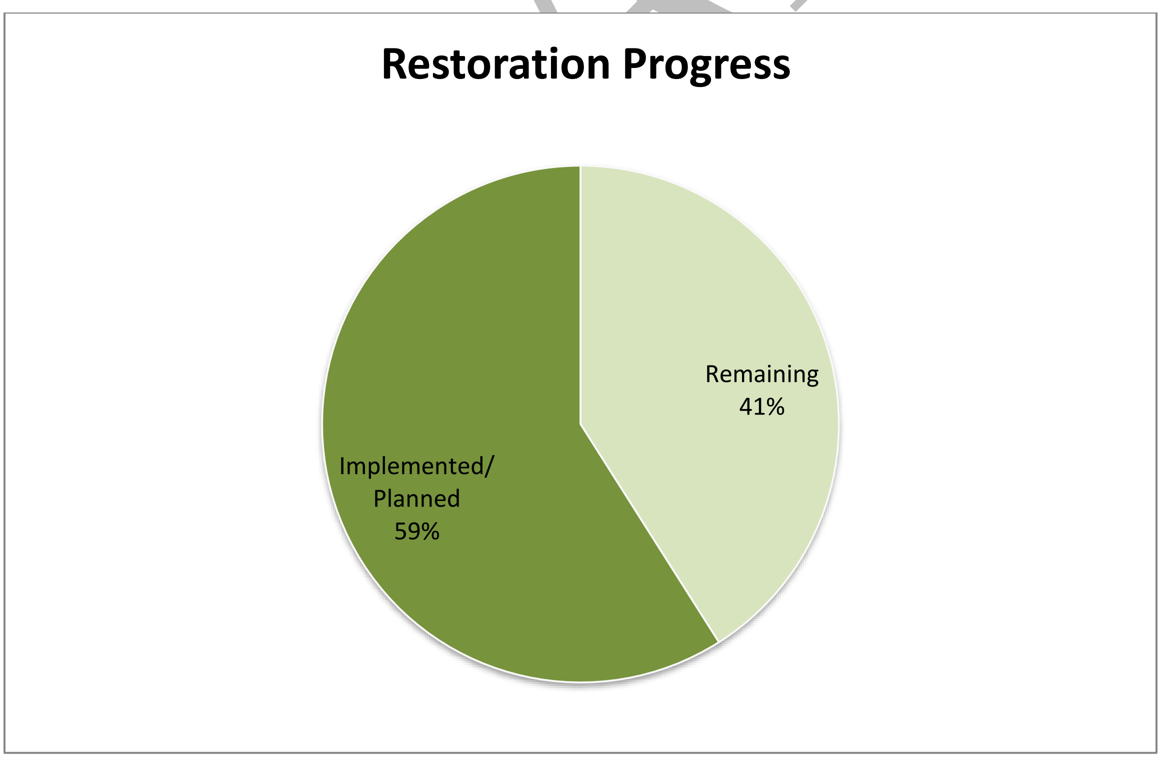


Figure 13: 2019 Restoration Progress-Sediment

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

d. Human Source Elimination

Elimination of human sources of bacteria within the Liberty Reservoir Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

The Carroll County Bureau of Utilities is in the process of completely updating their Regulations and Standard Specifications and Design Details for water and sewer infrastructure for the first time since 1992.

Changes that shall be implemented with this update include increasing required sewer main encasements at all proposed stream crossings.

This shall include both more comprehensives encasement design requirements as well as an increase in the distance encasement shall be required to be extended beyond the edges of the stream crossing. Additionally, manhole design requirements shall now include factory installed epoxy coatings on new manholes to be installed on proposed or upgraded sewer mains.

Table 15 lists infrastructure related measures that have been implemented since the 2003 baseline year that would assist in reducing bacteria counts within the watershed.

Table 15: Waste Collection Infrastructure Upgrades

	County	Hampstead	Manchester	Westminster
BAT Upgrades	247	0*	0*	0*
Casings/Linings	TBD	TBD	TBD	TBD
Lateral line replacements	TBD	TBD	TBD	TBD
Pump Station upgrade	TBD	TBD	TBD	TBD

***upgrades occurred within corporate boundaries**

e. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

f. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

1. Retrofit Monitoring

The Bureau of Resource Management currently monitors one location within the Liberty reservoir watershed. The Air Business Center regional stormwater management facility, shown in Figure 14, is used as the County's monitoring location for NPDES reporting, and is located within the West Branch Patapsco river subwatershed.

This stormwater management facility was originally constructed as a wet pond in 1979 and was retrofitted in 2008 as a wet pond with a forebay to provide water quality, recharge volume, and channel protection volume. The drainage area is approximately 562 acres, of which, 128 acres or 23% is impervious.

Chemical monitoring began at the Air Business site in August of 2000 and consists of; eight storm events at each location sampled throughout the year. All sampling is completed with automated equipment so that each limb of the storm; ascending, peak, and descending can be characterized. The chemical monitoring parameters, methods, and detection limits required for calculating event mean concentrations (EMC's) for NPDES reporting are listed in Table 16. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 16: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
First Flush Sample		
pH	-	EPA 150.1
Temperature	-	EPA 170.1
Specific Conductance	1.0 µmhos/cm	SM 2510 B-97
Total Petroleum Hydrocarbons	5.0 mg/L	EPA 1664
Escherichia Coli	1.0 organisms/ 100mL	SM 9223 B-94
Limb Samples		
Nitrate/Nitrite Nitrogen	0.05 mg/L	SM 4500NO3-H00
Biological Oxygen Demand	2.0 mg/L	SM 5210 B-01
Total Copper	2.0 µg/L	EPA 200.8
Total Lead	2.0 µg/L	EPA 200.8

Total Zinc	20.0 µg/L	EPA 200.8
Total Kjeldahl Nitrogen	0.5 mg/L	SM 4500NH3 C-97
Total Phosphorus	0.01 mg/L	SM 4500P-P E-99
Total Suspended Solids	3.0 mg/L	SM 2540 D-97

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Liberty Reservoir Watershed began in April of 2019, and is currently performed at one location, shown in Figure 13. Samples are currently collected on the 4th Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 17 shows the monitoring results for the entire year, whereas Table 18 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 17: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
WPU04	Low	7	312
	High	0	n/a
	All	7	312

Table 18: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
WPU04	Low	6	442
	High	0	n/a
	All	6	442

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 19 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 19: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2019	
			# Samples	% Exceeded
WPU04	576	low	**7**	**14%**
		high	n/a	n/a
	410	low	**7**	**71%**
		high	n/a	n/a
	298	low	**7**	**71%**
		high	n/a	n/a
	235	low	**7**	**71%**
		high	n/a	n/a

b. Historic Monitoring

The County performed monthly bacteria trend monitoring in conjunction with Baltimore County in the Liberty reservoir watershed on the first Thursday of each month from 2012-2016. Sampling was performed at 5 selected locations near the reservoir and collection occurred on the first Thursday of each month (Figure 13).

Sample results are reported in MPN/100mL. Table 20 shows the monitoring results for the entire year, whereas Table 21 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means.

Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 20: Historic Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2012		2013		2014		2015		2016	
		# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN
Lib-1	Low	5	97.95	8	39.89	7	39.22	8	77.04	8	105.96
	High	3	206.59	2	2,192.3	4	441.99	4	203.87	4	53.94
	All	8	129.58	10	88.91	11	81.11	12	109.75	12	80.88
Lib-2	Low	5	137.09	8	36.91	7	99.21	8	66.92	8	174.76
	High	3	162.29	2	816.46	4	462.65	4	446.97	4	29.07
	All	8	146.05	10	68.57	11	165.75	12	133.49	12	96.11
Lib-3	Low	5	464.19	8	168.88	7	324.7	8	336.5	8	507.25
	High	3	682.89	2	1,030.75	4	1,371.63	4	901.78	4	471.03
	All	8	536.49	10	242.49	11	500.28	12	481.58	12	492.44
Lib-4	Low	6	138.47	8	24.59	7	115.64	8	82.83	8	132.04
	High	2	171.7	2	365.58	4	390.24	4	404.79	4	193.47
	All	8	146.12	10	42.19	11	166.56	12	147.48	12	153.84
Lib-5	Low	6	220.45	8	35.68	7	155.28	8	132.17	8	326.2
	High	2	379.61	2	1,155.21	4	524.41	4	604.11	4	181.78
	All	8	252.53	10	77.27	11	223.71	12	242.73	12	258.17

Table 21: Historic Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2012		2013		2014		2015		2016	
		# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN	# Samples	MPN
Lib-1	Low	4	164.15	4	104.70	3	86.43	4	133.48	3	136.52
	High	1	108.1	1	1,986.3	1	579.4	0	n/a	1	24.3
	All	5	150.99	5	188.61	4	139.07	4	133.48	4	88.67
Lib-2	Low	4	308.11	4	71.85	3	158.58	4	132.82	3	138.72
	High	1	41.4	1	275.5	1	344.8	0	n/a	1	77.6
	All	5	206.24	5	94.00	4	192.57	4	132.82	4	119.97
Lib-3	Low	4	865.56	4	260.45	3	553.9	4	628.53	4	510.54
	High	1	141.4	1	1,732.9	1	1,553.1	0	n/a	0	n/a
	All	5	602.46	5	380.48	4	716.75	4	628.53	4	510.54
Lib-4	Low	4	171.82	4	83.72	3	172.66	4	194.31	4	151.68
	High	1	74.3	1	410.6	1	387.3	0	n/a	0	n/a
	All	5	145.3	5	115.06	4	211.3	4	194.31	4	151.68
Lib-5	Low	4	356.93	3	215.98	3	381.24	4	239.2	4	330.63
	High	1	156.5	1	770.1	1	613.1	0	n/a	0	n/a
	All	5	302.67	4	296.78	4	429.32	4	239.2	4	330.63

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 22 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 22: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-1	576	low	0	0%	0	0%	0	0%	0	0%	0	0%
		high	0	0%	2	100%	2	66%	1	25%	1	25%
	410	low	0	0%	0	0%	0	0%	0	0%	1	17%
		high	1	33%	2	100%	2	66%	2	50%	1	25%
	298	low	0	0%	0	0%	0	0%	0	0%	2	33%
		high	1	33%	2	100%	2	66%	2	50%	1	25%
	235	low	0	0%	0	0%	0	0%	1	14%	2	33%
		high	1	33%	2	100%	2	66%	2	50%	1	25%

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-2	576	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	1	33%	2	50%	0	0%
	410	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	1	33%	2	50%	0	0%
	298	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	1	50%	2	66%	3	75%	0	0%
	235	low	0	0%	0	0%	0	0%	1	14%	1	17%
		high	1	33%	2	100%	2	66%	3	75%	0	0%
Lib-3	576	low	4	66%	2	25%	1	14%	2	29%	3	50%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	410	low	4	66%	2	25%	4	57%	3	43%	3	50%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	298	low	5	83%	2	25%	5	71%	3	43%	4	66%
		high	1	50%	2	100%	3	100%	3	75%	2	50%
	235	low	5	83%	4	50%	5	71%	5	71%	5	83%
		high	1	50%	2	100%	3	100%	3	75%	2	50%

Location	MPN Criteria	Flow Type	2012		2013		2014		2015		2016	
			# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded	# Samples	% Exceeded
Lib-4	576	low	0	0%	0	0%	0	0%	0	0%	0	0%
		high	0	0%	0	0%	1	33%	2	50%	2	50%
	410	low	1	17%	0	0%	1	14%	1	14%	0	0%
		high	0	0%	1	50%	1	33%	2	50%	2	50%
	298	low	1	17%	0	0%	1	14%	1	14%	2	33%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
	235	low	2	33%	0	0%	2	29%	2	29%	2	33%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
Lib-5	576	low	0	0%	1	14%	0	0%	1	17%	1	17%
		high	1	50%	2	100%	2	66%	2	50%	1	25%
	410	low	1	17%	1	14%	1	14%	1	17%	1	17%
		high	1	50%	2	100%	2	66%	2	50%	2	50%
	298	low	4	66%	1	14%	3	50%	1	17%	2	33%
		high	1	50%	2	100%	2	66%	3	75%	2	50%
	235	low	4	66%	1	14%	4	66%	2	33%	4	66%
		high	1	50%	2	100%	2	66%	3	75%	2	50%

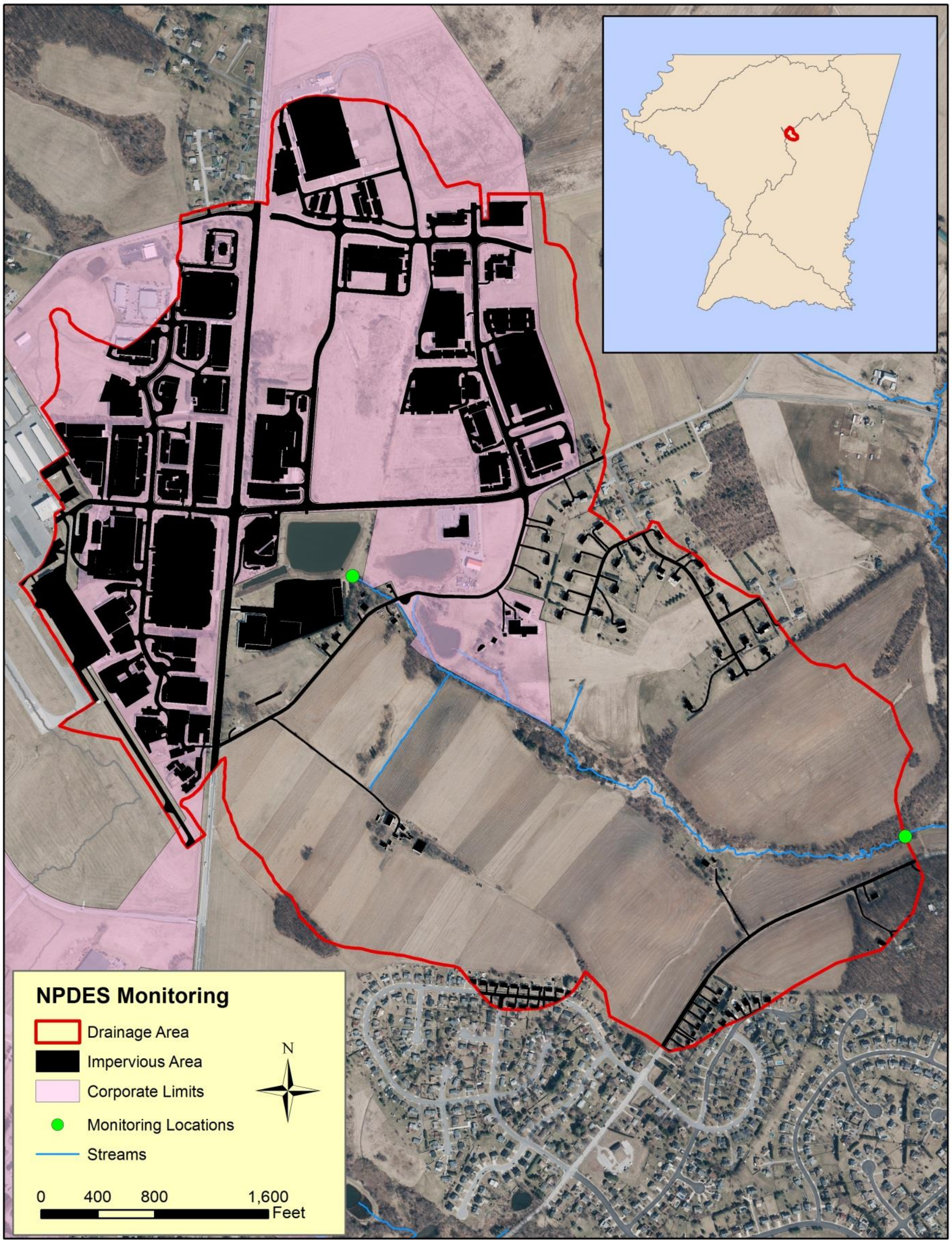


Figure 14: NPDES Monitoring Location

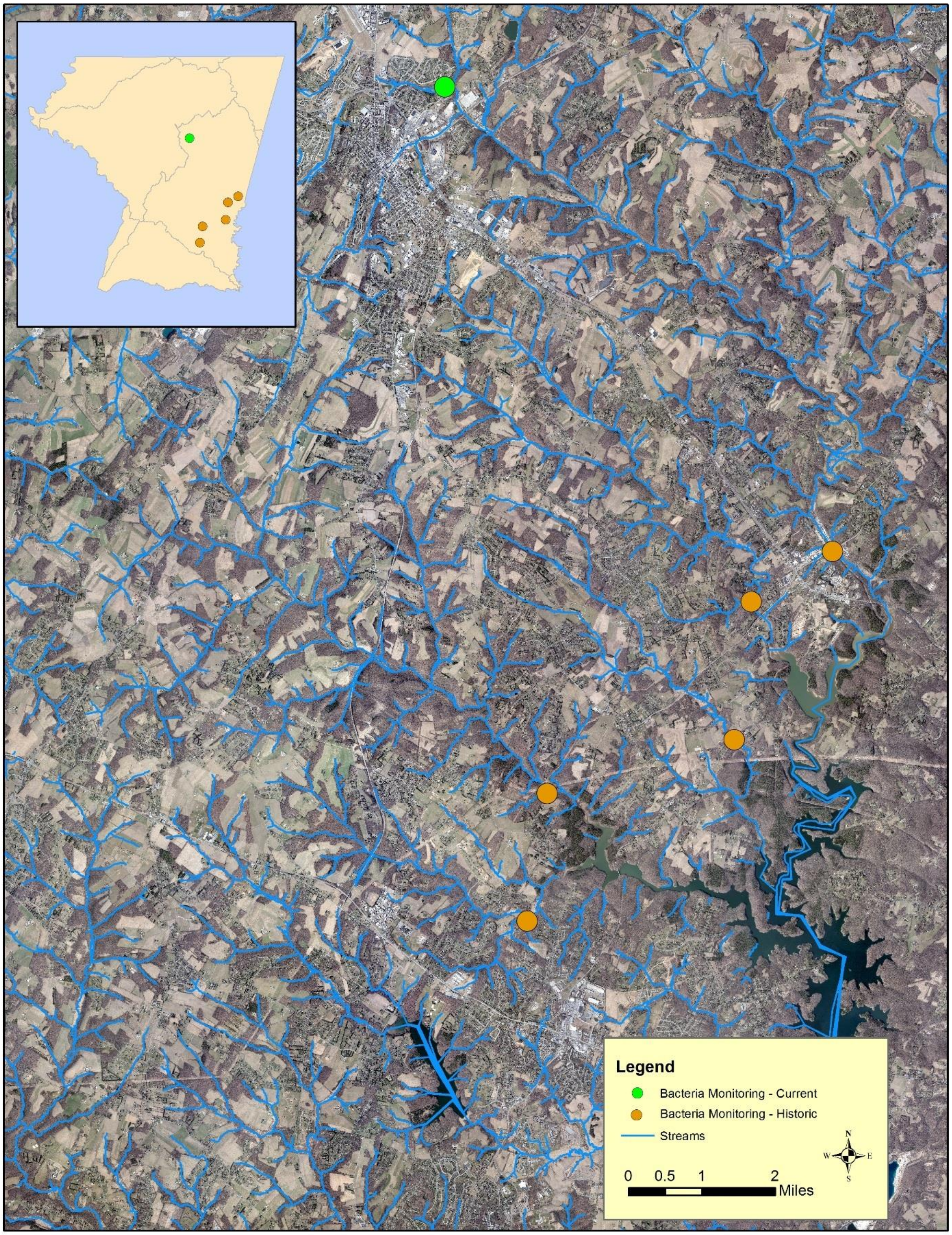


Figure 15: Bacteria Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 23). BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Liberty Watershed will have no effect on reducing loadings to the Chesapeake Bay, because of the edge of stream vs. the delivered load factor.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 23, and the tidal water designated use zones are shown in Figure 16.

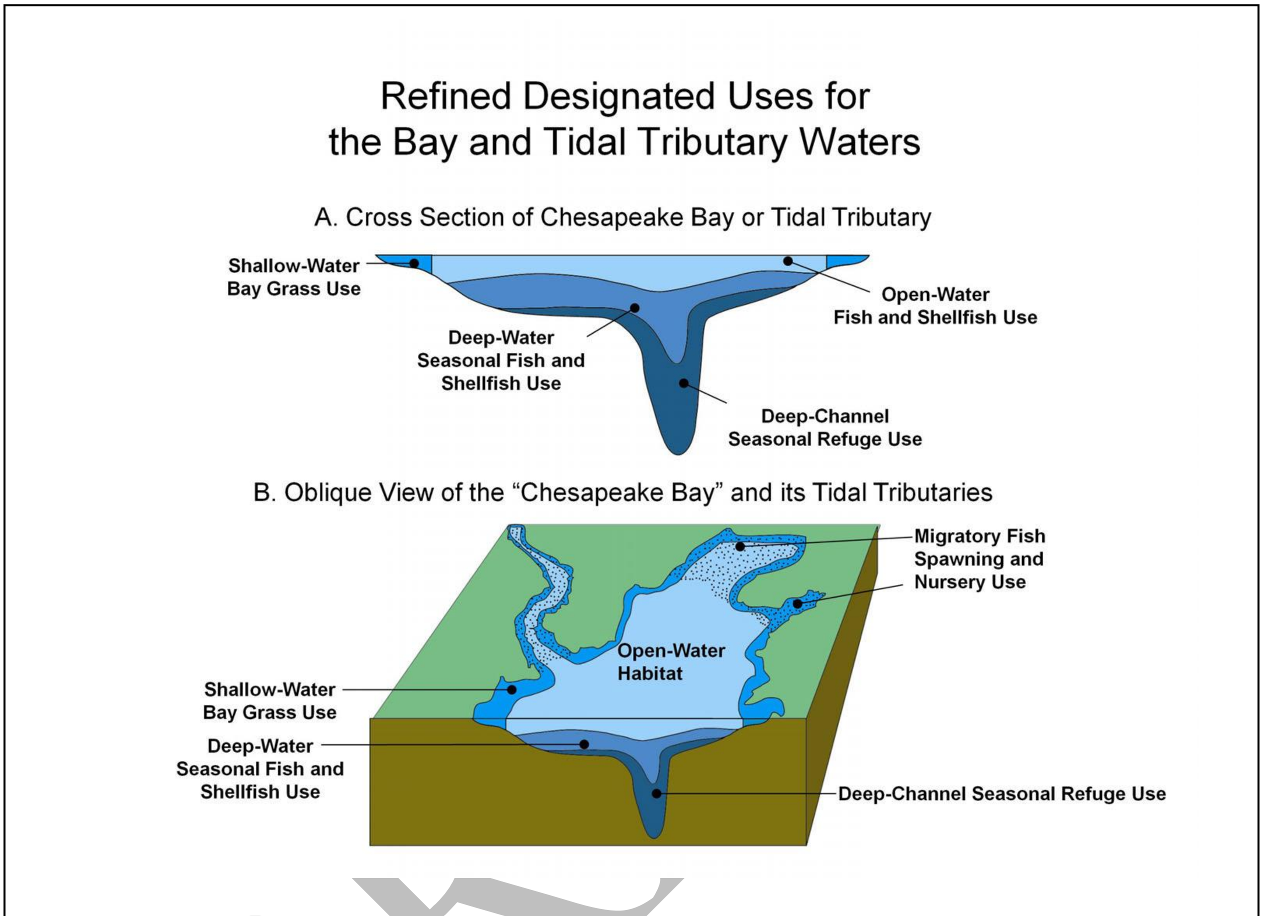


Figure 16: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 23: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Liberty Watershed is located within the Patapsco River segment of the Chesapeake Bay. The Patapsco segment covers 374,186 acres, approximately 126,716 acres (34%) of this river segment is within Carroll County. The location of the Patapsco River segment is shown in Figure 17.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix E) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 24. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Patapsco River segment within the Liberty Watershed are; 0.00 for nitrogen, 0.00 for phosphorus, and 0.00 for suspended sediment. Essentially, if one pound of nitrogen is discharged into a tributary within the Liberty portion of the Patapsco River segment, none of that pound is reaching the Bay due to the impoundment from the Liberty Reservoir dam.

Table 15 shows the Chesapeake Bay TMDL for the Patapsco land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Liberty Reservoir Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Liberty Reservoir Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Patapsco segment shed. The Liberty Reservoir Watershed covers 68.9% of the Patapsco land-river segment within Carroll County.

Note that the extent of BMPs implemented and planned for this watershed has no effect on the County's ability to meet the Chesapeake Bay TMDL requirement due to delivered load ratios of 0.00 for this river segment.

Table 24: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Liberty Reservoir Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2019-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
1,752.52	35.26%	618.00	0	0	0%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2019-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
16,038.74	13.79%	2,212.59	0	0	0%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Patapsco land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Liberty Reservoir Watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix E.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 25: Carroll County Patapsco River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	Total Phosphorus (TP)[3]			Total Nitrogen (TN)		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Liberty Reservoir Watershed	0	0	0%	0	0	0%
South Branch Patapsco Watershed	181.53	104.41	46.27%	663.32	285.73	42.89%
Total	**181.53**	**104.41**	**46.27%**	**663.32**	**285.73**	**42.89%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

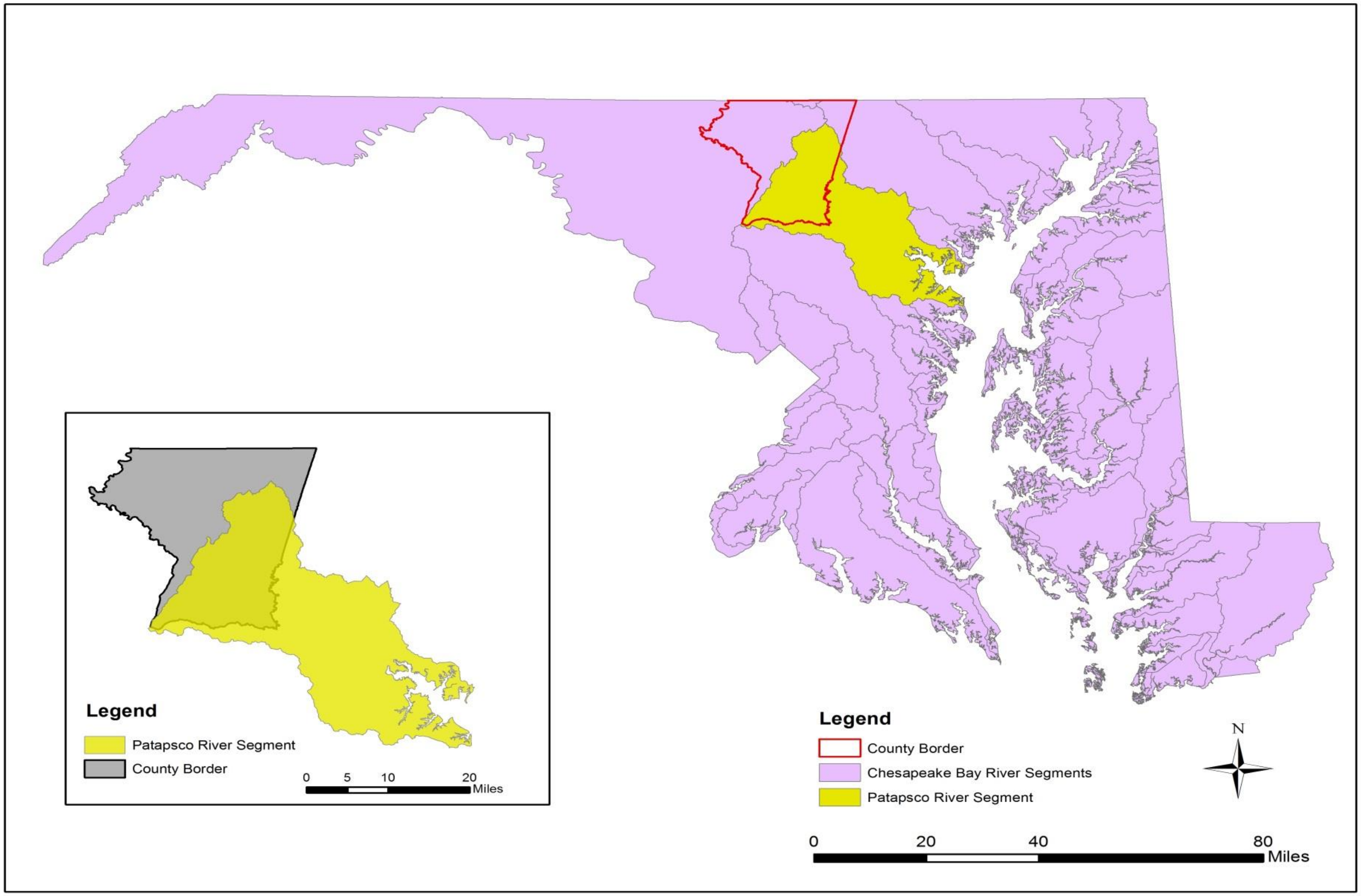


Figure 17: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 35% of the required reductions since the baseline year of 2009. Based on currently identified projects, the required reduction is expected to achieve 52% by 2025. The implementation from baseline through the current CIP is achieving approximately 3.25% reduction in the TMDL/year since the baseline.

The sediment TMDL through 2019 will have achieved 41% of the required reduction since the baseline year of 2009. Based on current projects is expected to achieve 59% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 3.69% reduction in the TMDL/year since the baseline.

If the County is able to maintain an approximate 3.0% reduction rate per year for sediment and phosphorus, the sediment and phosphorus TMDLs in the Liberty Reservoir Watershed would be achieved by 2041. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 26 lists the anticipated benchmark for each nutrient TMDL within the Liberty Reservoir Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 26: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2041
Phosphorus	35%	52%	100%
Sediment	41%	59%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Liberty Reservoir Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

XI. References

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost	Anticipated Completion
SWM Facilities	County	2130907	Completed	$14,385,491	Completed
Streambank Regeneration	County	2130907	Completed	N/A	Completed
Buffer Plantings	County	2130907	Completed	$227,181	Completed
Catch Basin/Inlet Cleaning	Hampstead	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Manchester	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Westminster	2130907	Completed	**	Annual
Street Sweeping	Westminster	2130907	Completed	**	Annual
Water/floodplain Easement	Watershed	2130907	Completed	N/A	Completed
SWM (Planned)	County	2130907	Planning/Design	$15,153,278	FY20-25
TBD	Watershed	8-Digit	Planning	$27,500,000	TBD

***Costs for proposed Stormwater facilities are based on current FY20-FY25 project costs, which may be subject to change.**

****Project Costs not reported**

XIII. Appendix B: Liberty BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2009-2019
1060	Aspen Run	Septic Repair	1	0	0	0	1	0	0	0	0	0	0	2
		New Construction	0	0	0	0	0	0	1	0	1	1	0	3
1057	Beaver Run	Septic Repair	1	0	0	0	1	0	2	4	0	0	0	8
		New Construction	0	0	0	1	2	4	5	4	3	1	1	21
1061	Cranberry Branch	Septic Repair	0	0	0	0	0	0	0	0	1	1	0	11
		New Construction	0	0	0	0	0	0	1	0	0	0	0	1
1058	Deep Run	Septic Repair	0	0	0	0	0	0	0	1	1	1	0	3
		New Construction	0	0	0	0	0	0	1	1	3	0	0	5
1052	East Branch Patapsco	Septic Repair	3	0	0	0	0	0	0	0	0	0	0	3
		New Construction	1	0	0	0	0	0	0	0	1	0	0	2
1059	East Branch Patapsco	Septic Repair	1	1	0	0	2	0	3	1	1	0	0	9
		New Construction	0	0	0	0	0	0	2	1	2	1	0	11
1046	Liberty Reservoir	Septic Repair	0	0	0	0	0	0	0	0	0	2	1	3
		New Construction	0	0	0	0	0	0	1	1	0	0	0	2
1047	Liberty Reservoir	Septic Repair	1	1	0	0	1	0	0	1	0	0	0	4
		New Construction	0	0	0	0	0	0	15	8	0	0	0	23
1049	Little Morgan Run	Septic Repair	1	0	0	1	0	0	0	1	1	0	0	4
		New Construction	1	0	0	0	1	0	15	21	3	0	2	43
1055	Little Morgan Run	Septic Repair	0	0	0	0	0	0	1	0	0	0	1	2
		New Construction	0	0	0	0	0	0	1	0	0	0	0	1
1056	Middle Run	Septic Repair	2	0	0	0	0	0	1	0	0	1	0	4
		New Construction	0	0	0	0	0	1	2	0	0	0	0	3
1053	Morgan Run	Septic Repair	0	0	0	0	1	0	1	1	0	0	0	3

		New Construction	0	0	0	0	0	0	3	1	0	0	0	4
1054	Morgan Run	Septic Repair	0	0	0	0	1	0	1	0	0	0	0	2
		New Construction	0	0	0	0	0	0	1	3	0	0	0	4
1050	Morgan Run	Septic Repair	3	0	0	1	0	0	3	1	0	1	1	10
		New Construction	0	0	0	0	0	0	11	14	0	0	0	25
1048	Roaring Run	Septic Repair	5	0	0	0	0	2	0	1	0	0	0	8
		New Construction	0	0	0	0	0	1	3	11	6	0	0	21
1051	West Branch Patapsco	Septic Repair	1	1	0	0	0	1	0	1	1	0	0	5
		New Construction	0	0	0	0	1	1	2	2	3	0	0	9
1062	West Branch Patapsco	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	2	1	0	0	0	3

XIV. Appendix C: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	0.56	ST	1.00	0.0043%	35%	0.42	0.0074%	55%	0.13	0.0105%	70%	0.36
Hickory Ridge	Retrofit	23.75	4.8	ST	2.50	0.0458%	39%	4.54	0.0796%	62%	1.43	0.1130%	79%	3.86
Bateman SW Pond	Facility	47.25	4.52	RR	2.50	0.1568%	68%	15.56	0.2014%	79%	3.61	0.2414%	85%	8.24
Marriot Wood 1 Facility #2	Retrofit	7.12	2.04	ST	2.50	0.0137%	39%	1.36	0.0239%	62%	0.43	0.0339%	79%	1.16
Marriot Wood II	Retrofit	7.51	1.38	ST	2.50	0.0145%	39%	1.44	0.0252%	62%	0.45	0.0357%	79%	1.22
Elderwood Village	Retrofit	7.64	2.47	ST	2.50	0.0485%	39%	4.81	0.0562%	62%	1.01	0.0394%	79%	1.35
Westminster Airport Pond	Retrofit	204.84	85	ST	1.40	1.2437%	38%	123.43	1.4367%	59%	25.77	1.0080%	75%	34.42
Oklahoma II Foothills	Retrofit	23.72	6.06	ST	2.35	0.0455%	39%	4.52	0.0792%	62%	1.42	0.1124%	78%	3.84
Oklahoma Phase I	Retrofit	24.44	7.27	ST	2.50	0.0471%	39%	4.67	0.0820%	62%	1.47	0.1163%	79%	3.97
Edgewood	Retrofit	38	12.12	ST	2.50	0.2412%	39%	23.94	0.2796%	62%	5.01	0.1960%	79%	6.69
Upper Patapsco Phase 1	Facility	24.6	10.1	ST	2.50	0.1562%	39%	15.50	0.1810%	62%	3.25	0.1269%	79%	4.33
Upper Patapsco Phase 2	Facility	101.8	2.98	ST	2.50	1.4051%	39%	139.45	3.6266%	62%	65.04	2.3023%	79%	78.63
Quail Meadowns	Retrofit	111.97	23.25	ST	1.00	0.1918%	35%	19.03	0.3326%	55%	5.97	0.4724%	70%	16.13
Heritage Heights	Retrofit	21.38	4.1	ST	1.00	0.0366%	35%	3.63	0.0635%	55%	1.14	0.0902%	70%	3.08
Westminster High School	Retrofit	117.25	32.59	ST	2.50	0.2259%	39%	22.42	0.3932%	62%	7.05	0.5577%	79%	19.05

Westminster Comm. Pond	Facility	250.22	63.89	ST	2.50	0.4821%	39%	47.84	0.8391%	62%	15.05	1.1902%	79%	40.65
Diamond Hills Section 5	Retrofit	51.8	12.94	ST	2.03	0.0992%	39%	9.85	0.1723%	61%	3.09	0.2445%	78%	8.35
Wilda Drive	Facility	6.75	1.6	ST	1.07	0.0118%	36%	1.17	0.0204%	56%	0.37	0.0290%	71%	0.99
Collins Estates	Retrofit	16.34	3.18	ST	1.87	0.0312%	39%	3.09	0.0541%	61%	0.97	0.0768%	78%	2.62
High Point	Retrofit	4.7	0.91	ST	1.00	0.0080%	35%	0.80	0.0140%	55%	0.25	0.0198%	70%	0.68
Willow Pond	Retrofit	601	72.75	ST	2.50	1.1579%	39%	114.91	2.0155%	62%	36.15	2.8588%	79%	97.63
Finksburg Industrial Park	Retrofit	67.8	22.12	ST	1.04	0.3866%	35%	38.37	0.4466%	56%	8.01	0.3134%	71%	10.70
Elderwood Village Parcel	Retrofit	144	61.00	ST	1.01	0.8148%	35%	80.87	0.9412%	55%	16.88	0.6604%	70%	22.55
Oklahoma 4	Retrofit	56.93	14.52	RR	2.5	0.1889%	68%	18.74	0.2427%	79%	4.35	0.2909%	85%	9.93
Miller/Watts	Retrofit	39.65	25.63	ST	2.50	0.2517%	39%	24.98	0.2917%	62%	5.23	0.2045%	79%	6.98
Central MD (Wet)	Retrofit	92.72	25.83	ST	2.50	0.1786%	39%	17.73	0.3109%	62%	5.58	0.4410%	79%	15.06
Randomhouse	Retrofit	41.8	16.38	ST	2.50	0.2653%	39%	26.33	0.3076%	62%	5.52	0.2156%	79%	7.36
Eldersburg Business Center	Retrofit	97.98	52.7	ST	2.34	0.6198%	39%	61.51	0.7177%	62%	12.87	0.5032%	78%	17.18
Feeser Property	Facility	4.38	1.72	RR	1.00	0.0423%	60%	4.19	0.0363%	70%	0.65	0.0214%	75%	0.73
Central MD (Dry)	Retrofit	63.35	45	RR	2.50	0.7038%	68%	69.85	0.6002%	79%	10.76	0.3513%	85%	12.00
Shiloh Middle	Retrofit	83.83	25.64	RR	1.32	0.8615%	64%	85.50	0.7407%	74%	13.28	0.4370%	80%	14.92
Aspen Run	Retrofit	14.4	1.7	RR	1.30	0.0448%	63%	4.44	0.0578%	74%	1.04	0.0690%	79%	2.36
Squires	Retrofit	36.8	10	ST	2.50	0.071%	39%	7.04	0.123%	62%	2.21	0.175%	79%	5.98
Springmount Estates	Retrofit	60	20	RR	2.50	0.656%	68%	65.09	0.561%	79%	10.07	0.332%	85%	11.35

Winters St. Pond	Retrofit	79.4	36.01	ST	1.00	0.448%	35%	44.47	0.518%	55%	9.28	0.363%	70%	12.40
Black and Decker	Facility	160.31	50.33	RR	2.50	1.752%	68%	173.91	1.499%	79%	26.89	0.888%	85%	30.32
Limton Springs	Retrofit	53.43	25.8	RR	2.50	0.584%	68%	57.96	0.500%	79%	8.96	0.296%	85%	10.11
W. Branch Trade Center	Retrofit	58.75	19.77	RR	2.50	0.642%	68%	63.73	0.550%	79%	9.86	0.325%	85%	11.11
Solo Cup	Retrofit	64	34.44	ST	1.00	0.3611%	35%	35.84	0.4172%	55%	7.48	0.2927%	70%	10.00
Hampstead Regional	Facility	350	85	ST	2.50	1.1612%	39%	115.24	1.4921%	62%	26.76	1.7882%	79%	61.07
Brynwood	Facility	95.5	21.7	RR	2.50	0.3168%	68%	31.44	0.4071%	79%	7.30	0.4879%	85%	16.66
Winters Mill High School	Retrofit	58.3	21.8	ST	1.00	0.3290%	35%	32.65	0.3800%	55%	6.82	0.2666%	70%	9.11
East Middle School Wetland	Retrofit	10.18	10.18	ST	1.00	0.0584%	35%	5.79	0.0672%	55%	1.21	0.0466%	70%	1.59
Eldersburg Marketplace	Retrofit	54.78	35.16	St	1.00	0.3091%	35%	30.68	0.3571%	55%	6.40	0.2505%	70%	8.56
Westminster Marketplace	Retrofit	52.07	40.4	ST	1.00	0.2987%	35%	29.64	0.3438%	55%	6.17	0.2384%	70%	8.14
Stone Manor	Retrofit	17.81	3.97	ST	1.00	0.031%	35%	3.03	0.053%	55%	0.95	0.075%	70%	2.57
Town Mall of Westminster	Retrofit	172.66	65.82	ST	1.00	0.9743%	35%	96.70	1.1254%	55%	20.18	0.7897%	70%	26.97

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Load Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Load Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.14	0.0005%	66	0.0449	0.0006%	77	0.0105	0.0005%	57	0.016
Planting 2	1.43	0.0046%	66	0.4590	0.0060%	77	0.1068	0.0049%	57	0.168
Planting 3	1.19	0.0038%	66	0.3820	0.0050%	77	0.0889	0.0041%	57	0.140
Planting 4	0.6	0.0019%	66	0.1926	0.0025%	77	0.0448	0.0021%	57	0.070
Planting 5	0.32	0.0010%	66	0.1027	0.0013%	77	0.0239	0.0011%	57	0.038
Planting 6	0.31	0.0010%	66	0.0995	0.0013%	77	0.0232	0.0011%	57	0.036
Planting 7	0.3	0.0010%	66	0.0963	0.0012%	77	0.0224	0.0010%	57	0.035
Planting 8	0.16	0.0005%	66	0.0514	0.0007%	77	0.0120	0.0006%	57	0.019
Planting 9	1.02	0.0033%	66	0.3274	0.0042%	77	0.0762	0.0035%	57	0.120
Planting 10	0.84	0.0027%	66	0.2696	0.0035%	77	0.0627	0.0029%	57	0.099
Planting 11	3.18	0.0103%	66	1.0207	0.0132%	77	0.2375	0.0109%	57	0.374
Planting 12	2.92	0.0094%	66	0.9373	0.0122%	77	0.2181	0.0100%	57	0.343
Planting 13	1.15	0.0037%	66	0.3691	0.0048%	77	0.0859	0.0040%	57	0.135
Planting 14	0.24	0.0008%	66	0.0770	0.0010%	77	0.0179	0.0008%	57	0.03
Planting 15	0.52	0.0017%	66	0.1669	0.0022%	77	0.0388	0.0018%	57	0.06
Planting 16	1.41	0.0046%	66	0.4526	0.0059%	77	0.1053	0.0049%	57	0.17
Planting 17	0.1	0.0003%	66	0.0321	0.0004%	77	0.0075	0.0003%	57	0.01
Planting 18	4.06	0.0131%	66	1.3032	0.0169%	77	0.3033	0.0140%	57	0.48
Planting 19	1.22	0.0039%	66	0.3916	0.0051%	77	0.0911	0.0042%	57	0.14

Planting 20	0.21	0.0007%	66	0.0674	0.0009%	77	0.0157	0.0007%	57	0.02
Planting 21	0.87	0.0028%	66	0.2793	0.0036%	77	0.0650	0.0030%	57	0.10
Planting 22	0.1	0.0003%	66	0.0321	0.0004%	77	0.0075	0.0003%	57	0.01
Planting 23	0.76	0.0025%	66	0.2439	0.0032%	77	0.0568	0.0026%	57	0.09
Planting 24	0.44	0.0014%	66	0.1412	0.0018%	77	0.0329	0.0015%	57	0.05
Planting 25	0.38	0.0012%	66	0.1220	0.0016%	77	0.0284	0.0013%	57	0.04
Planting 26	0.3	0.0010%	66	0.0963	0.0012%	77	0.0224	0.0010%	57	0.04
Planting 27	0.16	0.0005%	66	0.0514	0.0007%	77	0.0120	0.0006%	57	0.02
Planting 28	0.2	0.0006%	66	0.0642	0.0008%	77	0.0149	0.0007%	57	0.02
Planting 29	0.9	0.0029%	66	0.2889	0.0037%	77	0.0672	0.0031%	57	0.11
Planting 30	0.38	0.0012%	66	0.1220	0.0016%	77	0.0284	0.0013%	57	0.04
Planting 31	0.11	0.0004%	66	0.0353	0.0005%	77	0.0082	0.0004%	57	0.01
Planting 32	2.07	0.0067%	66	0.66	0.0086%	77	0.15	0.0071%	57	0.24
Planting 33	0.38	0.0012%	66	0.12	0.0016%	77	0.03	0.0013%	57	0.04
Planting 34	4	0.0129%	66	1.28	0.0167%	77	0.30	0.0138%	57	0.47
Planting 35	1.88	0.0061%	66	0.60	0.0078%	77	0.14	0.0065%	57	0.22
Planting 36	0.54	0.0017%	66	0.17	0.0022%	77	0.04	0.0019%	57	0.06
Total:	**34.79**	**0.1125%**		**11.1671**	**0.1449%**		**2.5987**	**0.1197%**		**4.087**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Hampstead	8.64	3.5	30.24 [1.2524]	1.4	12.096 [0.4884]	420	3,629 [472.99]	1.815 [0.237]
Manchester	0.674	3.5	2.359 [0.0977]	1.4	0.944 [0.0381]	420	283.08 [36.90]	0.142 [0.0184]
Westminster	0.49	3.5	1.715 [0.0710]	1.4	0.686 [0.0277]	420	205.8 [26.82]	0.103 [0.0134]
Total:			**34.314 [1.4211]**		**13.726 [0.5542]**		**4,117.88 [536.71]**	**2.06 [0.269]**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced [delivered] (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced [delivered] (Tons)
Westminster	5.28	11.7	61.776	4	2.47104 [0.1023]	0.68	3.5904	4	0.143616 [0.0058]	0.18	0.9504	10	0.09504 [0.0124]
Total:			**61.7760**		**2.4710 [0.1023]**		**3.5904**		**0.1436 [0.0058]**		**0.9504**		**0.0950 [0.0124]**

Stream Restoration

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Eden Farms	1,304	0.092%	9.10	0.439%	7.87	0.038%	2,598.09	1.30
Total:		**0.092%**	**9.10**	**0.439%**	**7.87**	**0.038%**	**2,598.09**	**1.30**

Streambank Regeneration[1]

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Hickory Ridge	165	0.012%	1.15	0.056%	1.00	0.005%	328.75	0.16
Marriot Wood 1 Facility #2	150	0.011%	1.05	0.050%	0.91	0.004%	298.86	0.15
Edgewood Section 1	240	0.017%	1.68	0.081%	1.45	0.007%	478.18	0.24
Heritage Heights	510	0.036%	3.56	0.172%	3.08	0.015%	1016.13	0.51
Westminster High School	416	0.029%	2.90	0.140%	2.51	0.012%	828.84	0.41
Central MD	960	0.0007%	6.70	0.0032%	5.79	0.0003%	1912.71	0.96
Hoff Pond	822	0.058%	5.74	0.277%	4.96	0.024%	1637.76	0.82
Total:		**0.164%**	**22.78**	**0.779%**	**19.70**	**0.067%**	**6,501.23**	**3.25**

[1]A study is currently underway by the County to evaluate streambank regeneration as an innovative practice following the guideline in MDE (2014). In the interim, the default stream restoration credit is combined with equivalent impervious area, as suggested in the 2014 MDE guidance, is used here to estimate nutrient and sediment reductions from this practice. Also see BMP Assumptions in Appendix D.

Forest Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Forest Buffer 2009-Current	273.490	0.6031%	45	59.85	0.5917%	40	10.61	0.9079%	55	31.00
Total:	**273.490**	**0.6031%**		**59.85**	**0.5917%**		**10.61**	**0.9079%**		**31.00**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Grass Buffer 2009-Current	215.470	0.3168%	30	31.44	0.4662%	40	8.36	0.7153%	55	24.43
Total:	**215.470**	**0.3168%**		**31.44**	**0.4662%**		**8.36**	**0.7153%**		**24.43**

XV. Appendix D: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Liberty Reservoir watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table D-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table D-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest
Shrub/Scrub	Open Land
Herbaceous	Open Land

Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table D-2 below and were based on literature and professional judgement.

Table D-2: Model parameter changes from default to better represent Carroll County.

Parameter	**Default**	**New Value**	**Units**	**Comments**
Practice Factor (pasture/hay)**	0.52	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.52	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation LD Mixed MD Mixed HD Mixed LD Residential	Imp. (Pervious) values 2.8 (0.8) 6.2 (0.8) 2.8 (0.8) 2.5 (1.3)	Imp. (Pervious) values 1.21 (0.19) 2.66 (0.30) 2.66 (0.30) 1.21 (0.19)	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was based on dominant parameter.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table D-3 for the Liberty Reservoir watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table D-3 based on professional judgement.

Table D-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
LD Mixed	15	>5 to <30	0.49	0.10	412.24
MD Mixed	52	>=30 to <70	1.60	0.21	446.90
HD Mixed	87	>=70	1.63	0.22	447.44
LD Residential	15	>5 to <30	0.49	0.10	412.24

The local TP and TSS TMDL baseline year is 2009, which means any retrofitted water quality BMPs installed since this year can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table D-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Liberty Reservoir watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.041, 0.040, and 0.130, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing. For qualifying street sweeping programs (25 times a year), TN, TP, and TSS reductions are 4%, 4%, and 10% respectively. Delivery ratios were also used to adjust these reductions.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XVI. Appendix E: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	0.56	ST	1.00	15.3	8.5680	35%	2.9945	1.69	0.9464	55%	0.5198	0.44	0.2464	70%	0.1722
Hickory Ridge	Retrofit	23.75	4.8	ST	2.50	15.3	73.4400	39%	28.8729	1.69	8.1120	62%	5.0292	0.44	2.1120	79%	1.6645
Bateman SW Pond	Facility	47.25	4.52	RR	2.50	15.3	69.1560	68%	46.8186	1.69	7.6388	79%	6.0203	0.44	1.9888	85%	1.6885
Marriot Wood 1 Facility #2	Retrofit	7.12	2.04	ST	2.50	15.3	31.2120	39%	12.2710	1.69	3.4476	62%	2.1374	0.44	0.8976	79%	0.7074
Marriot Wood II	Retrofit	7.51	1.38	ST	2.50	15.3	21.1140	39%	8.3010	1.69	2.3322	62%	1.4459	0.44	0.6072	79%	0.4785
Elderwood Village	Retrofit	7.64	2.47	ST	2.50	15.3	37.7910	39%	14.8575	1.69	4.1743	62%	2.5879	0.44	1.0868	79%	0.8565
Westminster Airport Pond	Retrofit	204.84	85	ST	1.40	15.3	1300.5000	38%	489.0375	1.69	143.6500	59%	84.8894	0.44	37.4000	75%	28.1282
Oklahoma II Foothills	Retrofit	23.72	6.06	ST	2.35	15.3	92.7180	39%	36.3301	1.69	10.2414	62%	6.3218	0.44	2.6664	78%	2.0930
Oklahoma Phase I	Retrofit	24.44	7.27	ST	2.50	15.3	111.2310	39%	43.7305	1.69	12.2863	62%	7.6172	0.44	3.1988	79%	2.5210
Edgewood	Retrofit	38	12.12	ST	2.50	15.3	185.4360	39%	72.9042	1.69	20.4828	62%	12.6988	0.44	5.3328	79%	4.2029
Upper Patapsco Phase 1	Facility	24.6	10.1	ST	2.50	15.3	154.5300	39%	60.7535	1.69	17.0690	62%	10.5823	0.44	4.4440	79%	3.5024
Upper Patapsco Phase 2	Facility	101.8	2.98	ST	2.50	15.3	45.5940	39%	17.9253	1.69	5.0362	62%	3.1223	0.44	1.3112	79%	1.0334
Quail Meadowns	Retrofit	111.97	23.25	ST	1.00	15.3	355.7250	35%	124.3259	1.69	39.2925	55%	21.5794	0.44	10.2300	70%	7.1508

Heritage Heights	Retrofit	21.38	4.1	ST	1.00	15.3	62.7300	35%	21.9241	1.69	6.9290	55%	3.8054	0.44	1.8040	70%	1.2610
Westminster High School	Retrofit	117.25	32.59	ST	2.50	15.3	498.6270	39%	196.0352	1.69	55.0771	62%	34.1463	0.44	14.3396	79%	11.3013
Westminster Comm. Pond	Facility	250.22	63.89	ST	2.50	15.3	977.5170	39%	384.3108	1.69	107.9741	62%	66.9409	0.44	28.1116	79%	22.1553
Diamond Hills Section 5	Retrofit	51.8	12.94	ST	2.03	15.3	197.9820	39%	77.3732	1.69	21.8686	61%	13.4445	0.44	5.6936	78%	4.4534
Wilda Drive	Facility	6.75	1.6	ST	1.07	15.3	24.4800	36%	8.7093	1.69	2.7040	56%	1.5117	0.44	0.7040	71%	0.5009
Collins Estates	Retrofit	16.34	3.18	ST	1.87	15.3	48.6540	39%	18.9371	1.69	5.3742	61%	3.2891	0.44	1.3992	78%	1.0896
High Point	Retrofit	4.7	0.91	ST	1.00	15.3	13.9230	35%	4.8661	1.69	1.5379	55%	0.8446	0.44	0.4004	70%	0.2799
Willow Pond	Retrofit	601	72.75	ST	2.50	15.3	1113.0750	39%	437.6054	1.69	122.9475	62%	76.2240	0.44	32.0100	79%	25.2277
Finksburg Industrial Park	Retrofit	67.8	22.12	ST	1.04	15.3	338.4360	35%	119.5339	1.69	37.3828	56%	20.7477	0.44	9.7328	71%	6.8751
Elderwood/ Village Parcel	Retrofit	144	61	ST	1.01	15.3	933.3000	35%	327.0777	1.69	103.0900	55%	56.7714	0.44	26.8400	70%	18.8123
Oklahoma 4	Retrofit	56.93	14.52	RR	2.50	15.3	222.1560	68%	150.3996	1.69	24.5388	79%	19.3395	0.44	6.3888	85%	5.4240
Miller/Watts	Retrofit	39.65	25.63	ST	2.50	15.3	392.1390	39%	154.1694	1.69	43.3147	62%	26.8539	0.44	11.2772	79%	8.8878
Central MD (Wet)	Retrofit	92.72	25.83	ST	2.50	15.3	395.1990	39%	155.3725	1.69	43.6527	62%	27.0634	0.44	11.3652	79%	8.9571
Randomhouse	Retrofit	41.8	16.38	ST	2.50	16.3	266.9940	39%	104.9687	2.69	44.0622	62%	27.3173	1.44	23.5872	79%	18.5895
Squires	Retrofit	36.8	10	ST	2.50	15.3	153.0000	39%	60.1520	1.69	16.9000	62%	10.4775	0.44	4.4000	79%	3.4677
Central MD (Dry)	Retrofit	63.35	45	RR	2.50	15.3	688.5000	68%	466.1145	1.69	76.0500	79%	59.9364	0.44	19.8000	85%	16.8098
Springmount Estates	Retrofit	60	20	RR	2.50	15.3	306.0000	68%	207.1620	1.69	33.8000	79%	26.6384	0.44	8.8000	85%	7.4710
Eldersburg Business Center	Retrofit	97.98	52.7	ST	2.34	15.3	806.3100	39%	315.9077	1.69	89.0630	62%	54.9680	0.44	23.1880	78%	18.1993
Winters St. Pond	Retrofit	79.4	36.01	ST	1.00	15.3	550.9530	35%	192.5581	1.69	60.8569	55%	33.4226	0.44	15.8444	70%	11.0752

Black and Decker	Facility	160.31	50.33	RR	2.50	15.3	770.0490	68%	521.3232	1.69	85.0577	79%	67.0356	0.44	22.1452	85%	18.8009
Limton Springs	Retrofit	53.43	25.8	RR	2.50	15.3	394.7400	68%	267.2390	1.69	43.6020	79%	34.3636	0.44	11.3520	85%	9.6376
W. Branch Trade Center	Retrofit	58.75	19.77	RR	2.50	15.3	302.4810	68%	204.7796	1.69	33.4113	79%	26.3321	0.44	8.6988	85%	7.3851
Feeser Property	Facility	4.38	1.72	RR	1.00	15.3	26.3160	60%	15.7238	1.69	2.9068	70%	2.0319	0.44	0.7568	75%	0.5669
Hampstead Regional	Facility	350	85	ST	2.50	15.3	1300.5000	39%	511.2916	1.69	143.6500	62%	89.0590	0.44	37.4000	79%	29.4756
Solo Cup	Retrofit	64	34.44	ST	1.00	15.3	526.9320	35%	184.1627	1.69	58.2036	55%	31.9654	0.44	15.1536	70%	10.5924
Brynwood	Facility	95.5	21.7	RR	2.50	15.3	332.0100	68%	224.7708	1.69	36.6730	79%	28.9027	0.44	9.5480	85%	8.1061
Shiloh Middle	Retrofit	83.83	25.64	RR	1.32	15.3	392.2920	64%	249.6827	1.69	43.3316	74%	32.2576	0.44	11.2816	80%	9.0031
Aspen Run	Retrofit	14.4	1.7	RR	1.30	15.3	26.0100	63%	16.5073	1.69	2.8730	74%	2.1327	0.44	0.7480	80%	0.5952
Winters Mill High School	Retrofit	58.3	21.8	ST	1.00	15.3	333.5400	35%	116.5722	1.69	36.8420	55%	20.2336	0.44	9.5920	70%	6.7048
East Middle School Wetland	Retrofit	10.18	10.18	ST	1.00	15.3	155.7540	35%	54.4360	1.69	17.2042	55%	9.4485	0.44	4.4792	70%	3.1310
Eldersburg Marketplace	Retrofit	54.78	35.16	ST	1.00	15.3	537.9480	35%	188.0128	1.69	59.4204	55%	32.6337	0.44	15.4704	70%	10.8138
Westminster Marketplace	Retrofit	52.07	40.4	ST	1.00	15.3	618.1200	35%	216.0329	1.69	68.2760	55%	37.4972	0.44	17.7760	70%	12.4254
Stone Manor	Retrofit	17.81	3.97	ST	1.00	15.3	60.7410	35%	21.2290	1.69	6.7093	55%	3.6847	0.44	1.7468	70%	1.2210
Town Mall of Westminster	Retrofit	172.66	65.82	ST	1.00	15.3	1007.0460	35%	351.9626	1.69	111.2358	55%	61.0907	0.44	28.9608	70%	20.2436
	Total:	**3,669.01**	**1,112.62**				**17,039.47**		**7,348.26**		**1,896.71**		**1,187.08**		**505.93**		**388.25**

Planned Facilities

SWM Facilities

Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Marriot Wood 1 Facility #1	Retrofit	2.5	1.94	ST	1.00	10.8	20.9520	35%	7.3227	0.43	0.8342	55%	0.4581	0.07	0.1358	70%	0.0949
Hickory Ridge	Retrofit	23.75	18.95	ST	2.50	10.8	204.6600	39%	80.4621	0.43	8.1485	62%	5.0518	0.07	1.3265	79%	1.0454
Bateman SW Pond	Facility	47.25	42.73	RR	2.50	10.8	461.4840	68%	312.4247	0.43	18.3739	79%	14.4808	0.07	2.9911	85%	2.5394
Marriot Wood 1 Facility #2	Retrofit	7.12	5.08	ST	2.50	10.8	54.8640	39%	21.5698	0.43	2.1844	62%	1.3543	0.07	0.3556	79%	0.2803
Marriot Wood II	Retrofit	7.51	6.13	ST	2.50	10.8	66.2040	39%	26.0281	0.43	2.6359	62%	1.6342	0.07	0.4291	79%	0.3382
Elderwood Village	Retrofit	7.64	5.17	ST	2.50	10.8	55.8360	39%	21.9519	0.43	2.2231	62%	1.3783	0.07	0.3619	79%	0.2852
Westminster Airport Pond	Retrofit	204.84	119.84	ST	1.40	10.8	1294.2720	38%	486.6955	0.43	51.5312	59%	30.4521	0.07	8.3888	75%	6.3091
Oklahoma II Foothills	Retrofit	23.72	17.66	ST	2.35	10.8	190.7280	39%	74.7337	0.43	7.5938	62%	4.6875	0.07	1.2362	78%	0.9704
Oklahoma Phase I	Retrofit	24.44	17.17	ST	2.50	10.8	185.4360	39%	72.9042	0.43	7.3831	62%	4.5773	0.07	1.2019	79%	0.9472
Edgewood	Retrofit	38	25.88	ST	2.50	10.8	279.5040	39%	109.8870	0.43	11.1284	62%	6.8993	0.07	1.8116	79%	1.4278
Upper Patapsco Phase 1	Facility	24.6	14.5	ST	2.50	10.8	156.6000	39%	61.5673	0.43	6.2350	62%	3.8655	0.07	1.0150	79%	0.7999
Upper Patapsco Phase 2	Facility	101.8	98.82	ST	2.50	10.8	1067.2560	39%	419.5917	0.43	42.4926	62%	26.3442	0.07	6.9174	79%	5.4517
Quail Meadowns	Retrofit	111.97	88.72	ST	1.00	10.8	958.1760	35%	334.8825	0.43	38.1496	55%	20.9518	0.07	6.2104	70%	4.3411
Heritage Heights	Retrofit	21.38	17.28	ST	1.00	10.8	186.6240	35%	65.2251	0.43	7.4304	55%	4.0808	0.07	1.2096	70%	0.8455

Westminster High School	Retrofit	117.25	84.66	ST	2.50	10.8	914.3280	39%	359.4681	0.43	36.4038	62%	22.5693	0.07	5.9262	79%	4.6705
Westminster Comm. Pond	Facility	250.22	186.33	ST	2.50	10.8	2012.3640	39%	791.1609	0.43	80.1219	62%	49.6733	0.07	13.0431	79%	10.2795
Diamond Hills Section 5	Retrofit	51.8	38.86	ST	2.03	10.8	419.6880	39%	164.0180	0.43	16.7098	61%	10.2730	0.07	2.7202	78%	2.1277
Wilda Drive	Facility	6.75	5.15	ST	1.07	10.8	55.6200	36%	19.7880	0.43	2.2145	56%	1.2380	0.07	0.3605	71%	0.2565
Collins Estates	Retrofit	16.34	13.16	ST	1.87	10.8	142.1280	39%	55.3190	0.43	5.6588	61%	3.4633	0.07	0.9212	78%	0.7174
High Point	Retrofit	4.7	3.79	ST	1.00	10.8	40.9320	35%	14.3057	0.43	1.6297	55%	0.8950	0.07	0.2653	70%	0.1854
Willow Pond	Retrofit	601	528.25	ST	2.50	10.8	5705.1000	39%	2242.9601	0.43	227.1475	62%	140.8251	0.07	36.9775	79%	29.1427
Finksburg Industrial Park	Retrofit	67.8	45.68	ST	1.04	10.8	493.3440	35%	174.2466	0.43	19.6424	56%	10.9016	0.07	3.1976	71%	2.2587
Elderwood/ Village Parcel	Retrofit	144	83	ST	1.01	10.8	896.4000	35%	314.1460	0.43	35.6900	55%	19.6544	0.07	5.8100	70%	4.0723
Oklahoma 4	Retrofit	56.93	42.41	RR	2.50	11.8	500.4380	68%	338.7965	1.43	60.6463	79%	47.7965	1.07	45.3787	85%	38.5257
Miller/Watts	Retrofit	39.65	14.02	ST	2.50	10.8	151.4160	39%	59.5292	0.43	6.0286	62%	3.7376	0.07	0.9814	79%	0.7735
Central MD (Wet)	Retrofit	92.72	66.89	ST	2.50	10.8	722.4120	39%	284.0163	0.43	28.7627	62%	17.8321	0.07	4.6823	79%	3.6902
Randomhouse	Retrofit	41.8	25.42	RR	2.50	10.8	274.5360	39%	107.9338	0.43	10.9306	62%	6.7767	0.07	1.7794	79%	1.4024
Squires	Retrofit	36.8	26.8	ST	2.50	10.8	289.4400	39%	113.7933	0.43	11.5240	62%	7.1446	0.07	1.8760	79%	1.4785
Central MD (Dry)	Retrofit	63.35	18.35	RR	2.50	10.8	198.1800	68%	134.1679	0.43	7.8905	79%	6.2187	0.07	1.2845	85%	1.0905
Springmount Estates	Retrofit	60	40	RR	2.50	10.8	432.0000	68%	292.4640	0.43	17.2000	79%	13.5556	0.07	2.8000	85%	2.3771
Eldersburg Business Center	Retrofit	97.98	45.28	ST	2.34	10.8	489.0240	39%	191.5969	0.43	19.4704	62%	12.0168	0.07	3.1696	78%	2.4877
Winters St. Pond	Retrofit	79.4	43.39	ST	1.00	10.8	468.6120	35%	163.7799	0.43	18.6577	55%	10.2468	0.07	3.0373	70%	2.1231
Black and Decker	Facility	160.31	109.98	RR	2.50	10.8	1187.7840	68%	804.1298	0.43	47.2914	79%	37.2712	0.07	7.6986	85%	6.5360

Limton Springs	Retrofit	53.43	27.63	RR	2.50	10.8	298.4040	68%	202.0195	0.43	11.8809	79%	9.3636	0.07	1.9341	85%	1.6420
W. Branch Trade Center	Retrofit	58.75	38.98	RR	2.50	10.8	420.9840	68%	285.0062	0.43	16.7614	79%	13.2100	0.07	2.7286	85%	2.3165
Feeser Property	Facility	4.38	2.66	RR	1.00	10.8	28.7280	60%	17.1650	0.43	1.1438	70%	0.7995	0.07	0.1862	75%	0.1395
Hampstead Regional	Facility	350	265	ST	2.50	10.8	2862.0000	39%	1125.1953	0.43	113.9500	62%	70.6458	0.07	18.5500	79%	14.6196
Solo Cup	Retrofit	64	29.56	ST	1.00	10.8	319.2480	35%	111.5772	0.43	12.7108	55%	6.9808	0.07	2.0692	70%	1.4464
Brynwood	Facility	95.5	73.8	RR	2.50	10.8	797.0400	68%	539.5961	0.43	31.7340	79%	25.0102	0.07	5.1660	85%	4.3858
Shiloh Middle	Retrofit	83.83	58.19	RR	1.32	10.8	628.4520	64%	399.9918	0.43	25.0217	74%	18.6270	0.07	4.0733	80%	3.2506
Aspen Run	Retrofit	14.4	12.7	RR	1.30	10.8	137.1600	63%	87.0486	0.43	5.4610	74%	4.0539	0.07	0.8890	80%	0.7074
Winters Mill High School	Retrofit	58.3	36.5	ST	1.00	10.8	394.2000	35%	137.7729	0.43	15.6950	55%	8.6197	0.07	2.5550	70%	1.7859
East Middle School Wetland	Retrofit	10.18	0	ST	1.00	10.8	0.0000	35%	0.0000	0.43	0.0000	55%	0.0000	0.07	0.0000	70%	0.0000
Eldersburg Marketplace	Retrofit	54.78	19.62	St	1.00	10.8	211.8960	35%	74.0577	0.43	8.4366	55%	4.6334	0.07	1.3734	70%	0.9600
Westminster Marketplace	Retrofit	52.07	11.67	ST	1.00	10.8	126.0360	35%	44.0496	0.43	5.0181	55%	2.7559	0.07	0.8169	70%	0.5710
Stone Manor	Retrofit	17.81	13.84	ST	1.00	10.8	149.4720	35%	52.2405	0.43	5.9512	55%	3.2684	0.07	0.9688	70%	0.6772
Town Mall of Westminster	Facility	172.66	106.84	ST	1.00	10.8	1153.8720	35%	403.2783	0.43	45.9412	55%	25.2309	0.07	7.4788	70%	5.2277
Total:		**3,669.01**	**2,556.39**				**27,609.01**		**11,823.92**		**1,099.25**		**692.78**		**178.95**		**139.01**

Planned Facilities

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.14	10.8	1.5120	66	0.9979	0.43	0.0602	77	0.0464	0.07	0.0098	57	0.0056
Planting 2	1.43	10.8	15.4440	66	10.1930	0.43	0.6149	77	0.4735	0.07	0.1001	57	0.0571
Planting 3	1.19	10.8	12.8520	66	8.4823	0.43	0.5117	77	0.3940	0.07	0.0833	57	0.0475
Planting 4	0.6	10.8	6.4800	66	4.2768	0.43	0.2580	77	0.1987	0.07	0.0420	57	0.0239
Planting 5	0.32	10.8	3.4560	66	2.2810	0.43	0.1376	77	0.1060	0.07	0.0224	57	0.0128
Planting 6	0.31	10.8	3.3480	66	2.2097	0.43	0.1333	77	0.1026	0.07	0.0217	57	0.0124
Planting 7	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 8	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 9	1.02	10.8	11.0160	66	7.2706	0.43	0.4386	77	0.3377	0.07	0.0714	57	0.0407
Planting 10	0.84	10.8	9.0720	66	5.9875	0.43	0.3612	77	0.2781	0.07	0.0588	57	0.0335
Planting 11	3.18	10.8	34.3440	66	22.6670	0.43	1.3674	77	1.0529	0.07	0.2226	57	0.1269
Planting 12	2.92	10.8	31.5360	66	20.8138	0.43	1.2556	77	0.9668	0.07	0.2044	57	0.1165
Planting 13	1.15	10.8	12.4200	66	8.1972	0.43	0.4945	77	0.3808	0.07	0.0805	57	0.0459
Planting 14	0.24	10.8	2.5920	66	1.7107	0.43	0.1032	77	0.0795	0.07	0.0168	57	0.0096
Planting 15	0.52	10.8	5.6160	66	3.7066	0.43	0.2236	77	0.1722	0.07	0.0364	57	0.0207
Planting 16	1.41	10.8	15.2280	66	10.0505	0.43	0.6063	77	0.4669	0.07	0.0987	57	0.0563

Planting 17	0.1	10.8	1.0800	66	0.7128	0.43	0.0430	77	0.0331	0.07	0.0070	57	0.0040
Planting 18	4.06	10.8	43.8480	66	28.9397	0.43	1.7458	77	1.3443	0.07	0.2842	57	0.1620
Planting 19	1.22	10.8	13.1760	66	8.6962	0.43	0.5246	77	0.4039	0.07	0.0854	57	0.0487
Planting 20	0.21	10.8	2.2680	66	1.4969	0.43	0.0903	77	0.0695	0.07	0.0147	57	0.0084
Planting 21	0.87	10.8	9.3960	66	6.2014	0.43	0.3741	77	0.2881	0.07	0.0609	57	0.0347
Planting 22	0.1	10.8	1.0800	66	0.7128	0.43	0.0430	77	0.0331	0.07	0.0070	57	0.0040
Planting 23	0.76	10.8	8.2080	66	5.4173	0.43	0.3268	77	0.2516	0.07	0.0532	57	0.0303
Planting 24	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 25	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 26	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 27	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 28	0.2	10.8	2.1600	66	1.4256	0.43	0.0860	77	0.0662	0.07	0.0140	57	0.0080
Planting 29	0.9	10.8	9.7200	66	6.4152	0.43	0.3870	77	0.2980	0.07	0.0630	57	0.0359
Planting 30	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 31	0.11	10.8	1.1880	66	0.7841	0.43	0.0473	77	0.0364	0.07	0.0077	57	0.0044
Planting 32	2.07	10.8	22.3560	66	14.7550	0.43	0.8901	77	0.6854	0.07	0.1449	57	0.0826
Planting 33	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 34	4	10.8	43.2000	66	28.5120	0.43	1.7200	77	1.3244	0.07	0.2800	57	0.1596
Planting 35	1.88	10.8	20.3040	66	13.4006	0.43	0.8084	77	0.6225	0.07	0.1316	57	0.0750
Planting 36	0.54	10.8	5.8320	66	3.8491	0.43	0.2322	77	0.1788	0.07	0.0378	57	0.0215

Total:	**34.79**		**375.7320**		**247.9831**		**14.9597**		**11.5190**		**2.4353**		**1.3881**

Catch Basin/inlet Cleaning

Location	Tons*	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hampstead	8.64	3.5	30.240	1.4	12.096	420	3628.8	1.814
Manchester	0.674	3.5	2.359	1.4	0.944	420	283.08	0.142
Westminster	0.49	3.5	1.715	1.4	0.686	420	205.8	0.103
		Total:	**34.3140**		**13.7256**		**4,118**	**2.059**

Street Sweeping

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Westminster	5.28	11.7	61.776	4	2.47104	0.68	3.5904	4	0.143616	0.18	0.9504	10	0.09504
		Total:	**61.7760**		**2.4710**		**3.5904**		**0.1436**		**0.9504**		**0.0950**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS Effi
Grass Buffer 2009-Current	215.470	2009 -current	11.7	2520.9990	30	756.29970	0.68	146.5196	40	58.6078	0.18	38.7846	
	215.470		**Total:**	**2520.9990**		**756.29970**		**146.5196**		**58.6078**		**38.7846**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS Effi
Forest Buffer 2009-Current	273.490	2009 -current	11.7	3199.8330	45	1439.9249	0.68	185.9732	40	74.3893	0.18	49.2282	
	273.490		**Total:**	**3199.8330**		**1439.92485**		**185.9732**		**74.3893**		**49.2282**	

Stream Restoration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Eden Farms	1304	0.075	97.800	0.068	88.672	44.88	58523.52	29.262
		Total:	**97.8000**		**88.6720**		**58,524**	**29.262**

Streambank Regeneration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hickory Ridge	165	0.075	12.375	0.068	11.220	44.88	7405.2	3.703
Marriot Wood 1 Facility #2	150	0.075	11.250	0.068	10.200	44.88	6732	3.366
Edgewood Section 1	240	0.075	18.000	0.068	16.320	44.88	10771.2	5.386
Heritage Heights	510	0.075	38.250	0.068	34.680	44.88	22888.8	11.444
Westminster High School	416	0.075	31.200	0.068	28.288	44.88	18670.08	9.335
Central MD	960	0.075	72.000	0.068	65.280	44.88	43084.8	21.542
Hoff Pond	822	0.075	61.650	0.068	55.896	44.88	36891.36	18.446
		Total:	**244.7250**		**221.8840**		**146,443**	**73.222**

XVII. Appendix F: Forest Buffer and Grass Buffer Protection Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Morgan Run	0.782061	2009
Plat of Anderson Farm	0.708874	2009
Liberty Reservoir	3.188138	2009
Derby Farms	0.235171	2009
Poignant Acres 6	0.107064	2009
Morgan Run	0.085616	2009
Poignant Acres 6	23.24688	2009
Beaver Run	0.491324	2009
Callier Property	0.561908	2009
East Branch Patapsco Riv*	3.713047	2009
Sterner Property	1.603185	2009
Liberty Reservoir	0.019775	2009
Poignant Acres 6	0.053046	2009
Poignant Acres 6	0.053046	2009
Poignant Acres 6	0.000022	2009
Poignant Acres 6	0.000445	2009
Poignant Acres 6	0.003395	2009
Poignant Acres 6	0.003635	2009
Poignant Acres 6	0.003635	2009
Beaver Run	0.000628	2009
East Branch Patapsco Riv*	0.00021	2009
Morgan Run	0.79768	2010
Beaver Run	1.587809	2010
Liberty Exchange	0.112335	2010
Little Morgan Run	4.156734	2010
Liberty Exchange	1.082034	2010
Flat Bush	0.052705	2010
Middle Run	0.919051	2010
Flat Bush	1.66202	2010
Wilmot Manor, Section 8	0.00595	2010
Beaver Run	0.172947	2010
Wilmot Manor, Section 8	0.114073	2010
Avalon Forest Estates	0.017078	2010
The Enclave at Morgan Run	0.023357	2010
Liberty Reservoir	0.399593	2010

Morgan Run	1.633522	2010
Morgan Run	0.140967	2010
Avalon Forest Estates	0.042696	2010
The Enclave at Morgan Run	0.002384	2010
The Enclave at Morgan Run	0.53877	2010
Harris-Bowlsbey Property	0.007672	2010
Harris-Bowlsbey Property	0.413521	2010
Wheatley Property	0.110294	2010
Manchester Farms, Sectio*	0.000834	2010
Harris-Bowlsbey Property	0.000239	2010
Beaver Run	0.288808	2010
Harris-Bowlsbey Property	0.166085	2010
Manchester Farms, Sectio*	0.241854	2010
Little Morgan Run	0.002768	2010
Clayton Woods, Section 2	0.018117	2011
West Branch Patapsco Riv*	1.615125	2011
Deep Run	3.965218	2011
West Branch Patapsco Riv*	10.205521	2011
West Branch Patapsco Riv*	12.022427	2011
Clayton Woods, Section 2	0.002688	2011
Morgan Run	0.01962	2011
Clayton Woods, Section 2	0.281747	2011
Roaring Run/Board Run	0.32936	2011
Little Morgan Run	2.859697	2011
Morgan Run	0.001187	2011
Clayton Woods, Section 2	0.430055	2011
The Mill at Clearfield	0.005983	2012
Beaver Run	8.02584	2012
The Mill at Clearfield	3.18837	2012
Marabrooke Farm	0.010777	2012
Marabrooke Farm	1.03191	2012
Little Morgan Run	8.255103	2012
Marabrooke Farm	0.767975	2012
Marabrooke Farm	4.244635	2012
Poignant Acres 7	0.014771	2012
Morgan Run	0.001826	2012
Poignant Acres 7	1.400599	2012
Windy Hills Farm, Phase 1	0.007806	2012
West Branch Patapsco Riv*	1.798007	2012
West Branch Patapsco Riv*	1.052197	2012
Windy Hills Farm, Phase 1	0.005463	2012

Windy Hills Farm, Phase 1	5.575906	2012
Marabrooke Farm	0.02462	2012
Little Morgan Run	1.51406	2012
Marabrooke Farm	1.239456	2012
Marabrooke Farm	0.001395	2012
Little Morgan Run	0.124773	2012
Marabrooke Farm	0.073075	2012
Poignant Acres 7	0.053046	2012
Poignant Acres 7	0.053046	2012
Poignant Acres 7	0.000022	2012
Poignant Acres 7	0.000445	2012
Poignant Acres 7	0.003395	2012
Windy Hills Farm, Phase 1	0.002487	2012
West Branch Patapsco Riv*	0.021029	2013
Beaver Run	0.036671	2013
Beaver Run	0.159299	2013
Pinewood	0.006133	2013
Liberty Reservoir	1.4474	2013
Pinewood	0.036143	2013
Beaver Run	0.078749	2013
Beaver Run	12.185722	2013
Beaver Run	8.777147	2013
Beaver Run	0.027141	2013
Beaver Run	0.004369	2013
Beaver Run	1.206841	2013
Beaver Run	0.018832	2013
Beaver Run	0.014478	2013
Beaver Run	0.011298	2013
Beaver Run	0.164839	2013
Beaver Run	0.565165	2013
Southview, Section 2	0.000393	2014
Beaver Run	0.160753	2014
Beaver Run	0.616088	2014
Southview, Section 2	0.710231	2014
Southview, Section 2	0.185555	2014
Cliff's Legacy	0.338343	2014
Beaver Run	0.707145	2014
Cliff's Legacy	2.384544	2014
Southview, Section 2	0.001391	2014
Southview, Section 2	0.000319	2014
Windy Hills Farms, Phase*	0.022382	2014

Windy Hills Farms, Phase*	0.009268	2014
West Branch Patapsco Riv*	0.050964	2014
Estates at Liberty Reser*	0.210023	2014
Liberty Reservoir	12.314665	2014
Estates at Liberty Reser*	2.832982	2014
Pooledale 3	0.154344	2014
Morgan Run	4.398078	2014
Pooledale 3	1.612706	2014
Pooledale 3	0.316697	2014
Pooledale 3	0.044913	2014
Little Morgan Run	0.950479	2014
Morgan Run	5.722444	2014
Pooledale 3	0.984824	2014
Pooledale 3	1.461143	2014
Roaring Run/Board Run	0.275957	2014
Pooledale 3	0.002312	2014
Little Morgan Run	0.000875	2014
Morgan Run	9.210315	2014
Pooledale 3	3.257559	2014
Windy Hills Farms, Phase*	0.031568	2014
West Branch Patapsco Riv*	1.849264	2014
West Branch Patapsco Riv*	0.162451	2014
Windy Hills Farms, Phase*	3.725261	2014
Hidden Valley, Sec. 2, L*	0.007335	2014
Aspen Run	0.090423	2014
Hidden Valley, Sec. 2, L*	0.046387	2014
Little Morgan Run	0.002809	2014
Morgan Run	0.019894	2014
Pooledale 3	0.000845	2014
Pooledale 3	0.002036	2014
Pooledale 3	0.002036	2014
Beaver Run	0.004793	2014
Beaver Run	0.004793	2014
Southview, Section 2	0.024037	2014
Southview, Section 2	0.024037	2014
West Branch Patapsco Riv*	0.003721	2014
West Branch Patapsco Riv*	0.003721	2014
Windy Hills Farms, Phase*	0.002487	2014
Pooledale 3	0.0014	2014
Pooledale 3	0.0014	2014
Little Morgan Run	7.283972	2015

Middle Run	0.270124	2015
Middle Run	0.238102	2015
Hewitt's Landing	0.001035	2015
Hewitt's Landing	0.006983	2015
Hewitt's Landing	0.002114	2015
Roaring Run/Board Run	7.23965	2015
Roaring Run/Board Run	1.061936	2015
Hewitt's Landing	1.490899	2015
Hewitt's Landing	0.415683	2015
Hewitt's Landing	0.000114	2015
Hewitt's Landing	1.095643	2015
Hewitt's Landing	0.000229	2015
Little Morgan Run	0.00971	2015
Bollinger Estates Amended	0.194409	2016
Liberty Reservoir	14.62958	2016
Nipkow Property	4.104625	2017
Hidden Creek	3.36733	2017
Hidden Creek	0.000799	2017
Morgan Creek	0.45514	2017
Windy Hill 4A	5.824233	2018
Windy Hill 4A	6.524907	2018
CAB LLC	0.233727	2018
Windy Hill 4A	0.033245	2018
Windy Hill 4A	0.410443	2018
Peng. Rand. House	0.687511	2018
Adms Pardise Snr Housing	1.395287	2018
Rustic Rising	1.879093	2018
Rustic Rising	0.018177	2018
Windy Hill 4A	0.619297	2018
Windy Hill 4A	0.619297	2018
Windy Hill 4A	6.723576	2018
Windy Hill 4A	6.723576	2018
Rustic Rising	0.200849	2018
Rustic Rising	0.200849	2018
Adms Pardise Snr Housing	0.019778	2018
Rustic Rising	0.019778	2018
Rustic Rising	0.000027	2018
Adms Pardise Snr Housing	0.000027	2018
Rustic Rising	0.000027	2018

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Sterner Property	0.002884	2009
Plat of Anderson Farm	0.009366	2009
Poignant Acres 6	0.000233	2009
Westminster Toyota IP, L*	0.523984	2009
Callier Property	0.10821	2009
Beaver Run	0.338896	2009
East Branch Patapsco Riv*	1.865879	2009
Morgan Run	0.038347	2009
Morgan Run	0.025347	2009
Deep Run	13.517339	2009
Deep Run	2.459505	2009
Plat of Anderson Farm	0.130476	2009
Poignant Acres 6	0.306813	2009
Liberty Reservoir	1.015207	2009
Sterner Property	0.157617	2009
Callier Property	0.48065	2009
Beaver Run	0.004482	2009
East Branch Patapsco Riv*	0.000029	2009
Morgan Run	0.00007	2009
Poignant Acres 6	0.00032	2009
Poignant Acres 6	0.00044	2009
Poignant Acres 6	0.00044	2009
Poignant Acres 6	0.003118	2009
Poignant Acres 6	0.003118	2009
Wilmot Manor, Section 8	0.042979	2010
Wheatley Property	0.367085	2010
Manchester Farms, Sectio*	2.282511	2010
HM Associates Property	0.089461	2010
Avalon Forest Estates	0.001434	2010
Flat Bush	0.000515	2010
McGrew Property, Section*	0.012376	2010
Morgan Run	1.425432	2010
Morgan Run	0.620868	2010
Beaver Run	4.489322	2010
East Branch Patapsco Riv*	1.046448	2010
Liberty Reservoir	1.253551	2010
Middle Run	0.322897	2010
Morgan Run	0.194324	2010

Avalon Forest Estates	0.161089	2010
Liberty Exchange	0.327901	2010
Flat Bush	0.019818	2010
Little Morgan Run	1.698223	2010
Wilmot Manor, Section 8	2.523888	2010
McGrew Property, Section*	0.671003	2010
The Enclave at Morgan Run	0.001612	2010
Bollinger Estates	0.174002	2011
West Branch Patapsco Riv*	3.764639	2011
Deep Run	0.661675	2011
West Branch Patapsco Riv*	31.196581	2011
Little Morgan Run	0.311453	2011
The Mill at Clearfield	0.004426	2012
My Ladies Manor 2	5.926913	2012
Poignant Acres 7	0.080246	2012
Windy Hills Farm, Phase 1	0.002121	2012
Morgan Run	0.08952	2012
Morgan Run	0.145117	2012
Little Morgan Run	0.242378	2012
Little Morgan Run	0.117432	2012
Beaver Run	1.48046	2012
Beaver Run	3.456276	2012
West Branch Patapsco Riv*	0.212161	2012
West Branch Patapsco Riv*	0.11209	2012
The Mill at Clearfield	2.188986	2012
Poignant Acres 7	4.401239	2012
Windy Hills Farm, Phase 1	0.637354	2012
Morgan Run	0.00007	2012
Poignant Acres 7	0.00032	2012
Poignant Acres 7	0.000035	2012
Poignant Acres 7	0.000035	2012
Poignant Acres 7	0.003118	2012
Poignant Acres 7	0.003118	2012
Beaver Run	0.036104	2013
Beaver Run	0.004704	2013
Liberty Reservoir	0.008262	2013
West Branch Patapsco Riv*	0.720815	2013
Beaver Run	0.04177	2013
Beaver Run	1.019242	2013
Beaver Run	0.292169	2013
Liberty Reservoir	0.000953	2013

Windy Hills Farms, Phase*	0.363587	2014
West Branch Patapsco Riv*	5.453712	2014
Pooledale 3	0.924753	2014
Southview, Section 2	2.868927	2014
Hidden Valley, Sec. 2, L*	0.005714	2014
West Branch Patapsco Riv*	1.342323	2014
Aspen Run	1.045301	2014
Beaver Run	0.640699	2014
Beaver Run	0.130472	2014
Beaver Run	1.965799	2014
Morgan Run	1.404154	2014
Roaring Run/Board Run	0.095855	2014
Little Morgan Run	3.8573	2014
Morgan Run	15.452228	2014
Windy Hills Farms, Phase*	4.389447	2014
Pooledale 3	4.342928	2014
Pooledale 3	4.218294	2014
Cliff's Legacy	0.080433	2014
Southview, Section 2	3.229968	2014
Hidden Valley, Sec. 2, L*	0.267086	2014
Little Morgan Run	0.119733	2014
Morgan Run	0.000346	2014
West Branch Patapsco Riv*	0.003208	2014
West Branch Patapsco Riv*	0.003208	2014
Hewitt's Landing	0.001203	2015
Bull Estates	0.000204	2015
Little Morgan Run	0.22432	2015
Little Morgan Run	0.00793	2015
Little Morgan Run	0.000241	2015
Roaring Run/Board Run	2.471159	2015
Roaring Run/Board Run	2.319319	2015
Little Morgan Run	2.263954	2015
Little Morgan Run	5.261483	2015
Hewitt's Landing	0.000357	2015
Hewitt's Landing	0.583775	2015
Hewitt's Landing	0.018246	2015
Bull Estates	0.326194	2015
Bull Estates	0.001911	2015
Bollinger Estates Amended	1.840054	2016
Liberty Reservoir	1.183807	2016
Emray Acres Lot 1	1.684728	2017

Hidden Creek	0.012349	2017
Hidden Creek	0.019792	2017
Penguin Random House Amd	2.817853	2017
Windy Hill 4A	22.363571	2018
Windy Hill 4A	3.087919	2018
Rustic Rising	0.200876	2018
CAB LLC	0.558854	2018
Windy Hill 4A	0.652542	2018
Windy Hill 4A	11.148652	2018
Peng. Rand. House	2.097179	2018
Peng. Rand. House	0.051098	2018
Peng. Rand. House	0.108934	2018
Peng. Rand. House	0.005448	2018
Peng. Rand. House	0.004106	2018
Basler Homestead	0.595949	2018
Adms Pardise Snr Housing	3.035072	2018
Adms Pardise Snr Housing	0.101125	2018
Rustic Rising	2.245364	2018
Rustic Rising	0.0857	2018

Loch Raven Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Loads (TMDL) requirements associated with the urban wasteload allocation (WLA) for Loch Raven watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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I. Introduction

The Loch Raven Reservoir Watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients and sediments in 1996. A Total Maximum Daily Load (TMDL) for phosphorus and sediment were developed and approved in March of 2007.

The Bureau of Resource Management, in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Town of Hampstead, and the Patapsco Chapter of Trout Unlimited.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Loch Raven Reservoir and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Loch Raven Watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority sub-watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Loch Raven Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Loch Raven Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered duing the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

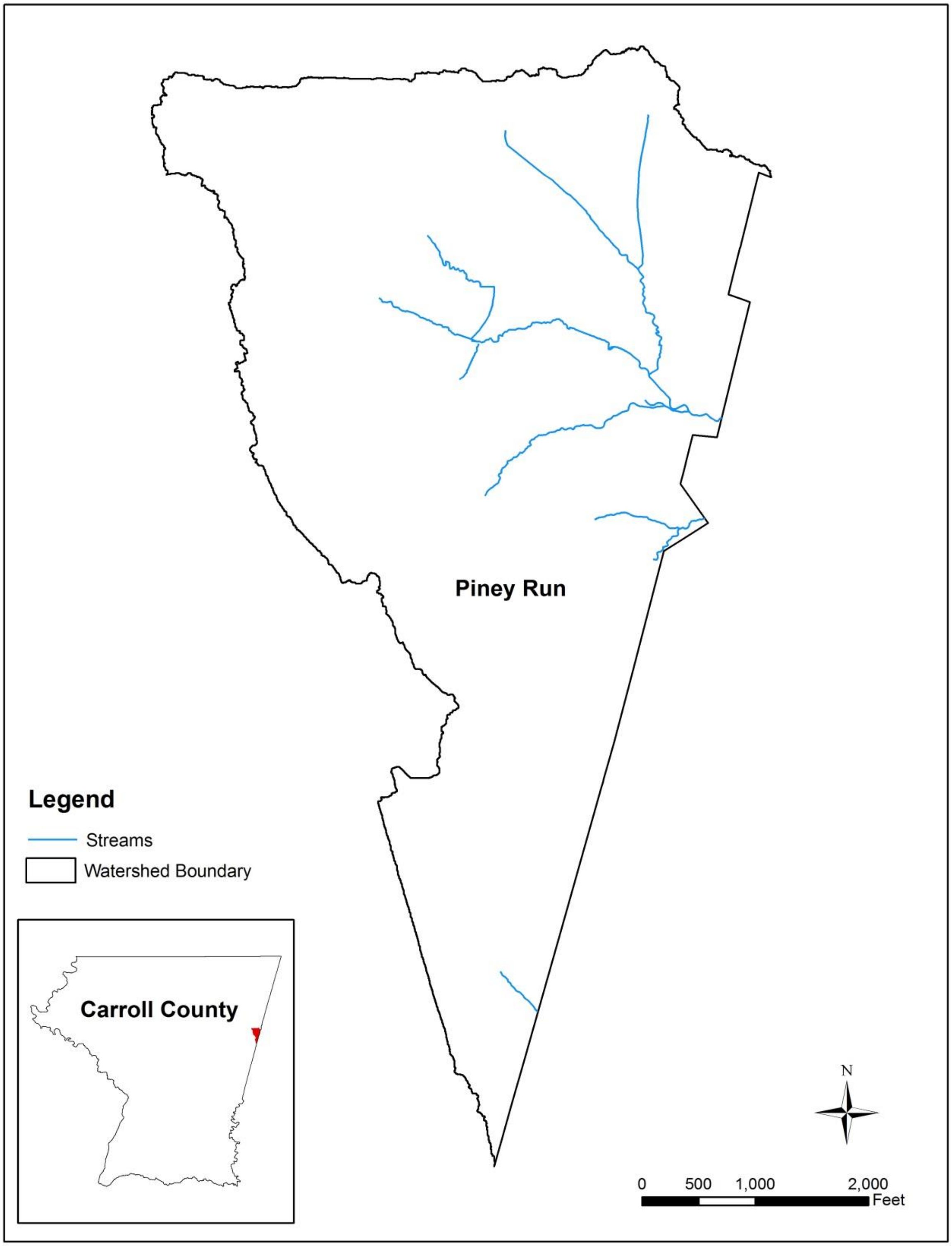

Figure 1: Loch Raven Watershed Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Loch Raven Watershed Water Quality Standards

The entire portion of the Loch Raven watershed within Carroll County is designated as use III-P, Non-tidal Cold Water and Public Water Supply. The use III-P is capable of growing and propagating trout, but may not be capable of supporting adult trout for a put-and-take fishery.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQS). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the Loch Raven watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. This restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Loch Raven watershed was determined by (MDE, 2009) to be 5,140 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 125 billion MPN/year, which is a reduction of 5,015 billion MPN/year (98%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Loch Raven Watershed.

Table 3: Loch Raven 8-digit Watershed Bacteria TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	426	21	95%
Hampstead	4,714	104	98%
Total	**5,140**	**125**	**98%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 472 lbs. /yr., the TMDL for the stormwater WLA was determined to be 401 lbs. /yr., which is a reduction of 71 lbs. /yr. (15%) from the current loading (Table 4). This stormwater WLA is an aggregate of the municipal and industrial stormwater, including the loads from construction activity. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2006).

Table 4: Loch Raven 8-digit Watershed Phosphorus TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	472	401	15%
Total	**472**	**401**	**15%**

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Loch Raven Reservoir. The TMDLs are based on average annual total phosphorus loads for the simulation period 1992-1997, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Loch Raven Watershed is located in the northeast corner of the County. The watershed is within the Gunpowder River Basin, which lies within the Piedmont physiographic province of Maryland, and covers a total land area of 592 acres. Figure 1 depicts the location of the Loch Raven watershed.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Loch Raven watershed, agriculture is the dominant land cover at about 41 percent of the total land, followed by low-density residential which accounts for 25 percent, and low-density mixed urban, which accounts for about 20 percent of the total land cover.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 accounting for stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 6% increase in low-density residential land cover since 2011, which has been incorporated into Table 5.

Table 4 shows the current land cover data for the Loch Raven watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Loch Raven Watershed can be found in Figure 2.

Table 5: Loch Raven Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	0	0%	0	0%	0	0%	0	0%
Low-Density Residential	135	23%	137	23%	147	25%	179	30%
Low-Density Mixed Urban	95	16%	98	17%	119	20%	119	20%
Medium-Density Mixed Urban	36	6%	39	7%	39	7%	39	7%
High-Density Mixed Urban	9	2%	9	2%	9	2%	9	2%
Forest	26	4%	25	4%	23	4%	22	4%
Shrub/Scrub	6	1%	6	1%	6	1%	6	1%
Grassland	0	0%	0	0%	0	0%	0	0%
Pasture/Hay	52	9%	52	9%	51	9%	48	8%
Cropland	229	39%	222	37%	195	32%	165	28%
Wetland	4	<1%	4	<1%	3	<1%	3	<1%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams, resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Loch Raven Watershed is estimated to have 109.25 acres of total impervious within the catchment and accounts for approximately 18.5 percent of the total land area. The impervious surface area and percentage within Loch Raven can be found in Table 6 and is shown in Figure 3.

Table 6: Loch Raven Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0308	Piney Run	592	109.25	18.5%
Loch Raven Watershed		**592**	**109.25**	**18.5%**

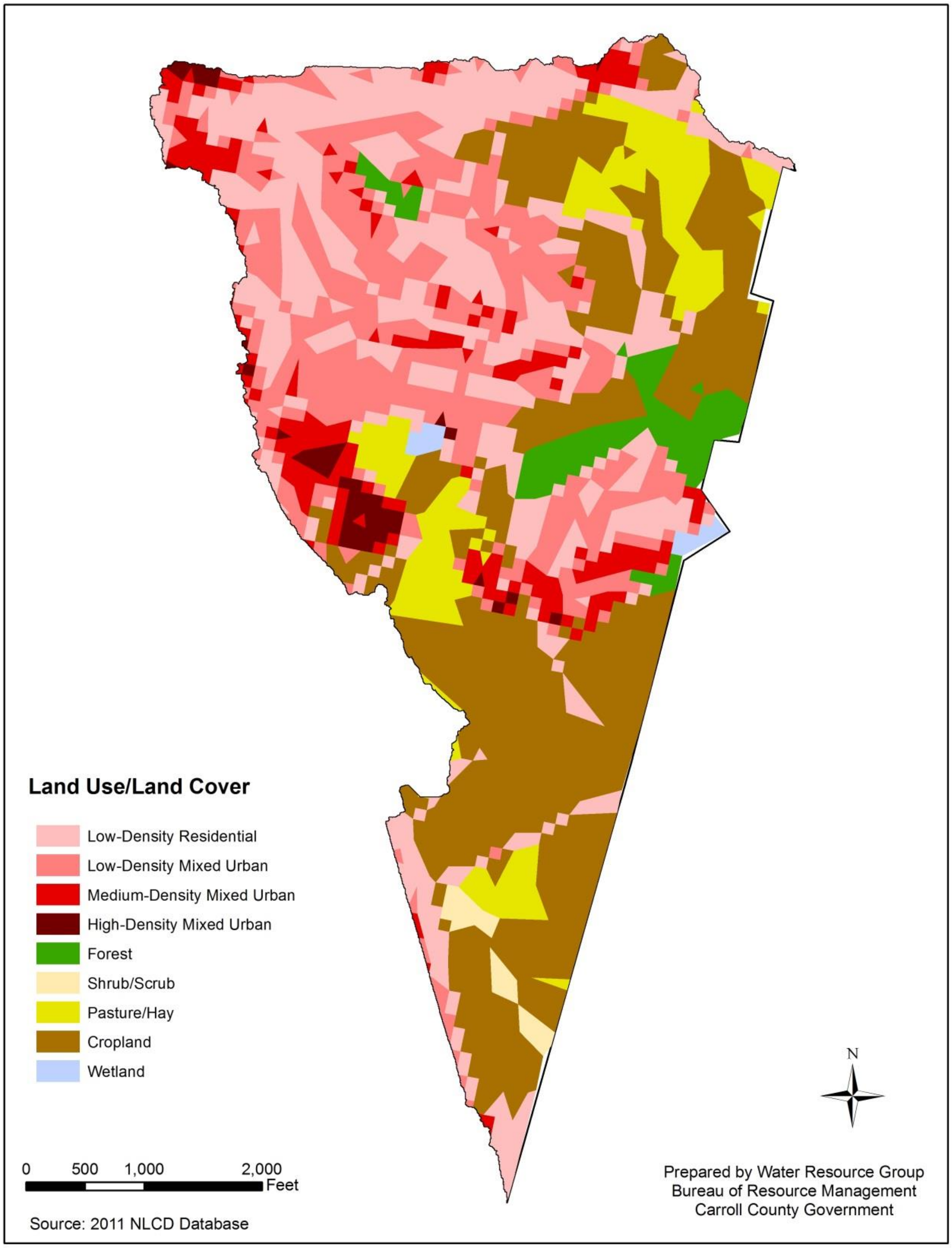

Figure 2: Loch Raven Watershed Land Use/Land Cover from 2011

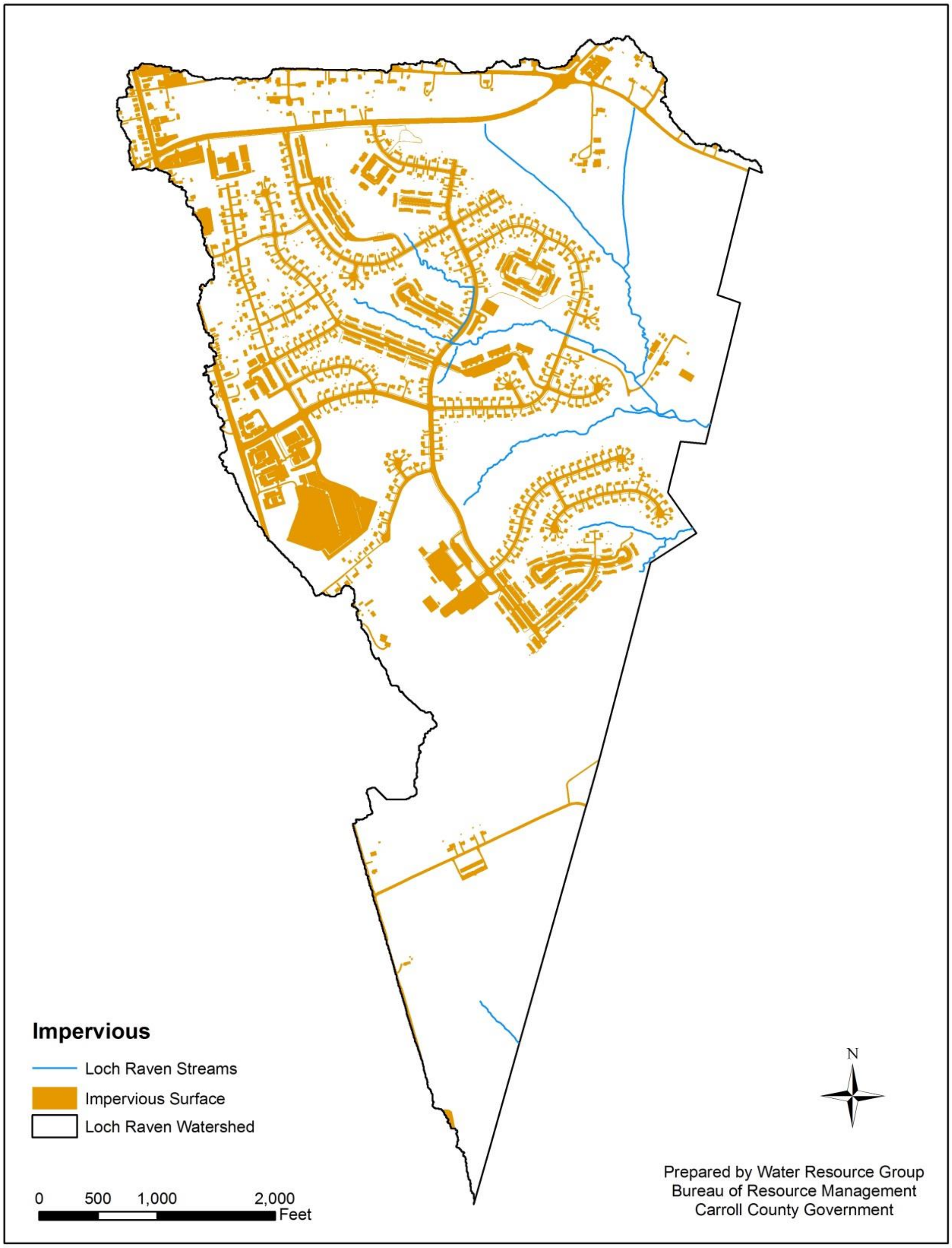

Figure 3: Loch Raven Watershed Impervious Surface Area

C. Watershed Characterization

Following the Loch Raven stream corridor assessment (SCA), completed in 2016, a Watershed Characterization for the Loch Raven watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Loch Raven watershed SCA will be used as the foundation for the watershed restoration plan. The Loch Raven SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/LochRaven/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/LochRaven/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Loch Raven Watershed there are no Tier II designations.

b. Ecologically Sensitive Areas

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. No areas within the Loch Raven Watershed have been identified as a stronghold watershed. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Loch Raven Watershed was conducted during the winter of 2016 by Carroll County Bureau of Resource Management staff. The Loch Raven SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Loch Raven SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/LochRaven/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along 1,990 linear feet of the corridor, 18% of the overall stream miles that were granted permission to assess within Piney Run. Table 7 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

Table 7: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Piney Run	2.81	2.11	1,990	18%
Total	**2.81**	**2.11**	**1,990**	**18%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Loch Raven Watershed there are 34 parcels remaining with potential development on 146 acres for an estimated lot yield of 281 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 4 shows the remaining parcels in the Loch Raven watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

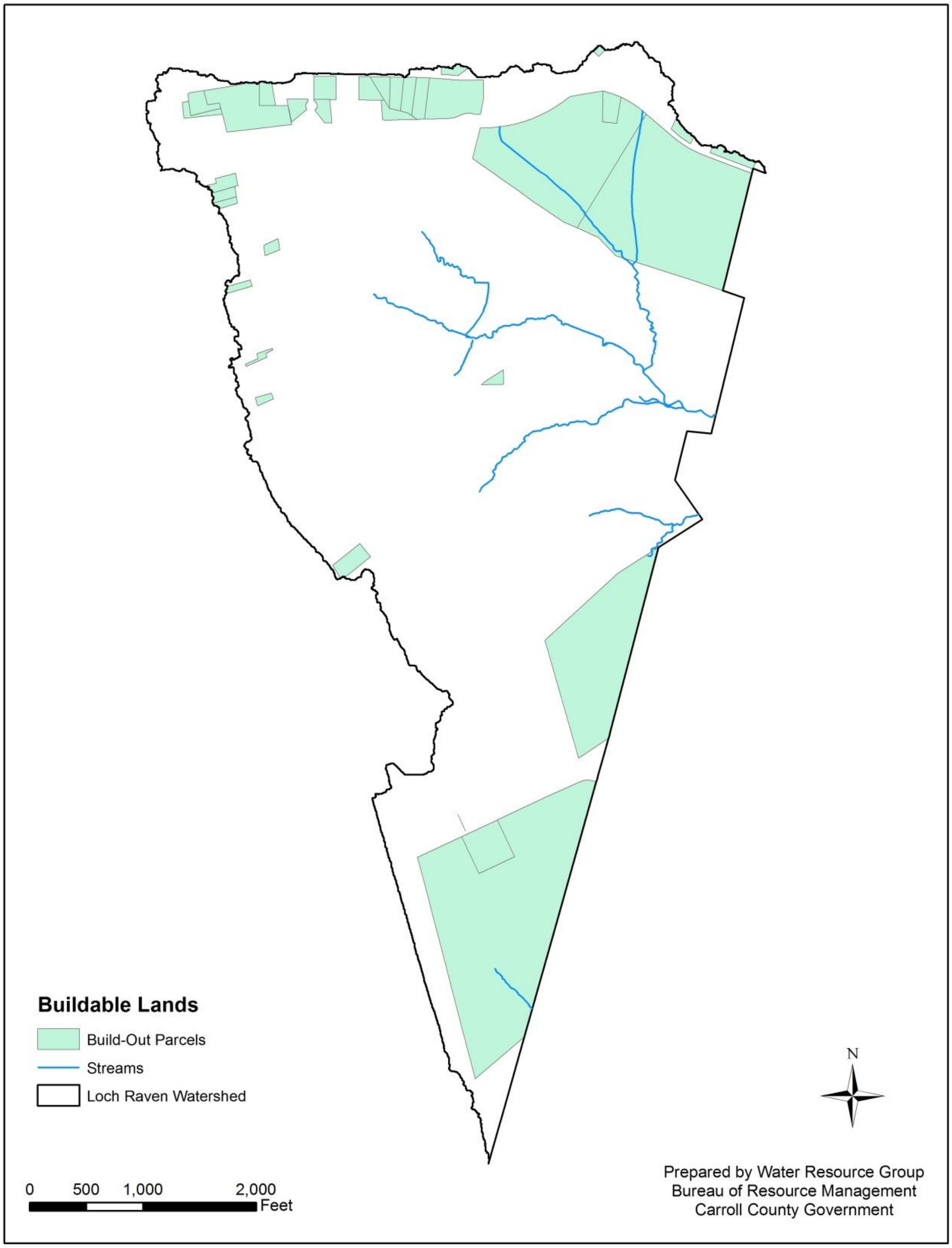

Figure 4: Loch Raven Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Loch Raven Watershed there are 6.23 acres of grass buffer and 0.213 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Loch Raven Reservoir Watershed can be found in Appendix B, and are shown in Figure 5. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Loch Raven watershed lies within the Upper Patapsco Rural Legacy area and encompasses 218 acres (37%) of the Loch Raven watershed. The extent of the Rural Legacy Area within Loch Raven can be found in Figure 6.

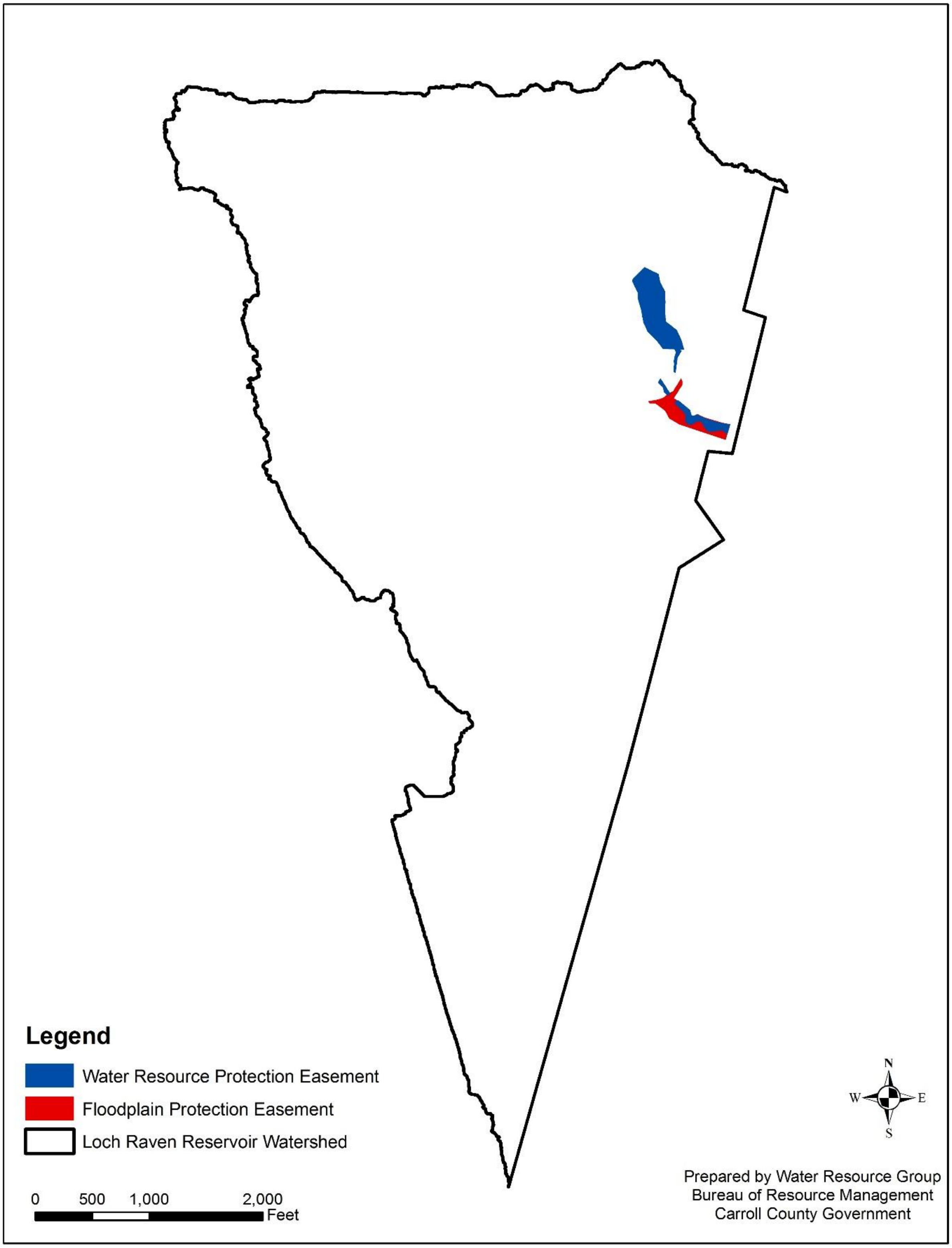

Figure 5: Water Resource and Floodplain Protection Easement Locations

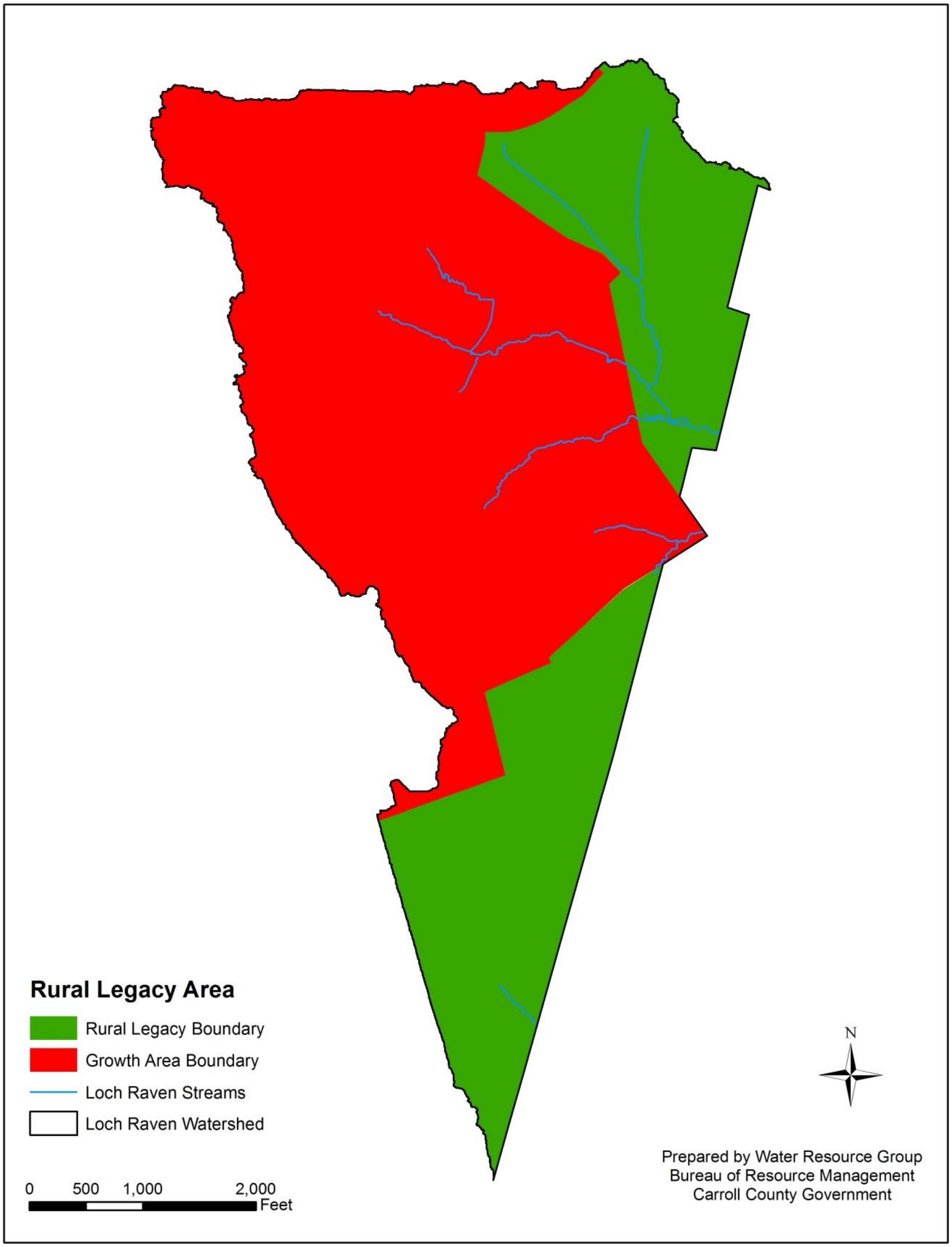

Figure 6: Upper Patapsco Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a Memorandum of Agreement (MOA) to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff is continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts.

Educational events that County staff have participated in that are either held within the Loch Raven Watershed or offered to citizens countywide can be found in Table 8.

Table 8: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide
Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide

Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Loch Raven Watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, Maryland Department of Environment (MDE) released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design (ESD) practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

B. Storm Drain Outfalls

During the Loch Raven Watershed SCA in 2016, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Reforesting riparian corridors will assist in meeting the overall goal of achieving TMDL compliance. As part of a stream restoration project at the Hampstead wastewater treatment plant the County reforested 1.15 acres along the Piney Run corridor.

Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative to address inadequate stream buffers countywide. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks. Currently no plantings have been implemented from this initiative in the Loch Raven Watershed.

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be inspected bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

D. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Loch Raven Watershed are shown in Table 9.

Table 9: Road Maintenance Projects

Management Practice	Inlet Cleaning		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Hampstead	19.69	Piney Run	Annual

E. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time. No septic systems within the Loch Raven Watershed have been repaired or built utilizing Best Available Technology (BAT) via the Bay Restoration Fund.

F. Agricultural Best Management Practices (BMPs)

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

G. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

In 1996, an assessment of the Piney Run basin was performed cooperatively between Carroll County and MDE. The results of that assessment were used as recommendations for stormwater management facility retrofits intended to reduce storm flows as they discharge from Carroll County into Baltimore County. The ultimate flows were used in a design that restored the stream channel adjacent to the Hampstead Wastewater Treatment Plant in 1999, which was channelized when the plant was constructed.

The resultant channelization directed flow through a concrete channel to a point approximately at the Baltimore/Carroll County boundary, altering the control that would normally occur in a natural channel. In an effort to return to a more natural state, the concrete channel was removed and reconstructed in a manner mimicking a natural state.

The size and geometry of the channel was based on a reduced flow volume being released from the upstream stormwater management facilities, and resulted in the channel being restored along 936 linear feet. The location of the restored channel can be found in Figure 7.

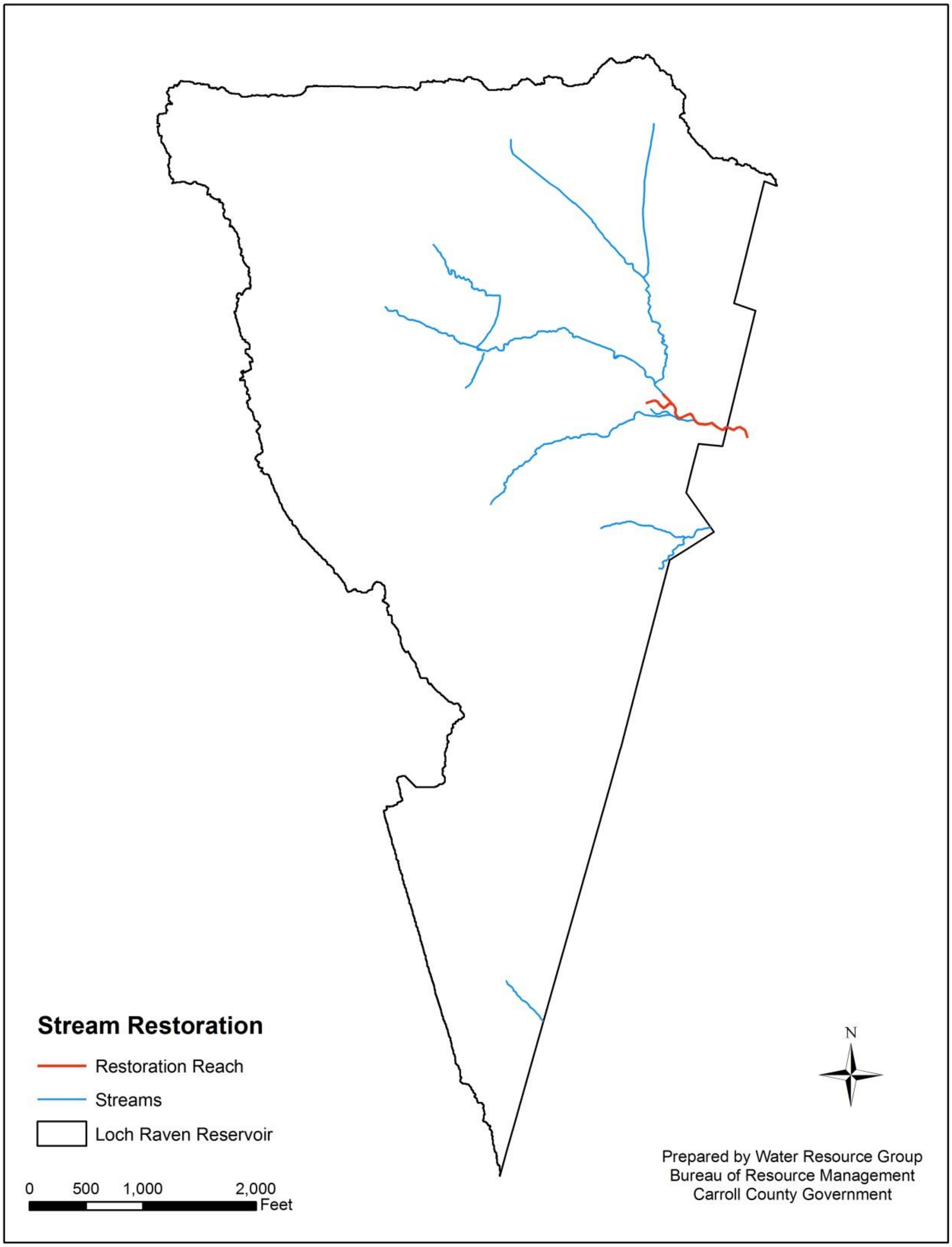

Figure 7: Stream Restoration Project Location

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix B provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with MapShed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix C.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Loch Raven watershed. As described in Section I, phosphorus and bacteria loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDL suggests an urban load reduction of 15% for phosphorus from the baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Loch Raven Reservoir). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reduction of 15% of the baseline year. A baseline year of 2001 was used as a proxy for the 1995 baseline year in the TMDL, as land cover data from 2001 was the closest available for that time period. The modeled 2001 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 1995 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2001 was used as the baseline proxy year. For reference, the modeled baseline urban P load using the 2001 land cover was 24.89 lbs, which equates to a 15% reduction of 3.73 lbs (Table 10).

The projects completed as of December 2019 (Table 11) are providing 7.50 pounds of TP reduction, which exceeds the stormwater WLA requirement for the Loch Raven Watershed (Figure 8). The majority of this reduction (5.98 lbs) is coming from the stream stabilization/restoration project at the Hampstead Wastewater Treatment Plant. These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, currently MDE does not provide guidance on bacteria reduction efficiencies.

Table 10: Total Phosphorus Load Reduction in the Loch Raven Reservoir Watershed (lbs/year) in Carroll County

Modeled Baseline Load (lbs)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs)	Reduction from Current BMPs (lbs)	Reduction from Restoration Plan Strategies (lbs)	Total % Reduction Achieved
24.89	15%	3.73	7.50		30%

Table 11: Comparison of Total Phosphorus delivered Load Reductions (lbs/year) by Restoration Strategies. This table includes both proposed and existing BMPs.

Status	Pond Retrofits (lbs)	Buffers (lbs)	Stream Restoration (lbs)	Easements	Catch Basin/ Inlet Cleaning (lbs)
Completed		0.06	5.98	0.18	1.28
Planned					

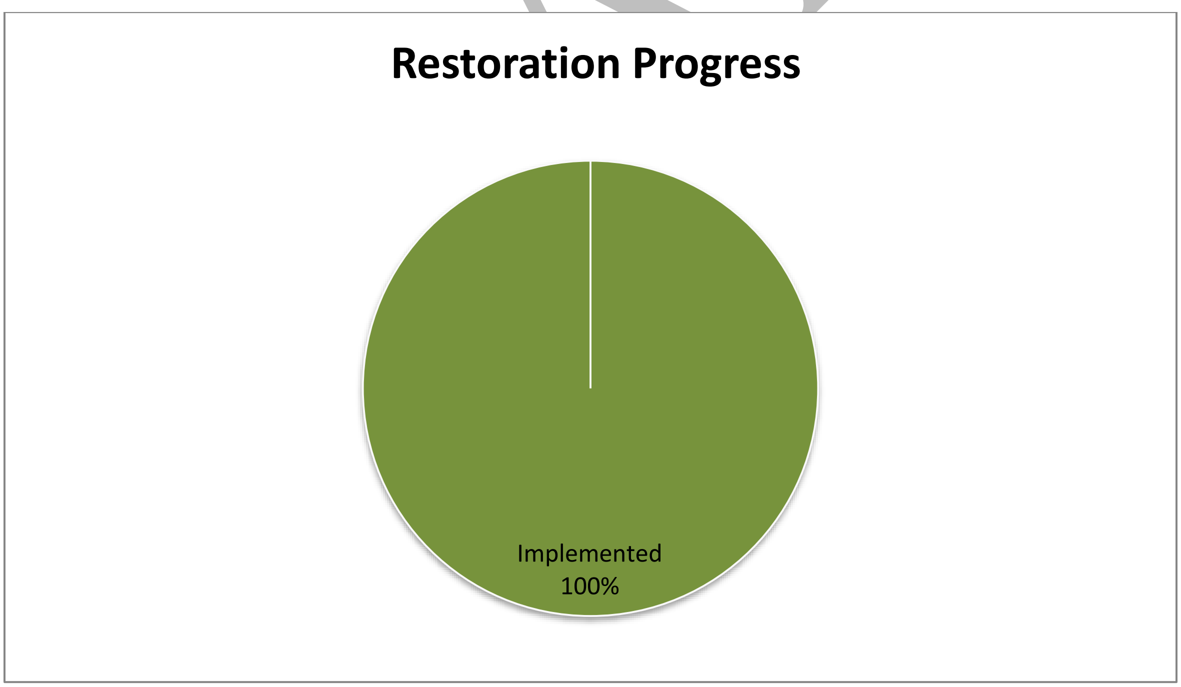

Figure 8: 2019 Restoration Progress

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Loch Raven Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

The Carroll County Bureau of Utilities is in the process of completely updating their Regulations and Standard Specifications and Design Details for water and sewer infrastructure for the first time since 1992.

Changes that shall be implemented with this update include increasing required sewer main encasements at all proposed stream crossings.

This shall include both more comprehensives encasement design requirements as well as an increase in the distance encasement shall be required to be extended beyond the edges of the stream crossing. Additionally, manhole design requirements shall now include factory installed epoxy coatings on new manholes to be installed on proposed or upgraded sewer mains.

Table 12 lists infrastructure related measures that have been implemented since the 1995 baseline year that would assist in reducing bacteria counts within the watershed.

Table 12: Waste Collection Infrastructure Upgrades

	County	Hampstead
BAT Upgrades	0	0*
Casings/Linings	TBD	n/a
Lateral line replacements	TBD	n/a
Pump Station upgrade	TBD	n/a

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach. This comprehensive monitoring program is intended to validate the overall effectiveness of BMPs and document the efficiency of innovations made to BMPs.

1. Retrofit Monitoring

Since there are no stormwater retrofit locations currently proposed within the County's Community Investment Program (CIP) for the Loch Raven Watershed, the Prettyboy monitoring location is being used as the conditions are considered representative of the condition within Loch Raven. The Whispering Valley site, shown in Figure 9, is located within the South Branch Gunpowder Falls subwatershed of the Prettyboy Resevoir Watershed, and is almost entirely within the corporate limits of the Town of Manchester.

The current facility is a dry detention pond that was built in 1983 for the Whispering Valley subdivision, and is scheduled to be retrofitted to a sand filter in FY20. The Whispering Valley location is primarily residential, which encompasses 84% of the land use. The drainage area to the monitoring site is approximately 95 acres, of which, 19 acres or 20% is impervious.

Bi-weekly monitoring at the Whispering Valley site began in January of 2015 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Whispering Valley site can be found in Table 13. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 13: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Loch Raven Watershed began in April of 2019, and is currently performed at one locations, shown in Figure 10. Samples are currently collected on the 4th Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 14 shows the monitoring results for the entire year, whereas Table 15 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 14: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
PRN13	Low	6	146
	High	0	n/a
	All	6	146

Table 15: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
PRN13	Low	5	237
	High	0	n/a
	All	5	237

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 16 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 16: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2019	
			# Samples	% Exceeded
PRN13	576	low	6	33%
		high	n/a	n/a
	410	low	6	50%
		high	n/a	n/a
	298	low	6	50%
		high	n/a	n/a
	235	low	6	50%
		high	n/a	n/a

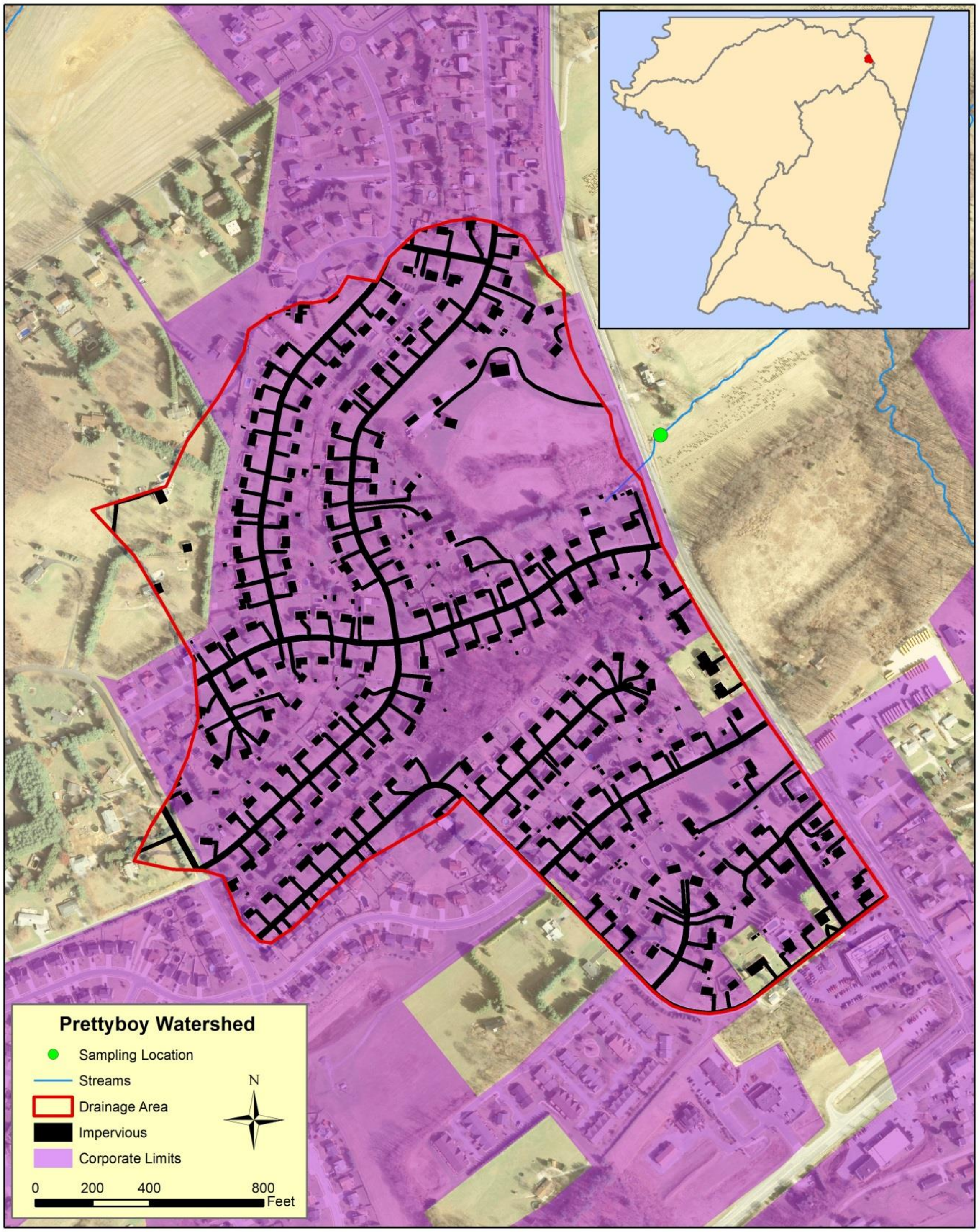

Figure 9: Whispering Valley Monitoring Location

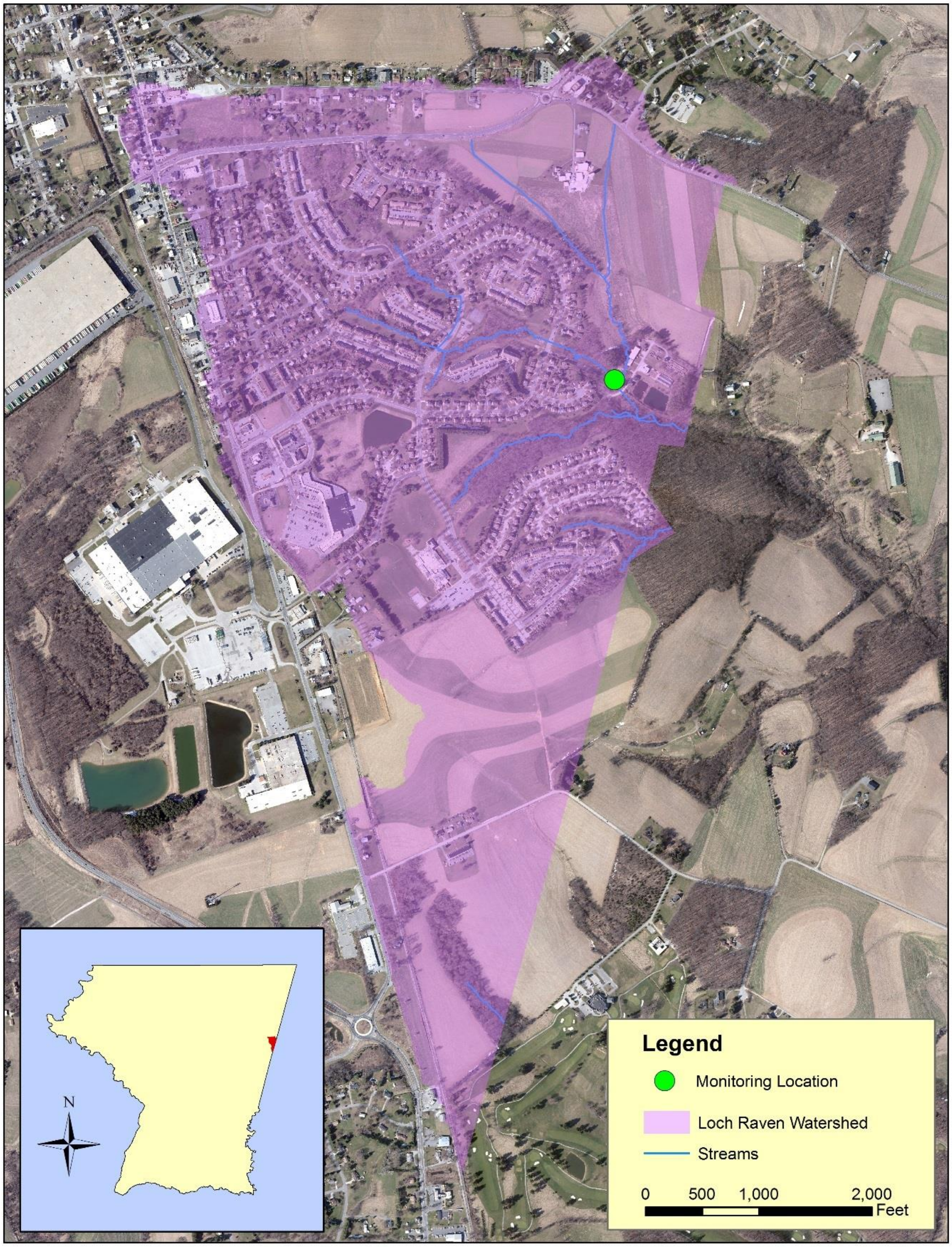

Figure 10: Loch Raven Bacteria Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 12). BMPs and restoration projects that have been either completed or proposed to address local TMDLs within the Loch Raven Watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 17, and the tidal water designated use zones are shown in Figure 11.

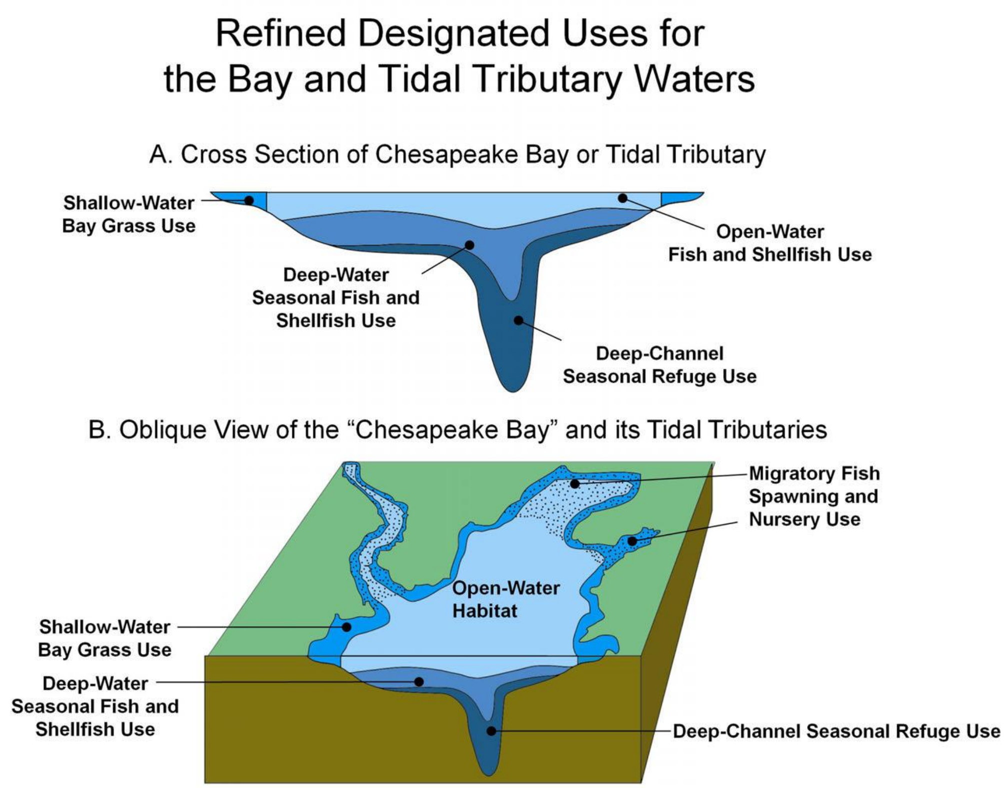

Figure 11: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 17: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Loch Raven watershed is located within the Gunpowder River segment of the Chesapeake Bay. The Gunpowder segment covers 283,263 acres across four counties and two states. Approximately 21,000 acres (7%) of the river segment is within Carroll County and includes both the Loch Raven and Prettyboy watersheds. The location of the Gunpowder river segment is shown in Figure 11.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix D) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 18. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Gunpowder River segment within the Loch Raven watershed are; 0.16 for nitrogen, 0.36 for phosphorus, and 0.23 for suspended sediment (MAST, 2016). Essentially, if one pound of nitrogen is discharged into a tributary within the Loch Raven portion of the Gunpowder River segment, only 16% of that pound is reaching the Bay.

Table 18 shows the Chesapeake Bay TMDL for the Gunpowder land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Loch Raven Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Gunpowder land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Loch Raven Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the

Gunpowder segment shed. The Loch Raven Watershed covers 2.7% of the Gunpowder land-river segment within Carroll County.

Table 18: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Loch Raven Reservoir Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
315.36	17.19%	54.21	10.555	0.00	19.47%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
4,010.75	9.59%	384.55	14.645	0.00	3.81%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Gunpowder land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Loch Raven Watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 19: Carroll County Gunpowder River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	Total Phosphorus (TP)[3]			Total Nitrogen (TN)		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2096 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Loch Raven Reservoir Watershed	10.555	0	19.47%	14.645	0	3.81%
Prettyboy Reservoir Watershed	8.42	7.26	28.92%	68.25	49.08	30.51%
Total	**18.975**	**7.26**	**48.39%**	**82.895**	**49.08**	**34.32%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

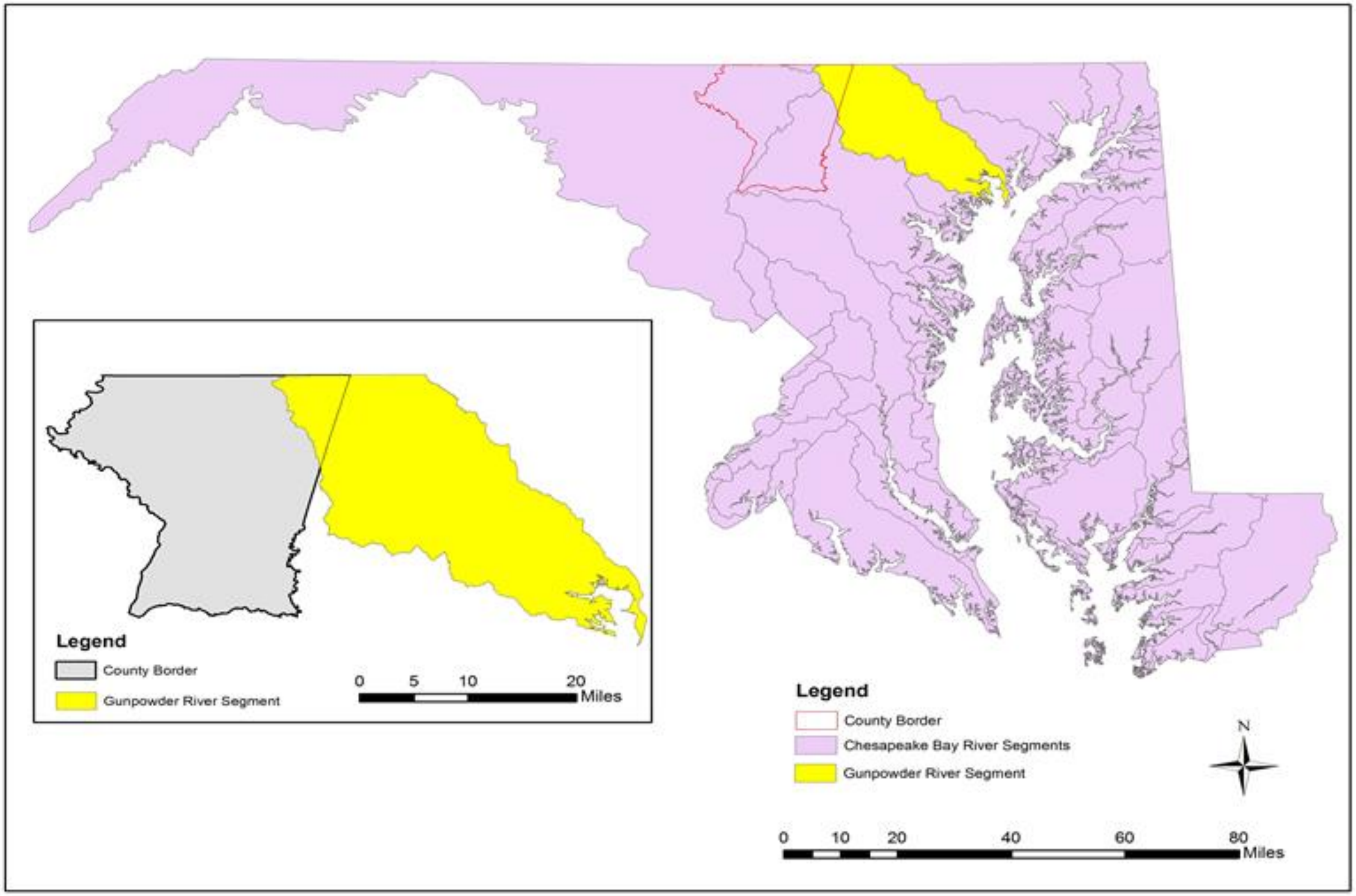

Figure 12: Chesapeake Bay River Segment

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the projects completed within the Loch Raven Watershed, the phosphorus TMDL has been fully achieved.

Table 20 lists the anticipated benchmark for each nutrient TMDL within the Loch Raven Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 20: Nutrient TMDL Benchmarks

Nutrient	2019	2025
Phosphorus	100%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Loch Raven Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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Appendix A:
Watershed Restoration Projects

XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost	Anticipated Completion	Drainage Area (acres) or Length (ft)
HWWTP Channel Reconstruct	County	21308050308	Completed	Not Reported	1999	936
HWWTP Buffer Planting	County	21308050308	Completed	Not Reported	1999	1.15
Roads: Street/Inlet Cleaning	Hampstead	21308050308	Annual	Not Reported	Annual	N/A

XIII. Appendix B: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

Stream Restoration

Location	Linear Feet	% Urban TN Load Reduced	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS Pollutant Loads Reduced (lbs)
Hampstead	936	3.9864%	7.06	24.0231%	5.98	3.2360%	1852.8
Total:	**936**	**3.9864%**	**7.06**	**24.0231%**	**5.98**	**3.2360%**	**1852.8**

Stream Buffer Plantings. These include a land cover change and an efficiency from an equivalent area outside of the buffer. Refer to Appendix C for additional information.

Project	Acres	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Load Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Load Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (lbs)
Hampstead WWTP	1.15	0.2302%	66	0.33	0.2465%	77	0.06	0.1870%	57	132.4
Total:	**1.15**	**0.2302%**		**0.33**	**0.2465%**		**0.06**	**0.1870%**		**132.4**

Catch Basin/inlet Cleaning after applying average delivery ratio from GWLF-E calculations

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Hampstead	19.69	3.5	68.915 [3.36]	1.4	27.566 [1.28]	420	8,270 [1,325.26]	4.135 [0.66]
	Total:		68.915 [3.36]		27.566 [1.28]		8,270 [1,325.26]	**4.135 [0.66]**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 2009-Current	6.230	2009 - current	0.4604%	30	0.82	0.6937%	40	0.17	1.2033%	55	0.34
	6.23		**0.4604%**		**0.82**	**0.6937%**		**0.17**	**1.2033%**		**0.34**

Forest Buffer Easements--Efficiency factors - 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 2009-Current	0.213	2009 - current	0.0236%	45	0.04	0.0237%	40	0.01	0.0411%	55	0.01
	0.213		**0.0236%**		**0.04**	**0.0237%**		**0.01**	**0.0411%**		**0.01**

XIV. Appendix C: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks. This was not required in the Loch Raven watershed due to its small size.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Loch Raven watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2001 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table C-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table C-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest

Shrub/Scrub	Open Land
Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table C-2, and were based on literature and professional judgement.

Table C-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)	0.74	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)	0.74	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation LD Mixed MD Mixed HD Mixed LD Residential	Imp. (Pervious) values 2.8 (0.8) 6.2 (0.8) 2.8 (0.8) 2.5 (1.3)	Imp. (Pervious) values 1.21 (0.19) 2.66 (0.30) 2.66 (0.30) 1.21 (0.19)	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-

E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table C-3 for the Loch Raven watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table C-3 based on professional judgement.

Table C-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
LD Mixed	15	>5 to <30	0.44	0.07	208
MD Mixed	52	>=30 to <70	1.63	0.19	242
HD Mixed	87	>=70	1.63	0.19	242
LD Residential	15	>5 to <30	0.44	0.07	208

Though this local TMDL was approved in 2007, the baseline year is 1995, which means any retrofitted water quality BMPs installed since 1995 can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated are based on the loading rates from the guidance document (i.e., detention basin retrofits, infiltration, bioretention, etc.) and represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Loch Raven watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.049, 0.046, and 0.160, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft)Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XV. Appendix D: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hampstead	7.14	3.5	24.99	1.4	9.99	420	2,999	1.499
		3.5	0.000	1.4	0.000	420	0	0.000
		Total:	**24.99**		**9.99**		**2,999**	**1.499**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficier
Grass Buffer 1995-2008		1995-2008	11.7	0.0000	30	0.00000	0.68	0.0000	40	0.0000	0.18	0.0000	55
Grass Buffer 2009-Current	6.230	2009 -current	11.7	72.8910	30	21.86730	0.68	4.2364	40	1.6946	0.18	1.1214	55
	6.230		**Total:**	**72.8910**		**21.86730**		**4.2364**		**1.6946**		**1.1214**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficier
Forest Buffer 1995-2008		1995-2008	11.7	0.0000	45	0.0000	0.68	0.0000	40	0.0000	0.18	0.0000	55
Forest Buffer 2009-Current	0.213	2009 -current	11.7	2.4921	45	1.1214	0.68	0.1448	40	0.0579	0.18	0.0383	55
	0.213		**Total:**	**2.4921**		**0.74763**		**0.1448**		**0.0579**		**0.0383**	

XVI. Appendix E: Forest Buffer and Grass Buffer Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Piney Run	0.00356	2014
Hampstead WWTP	0.209656	2018

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Piney Run	1.167948	2014
Hampstead WWTP	1.47217	2018
Hmpstd WWTP Solar	3.585235	2018

Prettyboy Reservoir Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Prettyboy watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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I. Introduction

The Prettyboy Reservoir Watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients in 1996 and again for bacteria in 2002. A Total Maximum Daily Load (TMDL) for phosphorus was developed and approved in March of 2007 with a subsequent TMDL for bacteria developed and approved in October of 2009.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Towns of Manchester and Hampstead, the Patapsco Chapter of Trout Unlimited, and the Prettyboy Watershed Alliance.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Prettyboy Reservoir and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Prettyboy Watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the Prettyboy Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the rural legacy area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Prettyboy Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

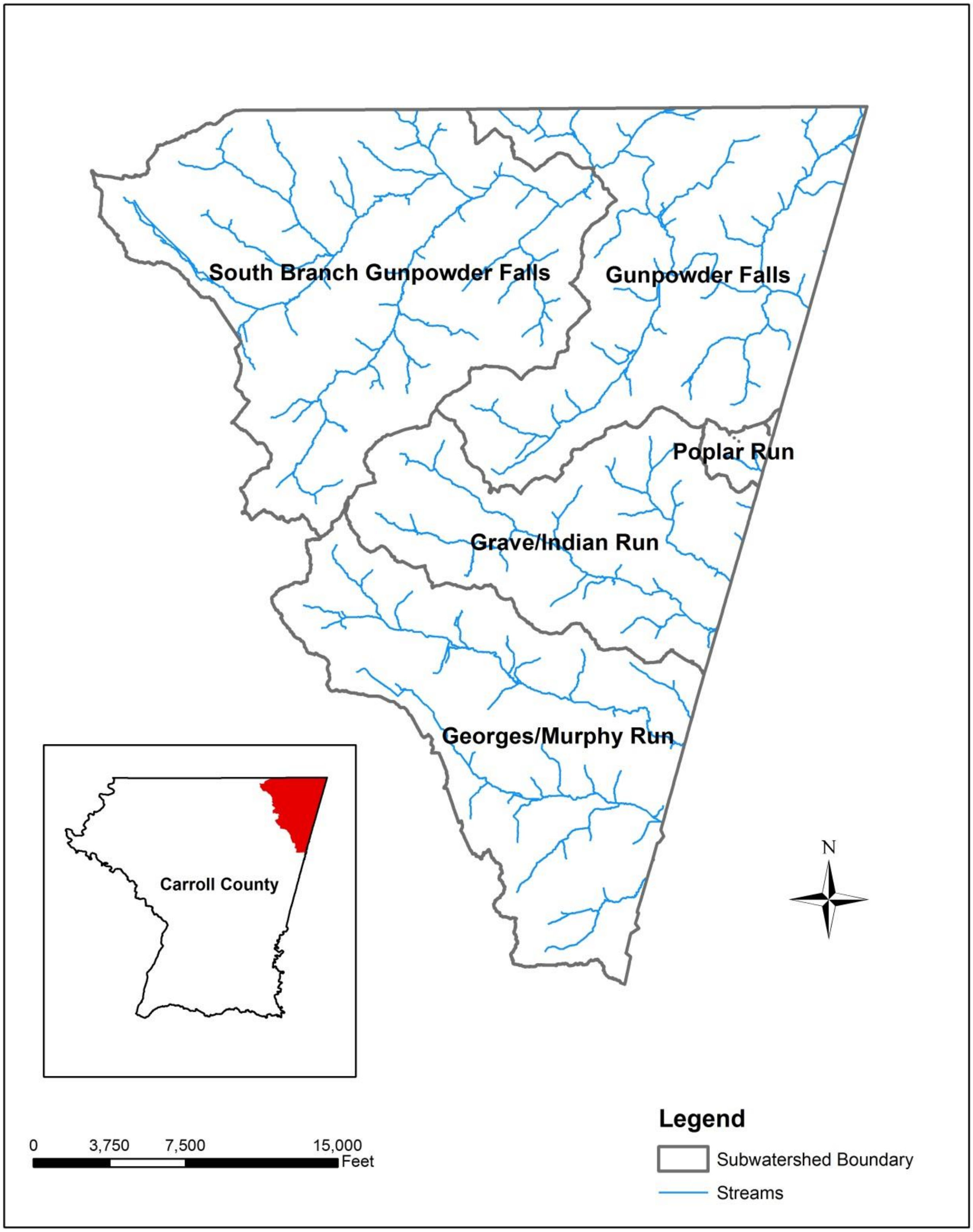

Figure 1: Prettyboy Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

Designated Uses	Use Classes I	I-P	II	II-P	III	III-P	IV	IV-P
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Prettyboy Watershed Water Quality Standards

The entire portion of the Prettyboy watershed within Carroll County is designated as use III-P, Non-tidal Cold Water and Public Water Supply. The use III-P is capable of growing and propagating trout, but may not be capable of supporting adult trout for a put-and-take fishery.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample: Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQS). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the Prettyboy watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. This restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

Table 3 lists the bacteria stormwater WLA for the phase II jurisdictions within the Prettyboy Watershed. These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009).

Table 3: Stormwater WLA for Bacteria by Jurisdiction (Source: MDE TMDL Data Center)

Carroll County (Phase 1)[1]	Hampstead (Phase II) Stormwater WLA (Billion MPN/Year)	% Reduction	Manchester (Phase II) Stormwater WLA (Billion MPN/Year)	% Reduction
N/A	2,311	79.7%	3,339	88.9%

[1] No stormwater WLA for the County's Phase I because the Prettyboy Reservoir watershed is essentially outside the reach of each County's stormwater system management plan. The predominate zoning and land use in the watershed is agriculture and as such, is not served by an organized storm sewer system. There is one area of urban development in the Prettyboy Watershed, represented by the Incorporated Towns of Manchester and Hampstead (MDE, 2009).

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 1,843 lbs. /yr., the TMDL for the stormwater WLA was determined to be 1,572 lbs. /yr., which is a reduction of 271 lbs. /yr. (15%) from the current loading (Table 4). This stormwater WLA is an aggregate of the municipal and industrial stormwater, including the loads from construction activity. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2006).

Table 4: Prettyboy 8-digit Watershed Phosphorus TMDL

Subwatershed	WGP0050		Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	1,843	1,572	15%
Total	**1,843**	**1,572**	**15%**

The purpose of phosphorus reductions is to reduce high chlorophyll a (Chla) concentrations that reflect excessive algal blooms and to maintain dissolved oxygen (DO) at a level supportive of the designated uses for Prettyboy Reservoir. The TMDLs are based on average annual total phosphorus loads for the simulation period 1992-1997, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Prettyboy Watershed is located in the northeast corner of the County. The watershed is within the Gunpowder River Basin, which lies within the Piedmont physiographic province of Maryland. There are five major sub-watersheds in the County that cover a total land area of 21,025 acres. Figure 1 depicts the location of the Prettyboy Watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Prettyboy watershed, agriculture is the dominant land cover at about 48 percent of the total land, followed by forest which accounts for 29 percent, and residential, which accounts for about 18 percent of the total land cover. Mixed urban accounts for less than 2 percent of the total land cover, which represents the relatively rural nature of the Prettyboy watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on section II.4 (table 1) of MDE's 2014 accounting for SW WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 7% increase in low-density residential land cover since 2011, which has been incorporated into Table 5 as "current acres".

Table 5 shows the current land cover data for the Prettyboy watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Prettyboy watershed can be found in Figure 2.

Table 5: Prettyboy Watershed Baseline and Current Land Cover

Land Use	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	5	<1%	5	<1%	5	<1%	5	<1%
Low-Density Residential	2,071	9.8%	2,065	9.8%	2,165	10%	3,697	17.5%
Low-Density Mixed Urban	313	1.5%	315	1.5%	359	1.7%	359	1.7%
Medium-Density Mixed	77	<1%	85	<1%	110	<1%	110	<1%
High-Density Mixed Urban	16	<1%	17	<1%	22	<1%	22	<1%
Forest	6,363	30%	6,336	30%	6,325	30%	6,155	29%
Shrub/Scrub	473	2.2%	468	2.2%	466	2.2%	429	2%
Grassland	29	<1%	50	<1%	48	<1%	43	<1%
Pasture/Hay	3,998	19%	3,800	18%	3,766	17.9%	3,257	15.5%
Cropland	7,500	36%	7,704	36.6%	7,580	36%	6,784	32%
Wetland	164	<1%	164	<1%	163	<1%	163	<1%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Prettyboy Watershed is estimated to have 993 acres of total impervious within the catchment and accounts for approximately 4.7 percent of the total land area. The impervious surface area within Prettyboy, by subwatershed can be found in Table 6 and is shown in Figure 3.

Table 6: Prettyboy Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
0313	Poplar Run	209	10.9	5.2
0314	Georges/Murphy Run	5,043	372.8	7.4
0315	Grave/Indian Run	3,558	107.1	3.0
0316	Gunpowder Falls	5,225	177.6	3.4
0317	South Branch Gunpowder Falls	6,990	324.6	4.6
Prettyboy Watershed		**21,025**	**993.0**	**4.7**

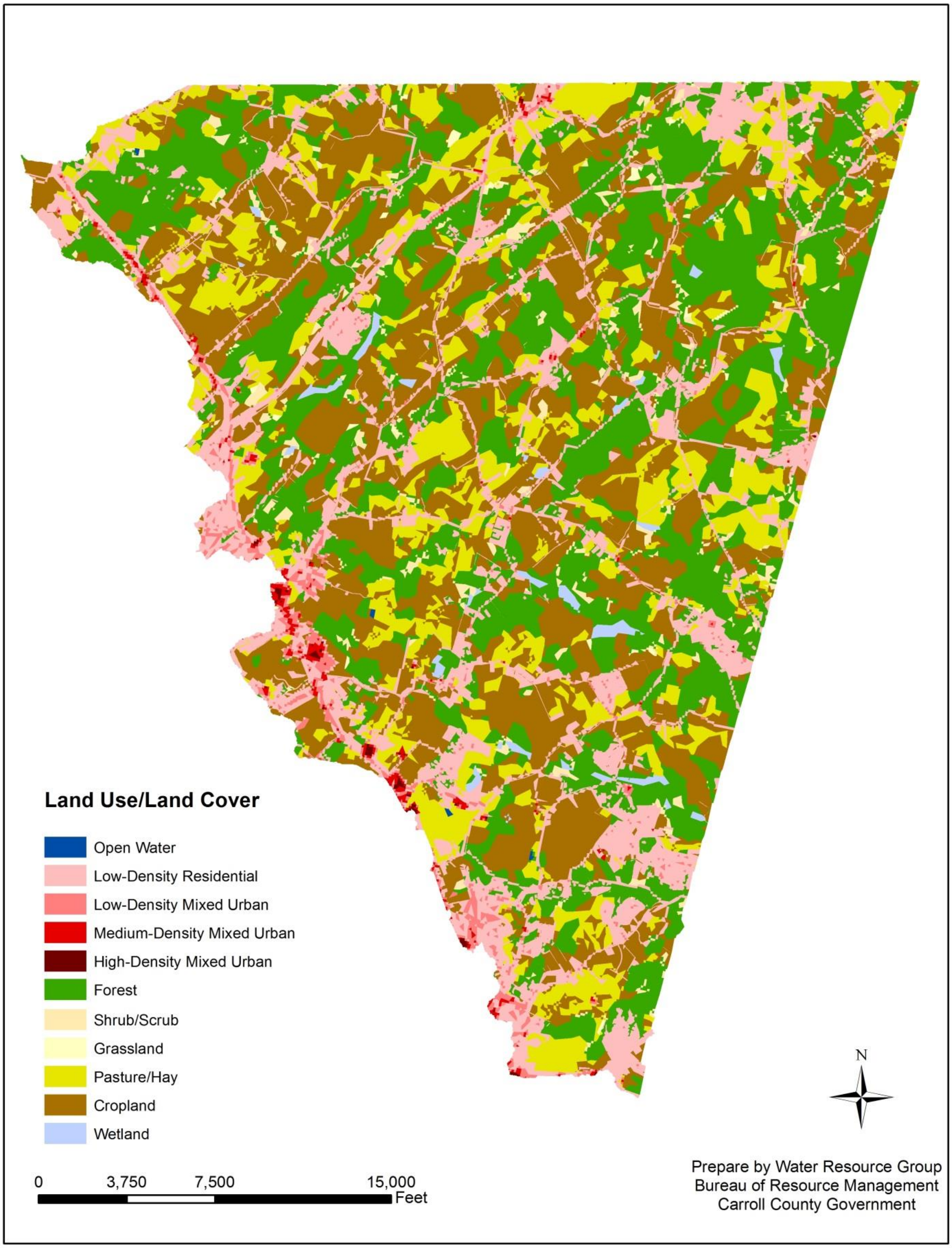

Figure 2: Prettyboy Watershed Land Use/Land Cover

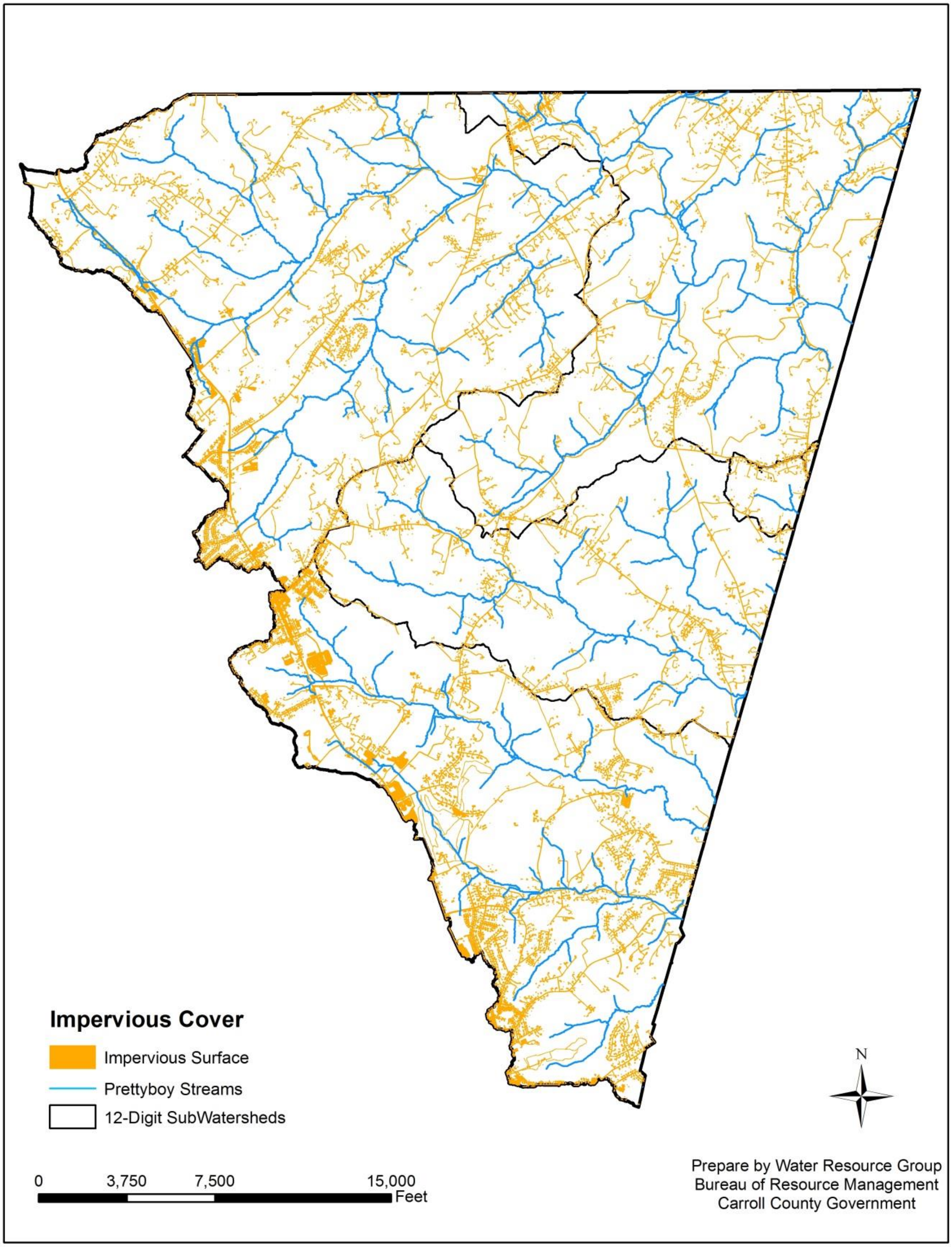

Figure 3: Prettyboy Watershed Impervious Surface Area

C. Watershed Characterization

Following the Prettyboy stream corridor assessment (SCA), completed in 2011, a Watershed Characterization for the Prettyboy watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Prettyboy watershed SCA will be used as the foundation for the watershed restoration plan. The Prettyboy SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/PrettyBoy/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/PrettyBoy/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Prettyboy Watershed, the Gunpowder Falls and South Branch Gunpowder Falls are the only subwatersheds listed as Tier II waters. Tier II designated watersheds and stream segments for the Prettyboy Watershed can be found in Figure 4.

b. Ecologically Sensitive Areas

The presence of Eastern Brook Trout in the Prettyboy watershed further defines the quality of water within the Prettyboy Watershed. This ecologically sensitive and threatened species requires clean, cold water to survive. Small populations of Eastern Brook Trout remain scattered in the headwaters of the Prettyboy Watershed. Their locations can be found in Figure 5. Any action to enhance or preserve their habitat is considered a priority in restoration planning.

A second ecologically sensitive and threatened species found in the Prettyboy Watershed is the bog turtle. The bog turtle is North America's smallest turtle, preferring relatively open habitats with slow flowing stream systems or surface seepages.

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

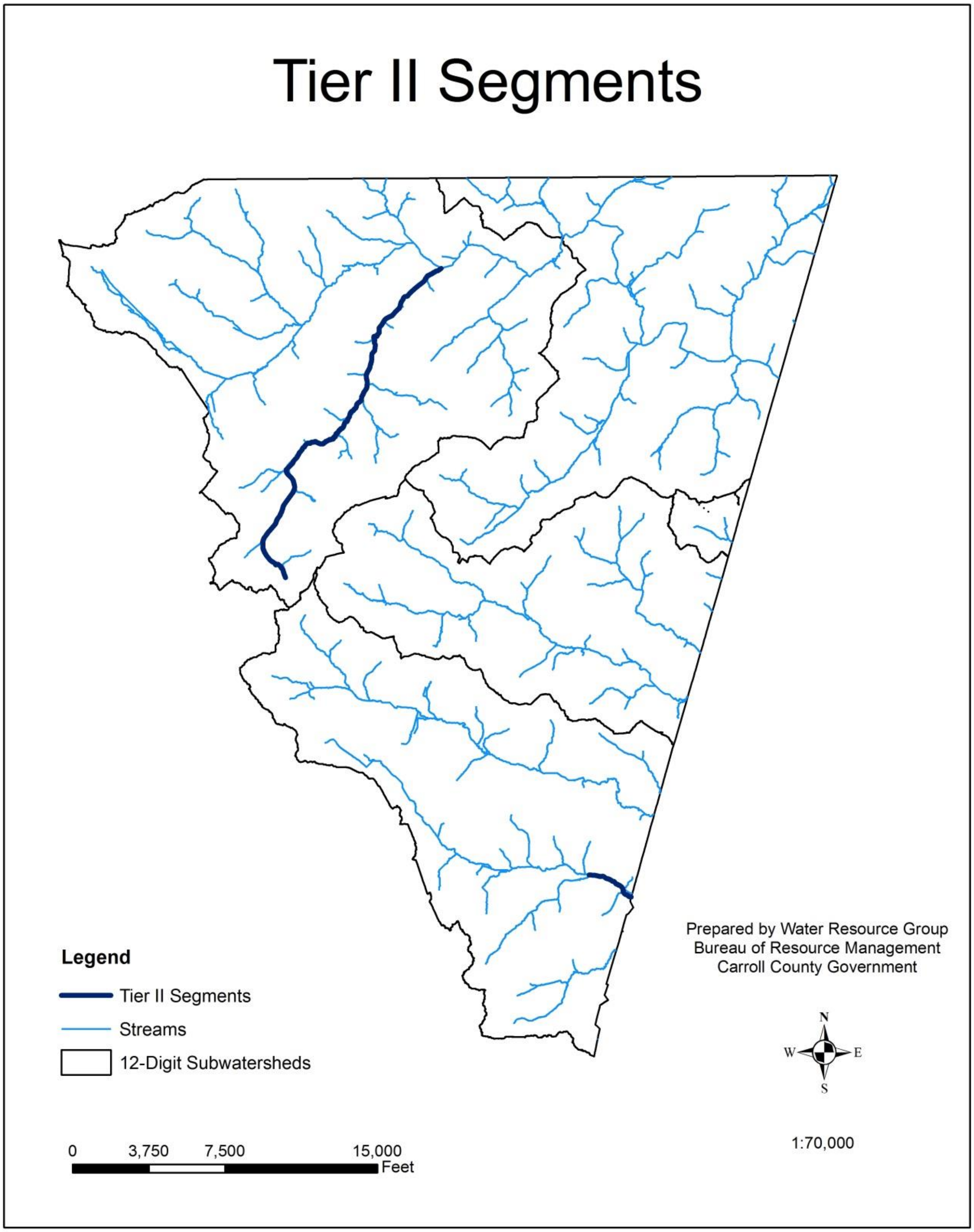

Figure 4: Tier II Waters

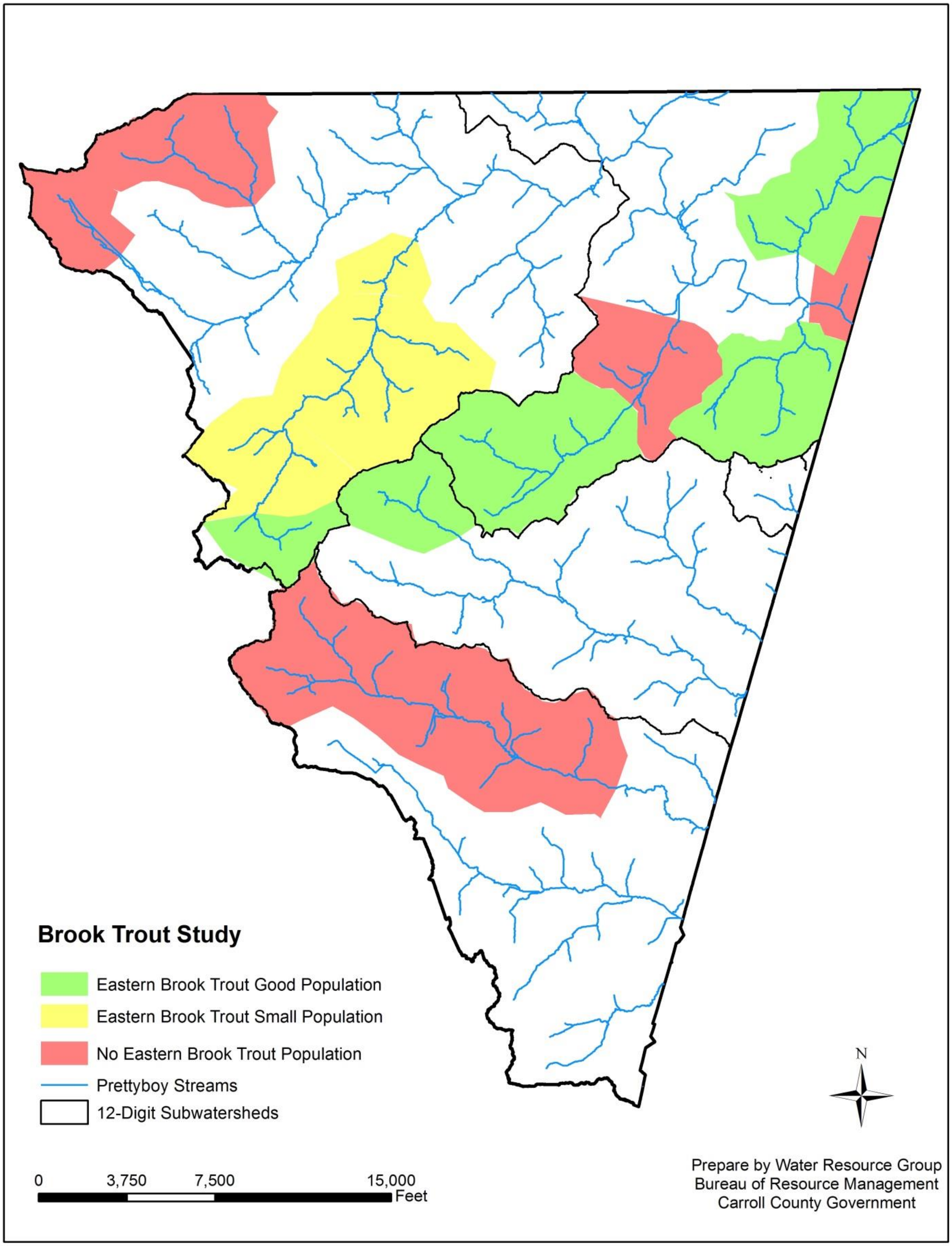

Figure 5: Brook Trout Study

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the Prettyboy Watershed was conducted during the winter of 2011 by Carroll County Bureau of Resource Management staff. The Prettyboy SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Prettyboy SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/PrettyBoy/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along 60,759 linear feet of the corridor, 19.6% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in South Branch Gunpowder Falls. A significant portion of the drainage within South Branch Gunpowder originates within the corporate limits of the town of Manchester. Table 7 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

Table 7: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Poplar Run	0.70	0.44	N/A	N/A
Georges/Murphy Run	22.70	18.11	12,375	13%
Grave Run/Indian Run	14.00	11.51	10,100	17%
South Branch Gunpowder Falls	33.00	17.38	30,019	33%
Gunpowder Falls	26.20	11.23	8,265	14%
Total	**96.60**	**58.67**	**60,759**	**19.6%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential; but does contain information on land zoned and designated for these uses. Within the Prettyboy Watershed there are 945 parcels remaining with potential development on 9,901 acres for an estimated lot yield of 2,815 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 6 shows the remaining parcels in Prettyboy watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

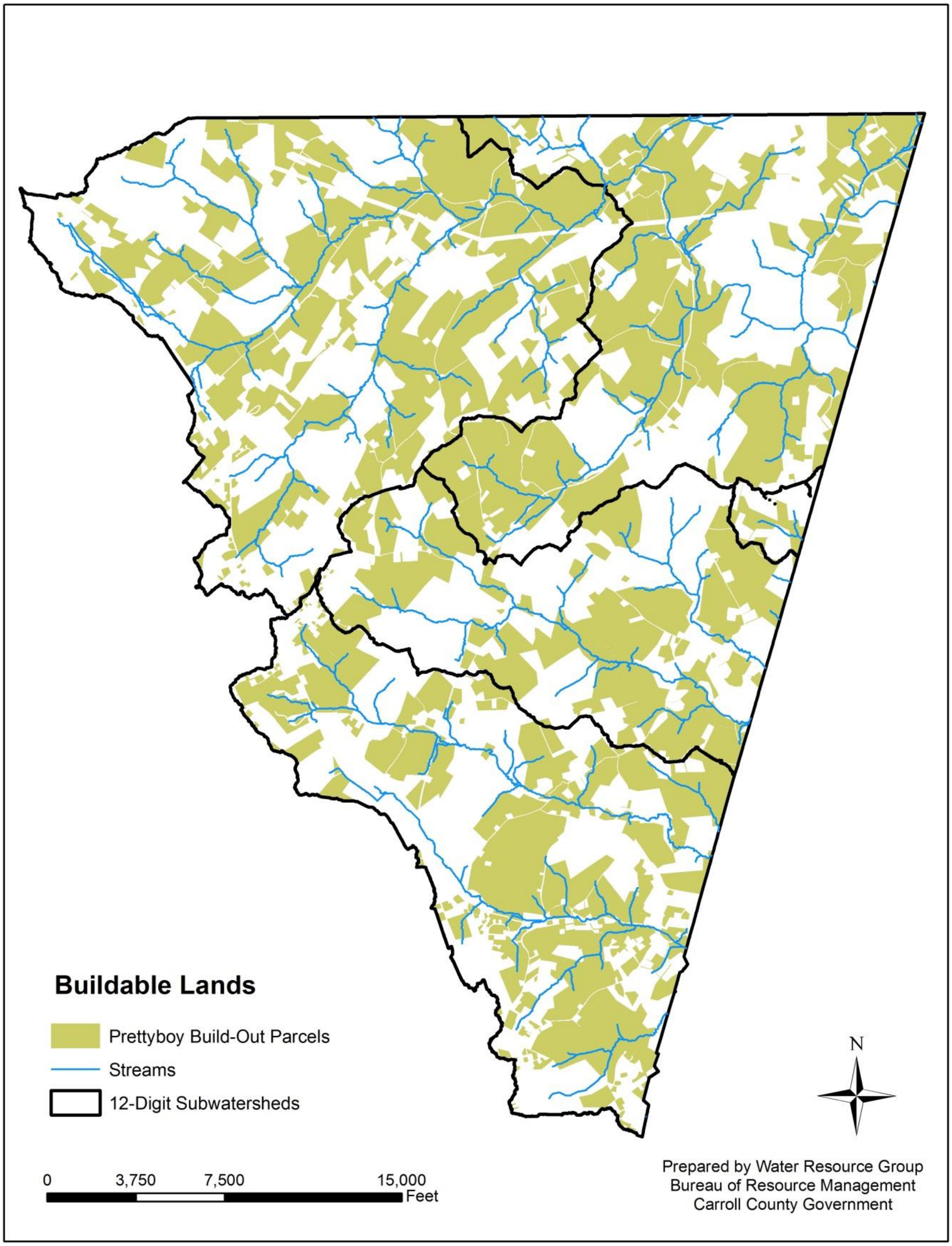

Figure 6: Prettyboy Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Prettyboy Reservoir Watershed there are 80.05 acres of grass buffer and 69.48 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Prettyboy Reservoir Watershed can be found in Appendix B, and are shown in Figure 7. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Prettyboy Watershed lies within the Upper Patapsco Rural Legacy area and encompasses 18,412 acres (88%) of the Prettyboy watershed. The extent of the Rural Legacy Area within Prettyboy can be found in Figure 8.

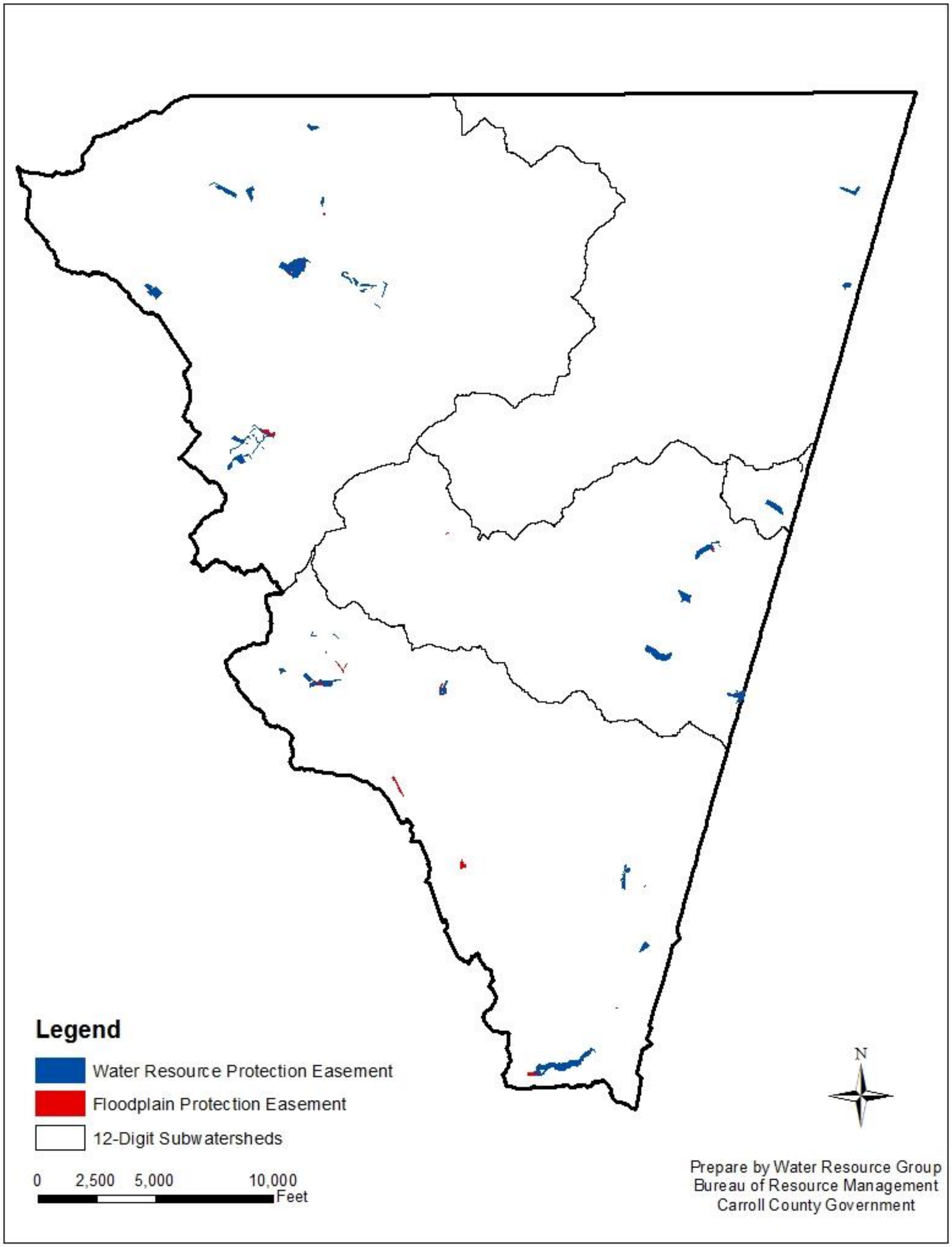

Figure 7: Water Resource and Floodplain Protection Easement Locations

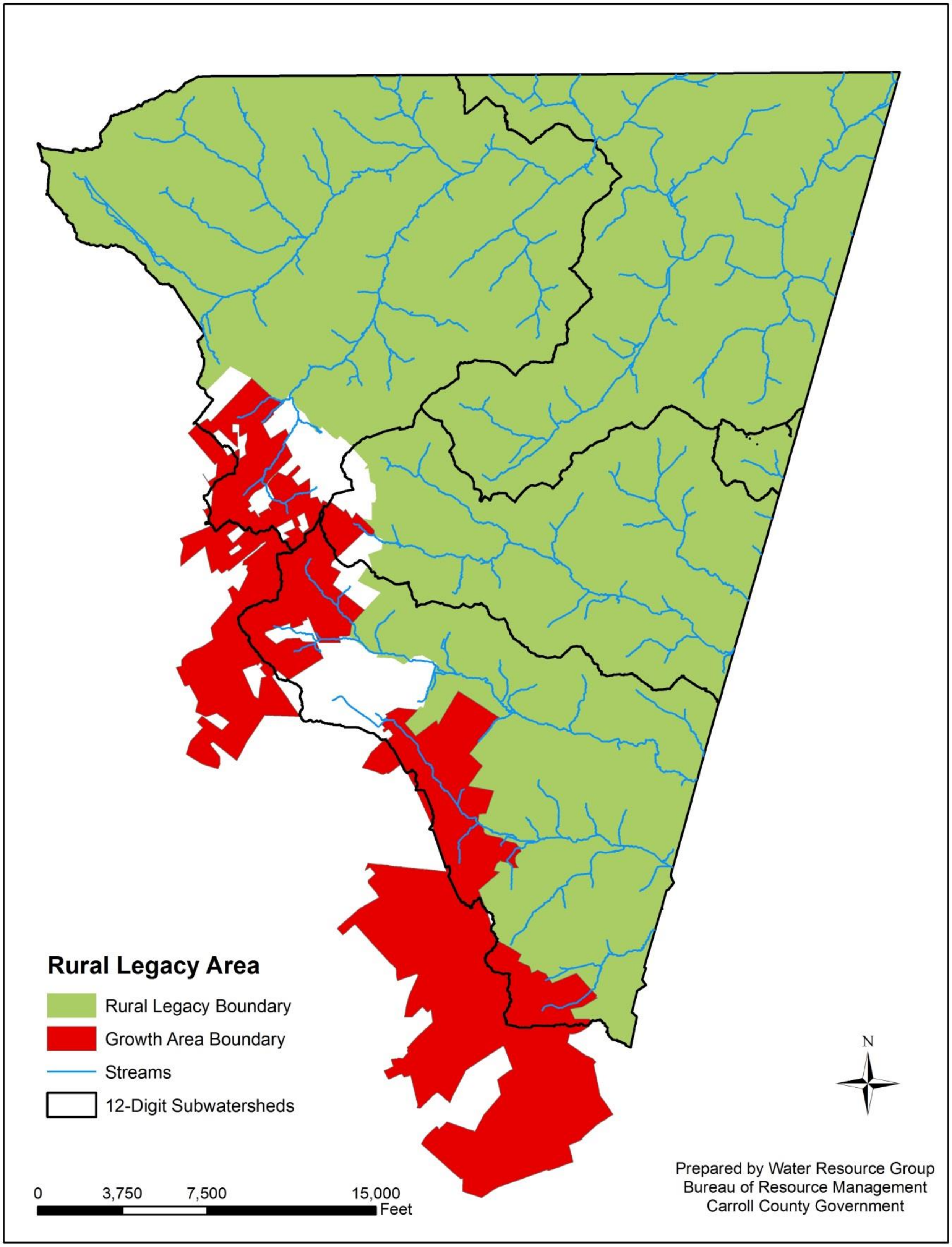

Figure 8: Upper Patapsco Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a Memorandum of Agreement (MOA) to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff is continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts. Educational

events that County staff have participated in that are either held within the Prettyboy Watershed or offered to citizens countywide can be found in Table 8.

Table 8: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Charlotte's Quest Nature Center Spring Fest	2018, 2019	Prettyboy
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide
Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide

Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Prettyboy Watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, Maryland Department of Environment (MDE) released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design (ESD) practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Prettyboy Watershed TMDL's are listed in Table 9. The location of each facility can be found in Figure 9, the practice type and runoff depth treated for each facility can be found in Appendix B.

Table 9: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Whispering Valley	88.99	20.9	Retrofit	Under Construction	South Branch Gunpowder Falls
Small Crossings	26.73	9.07	Retrofit	Completed	George's/Murphy Run
Small Crossings	1.15	0.51	Bio-Retention	Completed	George's/Murphy Run
Manchester Elementary	5.16	3.59	Facility	Planned	South Branch Gunpowder Falls
Valley Vista	27.09	4.73	Facility	Planned	South Branch Gunpowder Falls
Manchester East	103.98	36.6	Facility	Planned	George's/Murphy Run
Totals:	**253.1**	**75.4**			

B. Storm Drain Outfalls

During the Prettyboy Watershed SCA in 2011, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. Two elementary schools within the Prettyboy watershed; Ebb Valley and Manchester Elementary have planted two gardens that treat a total drainage area of 21,500 square feet.

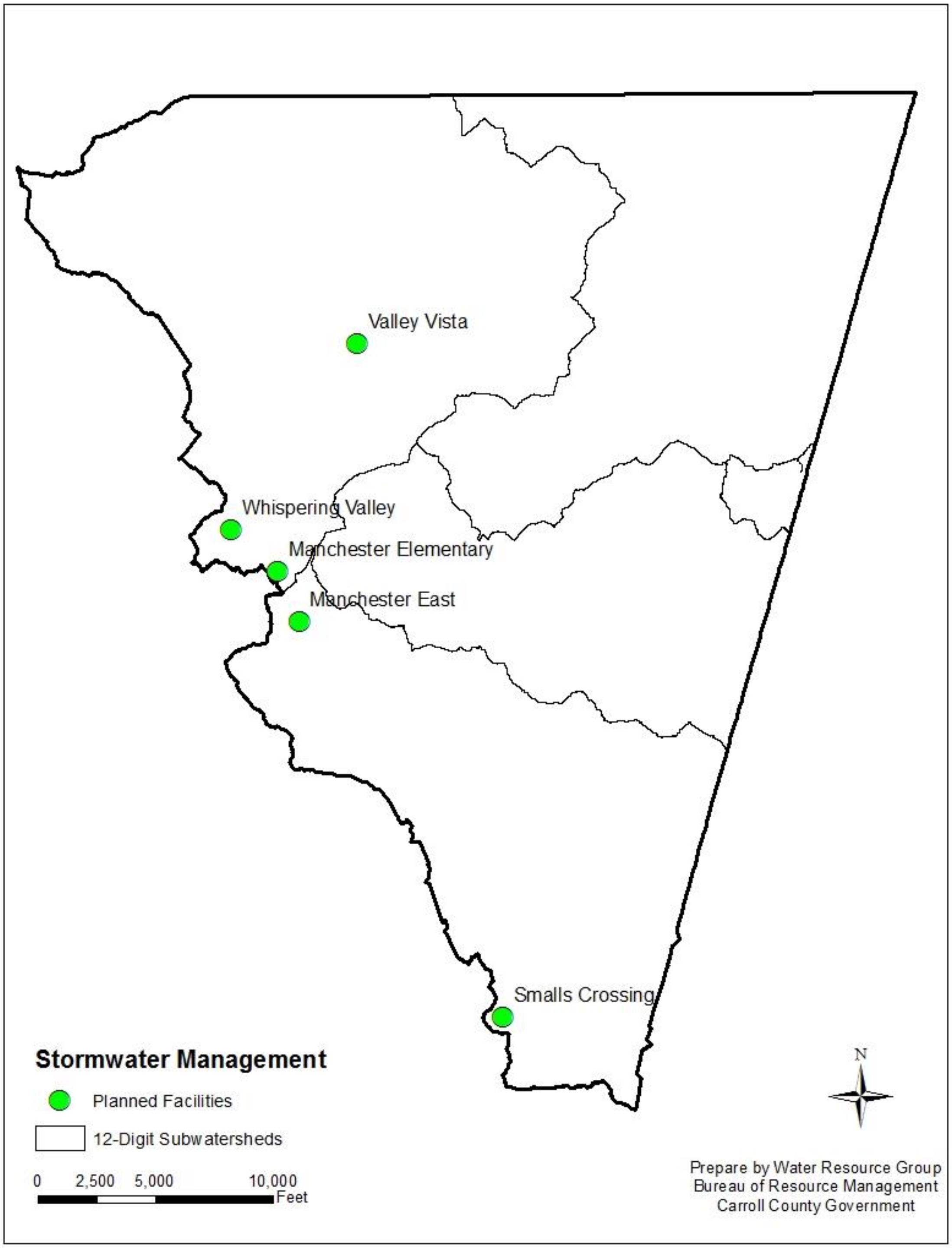

Figure 9: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

The 2011 Prettyboy SCA determined that approximately 65 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to 79 landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Resource Management staff were able to coordinate 15 site visits with property owners from the mailing. Four private properties participated in this initiative during the spring of 2013. The acreage planted for each location and the associated subwatershed can be found in Table 10. The approximate locations of the residential buffer plantings are shown in Figure 10.

Table 10: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	Subwatershed	Date Planted
Planting 1	0.53	575	60	South Branch Gunpowder Falls	Spring 2013
Planting 3	0.44	400	40	South Branch Gunpowder Falls	Spring 2013
Planting 4	0.35	325	50	George’s/Murphy Run	Spring 2013
Planting 5	1.95	575	200	George’s/Murphy Run	Fall 2014
Planting 6	2.48	380	100	Gunpowder Falls	Fall 2017
Planting 7	1.77	360	220	George’s/Murphy Run	Fall 2017
Planting 8	0.38	770	30	South Branch Gunpowder Falls	Fall 2017
Planting 9	0.40	630	35	George’s/Murphy Run	Fall 2017
Planting 10	0.41	500	20	Poplar Run	Fall 2017
Planting 11	0.50	250	100	George’s/Murphy Run	Fall 2018
Planting 12	0.78	600	50	George’s/Murphy Run	Fall 2018

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau’s stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be inspected bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

2. Municipal Plantings

The Town of Manchester and Manchester Parks Foundation have initiated multiple tree planting efforts within the Prettyboy Watershed. These projects include plantings at the local nature center, the Main Street Streetscapes Project, and the Tree Replacement Program.

The Charlotte's Quest nature center project consisted of planting 155 trees at a stocking rate of 300 trees per acre. The Main Streets Project involved planting 17,865 square feet of islands along Main Street.

Manchester's Tree Replacement Program was adopted by the Mayor and town council in 1992, in which a tree commission was created. This commission consists of five (5) members appointed by the Mayor, with at least one member having a background in horticulture, forestry, or related field. The responsibility of the tree commission is to; study, investigate, counsel, develop and/or update annually and recommend to the Mayor and Council a written plan for the care, preservation, pruning, planting, replanting, removal or disposition of trees and shrubs in parks, along streets and in other public areas.

The town of Hampstead also implemented planting projects at two locations within the watershed, which consisted of planting approximately 2,600 trees at a stocking rate of 300 trees per acre to restore forested buffer along 1,155 linear feet of stream.

The town of Manchester and Hampstead efforts are included in Appendix A.

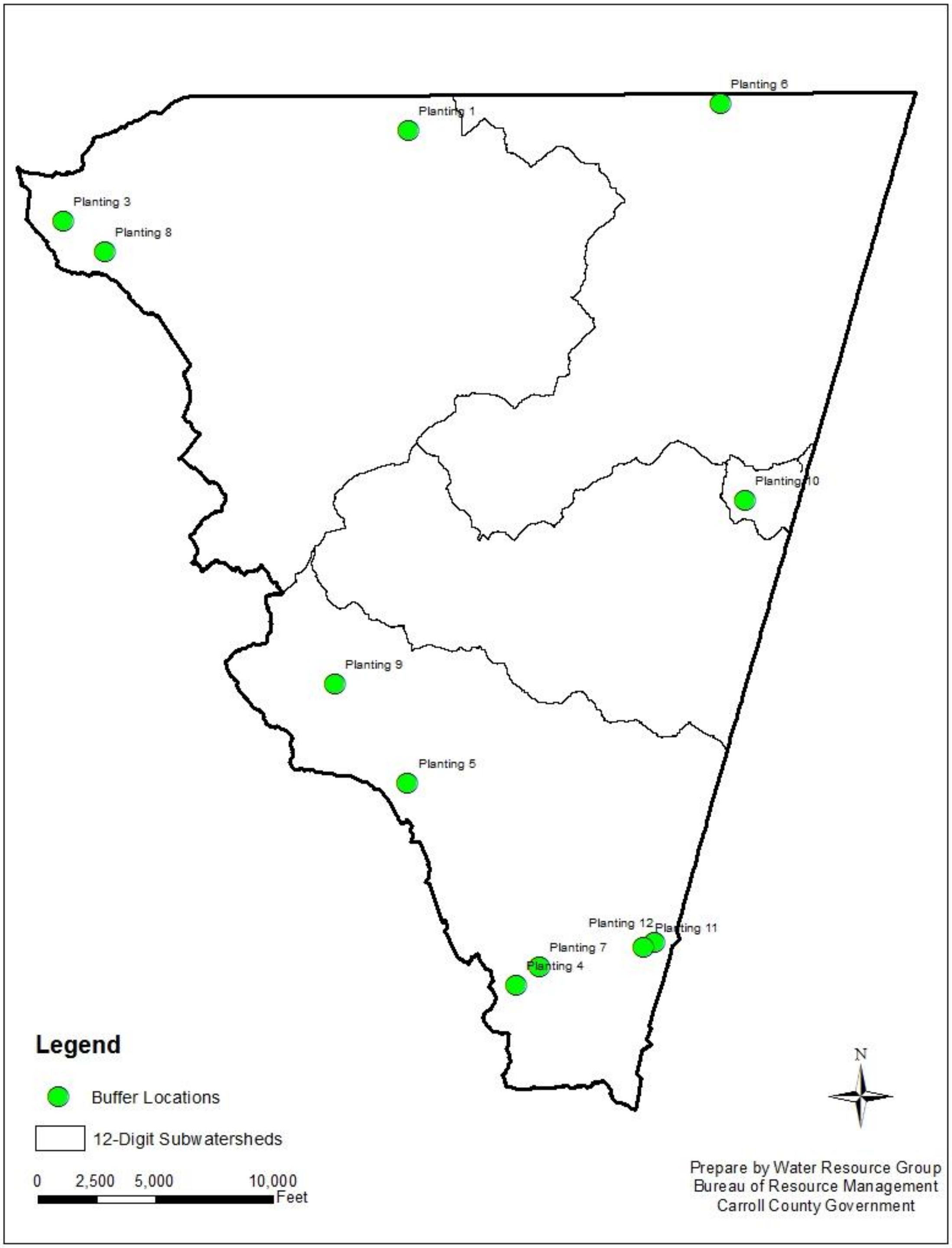

Figure 10: Stream Buffer Initiative Locations

E. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Prettyboy Watershed are shown in Table 11.

Table 11: Road Maintenance Projects

Management Practice	Inlet Cleaning		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Hampstead	8.6	George's/Murphy Run	Annual
Manchester	0.674	South Branch Gunpowder	Annual

Management Practice	Impervious to Pervious		
Town	# Acres Converted	12-Digit Watershed	Date of Completion
Hampstead	0.42 Acres	George's/Murphy Run	2012
Manchester	0.81 Acres	George's/Murphy Run	2012

F. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2007, twelve septic systems within the Prettyboy watershed have been repaired and twelve new systems have been built utilizing Best Available Technology (BAT). BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Prettyboy Watershed are listed in Appendix E.

G. Agricultural Best Management Practices (BMPs)

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

H. Streambank Regeneration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Accelerated streambank erosion occurs downstream of inadequately managed impervious from development. The proportion of rain water that previously infiltrated into the ground is reduced. Thus, causing immediate runoff, and increasing the total amount and velocity of flow in the receiving channel, accelerating erosion and resulting in greater sediment loads within the stream corridor.

There are two effective ways to reduce the destabilizing velocity increases in the receiving channel. The first is traditional stream restoration, increasing the plan form and bank resistance. The second is upland stormwater management, storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont, many residential, institutional, or commercial areas were developed prior to 1982 without any stormwater management or subsequently with peak flow control that matched existing conditions only, not really returning the runoff characteristics to predevelopment, as required by COMAR 26.17.02.01. Matching the existing hydrologic runoff response in these areas does not address existing streambank instability and does nothing to help restore streams or reduce current nutrient and legacy sediment export to the Bay.

Carroll County has been experimenting with the use of enlarged, enhanced, sand filters as primary stormwater management for more than 10 years. In an effort to determine the cause of these unanticipated stormwater management/quality/stream restoration benefits, we reanalyzed the design information. This showed that the Carroll County standard design reduced the two-year storm peak flow below that of an equivalent forested watershed in good condition. This has always been the goal of stormwater management, returning the hydrologic condition to that assumed to exist in pre-contact times.

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix B provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions rather than the broader accounting procedure used by the Chesapeake Bay Watershed Model.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix C.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater TMDL WLA requirements within the Prettyboy watershed. As described in

Section I, phosphorus and bacteria loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDL suggests an urban load reduction of 15% for phosphorus from the baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Prettyboy Reservoir). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reduction of 15% of the baseline year. A baseline year of 2001 was used as a proxy for the 1995 baseline year in the TMDL, as land cover data from 2001 was the closest available for that time period. The modeled 2001 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 1995 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2001 was used as the baseline proxy year. For reference, the modeled baseline urban P load using the 2001 land cover was 204.18 lbs, which equates to a 15% reduction of 30.63 lbs (Table 12).

The projects completed as of December, 2019 are providing 15.29 lbs. of TP reduction. These reductions are from a combination of stormwater management projects, buffers, impervious surface reduction, inlet cleaning, and easements. The planned projects would provide another 17.55 lbs of TP reduction (Table 13). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figure 11. To achieve remaining TMDL requirements, the county will utilize the mapshed model to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Prettyboy TMDL. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, or locations beyond the current CIP.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, currently MDE does not provide guidance on bacteria reduction efficiencies.

Table 12: Total Phosphorus Load Reduction in the Prettyboy Reservoir Watershed (lbs/year) in Carroll County

Modeled Baseline Load (lbs)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs)	Reduction from Current BMPs (lbs)	Reduction from Restoration Plan Strategies (lbs)	Total % Reduction Achieved
204.18	15%	30.63	15.29	17.55	16%

Table 13: Comparison of Total Phosphorus delivered Load Reductions (lbs/year) by Restoration Strategies. This table includes both proposed and existing BMPs.

Status	Pond Retrofits (lbs)	Buffers (lbs)	Stream Restoration (lbs)	Catch Basin/ Inlet Cleaning (lbs)	Impervious Reduction (lbs)	Easements (lbs)
Completed	9.37	0.66	0.00	0.46	0.13	4.67
Planned	17.55	0.00	0.00	0.00	0.00	0.00

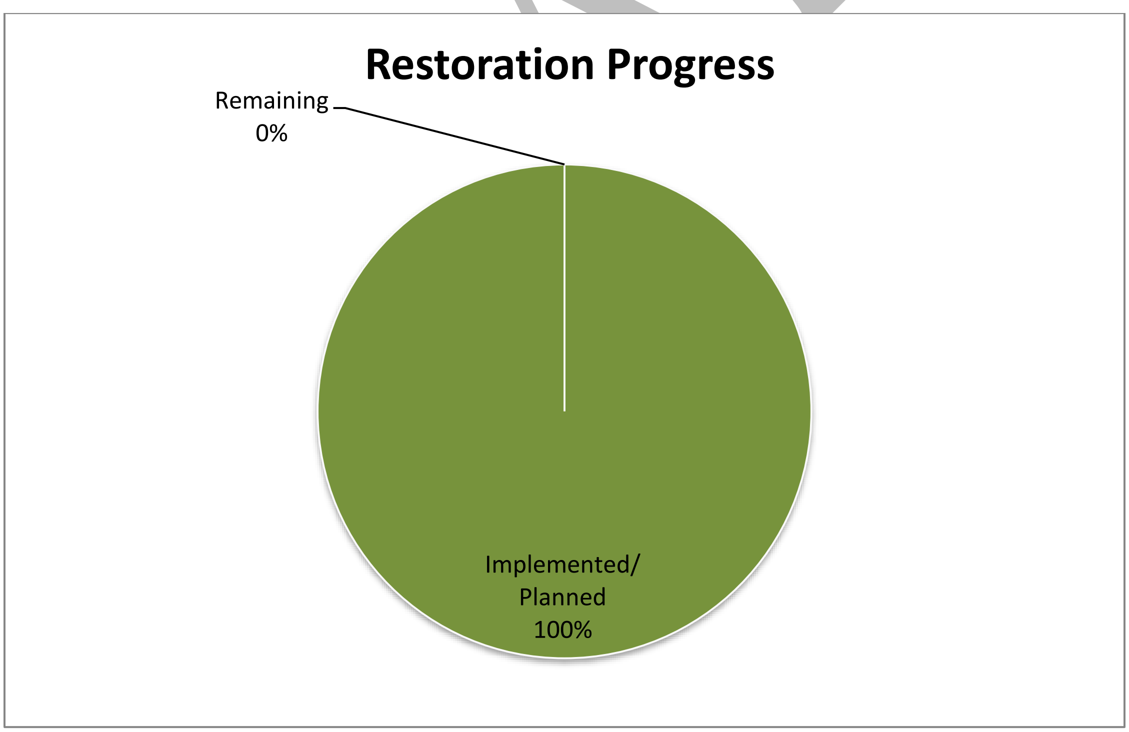

Figure 11: 2019 Restoration Progress

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Prettyboy Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

The Carroll County Bureau of Utilities is in the process of completely updating their Regulations and Standard Specifications and Design Details for water and sewer infrastructure for the first time since 1992.

Changes that shall be implemented with this update include increasing required sewer main encasements at all proposed stream crossings.

This shall include both more comprehensives encasement design requirements as well as an increase in the distance encasement shall be required to be extended beyond the edges of the stream crossing. Additionally, manhole design requirements shall now include factory installed epoxy coatings on new manholes to be installed on proposed or upgraded sewer mains.

Table 14 lists infrastructure related measures that have been implemented since the 1995 baseline year that would assist in reducing bacteria counts within the watershed.

Table 14: Waste Collection Infrastructure Upgrades

	Hampstead	Manchester	County
BAT Upgrades	1*	0*	23
Casings/Linings	n/a	TBD	TBD
Lateral line replacements	n/a	TBD	TBD
Pump Station upgrade	n/a	TBD	TBD

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach. This comprehensive monitoring program is intended to validate the overall effectiveness of BMPs and document the efficiency of innovations made to BMPs.

1. Retrofit Monitoring

The Bureau of Resource Management currently monitors one location within the Prettyboy reservoir watershed. The Whispering Valley site, shown in Figure 12, is located within the South Branch Gunpowder Falls subwatershed, and is almost entirely within the corporate limits of the Town of Manchester.

The current facility is a dry detention pond that was built in 1983 for the Whispering Valley subdivision, and is scheduled to be retrofitted to a sand filter in FY17. The Whispering Valley location is primarily residential, which encompasses 84% of the land use. The drainage area to the monitoring site is approximately 95 acres, of which, 19 acres or 20% is impervious.

Bi-weekly monitoring at the Whispering Valley site began in January of 2015 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Whispering Valley site can be found in Table 15. Additional monitoring at this location includes geomorphic channel surveys as well as spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 15: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Upper Monocacy Watershed began in April of 2019, and is currently performed at one location, shown in Figure 13. Samples are currently collected on the 4th Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 16 shows the monitoring results for the entire year, whereas Table 17 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 16: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
GMR04	Low	6	151
	High	0	n/a
	All	6	151

Table 17: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
GMR04	Low	5	228
	High	0	n/a
	All	5	228

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 18 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 18: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2019	
			# Samples	% Exceeded
GMR04	576	low	6	0%
		high	n/a	n/a
	410	low	6	0%
		high	n/a	n/a
	298	low	6	33%
		high	n/a	n/a
	235	low	6	50%
		high	n/a	n/a

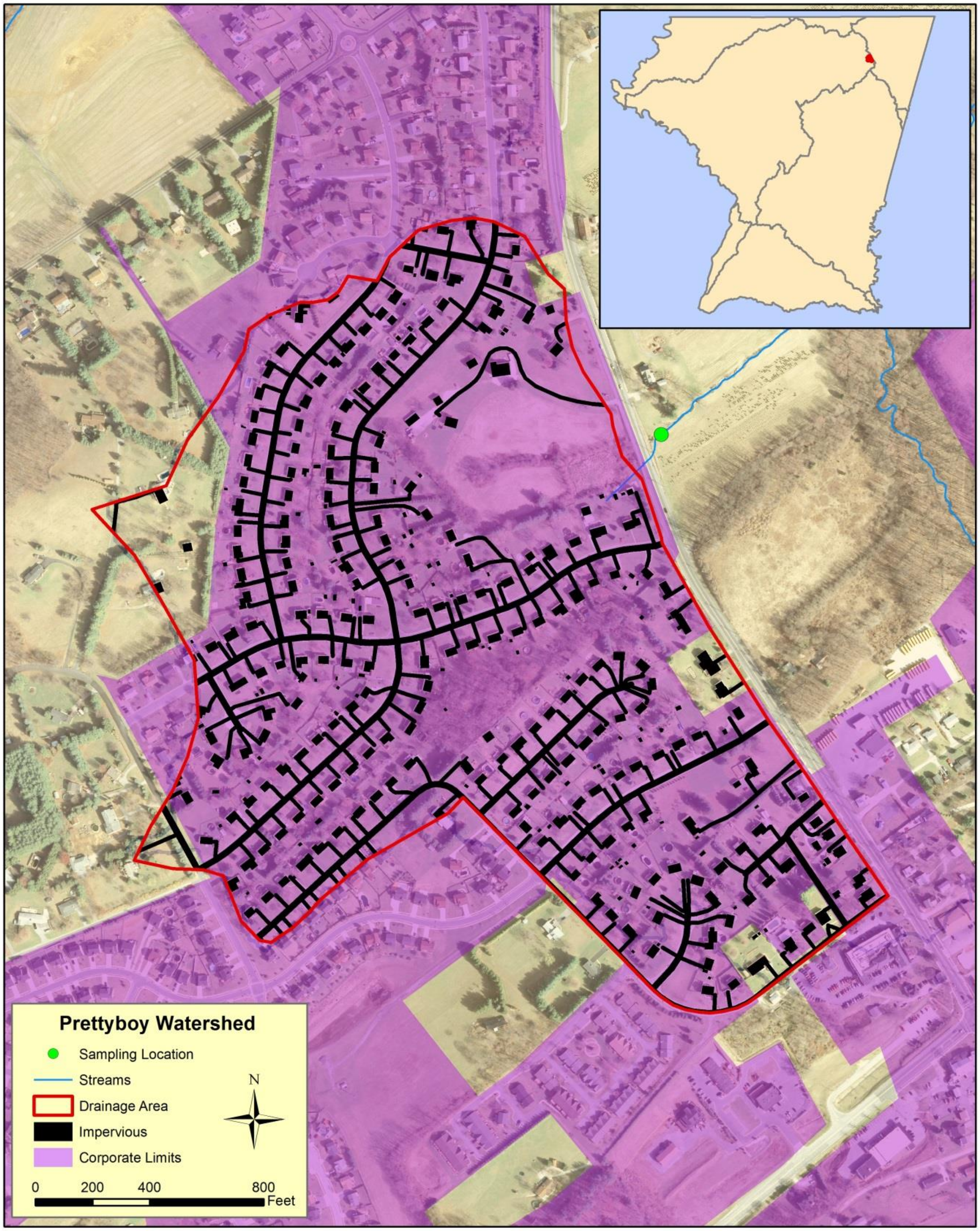

Figure 12: Whispering Valley Monitoring Location

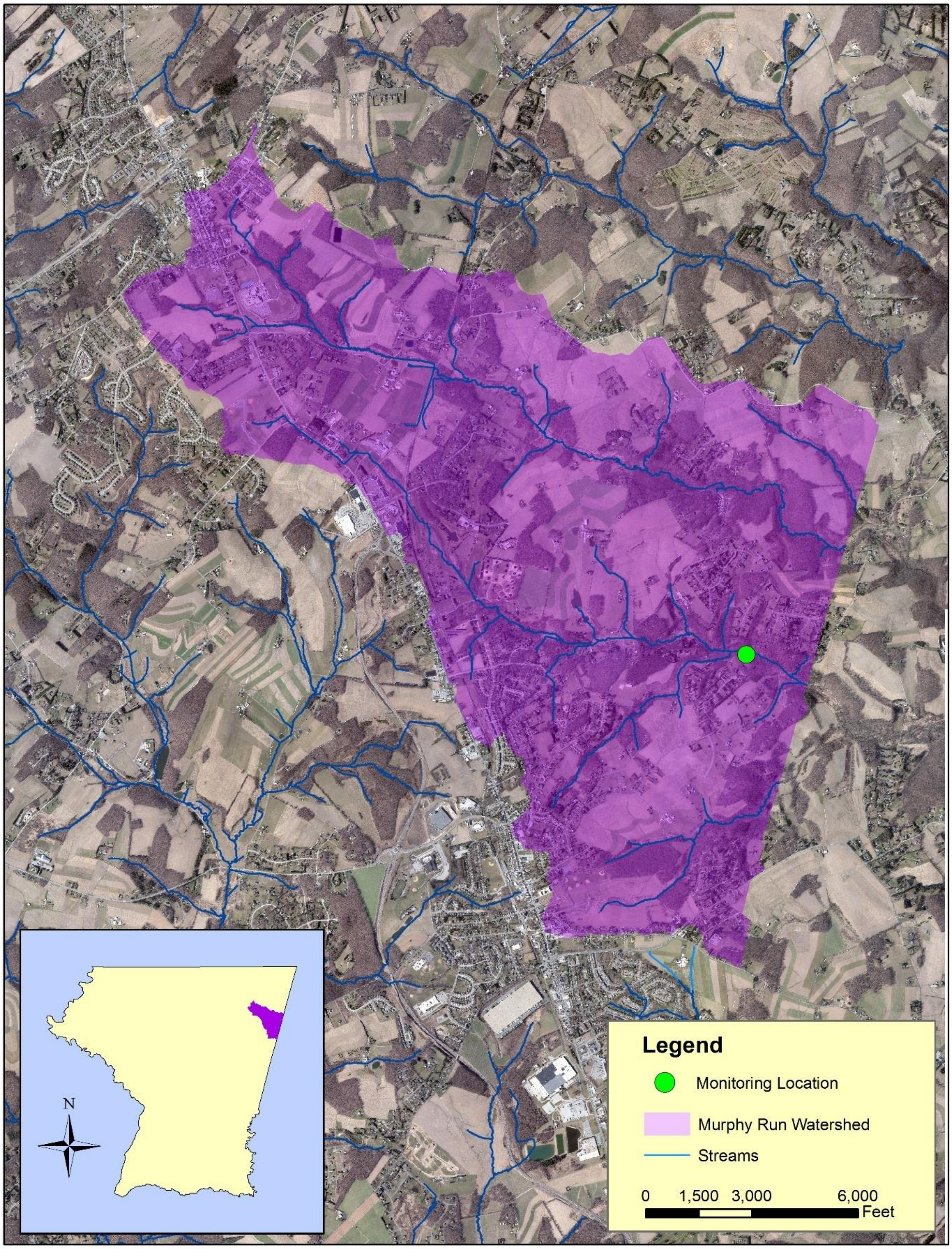

Figure 13: Bacteria Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 19). BMPs and restoration projects that have been either completed or currently planned to address local TMDL's within the Prettyboy Watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 19, and the tidal water designated use zones are shown in Figure 14.

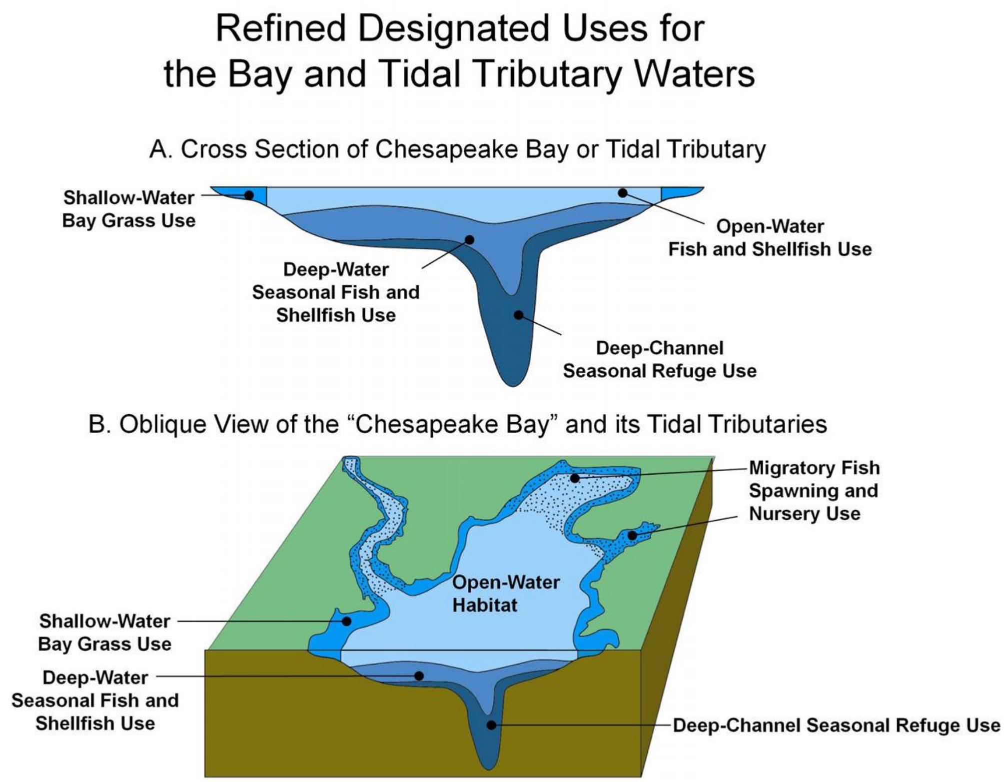

Figure 14: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 19: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Prettyboy watershed is located within the Gunpowder River segment of the Chesapeake Bay. The Gunpowder segment covers 283,263 acres across four counties and two states. Approximately 21,000 acres (7%) of the river segment is within Carroll County and includes both the Loch Raven and Prettyboy watersheds. The location of the Gunpowder River segment is shown in Figure 15.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix D) calculated using the 2014 MDE Accounting for Guidance Document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 20. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Gunpowder River segment within the Prettyboy watershed are; 0.05 for nitrogen, 0.08 for phosphorus, and 0.00 for suspended sediment (MAST, 2016). Essentially, if one pound of nitrogen is discharged into a tributary within the Prettyboy portion of the Gunpowder river segment, only 5% of that pound is reaching the Bay.

Table 20 shows the Chesapeake Bay TMDL for the Gunpowder land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Prettyboy Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Gunpowder land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Prettyboy Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the

Gunpowder segment shed. The Prettyboy Watershed covers 97.3% of the Gunpowder land-river segment within Carroll County.

Table 20: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Prettyboy Reservoir Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction Required	Required Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
315.36	17.19%	54.21	8.42	7.26	28.92%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction Required	Required Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
4,010.75	9.59%	384.55	68.25	49.08	30.51%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Gunpowder land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Prettyboy Watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 21: Carroll County Gunpowder River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	Total Phosphorus (TP)[3]			Total Nitrogen (TN)		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Loch Raven Reservoir Watershed	10.555	0	19.47%	14.645	0	3.81%
Prettyboy Reservoir Watershed	8.42	7.26	28.92%	68.25	49.08	30.51%
Total	**18.975**	**7.26**	**48.39%**	**82.895**	**49.08**	**34.32%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

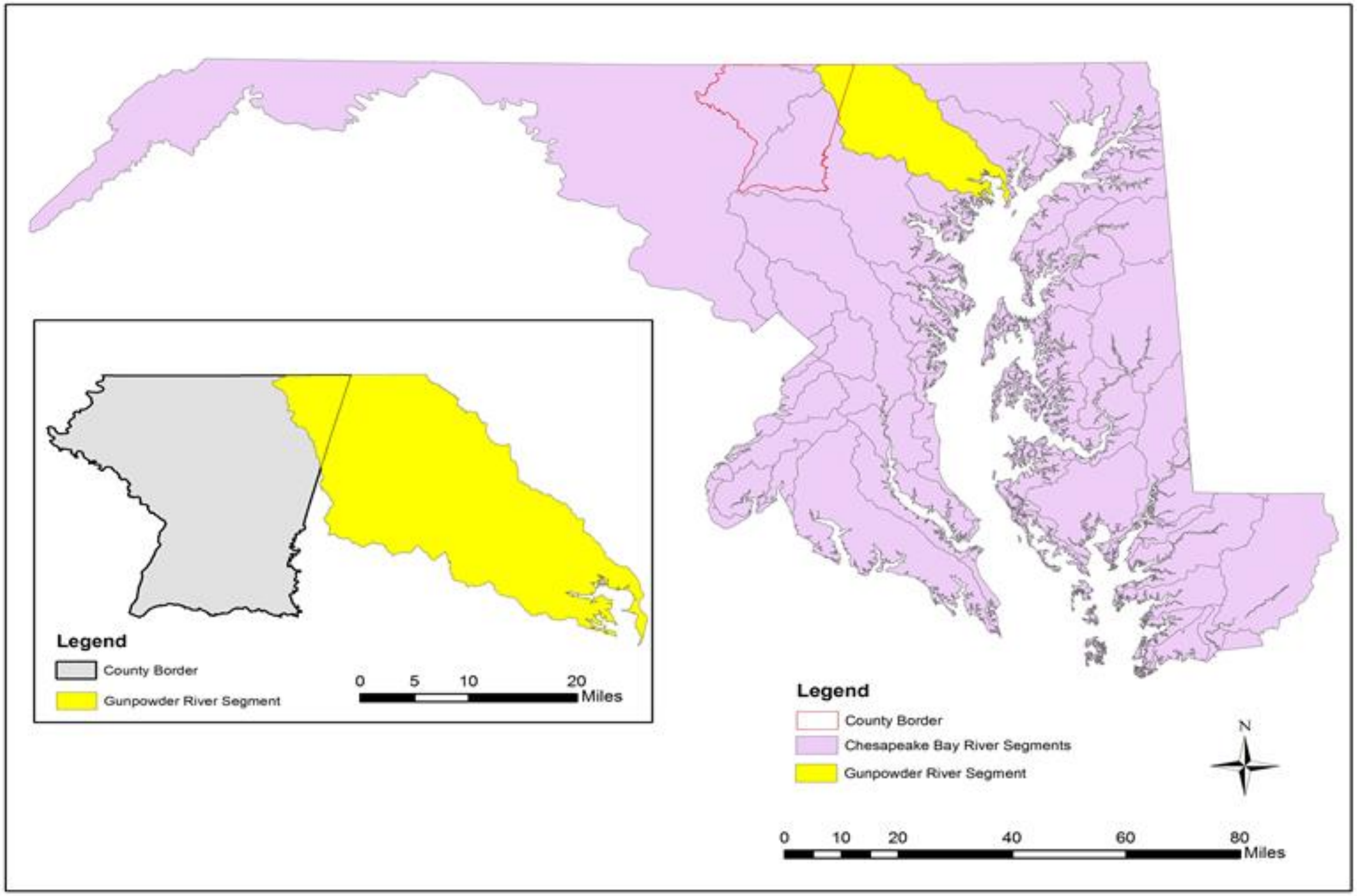

Figure 15: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 50% of the required reduction since the baseline year of 1995. Based on currently identified projects, the required reduction is expected to be fully achieved by 2025.

Table 22 lists the anticipated benchmark for each nutrient TMDL within the Prettyboy Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 22: Nutrient TMDL Benchmarks

Nutrient	2019	2025
Phosphorus	50%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Prettyboy Reservoir Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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Appendix A:
Watershed Restoration Projects

Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost*	Anticipated Completion
SWM Facilities	County	2130806	Completed	$1,374,615	Completed
Buffer Plantings	County	2130806	Completed	$70,884	Completed
Roads: Impervious to Pervious	Hampstead	21308060314	Completed	$7,000	2012
Roads: Impervious to Pervious	Manchester	21308060317	Completed	**	2012
Roads: Street/Inlet Cleaning	Hampstead	21308060314	Completed	$10,000	Annual
Roads: Street/Inlet Cleaning	Manchester	21308060317	Completed	$9,000	Annual
Water/floodplain Easement	County	2130806	Completed	N/A	Completed
SWM (Planned)	County	2130806	Planning/Design	$885,000	FY20-FY25
TBD	Watershed	2130806	Planning		TBD

***Costs for proposed Stormwater facilities are based on current FY20-FY25 project costs, which may be subject to change.**

****Project Costs not reported**

Appendix B:
Local TMDL Load Reduction Calculations

SWM Facilities

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Whispering Valley	Retrofit	88.99	20.9	RR	1.76	2.1658%	66%	24.61	2.6353%	77%	5.38	2.9576%	83%	10.08
Small Crossings	Retrofit	26.73	9.07	RR	1.86	2.255%	67%	25.621	1.882%	78%	3.843	1.003%	83%	3.419
Small Crossings	Bio-Retention	1.15	0.51	RR	1.00	0.087%	60%	0.989	0.073%	70%	0.148	0.039%	75%	0.132
Manchester Elementary	Facility	5.16	3.59	RR	2.50	0.443%	68%	5.028	0.368%	79%	0.751	0.368%	85%	0.670
Manchester East	Facility	103.98	36.6	RR	2.50	8.917%	68%	101.315	7.412%	79%	15.135	7.412%	855	13.504
Valley Vista	Facility	27.09	4.73	RR	2.50	0.673%	68%	7.649	0.816%	79%	1.666	0.816%	85%	3.132
		253.1	**75.4**			**14.54%**		**165.212**	**13.19%**		**26.923**	**12.60%**		**30.937**

Project	Acres	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.53	0.013%	66	0.146	0.016%	77	0.032	0.012%	57	0.041
Planting 3	0.44	0.011%	66	0.121	0.013%	77	0.026	0.010%	57	0.034
Planting 4	0.35	0.008%	66	0.096	0.010%	77	0.021	0.008%	57	0.027
Planting 5	1.95	0.047%	66	0.537	0.057%	77	0.117	0.045%	57	0.152
Planting 6	2.48	0.060%	66	0.683	0.073%	77	0.149	0.057%	57	0.193
Planting 7	1.77	0.0004%	66	0.49	0.0005%	77	0.11	0.00045	57	0.138
Planting 8	0.38	0.0001%	66	0.10	0.0001%	77	0.02	0.0001%	57	0.030

Planting 9	0.4	0.0001%	66	0.11	0.0001%	77	0.02	0.0001%	57	0.031
Planting 10	0.41	0.0001%	66	0.11	0.0001%	77	0.02	0.0001%	57	0.032
Charlotte's Quest	0.52	0.013%	66	0.143	0.015%	77	0.031	0.012%	57	0.040
Manchester Streetscapes*	0.41	0.010%	66	0.113	0.012%	77	0.025	0.009%	57	0.032
Planting 11	0.50	0.012%	66	0.14	0.015%	77	0.03	0.011%	57	0.04
Planting 12	0.78	0.019%	66	0.21	0.023%	77	0.05	0.018%	57	0.06
Total:	**9.64**	**0.194%**		**2.999**	**0.235%**		**0.651**	**0.227%**		**0.850**

Impervious to Pervious

Location	Acres	% Urban TN Load	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Hampstead	0.42	0.039%	N/A	0.447	0.022%	N/A	0.045	0.002%	N/A	0.007
Manchester	0.81	0.076%	N/A	0.863	0.042%	N/A	0.086	0.004%	N/A	0.014
Total		**0.115%**		**1.31**	**0.064%**		**0.131**	**0.006**		**0.021**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered]	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (Tons)
Hampstead	8.6	3.5	30.01 [1.10]	1.4	12.04 [0.43]	420	1.806 [0.17]
Manchester	0.674	3.5	2.36 [0.09]	1.4	0.994 [0.03]	420	0.119 [0.01]
		Total:	32.37 [1.19]		**13.034 [0.46]**		**1.925 [0.18]**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 1995-2008	51.720	1995-2008	0.5696%	30	6.471	0.7906%	40	1.614	1.1395%	55	3.885
Grass Buffer 2009-Current	28.330	2009 - current	0.3120%	30	3.545	0.4330%	40	0.884	0.6242%	55	2.128
	80.05		**0.8816%**		**10.016**	**1.2236%**		**2.498**	**1.7637%**		**6.013**

Forest Buffer Easements--Efficiency factors - 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 1995-2008	26.630	1995-2008	0.4399%	45	4.998	0.4071%	40	0.831	0.5867%	55	2.00
Forest Buffer 2009-Current	42.850	2009 - current	0.7078%	45	8.042	0.6550%	40	1.337	0.9441%	55	3.218
	69.48		**1.1477%**		**13.04**	**1.0621%**		**2.168**	**1.5308%**		**5.218**

Appendix C: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks. This was not required in the Loch Raven watershed due to its small size.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Loch Raven watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2001 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table C-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table C-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest
Shrub/Scrub	Open Land

Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table C-2 below and were based on literature and professional judgement.

Table C-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)	0.74	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)	0.74	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation	Imp. (Pervious) values	Imp. (Pervious) values	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.
LD Mixed	2.8 (0.8)	1.21 (0.19)		
MD Mixed	6.2 (0.8)	2.66 (0.30)		
HD Mixed	2.8 (0.8)	2.66 (0.30)		
LD Residential	2.5 (1.3)	1.21 (0.19)		

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table C-3 for the Prettyboy watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table C-3 based on professional judgement.

Table C-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
LD Mixed	15	>5 to <30	0.42	0.08	273
MD Mixed	52	>=30 to <70	1.44	0.18	307
HD Mixed	87	>=70	1.48	0.19	307
LD Residential	15	>5 to <30	0.42	0.08	273

Though this local TMDL was approved in 2007, the baseline year is 1995, which means any retrofitted water quality BMPs installed since 1995 can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated are based on the loading rates from the guidance document (i.e., detention basin retrofits, infiltration, bioretention, etc.) and represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Prettyboy watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.037, 0.036, and 0.094, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program (CBP) as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft)Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

Appendix D
Chesapeake Bay TMDL
Edge-of-Stream
Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Whispering Valley	Retrofit	88.99	20.9	RR	1.76	15.3	319.7700	66%	212.0085	1.69	35.3210	77%	27.3713	0.44	9.1960	83%	7.6459
Small Crossings	Retrofit	26.73	9.07	RR	1.86	15.3	138.7710	67%	92.4176	1.69	15.3283	78%	11.9325	0.44	3.9908	84%	3.3342
Small Crossings	Bio-Retention	1.15	0.51	RR	1.00	15.3	7.8030	60%	4.6623	1.69	0.8619	70%	0.6025	0.44	0.2244	75%	0.1681
Manchester Elementary	Facility	5.16	3.59	RR	2.50	15.3	54.9270	68%	37.1856	1.69	6.0671	79%	4.7816	0.44	1.5796	85%	1.3411
Valley Vista	Facility	27.09	4.73	RR	2.50	15.3	72.3690	68%	48.9938	1.69	7.9937	79%	6.3000	0.44	2.0812	85%	1.7669
Manchester East	Facility	103.98	36.6	RR	2.50	15.3	336.6000	68%	227.8782	1.69	61.8540	79%	48.7483	0.44	16.1040	85%	13.6720
	Total:	**257.81**	**80**				**1000.6200**		**644.2521**		**135.2000**		**102.4883**		**35.2000**		**28.6872**

SWM Facilities Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Whispering Valley	Retrofit	88.99	68.09	RR	1.76	10.8	735.3720	66%	487.5540	0.43	29.2787	77%	22.6889	0.07	4.7663	83%	3.9629
Small Crossings	Retrofit	26.73	17.66	RR	1.86	10.8	190.7280	67%	127.0195	0.43	7.5938	78%	5.9115	0.07	1.2362	84%	1.0328
Small Crossings	Bio-Retention	1.15	0.64	RR	1.00	10.8	6.9120	60%	4.1299	0.43	0.2752	70%	0.1924	0.07	0.0448	75%	0.0336
Manchester Elementary	Facility	5.16	1.57	RR	2.50	10.8	16.9560	68%	11.4792	0.43	0.6751	79%	0.5321	0.07	0.1099	85%	0.0933
Valley Vista	Facility	27.09	22.36	RR	2.50	10.8	241.4880	68%	163.4874	0.43	9.6148	79%	7.5776	0.07	1.5652	85%	1.3288
Manchester East	Facility	103.98	67.38	RR	2.50	10.8	727.7040	68%	492.6556	0.43	28.9734	79%	22.8345	0.07	4.7166	85%	4.0043
	Total:	**257.81**	**177.81**				**1920.3480**		**1238.8662**		**76.4583**		**57.5469**		**12.4467**		**10.0690**

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.53	10.8	5.7240	66	3.7778	0.43	0.2279	77	0.1755	0.07	0.0371	57	0.0211
Planting 3	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 4	0.35	10.8	3.7800	66	2.4948	0.43	0.1505	77	0.1159	0.07	0.0245	57	0.0140
Planting 5	1.95	10.8	21.0600	66	13.8996	0.43	0.8385	77	0.6456	0.07	0.1365	57	0.0778
Charlotte's Quest	0.52	10.8	5.6160	66	3.7066	0.43	0.2236	77	0.1722	0.07	0.0364	57	0.0207
Manchester Streetscapes*	0.41	10.8	4.4280	66	2.9225	0.43	0.1763	77	0.1358	0.07	0.0287	57	0.0164
Planting 6	2.48	10.8	26.7840	66	17.6774	0.43	1.0664	77	0.8211	0.07	0.1736	57	0.0990
Planting 7	1.77	10.8	19.1160	66	12.6166	0.43	0.7611	77	0.5860	0.07	0.1239	57	0.0706
Planting 8	0.38	10.8	4.1040	66	2.7086	0.43	0.1634	77	0.1258	0.07	0.0266	57	0.0152
Planting 9	0.4	10.8	4.3200	66	2.8512	0.43	0.1720	77	0.1324	0.07	0.0280	57	0.0160
Planting 10	0.41	10.8	4.4280	66	2.9225	0.43	0.1763	77	0.1358	0.07	0.0287	57	0.0164
Planting 11	0.5	10.8	5.4000	66	3.5640	0.43	0.2150	77	0.1656	0.07	0.0350	57	0.0200
Planting 12	0.78	10.8	8.4240	66	5.5598	0.43	0.3354	77	0.2583	0.07	0.0546	57	0.0311
Total:	**10.92**		**117.9360**		**77.8378**		**4.6956**		**3.6156**		**0.7644**		**0.4357**

Impervious to Pervious

Location	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load (tons/ac)	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Hampstead	0.42	11.7	4.914	13	0.63882	0.68	0.2856	72	0.205632	0.18	0.0756	84	0.063504
Manchester	0.81	11.7	9.477	13	1.23201	0.68	0.5508	72	0.396576	0.18	0.1458	84	0.122472
		Total:	**14.3910**		**1.8708**		**0.8364**		**0.6022**		**0.2214**		**0.1860**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Hampstead	8.6	3.5	30.100	1.4	12.040	420	3612	1.806
Manchester	0.674	3.5	2.359	1.4	0.944	420	283.08	0.142
		Total:	**32.4590**		**12.9836**		**3,895**	**1.948**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 1995-2008	51.720	1995-2008	11.7	605.1240	30	181.53720	0.68	35.1696	40	14.0678	0.18	9.3096	55	5.1203
Grass Buffer 2009-Current	28.330	2009 -current	11.7	331.4610	30	99.43830	0.68	19.2644	40	7.7058	0.18	5.0994	55	2.8047
	80.050		**Total:**	**936.5850**		**280.97550**		**54.4340**		**21.7736**		**14.4090**		**7.9250**

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 1995-2008	26.630	1995-2008	11.7	311.5710	45	140.2070	0.68	18.1084	40	7.2434	0.18	4.7934	55	2.6364
Forest Buffer 2009-Current	42.850	2009 -current	11.7	501.3450	45	225.6053	0.68	29.1380	40	11.6552	0.18	7.7130	55	4.2422
	69.480		**Total:**	**812.9160**		**243.87480**		**47.2464**		**18.8986**		**12.5064**		**6.8785**

Appendix E

Prettyboy BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2009-2019
0313	Poplar Run	Septic Repair	0	0	0	0	0	0	0	0	0	0	0	0
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0
0314	Georges/Murphy Run	Septic Repair	0	0	0	0	0	0	0	0	0	1	1	2
		New Construction	1	0	0	0	1	0	1	2	0	0	0	5
0315	Grave/Indian Run	Septic Repair	0	0	0	0	0	0	0	0	0	1	0	1
		New Construction	0	0	0	0	0	0	0	0	0	0	0	0
0316	Gunpowder Falls	Septic Repair	2	1	0	0	0	0	0	1	1	1	0	6
		New Construction	0	0	0	0	0	0	2	2	0	0	0	4
0317	South Branch Gunpowder Falls	Septic Repair	2	0	0	0	0	0	0	0	0	0	1	3
		New Construction	0	0	0	0	1	0	0	1	1	0	0	3

Appendix F: Forest Buffer and Grass Buffer Protection Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
South Branch Gunpowder F*	1.169527	1995
South Branch Gunpowder F*	0.559245	1995
South Branch Gunpowder F*	1.947195	1995
South Branch Gunpowder F*	0.135431	1998
Gunpowder Falls	0.991517	1998
Poplar Run	0.621161	1998
Gunpowder Falls	0.554649	1998
South Branch Gunpowder F*	2.76622	2001
Georges/Murphy Run	1.033431	2002
Grave/Indian Run	5.634404	2003
South Branch Gunpowder F*	0.71404	2003
Curren's Manor	0.036296	2005
Grave/Indian Run	0.688705	2005
Curren's Manor	0.091735	2005
St. Bartholomew	0.004195	2006
Georges/Murphy Run	0.778717	2006
St. Bartholomew	0.029532	2006
Charles Sutton Property	0.195811	2006
Grandview Manor	0.011045	2006
Grave/Indian Run	0.8516	2006
Grandview Manor	0.489094	2006
Gunpowder Falls	0.133176	2006
Manchester/Black Farm, L*	0.025535	2007
Bachman Overlook	0.03966	2007
Bachman Overlook	0.000623	2007
South Branch Gunpowder F*	0.056102	2007
Bachman Overlook	0.466702	2007
Bachman Overlook	0.18851	2007
Manchester/Black Farm, L*	1.139326	2007
South Branch Gunpowder F*	5.281481	2007
Leister Park	0.001318	2011
Georges/Murphy Run	1.032505	2011
Leister Park	0.731332	2011
Melrose Crossings, LLC	0.006527	2012
South Branch Gunpowder F*	0.051639	2012

South Branch Gunpowder F*	0.256762	2012
Melrose Crossings, LLC	0.194666	2012
Melrose Crossings, LLC	0.05859	2012
Melrose Crossings, LLC	0.023891	2012
South Branch Gunpowder F*	0.01406	2012
Melrose Crossings, LLC	1.440628	2012
Georges/Murphy Run	0.733467	2013
Manchester Valley High S*	0.484179	2013
Georges/Murphy Run	0.163379	2013
Georges/Murphy Run	4.902243	2013
Manchester Valley High S*	5.793083	2013
Maple Grove Equipment	0.013024	2016
Georges/Murphy Run	0.092961	2016
Maple Grove Equipment	0.719814	2016
Rvr Vly Rnch Ft Rolr	26.13572	2019

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
South Branch Gunpowder F*	4.335589	1995
South Branch Gunpowder F*	0.386138	1997
Grave/Indian Run	3.0813	1998
Gunpowder Falls	0.099094	1998
South Branch Gunpowder F*	1.751483	1998
Poplar Run	2.827458	1998
Georges/Murphy Run	1.306936	2000
South Branch Gunpowder F*	1.140732	2001
Georges/Murphy Run	4.900333	2002
Grave/Indian Run	0.739571	2003
South Branch Gunpowder F*	2.503225	2003
Curren's Manor	0.016768	2005
Grave/Indian Run	1.633285	2005
Curren's Manor	0.498674	2005
Grandview Manor	0.003717	2006
Charles Sutton Property	0.058452	2006
Sterner Estates, Section*	0.033769	2006
Georges/Murphy Run	0.003289	2006
Grave/Indian Run	0.207414	2006
Gunpowder Falls	0.981933	2006
Grandview Manor	0.003431	2006
Hampstead Marketplace	0.80292	2007

Bachman Overlook	0.014458	2007
Bachman Overlook	0.072956	2007
Manchester/Black Farm, L*	0.613905	2007
South Branch Gunpowder F*	4.372568	2007
Bachman Overlook	2.904517	2007
Bachman Overlook	2.891472	2007
South Branch Gunpowder F*	3.739846	2007
South Branch Gunpowder F*	9.793627	2007
Manchester/Black Farm, L*	0.003748	2007
South Branch Gunpowder F*	0.001065	2007
South Branch Gunpowder F*	0.001065	2007
Dug Hill Valley, Amend. *	0.118022	2009
Leister Park	0.842004	2011
Georges/Murphy Run	8.434304	2011
Leister Park	5.632854	2011
Melrose Crossings, LLC	0.144053	2012
Little Roundtop, Section*	0.026712	2012
South Branch Gunpowder F*	0.816036	2012
South Branch Gunpowder F*	0.035447	2012
South Branch Gunpowder F*	0.026708	2012
Melrose Crossings, LLC	1.899701	2012
Little Roundtop, Section*	0.970787	2012
Manchester Valley High S*	0.577021	2013
Manchester Valley High S*	0.678218	2013
Georges/Murphy Run	0.760507	2013
Georges/Murphy Run	2.099519	2013
Georges/Murphy Run	0.653336	2013
Manchester Valley High S*	0.144126	2013
Manchester Valley High S*	1.84261	2013
North Carroll Farms 5	0.257548	2015
North Carroll Farms 5	0.394193	2015
Maple Grove Equipment	0.270222	2016
Georges/Murphy Run	0.336202	2016
Maple Grove Equipment	1.370557	2016

Lower Monocacy River Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Lower Monocacy River watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative best management practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Annual updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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I. Introduction

The Lower Monocacy River watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients in 1996 and again for fecal bacteria in 2002. A Total Maximum Daily Load (TMDL) for bacteria was developed and approved in 2009 with a subsequent TMDL for phosphorus developed and approved in May of 2013 for the Lower Monocacy River watershed.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the Town of Mount Airy, and the Monocacy Scenic River Citizens Advisory Board.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Potomac River and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Lower Monocacy River watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the Stream Corridor Assessment (SCA) that was performed by the BRM and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Lower Monocacy River watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the Rural Legacy Area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the BRM and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; describes the Best Management Practices (BMPs) and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Lower Monocacy River watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

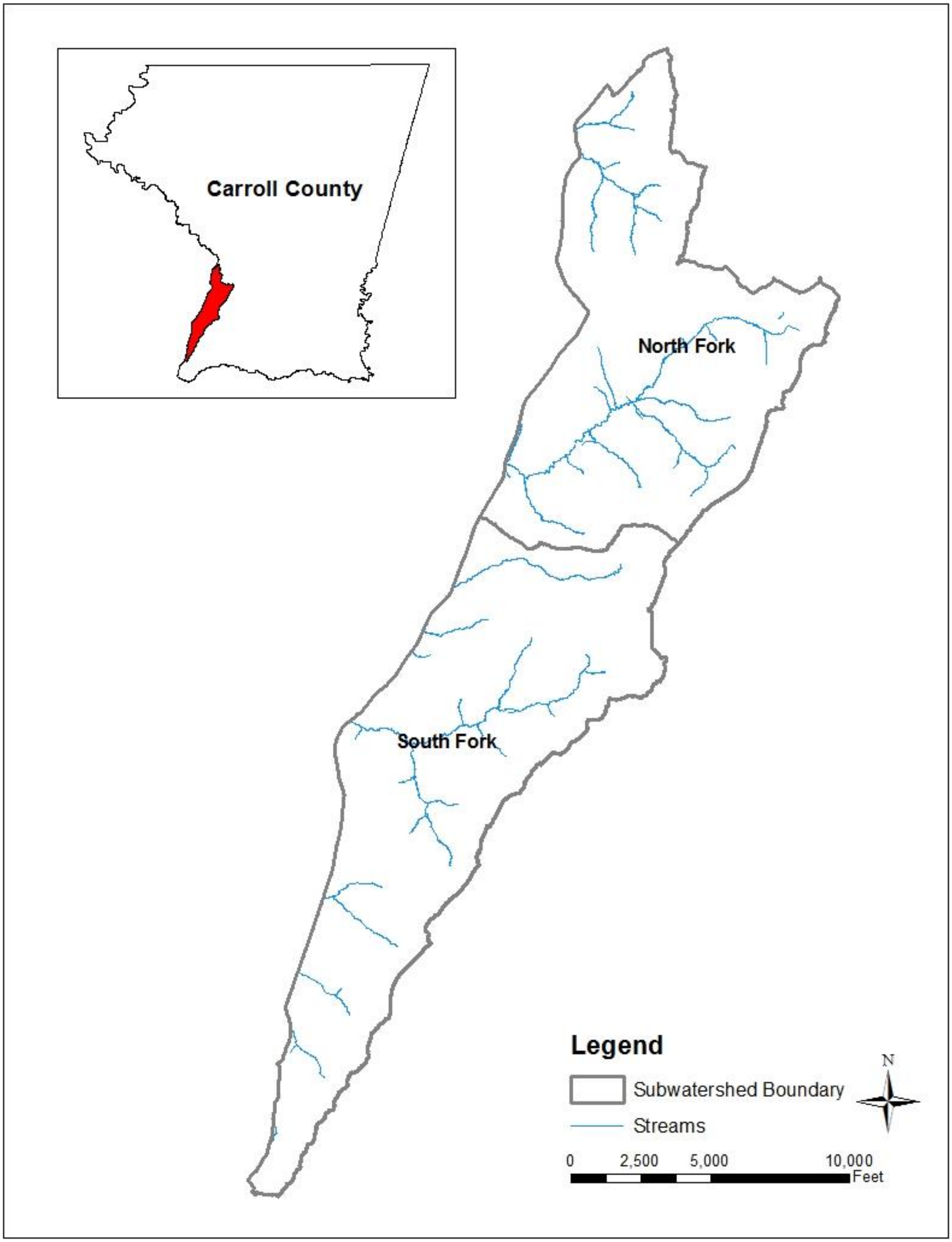

Figure 1: Lower Monocacy River Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Lower Monocacy River Water Quality Standards

The entire portion of the Lower Monocacy River watershed within Carroll County is designated as use IV-P, Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters and Public Water Supply. The use IV-P waters are not capable of growing and propagating trout, but are capable of supporting adult trout for a put-and-take fishery.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQSs). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources, which are referred to as WLAs. Within the Lower Monocacy River watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. Due to the Memorandum of Agreement (MOA) between the County and each of the Municipalities, this restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Lower Monocacy Watershed as determined by the Maryland Department of Environment (MDE) TMDL Data Center is 116,000 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 1,856 billion MPN/year, which is a reduction of 114,144 billion MPN/year (98.4%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Lower Monocacy Watershed.

Table 3: Lower Monocacy River 8-digit Watershed Bacteria TMDL

Lower Monocacy Watershed			Percent Reduction
Jurisdiction	Baseline	TMDL	
Carroll County	116,000	1,856	98.4%
Total	**116,000**	**1,856**	**98.4%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by the MDE TMDL Data Center is 1,155 lbs. /yr., the TMDL for the stormwater WLA was determined to be 806 lbs. /yr., which is a reduction of 349 lbs. /yr. (30%) from the current loading (MDE 2012) (Table 4).

Table 4: Lower Monocacy River 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs./yr)	TMDL (lbs./yr)	Percent Reduction
Carroll County	1,155	806	30%
Total	**1,155**	**806**	**30%**

The TMDLs are based on average annual total phosphorus loads for the simulation period 1991-2000, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions (MDE, 2012). Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease.

II. Background

A. Location and Subwatershed Map

The Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland where it finally empties into the Potomac River. The Upper Monocacy River drains into the Lower Monocacy River which eventually empties into the Middle Potomac River. The Lower Monocacy River watershed is located in the Potomac River Sub-basin, which lies within the Piedmont physiographic province. The Lower Monocacy River watershed is primarily within Frederick County, and small portions of Carroll and Montgomery Counties covering a total of approximately 194,790 acres. The watershed area within Carroll County covers 5,463 acres within two sub-watersheds. Figure 1 depicts the location of the Lower Monocacy River watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Lower Monocacy River watershed, forest is the dominant land cover at about 36 percent of the total land, followed by agriculture which accounts for 34 percent, and residential, which accounts for about 25 percent of the total land cover. Mixed urban uses account for less than 3 percent of the total land cover which represents the relatively rural nature of the Lower Monocacy River watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 accounting for stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 10% increase in low-density residential land cover since 2011, which has been incorporated into Table 5.

Table 5 shows the current land cover data for the Lower Monocacy River watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Lower Monocacy River watershed can be found in Figure 2.

Table 5: Lower Monocacy River Watershed Baseline and Current Land Cover

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Low-Density Residential	896	16%	908	17%	906	17%	1,375	25%
Low-Density Mixed Urban	180	3%	192	4%	191	4%	125	2%
Medium-Density Mixed Urban	24	<1%	37	<1%	38	<1%	30	<1%
High-Density Mixed Urban	3	<1%	4.30	<1%	5	<1%	4	<1%
Barren Land	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Forest	2,004	37%	1,997	37%	1,999	37%	1,971	36%
Shrub/Scrub	51	<1%	50	<1%	49	<1%	27	<1%
Grassland	18	<1%	22	<1%	22	<1%	15	<1%
Pasture/Hay	820	15.0%	815	15%	815	15%	751	14%
Cropland	1,374	25%	1,346	25%	1,346	25%	1,087	20%
Wetland	79	1%	79	1%	75	1%	75	1%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Lower Monocacy River watershed is estimated to have 347 acres of total impervious within the catchment and accounts for approximately 6.3 percent of the total land area. The impervious surface area within Lower Monocacy River watershed, by subwatershed can be found in Table 6 and is shown in Figure 3.

Table 6: Lower Monocacy River Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021403020238	North Fork	2,569.3	117.6	4.6
021403020235	South Fork	2,893.4	229.5	7.9
Lower Monocacy River Watershed		**5,462.7**	**347.1**	**6.3**

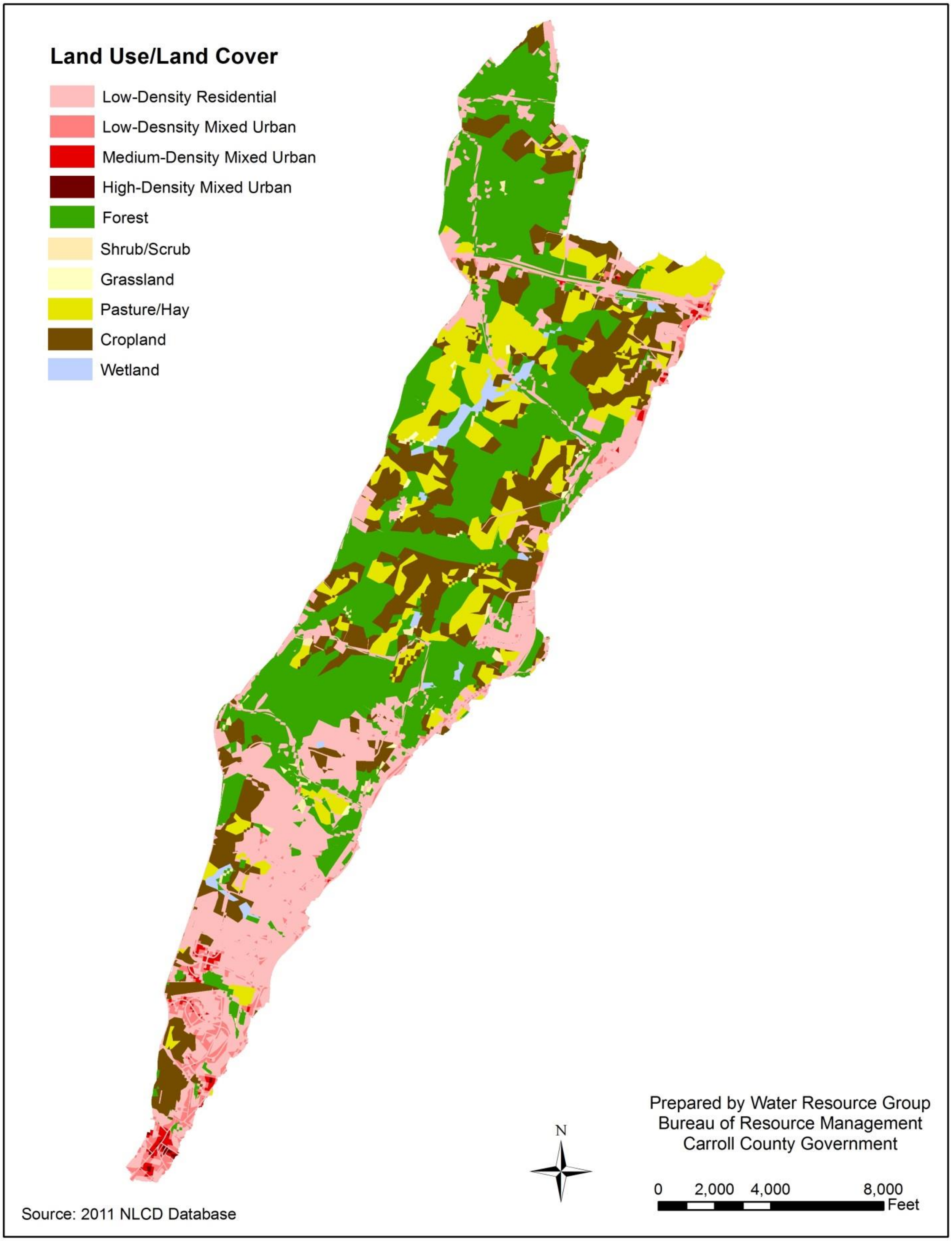

Figure 2: Lower Monocacy River Watershed Land Use/Land Cover from 2011

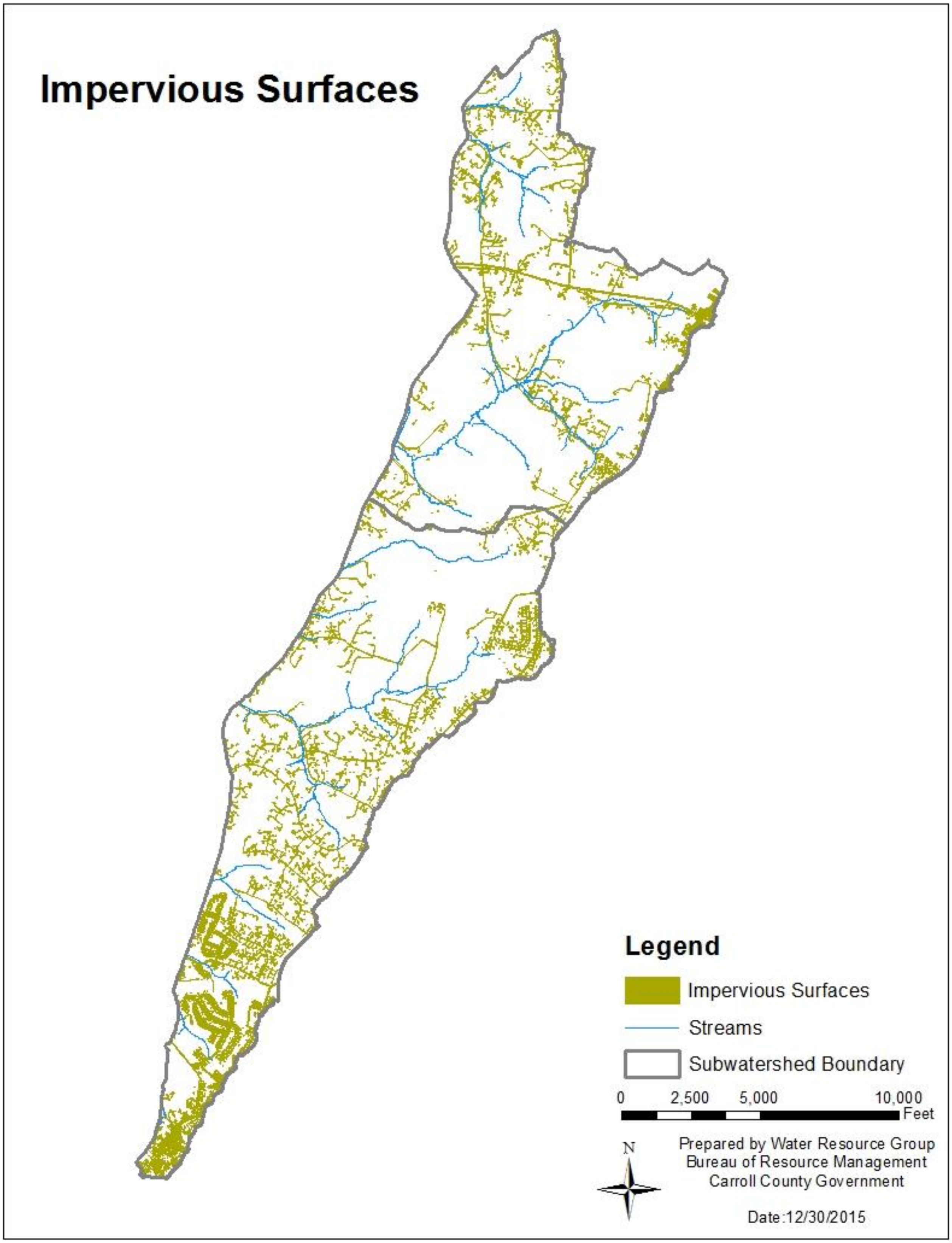

Figure 3: Lower Monocacy River Watershed Impervious Surface Area

C. Watershed Characterization

Following the Lower Monocacy River watershed stream corridor assessment (SCA, completed in 2014, a Watershed Characterization for the Lower Monocacy River watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Lower Monocacy River watershed SCA will be used as the foundation for the watershed restoration and implementation plan. The Lower Monocacy River SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/LowerMonocacy/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/LowerMonocacy/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Lower Monocacy River watershed, there are no listed Tier II waters, though portions of the watershed are part of Tier II catchment basins.

b. Ecologically Sensitive Areas

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. There are approximately 24.5 acres of targeted ecological areas within the Lower Monocacy River watershed, as shown in Figure 4. Targeted ecological areas are a limited number of areas that rank exceptionally high for ecological criteria and that have a practical potential for preservation. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

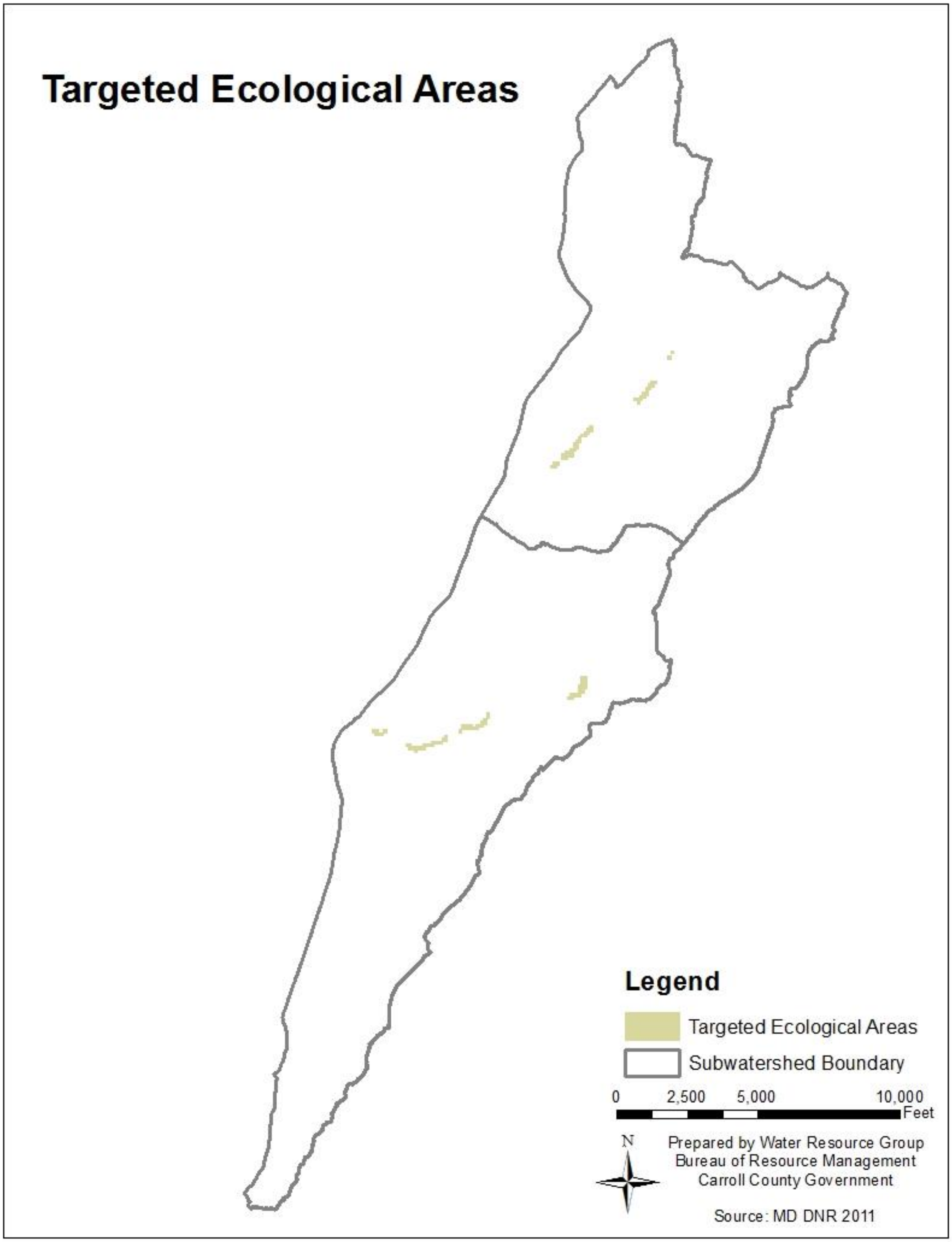

Figure 4: Lower Monocacy River Watershed Targeted Ecological Areas

2. Stream Corridor Assessment

A SCA of the Lower Monocacy River watershed was conducted during the winter of 2014 by Carroll County BRM staff. The Lower Monocacy River SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Lower Monocacy River SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/LowerMonocacy/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along 3,767 linear feet of the corridor, 8.62% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed was in South Fork, which partially originates within the corporate limits of the Town of Mount Airy. Table 7 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear feet of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area being treated and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

All of the proposed stormwater mitigation practices identified in *Section V.* of this report to address the stormwater WLA are focused in the South Fork subwatershed.

Table 7: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
North Fork 021403020238	13.67	3.70	470	2.41%
South Fork 021403020235	10.37	4.58	3,297	13.63%
Total	**24.04**	**8.28**	**3,767**	**8.62%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Lower Monocacy Watershed there are 244 parcels remaining with potential development on 2,078 acres for an estimated lot yield of 420 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 5 shows the remaining parcels in Lower Monocacy Watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

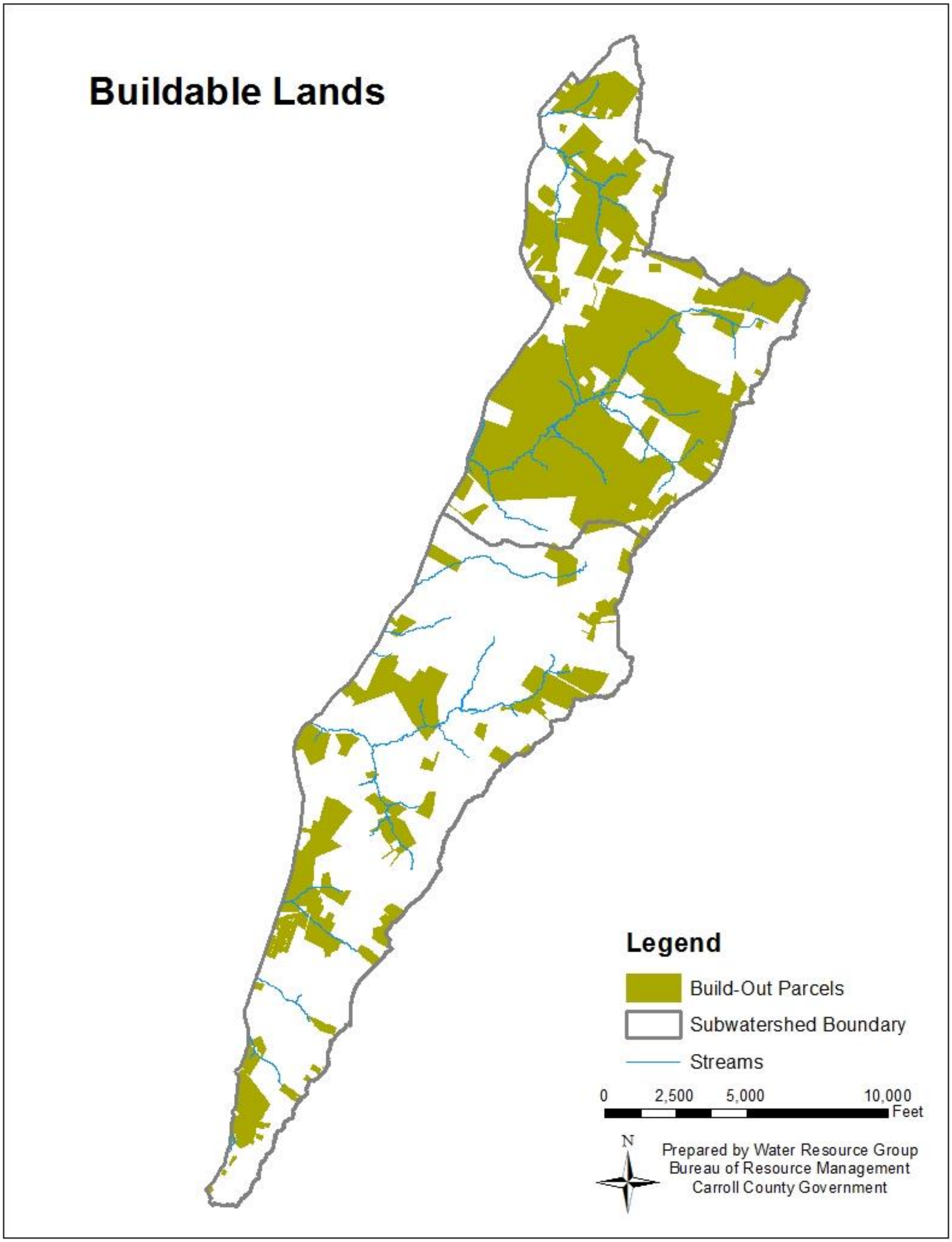

Figure 5: Lower Monocacy River Watershed Build Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Lower Monocacy Watershed there are 0.68 acres of grass buffer and 0.98 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Lower Monocacy Watershed can be found in Appendix B, and are shown in Figure 6. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Lower Monocacy River watershed lies just south of the Little Pipe Creek Rural Legacy area. The Lower Monocacy River watershed does not contain any rural legacy areas. The location of Lower Monocacy River watershed in relation to the Little Pipe Creek Rural Legacy area, and extent of growth area boundaries are shown in Figure 7.

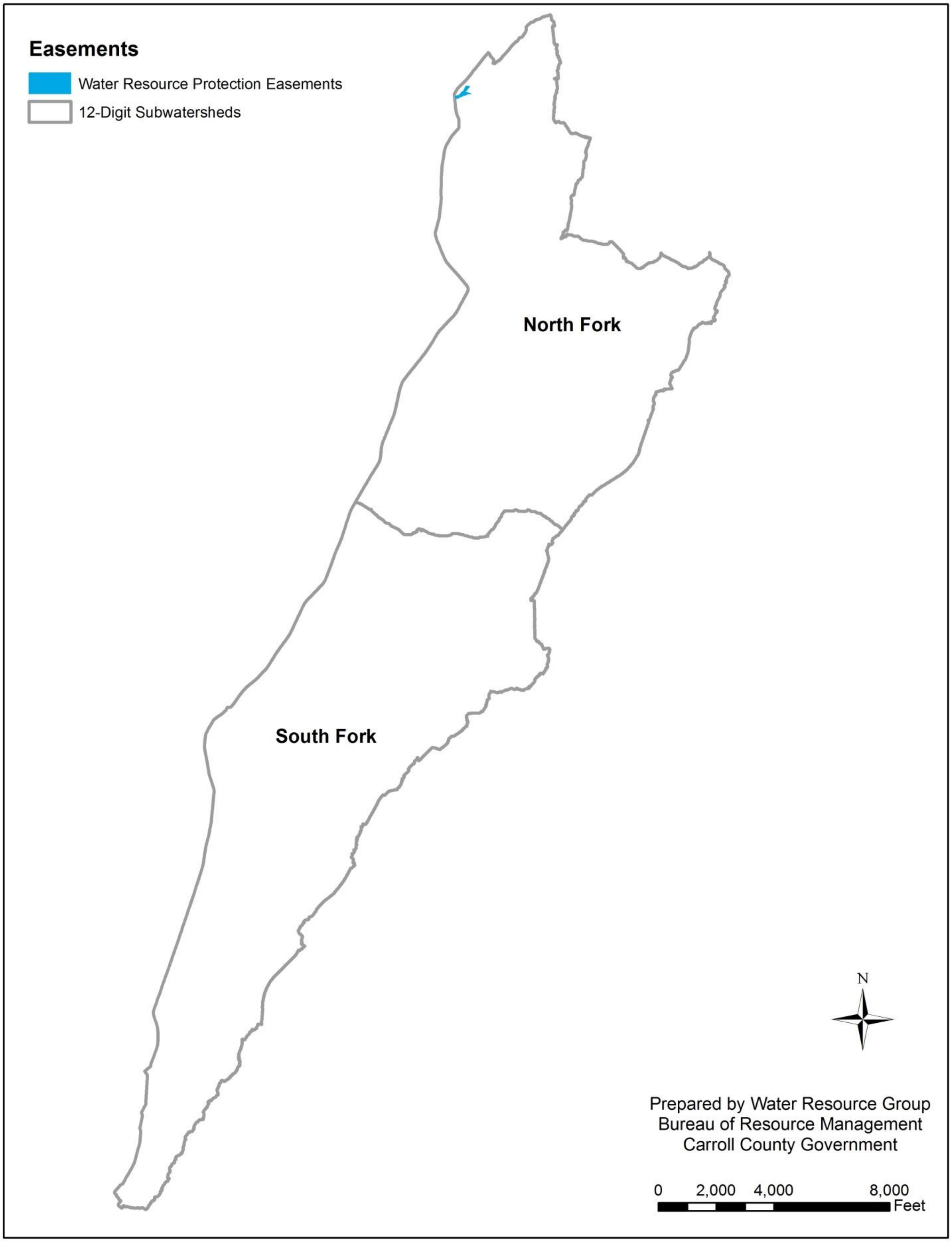

Figure 6: Water Resource Protection Easement Locations

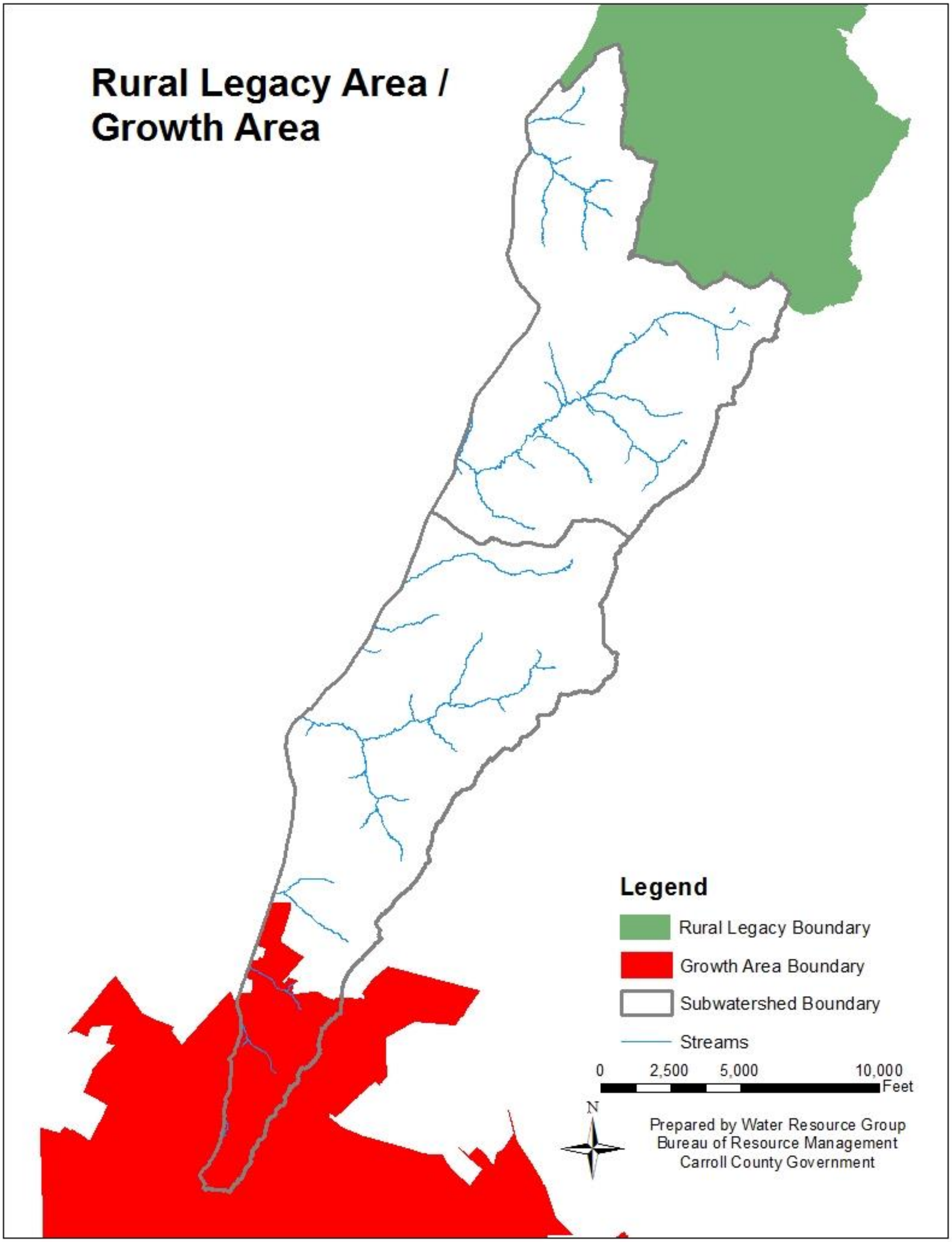

Figure 7: Little Pipe Creek Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a MOA to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issue of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff are continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts. Educational events that County staff has participated in that are either held within the Lower Monocacy River Watershed or offered to citizens countywide can be found in Table 8.

Table 8: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide
Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide

Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Lower Monocacy River watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, MDE released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of ESD practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.), as properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Lower Monocacy River watershed TMDL's are listed in Table 9. The location of each facility can be found in Figure 8, the practice type and runoff depth treated for each facility can be found in Appendix B.

Table 9: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Subwatershed
Candice Estates	35	13	Planned	South Fork 021403020235
Windsong	135	16	Planned	South Fork 021403020235
Totals:	**170.0**	**29.0**		

B. Storm Drain Outfalls

During the Lower Monocacy River watershed SCA in winter 2014, erosion sites were documented and rated on severity. Stream Corridor Assessment identified erosion sites were analyzed in GIS to the location of existing SWM facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. There are no elementary schools in the Lower Monocacy River watershed that have planted rain gardens.

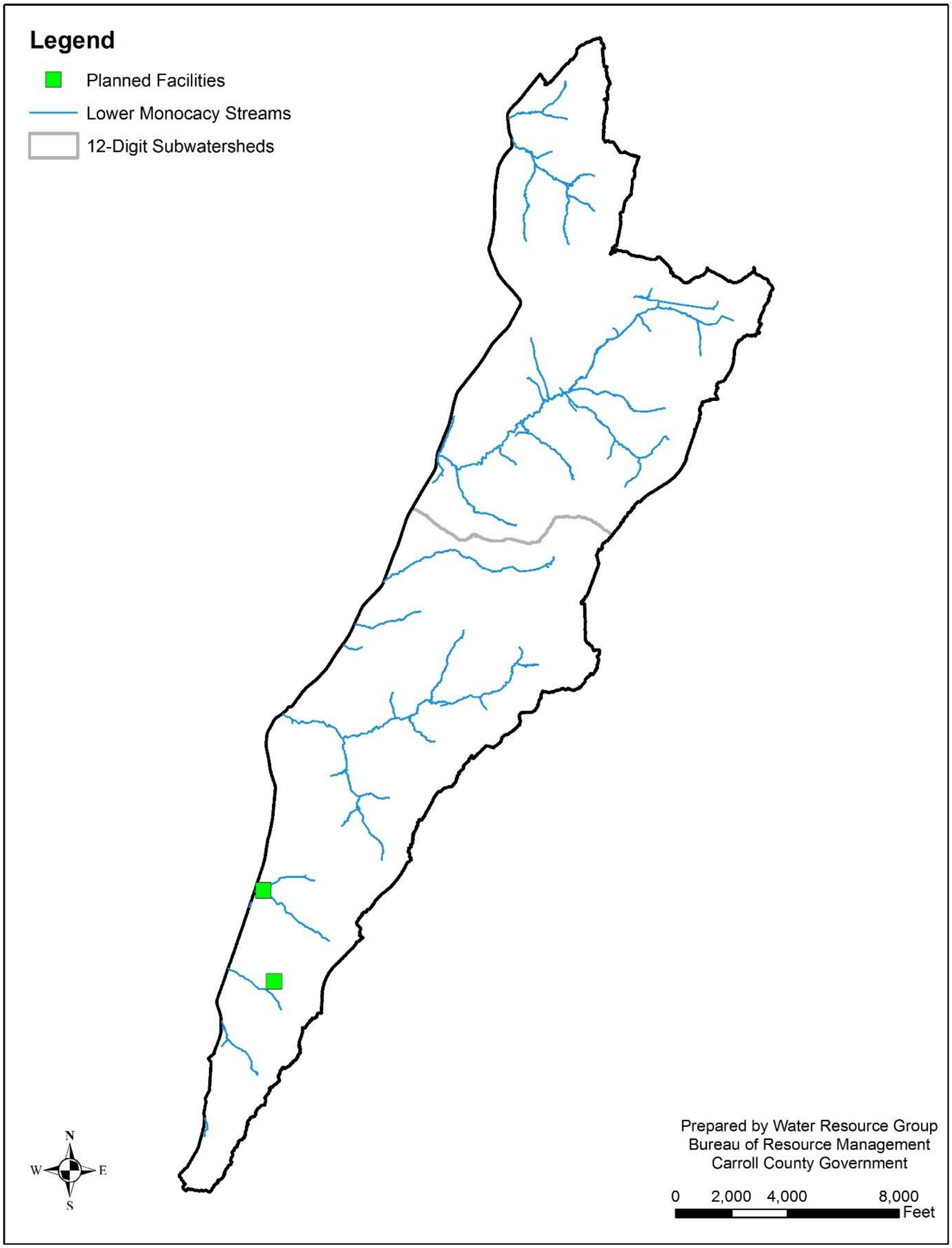

Figure 8: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Two tree planting initiatives were offered to landowners in the Lower Monocacy River watershed. These initiatives were completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

a. Neighborhood Green Program

The BRM assisted Frederick County to plant trees in the Linganore watershed, within the Lower Monocacy River watershed. Frederick County's Office of Sustainability & Environmental Resources received a grant from the National Fish & Wildlife Foundation to work with landowners to improve local water quality in the Linganore watershed through tree plantings. Participation in this stream buffer initiative was completely voluntary. The goal was to convert portions of mowed lawn to more natural areas with native trees and shrubs. Letters were mailed to landowners whose properties were identified as being part of the Linganore watershed. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at reduced cost to the homeowner. Eleven private properties participated in this initiative during 2013. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the buffer plantings are shown in Figure 9.

b. Carroll County Stream Buffer Initiative

Following the completion of the winter 2014 SCA in the Lower Monocacy River watershed, the BRM began a stream buffer initiative. The winter 2014 Lower Monocacy River watershed SCA determined that over 80 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer during the SCA. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. One private property participated in this initiative during the Fall of 2014. The acreage planted for that location and the associated subwatershed can be found in Table 10. The approximate location of the buffer planting is included in Figure 9.

Table 10: Residential Buffer Plantings

	Acres Planted	Buffer Length	Buffer Width	Subwatershed	Date Planted
Planting 1	0.51	120	200	North Fork 021403020238	2013
Planting 2	0.58	170	140	South Fork 021403020235	2013
Planting 3	1.2	220	250	South Fork 021403020235	2014
Planting 4	5.8	730	300	South Fork 021403020235	2013
Planting 5	0.44	140	100	South Fork 021403020235	2013
Planting 6	0.43	230	50	South Fork 021403020235	2013
Planting 7	0.53	200	80	South Fork 021403020235	2013
Planting 8	1.44	300	200	South Fork 021403020235	2013
Planting 9	0.28	140	75	North Fork 021403020238	2013
Planting 10	0.61	160	140	South Fork 021403020235	2013
Planting 11	0.18	70	50	South Fork 021403020235	2013
Planting 12	0.22	100	95	South Fork 021403020235	Fall 2014

c. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be monitored bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

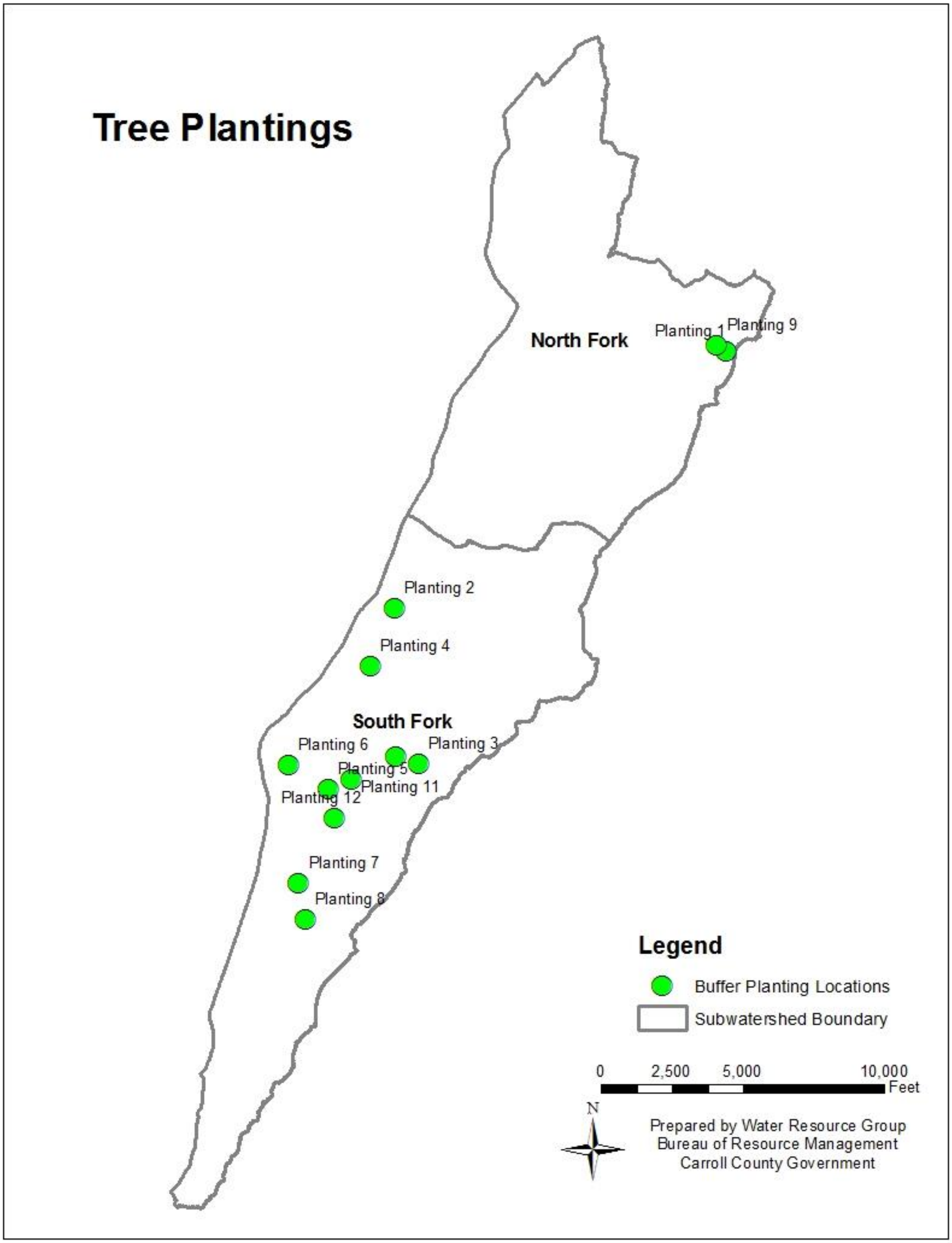

Figure 9: Buffer Planting Locations

E. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Lower Monocacy River watershed, and their associated reduction values are shown in Table 11.

Table 11: Road Maintenance Projects

Management Practice	Inlet Cleaning		
Town/City	Tons Removed	12-Digit Watershed	Date of Completion
Mount Airy	n/a		

F. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2007, five septic systems within the Lower Monocacy River watershed have been built utilizing BAT, and four have been repaired using BRF. Best available technology has been proven to be effective at nitrogen removal but has not been shown to reduce phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Lower Monocacy River watershed are listed in Table 12.

Table 12: Septic Systems

Project Type	Subwatershed	Best Available Technology	Bay Restoration Funding	Completion Date
New Construction	021403020238	True	False	4/25/2014
New Construction	021403020235	True	False	2/24/2015
Repair	021403020238	True	True	11/16/2015
New Construction	021403020235	True	False	09/28/2015
Repair	021403020235	True	True	04/07/2015
Repair	021403020238	True	True	6/24/2016
Repair	021403020235	True	True	5/31/2016
New Construction	021403020238	True	False	1/13/2017
New Construction	021403020238	True	False	7/21/2016

G. Agricultural Best Management Practices

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allow for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

H. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has identified the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix B provides the associated reduction values.

I. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

J. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix C.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Lower Monocacy watershed. As described in Section I, phosphorus and bacteria loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDL suggests an urban phosphorus load reduction of 30% from the baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Lower Monocacy). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reduction of 30% of the baseline year. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the TMDL, as land cover data from 2011 was the closest available for that time period. The modeled 2011 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2011 was used as the baseline proxy year. For reference, the modeled baseline urban P load using the 2011 land cover was 180.66 lbs, which equates to a 30% reduction of 54.20 lbs (Table 13).

The projects completed as of December 2019 are providing 0.96 pounds of TP reduction, the planned projects within the current CIP will provide another 12.76 pounds of TP reduction. These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figure 10. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Lower Monocacy TMDL. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, MDE does not currently provide guidance on bacteria reduction efficiencies.

Table 13: Total Phosphorus Load Reduction in the Lower Monocacy Watershed (lbs/year) in Carroll County

Modeled Baseline Load (lbs)	% Required Reduction from TMDL	Required Load Reduction based on Modeled Baseline (lbs)	Reduction from Current BMPs (lbs)	Reduction from Restoration Plan Strategies (lbs)	Total % Reduction Achieved
180.66	30%	54.20	0.96	12.76	8%

Table 14: Comparison of Total Phosphorus delivered Load Reductions (lbs/year) by Restoration Strategies. This table includes both proposed and existing BMPs.

Status	Pond Retrofits (lbs)	Buffers (lbs)	Catch Basin/ Inlet Cleaning (lbs)	Water Resource Easements (lbs)
Completed		0.90	0.00	0.06
Planned	12.76			

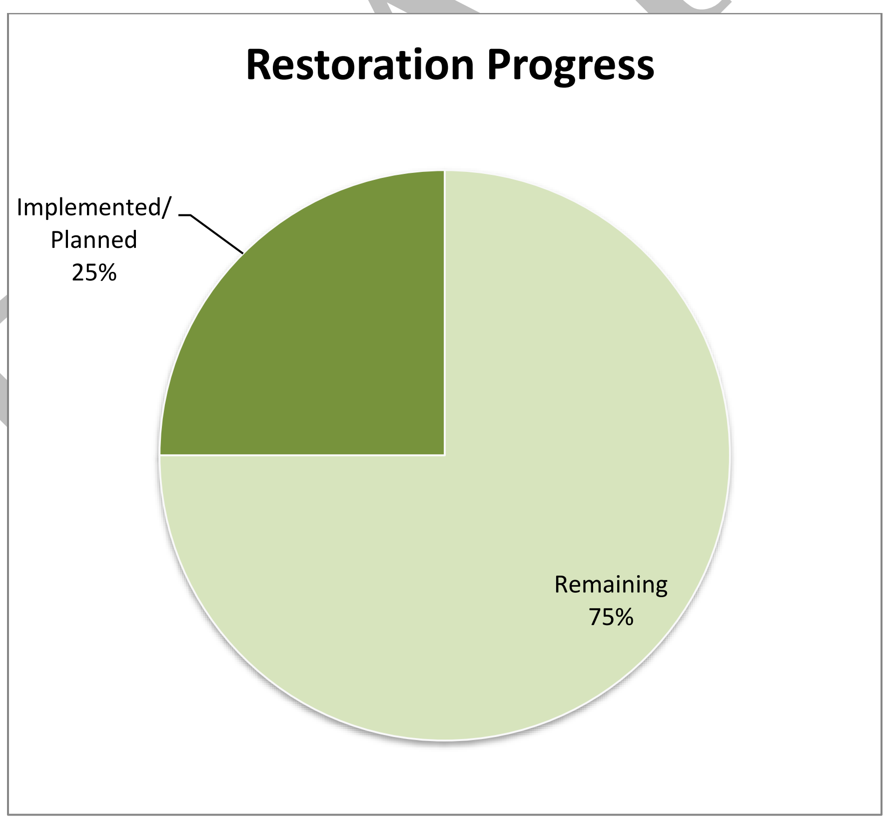

Figure 10: 2019 Restoration Progress Phosphorus

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Lower Monocacy Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

Table 15 lists infrastructure related measures that have been implemented since the 2004 baseline year that would assist in reducing bacteria counts within the watershed.

Table 15: Waste Collection Infrastructure Upgrades

	County	Mount Airy
BAT Upgrades	**9**	**0***
Casings/Linings	n/a	TBD
Lateral line replacements	n/a	TBD
Pump Station upgrade	n/a	TBD

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County’s MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

K. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

1. Retrofit Monitoring

The BRM has considered adding one location within the Lower Monocacy River watershed to our retrofit monitoring program. The Candice Estates site, shown in Figure 11 is located within the South Fork (0235) subwatershed.

Currently there are no stormwater controls to this location; a developer is in the planning phase for a project at this site that will consist of a surface sand filter. The Candice Estates location is primarily low-density residential, which encompasses 79% of the land cover. The drainage area to the monitoring site is approximately 39 acres, of which, 13 acres or 33% is impervious.

Bi-weekly monitoring at the Candice Estates site would consist of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Candice Estates site can be found in Table 16. Additional monitoring at this location will include spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 16: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. The County is currently exploring locations within the Lower Monocacy Watershed to include within the countywide bacteria trend monitoring program.

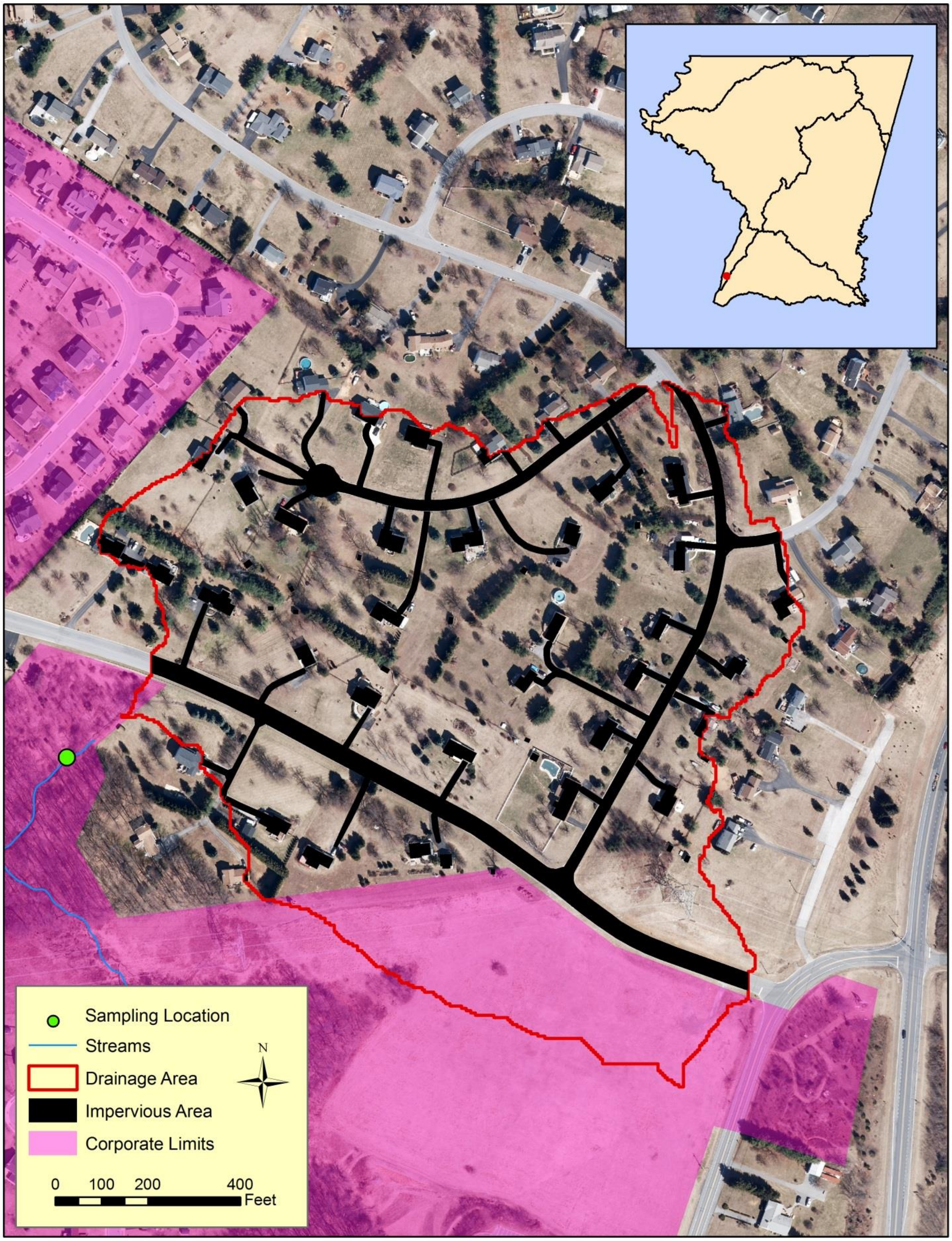

Figure 11: Candice Estates Monitoring Location

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 18). Best management practices and restoration projects that have been either completed or proposed to address local TMDL's within the Lower Monocacy River watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 17, and the tidal water designated use zones are shown in Figure 12.

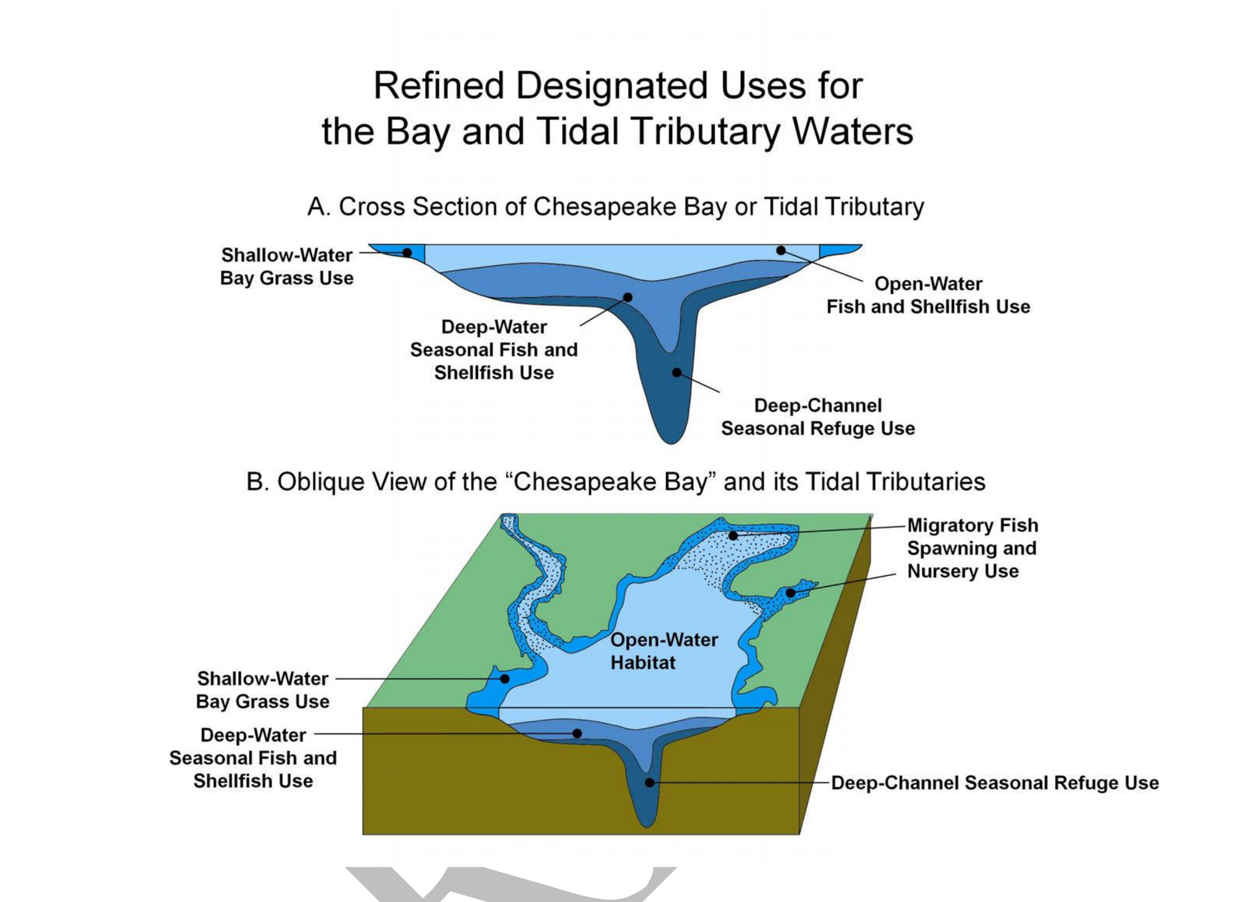

Figure 12: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 17: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Lower Monocacy River watershed is located within the Potomac River Basin of the Chesapeake Bay. Within Maryland, the Potomac River Basin covers 1,539,973 acres across eight counties. Approximately 137,878 acres (9%) of the Potomac River Basin located in Maryland is within Carroll County, 4% of which is located in Lower Monocacy River watershed. The location of the Potomac River Basin segment is shown in Figure 13.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix D) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 18. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Potomac River Basin river segment within the Lower Monocacy River watershed are; 0.37 for nitrogen, 0.47 for phosphorus, and 0.65 for TSS. (MAST, 2016). Essentially, if one pound of nitrogen is discharged into a tributary within the Lower Monocacy River portion of the Potomac River Basin river segment, only 37% of that pound is reaching the Bay.

Table 19 shows the Chesapeake Bay TMDL for the Potomac land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Lower Monocacy Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Lower Monocacy Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Potomac segment shed. The Lower Monocacy Watershed covers approximately 4% of the Potomac land-river segment within Carroll County.

Table 18: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Lower Monocacy Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
10,100.99	22.07%	2,228.95	2.11	31.83	1.5%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
110,661.46	9.25%	10,232.26	35.02	307.19	3.34%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Potomac land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Lower Monocacy watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 19: Carroll County Potomac River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	Total Phosphorus (TP)[3]			Total Nitrogen (TN)		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Lower Monocacy Watershed	2.11	31.83	1.5%	35.02	307.19	3.34%
Upper Monocacy Watershed	69.73	57.11	5.69%	473.39	469.79	9.22%
Double Pipe Creek Watershed	152.95	266.16	18.80%	855.30	593.77	14.16%
Total	**224.79**	**355.10**	**25.99%**	**1,363.71**	**1,370.75**	**26.72%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

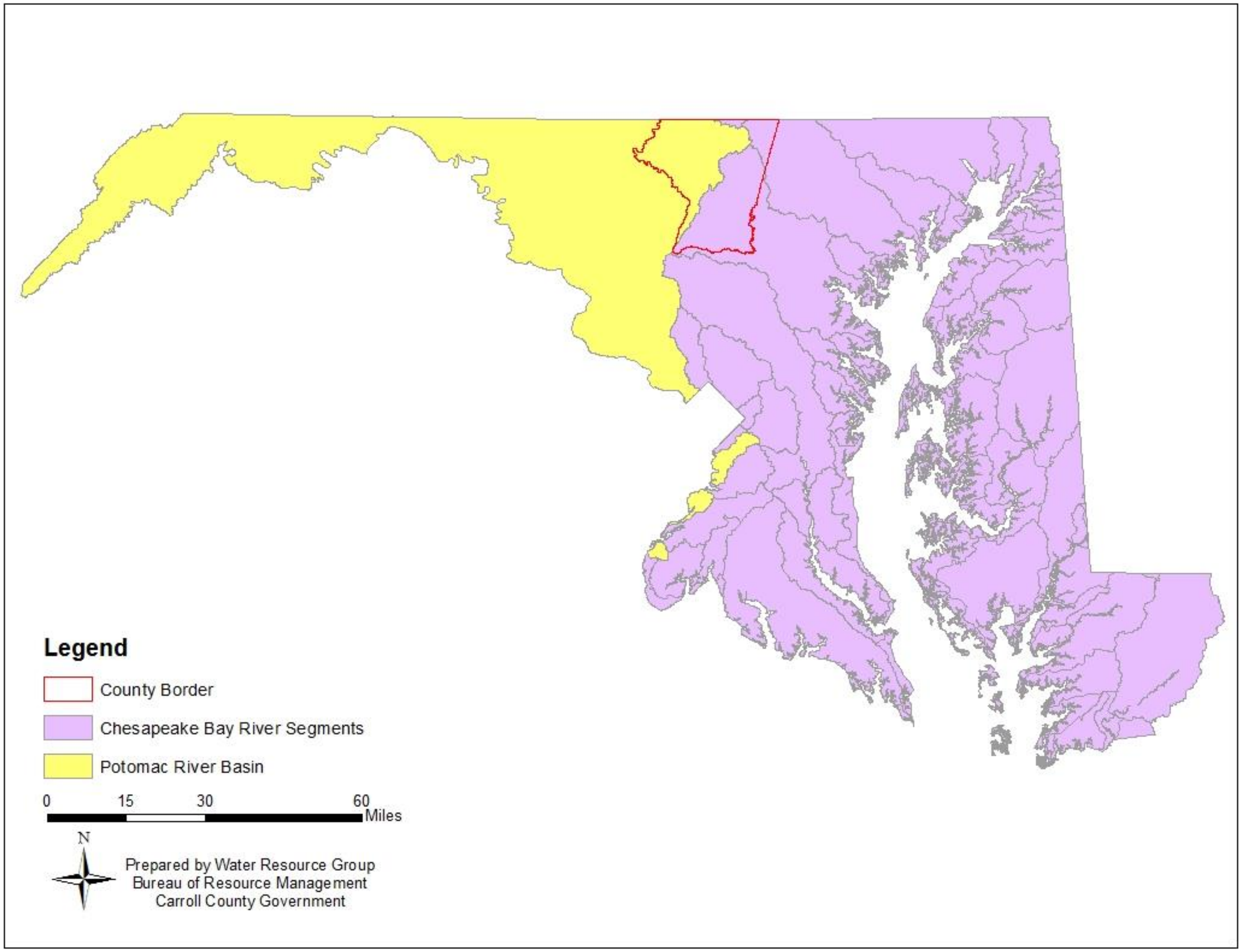

Figure 13: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 2% of the required reduction since the baseline year of 2009. Based on currently identified projects, the required reduction is expected to achieve 25% by 2025. The implementation from baseline through the current CIP is achieving approximately 1.56% reduction in the TMDL/year since the baseline.

If the County is able to achieve a 2.25% reduction rate per year until the phosphorus TMDL is fully implemented, the phosphorus TMDL in the Lower Monocacy Watershed would be achieved by 2058. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 20 lists the anticipated benchmark for each nutrient TMDL within the Lower Monocacy Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 20: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2058
Phosphorus	2%	25%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Lower Monocacy Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost*	Anticipated Completion
SWM (Completed)	County	2140302	Completed	$0	Completed
Buffer Plantings	County	2140302	Completed	$21,025	Completed
Roads: Street/Inlet Cleaning	Manchester	2140302	Annual	**	Annual
Water/floodplain Easement	County	2140302	Completed	N/A	Completed
SWM (Planned)	County	2140302	Planning/Design	$850,000	FY19-FY25
TBD	Watershed	2140302	Planning	$2,613,000	TBD

***Costs for proposed Stormwater facilities are based on current FY19-FY25 project costs, which may be subject to change.**

****Project Costs not reported.**

XIII. Appendix B: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

SWM Facilities (Pond Retrofits)

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Candice Estates	Retrofit	35	13	RR	2.50	3.7779%	68%	38.48	3.1532%	79%	5.70	1.7401%	85%	5.73
IDA Property	Facility	75.5	10.5	RR	2.50	2.6472%	68%	26.96	3.1375%	79%	5.67	3.4341%	85%	11.31
Windermere/Windsong	Facility	135	16	ST	1.00	2.4436%	35%	24.89	3.9094%	55%	7.06	5.0706%	70%	16.69
	Total:	**245.5**	**39.5**			**8.8687%**		**90.33**	**10.2001%**		**18.43**	**10.2447%**		**33.73**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 2009-Current	0.680	2009 -current	0.011%	30	0.11	0.014%	40	0.03	0.020%	55	0.07
		Total:	**0.011%**		**0.26**	**0.014%**		**0.03**	**0.020%**		**0.07**

Forest Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 2009-Current	0.980	2009 -current	0.023%	45	0.23	0.021%	40	0.04	0.029%	55	0.10
		Total:	**0.023%**		**0.23**	**0.021%**		**0.04**	**0.029%**		**0.10**

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.51	0.017%	66	0.18	0.021%	77	0.04	0.016%	57	0.05
Planting 2	0.58	0.020%	66	0.20	0.024%	77	0.04	0.018%	57	0.06
Planting 3	1.2	0.041%	66	0.42	0.049%	77	0.09	0.037%	57	0.12
Planting 4	5.8	0.198%	66	2.02	0.235%	77	0.43	0.178%	57	0.58
Planting 5	0.44	0.015%	66	0.15	0.018%	77	0.03	0.013%	57	0.04
Planting 6	0.43	0.015%	66	0.15	0.017%	77	0.03	0.013%	57	0.04
Planting 7	0.53	0.018%	66	0.18	0.022%	77	0.04	0.016%	57	0.05
Planting 8	1.44	0.049%	66	0.50	0.058%	77	0.11	0.044%	57	0.15
Planting 9	0.28	0.010%	66	0.10	0.011%	77	0.02	0.009%	57	0.03
Planting 10	0.61	0.021%	66	0.21	0.025%	77	0.04	0.019%	57	0.06
Planting 11	0.18	0.006%	66	0.06	0.007%	77	0.01	0.006%	57	0.02
Planting 12	0.22	0.008%	66	0.08	0.009%	77	0.02	0.007%	57	0.02
Total:	**12.22**	**0.418%**		**4.25**	**0.496%**		**0.90**	**0.374%**		**1.23**

XIV. Appendix C: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks. This was not required in the Lower Monocacy watershed due to its small size.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Lower Monocacy watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table C-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table C-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest

Shrub/Scrub	Open Land
Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table C-2, and were based on literature and professional judgement.

Table C-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.61	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.59	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation	Imp. (Pervious) values	Imp. (Pervious) values	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.
LD Mixed	2.8 (0.8)	1.21 (0.19)		
MD Mixed	6.2 (0.8)	2.66 (0.30)		
HD Mixed	2.8 (0.8)	2.66 (0.30)		
LD Residential	2.5 (1.3)	1.21 (0.19)		

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was area weighted using pasture/hay or cropland area of the subcatchments of this watershed.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following

MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table C-3 for the Lower Monocacy watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table C-3 based on professional judgement.

Table C-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
LD Mixed	15	>5 to <30	0.53	0.10	353.83
MD Mixed	52	>=30 to <70	1.62	0.21	386.75
HD Mixed	87	>=70	1.66	0.21	389.73
LD Residential	15	>5 to <30	0.53	0.10	353.77

The baseline year for this TMDL is 2009, which means any retrofitted water quality BMPs installed since 2009 can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table C-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Lower Monocacy watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.042, 0.041, and 0.093, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious)

XV. Appendix D: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Candice Estates	Retrofit	35	13	RR	2.50	15.3	198.9000	68%	134.6553	1.69	21.9700	79%	17.3150	0.44	5.7200	85%	4.8562
IDA Property	Facility	75.5	10.5	RR	2.50	15.3	160.6500	68%	108.7601	1.69	17.7450	79%	13.9852	0.44	4.6200	85%	3.9223
Windermere/ Windsong	Facility	135	16	ST	1.00	15.3	244.8000	35%	85.5576	1.69	27.0400	55%	14.8504	0.44	7.0400	70%	4.9210
	Total:	**245.5**	**39.5**				**604.35**		**328.97295**		**66.755**		**46.15050416**		**17.38**		**13.69942613**

SWM Facilities

Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Candice Estates	Retrofit	35	22	RR	2.50	10.8	237.6000	68%	160.8552	0.43	9.4600	79%	7.4556	0.07	1.5400	85%	1.3074
IDA Property	Facility	75.5	65	RR	2.50	10.8	702.0000	68%	475.2540	0.43	27.9500	79%	22.0279	0.07	4.5500	85%	3.8629
Windermere/ Windsong	Facility	135	119	ST	1.00	10.8	1285.2000	35%	449.1774	0.43	51.1700	55%	28.1026	0.07	8.3300	70%	5.8227
	Total:	**245.5**	**206**				**2224.8**		**1085.2866**		**88.58**		**57.58608644**		**14.42**		**10.99296581**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Grass Buffer 2009-Current	0.680	2009 -current	11.7	7.9560	30	2.38680	0.68	0.4624	40	0.1850	0.18	0.1224	55
	0.680		**Total:**	**7.9560**		**2.38680**		**0.4624**		**0.1850**		**0.1224**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Forest Buffer 2009-Current	0.980	2009 -current	11.7	11.4660	45	5.1597	0.68	0.6664	40	0.2666	0.18	0.1764	55
	0.980		**Total:**	**11.4660**		**5.15970**		**0.6664**		**0.2666**		**0.1764**	

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	0.51	10.8	5.5080	66	3.6353	0.43	0.2193	77	0.1689	0.07	0.0357	57	0.0203
Planting 2	0.58	10.8	6.2640	66	4.1342	0.43	0.2494	77	0.1920	0.07	0.0406	57	0.0231
Planting 3	1.2	10.8	12.9600	66	8.5536	0.43	0.5160	77	0.3973	0.07	0.0840	57	0.0479
Planting 4	5.8	10.8	62.6400	66	41.3424	0.43	2.4940	77	1.9204	0.07	0.4060	57	0.2314
Planting 5	0.44	10.8	4.7520	66	3.1363	0.43	0.1892	77	0.1457	0.07	0.0308	57	0.0176
Planting 6	0.43	10.8	4.6440	66	3.0650	0.43	0.1849	77	0.1424	0.07	0.0301	57	0.0172
Planting 7	0.53	10.8	5.7240	66	3.7778	0.43	0.2279	77	0.1755	0.07	0.0371	57	0.0211
Planting 8	1.44	10.8	15.5520	66	10.2643	0.43	0.6192	77	0.4768	0.07	0.1008	57	0.0575

Planting 9	0.28	10.8	3.0240	66	1.9958	0.43	0.1204	77	0.0927	0.07	0.0196	57	0.0112
Planting 10	0.61	10.8	6.5880	66	4.3481	0.43	0.2623	77	0.2020	0.07	0.0427	57	0.0243
Planting 11	0.18	10.8	1.9440	66	1.2830	0.43	0.0774	77	0.0596	0.07	0.0126	57	0.0072
Planting 12	0.22	10.8	2.3760	66	1.5682	0.43	0.0946	77	0.0728	0.07	0.0154	57	0.0088
Total:	**12.22**		**131.9760**		**87.1042**		**5.2546**		**4.0460**		**0.8554**		**0.4876**

XVI. Appendix E: Forest Buffer and Grass Buffer Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
North Fork	0.787905	2012
North Fork	0.189594	2012

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
North Fork	0.681419	2012

Upper Monocacy River Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local total maximum daily load (TMDL) requirements associated with the urban wasteload allocation (WLA) for Upper Monocacy River watershed within Carroll County, Maryland. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative best management practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Annual updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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Upper Monocacy River Watershed Restoration Plan

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I. Introduction

The Upper Monocacy River watershed (Figure 1) was placed on Maryland's 303(d) list of impaired waters for nutrients and sediments in 1996 and again for fecal bacteria in 2002. A Total Maximum Daily Load (TMDL) for Total Suspended Sediments (TSS) and bacteria were developed and approved in December of 2009 with a subsequent TMDL for phosphorus developed and approved in May of 2013 for the Upper Monocacy River watershed.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA). Additional stakeholders in this planning process include the City of Taneytown, and the Monocacy Scenic River Citizens Advisory Board.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. In addition, restoration goals include the protection of source water for the Potomac River and ecologically sensitive and threatened species. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the Upper Monocacy River watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the Stream Corridor Assessment (SCA) that was performed by the BRM and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Upper Monocacy River watershed.

Section III: New Development; this section will discuss the Water Resource Ordinance, Chapter 154 of the County code, and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the rural legacy area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the BRM and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; describes the Best Management Practices (BMPs) and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Upper Monocacy River watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed, as discussed in Section V, will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

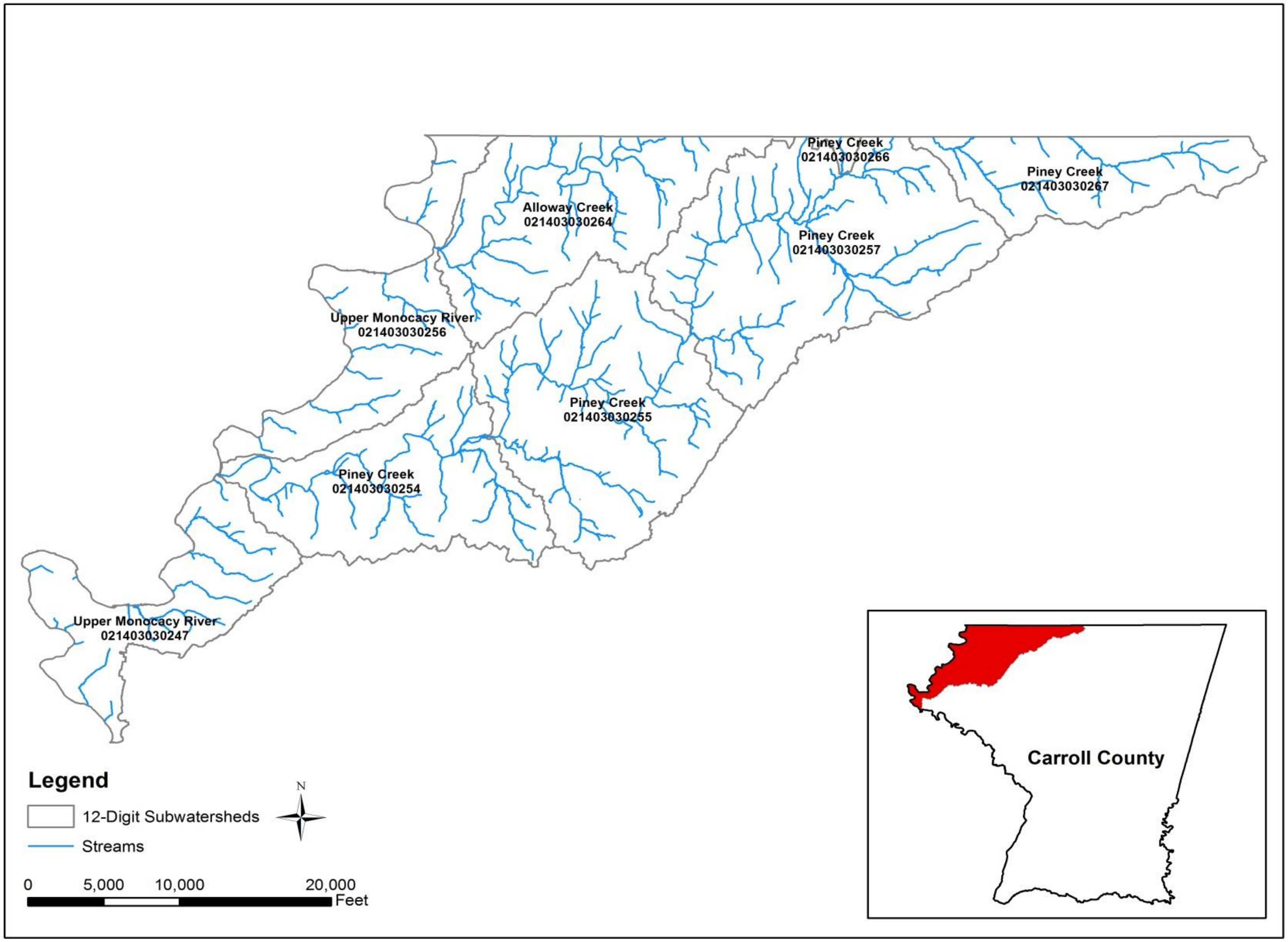

Figure 1: Upper Monocacy River Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. Upper Monocacy River Water Quality Standards

The entire portion of the Upper Monocacy River watershed within Carroll County is designated as use IV-P, Water Contact Recreation, Protection of Aquatic Life, Recreational Trout Waters and Public Water Supply. The use IV-P waters are not capable of growing and propagating trout, but are capable of supporting adult trout for a put-and-take fishery.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQSs). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources, which are referred to as WLAs. Within the Upper Monocacy River watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. Due to the Memorandum of Agreement (MOA) between the County and each of the Municipalities, this restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Bacteria

The current estimated stormwater baseline load for bacteria within the Carroll County portion of Upper Monocacy Watershed as determined by the Maryland Department of Environment (MDE) TMDL data center is 432,969 billion MPN/year (MPN, or most probable number is a technique used to estimate microbial populations). The TMDL to meet the watersheds designated use was determined by MDE to be 13,855 billion MPN/year, which is a reduction of 419,114 billion MPN/year (96.8%) from the current estimated loading.

These maximum practicable reduction targets are based on the available literature and best professional judgment. There is much uncertainty with estimated reductions from BMPs. In certain watersheds, the goal of meeting water quality standards may require very high reductions that are not achievable with current technologies and management practices (MDE, 2009). Table 3 outlines the bacteria baseline and TMDL for the Carroll County portion of the Upper Monocacy Watershed.

Table 3: Upper Monocacy River 8-digit Watershed Bacteria TMDL

Upper Monocacy Watershed			Percent Reduction
Jurisdiction	Baseline (Billion MPN/yr)	TMDL (Billion MPN/yr)	
Carroll County	432,969	13,855	96.8%
Total	**432,969**	**13,855**	**96.8%**

b. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by the MDE TMDL Data Center is 1,427 lbs. /yr., the TMDL for the stormwater WLA was determined to be 1,353 lbs. /yr., which is a reduction of 74 lbs. /yr. (5%) from the current loading (MDE 2012) (Table 4). This stormwater WLA includes all Carroll County jurisdictional MS4s.

Table 4: Upper Monocacy River 8-digit Watershed Phosphorus TMDL

Jurisdiction	Baseline (lbs./yr)	TMDL (lbs./yr)	Percent Reduction
Carroll County	1,427	1,353	5%
Total	**1,427**	**1,353**	**5%**

The TMDLs are based on average annual total phosphorus loads for the simulation period 1991-2000, which includes both wet and dry years, and thus takes into account a variety of hydrological conditions. Phosphorus remains as the only nutrient TMDL within the watershed and has been determined by MDE to be the limiting nutrient. If phosphorus is used up or removed, excess algal growth within the system will cease (MDE, 2012).

c. Total Suspended Sediments

The current estimated stormwater baseline load for the Carroll County segments of the Upper Monocacy River watershed as determined by the MDE TMDL Data Center is 657.9 ton /yr., the TMDL for the stormwater WLA was determined to be 371.5 ton /yr., which is a reduction of 286.4 ton /yr. (44%) from the current loading (MDE 2009) (Table 5).

Table 5: Upper Monocacy River 8-digit Watershed TSS TMDL

Jurisdiction	Baseline (Tons/yr)	TMDL (Tons/yr)	Percent Reduction
Carroll County	657.9	371.5	44%
Total	**657.9**	**371.5**	**44%**

In Maryland there are no specific numeric criteria that quantify the impact of sediment on the aquatic health of non-tidal stream systems. The threshold used to determine watershed specific sediment TMDL is the sediment loading threshold from a reference waters based on Maryland's bio-criteria (MDE, 2009).

II. Background

A. Location and Subwatershed Map

The Upper Monocacy River watershed is located in the Potomac River Sub-basin in Frederick and Carroll Counties, Maryland, which lies within the Piedmont physiographic province. The Upper Monocacy River is a free-flowing stream that originates in Pennsylvania and flows 58 miles within Maryland where it finally empties into the Potomac River. The watershed area within Carroll County covers 27,123 acres within eight sub-watersheds. Figure 1 depicts the location of the Upper Monocacy River watershed and its subwatersheds.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream. Within the Upper Monocacy River watershed, agriculture is the dominant land cover at about 69 percent of the total land, followed by forest which accounts for about 17 percent, and residential, which accounts for about 9 percent of the total land cover. Mixed urban uses account for less than 3 percent of the total land cover which represents the relatively rural nature of the Upper Monocacy River watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 Accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 5% increase in low-density residential land cover since 2011, which has been incorporated into Table 6.

Table 6 shows the current land cover data for the Upper Monocacy River watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the Upper Monocacy River watershed can be found in Figure 2.

Table 6: Upper Monocacy River Watershed Baseline and Current Land Cover

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	164	<1%	162	<1%	162	<1%	161	<1%
Low-Density Residential	1,492	5.5%	1,471	5.4%	1,474	5.4%	2,323	8.6%
Low-Density Mixed Urban	671	2.5%	663	2.4%	661	2.4%	661	2.4%
Medium-Density Mixed Urban	105	<1%	139	<1%	151	<1%	151	<1%
High-Density Mixed Urban	14	<1%	23	<1%	28	<1%	28	<1%
Barren Land	8	<1%	8	<1%	8	<1%	8	<1%
Forest	4,559	17%	4,548	17%	4,533	16.7%	4,489	16.6%
Shrub/Scrub	39	<1%	39	<1%	39	<1%	36	<1%
Grassland	22	<1%	26	<1%	22	<1%	22	<1%
Pasture/Hay	6,620	24%	6,816	25%	6,838	25%	6,581	24.3%
Cropland	12,953	48%	12,749	47%	12,732	47%	12,195	45%
Wetland	442	1.6%	443	1.6%	442	1.6%	441	1.6%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The Upper Monocacy River watershed is estimated to have 855 acres of total impervious within the catchment and accounts for approximately 3.2 percent of the total land area. The impervious surface area within Upper Monocacy River watershed, by subwatershed can be found in Table 7 and is shown in Figure 3.

Table 7: Upper Monocacy River Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021403030264	Alloway Creek	3,953	74.3	1.88
021403030254	Piney Creek	3,763	64.2	1.71
021403030255	Piney Creek	5,294	399.7	7.55
021403030257	Piney Creek	5,989	122.2	2.04
021403030266	Piney Creek	95.1	0.81	0.85
021403030267	Piney Creek	2,371	59.1	2.49
021403030247	Upper Monocacy River	2,744	54.0	1.97
021403030256	Upper Monocacy River	2,915	80.9	2.78
Upper Monocacy River Watershed		**27,124**	**855.2**	3.15

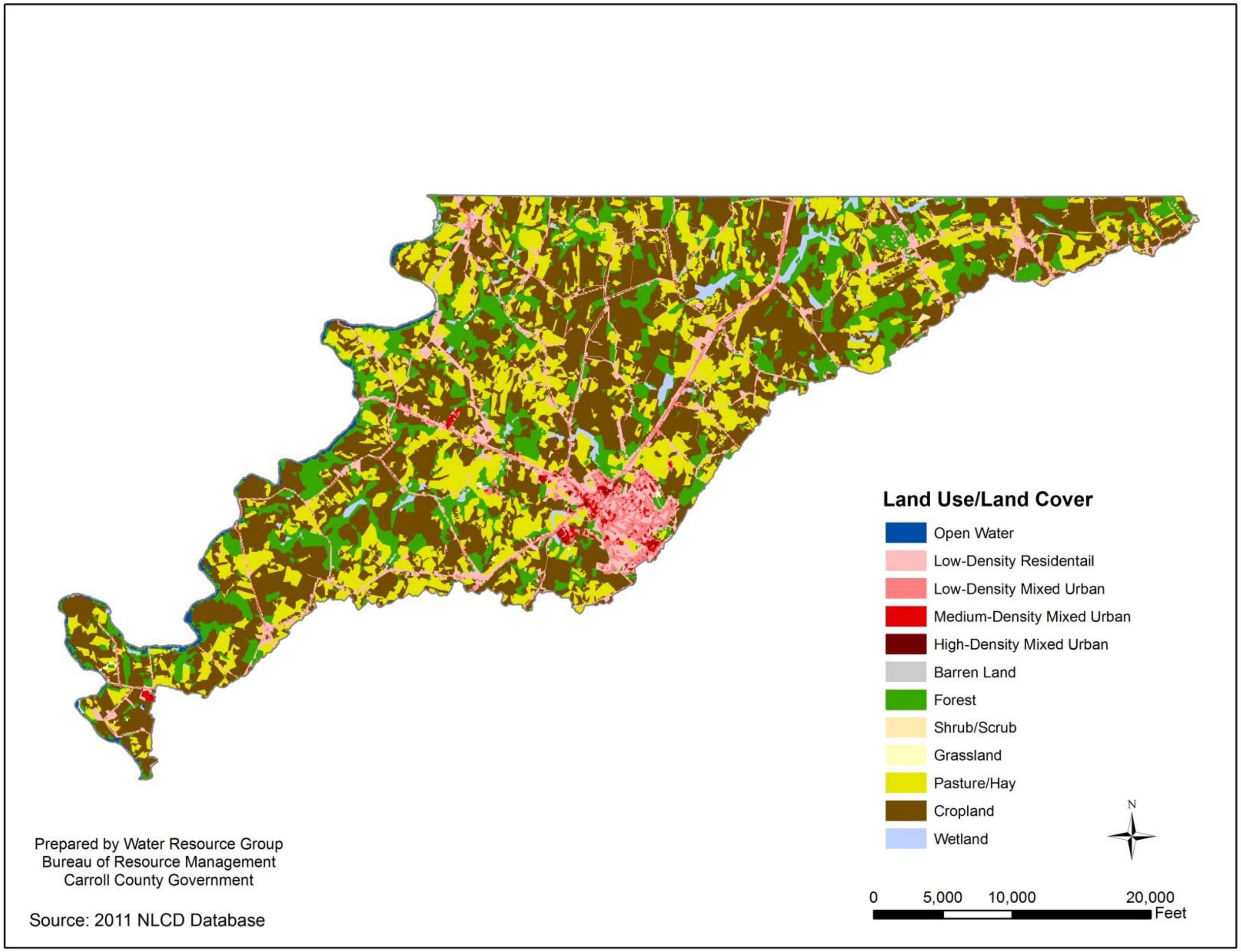

Figure 2: Upper Monocacy River Watershed Land Use/Land Cover

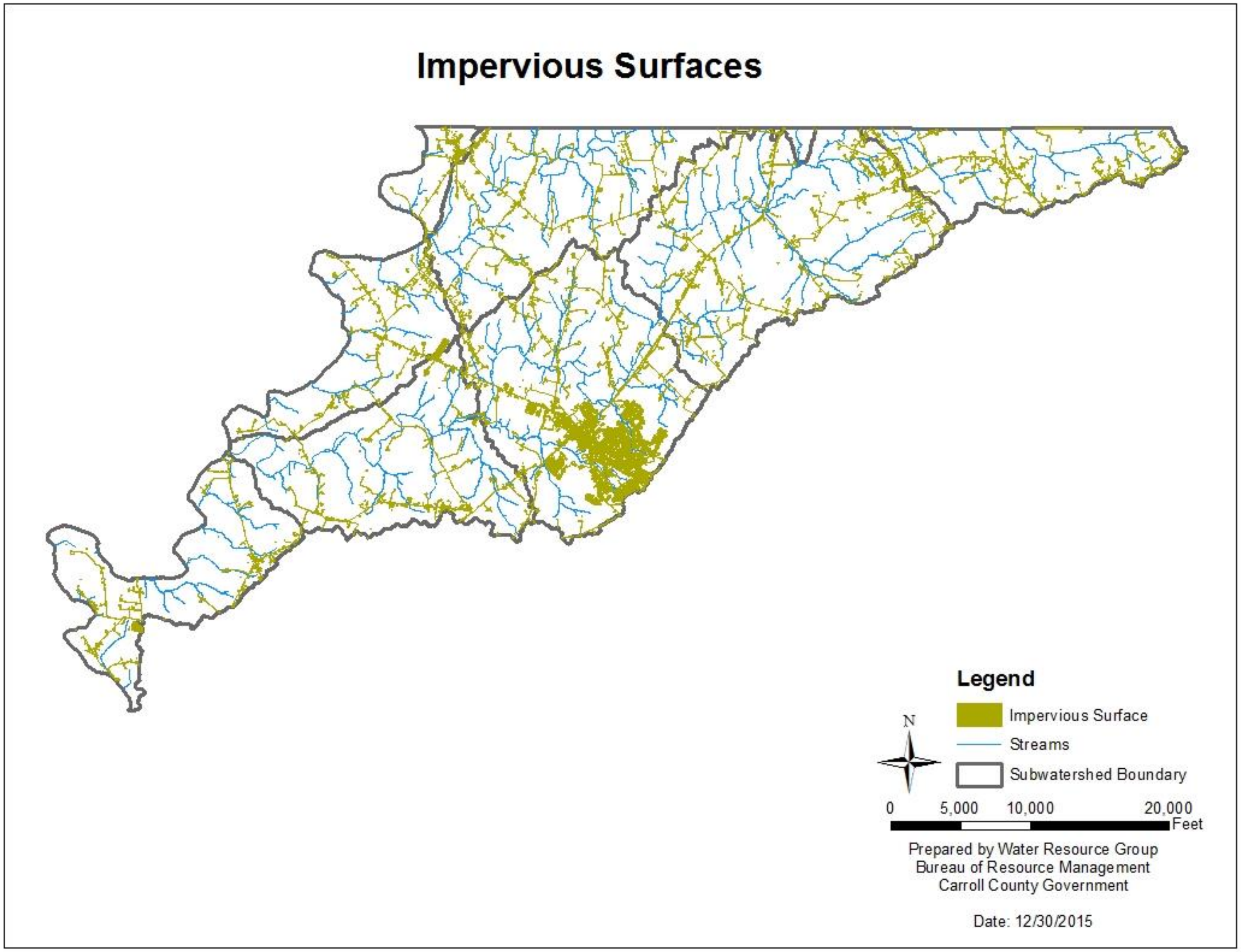

Figure 3: Upper Monocacy River Watershed Impervious Surface Area

C. Watershed Characterization

Following the Upper Monocacy River watershed stream corridor assessment (SCA), completed in 2015, a Watershed Characterization for the Upper Monocacy River watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the Upper Monocacy River watershed SCA will be used as the foundation for the watershed restoration and implementation plan. The Upper Monocacy River SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the Upper Monocacy River watershed, there are no listed Tier II waters.

b. Ecologically Sensitive Areas

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. There are approximately 4,348 acres of targeted ecological areas within the Upper Monocacy River watershed, as shown in Figure 4. Targeted ecological areas are a limited number of areas that rank exceptionally high for ecological criteria and that have a practical potential for preservation. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

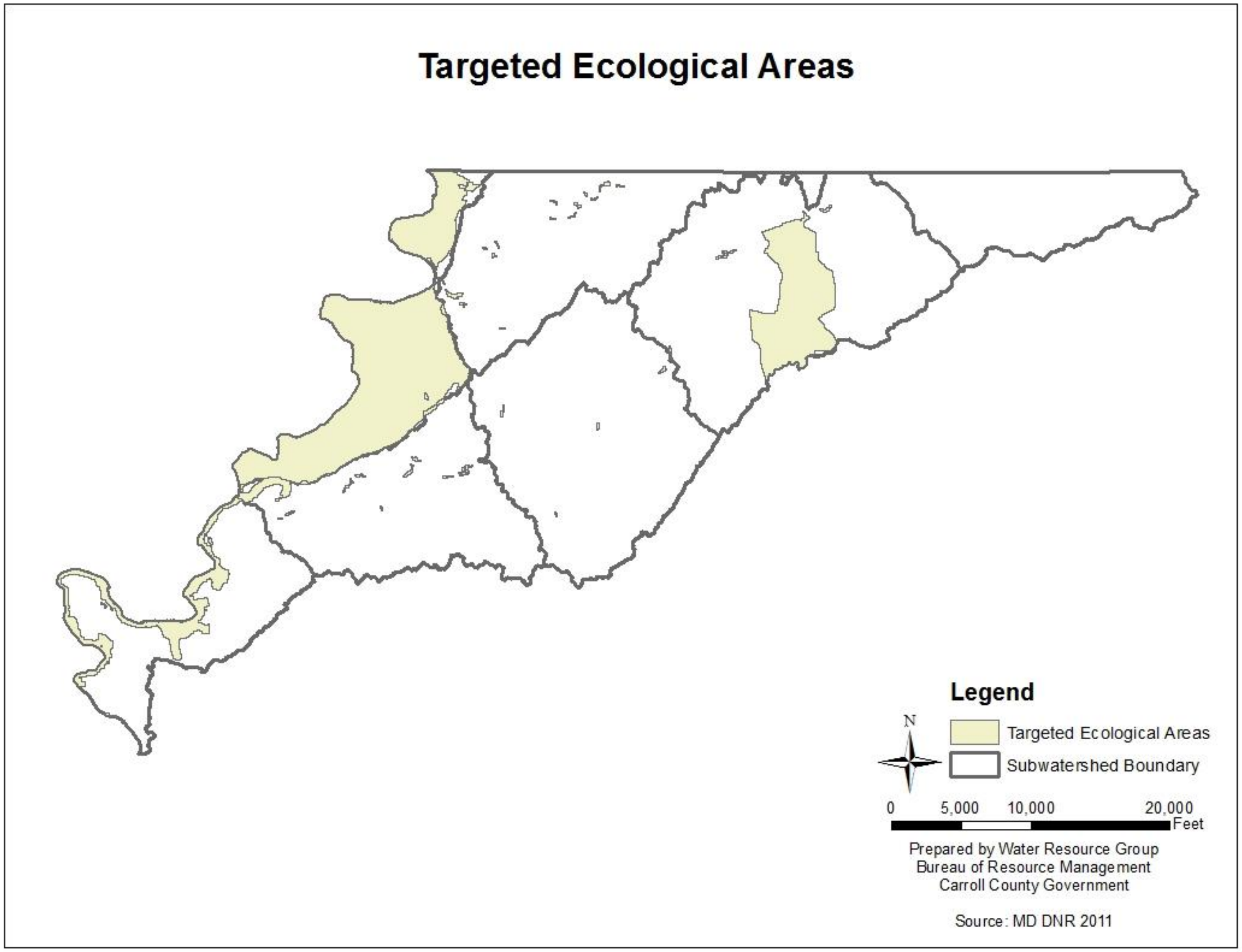

Figure 4: Upper Monocacy River Watershed Targeted Ecological Areas

2. Stream Corridor Assessment

A SCA of the Upper Monocacy River watershed was conducted during the winter of 2014-2015 by Carroll County BRM staff. The Upper Monocacy River SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire Upper Monocacy River SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/UpperMonocacy/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along 25,535 linear feet of the corridor, 7% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Piney Creek (0254). A significant portion of the drainage within Piney Creek originates within the corporate limits of the City of Taneytown. Table 8 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear feet of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area being treated and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

All of the proposed stormwater mitigation practices identified in *Section V.* of this report to address the stormwater WLA are focused in the Piney Creek (0255) subwatershed.

Table 8: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
021403030264	21.29	11.82	3,320	5.32%
021403030254	20.58	6.98	6,185	16.78%
021403030255	27.43	16.82	7,650	8.62%
021403030257	33.38	16.36	4,470	5.17%
021403030266	0.67	0.00	N/A	N/A
021403030267	10.80	3.86	800	3.92%
021403030247	10.10	5.02	2,900	10.94%
021403030256	9.04	5.53	210	0.72%
Total	133.29	66.39	25,535	7.28%

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the Upper Monocacy Watershed there are 630 parcels remaining with potential development on 10,846 acres for an estimated lot yield of 3,143 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 5 shows the remaining parcels in the Upper Monocacy watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

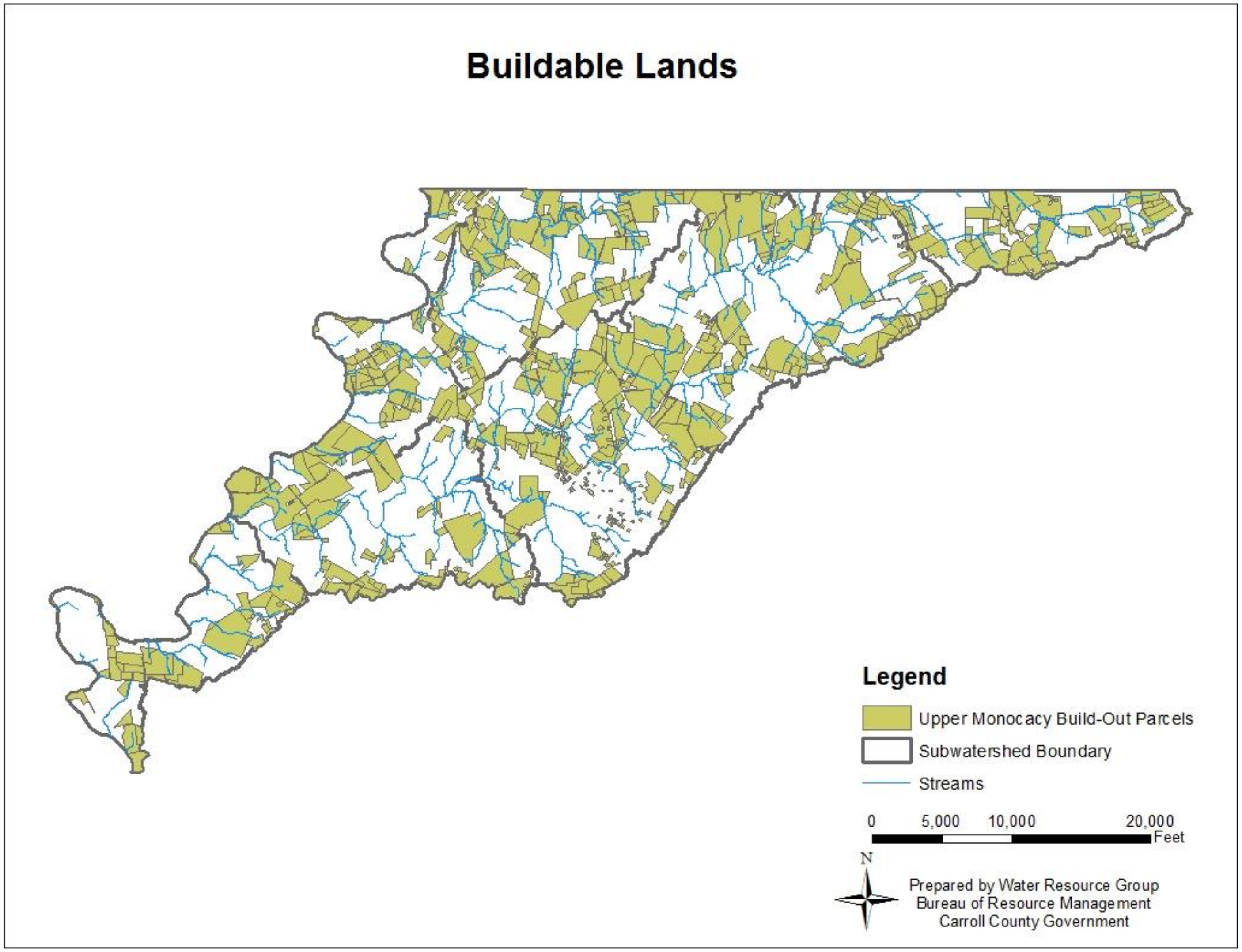

Figure 5: Upper Monocacy River Watershed Build Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the Upper Monocacy Watershed there are 26.82 acres of grass buffer and 8.33 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the Upper Monocacy Watershed can be found in Appendix B, and are shown in Figure 6. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the Rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The Upper Monocacy River watershed lies within the Little Pipe Creek Rural Legacy area and encompasses 24,338 acres (90%) of the Upper Monocacy River watershed. The extent of the Rural Legacy Area within Upper Monocacy River can be found in Figure 7.

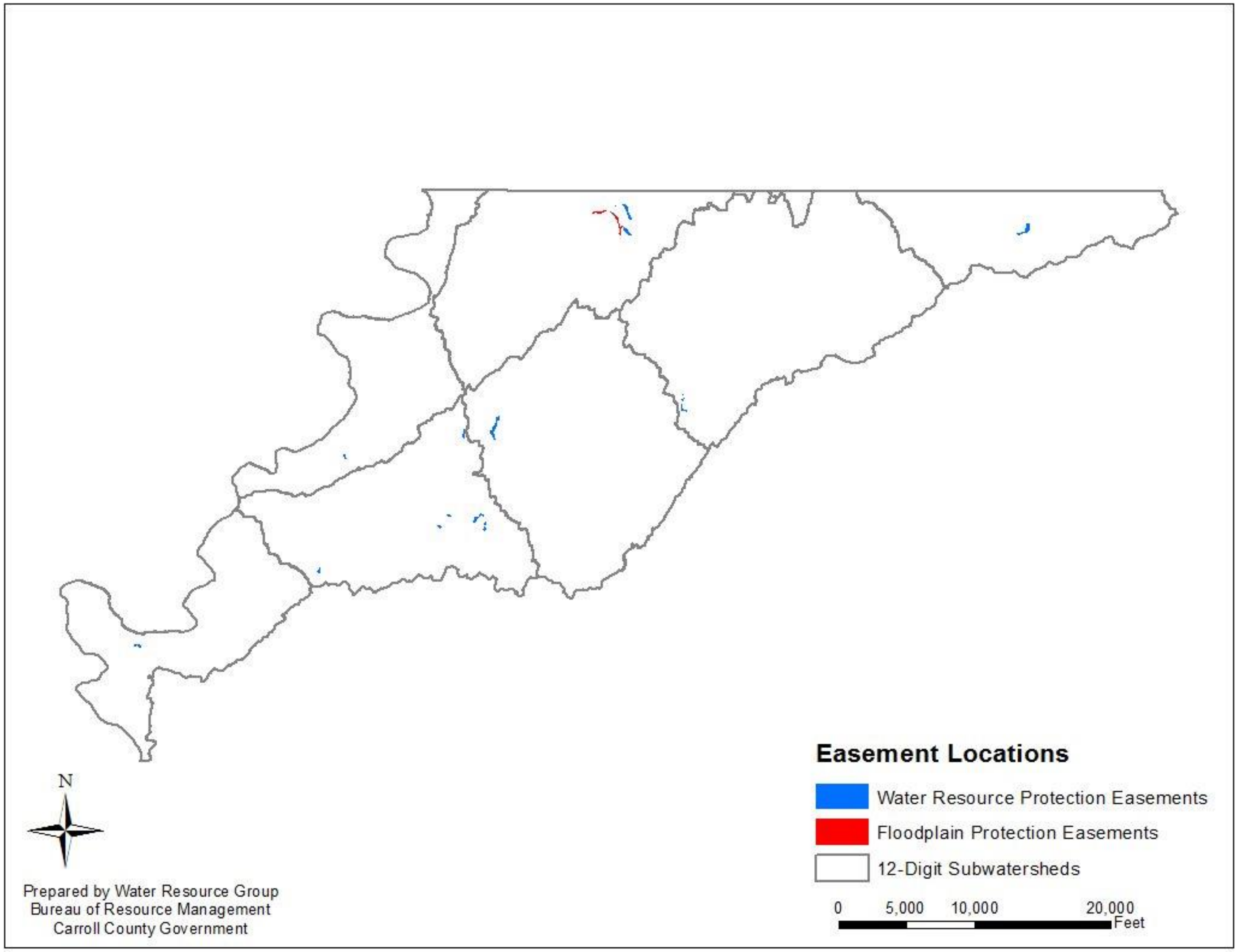

Figure 6: Water Resource and Floodplain Protection Easement Locations

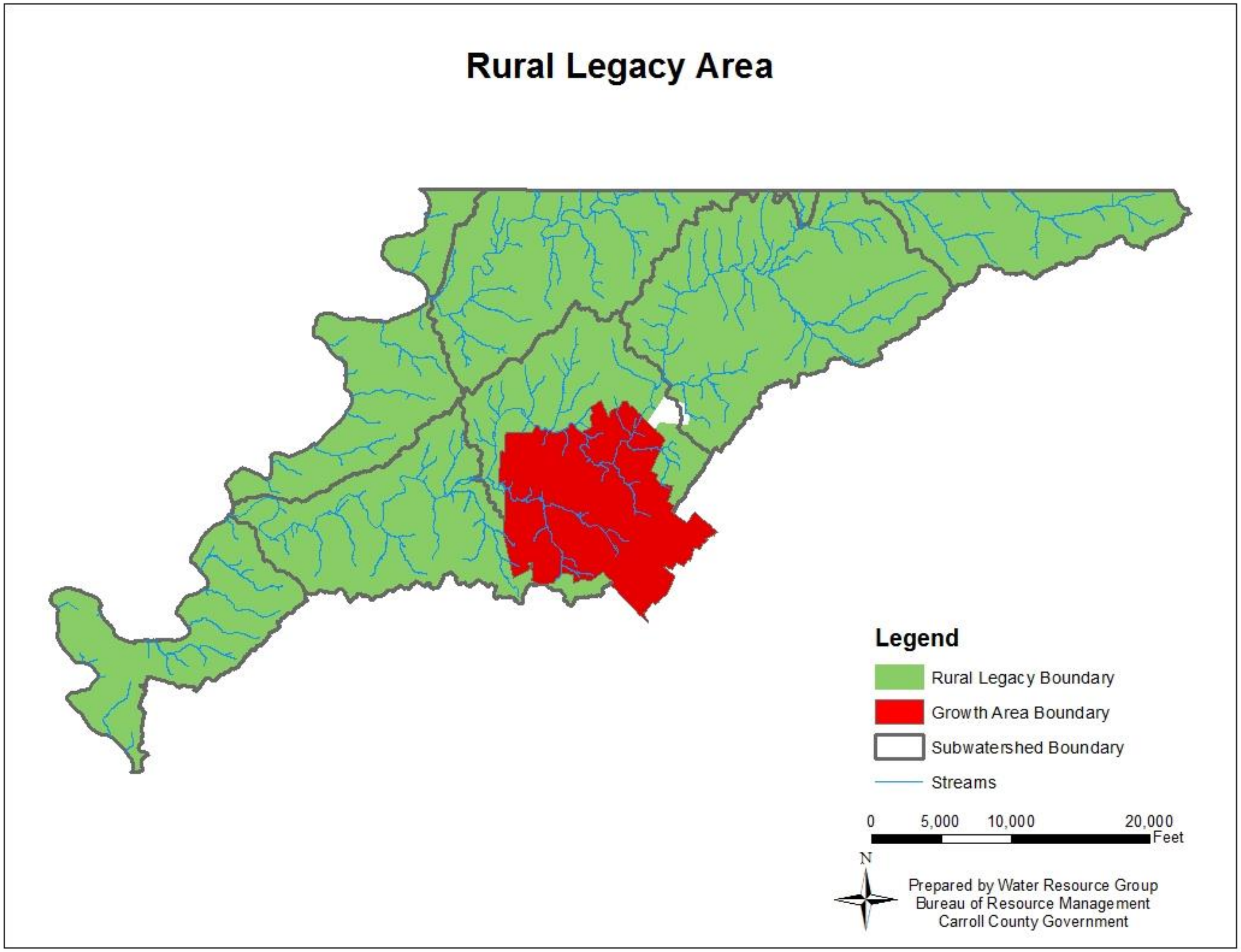

Figure 7: Little Pipe Creek Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a MOA to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff are continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts.

Educational events that County staff have participated in that are either held within the Upper Monocacy River Watershed or offered to citizens countywide can be found in Table 9.

Table 9: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Bollinger Park and Taneytown Memorial Tree Planting	2014	Upper Monocacy
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide

Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide
Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Regional Monocacy Scenic River Watershed Clean-Up	2016	Upper Monocacy
Scrap Tire Drop Off Day	2019	Countywide
Taneytown Harvest Festival	2012, 2013, 2014, 2015, 2017	Upper Monocacy
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Upper Monocacy River watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, MDE released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of ESD practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Upper Monocacy River watershed TMDL's are listed in Table 10. The location of each facility can be found in Figure 8, the practice type and runoff depth treated for each facility can be found in Appendix B.

Table 10: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Robert's Mill Area	303.6	88.48	Retrofit	Under Construction	Piney Creek 021403030255
Trevanion Terrace	181.00	52.00	Retrofit	Planned	Piney Creek 021403030255
Meadowbrook	64.77	8.7	Retrofit	Planned	Piney Creek 021403030255
Totals:	**549.37**	**149.18**			

B. Storm Drain Outfalls

During the Upper Monocacy River watershed SCA in winter 2014-2015, erosion sites were documented and rated on severity. Stream Corridor Assessment identified erosion sites were analyzed in GIS to the location of existing SWM facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. One elementary school within the Upper Monocacy River watershed; Taneytown Elementary has planted one garden that treats 23,000 square feet of drainage area.

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the winter 2014-2015 SCA in the Upper Monocacy River watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

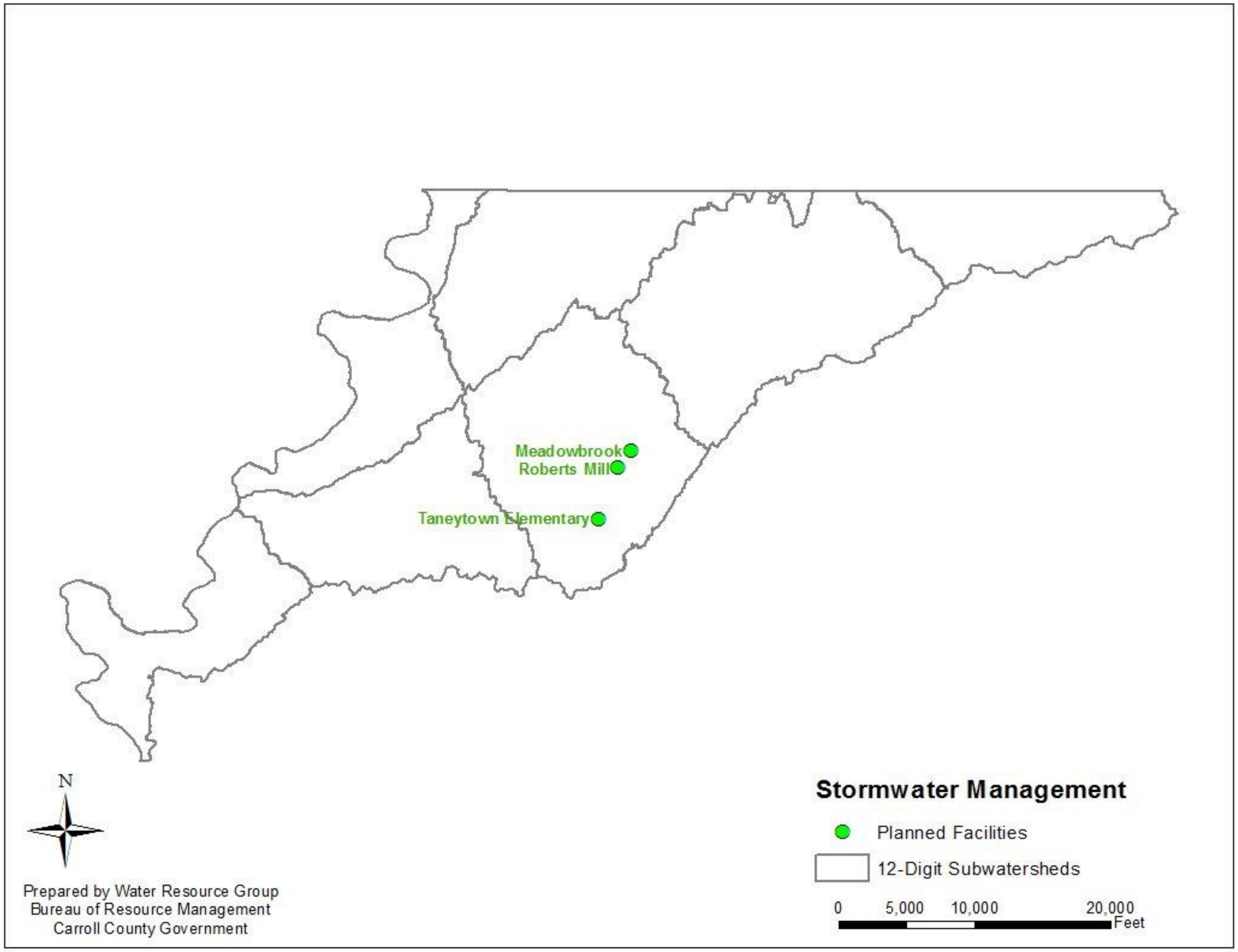

Figure 8: Stormwater Management Locations

1. Residential Buffer Plantings

The winter 2014-2015 Upper Monocacy River watershed SCA determined that approximately 44 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to the 36 landowners whose properties were identified as having an inadequate buffer during the SCA. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. One municipality participated during the fall of 2014, and five private properties participated in this initiative during the fall of 2015. The acreage planted for each location and the associated subwatershed can be found in Table 11. The approximate locations of the buffer plantings are shown in Figure 9.

2. Municipal Plantings

The City of Taneytown has initiated multiple tree planting efforts within the Upper Monocacy River watershed. These projects include plantings at Bollinger Park, Robert's Mill Park, and Taneytown Memorial Park.

The Bollinger Park project consisted of planting over 3,900 trees at a stocking rate of 300 trees per acre for 13.2 acres to enlarge an existing forest stand. The Robert's Mill Park project planted over 120 trees in an effort to increase the size of existing forest stand. The Taneytown Memorial Park project planted nearly 600 trees on almost 2 acres enhancing a stream buffer along the southern portion of the Park.

Table 11: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	Subwatershed	Date Planted
Planting 1	13.19	700	600	Piney Creek 021403030255	Fall 2014
Planting 2	0.51	200	140	Piney Creek 021403030255	Fall 2014
Planting 3	0.97	1,000	80	Piney Creek 021403030255	2014
Planting 4	0.85	1,000	80	Piney Creek 021403030255	2014
Planting 5	0.95	630	30	Alloway Creek 021403030264	Fall 2015
Planting 6	7	1,700	150	Piney Creek 021403030255	Fall 2015
Planting 7	0.65	500	40	Piney Creek 021403030257	Fall 2015
Planting 8	2.18	1,400	50	Upper Monocacy River 021403030256	Fall 2015
Planting 9	1.9	2,000	40	Piney Creek 021403030255	Fall 2015

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be monitored bi-annually for ten years to ensure the success of the program, and once every three years after the ten-year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

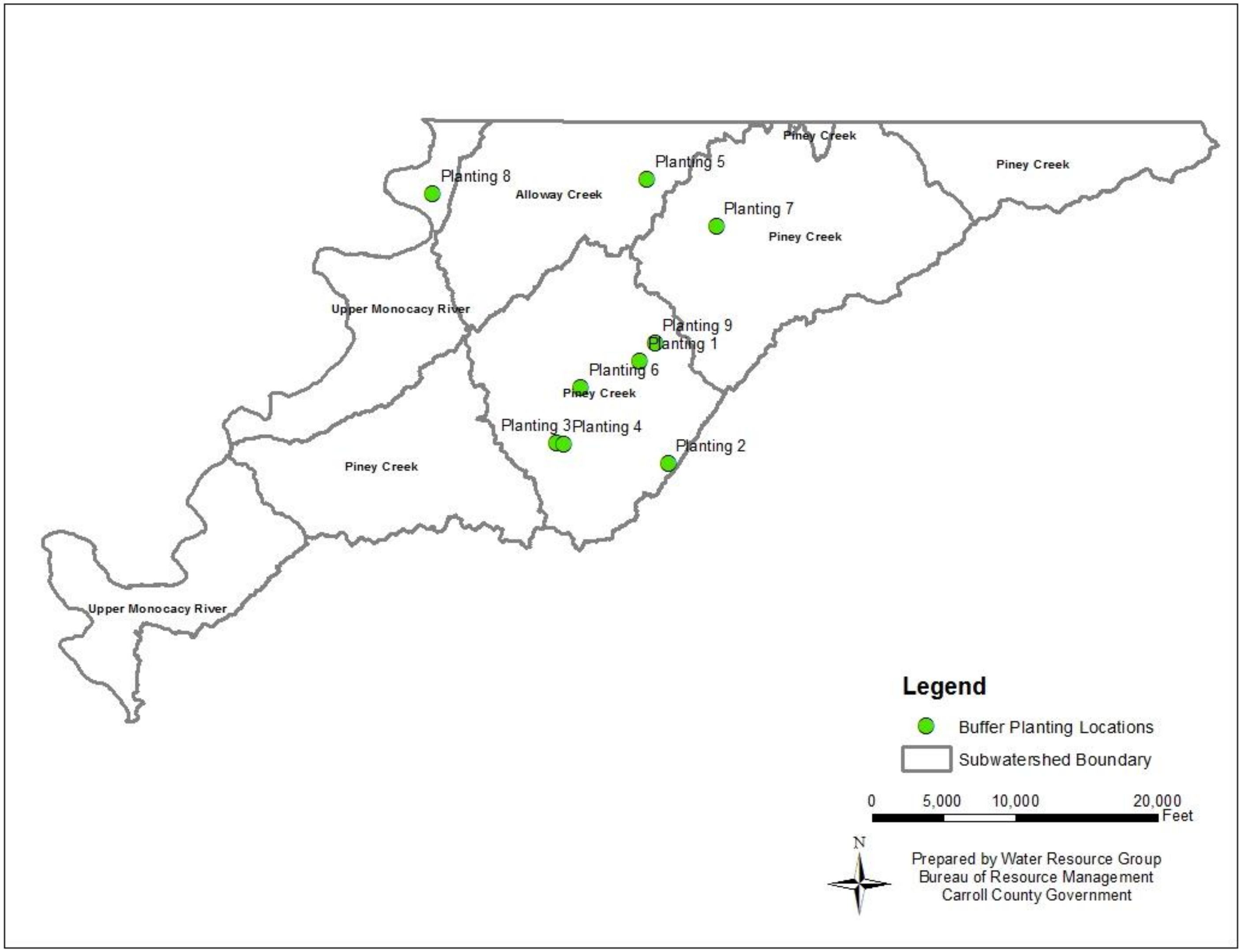

Figure 9: Stream Buffer Initiative Locations

E. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the Upper Monocacy River Watershed are shown in Table 12.

Table 12: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town/City	Tons Removed	12-Digit Watershed	Date of Completion
Taneytown	0.08	021403030255	Annual

F. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2007, eleven septic systems within the Upper Monocacy River watershed have been repaired via the BRF, and seven new systems have been built utilizing BAT. Best available technology has been proven to be effective at nitrogen removal but has not been shown to reduce phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the Upper Monocacy River watershed are listed in Table 13.

Table 13: Septic Systems

Project Type	Subwatershed	Best Available Technology	Bay Restoration Funding	Completion Date
Repair	021403030247	True	True	7/17/2013
Repair	021403030255	True	True	7/27/2009
Repair	021403030256	True	True	Post-2007
Repair	021403030264	True	True	9/28/2011
New Construction	021403030247	True	False	Post-2007
Sandmound	021403030254	True	False	3/25/2011
New Construction	021403030257	True	False	2/25/2015
New Construction	021403030247	True	False	9/9/2015
Repair	021403030257	True	True	7/28/2015
New Construction	021403030267	True	False	11/10/2015
New Construction	021403030254	True	False	3/14/2016
Repair	021403030267	True	True	1/6/2016
Repair	021403030267	True	True	1/6/2016

Repair	021403030267	True	True	1/6/2016
Repair	021403030267	True	True	1/19/2016
New Construction	021403030257	True	False	7/8/2016
Repair	021403030257	True	True	6/30/2017
New Construction	021403030254	True	False	11/29/2017
Repair	021403030254	True	False	6/10/2019

G. Agricultural Best Management Practices

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

H. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has identified the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix B provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix C.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Upper Monocacy River watershed. As described in Section I, bacteria, phosphorus and TSS loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014, and an updated version due out for review in the Fall of 2019.

The local TMDLs suggests an urban TP load reduction of 5% from the 2009 baseline year and TSS load reduction of 43.5% from the 2000 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Upper Monocacy watershed). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban TP load reductions of 5% and urban TSS load reductions of 43.5% of the local TMDL baseline years. A baseline year of 2011 was used as a proxy for the 2009 baseline year in the local TP TMDL, as land cover data from 2011 was the closest available for that time period. Similarly, a baseline year of 2001 was used as a proxy for the 2000 baseline year in the local TSS TMDL. The modeled baseline scenarios did not include any BMPs and therefore represent the land use loads with no treatment provided. Load reductions from BMPs installed after the 2009 TP TMDL and 2000 TSS TMDL baseline years can be counted toward load reductions necessary to meet the TMDLs, even though 2011 and 2001 were used as the baseline proxy years. For reference, the modeled baseline urban P load using the 2011 land cover was 283.67 lbs, which equates to a 5% reduction of 14.18 lbs. The modeled baseline urban TSS load using the 2001 land cover was 273.65 tons, which equates to a 43.5% reduction of 119.04 tons (Table 14).

The projects completed as of December 2019 are providing 18.05 pounds of TP reduction, and 35.74 tons of TSS reduction. The planned projects would provide another 14.44 lbs. of TP reduction and 26.08 tons of sediment (Table 15). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 10 and 11. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future CIP budgets to progress towards fully attaining the Upper Monocacy TMDLs. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, locations, or costs beyond the current CIP.

Table 14: Total Phosphorus and Total Suspended Sediment Load Reduction in the Upper Monocacy Watershed in Carroll County

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
283.67	5%	14.18	18.05	14.44	15%
Total Suspended Sediment Load Reduction					
Modeled Baseline Load (tons)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (tons)**	**Reduction from Current BMPs (tons)**	**Reduction from Planned Strategies (tons)**	**Total % Reduction Achieved**
273.65	43.5%	119.04	35.74	26.08	23%

Table 15: Comparison of Total Phosphorus and Total Suspended Sediment Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

Total Phosphorus Delivered Load Reductions (lbs/yr)				
Status	**Pond Retrofits**	**Buffers**	**Easements**	**Catch Basin/ Inlet Cleaning**
Completed	14.86	1.94	1.25	0.00
Planned	15.82			
Total Suspended Sediment Delivered Load Reductions (tons/yr)				
Completed	30.63	2.32	2.79	0.00
Planned	26.08			

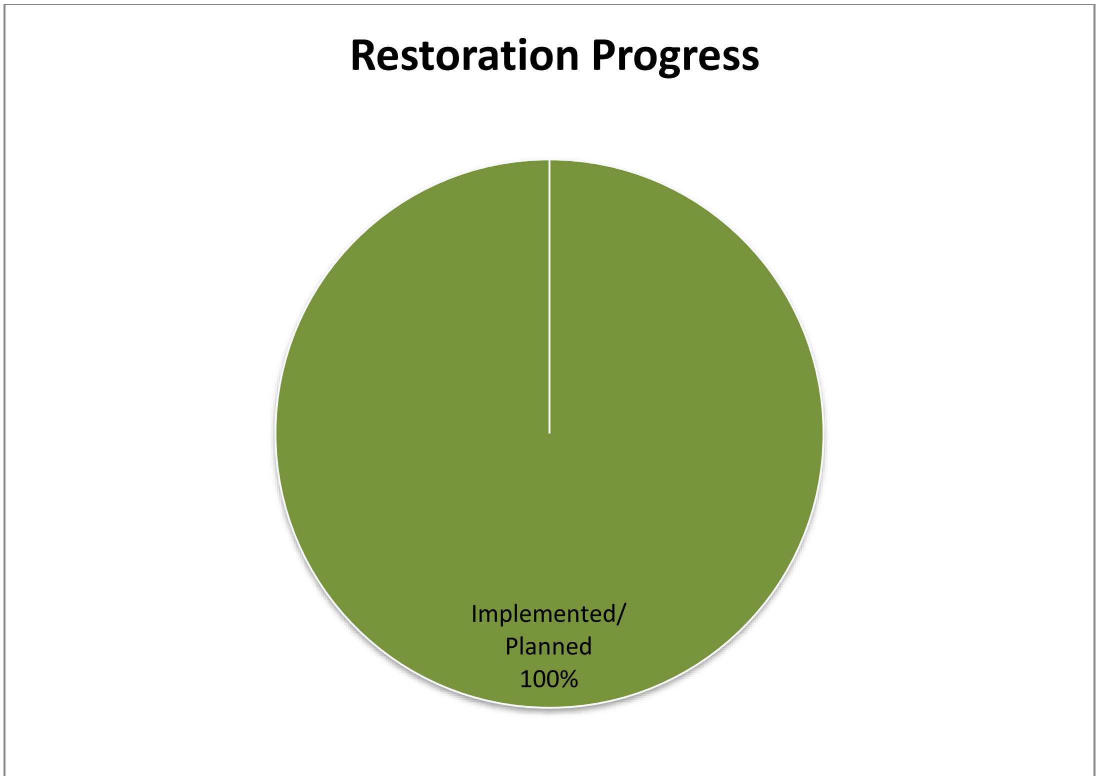

Figure 10: 2019 Restoration Progress - Phosphorus

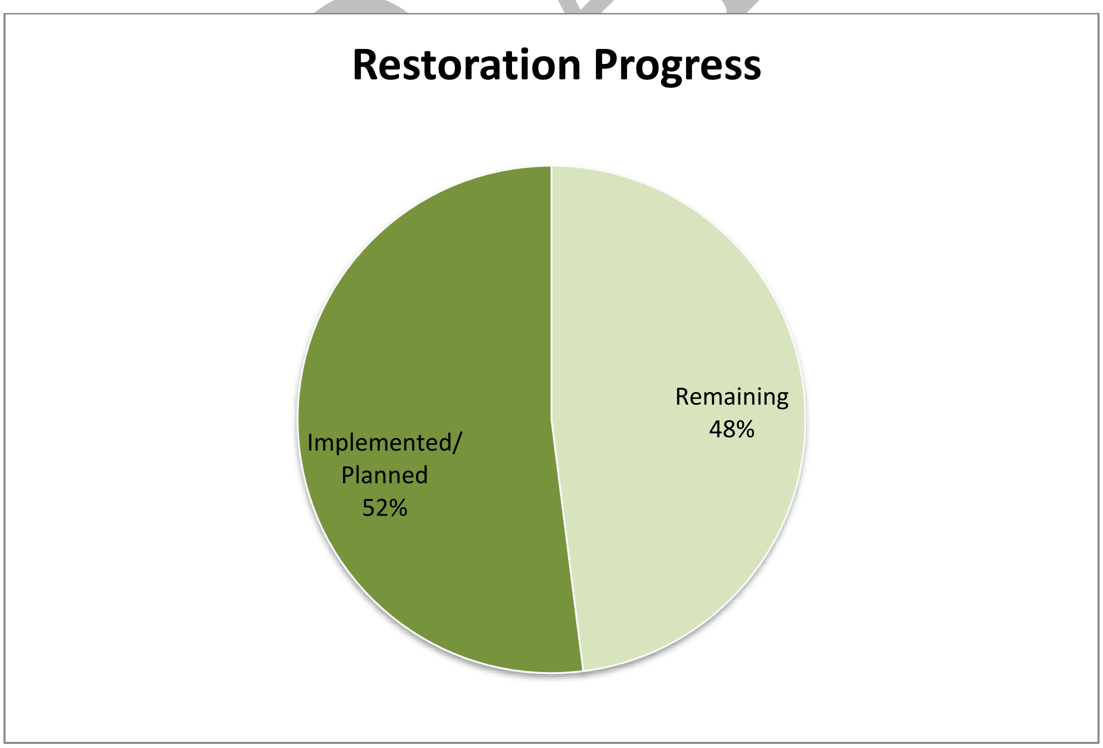

Figure 11: 2019 Restoration Progress – TSS

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

a. Human Source Elimination

Elimination of human sources of bacteria within the Upper Monocacy Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

Table 16 lists infrastructure related measures that have been implemented since the 2004 baseline year that would assist in reducing bacteria counts within the watershed.

Table 16: Waste Collection Infrastructure Upgrades

	County	Taneytown
BAT Upgrades	19	0*
Casings/Linings	n/a	TBD
Lateral line replacements	n/a	TBD
Pump Station upgrade	n/a	TBD

***upgrades occurred within corporate boundaries**

b. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

c. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach.

1. Retrofit Monitoring

The BRM currently monitors one retrofit location within the Upper Monocacy River watershed. The Robert's Mill site, shown in Figure 12, is located within the Piney Creek (0255) subwatershed, and is almost entirely within the corporate limits of the City of Taneytown.

The current facility is a dry detention pond that was built the late 1980's. The Robert's Mill location is primarily low-density mixed urban, which encompasses 41% of the land cover, followed by low-density residential at 32% of the land cover. The drainage area to the monitoring site is approximately 274 acres, of which, 83 acres or 30% is impervious.

Bi-weekly monitoring at the Robert's Mill site began in January of 2016 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Robert's Mill site can be found in Table 17. Additional monitoring at this location includes spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 17: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00
Total Kjeldahl Nitrogen	0.5mg/l	SM 4500-NH3 C97

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the Upper Monocacy Watershed began in February of 2018, and is currently performed at two locations, shown in Figure 13. Samples are currently collected on the 3rd Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 18 shows the monitoring results for the entire year, whereas Table 19 displays only seasonal data (May 1st to September 30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 18: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2018		2019	
		# Samples	MPN	# Samples	MPN
PIC01	Low	10	287	8	163
	High	0	n/a	0	n/a
	All	10	287	8	163
PIC03	Low	n/a	n/a	6	436
	High	n/a	n/a	0	n/a
	All	n/a	n/a	6	436

Table 19: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2018		2019	
		# Samples	MPN	# Samples	MPN
PIC01	Low	3	1133	3	1475
	High	0	n/a	0	n/a
	All	3	1133	3	1475
PIC03	Low	n/a	n/a	3	2021
	High	n/a	n/a	0	n/a
	All	n/a	n/a	3	2021

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 20 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 20: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2018		2019	
			# Samples	% Exceeded	# Samples	% Exceeded
PIC01	576	low	**10**	**40%**	**8**	**25%**
		high	n/a	n/a	n/a	n/a
	410	low	**10**	**50%**	**8**	**38%**
		high	n/a	n/a	n/a	n/a
	298	low	**10**	**60%**	**8**	**38%**
		high	n/a	n/a	n/a	n/a
	235	low	**10**	**60%**	**8**	**50%**
		high	n/a	n/a	n/a	n/a
PIC03	576	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	410	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	298	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a
	235	low	n/a	n/a	**6**	**66%**
		high	n/a	n/a	n/a	n/a

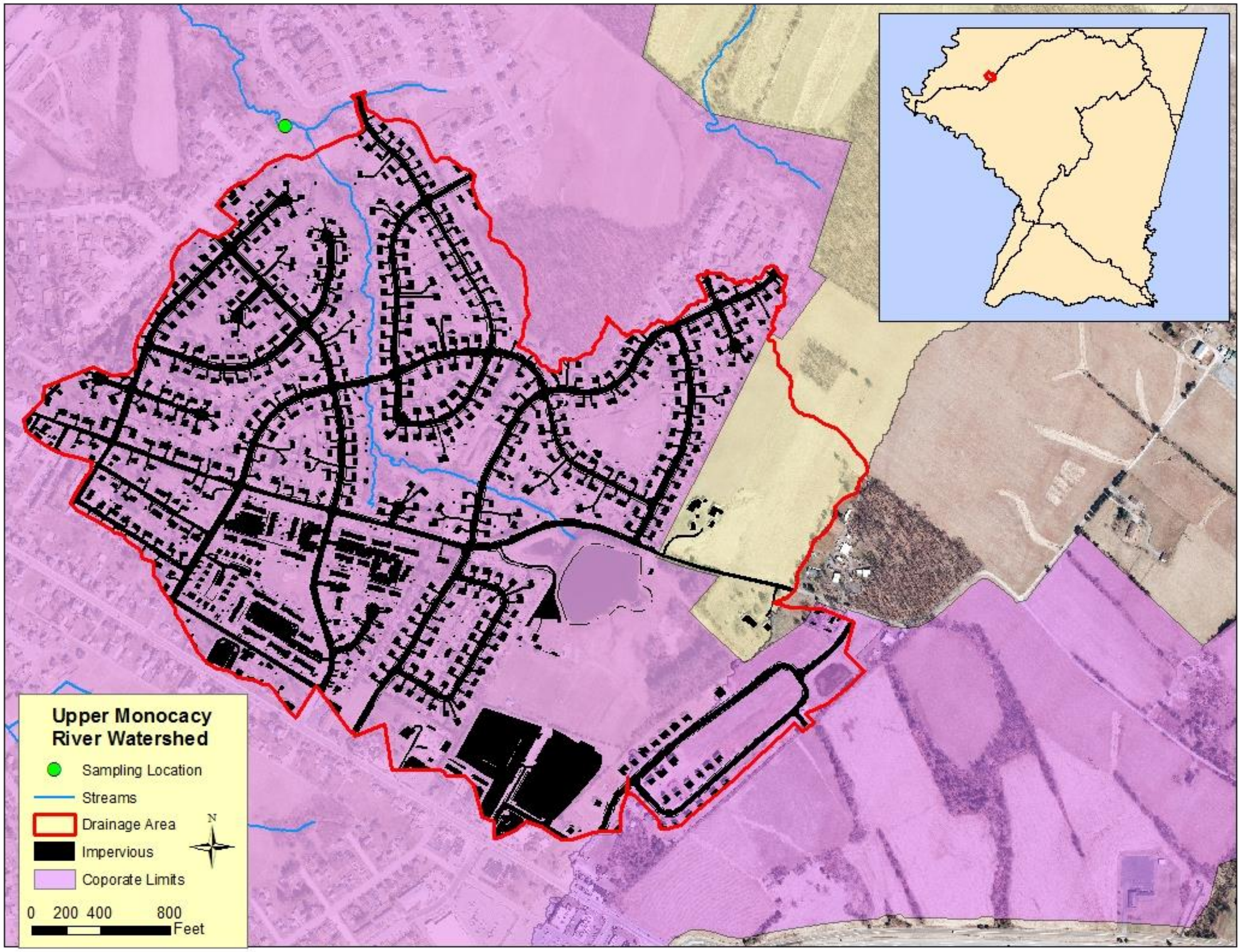

Figure 12: Robert's Mill Monitoring Location

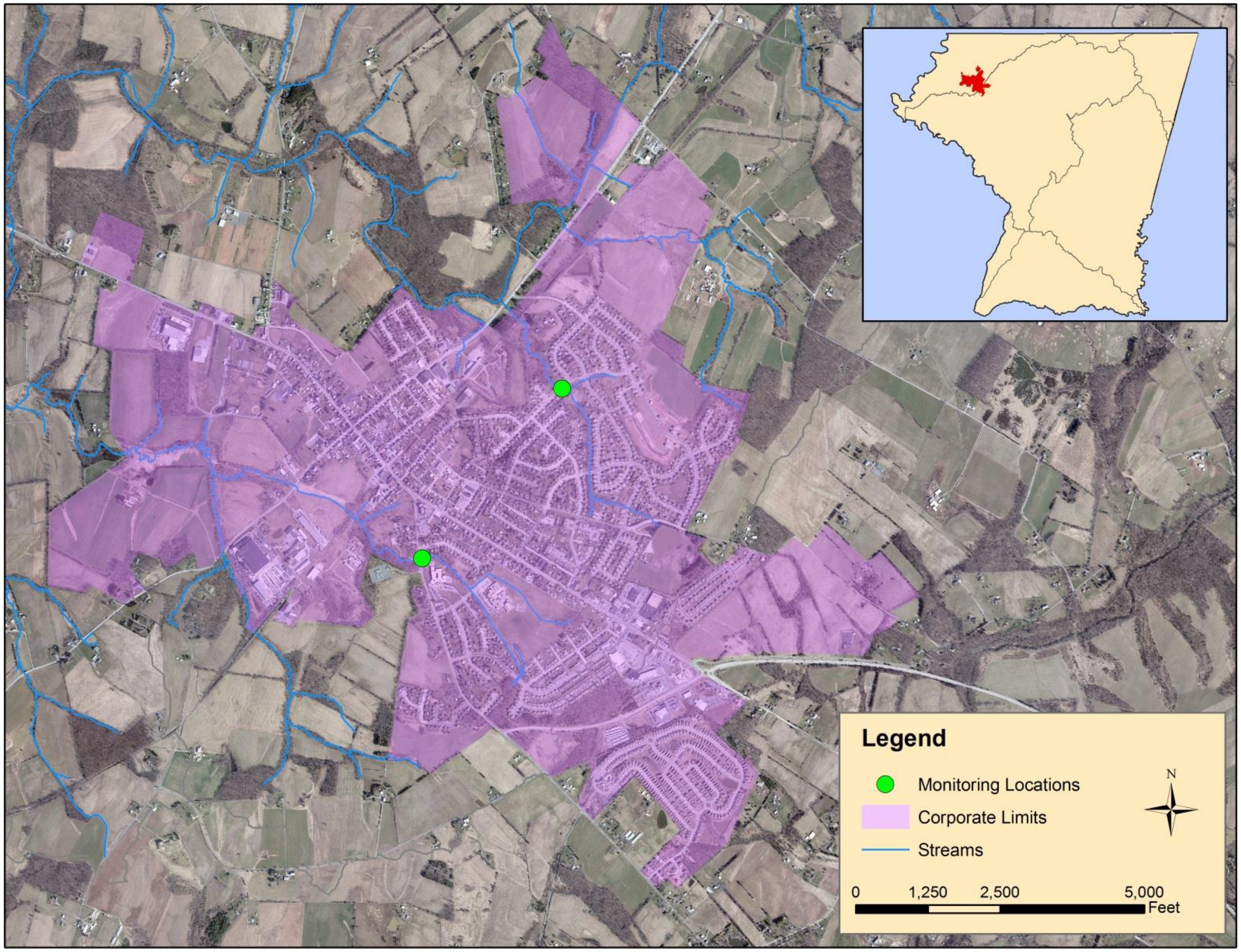

Figure 13: Upper Monocacy Bacteria Monitoring Locations

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 22). BMPs and restoration projects that have been either completed or proposed to address local TMDLs within the Upper Monocacy River watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 21, and the tidal water designated use zones are shown in Figure 14.

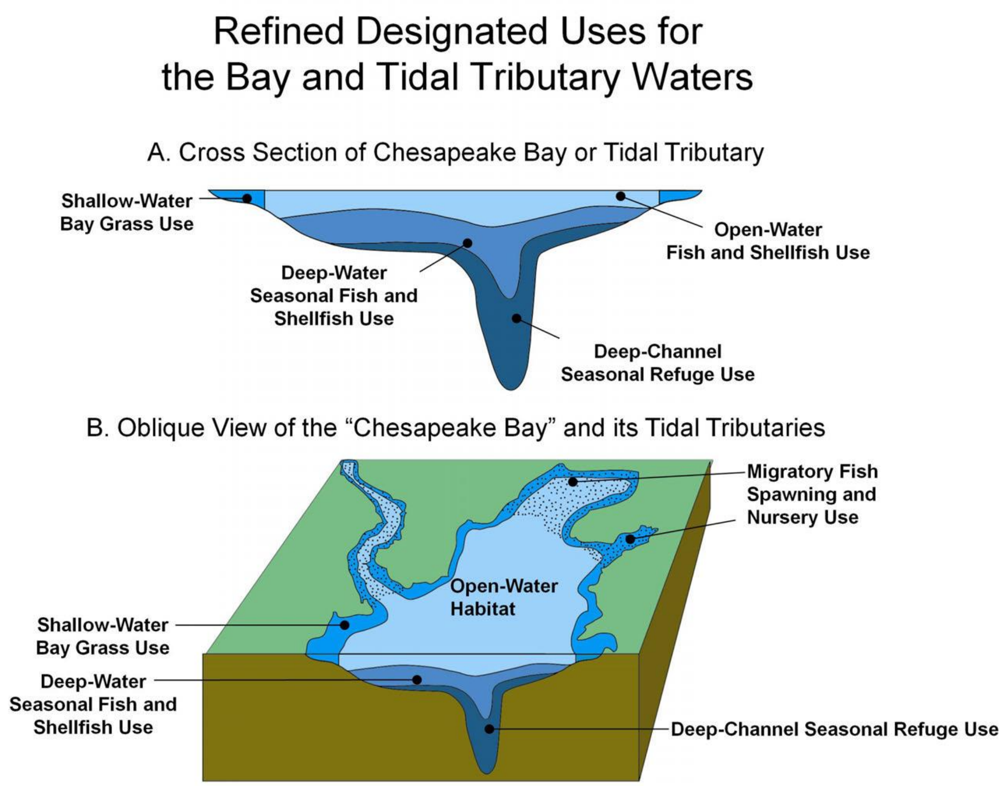

Figure 14: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 21: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The Upper Monocacy River watershed is located within the Potomac River Basin of the Chesapeake Bay. Within Maryland the Potomac River Basin covers 1,539,973 acres across eight counties. Approximately 137,878 acres (9%) of the Potomac River Basin located in Maryland is within Carroll County, 19.7% of which is located in Upper Monocacy River watershed. The location of the Potomac River Basin segment is shown in Figure 15.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix D) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 22. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Potomac River Basin river segment within the Upper Monocacy River watershed are; 0.30 for nitrogen, 0.47 for phosphorus, and 0.65 for TSS (MAST, 2016). Essentially, if one pound of nitrogen is discharged into a tributary within the Upper Monocacy River portion of the Potomac River Basin river segment, only 30% of that pound is reaching the Bay.

Table 22 shows the Chesapeake Bay TMDL for the Potomac land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the Upper Monocacy watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the Upper Monocacy watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Potomac segment shed. The Upper Monocacy Watershed covers 19.7% of the Potomac land-river segment within Carroll County.

Table 22: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the Upper Monocacy Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Reduced by BMPs 2009-2025
10,100.99	22.07%	2,228.95	69.73	57.11	5.69%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction Required	Required Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Reduced by BMPs 2009-2025
110,661.46	9.25%	10,232.26	473.39	469.79	9.22%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Potomac land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the Upper Monocacy watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 23: Carroll County Potomac River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	Total Phosphorus (TP)[3]			Total Nitrogen (TN)		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Lower Monocacy Watershed	2.11	31.83	1.5%	35.02	307.19	3.34%
Upper Monocacy Watershed	69.73	57.11	5.69%	473.39	469.79	9.22%
Double Pipe Creek Watershed	152.95	266.16	18.80%	855.30	593.77	14.16%
Total	**224.79**	**355.10**	**25.99%**	**1,363.71**	**1,370.75**	**26.72%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

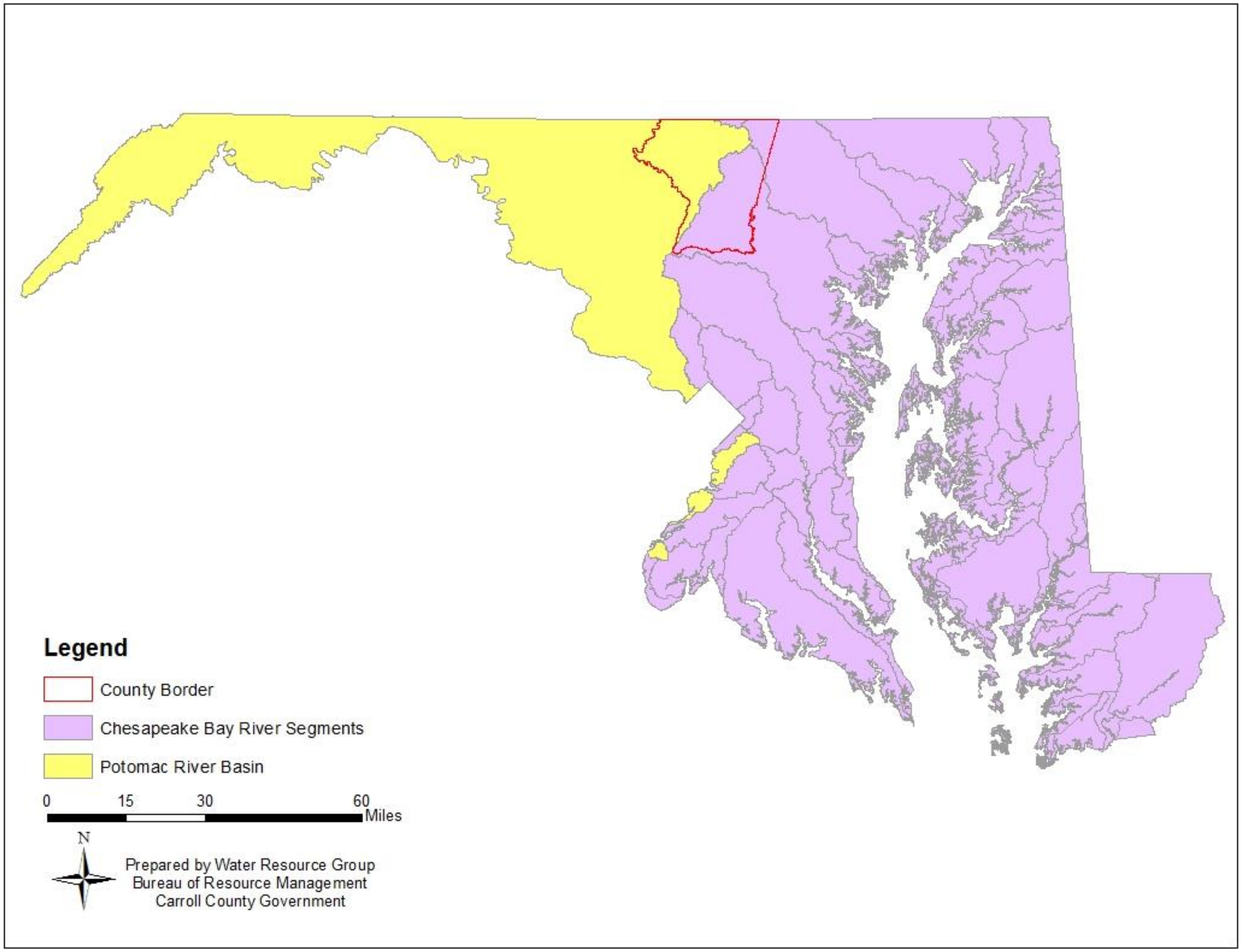

Figure 15: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the Upper Monocacy phosphorus TMDL will be achieved in 2019.

The sediment TMDL through 2019 will have achieved 30% of the required reduction since the baseline year of 2000 and based on current projects is expected to achieve 52% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 2.08% reduction in the TMDL/year since the baseline.

If the County is able to maintain a 2.08% reduction rate per year until the sediment TMDL is fully implemented, the sediment TMDL in the Upper Monocacy Watershed would be achieved by 2048. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 24 lists the anticipated benchmark for each nutrient TMDL within the Upper Monocacy Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 24: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2048
Phosphorus	100%	100%	100%
Sediment	30%	52%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Upper Monocacy Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty-day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost*	Anticipated Completion
SWM Facilities	County	2140303	Completed	$3,100,000	Completed
Buffer Plantings	County	2140303	Completed	$221,364	Completed
Roads: Street/Inlet Cleaning	Taneytown	2140303	Annual	**	Annual
Water/Floodplain Easement	County	2140303	Completed	N/A	Completed
SWM (Planned)*	County	2140303	Planning/Design	$1,175,000	FY20-FY25
TBD*	Watershed	2140303	Planning	$4,150,000	TBD

***Costs for proposed Stormwater facilities are based on current FY20-FY25 project costs, which may be subject to change.**

****Project Costs not reported**

XIII. Appendix B: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

SWM Facilities Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	303.6	88.48	ST	1.00	4.9487%	35%	48.60	8.2530%	55%	14.86	11.1925%	70%	30.63
Taneytown Elementary	Retrofit	181	52	RR	1.00	5.0438%	60%	49.53	6.2623%	70%	11.27	7.1415%	75%	19.54
Meadowbrook	Retrofit	64.77	8.7	ST	1.00	1.0557%	35%	10.37	1.7607%	55%	3.17	2.3878%	70%	6.53
	Total:	**549.37**	**149.18**			**11.05%**		**108.5**	**16.28%**		**29.3**	**20.72%**		**56.7**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Taneytown	0.08	3.5	0.28 [0.01]	1.4	0.112 [0.00]	420	34 [3.92]	0.017 [0.00]
		Total:	**0.28 [0.01]**		**0.112 [0.00]**		**34 [3.92]**	**0.017 [0.00]**

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Grass Buffer 2000-2008	13.050	2000-2008	0.1826%	30	1.79	0.2584%	40	0.47	0.3785%	55	1.04
Grass Buffer 2009-Current	13.770	2009 - current	0.1927%	30	1.89	0.2726%	40	0.49	0.3994%	55	1.09
Total:	**26.82**		**0.3753%**		**3.68**	**0.531%**		**0.96**	**0.7779%**		**2.13**

Forest Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	Recorded Date	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Forest Buffer 2000-2008	0.120	2000-2008	0.0025%	45	0.02	0.0024%	40	0.00	0.0035%	55	0.01
Forest Buffer 2009-Current	8.210	2009 - current	0.1723%	45	1.69	0.1625%	40	0.29	0.2382%	55	0.65
Total:	**8.33**		**0.1748%**		**1.71**	**0.1649%**		**0.29**	**0.2417%**		**0.66**

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	13.19	0.4060%	66	4.17	0.5027%	77	0.99	0.3965%	57	1.09
Planting 2	0.51	0.0157%	66	0.16	0.0194%	77	0.04	0.0153%	57	0.04
Planting 3	0.97	0.0299%	66	0.31	0.0370%	77	0.07	0.0292%	57	0.08

Planting 4	0.85	0.0262%	66	0.27	0.0324%	77	0.06	0.0256%	57	0.07
Planting 5	0.95	0.0292%	66	0.30	0.0362%	77	0.07	0.0286%	57	0.08
Planting 6	7	0.2155%	66	2.21	0.2668%	77	0.53	0.2104%	57	0.58
Planting 7	0.65	0.0200%	66	0.21	0.0248%	77	0.05	0.0195%	57	0.05
Planting 8	2.18	0.0671%	66	0.69	0.0831%	77	0.16	0.0655%	57	0.18
Planting 9	1.9	0.0585%	66	0.60	0.0724%	77	0.14	0.0571%	57	0.16
Total:	**28.2**	**0.868%**		**8.92**	**1.075%**		**2.12**	**0.848%**		**2.32**

XIV. Appendix C: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Upper Monocacy watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2001 and 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table C-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table C-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest

Mixed Forest	Forest
Shrub/Scrub	Open Land
Herbaceous	Open Land
Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table C-2 below and were based on literature and professional judgement.

Table C-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.46	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.46	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation	Imp. (Pervious) values	Imp. (Pervious) values	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.
LD Mixed	2.8 (0.8)	1.21 (0.19)		
MD Mixed	6.2 (0.8)	2.66 (0.30)		
HD Mixed	2.8 (0.8)	2.66 (0.30)		
LD Residential	2.5 (1.3)	1.21 (0.19)		

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was area weighted using pasture/hay or cropland area of the subcatchments of this watershed.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table C-3 for the Upper Monocacy watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table C-3 based on professional judgement.

Table C-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)		TP (lbs/ac)		TSS (lbs/ac)	
			2011	2001	2011	2001	2011	2001
LD Mixed	15	>5 to <30	0.48	0.46	0.10	0.09	336.99	288.65
MD Mixed	52	>=30 to <70	1.52	1.48	0.21	0.19	371.27	322.21
HD Mixed	87	>=70	1.53	1.48	0.21	0.20	371.80	322.94
LD Residential	15	>5 to <30	0.48	0.46	0.10	0.09	336.94	288.61

The local TP TMDL baseline year is 2009 and the local TSS TMDL baseline year is 2000, which means any retrofitted water quality BMPs installed since these years can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table C-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Upper Monocacy watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.042, 0.041, and 0.115, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XV. Appendix D: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	303.6	88.48	ST	1.00	15.3	1353.7440	35%	473.1335	1.69	149.5312	55%	82.1225	0.44	38.9312	70%	27.2129
Trevanion Terrace	Retrofit	181	52	RR	1.00	15.3	795.6000	60%	475.3710	1.69	87.8800	70%	61.4281	0.44	22.8800	75%	17.1394
Meadowbrook	Retrofit	64.77	8.7	ST	1.00	15.3	133.1100	35%	46.5219	1.69	14.7030	55%	8.0749	0.44	3.8280	70%	2.6758
	Total:	**526.97**	**147.7**				**2259.8100**		**987.1124**		**249.6130**		**150.2519**		**64.9880**		**46.5729**

SWM Facilities Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Robert's Mill	Retrofit	303.6	215.12	ST	1.00	10.8	2323.2960	35%	811.9920	0.43	92.5016	55%	50.8019	0.07	15.0584	70%	10.5258
Trevanion Terrace	Retrofit	181	129	RR	1.00	10.8	1393.2000	60%	832.4370	0.43	55.4700	70%	38.7735	0.07	9.0300	75%	6.7644
Meadowbrook	Retrofit	64.77	56.07	ST	1.00	10.8	605.5560	35%	211.6418	0.43	24.1101	55%	13.2413	0.07	3.9249	70%	2.7435
	Total:	**526.97**	**379.27**				**4096.1160**		**1777.1061**		**163.0861**		**97.8763**		**26.5489**		**19.0101**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Taneytown	0.08	3.5	0.280	1.4	0.112	420	33.6	0.017
		Total:	**0.2800**		**0.1120**		**34**	**0.017**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Grass Buffer 2000-2008	13.050	2000-2008	11.7	152.6850	30	45.80550	0.68	8.8740	40	3.5496	0.18	2.3490	55
Grass Buffer 2009-Current	13.770	2009 -current	11.7	161.1090	30	48.33270	0.68	9.3636	40	3.7454	0.18	2.4786	55
	26.820		**Total:**	**313.7940**		**94.13820**		**18.2376**		**7.2950**		**4.8276**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Forest Buffer 2000-2008	0.120	2000-2008	11.7	1.4040	45	0.6318	0.68	0.0816	40	0.0326	0.18	0.0216	55
Forest Buffer 2009-Current	8.210	2009 -current	11.7	96.0570	45	43.2257	0.68	5.5828	40	2.2331	0.18	1.4778	55
	8.330		**Total:**	**97.4610**		**43.85745**		**5.6644**		**2.2658**		**1.4994**	

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	13.19	11.7	154.3230	66	101.8532	0.68	8.9692	77	6.9063	0.18	2.3742	57	1.3533
Planting 2	0.51	11.7	5.9670	66	3.9382	0.68	0.3468	77	0.2670	0.18	0.0918	57	0.0523
Planting 3	0.97	11.7	11.3490	66	7.4903	0.68	0.6596	77	0.5079	0.18	0.1746	57	0.0995
Planting 4	0.85	11.7	9.9450	66	6.5637	0.68	0.5780	77	0.4451	0.18	0.1530	57	0.0872
Planting 5	0.95	11.7	11.1150	66	7.3359	0.68	0.6460	77	0.4974	0.18	0.1710	57	0.0975
Planting 6	7	11.7	81.9000	66	54.0540	0.68	4.7600	77	3.6652	0.18	1.2600	57	0.7182
Planting 7	0.65	11.7	7.6050	66	5.0193	0.68	0.4420	77	0.3403	0.18	0.1170	57	0.0667
Planting 8	2.18	11.7	25.5060	66	16.8340	0.68	1.4824	77	1.1414	0.18	0.3924	57	0.2237
Planting 9	1.9	11.7	22.2300	66	14.6718	0.68	1.2920	77	0.9948	0.18	0.3420	57	0.1949
Total:	**28.2**		**329.9400**		**217.7604**		**19.1760**		**14.7655**		**5.0760**		**2.8933**

XVI. Appendix E: Forest Buffer and Grass Buffer Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Alloway Creek	0.01752	2002
H & K Acres	0.002361	2005
Alloway Creek	0.048271	2005
H & K Acres	0.046774	2005
Upper Monocacy River	0.000718	2007
Bullfrog Plateau	0.001083	2011
Upper Monocacy River	0.817222	2011
Bullfrog Plateau	0.154025	2011
Walnut Grove Acres, Lot 5	4.746919	2012
Maidens Point	0.033949	2012
Piney Creek	0.033948	2012
Maidens Point	1.218337	2012
Piney Creek	0.632901	2013
Upper Monocacy River	0.570839	2016

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Piney Creek	2.642764	2000
Piney Creek	0.520078	2002
Alloway Creek	5.892804	2002
H & K Acres	0.002547	2005
H & K Acres	1.66744	2005
Alloway Creek	2.228816	2005
Upper Monocacy River	0.093309	2007
Piney Creek	1.639133	2011
Upper Monocacy River	0.187298	2011
Bullfrog Plateau	0.038213	2011
Walnut Grove Acres, Lot 5	4.499815	2012
Piney Creek	0.662455	2013
Piney Creek	5.384928	2015
Upper Monocacy River	1.360719	2016

Baltimore Harbor
Interim Restoration Plan
Carroll County, Maryland

2019

Prepared by
Carroll County Government Bureau of Resource Management

Forward

This document summarizes proposed and potential restoration strategies to meet local Total Maximum Daily Load (TMDL) requirements associated with the urban wasteload allocation (WLA) for the Baltimore Harbor Watershed. This document is an ongoing, iterative process that will be updated as needed to track implementation of structural and nonstructural projects, alternative Best Management Practices (BMP's), and any program enhancements that assist in meeting Environmental Protection Agency (EPA) approved TMDL stormwater WLAs. Updates will evaluate the success of Carroll County's watershed restoration efforts and document progress towards meeting approved stormwater WLAs. Some of the strategies presented in this document are considered "potential" and additional assessment will be required before any project is considered final or approved.

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Baltimore Harbor Watershed Restoration Plan

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I. Introduction

Baltimore Harbor (basin number 02130903) was identified on the State's 1996 list of water quality limited segments (WQLSs) submitted to the U.S. EPA by the Maryland Department of the Environment (MDE) as impaired by nutrients. The Baltimore Harbor has also been identified on the 303(d) list as impaired by bacteria (fecal coliform) (1998), toxics (polychlorinated biphenyls, or PCBs) (1998), metals (chromium, zinc and lead) (1998), suspended sediments (1996), and impacts to biological communities (2004). This document will address the water quality impairments associated with excess nutrient loadings.

The Bureau of Resource Management (BRM), in part to fulfill the County's regulatory requirements as designated through the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit has initiated watershed restoration planning to address the developed and approved watershed TMDL Wasteload Allocations (WLA) within the Baltimore Harbor basin of Carroll County (Figure1). Additional stakeholders in this planning process include the Towns of Sykesville and Mount Airy, and the Patapsco Chapter of Trout Unlimited.

A. Purpose and Scope

This document presents restoration strategies that are proposed to meet watershed-specific water quality standards, associated TMDL WLAs for developed source types for Carroll County. This Watershed Restoration Plan also establishes a reporting framework for project tracking, monitoring, and reporting and was developed to meet the restoration plan requirement designated in the County's NPDES MS4 Permit (Section IV.E.2).

1. Document Organization

Section I: Introduction; discusses the history of TMDL development within the South Branch Patapsco Watershed, outlines the purpose and scope of this document, and provides a description of water quality standards and the TMDL's being addressed by this document.

Section II: Background; describes the location of the watershed and outlines any ecologically sensitive areas as well as locations of tier II waters within the watershed. This section will also summarize the stream corridor assessment (SCA) that was performed by the Bureau of Resource Management and identifies priority watersheds based on the assessment. The background section will also look at baseline and current land use within the Carroll County portion of the South Branch Patapsco Watershed.

Section III: New Development; this section will discuss the Chapter 154; Water Resource Ordinance and how easements are set aside in perpetuity during the development phase to protect ground and surface water resources across the watershed. This section will also summarize the build-out analysis done for the watershed and discuss the Rural Legacy Area that encompasses most of the watershed.

Section IV: Public Outreach and Education; summarizes the current outreach being undertaken by the County and discusses the various councils and the role they play in watershed restoration.

Section V: Restoration Implementation; Describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the South Branch Patapsco Watershed. Appendix A will also provide a complete list of restoration activities, their associated reduction values, subwatershed location, project status, and anticipated completion.

Section VI: Project Tracking, Reporting, and Monitoring; defines how data will be tracked and summarized to document the success of this plan in improving water quality conditions, and will document progress made through practice implementation, as well as discuss the current monitoring efforts within the watershed.

Section VII: Chesapeake Bay Restoration; describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed; BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the Watershed will ultimately reduce loadings to the Chesapeake Bay.

Section VIII: Caveats; explains that this document provides potential restoration strategies that require additional assessment, and that implementation of projects depends on funding and prioritization with other projects County-wide.

Section IX: Public Participation; public outreach of this restoration plan will focus on landowners who will potentially be affected by the watershed plan. Inputs from any stakeholder or the public will be gathered during the public comment period, and addressed before the final plan is released.

Section X: References; provides a list of the references sited in this document

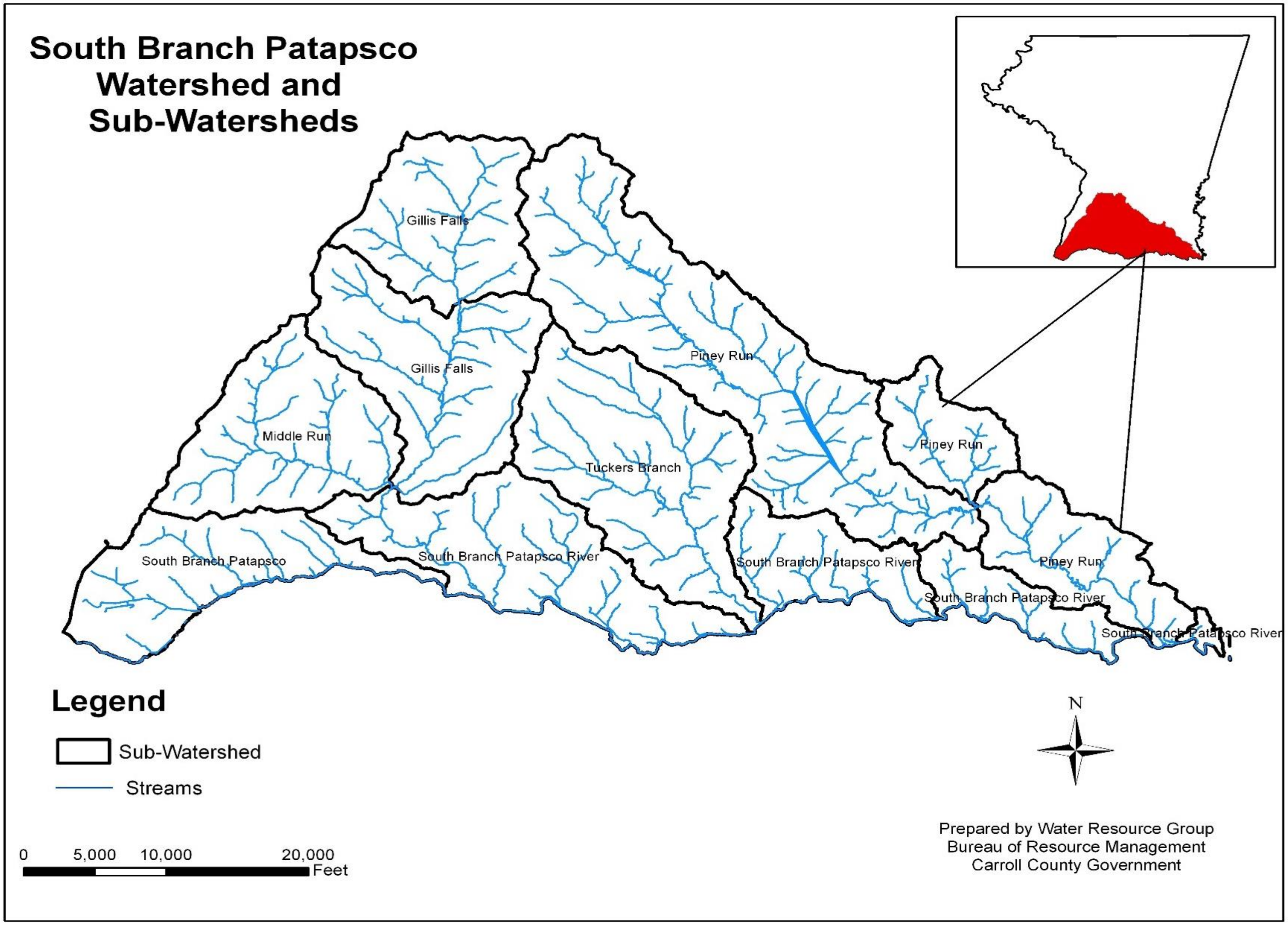


Figure 1: South Branch Patapsco Watershed and Subwatersheds Map

B. Regulatory Setting and Requirements

Maryland water quality standards have been adopted per the Federal Clean Water Act Section 101 to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Individual standards are established to support the beneficial uses of water bodies such as fishing, aquatic life, drinking water supply, boating, water contact recreation as well as terrestrial wildlife that depend on water.

The County's NPDES MS4 permit requires that a restoration plan for each stormwater WLA approved by EPA be submitted to MDE for approval. Any subsequent TMDL WLA approved by the EPA is required to be addressed in a restoration plan within one year of EPA approval.

1. Use Class Designations and Water Quality Standards

All bodies of water, including streams within Maryland and all other states, are each assigned a designated use. Maryland's designated water uses are identified in the Code of Maryland Regulations (COMAR) 26.08.02.08. The designated use of a water body refers to its anticipated use and any protections necessary to sustain aquatic life. Water quality standards refer to the criteria required to meet the designated use of a water body. A listing of Maryland's designated water uses are as follows:

- Use I: Water contact recreation, and protection of nontidal warm water aquatic life.
- Use II: Support of estuarine and marine aquatic life and shellfish harvesting (not all subcategories apply to each tidal water segment)
    - Shellfish harvesting subcategory
    - Seasonal migratory fish spawning and nursery subcategory (Chesapeake Bay only)
    - Seasonal shallow-water submerged aquatic vegetation subcategory (Chesapeake Bay only)
    - Open-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-water fish and shellfish subcategory (Chesapeake Bay only)
    - Seasonal deep-channel refuge use (Chesapeake Bay only)
- Use III: Nontidal cold water – usually considered natural trout waters
- Use IV: Recreational trout waters – waters are stocked with trout

If the letter "P" follows the use class listing, that particular stream has been designated as a public water supply. The designated use and applicable use classes can be found in Table 1.

Table 1: Maryland Designated Uses

	Use Classes							
Designated Uses	**I**	**I-P**	**II**	**II-P**	**III**	**III-P**	**IV**	**IV-P**
Growth and Propagation of fish (not trout), other aquatic life and wildlife	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Sports	✓	✓	✓	✓	✓	✓	✓	✓
Leisure activities involving direct contact with surface water	✓	✓	✓	✓	✓	✓	✓	✓
Fishing	✓	✓	✓	✓	✓	✓	✓	✓
Agricultural Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Industrial Water Supply	✓	✓	✓	✓	✓	✓	✓	✓
Propagation and Harvesting of Shellfish			✓	✓				
Seasonal Migratory Fish Spawning and Nursery Use			✓	✓				
Seasonal Shallow-Water Submerged Aquatic Vegetation Use			✓	✓				
Open-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Water Fish and Shellfish Use			✓	✓				
Seasonal Deep-Channel Refuge Use			✓	✓				
Growth and Propagation of Trout					✓	✓		
Capable of Supporting Adult Trout for a Put and Take Fishery							✓	✓
Public Water Supply		✓		✓		✓		✓

a. South Branch Patapsco Watershed Water Quality Standards

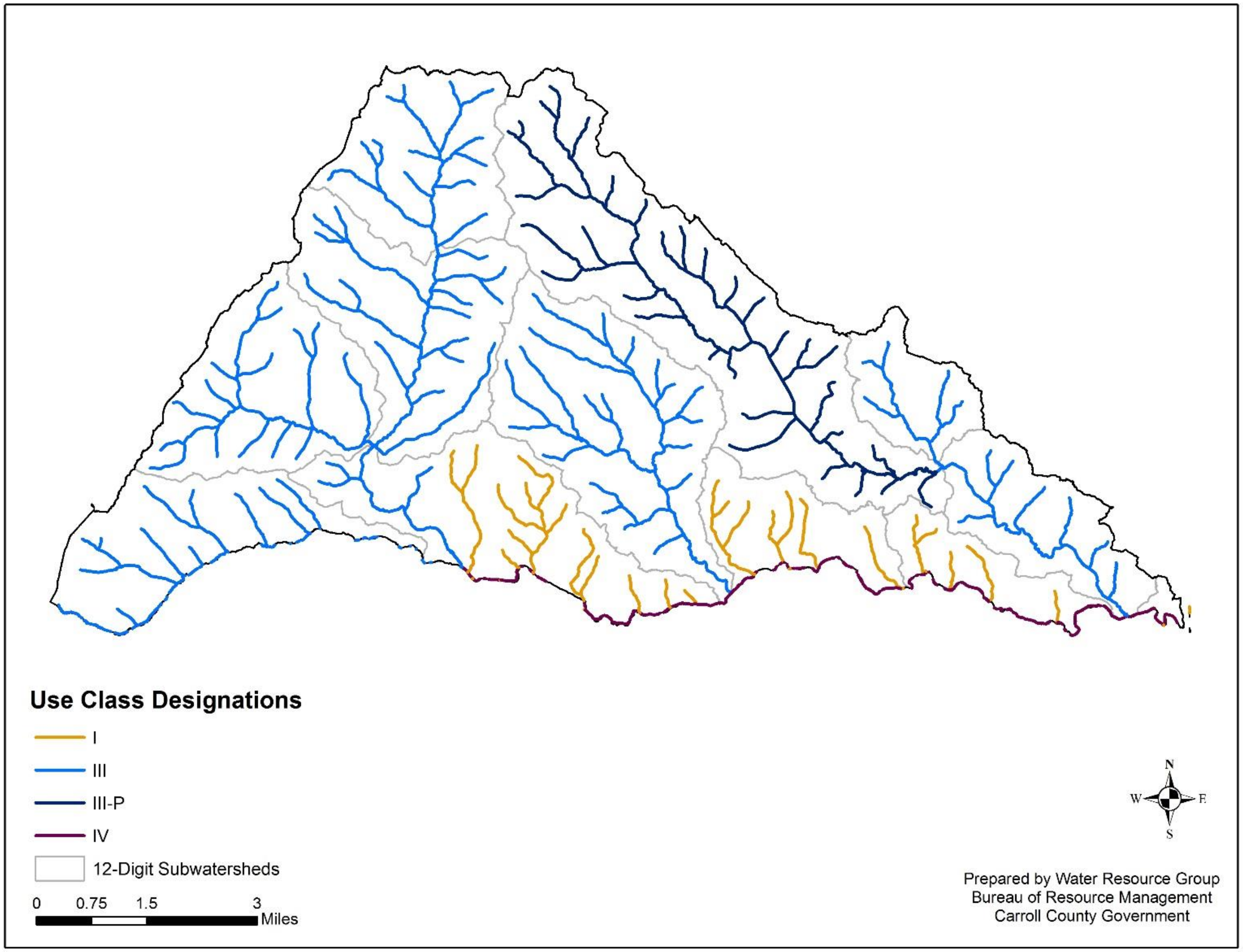
The South Branch Patapsco Watershed within Carroll County has multiple designated uses throughout the watershed and range from use I; non-tidal warm water to use IV-P; recreational trout waters and public water supply. The use III-P is capable of growing and propagating trout, whereas the use IV and IV-P are capable of supporting adult trout for a put-and-take fishery. The designated use for each stream segment within the South Branch Patapsco Watershed as determined by MDE can be found in Figure 2.

2. Water Quality Criteria

Water quality criteria is developed for each designated use and defines the level or pollutant concentration allowable to support that designated use (EPA, 2008). An example would be the human health criteria for bacteria, which are based on full body contact for a single sample or a steady state geometric mean of five samples. The freshwater criteria for bacteria are listed in Table 2.

Table 2: Freshwater Bacteria Criteria (MPN/100 mL)

Indicator	Steady State Geometric Mean Density	Maximum Allowable Density – Single Sample			
		Frequent Full Body Contact	Moderately Frequent Full Body Contact	Occasional Full Body Contact	Infrequent Full Body Contact
E. Coli	126	235	298	410	576



Source: MDE

Figure 2: South Branch Patapsco Watershed Designated Uses

3. Total Maximum Daily Loads (TMDLs)

A TMDL establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet Water Quality Standards (WQS). TMDLs are based on the relationship between pollution sources and in-stream water quality conditions (mde.state.md.us). TMDLs calculate pollution contributions from the entire watershed and then allocate reduction requirements to the various contributing sources. Within the South Branch Patapsco Watershed, these allocations are divided among counties and municipalities and then further divided by sources, including agricultural, wastewater, and stormwater. The Memorandum of Agreement (MOA) between the County and each of the Municipalities has combined the jurisdictions into one permit. This restoration plan will concentrate on joint requirements for reducing TMDL loadings associated with the stormwater WLA.

a. Phosphorus

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 7,889 lbs. /yr., the TMDL for the stormwater WLA was determined to be 6,706 lbs. /yr., which is a reduction of 1,183 lbs. /yr. (15%) from the current loading (Table 3). The baseline loads for the County and Towns were derived from the TMDL Data Center. Estimating a load contribution from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time (MDE, 2008).

Table 3: Baltimore Harbor Watershed Phosphorus TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	7,889	6,706	15%
Total	**7,889**	**6,706**	**15%**

b. Nitrogen

The current estimated stormwater baseline load for Carroll County as determined by MDE TMDL Data Center is 72,890 lbs./yr., the TMDL for the stormwater WLA was determined to be 61,957 lbs./yr., which is a reduction of 10,933 lbs./yr. (15%) from the current loading (Table 4).

Table 4: Baltimore Harbor Watershed Nitrogen TMDL

Jurisdiction	Baseline	TMDL	Percent Reduction
Carroll County	72,890	61,957	15%
Total	**72,890**	**61,957**	**15%**

II. Background

A. Location and Subwatershed Map

The Carroll County portion of the Baltimore Harbor Watershed is located along the southern portion of the County. The watershed is within the Patapsco River Basin, which lies within the Piedmont physiographic province of Maryland. There are eleven (11) major sub-watersheds in the Watershed that cover a total land area of 38,735 acres.

B. Baseline and Current Land Cover

As the land use of a watershed is modified over time it will ultimately influence the water quality within that watershed. Natural landscapes, like forests and grasslands allow for infiltration of stormwater while absorbing excess nutrients. Unmanaged impervious surfaces don't allow for infiltration, causing stormwater to concentrate. The increased runoff velocity will de-stabilize stream banks, causing potential sedimentation problems downstream.

Within the South Branch Patapsco Watershed, agriculture is the dominant land cover at about 38.5 percent of the total land, followed by low density residential which accounts for 26.7 percent, and forest, which accounts for about 25 percent of the total land cover. Mixed urban accounts for approximately 5.5 percent of the total land cover, which represents the relatively rural nature of the South Branch Patapsco Watershed.

The 2011 National Land Cover Database (NLCD) data was compared to current property data and existing land uses within the county in order to identify any gaps in urban land cover. Additional areas identified as urban were based on Section II.4 (Table 1) of MDE's 2014 Accounting for Stormwater WLA document, and consisted of rural residential lots less than three (3) acres that were listed as non-urban land uses within the NLCD database. This analysis showed a 7% increase in low-density residential land cover since 2011, which has been incorporated into Table 6.

Table 5 shows the current land cover data for the South Branch Patapsco Watershed, as well as the changes in land cover over time since 2001. The current land cover, as of 2011, within the South Branch Patapsco Watershed can be found in Figure 3.

Table 5: South Branch Patapsco Watershed Baseline and Current Land Cover

Land Cover	Acres 2001	Percent 2001	Acres 2006	Percent 2006	Acres 2011	Percent 2011	Current Acres	Percent
Open Water	289.31	<1%	289.08	<1%	289.08	<1%	289.08	<1%
Low-Density Residential	6,101.55	15.8%	6,287.98	16.2%	7,629.91	19.7%	10,341.28	26.7%
Low-Density Mixed Urban	1,492.73	3.9%	1,635.29	4.2%	1,902.51	4.9%	1,660.10	4.3%
Medium-Density Mixed Urban	347.82	<1%	454.77	1.2%	540.31	1.4%	481.68	1.2%
High-Density Mixed Urban	48.81	<1%	79.58	<1%	91.05	<1%	86.44	<1%
Barren Land	11.04	<1%	16.17	<1%	20.75	<1%	10.77	<1%
Forest	11,307.70	29.2%	11,133.74	28.7%	11,143.46	28.8%	9,722.66	25.1%
Shrub/Scrub	311.61	<1%	298.71	<1%	315.38	<1%	245.58	<1%
Grassland	60.68	<1%	99.53	<1%	89.25	<1%	73.64	<1%
Pasture/Hay	8,456.01	21.8%	8,008.07	20.7%	8,200.84	21.2%	6,836.87	17.6%
Cropland	9,376.97	24.2%	9,505.51	24.5%	9,909.01	25.6%	8,111.94	20.9%
Wetland	906.19	2.3%	901.84	2.3%	909.10	2.3%	879.42	2.3%

Source: National Land Cover Database

1. Impervious Surfaces

An increase in impervious surface cover within a watershed alters the hydrology and geomorphology of streams; resulting in increased loadings of nutrients, sediment, and other contaminants to the stream (Paul and Meyer, 2001).

The South Branch Patapsco Watershed is estimated to have 2,522 acres of total impervious within the catchment and accounts for approximately 6.5 percent of the total land area. The impervious surface area within South Branch Patapsco, by subwatershed can be found in Table 6 and is shown in Figure 4.

Table 6: South Branch Patapsco Watershed Estimated Impervious Surface Area

DNR 12-digit Scale	Subwatershed	Acres	Impervious Acres	Percent Impervious
021309081031	Gills Falls Upper	3,118.40	174.35	5.6%
021309081030	Gills Falls Lower	4,243.17	113.21	2.7%
021309081029	Middle Run	3,781.73	186.83	4.9%
021309081021	Piney Run Lower	2,306.82	151.76	6.6%
021309081023	Piney Run Main	8,007.30	504.27	6.3%
021309081024	Piney Run Tributary	1,442.79	316.29	21.9%
021309081028	South Branch Patapsco	3,169.38	419.50	13.2%
021309081025	South Branch Patapsco River	4,116.38	157.95	3.8%
021309081022	South Branch Patapsco River	1,953.15	228.86	11.7%
021309081020	South Branch Patapsco River	1,430.57	38.36	2.7%
021309081026	Tuckers Branch	5,166.27	230.55	4.5%
South Branch Patapsco Watershed		**38,735.95**	**2,521.93**	**6.5%**

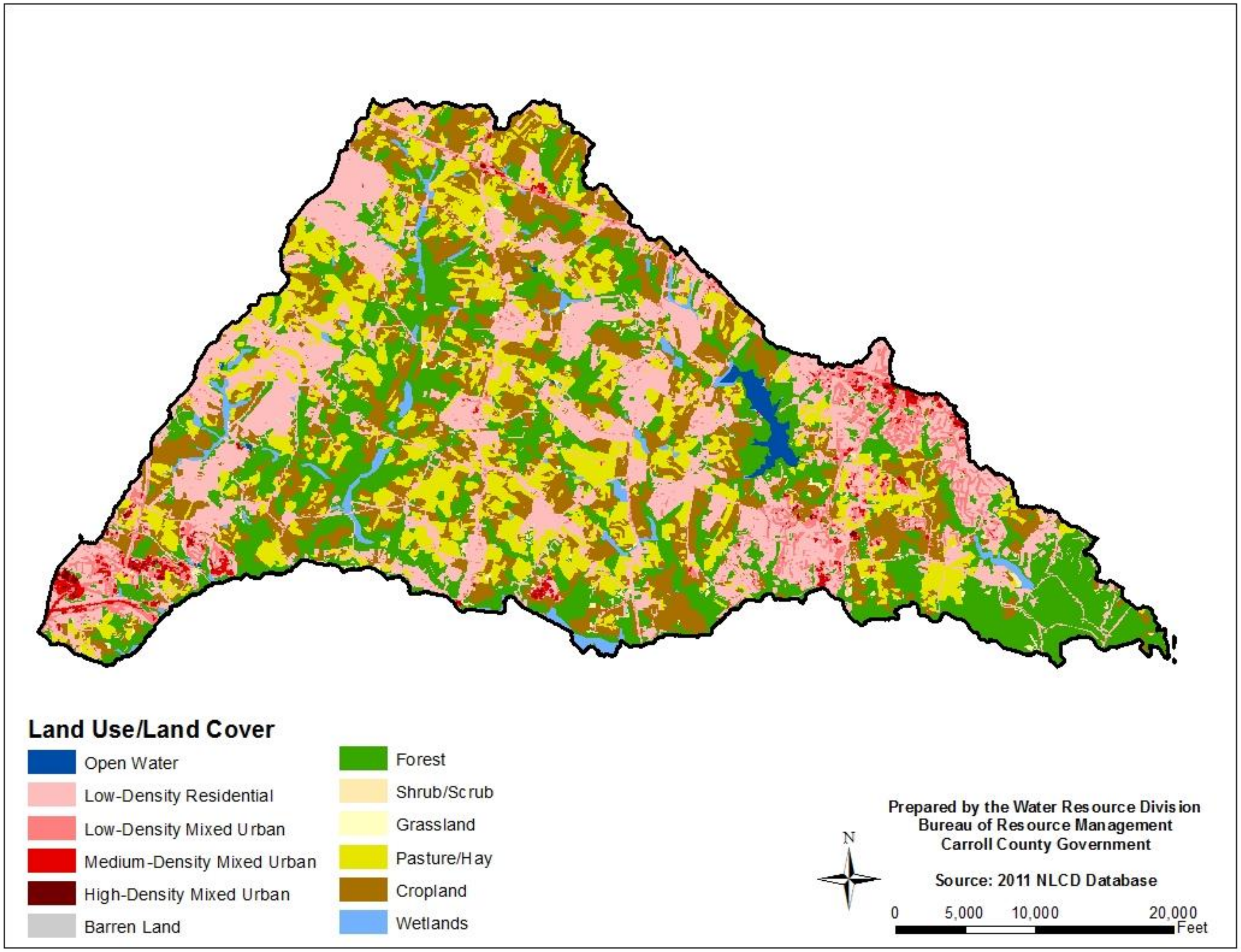


Figure 3: South Branch Patapsco Watershed Land Use/Land Cover

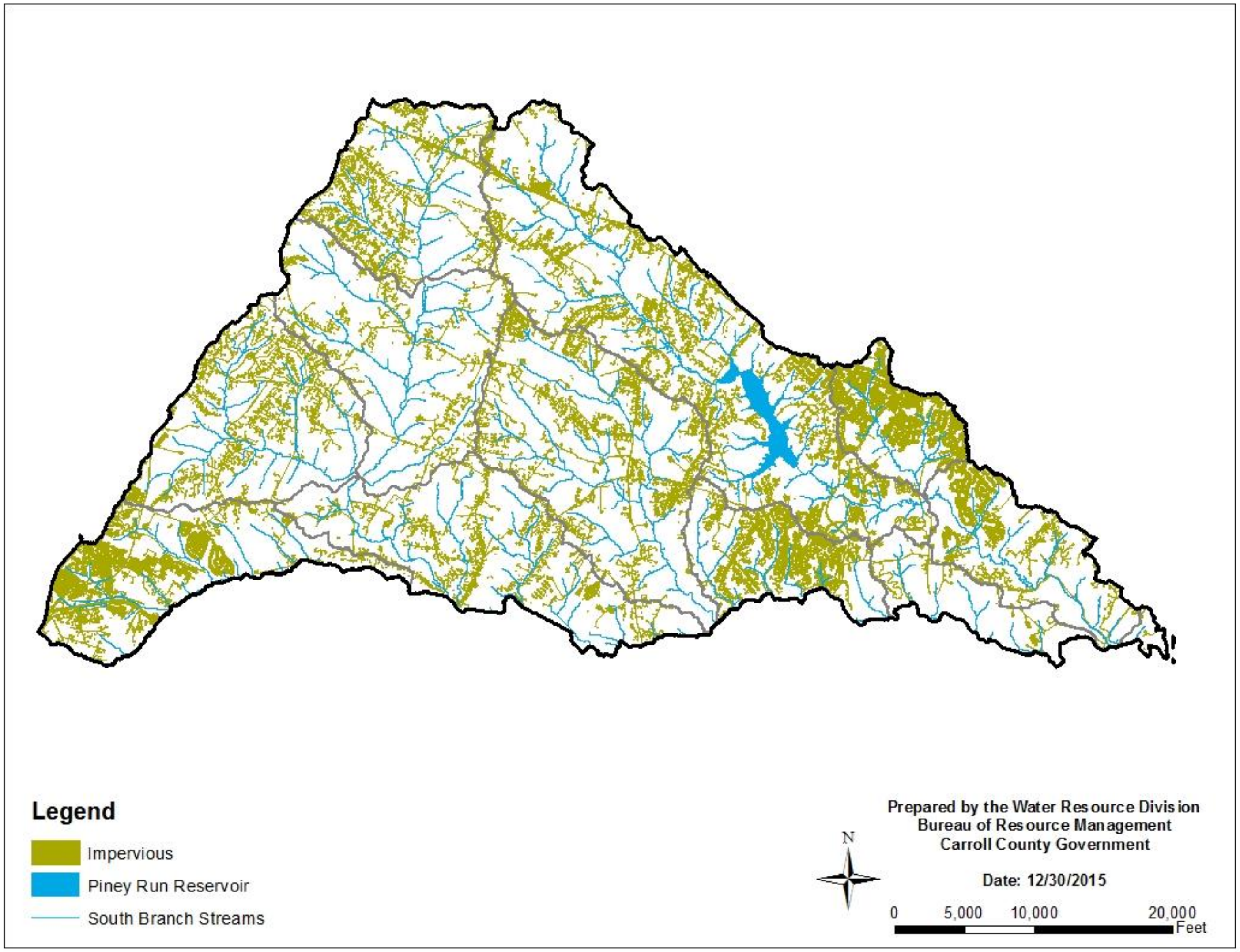


Figure 4: South Branch Patapsco Watershed Impervious Surface Area

C. Watershed Characterization

Following the South Branch Patapsco stream corridor assessment (SCA), completed in 2013, a Watershed Characterization for the South Branch Patapsco Watershed was completed. The characterization provides background on the natural and human characteristics of the watershed. The information provided in the characterization as well as information gathered during the South Branch Watershed SCA will be used as the foundation for the watershed restoration plan. The South Branch SCA and characterization documents can be found at:

http://ccgovernment.carr.org/ccg/resmgmt/southbranch/Assessment.aspx

http://ccgovernment.carr.org/ccg/resmgmt/southbranch/Character.aspx

1. Tier II Waters and Ecological Sensitive Areas

a. Tier II Waters

States are required by the federal Clean Water Act to develop policies, guidance, and implementation procedures to protect and maintain existing high quality waters and prevent them from degrading to the minimum allowable water quality. Tier II waters have chemical or biological characteristics that are significantly better than the minimum water quality requirements. All Tier II designations in Maryland are based on having healthy biological communities of fish and aquatic insects. Within the South Branch Patapsco Watershed, sections of Gillis Falls, Tuckers Branch, and Middle Run are listed as Tier II waters. Tier II designated stream segments for the South Branch Patapsco Watershed can be found in Figure 5.

b. Ecologically Sensitive Areas

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State (imap.maryland.gov). Targeted ecological areas within the South Branch Patapsco Watershed are shown in Figure 6.

For watershed restoration purposes, it is important to know and account for the habitats of sensitive species. Protecting and expanding these habitats help to preserve biodiversity and is a critical component in successfully restoring a watershed. DNR's Wildlife and Heritage Service identifies important areas for sensitive species conservation known as "stronghold watersheds". Stronghold watersheds are the places where rare, threatened, and endangered species have the highest abundance of natural communities. A complete list of all rare, threatened, and endangered plants and animals within Carroll County and throughout the state of Maryland can be found at:

http://www.dnr.state.md.us/wildlife/espaa.asp.

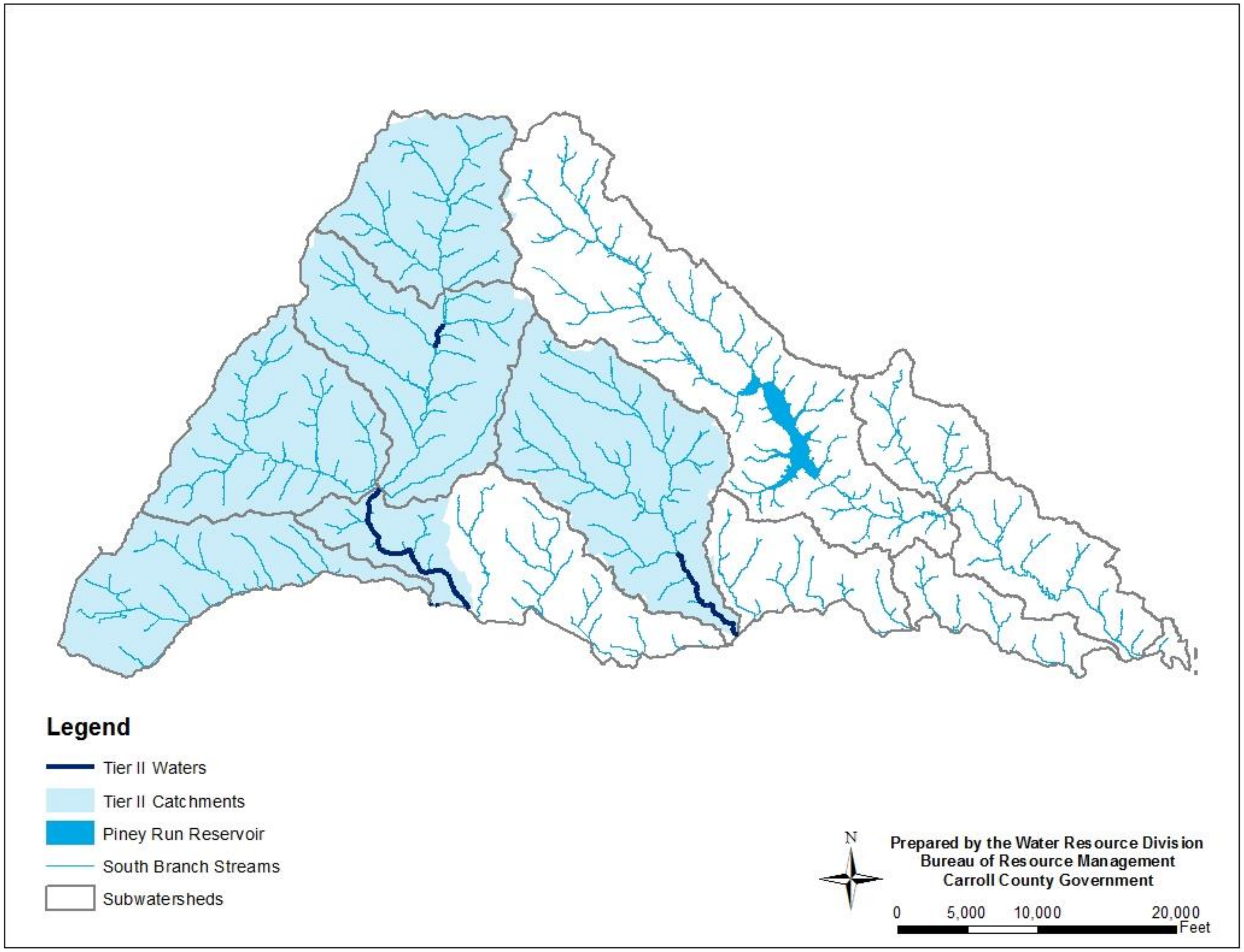


Figure 5: Tier II Waters

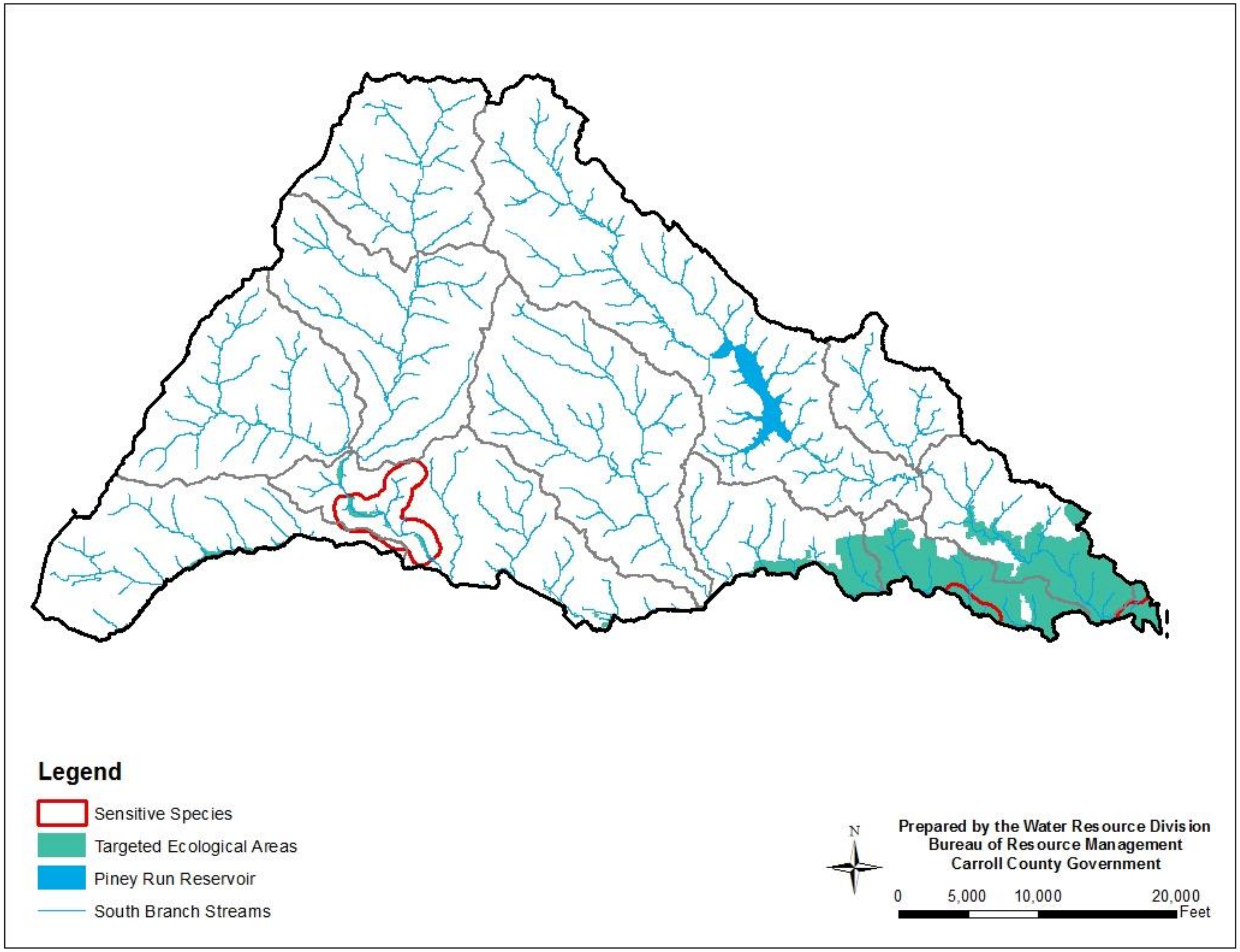


Figure 6: Targeted Ecological Areas

2. Stream Corridor Assessment (SCA)

A Stream Corridor Assessment (SCA) of the South Branch Patapsco Watershed was conducted during the winter of 2013 by Carroll County Bureau of Resource Management staff. The South Branch SCA was based on protocols developed by the Maryland Department of Natural Resources watershed restoration division (Yetman, 2001). The goal of this assessment was to identify and rank current impairments within the watershed to assist in prioritizing locations for restoration implementation. A summary of the entire South Branch SCA is available at:

http://ccgovernment.carr.org/ccg/resmgmt/southbranch/Assessment.aspx

3. Priority Watersheds

During the SCA, field crews identified erosion problems along approximately 54,500 linear feet of the corridor, 7.22% of the overall stream miles that were granted permission to assess. The highest percent of erosion based on the stream miles assessed were in Piney Run Main (1049) and Tucker's Branch (1059). Table 7 lists the total stream miles in each subwatershed, the amount of stream miles that were granted permission to assess within each subwatershed, as well as the total linear foot of erosion identified in each subwatershed, and what percent of the streams within each watershed were eroded based on the miles assessed.

Priority for restoration projects will be based on; the amount of impervious area in need of treatment and will focus on areas that will address significant downstream erosion that reduces nutrient and sediment loadings.

Table 7: Subwatershed Erosion Statistics

Stream Segment	12-Digit Stream Miles	Stream Miles Assessed (granted permission)	Erosion (Linear Ft.)	Percent of Erosion Within Assessed Corridor
Gills Falls Upper (1030)	20.39	13.49	6,060	8.51%
Gills Falls Lower (1031)	14.37	10.72	4,100	7.24%
Middle Run (1029)	18.36	14.71	3,370	4.34%
Piney Run Lower (1021)	11.46	12.66	5,170	7.73%
Piney Run Main (1023)	39.85	30.20	18,760	11.76%
Piney Run Tributary (1024)	7.15	5.51	0	0%

South Branch Patapsco (1028)	18.09	10.73	1,925	3.40%
South Branch Patapsco River (1020)	10.15	10.64	1,190	2.12%
South Branch Patapsco River (1022)	11.89	10.25	5,490	10.14%
South Branch Patapsco River (1025)	24.49	12.96	2,400	3.51%
Tuckers Branch (1026)	25.02	11.18	6,035	10.22%
Total	**201.22**	**143.05**	**54,500**	**7.22%**

III. New Development

A. Build-Out Analysis

Buildable Land Inventory (BLI) analyzes the number of residential lots that could be created, or single-family units constructed. The BLI is estimated based on the jurisdiction's current zoning and/or proposed future zoning (called "land use designation"). The BLI looks at existing development and, based on a yield calculation, determines how many more residential units can be built in the future. The BLI model does not include commercial or industrial development potential, but does contain information on land zoned and designated for these uses. Within the South Branch Patapsco Watershed there are 2,053 parcels remaining with potential development on 12,310 acres for an estimated lot yield of 4,581 (build out data was provided by the GIS group of Carroll County's Department of Land and Resource Management). This data is based on a medium range buildable land inventory estimate by land use designations. The medium range estimates have been determined to be the most accurate for build out. The full buildable land inventory report can be found at: http://ccgovernment.carr.org/ccg/compplanning/BLI/. Figure 7 shows the remaining parcels in South Branch Patapsco Watershed where residential units could be built.

In addition to the BLI, the Carroll County Department of Land and Resource Management, Bureau of Development Review oversees the division of land and lot yield potential for properties in Carroll County. A parcel's potential lot yield is dependent on its size, the zoning district, the history of the property and whether or not it has in-fee frontage on a publically maintained road. The development and subdivision of land is regulated under Carroll County Code Chapter 155, and the Zoning Regulations are regulated under Carroll County Code Chapter 158.

B. Stormwater Management

Stormwater runoff associated with new development is addressed through Chapter 151 of the Carroll County Code of Public Local Laws and Ordinances. The purpose of this chapter is to protect, maintain, and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The goal of Chapter 151 is to manage stormwater by using environmental site design (ESD) to the maximum extent practicable (MEP) to maintain after development as nearly as possible, the predevelopment runoff characteristics, and to reduce stream channel erosion, pollution, and sedimentation, and use appropriate structural BMPs only when necessary. Implementation of Chapter 151 will help restore, enhance, and maintain the physical, chemical, and biological integrity of streams, minimize damage to public and private property, and reduce impacts of land development.

The current chapter was adopted in 2010 and was written to adopt the State of Maryland revisions to the design manual (MD Code, Environmental Article, Title 4, Subtitle 2), which mandated the use of non-structural ESD practices statewide to the MEP to mimic totally undeveloped hydrologic conditions.

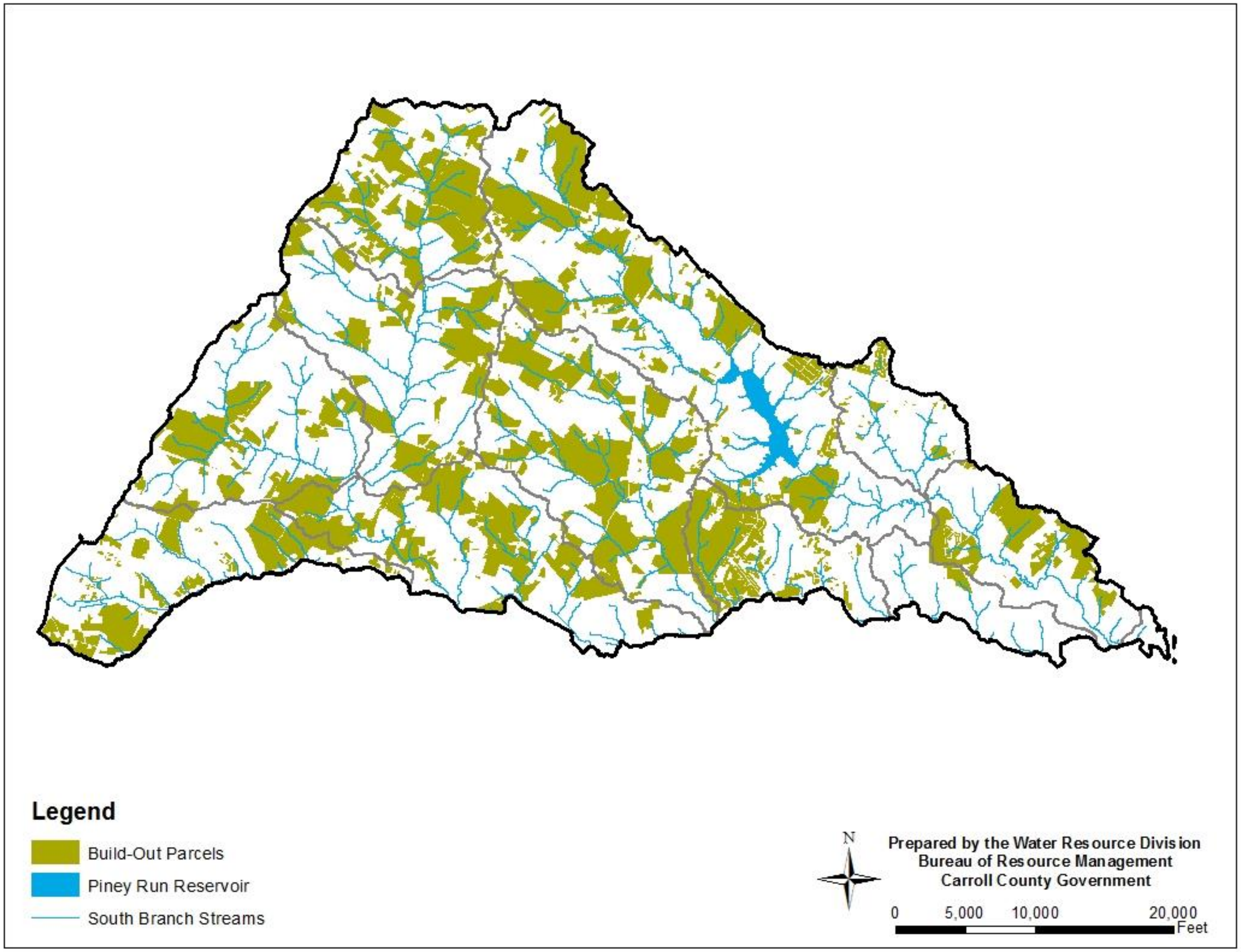


Figure 7: South Branch Patapsco Watershed Build-Out Parcels

C. County Easements

As part of the development process, Carroll County protects waterways and floodplains with perpetual easements to minimize the potential for impacts during and after construction to these sources. The purpose of the Carroll County Water Resource code (Chapter 154) is to protect and maintain ground and surface water resources of the County by establishing minimum requirements for their protection. Chapter 153 provides a unified, comprehensive approach to floodplain management. Floodplains are an important asset as they perform vital natural functions such as; temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, and prevention of erosion. Within the South Branch Patapsco Watershed there are 158.72 acres of grass buffer and 272.17 acres of forest buffer protection easements. A list of the grass buffer and forest buffer protection easements within the South Branch Patapsco Watershed can be found in Appendix B, and are shown in Figure 8. These perpetually protected easements limit landowner use of environmentally sensitive areas and reduce the amount of nutrients entering the waterway.

D. Rural Legacy Areas

Maryland's Rural Legacy Program was created in 1997 to protect large, continuous tracts of land from sprawl development and to enhance natural resource, agricultural, forestry and environmental protection through cooperative efforts among state and local governments and land trusts. http://www.dnr.state.md.us/land/rurallegacy/index.asp

The goals of the rural Legacy Program are to:

- Establish greenbelts of forests and farms around rural communities in order to preserve their cultural heritage and sense of place;
- Preserve critical habitat for native plant and wildlife species;
- Support natural resource economies such as farming, forestry, tourism, and outdoor recreation, and;
- Protect riparian forests, wetlands, and greenways to buffer the Chesapeake Bay and its tributaries from pollution run-off.

The South Branch Patapsco watershed lies just south of the Little Pipe Creek Rural Legacy area but is not within the Rural Legacy Area. The location of South Branch Patapsco watershed in relation of the Rural Legacy Area can be found in Figure 9.

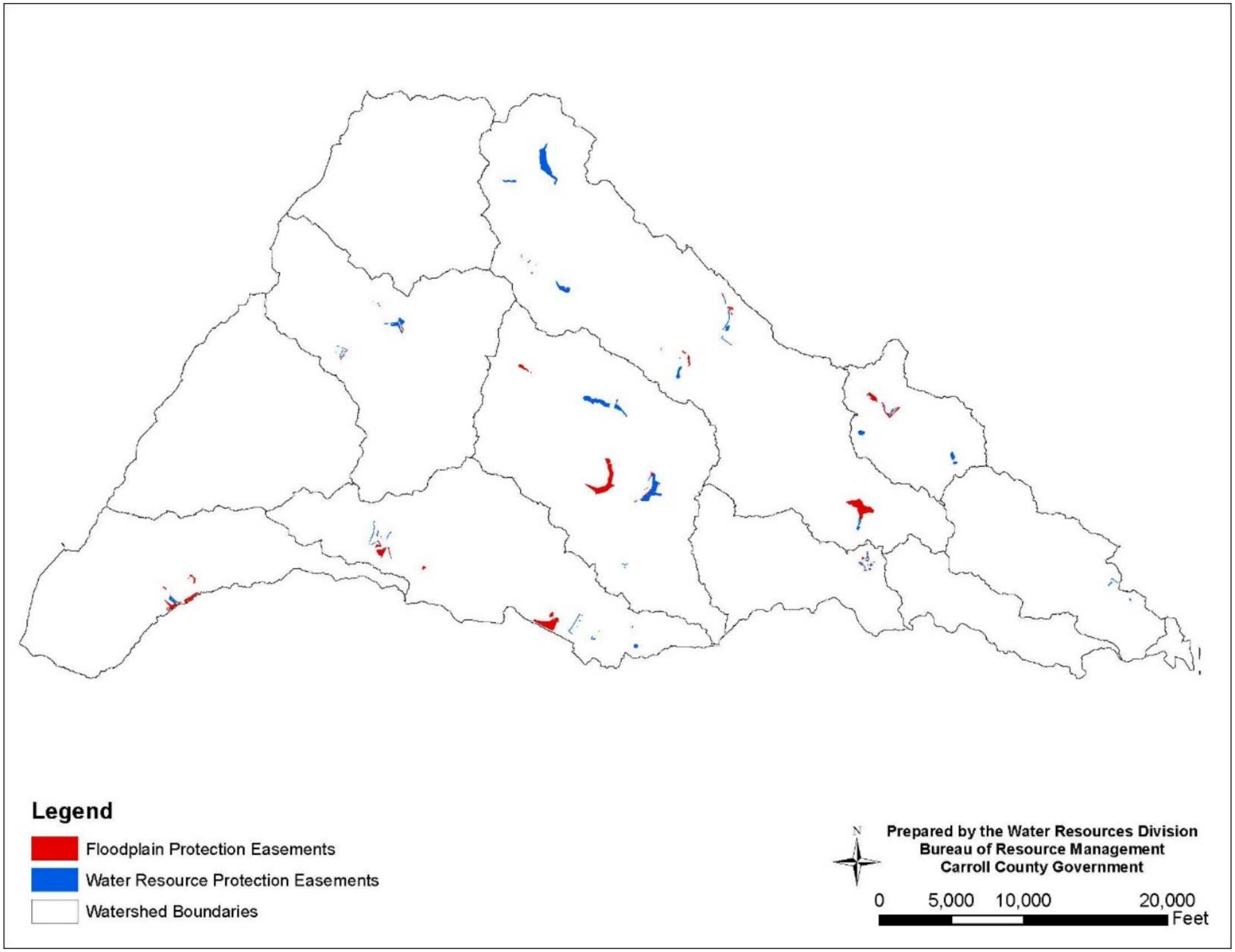


Figure 8: Water Resource and Floodplain Protection Easement Locations

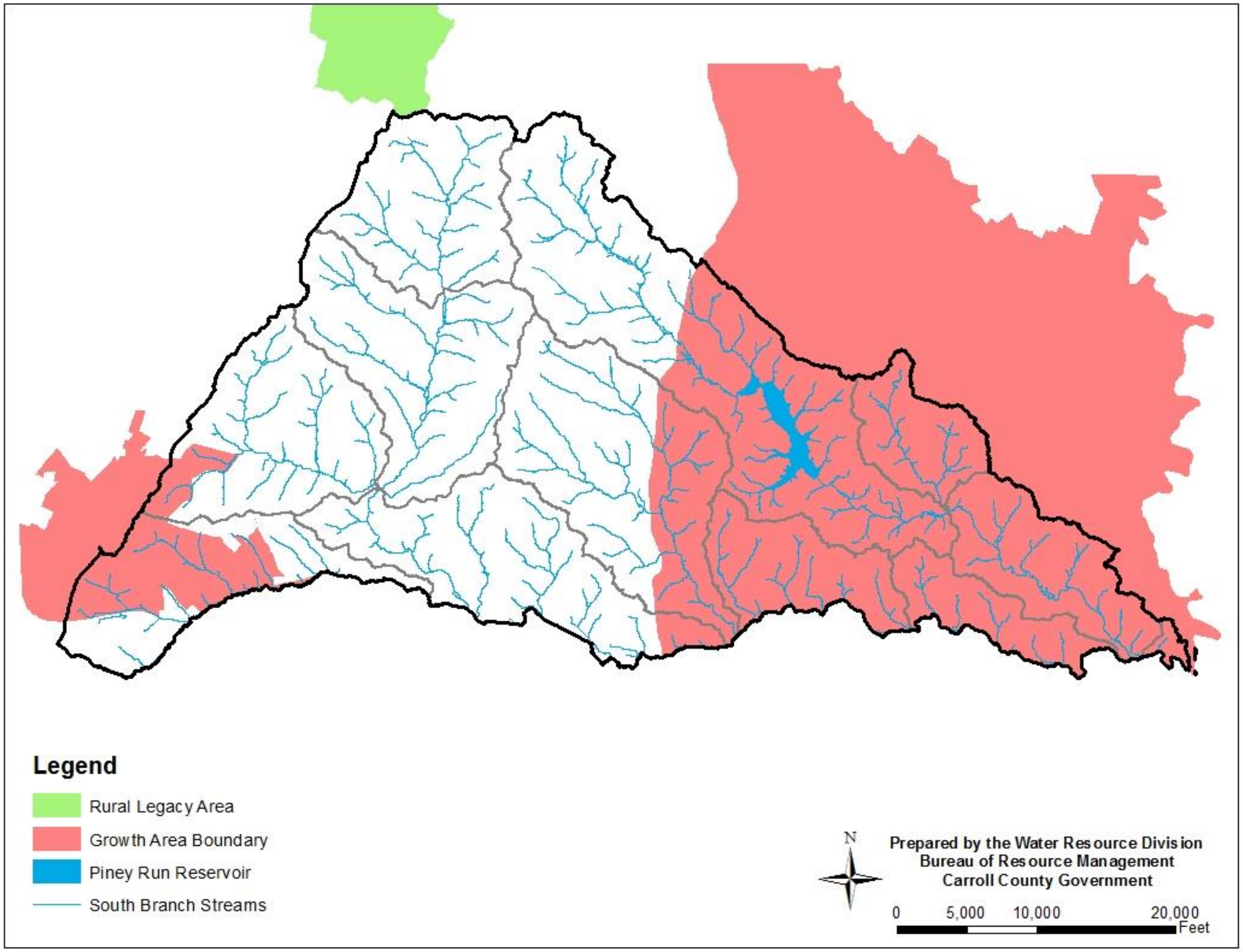


Figure 9: Upper Patapsco Rural Legacy Area

IV. Public Outreach and Education

An informed community is crucial to the success of any stormwater management program (US EPA, 2005). The benefits of public education are unmeasurable; the National Environmental Education & Training Foundation (NEETF) found that 78 percent of the American public does not understand that runoff from impervious surfaces, lawns, and agricultural lands, is now the most common source of water pollution (Coyle, 2005). Throughout the year, County staff regularly hosts or participates in events to help inform the public of the importance of stormwater management.

A. Water Resources Coordination Council

The Water Resources Coordination Council (WRCC) was formed by the County Commissioners, eight municipalities, and the Carroll County Health Department in February of 2007 through a cooperative partnership and by formal joint resolution to discuss and address issues related to water resources. The monthly meetings, composed of representatives from the eight municipalities, the County, and the Carroll County Health Department provide an excellent opportunity to discuss pertinent issues related to water, wastewater, and stormwater management.

WRCC took the lead in coordinating and developing a joint Water Resources Element (WRE), which was adopted by the County and seven municipalities. The WRCC also serves as the local Watershed Implementation Plan (WIP) team for development and implementation of Maryland's Phase III WIP and continues to address WIP related issues and tasks as they arise.

In FY 2013 and FY 2014, the WRCC collaborated to develop, sign, and implement a Memorandum of Agreement (MOA) to implement NPDES permit requirements with specific provisions to cost-share the capital costs of meeting the municipalities' stormwater mitigation requirements. The WRCC will act as the forum for setting project priorities, and the County will continue to provide administrative and operating support services for the stormwater mitigation program.

1. Carroll County NPDES MS4 Team

The NPDES team was formed following the issuance of the County's most recent MS4 permit, which became effective on December 29, 2014. The team meets on a quarterly basis to discuss goals and deadlines related to NPDES MS4 discharge permit compliance. The team consists of personnel from the Department of Land and Resource Management; administration, water resources, stormwater, grading, engineering, and compliance.

B. Environmental Advisory Council (EAC)

The Environmental Advisory Council (EAC) is currently the mechanism in which the County continues to provide an open forum on environmental issues and concerns. This Commissioner-appointed citizen board holds monthly meetings, which are open to the public. The EAC functions at the direction of the Carroll County Board of Commissioners; works cooperatively with County environmental staff to research environmental policy issues, advises the Board of County Commissioners on environmental issues, fosters environmental education, and generally acts in the best interest of County residents by promoting effective environmental protection and management principles. EAC has been regularly briefed on NPDES permit specifics and implementation.

1. Community Outreach

In its role to promote environmental awareness and outreach, every other year, the EAC accepts nominations for Environmental Awareness Awards. Winners are recognized in a joint ceremony with the Board of County Commissioners, in the press, and on the EAC's website.

Since 2014, the EAC annually prepares a Carroll County Environmental Stewardship booklet, which is made available on the website, as well as various other venues. The booklet describes various efforts and initiatives undertaken by the County to demonstrate environmental stewardship and protection, including stormwater mitigation, management projects, and progress.

C. Public Outreach Plan

The public outreach plan provides a holistic review of the public outreach opportunities currently provided and available to residents and businesses in Carroll County and its eight municipalities. The goal of the public outreach plan is to raise public awareness and encourage residents and businesses to take measures to reduce and prevent stormwater pollution.

Public outreach efforts will focus on the issues and topics prescribed in the County's MS4 permit. The permit requires outreach to County and municipal staff, general public, and the regulated community. Emphasis will be given to facilities and businesses at a higher risk for stormwater pollution or potential illicit discharges, as well as homeowner associations and school students.

D. Educational Venues

County staff is continuously involved in environmental education efforts such as regularly speaking at schools, community organizations, club meetings, and other venues in an effort to ensure that key environmental information is available to the community. An information booth is set up at events sponsored by the Towns and County providing citizens with informational materials relating to homeowner stewardship, restoration efforts throughout the County, and an opportunity to volunteer in these efforts. Educational

events that County staff have participated in that are either held within the South Branch Patapsco Watershed or offered to citizens countywide can be found in Table 8.

Table 8: MS4 Public Outreach Events

Event	Year	Watershed
12SW/SR Permittee Workshop	2018	Countywide
Agricultural Tire Amnesty Program	2016	Countywide
Annual Backyard Buffers Education Day	2017, 2018, 2019	Countywide
Arbor Day Tree Planting Ceremony	2016	Countywide
America Recycles Day	2017, 2018	Countywide
Carroll Arts Council Festival of Wreaths	2015, 2017, 2018	Countywide
Carroll County 4H Fair	2015, 2016	Countywide
Carroll County NPDES MS4 Permit Annual Stormwater Pollution Prevention Compliance Training	2015, 2016, 2017, 2018	Countywide
Carroll County Employee Appreciation Day	2016, 2017, 2018, 2019	Countywide
Carroll County Envirothon	2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019	Countywide
Carroll County Home Show	2016, 2017, 2018, 2019	Countywide
Carroll County Household Hazardous Waste Fall Clean-Up	2016, 2017, 2018, 2019	Countywide
Carroll County Seniors on the Go Expo	2016, 2017, 2018, 2019	Countywide
Chesapeake Bay Awareness Week Stormwater Tour	2017	Countywide
Choose Clean Water Coalition NPDES MS4 Tour	2018	Countywide
Earth Day Celebration	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Advisory Council	2014, 2015, 2016, 2017, 2018, 2019	Countywide
Environmental Awareness Awards Presentation	2016	Countywide
Hampstead Fall Fest	2016, 2017, 2018	Countywide
Hampstead-Manchester Business & Community Expo	2017, 2018, 2019	Countywide

Homeowners & Stormwater Workshop	2017	Countywide
Mid-Atlantic Car Wash Association "Wash to Save the Bay"	2019	Countywide
National Night Out	2014, 2015, 2016, 2017, 2018	Countywide
Rain Barrel & Composting Event	2015, 2016, 2017, 2018, 2019	Countywide
Scrap Tire Drop Off Day	2019	Countywide
Sykesville Annual Spring Clean-Up Day	2018, 2019	South Branch
Town Mall Earth Day Event	2016	Countywide
Westminster FallFest	2015, 2016, 2017, 2018	Countywide
Westminster Flower & Jazz Festival	2017, 2018, 2019	Countywide
Workshop: Businesses for Clean Water	2016	Countywide

The County continues to expand their education and outreach efforts within all watersheds, and always looks for additional opportunities to engage the public with water resource related issues.

V. Restoration Implementation

The following describes the BMPs and restoration projects that have been either completed or proposed to meet the local TMDL requirements for the Baltimore Harbor Watershed. Appendix A also provides a complete list of restoration activities, their associated reduction values, subwatershed location, project status, project cost and anticipated completion date.

A. Stormwater Management Facilities

When runoff from precipitation flows over impervious surfaces it can accumulate various debris, chemicals, sediment, or other pollutants that could adversely affect the water quality of a stream. If not controlled, there is a high potential for stream degradation. This is due not only to pollutants that are carried directly into the water, but also the volume and velocity of the water that physically cuts away the stream bank, which results in habitat degradation and sediment mobilization.

The State of Maryland began requiring stormwater management in the mid 1980's for new development to manage the quantity of runoff. These requirements were initially established for any subdivision with lots of less than 2 acres in size. For lots greater than 2 acres, stormwater management was only required to address road runoff. In 2000, Maryland Department of Environment (MDE) released a new design manual for stormwater (MDE, 2000). The new manual required greater water quality and quantity controls and included stormwater management for subdivisions with lots greater than 2 acres. The manual was then revised in 2009 to reflect the use of environmental site design (ESD) practices.

Chapter 151 of the Carroll County Code was adopted pursuant to the Environmental Article, Title 4, Subtitle 2 of the Annotated Code of Maryland. Municipalities in Carroll County have either delegated authority to implement Chapter 151, or have their own code to administer stormwater management. These codes apply to all development and establish minimum requirements to control the adverse impacts associated with increased stormwater runoff.

Properly designed and maintained stormwater ponds will help improve their performance (Clary et al. 2010; US EPA 2012). In 2007, the Department of Public Works provided BRM with a County-wide list of SWM facilities owned by the County which had issues relating to maintenance (i.e. no available easements for accessing the property, slopes too steep to mow, trees too large to remove, etc.) After reviewing the list, BRM performed a GIS exercise to determine the drainage areas and impervious acres associated with these facilities. Field investigations were performed to determine the existing conditions of the facilities and if additional drainage could be diverted into the facilities for treatment. A stormwater management facility retrofit program, which included a project schedule, was then established based on projected costs associated with the retrofits, outstanding compliance issues, and funding available in fiscal years 2008 thru 2013. This process and the SCA(s) have aided BRM in establishing projects to date for the program.

The facilities proposed for implementation to assist in addressing the Baltimore Harbor Watershed TMDL's, that have been either completed or planned, are listed in Table 9. The location of each facility can be found in Figure 10, the practice type and runoff depth treated for each facility can be found in Appendix C.

Table 9: Proposed Stormwater Management Projects

Project Name	Drainage Area	Impervious Area	Project Type	Implementation Status	Subwatershed
Arthurs Ridge	51.17	5.14	Retrofit	C	1023
South Carroll High-Fine Arts	24.22	12.94	Facility	C	1023
Brimfield	34.69	9.15	Retrofit	C	1021
Harvest Farms 1A	43.8	11.25	Retrofit	C	1021
Parrish Park	94.23	18.2	Retrofit	C	1024
Clipper Hills Gardenia	33.19	11.08	Retrofit	C	1021
Clipper hills Hilltop	80.17	18.54	Retrofit	C	1021
Carroltowne 2B	34.61	10.38	Retrofit	C	1024
Carroltowne 2A	87.73	34.43	Retrofit	C	1024
Benjamins Claim	47.1	15.78	Retrofit	C	1024
Eldersburg Estates 3-5	34.91	8.16	Retrofit	C	1024
Braddock Manor West	49.3	7.65	Retrofit	C	1023
Benjamins Claim Basin B	1.33	0.55	Retrofit	C	1024
Hawks Ridge	63.48	19.8	Retrofit	C	1022
Merridale Gardens	81	23.81	Retrofit	C	1028
Shannon Run	213.5	34.1	Retrofit	C	1022
Piney Ridge Village AB 57	25.7	8	Retrofit	P	1024
Woodyside Estates Small	9.02	2.11	Retrofit	P	1023
Woodyside Estates Large	63.36	14.02	Retrofit	P	1023
Lexington Run Section 1	12.87	2.62	Retrofit	P	1022
Waters Edge Section 4	72.4	21.19	Retrofit	P	1023
Melstone Valley	170	22.5	Retrofit	P	1021

IDA Property	75.5	10.5	Facility	P	1029
Winfield Fire Dept.	0.22	0.22	Facility	P	1023
Totals:	**1,403.50**	**322.12**			

B. Storm Drain Outfalls

During the South Branch Watershed SCA in 2013, erosion sites were documented and rated on severity. SCA identified erosion sites were analyzed in GIS to the location of existing stormwater management facilities and identified any gaps in the storm drain network that were then further investigated in the field. Storm drain outfalls that have no stormwater controls or where stormwater management is not up to current standards have been identified as possible locations where stormwater practices could be implemented as a way to reduce erosive flows and consequently allow for natural regeneration of vegetation to occur within the stream corridors.

C. Rain Gardens

Most elementary schools within Carroll County have planted a rain garden as part of the Science, Technology, Engineering, and Mathematics (STEM) program. Rain gardens are shallow depressions that assist with treating stormwater by using native plants to soak up and filter runoff from the surrounding impervious surfaces. Five elementary schools within the South Branch Patapsco Watershed have planted implemented rain gardens with a total drainage area of 2.59 acres.

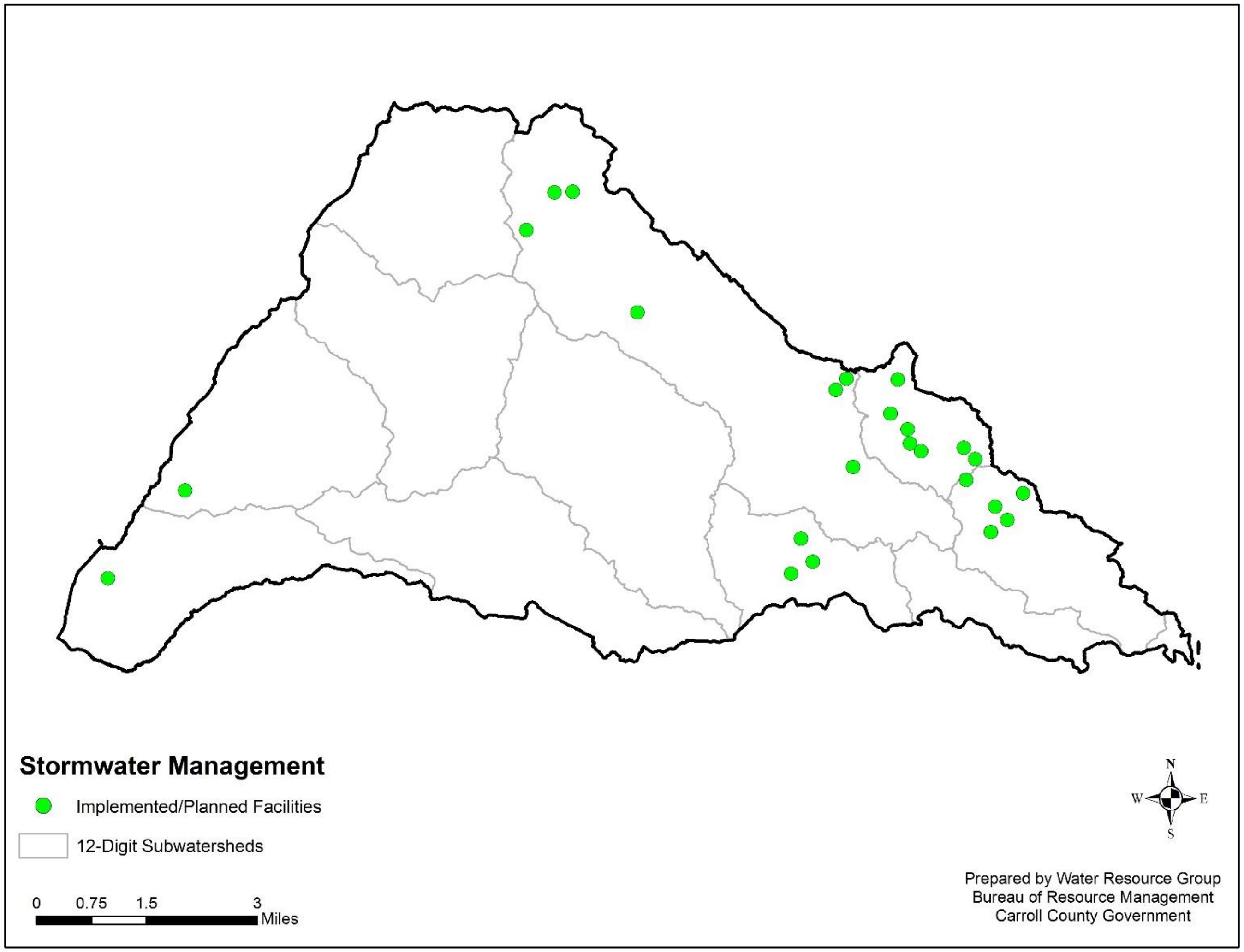


Figure 10: Stormwater Management Locations

D. Tree Planting and Reforestation

Stream buffers are vegetated areas along streams that reduce erosion, sedimentation and pollution of water (US EPA 2012a). Following the completion of the 2011 SCA in the Prettyboy Watershed, the BRM began a stream buffer initiative. This initiative is completely voluntary to landowners with a goal of re-establishing forested corridors along as many streams as possible utilizing native tree stocks.

1. Residential Buffer Plantings

The 2013 South Branch SCA determined that approximately 8 percent of stream miles walked were inadequately buffered. In an effort to address inadequately buffered streams, letters were mailed to landowners whose properties were identified as having an inadequate buffer. This letter provided education on the importance of stream buffers and offered grant-assisted buffer plantings at no cost to the homeowner. Nine properties participated in this initiative over three different planting cycles. The acreage planted for each location and the associated subwatershed can be found in Table 10. The approximate locations of the residential buffer plantings are shown in Figure 11.

Table 10: Stream Buffer Plantings (Municipal/Residential)

	Acres Planted	Buffer Length	Buffer Width	12- Digit Subwatershed	Date Planted
Planting 1	5.6	1,860	75	1023	Fall 2014
Plating 2	3.45	275	400	1031	Fall 2014
Planting 3	0.16	243	20	1026	Fall 2014
Planting 4	3.2	176	--	1028	Spring 2015
Planting 5	0.3	300	30	1025	Fall 2015
Planting 6	3	--	--	1023	Fall 2015
Planting 7	0.23	240	30	1023	Fall 2018
Planting 8	0.13	140	50	1023	Fall 2018
Planting 9	0.13	120	45	1023	Fall 2018

a. Monitoring Schedule & Implementation Assurance

Plantings implemented through the Bureau's stream buffer initiative include a maintenance term, which consists of mowing, stake repair, and shelter maintenance. Successful plantings require the survival of 100 trees per acre. Each planting will be inspected bi-annually for ten years to ensure the success of the program, and once every three years after the ten year period. In addition, the homeowners have signed agreements to ensure that the planting areas are maintained and protected.

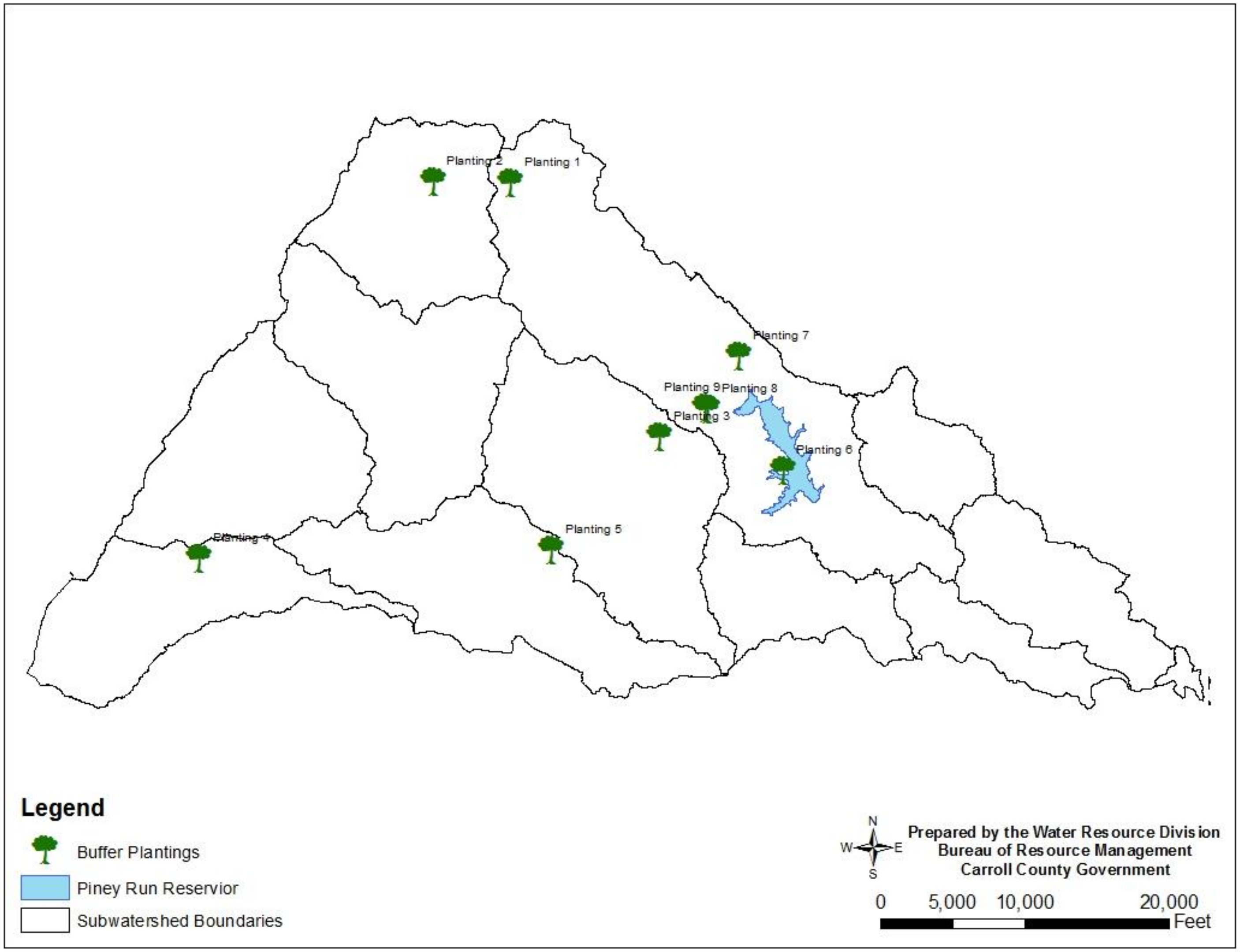


Figure 11: Stream Buffer Initiative Locations

E. Stream Restoration

Streams are dynamic systems that adjust to tectonic, climatic and environmental changes imposed upon them (Dollar, 2000). A stream system adjusts in order to maintain a steady state, or dynamic equilibrium between the driving mechanisms of flow and sediment transport and the resisting forces of bed and bank stability and resistance to flow (Soar et al., 2001).

Historic land use and more recently, urbanization, has deteriorated the quality of streams within the Piedmont. Booth and Henshaw (2001) documented the increase of sediment yield and channel erosion within urbanizing streams, and research has shown that sediment yields in urban streams are more than an order of magnitude higher when compared to rural streams (Langland and Cronin, 2003).

The County has identified the implementation of stream restoration practices as a method to potentially reduce nutrient and sediment loadings within the watershed.

F. Streambank Regeneration

Accelerated streambank erosion occurs downstream of inadequately managed impervious from development. The proportion of rain water that previously infiltrated into the ground is reduced. Thus, causing immediate runoff, and increasing the total amount and velocity of flow in the receiving channel, accelerating erosion and resulting in greater sediment loads within the stream corridor.

There are two effective ways to reduce the destabilizing velocity increases in the receiving channel. The first is traditional stream restoration, increasing the plan form and bank resistance. The second is upland stormwater management, storing the total runoff volume and dissipating the acquired kinetic energy as turbulence in the water pool.

In the Piedmont, many residential, institutional, or commercial areas were developed prior to 1982 without any stormwater management or subsequently with peak flow control that matched existing conditions only, not really returning the runoff characteristics to predevelopment, as required by COMAR 26.17.02.01. Matching the existing hydrologic runoff response in these areas does not address existing streambank instability and does nothing to help restore streams or reduce current nutrient and legacy sediment export to the Bay.

Carroll County has been experimenting with the use of enlarged, enhanced, sand filters as primary stormwater management for more than 10 years. In an effort to determine the cause of these unanticipated stormwater management/quality/stream restoration benefits, we reanalyzed the design information. This showed that the Carroll County standard design reduced the two-year storm peak flow below that of an equivalent forested watershed in good condition. This has always been the goal of stormwater management, returning the hydrologic condition to that assumed to exist in pre-contact times.

Since the two-year flow is thought to control bank geometry, it makes sense that this would be an unintended benefit of truly adequate stormwater management. How far downstream the effect extends is site specific and depends on the soil types and land uses in the unmanaged portion of the watershed below the sand filter.

Although streambank regeneration is not currently an approved practice in the 2014 MDE guidance document (MDE, 2014), the guidance states that innovative practices that are not approved under the Maryland Stormwater Design Manual (MDE, 2000) nor have an MDE or CBP assigned pollution removal efficiency can be used to offer jurisdictions additional options toward watershed restoration activities, provided that there is proper documentation and monitoring to verify pollutant removal efficiencies acceptable to MDE. The County has developed a paired watershed approach to evaluate the effectiveness of upland stormwater management practices on stream channel protection protection and began a 3-year study in 2016 collecting the necessary data to document the sediment and nutrient reduction benefits associated with this practice. The results will inform recommendations to credit upland stormwater practices as a hydrogeomorphic stream stabilization technique for sediment reductions.

Interim nutrient reductions associated with streambank regeneration are included in Appendix C in anticipation of the study results and are derived from the default stream restoration credit included in the 2014 MDE guidance.

G. Road Maintenance Projects

County and Municipal road crews perform regular maintenance to infrastructure such as; inlet cleaning, street sweeping, storm drain cleaning, and removal of impervious surfaces. Accounting for the number of inlets cleaned or the tons of debris removed provides an accurate measurement of how these particular practices reduce loadings within the watershed.

Street sweeping, using either mechanical or vacuum-assisted equipment will remove buildup of pollutants that have been deposited along the street or curb, whereas, the removal of impervious surfaces will improve water quality by changing the hydrologic conditions within the watershed. Road maintenance projects completed within the South Branch Patapsco Watershed are shown in Table 11.

Table 11: Road Maintenance Projects

Management Practice	**Inlet Cleaning**		
Town	Tons Removed	12-Digit Watershed	Date of Completion
Sykesville	0.25	1022	Annual

H. Septic Systems

With the decline in water quality to the Chesapeake Bay, Senate Bill 320, Bay Restoration Fund, was signed into law in May of 2004. The purpose of the Bay Restoration Fund (BRF) was to address a major contributor of nutrients to the Bay such as effluent discharge, by creating a dedicated fund to upgrade Maryland's wastewater treatment plants with enhanced nutrient removal (ENR) technology to improve wastewater effluent quality. A portion of the BRF also collects fees from septic system users that will be utilized to upgrade on-site disposal systems (OSDS) to best available technology (BAT) as the drainage from failed septic systems may make its way through the drain field and eventually into local waters (Clary, et al. 2008). New septic systems, repairs, and replacements are tracked through the County Health Department.

Nutrient loads from failing septic systems are not part of the MS4 load reduction requirements for the County or Towns. However, upgrading septic systems or connecting houses to a sanitary sewer system will help the overall achievability of the TMDLs. Since 2009, thirty one (31) septic systems within the South Branch Patapsco Watershed have been repaired and thirty five (35) new systems have been built utilizing Best Available Technology (BAT). Twenty nine (29) of these projects have been via the Bay Restoration Fund. BAT has been proven to be effective at nitrogen removal but has not been shown to reduce Phosphorus. Any reductions to bacteria loading are also unknown at this time. Septic systems that have been built or repaired utilizing BAT within the South Branch Pataspco Watershed are listed in Appendix C.

I. Agricultural Best Management Practices (BMPs)

Agricultural BMPs are on-the-ground practices that help minimize runoff and delivery of pollutants into our waterways. Practices can be categorized as soft BMPs such as streambank fencing and cover cropping or hard BMPs like heavy use areas and waste storage structures. Long term waste storage structures allows for manure to be applied during appropriate weather conditions to reduce runoff and allows some bacteria to die off during the storage practice (Walker, et al. 1990).

Farm conservation and nutrient management plans consist of a combination of agronomic and engineered management practices that protect and properly utilize natural resources in order to prevent deterioration of the surrounding soil and water. A conservation plan is written for each individual operation and dictates management practices that are necessary to protect and improve soil and water quality. A nutrient management plan is a plan written for the operator to manage the amount, timing, and placement of nutrients in order to minimize nutrient loss to the surrounding bodies of water while maintaining optimum crop yield.

This document presents restoration strategies that are proposed to meet water quality standards for developed source types. Nutrient reductions for agronomic practices are not quantified or used as credit to meet TMDLs for developed land.

VI. Local TMDL Project Tracking, Reporting, Modeling and Monitoring

The restoration projects listed in this plan and any future projects progress towards meeting the stormwater WLA will be documented through a combination of modeling and BMP reductions calculated based on the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*, and all future guidance revisions. Project information will also be tracked through an Excel spreadsheet database. The database will track implementation data over time, such as drainage area, impervious area, runoff depth treated, project type, project location, inspection, maintenance, and performance. GIS will also be used to track the location of projects. Appendix A provides a complete list of restoration activities and project status. Appendix C provides the associated reduction values.

A. Data Reporting

Information derived from the baseline tracking and project monitoring will be updated and summarized in Appendix A of this document as needed. Implementation progress will also be included in the County's annual MS4 report, which will document the success to date of the plan in improving watershed conditions and progress towards meeting all applicable TMDL's as per section E.4 of the County's NPDES MS4 permit.

B. Modeling with Mapshed

The MapShed (version 1.3.0; MapShed, 2015) tool developed by Penn State University was utilized by the Bureau of Resource Management to document progress towards meeting the stormwater WLA. This modeling approach allowed for specific local data (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions.

1. Model Description

MapShed is a customized GIS interface that is used to create input data for the enhanced version of the Generalized Watershed Loading Function (GWLF-E) watershed model. The MapShed tool uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to develop an input file for the GWLF-E model. The basic process when using MapShed is: 1) select an area of interest, 2) create GWLF-E model input files, 3) run the GWLF-E simulation model, and 4) view the output. The MapShed geospatial evaluator and the GWLF-E models have been used for TMDL studies in Pennsylvania (Betz & Evans, 2015), New York (Cadmus, 2009), and New England (Penn State, 2016). More information about model inputs and BMP assumptions can be found in Appendix D.

2. Restoration Progress: December 2019

Current restoration strategies outlined in this document are efforts initiated to meet Stormwater WLA TMDL requirements within the Liberty Watershed. As described in Section I, phosphorus and nitrogen loads within the watershed must be reduced in order to meet water quality standards.

The Maryland Department of the Environment (MDE) has provided a guidance document for NPDES – MS4 permits entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*. The draft document was released in June 2011, followed by a final release in August 2014.

The local TMDL suggests an urban phosphorus load reduction of 15% and urban nitrogen load reduction of 15% from the 1995 baseline year. The GWLF-E modeling approach used has a different accounting procedure than the Chesapeake Bay Watershed Model, as the inputs, the load estimation algorithms, and the end-points are different. As the focus of this effort is on local TMDLs, with the assumption that meeting local TMDLs will lead to meeting the Chesapeake Bay TMDL requirements, the end point is the waterbody of concern (i.e. Liberty Reservoir). The GWLF-E model allowed for specific local GIS information (streams, topology, and land use) to be used as the basis for TN, TP, and TSS reductions while still maintaining the ability to estimate the relative urban load reductions from the baseline year. A baseline year of 2001 was used as a proxy for the 1995 baseline year in the TMDL, as land cover data from 2001 was the closest available for that time period. The modeled 2001 baseline scenario did not include any BMPs and therefore represents the land use loads with no treatment provided. Load reductions from BMPs installed after the 1995 TMDL baseline year can be counted toward load reductions necessary to meet the TMDL, even though 2001 was used as the baseline proxy year. For reference, the modeled baseline urban phosphorus load using the 2001 land cover was 861.77 lbs, which equates to a 15% reduction of 129.26 lbs and the modeled urban nitrogen load was 4,815.23 lbs., which equates to a 15% reduction of 722.28 lbs. (Table 12).

The projects completed as of December, 2019 are providing 108.75 pounds of TP reduction, and 431.61 pounds of TN reduction. The planned projects, would provide another 41.23 lbs of TP reduction and 136.93 pounds of TN reduction (Table 13). These reductions are delivered (i.e. they include the GWLF-E estimated TN, TP, and TSS delivery ratios). Refer to Appendix B for the complete documentation of load reductions from different practice types.

The current progress of implemented and planned projects is shown in Figures 12 and 13. To achieve remaining TMDL requirements, the county will utilize the MapShed tool to assist in selecting a mix of techniques and practice types for locations identified in future Community Investment Program (CIP) budgets to progress towards fully attaining the Baltimore Harbor TMDL. At this point it is not feasible, and is fiscally not possible to identify or specify the exact projects, or locations beyond the current CIP.

It is likely that these projects will also reduce bacteria contributions to the watershed. However, currently MDE does not provide guidance on bacteria reduction efficiencies.

Table 12: Total Phosphorus and Total Nitrogen Load Reduction in the South Branch Patapsco Watershed in Carroll County.

Total Phosphorus Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
861.77	15%	129.26	108.75	41.23	17%
Total Nitrogen Load Reduction					
Modeled Baseline Load (lbs)	**% Required Reduction from TMDL**	**Required Load Reduction based on Modeled Baseline (lbs)**	**Reduction from Current BMPs (lbs)**	**Reduction from Planned Strategies (lbs)**	**Total % Reduction Achieved**
4,815.23	15%	722.28	431.61	136.93	12%

Table 13: Comparison of Total Phosphorus and Total Nitrogen Delivered Load Reductions by Restoration Strategies. This table includes both proposed and existing BMPs.

Total Phosphorus Delivered Load Reductions (lbs/yr)					
Status	**Pond Retrofits**	**Buffers**	**Stream Restoration**	**Catch Basin/ Inlet Cleaning**	**Easements**
Completed	76.74	1.14	14.44	0.02	16.41
Planned	28.49		12.74		
Total Nitrogen Delivered Load Reductions (lbs/yr)					
Completed	324.39	5.12	16.87	0.05	85.20
Planned	122.05		14.88		

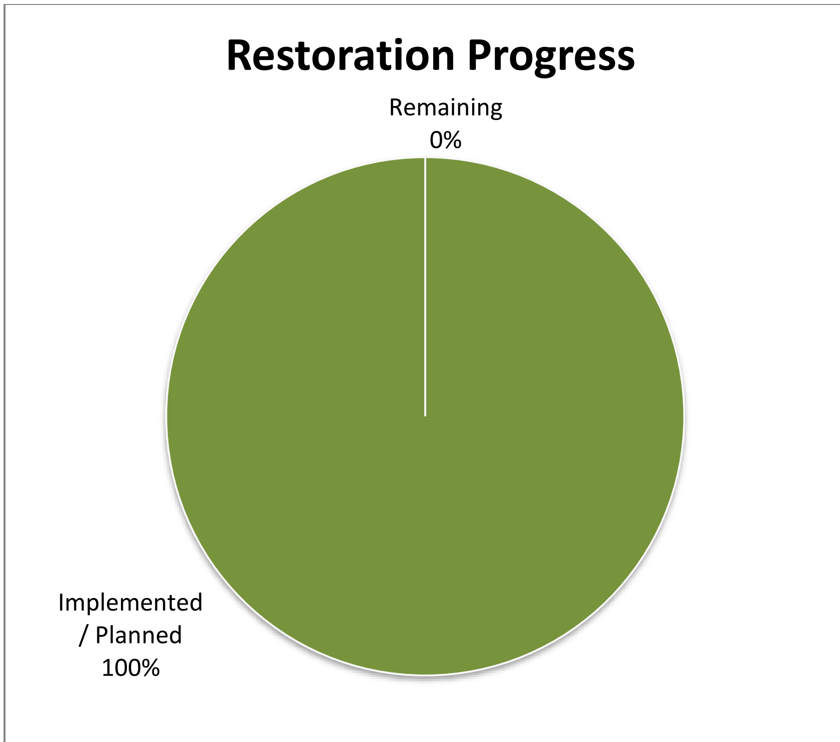


Figure 12: 2019 Restoration Progress-Phosphorus

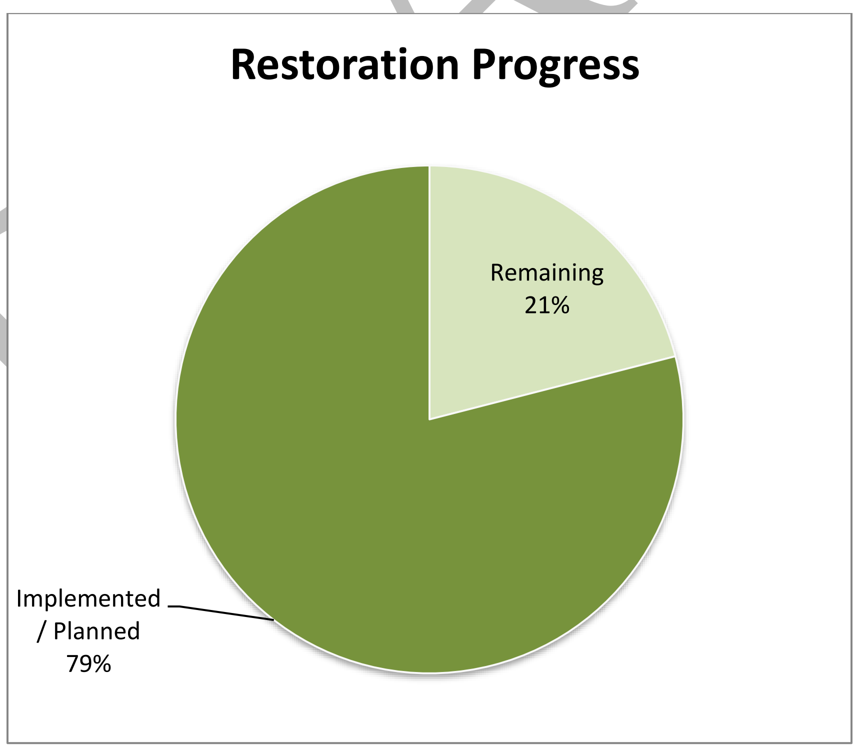


Figure 13: 2019 Restoration Progress-Nitrogen

3. Bacteria Load Reduction

The bacteria TMDL is calculated and broken down into four main sources; human, domestic pet, livestock and wildlife. While the County recognizes a need for bacteria reductions across all sources, this plan will focus primarily on the reduction of human related sources associated with the SW WLA.

c. Human Source Elimination

Elimination of human sources of bacteria within the South Branch Patapsco Watershed will occur through continued implementation of measures by the County and the municipalities public works departments. Replacing or repairing failing infrastructure within the service area will reduce the infiltration and inflow (I&I) being treated at the facility.

The Carroll County Bureau of Utilities is in the process of completely updating their Regulations and Standard Specifications and Design Details for water and sewer infrastructure for the first time since 1992.

Changes that shall be implemented with this update include increasing required sewer main encasements at all proposed stream crossings.

This shall include both more comprehensives encasement design requirements as well as an increase in the distance encasement shall be required to be extended beyond the edges of the stream crossing. Additionally, manhole design requirements shall now include factory installed epoxy coatings on new manholes to be installed on proposed or upgraded sewer mains.

Table 14 lists infrastructure related measures that have been implemented since the baseline year that would assist in reducing bacteria counts within the watershed.

Table 14: Waste Collection Infrastructure Upgrades

	County	Sykesville	Mount Airy
BAT Upgrades	66	0*	0*
Casings/Linings	TBD	TBD	TBD
Lateral line replacements	TBD	TBD	TBD
Pump Station upgrade	TBD	TBD	TBD

***upgrades occurred within corporate boundaries**

d. Domestic Pet Source Elimination

Bacteria contributions from domestic pets can potentially have a significant impact on receiving water bodies from runoff carrying waste into nearby streams. The County anticipates reductions from domestic pet sources to occur through education and outreach of the importance of eliminating this potential source.

e. Stormwater Source Elimination

It is likely that stormwater management projects will also reduce bacteria contributions within the watershed, particularly wet or failing facilities converted to surface sand filters. However, currently MDE does not provide guidance on bacteria reduction efficiencies or loading rates of bacteria by land use.

The County is focused on retrofitting older facilities to current standards, maintaining current facilities that will reduce and deter wildlife sources of bacteria from entering the County's MS4 network, as well as continuing to implement alternative practices such as street sweeping and inlet cleanings to minimize potential bacteria sources from entering the storm drain system.

C. Water Quality Monitoring

The County's current monitoring strategy is focused primarily around retrofit locations where reductions in loadings can be documented from the before and after study approach. This comprehensive monitoring program is intended to validate the overall effectiveness of BMPs and document the efficiency of innovations made to BMPs.

1. Retrofit Monitoring

The Bureau of Resource Management currently monitors one location within the South Branch Patapsco Watershed. The Meridale Gardens site, shown in Figure 14, is located within the South Branch Patapsco subwatershed (1028), and is located entirely within the corporate limits of the Town of Manchester.

This stormwater management facility was originally constructed as a detention facility in 1993 and was retrofitted in 2018 to a surface sand filter to provide water quality, recharge, and channel protection volume. The drainage area is approximately 81 acres, of which, 24 acres or 29.6% is impervious.

Bi-weekly monitoring at the Meridale Gardens site began in December of 2017 and consists of chemical grab samples with corresponding discharge measurements in order to calculate loadings. The chemical monitoring parameters, methods, and detection limits for the Meridale Gardens site can be found in Table 15. Additional monitoring at this location includes spring macro-invertebrate collection, which are based upon protocols set by Maryland's MBSS program (Stranko et al, 2014).

Table 15: Water Quality Parameters and Methods

Parameter	Reporting Limit	Method
Total Suspended Solids	1 mg/l	SM 2540 D-97
Total Phosphorus	0.01 mg/l	SM 4500-P E-99
Ortho Phosphorus	0.01 mg/l	SM 4500-P E-99
Nitrate-Nitrite	0.05 mg/l	SM 4500-NO3 H00

2. Bacteria Trend Monitoring

Carroll County's trend monitoring program is focused around showing long term trends of bacteria concentrations within the urbanized areas of Carroll County associated with the SW WLA. Monitoring within the South Branch Patapsco Watershed began in June of 2019, and is currently performed at seven locations, shown in Figure 15. Samples are currently collected on the 2nd Thursday of each month by the County's Bureau of Resource Management.

a. Monitoring Results

Sample results are reported in MPN/100mL. Table 16 shows the monitoring results for the entire year, whereas Table 17 displays only seasonal data (May 1st to September

30th). Both the annual and seasonal table differentiate samples between low flows, high flows, as well as all flows combined, and are reported as geometric means. Geometric means that are below the 126 MPN/100mL water quality standard are highlighted in blue.

Table 16: Bacteria Monitoring Annual Data MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
PRT06	Low	4	56
	High	0	n/a
	All	4	56
PRT07	Low	4	91
	High	0	n/a
	All	4	91
PRT08	Low	4	84
	High	0	n/a
	All	4	84
PRT09	Low	4	64
	High	0	n/a
	All	4	64
PRT10	Low	4	386
	High	0	n/a
	All	4	386
PRT11	Low	2	169
	High	0	n/a
	All	2	169
PRT12	Low	3	251
	High	0	n/a
	All	3	251

Table 17: Bacteria Monitoring Seasonal Data (May 1 – September 30) MPN/100mL

Location	Flow Type	2019	
		# Samples	MPN
PRT06	Low	4	56
	High	0	n/a
	All	4	56
PRT07	Low	4	91
	High	0	n/a
	All	4	91
PRT08	Low	4	84
	High	0	n/a
	All	4	84
PRT09	Low	4	64
	High	0	n/a
	All	4	64
PRT10	Low	4	386
	High	0	n/a
	All	4	386
PRT11	Low	2	169
	High	0	n/a
	All	2	169
PRT12	Low	3	251
	High	0	n/a
	All	3	251

In addition to geometric mean calculations, each individual sample was analyzed and compared to the single sample exceedance standards, as presented in Table 2 for full body contact. Table 18 shows the percentage of individual samples that exceeded the standards based on frequency of full body contact during the seasonal time period.

Table 18: Single Sample Exceedance Frequency

Location	MPN Criteria	Flow Type	2019	
			# Samples	% Exceeded
PRT06	576	low	4	0%
		high	n/a	n/a
	410	low	4	0%
		high	n/a	n/a
	298	low	4	0%
		high	n/a	n/a
	235	low	4	0%
		high	n/a	n/a
PRT07	576	low	4	0%
		high	n/a	n/a
	410	low	4	0%
		high	n/a	n/a
	298	low	4	0%
		high	n/a	n/a
	235	low	4	0%
		high	n/a	n/a
PRT08	576	low	4	0%
		high	n/a	n/a
	410	low	4	0%
		high	n/a	n/a
	298	low	4	0%
		high	n/a	n/a
	235	low	4	25%
		high	n/a	n/a
PRT09	576	low	4	0%
		high	n/a	n/a
	410	low	4	0%
		high	n/a	n/a

	298	low	4	0%
		high	n/a	n/a
	235	low	4	0%
		high	n/a	n/a
PRT10	576	low	4	25%
		high	n/a	n/a
	410	low	4	25%
		high	n/a	n/a
	298	low	4	25%
		high	n/a	n/a
	235	low	4	50%
		high	n/a	n/a
PRT11	576	low	2	0%
		high	n/a	n/a
	410	low	2	0%
		high	n/a	n/a
	298	low	2	0%
		high	n/a	n/a
	235	low	2	0%
		high	n/a	n/a
PRT12	576	low	3	0%
		high	n/a	n/a
	410	low	3	33%
		high	n/a	n/a
	298	low	3	33%
		high	n/a	n/a
	235	low	3	33%
		high	n/a	n/a

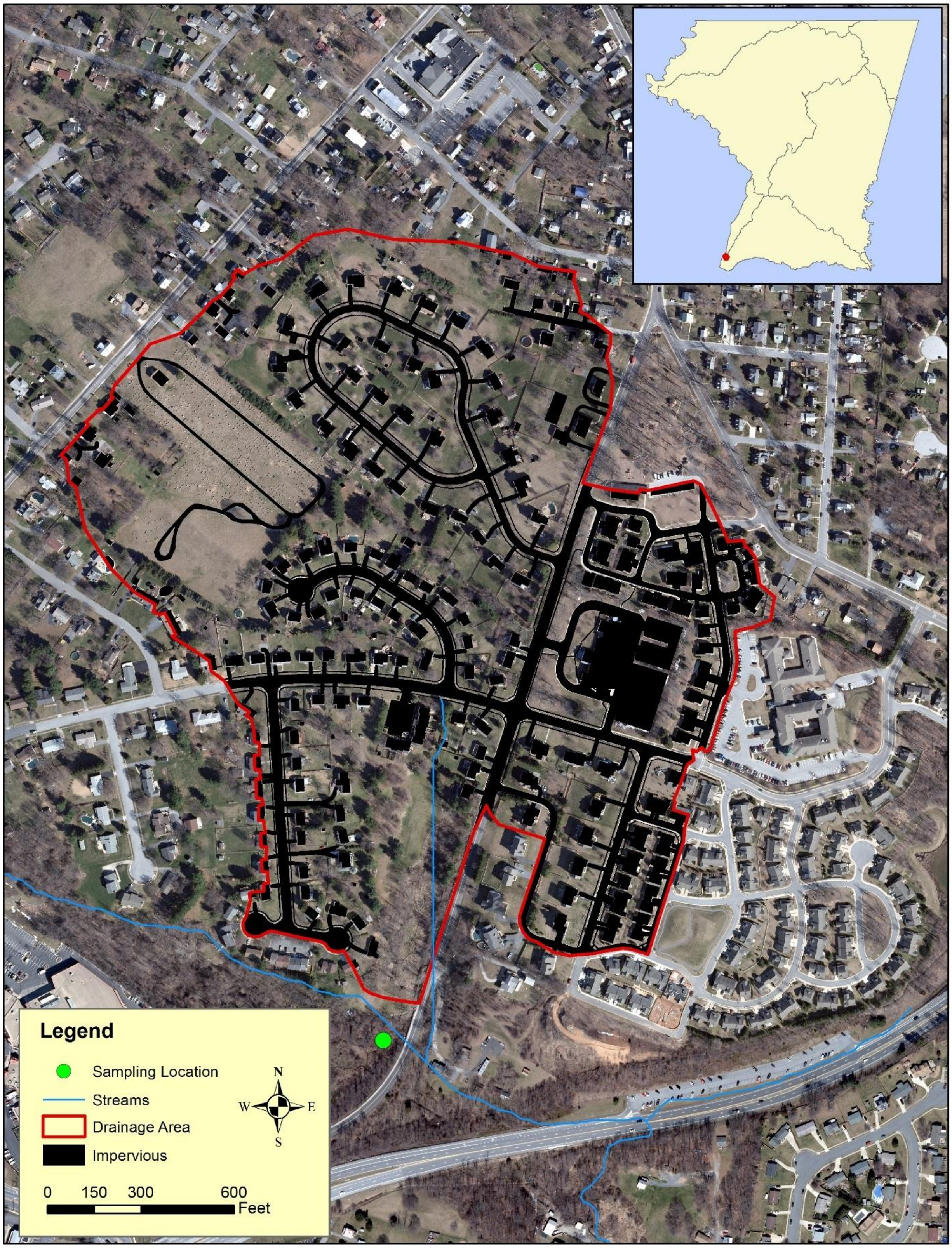


Figure 14: Retrofit Monitoring Location

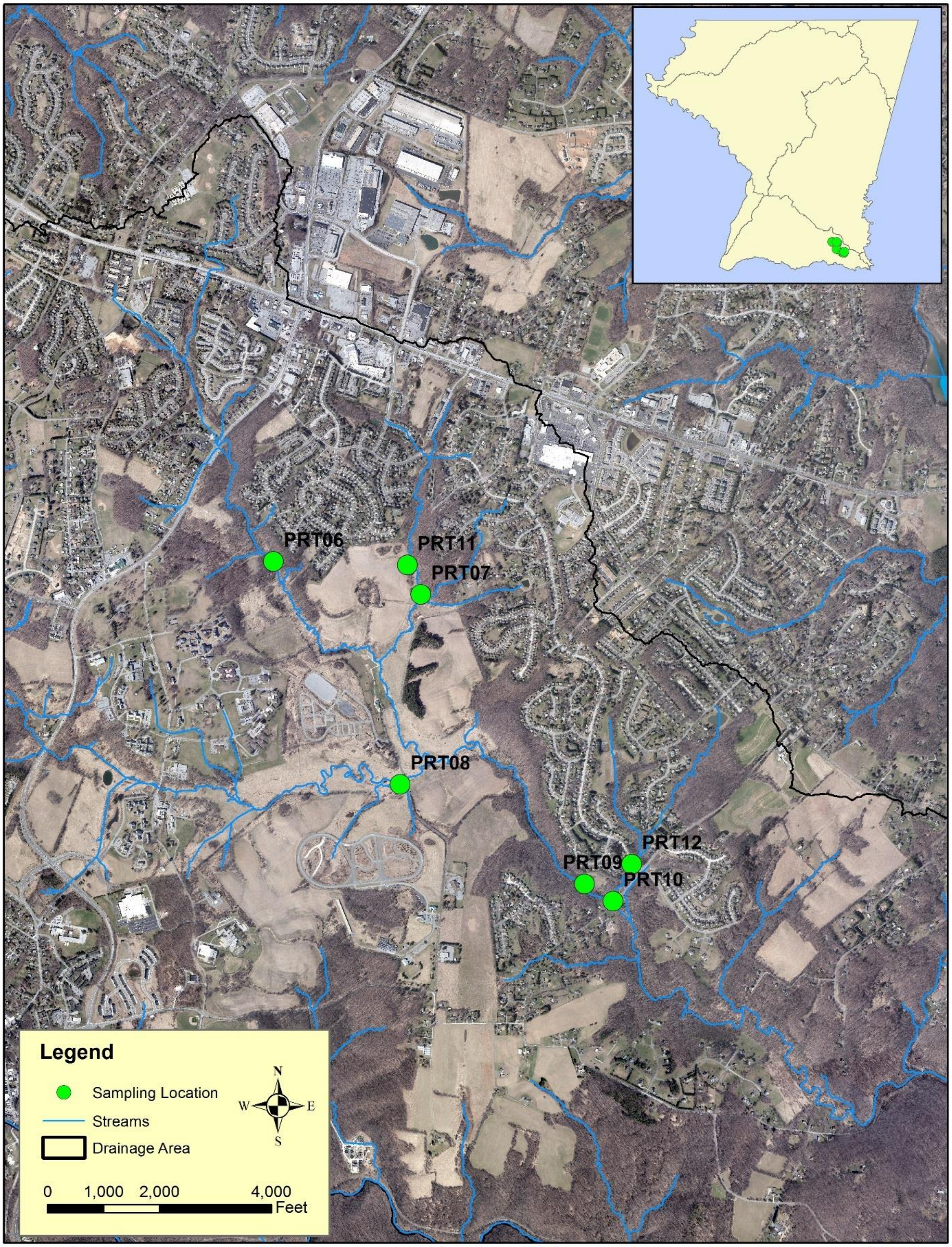


Figure 15: Bacteria Monitoring Locations

VII. Chesapeake Bay Restoration

This section describes progress towards achieving the County's TMDL requirements associated with the stormwater WLA for the Chesapeake Bay watershed (Table 20). BMPs and restoration projects that have been either completed or proposed to address local TMDL's within the South Branch Patapsco Watershed will ultimately reduce loadings to the Chesapeake Bay.

A. Purpose and Scope

The purpose of the Chesapeake Bay TMDL is to establish specific pollutant loadings for all 92 river segments within the Bay watershed in order to meet the individual designated uses within the Chesapeake Bay. The Chesapeake Bay TMDL is the largest in the country, covering 64,000 square miles across seven jurisdictions; Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

Each designated use has established water quality standards or criteria for supporting those uses, which is established by individual states within the Chesapeake Bay watershed. The requirement for States to establish water quality criteria to meet specific designated uses came from section 303(c) of the 1972 Clean Water Act (CWA) that requires all waters of the U.S. to be "fishable" or "swimmable".

B. Background

Despite restoration efforts over the last couple of decades to restore the Chesapeake Bay and its tributaries, the EPA, in December of 2010, established the Chesapeake TMDL. The Chesapeake Bay TMDL identified reductions necessary across all jurisdictions within the watershed, and set limits on nutrient loadings in order to meet the designated uses within the Bay and its tributaries.

The pollutants of concern for the Bay TMDL are sediment and nutrients; more specifically nitrogen and phosphorus. Excessive nitrogen and phosphorus in the Chesapeake Bay and its tidal tributaries promote a number of undesirable water quality conditions such as excessive algal growth, low dissolved oxygen (DO), and reduced water clarity (Smith et al. 1992; Kemp et al. 2005).

The TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year; a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. The Bay TMDL further states that all necessary control measures to reduce loadings must be in place by 2025, with a 60% reduction in loadings by 2017.

1. Water Quality Standards and Designated Uses

EPA's water quality standards (WQS) regulation defines designated uses as the "uses specified in WQS for each waterbody or segment, whether or not they are being attained" (40 CFR131.3). The 1987 Chesapeake Bay Agreement included a commitment to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use

these guidelines in the implementation of water quality and habitat quality programs" (CEC 1987). Chesapeake Bay designated uses, protection, habitats and locations are listed in Table 19, and the tidal water designated use zones are shown in Figure 16.

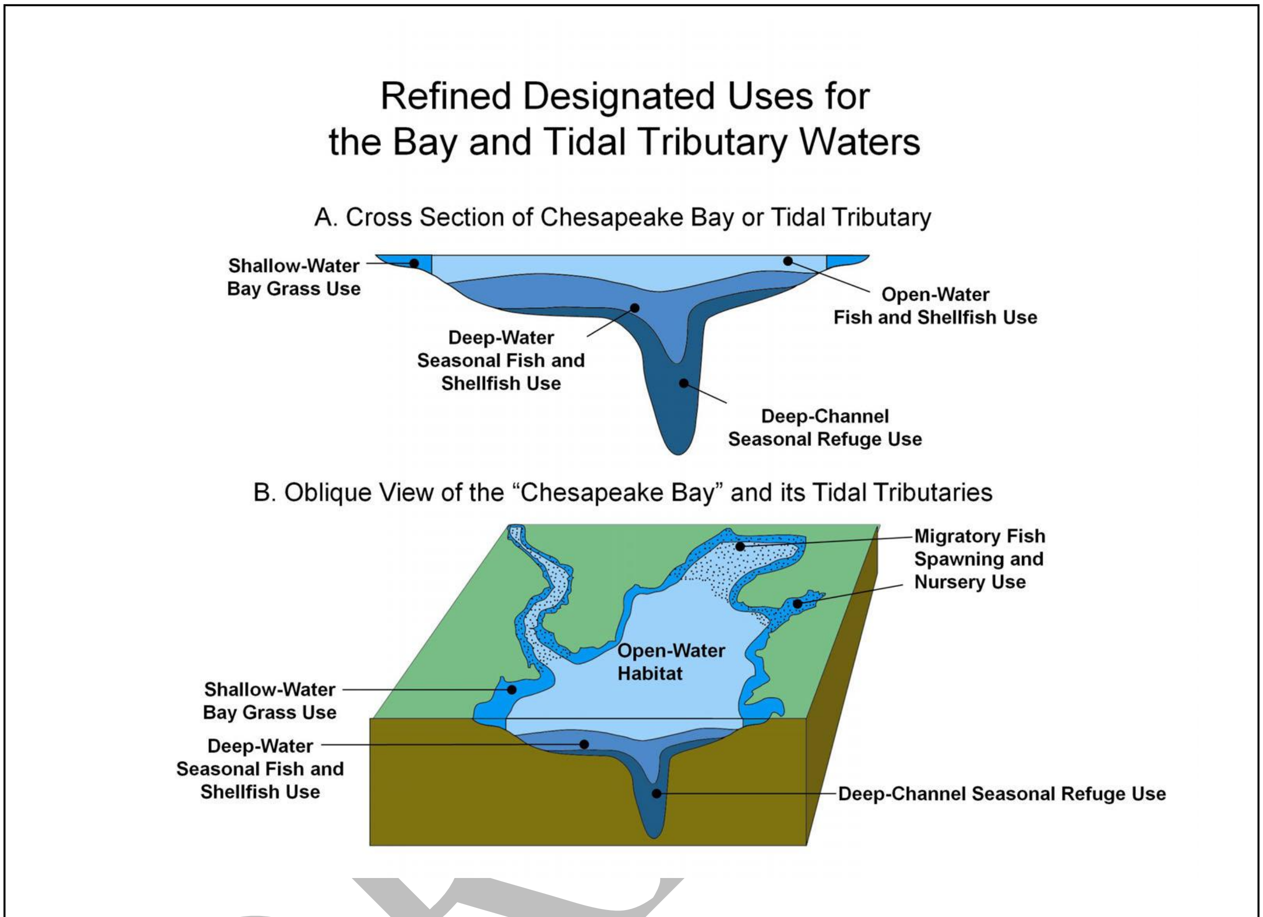


Figure 16: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

The Chesapeake Bay designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, and other scientific considerations (USEPA 2003d, 2004e, 2010a). The tidal water designated use zones for areas within Carroll County include; use 1, migratory fish and spawning nursery, use 2, shallow water, and use 3, open water fish and shellfish. Criteria for the migratory fish spawning and nursery, shallow-water Bay grass and open-water fish and shellfish designated uses were set at levels to prevent impairment of growth and to protect the reproduction and survival of all organisms living in the open-water column habitats (USEPA 2003a).

Table 19: Chesapeake Bay Designated Uses

Designated Use	What is Protected	Habitats and Locations
1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow-Water	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3. Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.
4. Deep-Water Seasonal Fish and Shellfish	The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.	Living resources inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months. The deep-water designated use recognizes that low dissolved oxygen conditions prevail during the summer due to a water density gradient (pycnocline) formed by temperature and salinity that reduces re-oxygenation of waters below the upper portion of the gradient.
5. Deep-Channel Seasonal Refuge	Bottom sediment-dwelling worms and small clams that act as food for bottom-feeding fish and crabs in the very deep channel in summer.	Deep-channel designated use recognizes that low dissolved oxygen conditions prevail in the deepest portions of this habitat zone and will naturally have very low to no oxygen during the summer.

C. River Segment Location

The South Branch Patapsco Watershed is located within the Patapsco River segment of the Chesapeake Bay. The Patapsco segment covers 374,186 acres, approximately 126,716 acres (34%) of this river segment is within Carroll County. The location of the Patapsco River segment is shown in Figure 17.

D. Restoration Progress

Chesapeake Bay TMDL baseline loads and required reductions for Carroll County were obtained from MDE and used in conjunction with the 2014 MDE Guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* to evaluate Bay restoration progress. Loading rates of TN, TP, and TSS for urban land were obtained from MDE (MDE, 2014) and used to calculate load reductions from BMPs. These loading rates from MDE were used instead of developing watershed-specific loading rates using MapShed because they correspond to the broader accounting procedure used by the Chesapeake Bay Watershed Model.

Delivered load ratios were applied to BMP load reductions (Appendix E) calculated using the 2014 MDE Guidance document so that they correspond to the Bay TMDL delivered load allocations and reductions shown in Table 20. A delivered load is the amount of pollutant delivered to the tidal waters of the Chesapeake Bay or its tidal tributaries from an upstream point (chesapeakebay.net). Delivery factors differ by land-river segment and are based upon the estimated amount of attenuation that occurs in the tributaries before it reaches the mainstem of the Chesapeake Bay due to natural in-stream processes. The delivered load ratios for the Patapsco River segment within the South Branch Patapsco Watershed are; 0.11 for nitrogen, 0.27 for phosphorus, and 0.47 for suspended sediment. Essentially, if one pound of nitrogen is discharged into a tributary within the South Branch portion of the Patapsco River segment, only 11% of that pound is reaching the Bay.

Table 20 shows the Chesapeake Bay TMDL for the Patapsco land river segment portion of Carroll County, as well as the progress toward meeting the TMDL from BMPs that are both implemented and planned within the South Branch Patapsco Watershed.

The baseline and reductions represent a combination of the County Phase I and Municipal Phase II based on the MOA between the County and each of the Municipalities that combined the jurisdictions into one permit. The aggregated load allocations for municipalities within the Potomac land river segment were added to the County load allocations obtained from the TMDL Data Center to determine the combined baseline loads and reductions.

The load reductions from BMPs implemented in the South Branch Patapsco Watershed show the restoration progress towards meeting the County's Bay TMDL reductions for the Patapsco segment shed. The South Branch Patapsco Watershed covers 30.57% of the Patapsco land-river segment within Carroll County.

Table 20: Carroll County[1] Bay TMDL Restoration Progress, including planned practices for the South Branch Patapsco Watershed based on Delivered Loads[2]

Total Phosphorus (TP)[3]					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
1,752.52	35.26%	618.00	181.53	104.41	46.27%
Total Nitrogen (TN)					
2009 Delivered Baseline (lbs.)	% Reduction	Reduction (lbs.)	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
16,038.74	13.79%	2,212.59	663.32	285.73	42.89%

[1]This table represents the combined County Phase I and Municipal Phase II loads and reductions for the Patapsco land river segment of Carroll County. The BMP load reductions represent the combined reductions for County and Municipal projects in the South Branch Patapsco Watershed.

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix E.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

Table 21: Carroll County Patapsco River Segment TMDL Restoration Progress, including planned practices for each watershed based on Delivered Loads[2]

8-Digit Watershed	**Total Phosphorus (TP)[3]**			**Total Nitrogen (TN)**		
	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025	Reduction from BMPs implemented 2009-2019 (lbs.)	Reduction from BMPs implemented 2020-2025 (lbs.)	% Bay TMDL Red. by BMPs 2009-2025
Liberty Reservoir Watershed	0	0	0%	0	0	0%
South Branch Patapsco Watershed	181.53	104.41	46.27%	663.32	285.73	42.89%
Total	**181.53**	**104.41**	**46.27%**	**663.32**	**285.73**	**42.89%**

[2]BMP load reductions reflect delivery ratios that have been applied to the edge-of-stream load reductions calculated in Appendix D.

[3]There is no Chesapeake Bay TMDL allocation for TSS. Per Maryland's Phase II WIP, if TP target is met, TSS target will be met.

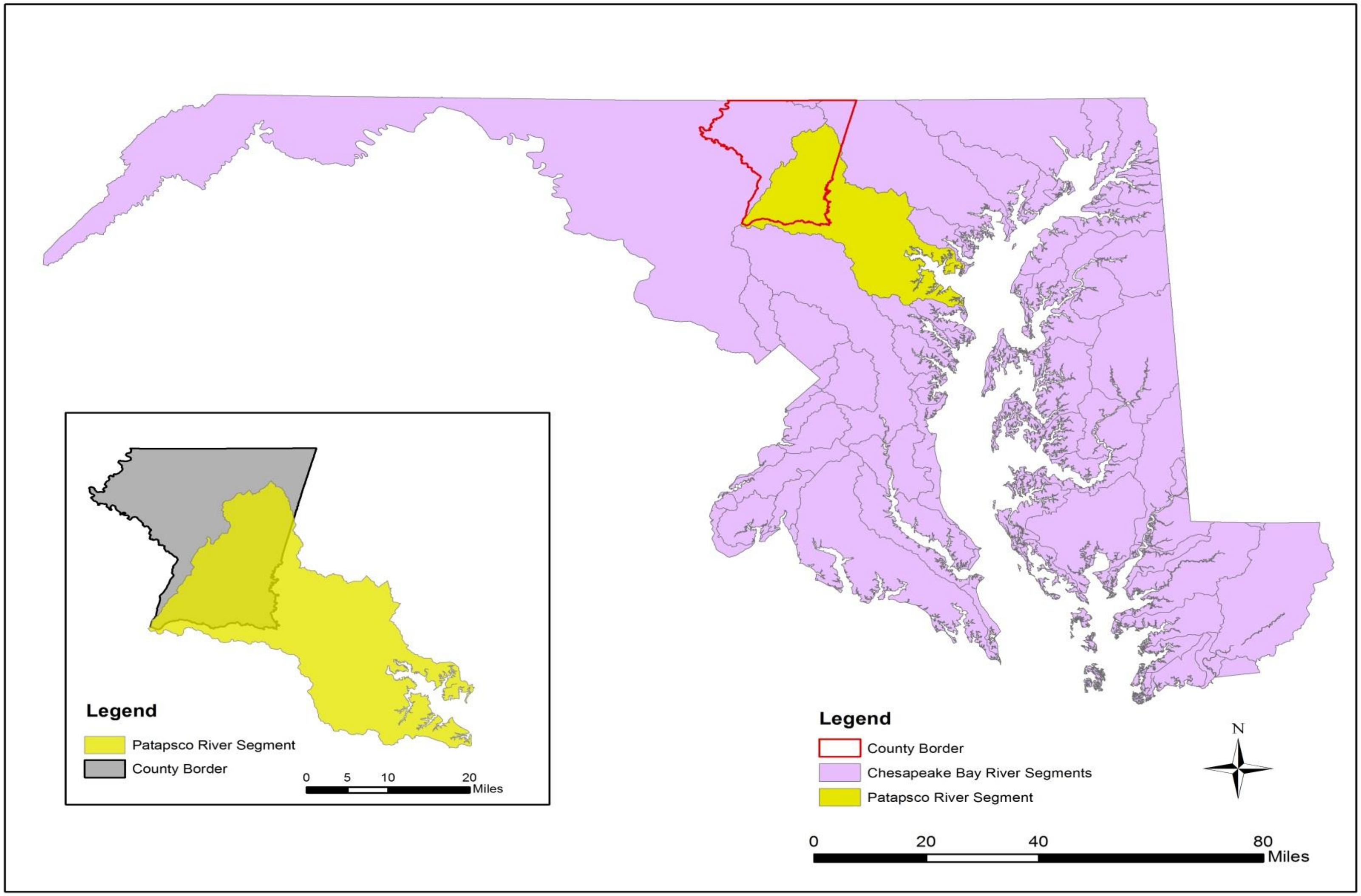


Figure 17: Chesapeake Bay River Segments

VIII. TMDL Implementation

Through the implementation of alternative BMPs, as well as the completed and planned stormwater management projects identified in the County's CIP, the phosphorus TMDL through 2019 will have achieved 94% of the required reductions since the baseline year of 1995. Based on currently identified projects, the required reduction is expected to be fully achieved by 2025. The implementation from baseline through the current CIP is achieving approximately 3.13% reduction in the TMDL/year since the baseline.

The nitrogen TMDL through 2019 will have achieved 62% of the required reduction since the baseline year of 1995. Based on current projects is expected to achieve 79% of the required reduction by 2025. The implementation from baseline through the current CIP is achieving approximately 2.63% reduction in the TMDL/year since the baseline.

If the County is able to maintain an approximate 2.63% reduction rate per year for nitrogen, the nitrogen TMDL in the Baltimore Harbor Watershed would be achieved by 2033. To achieve this goal, the County will continue to primarily focus on stormwater retrofits, implementing additional streamside buffer plantings, increased street sweeping and inlet cleaning, as well as potential stream restoration projects.

Table 22 lists the anticipated benchmark for each nutrient TMDL within the South Branch Patapsco Watershed, the current progress through the 2019 reporting year, the expected progress through the County's current CIP of 2025, and finally the projected end date of full implementation based on timeframe of implementation to date.

Table 22: Nutrient TMDL Benchmarks

Nutrient	2019	2025	2033
Phosphorus	94%	100%	100%
Nitrogen	62%	79%	100%

A. Bacteria Implementation

Through continued implementation of the County's restoration and programmatic programs to reduce pollutant loads within the watershed, the County anticipates a 2% reduction in the bacteria geometric mean per year during low flow conditions within the targeted monitoring locations associated with the County's SW WLA.

As more information regarding bacteria becomes better understood, the County will use an adaptive management process as to how to reach the pollutant target load.

IX. Caveats

While it is acknowledged lack of funding does not constitute a justification for noncompliance, this document provides potential restoration strategies that require additional assessment. Calculated nutrient reductions associated with projects that are in the preliminary planning stages may change as construction plans are finalized. It is not guaranteed that projects listed will be implemented. Implementation is contingent on approved funding and prioritization with other priorities County-wide.

In addition, Carroll County and its municipal partners still do not agree with the quantitative expectations related to Bay stormwater allocations (developed by MDE) for watersheds in Carroll County. Those objections have been forwarded to MDE by the Carroll County Water Resources Coordination Council via letters dated; November 11, 2011, June 27, 2012, and May 2, 2014. Therefore, the County and its municipal partners reserve the right to make future refinements to this plan based upon new or additional information, or should any previously designated allocation be found to be invalid by technical or legal processes.

X. Public Participation

Initial public outreach of this restoration plan will focus on landowners who will potentially be impacted by the watershed plan. Upon draft completion of the Baltimore Harbor Watershed restoration plan, the Bureau of Resource Management will post the plan for a period of thirty (30) days on the County's website. During the thirty day public comment period, input from any stakeholder or others will be gathered and, as appropriate, may be incorporated into the plan before the final plan is released.

XI. References

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XII. Appendix A: Watershed Restoration Projects

Project Name	Town/County	Watershed	Project Status	Project Cost	Anticipated Completion
SWM Facilities	County	2130907	Completed	$7,999,941	Completed
Streambank Regeneration	County	2130907	Completed	N/A	Completed
Buffer Plantings	County	2130907	Completed	$119,352	Completed
Catch Basin/Inlet Cleaning	Mount Airy	2130907	Completed	**	Annual
Catch Basin/Inlet Cleaning	Sykesville	2130907	Completed	**	Annual
Street Sweeping		2130907	Completed	**	Annual
Water/floodplain Easement	Watershed	2130907	Completed	N/A	Completed
SWM (Planned)	County	2130907	Planning/Design	$5,486,614	FY20-25
TBD	Watershed	8-Digit	Planning	$3,700,000	TBD

***Costs for proposed Stormwater facilities are based on current FY20-FY25 project costs, which may be subject to change.**

****Project Costs not reported**

XIII. Appendix B: South Branch Patapsco BAT Septic Systems

DNR 12-digit scale	SubWatershed	Project Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2009-2019
1030	Gills Falls Upper	Septic Repair	1							1			1	3
		New Construction							3	2				5
1031	Gills Falls Lower	Septic Repair								1				1
		New Construction												0
1029	Middle Run	Septic Repair	4				1			2				7
		New Construction							1	1	2			4
1021	Piney Run Lower	Septic Repair	1											1
		New Construction					1	1			1			3
1023	Piney Run Main	Septic Repair	2						1	1		1		5
		New Construction							2	3				5
1024	Piney Run Tributary	Septic Repair										1		1
		New Construction												0
1028	South Branch Patapsco	Septic Repair	2					2		1	1	1		7
		New Construction												0
1020	South Branch Patapsco River	Septic Repair												0
		New Construction												0
1022	South Branch Patapsco River	Septic Repair												0
		New Construction												0
1025	South Branch Patapsco River	Septic Repair						1			1			2
		New Construction				1			4					5
1026	Tuckers Branch	Septic Repair	1			2					2			5
		New Construction							2	9	1			12

XIV. Appendix C: Local TMDL Load Reduction Calculations with GWLF-E Land Cover Loading Rates and MDE (2014)

Stormwater Management

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Arthurs Ridge	Retrofit	51.17	5.14	ST	2.13	0.2083%	39%	10.03	0.3482%	62%	3.00	0.4749%	78%	7.33
South Carroll High-Fine Arts	New construction	24.22	12.94	RR	1.00	0.4840%	60%	23.31	0.4106%	70%	3.54	0.2346%	75%	3.62
Brimfield	Retrofit	34.69	9.15	RR	2.50	0.2443%	68%	11.76	0.3021%	79%	2.60	0.3480%	85%	5.37
Harvest Farms 1A	Retrofit	43.8	11.25	ST	1.00	0.1592%	35%	7.67	0.2658%	55%	2.29	0.3628%	70%	5.60
Parrish Park	Retrofit	94.23	18.2	ST	1.00	0.3426%	35%	16.50	0.5719%	55%	4.93	0.7805%	70%	12.04
Clipper Hills Gardenia	Retrofit	33.19	11.08	ST	2.50	0.4364%	39%	21.02	0.4991%	62%	4.30	0.3386%	79%	5.22
Clipper hills Hilltop	Retrofit	80.17	18.54	ST	2.50	0.3279%	39%	15.79	0.5492%	62%	4.73	0.7487%	79%	11.55
Carroltowne 2B	Retrofit	34.61	10.38	ST	2.50	0.1415%	39%	6.82	0.2371%	62%	2.04	0.3232%	79%	4.99
Carroltowne 2A	Retrofit	87.73	34.43	ST	2.49	1.1532%	39%	55.53	1.3185%	62%	11.36	0.8948%	79%	13.80
Benjamins Claim	Retrofit	47.1	15.78	ST	2.21	0.6167%	39%	29.70	0.7040%	62%	6.07	0.4780%	78%	7.37
Eldersburg Estates 3-5	Retrofit	34.91	8.16	ST	2.50	0.1428%	39%	6.87	0.2392%	62%	2.06	0.3260%	79%	5.03
Braddock Manor West	Retrofit	49.3	7.65	ST	2.50	0.2016%	39%	9.71	0.3377%	62%	2.91	0.4604%	79%	7.10
Benjamins Claim Basin B	Retrofit	1.33	0.55	ST	1.04	0.0157%	35%	0.76	0.0179%	56%	0.15	0.0122%	71%	0.19
Hawks Ridge	Retrofit	63.48	19.8	ST	2.07	0.8303%	39%	39.98	0.9472%	62%	8.16	0.6432%	78%	9.92
Merridale Gardens	Retrofit	81	23.81	RR	1.77	0.5589%	66%	26.91	0.6940%	78%	5.98	0.7968%	83%	12.29

Shannon Run	Retrofit	213.5	34.1	ST	2.50	0.8732%	39%	42.04	1.4627%	62%	12.60	1.9939%	79%	30.76
Piney Ridge Village AB 57	Retrofit	25.7	8	RR	2.50	0.5819%	68%	28.02	0.4912%	79%	4.23	0.2816%	85%	4.34
Woodyside Estates Small	Retrofit	9.02	2.11	RR	0.50	0.0421%	45%	2.03	0.0521%	52%	0.45	0.0598%	56%	0.92
Woodyside Estates Large	Retrofit	63.36	14.02	RR	2.50	0.4462%	68%	21.49	0.5518%	79%	4.76	0.6355%	85%	9.80
Lexington Run Section 1	Retrofit	12.87	2.62	ST	1.00	0.0468%	35%	2.25	0.0781%	55%	0.67	0.1066%	70%	1.64
Waters Edge Section 4	Retrofit	72.4	21.19	ST	1.00	0.2632%	35%	12.67	0.4394%	55%	3.79	0.5997%	70%	9.25
Melstone Valley	Retrofit	170	22.5	ST	1.00	0.6181%	35%	29.76	1.0317%	55%	8.89	1.4081%	70%	21.72
IDA Property	Facility	75.5	10.5	RR	2.50	0.5317%	68%	25.60	0.6575%	79%	5.67	0.7573%	85%	11.68
Winfield Fire Dept.	Facility	0.22	0.22	RR	1.14	0.0046%	62%	0.22	0.0039%	72%	0.03	0.0022%	77%	0.03
	Total:	**1,403.50**	**322.12**			**9.2712%**		**446.44**	**12.2109%**		**105.21**	**13.0674%**		**201.56**

Stream Buffer Plantings

Project	Acres	% Urban TN Load Reduced	TN BMP Efficiency (%)	TN Pollutant Load Reduced (lbs)	% Urban TP Load Reduced	TP BMP Efficiency	TP Pollutant Load Reduced (lbs)	% Urban TSS Load Reduced	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	4.9	0.0336%	66	1.620	0.0417%	77	0.359	0.0331%	57	0.511
Planting 2	3.45	0.0237%	66	1.14	0.0294%	77	0.25	0.0233%	57	0.36
Planting 3	0.16	0.0011%	66	0.05	0.0014%	77	0.01	0.0011%	57	0.02
Planting 4	3.2	0.0220%	66	1.06	0.0272%	77	0.23	0.0216%	57	0.33
Planting 5	0.3	0.0021%	66	0.10	0.0026%	77	0.02	0.0020%	57	0.03
Planting 6	3	0.0206%	66	0.99	0.0255%	77	0.22	0.0203%	57	0.31
Planting 7	0.23	0.0016%	66	0.08	0.0020%	77	0.02	0.0016%	57	0.02
Planting 8	0.13	0.0009%	66	0.04	0.0011%	77	0.01	0.0009%	57	0.01
Planting 9	0.13	0.0009%	66	0.04	0.0011%	77	0.01	0.0009%	57	0.01
Total:	**15.50**	**0.1065%**		**5.12**	**0.1320%**		**1.129**	**0.1048%**		**1.601**

Catch Basin/inlet Cleaning

Location	Tons	TN lbs reduced/ton	TN Pollutant Loads Reduced [delivered] (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced [delivered] (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced [delivered] (lbs)	TSS Pollutant Loads Reduced [delivered] (Tons)
Sykesville	0.25	3.5	0.875 [0.04]	1.4	0.35 [0.01]	420	105 [11.88]	0.053 [0.01]
Total:			**0.875 [0.04]**		**0.35 [0.01]**		**105 [11.88]**	**0.053 [0.01]**

Stream Restoration

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Woodyside	2,100	0.3090%	14.88	1.4787%	12.74	0.1333%	4,114.29	2.06
Total:		**0.3090%**	**14.88**	**1.4787%**	**12.74**	**0.1333%**	**4,114.29**	**2.06**

Streambank Regeneration[1]

Location	Linear Feet	% Urban TN Load Reduction	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (tons)
Carroltonwe 2A	1100	0.1619%	7.79	0.7746%	6.68	0.0698%	2155.10	1.08
Eledersburg Estates 3-5	600	0.0883%	4.25	0.4225%	3.64	0.0381%	1175.51	0.59
Shannon Run	680	0.1001%	4.82	0.4788%	4.13	0.0432%	1332.25	0.67
Total:	**2,380**	**0.3503%**	**16.86**	**1.6759%**	**14.45**	**0.1511%**	**4,662.86**	**2.34**

[1]A study is currently underway by the County to evaluate streambank regeneration as an innovative practice following the guideline in MDE (2014). In the interim, the default stream restoration credit is combined with equivalent impervious area, as suggested in the 2014 MDE guidance, is used here to estimate nutrient and sediment reductions from this practice. Also see BMP Assumptions in Appendix D.

Grass Buffer Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Grass Buffer 1995-2008	89.080	0.2780%	30	13.39	0.3937%	40	3.39	0.5806%	55	8.96
Grass Buffer 2009-Current	69.640	0.2173%	30	10.46	0.3078%	40	2.65	0.4539%	55	7.00
Total:	**158.72**	**0.4953%**		**23.85**	**0.7015%**		**6.04**	**1.0345%**		**15.96**

Floodplain Easements--Efficiency factors from 2011 Guidance

Subdivision	Acres	% Urban TN Load Reduction	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	% Urban TP Load Reduction	TP BMP Efficiency (%)	TP Pollutant Loads Reduced (lbs)	% Urban TSS Load Reduction	TSS BMP Efficiency (%)	TSS Pollutant Loads Reduced (tons)
Forest Buffer 1995-2008	166.030	0.7772%	45	37.42	0.7339%	40	6.32	1.0821%	55	16.69
Forest Buffer 2009-Current	106.140	0.4969%	45	23.92	0.4692%	40	4.04	0.6917%	55	10.67
Total:	**272.17**	**1.2741%**		**61.34**	**1.2031%**		**10.36**	**1.7738%**		**27.36**

XV. Appendix D: GWLF-E Modeling Assumptions

1. Model Inputs

The GIS Data layers used for MapShed input are summarized below and include watershed boundaries (basins), Digital Elevation Model (DEM), land use, soils, streams, weather stations and directory, physiographic provinces, and counties.

- Watershed Boundaries: Maryland's 12 digit watersheds were obtained from https://data.maryland.gov/Energy-and-Environment/Maryland-s-Third-Order-12-Digit-Watersheds/wcjn-bzdz. The County also maintains a similar watershed boundary dataset, but its use for model input would require additional processing for topology correction. When 12 digit watersheds were larger than ~7000 acres or had a complex stream network, the MapShed model exhausted computer memory resources. These watersheds were broken into sub-basins to approximately split these into halves or quarters at natural stream and topographic breaks.
- Digital Elevation Model: The County's DEM derived from Lidar data was clipped to the Carroll County portion of the Liberty Reservoir watershed to speed processing time. This option was chosen over lowering resolution from 5 feet in order to maintain information on steep slopes for the modeling purposes.
- Land Use / Land Cover: Land cover data was obtained from the 2011 National Land Cover Database (NLCD). These data were used instead of County parcel data as NLCD does not consider political boundaries. NLCD data were reclassified using ArcMap 10.2 to fit into the MapShed land use/land cover classifications (Table D-1) following guidance in Appendix G of the MapShed documentation (Evans and Corradini, 2015).

Table D-1: NLCD Reclassification into MapShed Input

NLCD (2001) Classification	Corresponding GWLF-E Classification
Open Water	Open Water
Developed, Open Space	LD Residential
Developed Low Intensity	LD Developed
Developed Medium Intensity	MD Developed
Developed, High Intensity	HD Developed
Barren Land	Disturbed
Deciduous Forest	Forest
Evergreen Forest	Forest
Mixed Forest	Forest
Shrub/Scrub	Open Land
Herbaceous	Open Land

Hay/Pasture	Hay/Pasture
Cultivated Crops	Cropland
Woody Wetlands	Wetlands
Emergent Herbaceous Wetlands	Wetlands

- Soils: Soil data was obtained from the Natural Resources Conservation Service Soil Survey (SSURGO). The data required substantial formatting and aggregating to include needed model information and was completed, in part, with the USDA Soil Data Viewer (http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/home/?cid=nrcs142p2_053620) through ArcMap 10.2. Soil parameters required were area, available water-holding capacity, soil erodibility factor, and dominant hydrologic soil group.
- Streams: County stream data were visually evaluated to remove loops and parallel stream lines through reservoirs. These streams were generated from LIDAR data using ArcHydro. The stream locations are verified through a process that includes comparison with orthophotography and field stream walk maps.
- Weather Stations: The weather stations and the weather directory from Pennsylvania were previously developed by Penn State and are provided through the MapShed website (http://www.mapshed.psu.edu/download.htm). Hanover weather station data were used in the model and included a 22 year weather period from 1975 to 1996. The long weather period assured long-term averages were representative of wet, dry, and average years. The growing period was specified between April and September and primarily influences agricultural production and evapotranspiration.
- Physiographic Province: The physiographic province, another spatial MapShed input, from southcentral Pennsylvania was used to set the groundwater recession coefficient and rainfall coefficients (provided through the MapShed website). This shapefile was modified to include Carroll County. Soil loss coefficients, which are included in the physiographic province data, from southcentral Pennsylvania were also used for Carroll County.

Model default values were maintained for all parameters with the exception of the Universal Soil Loss Equation (USLE) practice factors for both Hay/Pasture and Cropland, the cover factor for Cropland, the dissolved P concentration of forest, and TSS accumulation on urban surfaces. Parameter adjustments from model defaults are shown in Table D-2 below and were based on literature and professional judgement.

Table D-2: Model parameter changes from default to better represent Carroll County.

Parameter	Default	New Value	Units	Comments
Practice Factor (pasture/hay)**	0.52	0.25	NA	Little disturbance and heavy forage assumed.
Practice Factor (cropland)**	0.52	0.25	NA	Assume contour farming and cover crops are broadly used.
Cover Factor (cropland)*	0.42	0.20	NA	Based on 2012 Agricultural Census for Corn, Beans, Canola, and Cereals acreage and state averages for no-till, conservation tillage and conventional tillage.
Dissolved P Concentration for Forest	0.01	0.1	mg/l	Assumed equal to the median open space concentration from Tetra Tech (2014). The increase accounts for potentially elevated P concentration from runoff contact with leaves.
TSS Accumulation LD Mixed MD Mixed HD Mixed LD Residential	Imp. (Pervious) values 2.8 (0.8) 6.2 (0.8) 2.8 (0.8) 2.5 (1.3)	Imp. (Pervious) values 1.21 (0.19) 2.66 (0.30) 2.66 (0.30) 1.21 (0.19)	kg/ha/yr	EMCs from Tetra Tech (2014) used with GWLF-E runoff estimates. These adjustments were made by estimating runoff volume using GWLF-E default Curve Number (CN) values for impervious and pervious each land use and applying the average event mean concentration (EMC) of 140.44 mg/l.

* Cropping factors for the USLE were area weighted based on county and state averages for crop type and tillage type, respectively (see www.nass.usda.gov/Statistics_by_State/Maryland/Publications/News_Releases/2012/mpr09-12tillage.pdf for tillage and see 2012 Carroll County Ag Census www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Maryland/ for crop breakdown). Base cropping factors were compiled from www.omafra.gov.on.ca/english/engineer/facts/12-051.htm.

** The default was based on dominant parameter.

2. BMP Assumptions

There are seven primary categories of BMPs evaluated for this plan, though not all categories have implemented or planned BMPs. The assumptions listed here are intended to align the information available for each practice (i.e. drainage area), while following MDE guidance by using the state of the science BMP efficiencies. The MapShed/GWLF-E process allows for the development of spatially referenced land cover loading rates for subsequent use in BMP estimates. As BMPs were decoupled from GWLF-E, post processing of these BMP data allows for BMP efficiencies consistent with MDE guidance.

Land cover loading rates from GWLF-E were developed for urban land cover and are represented in Table D-3 for the Liberty Reservoir watershed. These categories and percent imperviousness are default GWLF-E values that were verified through literature review. Drainage areas for each BMP were lumped into these categories based on the percent impervious as shown in Table D-3 based on professional judgement.

Table D-3: GWLF-E impervious assumptions, BMP drainage area grouping, and urban land cover delivered loading rates. These rates include the urban portion of stream erosion.

Land Cover	% Impervious	BMP Drainage Area % Impervious Range	TN (lbs/ac)	TP (lbs/ac)	TSS (lbs/ac)
LD Mixed	15	>5 to <30	0.49	0.10	412.24
MD Mixed	52	>=30 to <70	1.60	0.21	446.90
HD Mixed	87	>=70	1.63	0.22	447.44
LD Residential	15	>5 to <30	0.49	0.10	412.24

The local TP and TSS TMDL baseline year is 2009, which means any retrofitted water quality BMPs installed since this year can be included in the accounting process to estimate TMDL reductions. BMP efficiencies were obtained from the 2014 Maryland Department of the Environment (MDE) guidance document entitled: *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated*.

The load reductions from BMPs calculated based on the loading rates in Table D-3 (i.e., detention basin retrofits, infiltration, bioretention, etc.) represent delivered load reductions because the loading rates are delivered. However, a delivery ratio must be applied to any BMPs with edge of stream load reductions (i.e., stream restoration, street sweeping), as they are being done before any stream processing. In the Liberty Reservoir watershed, the load weighted average TN, TP, and TSS delivery ratios are 0.041, 0.040, and 0.130, respectively. Delivery ratios are based on total aerial deposited TN, TP, and sediment on urban areas (both impervious and pervious) compared to TN, TP, and TSS at the watershed outlet. These numbers were derived using the GWLF-E model.

Detention Basin Retrofits

Pond retrofits to a sand filter were assumed to be stormwater treatment (ST). The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Water Resource, Floodplain Easements

These practices have previously agreed upon efficiencies of 30%, 40%, and 55% TN, TP, and TSS reductions, respectively (MDE, 2011). A Low Density Mixed land cover is used as the basis for loading rates.

Buffer Strips

Consistent with MDE guidance (MDE, 2014), this BMP has efficiencies of 66%, 77%, and 57%, for TN, TP, and TSS, respectively. A Low Density Mixed land cover is used as the basis for loading rates.

Stream Stabilization

For consistency with the Chesapeake Bay Program as well as taking into account potential headwater stabilization projects not reflected in the blue-line streams used in the MapShed/GWLF-E process, 1000 linear feet of stream stabilization/restoration was set equal to 4.9, 40.2, and 51.0 acres of high density mixed urban (87% impervious) for TN, TP, and TSS, respectively. These equivalencies were based on CBP river segment loading rates and the interim stream restoration credit of 75, 68, and 44,880 lbs of TN, TP, and TSS per 1000 linear feet of stream restoration (i.e. 68 lbs/1000 ft or1.69 lbs P/ac = 40.2 ac/1000 ft). Using this method, only linear feet of stabilization/restoration is needed for reporting. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing.

Infiltration and Bioretention

All infiltration and bioretention projects are treated as runoff reduction (RR) projects. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Constructed Wetlands

Constructed wetlands were considered a stormwater treatment (ST) practice. The Chesapeake Bay retrofit curves were used along with County design volume to estimate relative TN, TP, and TSS reductions. These relative reductions were coupled with land cover loading rates from GWLF-E and drainage area characteristics to calculate a load reduction.

Street Sweeping and Catch Basin Cleaning

Total Nitrogen (3.5 lbs/ton), TP (1.4 lbs/ton), and TSS (420 lbs/ton) concentrations from catch basin cleaning solids, as reported in the 2014 MDE Guidance, were used along with County measured material removed to make edge of stream estimates. The delivery ratio described above was applied to these estimates as they are being done at the edge of stream before any stream processing. For qualifying street sweeping programs (25 times a year), TN, TP, and TSS reductions are 4%, 4%, and 10% respectively. Delivery ratios were also used to adjust these reductions.

Impervious Surface Reduction

Impervious surface reduction effectively changes the % impervious for the sub basin. The post processing procedure for this practice was simply the difference in land cover loading rate of high density mixed urban (87% impervious) and low density mixed urban (15% impervious).

XVI. Appendix E: Chesapeake Bay TMDL Edge-of-Stream Load Reduction Calculations

SWM Facilities Impervious Treatment

Project	Project Type	Drainage Area (Ac)	Impervious Area (Acres)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Arthurs Ridge	Retrofit	51.17	5.14	ST	2.13	15.3	78.6420	39%	30.7707	1.69	8.6866	62%	5.3487	0.44	2.2616	78%	1.7715
South Carroll High-Fine Arts	New construction	24.22	12.94	RR	1.00	15.3	197.9820	60%	118.2942	1.69	21.8686	70%	15.2862	0.44	5.6936	75%	4.2651
Brimfield	Retrofit	34.69	9.15	RR	2.50	15.3	139.9950	68%	94.7766	1.69	15.4635	79%	12.1871	0.44	4.0260	85%	3.4180
Harvest Farms 1A	Retrofit	43.8	11.25	ST	1.00	15.3	172.1250	35%	60.1577	1.69	19.0125	55%	10.4417	0.44	4.9500	70%	3.4601
Parrish Park	Retrofit	94.23	18.2	ST	1.00	15.3	278.4600	35%	97.3218	1.69	30.7580	55%	16.8923	0.44	8.0080	70%	5.5976
Clipper Hills Gardenia	Retrofit	33.19	11.08	ST	2.50	15.3	169.5240	39%	66.6484	1.69	18.7252	62%	11.6091	0.44	4.8752	79%	3.8422
Clipper hills Hilltop	Retrofit	80.17	18.54	ST	2.50	15.3	283.6620	39%	111.5217	1.69	31.3326	62%	19.4253	0.44	8.1576	79%	6.4292
Carroltowne 2B	Retrofit	34.61	10.38	ST	2.50	15.3	158.8140	39%	62.4377	1.69	17.5422	62%	10.8757	0.44	4.5672	79%	3.5995
Carroltowne 2A	Retrofit	87.73	34.43	ST	2.49	15.3	526.7790	39%	207.0259	1.69	58.1867	62%	36.0580	0.44	15.1492	79%	11.9343
Benjamins Claim	Retrofit	47.1	15.78	ST	2.21	15.3	241.4340	39%	94.5156	1.69	26.6682	62%	16.4347	0.44	6.9432	78%	5.4426
Eldersburg Estates 3-5	Retrofit	34.91	8.16	ST	2.50	15.3	124.8480	39%	49.0840	1.69	13.7904	62%	8.5497	0.44	3.5904	79%	2.8297

Braddock Manor West	Retrofit	49.3	7.65	ST	2.50	15.3	117.0450	39%	46.0162	1.69	12.9285	62%	8.0153	0.44	3.3660	79%	2.6528
Benjamins Claim Basin B	Retrofit	1.33	0.55	ST	1.04	15.3	8.4150	35%	2.9721	1.69	0.9295	56%	0.5159	0.44	0.2420	71%	0.1709
Hawks Ridge	Retrofit	63.48	19.8	ST	2.07	15.3	302.9400	39%	118.4601	1.69	33.4620	62%	20.5866	0.44	8.7120	78%	6.8188
Merridale Gardens	Retrofit	81	23.81	RR	1.77	15.3	364.2930	66%	241.6521	1.69	40.2389	78%	31.1985	0.44	10.4764	83%	8.7152
Shannon Run	Retrofit	213.5	34.1	ST	2.50	15.3	521.7300	39%	205.1181	1.69	57.6290	62%	35.7284	0.44	15.0040	79%	11.8249
Piney Ridge Village AB 57	Retrofit	25.7	8	RR	2.50	15.3	122.4000	68%	82.8648	1.69	13.5200	79%	10.6554	0.44	3.5200	85%	2.9884
Woodyside Estates Small	Retrofit	9.02	2.11	RR	0.50	15.3	32.2830	45%	14.4709	1.69	3.5659	52%	1.8638	0.44	0.9284	56%	0.5199
Woodyside Estates Large	Retrofit	63.36	14.02	RR	2.50	15.3	214.5060	68%	145.2206	1.69	23.6938	79%	18.6735	0.44	6.1688	85%	5.2372
Lexington Run Section 1	Retrofit	12.87	2.62	ST	1.00	15.3	40.0860	35%	14.0101	1.69	4.4278	55%	2.4317	0.44	1.1528	70%	0.8058
Waters Edge Section 4	Retrofit	72.4	21.19	ST	1.00	15.3	324.2070	35%	113.3103	1.69	35.8111	55%	19.6675	0.44	9.3236	70%	6.5172
Melstone Valley	Retrofit	170	22.5	ST	1.00	15.3	344.2500	35%	120.3154	1.69	38.0250	55%	20.8833	0.44	9.9000	70%	6.9201
IDA Property	Facility	75.5	10.5	RR	2.50	16.3	171.1500	68%	115.8686	2.69	28.2450	79%	22.2604	1.44	15.1200	85%	12.8366
Winfield Fire Dept.	Facility	0.22	0.22	RR	1.14	17.3	3.8060	62%	2.3500	3.69	0.8118	72%	0.5865	2.44	0.5368	77%	0.4156
Total:		**1,403.50**	**322.12**				**4,939.38**		**2,096.97**		**526.27**		**333.33**		**137.02**		**105.76**

SWM Facilities

Pervious Treatment

Project	Project Type	Drainage Area (Ac)	Pervious Area (Ac)	Practice Type	Runoff depth treated (In.)	TN Pollutant Runoff Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Arthurs Ridge	Retrofit	51.17	46.03	ST	2.13	10.8	497.1240	39%	194.5127	0.43	19.7929	62%	12.1873	0.07	3.2221	78%	2.5238
South Carroll High-Fine Arts	New construction	24.22	11.28	RR	1.00	10.8	121.8240	60%	72.7898	0.43	4.8504	70%	3.3904	0.07	0.7896	75%	0.5915
Brimfield	Retrofit	34.69	25.54	RR	2.50	10.8	275.8320	68%	186.7383	0.43	10.9822	79%	8.6553	0.07	1.7878	85%	1.5178
Harvest Farms 1A	Retrofit	43.8	32.55	ST	1.00	10.8	351.5400	35%	122.8632	0.43	13.9965	55%	7.6869	0.07	2.2785	70%	1.5927
Parrish Park	Retrofit	94.23	76.03	ST	1.00	10.8	821.1240	35%	286.9828	0.43	32.6929	55%	17.9549	0.07	5.3221	70%	3.7201
Clipper Hills Gardenia	Retrofit	33.19	22.11	ST	2.50	10.8	238.7880	39%	93.8795	0.43	9.5073	62%	5.8943	0.07	1.5477	79%	1.2198
Clipper hills Hilltop	Retrofit	80.17	61.63	ST	2.50	10.8	665.6040	39%	261.6822	0.43	26.5009	62%	16.4298	0.07	4.3141	79%	3.4000
Carroltowne 2B	Retrofit	34.61	24.23	ST	2.50	10.8	261.6840	39%	102.8811	0.43	10.4189	62%	6.4594	0.07	1.6961	79%	1.3367
Carroltowne 2A	Retrofit	87.73	53.3	ST	2.49	10.8	575.6400	39%	226.2284	0.43	22.9190	62%	14.2028	0.07	3.7310	79%	2.9392
Benjamins Claim	Retrofit	47.1	31.32	ST	2.21	10.8	338.2560	39%	132.4190	0.43	13.4676	62%	8.2996	0.07	2.1924	78%	1.7186
Eldersburg Estates 3-5	Retrofit	34.91	26.75	ST	2.50	10.8	288.9000	39%	113.5810	0.43	11.5025	62%	7.1312	0.07	1.8725	79%	1.4758
Braddock Manor West	Retrofit	49.3	41.65	ST	2.50	10.8	449.8200	39%	176.8467	0.43	17.9095	62%	11.1034	0.07	2.9155	79%	2.2978
Benjamins Claim Basin B	Retrofit	1.33	0.78	ST	1.04	10.8	8.4240	35%	2.9753	0.43	0.3354	56%	0.1861	0.07	0.0546	71%	0.0386

Hawks Ridge	Retrofit	63.48	43.68	ST	2.07	10.8	471.7440	39%	184.4683	0.43	18.7824	62%	11.5554	0.07	3.0576	78%	2.3932
Merridale Gardens	Retrofit	81	57.19	RR	1.77	10.8	617.6520	66%	409.7167	0.43	24.5917	78%	19.0667	0.07	4.0033	83%	3.3303
Shannon Run	Retrofit	213.5	179.4	ST	2.50	10.8	1937.5200	39%	761.7360	0.43	77.1420	62%	47.8259	0.07	12.5580	79%	9.8972
Piney Ridge Village AB 57	Retrofit	25.7	17.7	RR	2.50	10.8	191.1600	68%	129.4153	0.43	7.6110	79%	5.9984	0.07	1.2390	85%	1.0519
Woodyside Estates Small	Retrofit	9.02	6.91	RR	0.50	10.8	74.6280	45%	33.4520	0.43	2.9713	52%	1.5530	0.07	0.4837	56%	0.2709
Woodyside Estates Large	Retrofit	63.36	49.34	RR	2.50	10.8	532.8720	68%	360.7543	0.43	21.2162	79%	16.7209	0.07	3.4538	85%	2.9322
Lexington Run Section 1	Retrofit	12.87	10.25	ST	1.00	10.8	110.7000	35%	38.6897	0.43	4.4075	55%	2.4206	0.07	0.7175	70%	0.5015
Waters Edge Section 4	Retrofit	72.4	51.21	ST	1.00	10.8	553.0680	35%	193.2973	0.43	22.0203	55%	12.0935	0.07	3.5847	70%	2.5057
Melstone Valley	Retrofit	170	147.5	ST	1.00	10.8	1593.0000	35%	556.7535	0.43	63.4250	55%	34.8330	0.07	10.3250	70%	7.2172
IDA Property	Facility	75.5	65	RR	2.50	11.8	767.0000	68%	519.2590	1.43	92.9500	79%	73.2556	1.07	69.5500	85%	59.0466
Winfield Fire Dept.	Facility	0.22	0	RR	1.14	12.8	0.0000	62%	0.0000	2.43	0.0000	72%	0.0000	2.07	0.0000	77%	0.0000
Total:		**1,403.50**	**1,081.38**				**11,743.90**		**5,161.92**		**529.99**		**344.90**		**140.70**		**113.52**

Stream Restoration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Woodyside	2100	0.075	157.500	0.068	142.800	248	520800	260.400
		Total:	**157.5000**		**142.8000**		**520,800**	**260.400**

Streambank Regeneration

Location	Linear Feet	TN lbs reduced/linear ft	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/linear ft	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/linear ft	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Carroltonwe 2A	1100	0.075	82.500	0.068	74.800	44.8	49280	24.640
Eledersburg Estates 3-5	600	0.075	45.000	0.068	40.800	44.8	26880	13.440
Shannon Run	680	0.075	51.000	0.068	46.240	44.8	30464	15.232
		Total:	**178.5000**		**161.8400**		**106,624**	**53.312**

Catch Basin/inlet Cleaning

Location	Tons*	TN lbs reduced/ton	TN Pollutant Loads Reduced (lbs)	TP lbs reduced/ton	TP Pollutant Loads Reduced (lbs)	TSS lbs reduced/ton	TSS Pollutant Loads Reduced (lbs)	TSS Pollutant Loads Reduced (Tons)
Sykesville	0.25	3.5	0.875	1.4	0.350	420	105	0.053
		Total:	**0.8750**		**0.3500**		**105**	**0.053**

Stream Buffer Plantings

Project	Acres	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BMP Efficiency	TSS Pollutant Loads Reduced (Tons)
Planting 1	4.9	10.8	52.9200	66	34.9272	0.43	2.1070	77	1.6224	0.07	0.3430	57	0.1955
Planting 2	3.45	10.8	37.2600	66	24.5916	0.43	1.4835	77	1.1423	0.07	0.2415	57	0.1377
Planting 3	0.16	10.8	1.7280	66	1.1405	0.43	0.0688	77	0.0530	0.07	0.0112	57	0.0064
Planting 4	3.2	10.8	34.5600	66	22.8096	0.43	1.3760	77	1.0595	0.07	0.2240	57	0.1277
Planting 5	0.3	10.8	3.2400	66	2.1384	0.43	0.1290	77	0.0993	0.07	0.0210	57	0.0120
Planting 6	3	10.8	32.4000	66	21.3840	0.43	1.2900	77	0.9933	0.07	0.2100	57	0.1197
Planting 7	0.23	10.8	2.4840	66	1.6394	0.43	0.0989	77	0.0762	0.07	0.0161	57	0.0092
Planting 8	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Planting 9	0.13	10.8	1.4040	66	0.9266	0.43	0.0559	77	0.0430	0.07	0.0091	57	0.0052
Total:	**15.5**		**167.4000**		**110.4840**		**6.6650**		**5.1321**		**1.0850**		**0.6185**

Grass Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Grass Buffer 1995-2008	89.080	1995-2008	11.7	1042.2360	30	312.67080	0.68	60.5744	40	24.2298	0.18	16.0344	55
Grass Buffer 2009-Current	69.640	2009 -current	11.7	814.7880	30	244.43640	0.68	47.3552	40	18.9421	0.18	12.5352	55
	158.720		**Total:**	**1857.0240**		**557.10720**		**107.9296**		**43.1718**		**28.5696**	

Forest Buffer Easements

Subdivision	Acres	Recorded Date	TN Pollutant Load	Total Loads (lbs)	TN BMP Efficiency (%)	TN Pollutant Loads Reduced (lbs)	TP Pollutant Load	Total Loads (lbs)	TP BMP Efficiency	TP Pollutant Loads Reduced (lbs)	TSS Pollutant Load	Total Loads (tons)	TSS BM Efficien
Forest Buffer 1995-2008	166.030	1995-2008	11.7	1942.5510	45	874.1480	0.68	112.9004	40	45.1602	0.18	29.8854	55
Forest Buffer 2009-Current	106.140	2009 -current	11.7	1241.8380	45	558.8271	0.68	72.1752	40	28.8701	0.18	19.1052	55
	272.170		**Total:**	**3184.3890**		**955.31670**		**185.0756**		**74.0302**		**48.9906**	

XVII. Appendix F: Forest Buffer and Grass Buffer Protection Easements

Forest Buffer Protection Easements

Project Name	Acres	Implementation Year
Piney Run	0.819519	1995
Piney Run	1.612281	1995
Middle Run	2.521235	1996
Piney Run	2.200353	1996
Middle Run	0.001568	1996
Piney Run	2.419142	1997
Piney Run	0.698063	1997
Piney Run	4.475535	1997
Piney Run	0.329898	1997
South Branch Patapsco Ri*	0.159596	1998
South Branch Patapsco Ri*	0.000167	1998
Gillis Falls	8.003215	1999
Middle Run	2.316767	1999
Middle Run	9.444429	1999
Piney Run	0.218304	1999
South Branch Patapsco Ri*	12.849819	1999
Piney Run	0.329898	1999
Middle Run	0.001568	1999
Middle Run	0.001759	1999
Middle Run	0.001759	1999
Middle Run	0.073559	1999
Middle Run	0.205668	1999

South Branch Patapsco Ri*	1.770189	2001
Piney Run	2.930098	2001
Piney Run	1.528832	2001
Middle Run	3.793286	2001
South Branch Patapsco Ri*	0.820609	2002
Middle Run	0.314362	2002
Pine Brook Farm, Section*	3.472799	2002
Pine Brook Farm, Section*	4.839581	2002
Pine Brook Farm, Section*	0.030559	2002
Middle Run	8.582648	2002
Middle Run	0.098132	2002
Middle Run	0.106279	2002
Tuckers Branch	0.899804	2002
Pine Brook Farm, Section*	0.000292	2002
Pine Brook Farm, Section*	0.000058	2002
Pine Brook Farm, Section*	0.002605	2002
Pine Brook Farm, Section*	0.002605	2002
Middle Run	0.015489	2002
Middle Run	0.205668	2002
Tuckers Branch	10.289335	2004
Tuckers Branch	7.948689	2004
Pine Brook Farm II	5.742907	2004
Piney Run	6.616725	2004
Pine Brook Farm II	14.04952	2004
Gillis Falls	0.518025	2004
Gillis Falls	0.696524	2004
Pine Brook Farm II	0.000292	2004

Pine Brook Farm II	0.000058	2004
Whitetail Run Estates	0.137291	2005
Whitetail Run Estates	0.088453	2005
Whitetail Run Estates	0.626687	2005
Freedom Hills Farms	0.042157	2005
Tuckers Branch	12.665644	2005
Freedom Hills Farms	3.228446	2005
Piney Run	2.157508	2006
Kraft Heritage	0.067127	2006
Gillis Falls	2.869574	2006
Kraft Heritage	2.270669	2006
Piney Run	4.803649	2006
Kraft Heritage	0.000268	2006
Gillis Falls	0.443856	2006
Kraft Heritage	0.022345	2006
South Branch Patapsco Ri*	0.97809	2007
S. Carroll Gateway Ind P*	0.020584	2007
S. Carroll Gateway Ind P*	0.000453	2007
South Branch Patapsco Ri*	0.045509	2007
South Branch Patapsco Ri*	0.001967	2007
Symphony Hill	0.019238	2007
George Duke Subdivision	0.000033	2007
SES Americom	0.000131	2007
Symphony Hill	0.045064	2007
South Branch Patapsco Ri*	0.477789	2007
Symphony Hill	8.490547	2007
George Duke Subdivision	0.00799	2007

SES Americom	0.011223	2007
Symphony Hill	0.00248	2007
SES Americom	0.00248	2007
Symphony Hill	0.00034	2007
Symphony Hill	0.000048	2007
South Branch Patapsco Ri*	0.000167	2007
Symphony Hill	0.005617	2007
SES Americom	0.005617	2007
Symphony Hill	0.00027	2007
George Duke Subdivision	0.001437	2007
Symphony Hill	0.069233	2007
Symphony Hill	0.069233	2007
SES Americom	0.069233	2007
Symphony Hill	0.014183	2007
Symphony Hill	0.014183	2007
SES Americom	0.014183	2007
Raincliffe	0.022384	2008
South Branch Patapsco Ri*	0.146499	2008
Raincliffe	0.109735	2008
Piney Ridge Elementary	1.101836	2008
Shaw Glen, Section 2	0.011462	2008
Shaw Glen, Section 2	0.117303	2008
Raincliffe	0.001241	2008
South Branch Patapsco Ri*	0.151936	2008
Raincliffe	0.105191	2008
Harrison's Subdivision, *	0.494237	2008
Piney Ridge Elementary	0.013829	2008

George Duke Subdivision	0.372332	2009
George Duke Subdivision	0.345582	2009
George Duke Subdivision	4.124304	2009
George Duke Subdivision	3.448827	2009
Tuckers Branch	0.107031	2009
Talley's Hallowell, Lot *	0.054936	2009
George Duke Subdivision	0.133371	2009
George Duke Subdivision	0.001976	2009
George Duke Subdivision	0.019665	2009
George Duke Subdivision	0.007008	2009
George Duke Subdivision	0.001437	2009
George Duke Subdivision	0.133371	2009
Warfield Commerce & Cult*	0.001724	2010
Piney Run	0.258259	2010
Warfield Commerce & Cult*	0.574317	2010
GI-NA Farms Estates, Lot*	0.060278	2010
SES Americom	0.001134	2011
SES Americom	0.00888	2011
South Branch Patapsco Ri*	20.180166	2011
SES Americom	3.683354	2011
SES Americom	1.03121	2011
Mount Airy WWTP	0.587209	2011
Chimney Rock	1.151533	2011
Piney Ridge Village 8	0.010201	2011
Piney Run	0.003932	2011
Piney Run	0.001799	2011
Piney Ridge Village 8	0.504619	2011

Piney Ridge Village 8	0.080171	2011
Piney Run	14.691191	2011
Chimney Rock	0.078517	2011
SES Americom	0.000339	2011
South Branch Patapsco Ri*	0.026195	2011
SES Americom	0.003552	2011
SES Americom	0.011223	2011
Piney Ridge Village 8	0.00163	2011
Piney Ridge Village 8	0.00163	2011
SES Americom	0.133371	2011
SES Americom	0.133371	2011
SES Americom	0.001976	2011
SES Americom	0.00034	2011
SES Americom	0.019665	2011
SES Americom	0.007008	2011
SES Americom	0.014356	2011
SES Americom	0.014356	2011
SES Americom	0.000048	2011
SES Americom	0.00027	2011
SES Americom	0.069233	2011
SES Americom	0.014183	2011
South Branch Patapsco Ri*	7.671389	2012
Piney Run	0.880265	2012
Piney Run	2.115213	2012
Piney Run	0.29073	2012
Long Reach Farm	0.019762	2012
Long Reach Farm	0.004909	2012

Long Reach Farm	0.205621	2012
Piney Run	0.314396	2012
Long Reach Farm	0.248453	2012
Piney Run	2.189766	2012
Piney Run	0.372876	2012
Piney Run	0.290884	2012
Piney Run	0.000468	2012
Long Reach Farm	0.001715	2012
Long Reach Farm	0.001715	2012
Twin Arch Business Park	2.186463	2013
South Branch Patapsco	0.088527	2013
South Branch Patapsco	0.002408	2013
Twin Arch Business Park	0.513831	2013
Twin Arch Business Park	2.521146	2014
Twin Arch Business Park	1.436673	2014
Gillis Falls	5.798724	2014
Piney Run	1.136815	2015
Arrington Estates Parcel*	0.067942	2015
Piney Run	1.460983	2015
Piney Run	1.066132	2015
Brotman Property	0.04536	2015
Brotman Property	0.025479	2015
Brotman Property	0.006713	2015
Brotman Property	0.019761	2015
Brotman Property	0.131323	2015
Brotman Property	0.00829	2015
Brotman Property	0.028027	2015

Brotman Property	0.00002	2015
Brotman Property	0.005064	2015
Piney Run	0.934907	2015
Piney Run	0.03485	2015
Piney Run	0.491714	2015
Piney Run	0.90765	2015
Piney Run	0.000203	2015
Piney Run	0.000203	2015
Colonial Pipeline	13.240701	2019
Twin Arch Business Park	4.566503	2019
Cody's Crossing	2.692633	2019

Grass Buffer Protection Easements

Project Name	Acres	Implementation Year
Piney Run	0.407599	1995
Middle Run	1.982428	1996
Piney Run	0.211346	1997
South Branch Patapsco Ri*	1.002626	1997
Piney Run	14.697859	1997
Piney Run	0.818089	1997
Piney Run	0.33512	1999
Piney Run	2.518304	1999
South Branch Patapsco Ri*	1.656513	1999
Gillis Falls	18.154279	1999
Gillis Falls	1.815467	1999
Piney Run	1.786423	1999
Piney Run	0.818089	1999

Middle Run	2.790963	2001
Piney Run	1.202785	2001
Piney Run	0.327877	2001
South Branch Patapsco Ri*	0.06047	2001
Piney Run	0.575915	2001
Pine Brook Farm, Section*	5.488336	2002
Middle Run	3.291268	2002
Tuckers Branch	0.661302	2002
Middle Run	1.558596	2002
Piney Run	0.059753	2002
South Branch Patapsco Ri*	1.599781	2002
Middle Run	0.14382	2002
Pine Brook Farm, Section*	4.556554	2002
Middle Run	0.007228	2002
Piney Run	0.427115	2003
Piney Run	0.080537	2004
Pine Brook Farm II	0.958692	2004
Piney Run	0.200618	2004
Tuckers Branch	0.051204	2004
Tuckers Branch	0.362898	2004
Gillis Falls	0.963341	2004
Gillis Falls	0.126211	2004
Pine Brook Farm II	0.333209	2004
Whitetail Run Estates	0.00004	2005
Freedom Hills Farms	0.576129	2005
Tuckers Branch	3.69012	2005
Whitetail Run Estates	0.248671	2005

Whitetail Run Estates	0.019716	2005
Freedom Hills Farms	2.498322	2005
Gillis Falls	0.023764	2006
S. Carroll Gateway Ind P*	0.009401	2007
South Branch Patapsco Ri*	0.008542	2007
S. Carroll Gateway Ind P*	0.228586	2007
Piney Ridge Elementary	2.657464	2008
Raincliffe	0.066226	2008
Raincliffe	0.022997	2008
Raincliffe	0.250395	2008
Raincliffe	0.03268	2008
Raincliffe	0.038292	2008
Shaw Glen, Section 2	0.249229	2008
Shaw Glen, Section 2	1.225335	2008
Raincliffe	0.015574	2008
South Branch Patapsco Ri*	2.461916	2008
Piney Ridge Elementary	0.000818	2008
Piney Ridge Elementary	0.000785	2008
Raincliffe	0.255287	2008
Raincliffe	0.109487	2008
Raincliffe	1.949209	2008
Raincliffe	0.039045	2008
Raincliffe	0.36564	2008
Talley's Hallowell, Lot *	0.046277	2009
Tuckers Branch	0.383016	2009
Talley's Hallowell, Lot *	0.265025	2009
Warfield Commerce & Cult*	1.729928	2010

GI-NA Farms Estates, Lot*	0.204583	2010
Warfield Commerce & Cult*	4.813123	2010
Piney Run	1.948764	2010
Piney Ridge Village 8	0.011322	2011
Piney Ridge Village 8	0.104681	2011
Chimney Rock	1.81542	2011
Chimney Rock	17.445073	2011
Mount Airy WWTP	1.013647	2011
SES Americom	0.070891	2011
Piney Run	5.931667	2011
South Branch Patapsco Ri*	1.403404	2011
South Branch Patapsco Ri*	0.150587	2011
Piney Ridge Village 8	1.521398	2011
Piney Ridge Village 8	2.572473	2011
SES Americom	0.264327	2011
SES Americom	0.166024	2011
Piney Run	0.004224	2011
Piney Run	0.0673	2011
Piney Ridge Village 8	0.044391	2011
Piney Ridge Village 8	0.301637	2011
Piney Run	0.000016	2011
Piney Run	0.000016	2011
Piney Ridge Village 8	0.001698	2011
Piney Ridge Village 8	0.001698	2011
Piney Ridge Village 8	0.021758	2011
Piney Ridge Village 8	0.021758	2011
Long Reach Farm	1.52808	2012

Long Reach Farm	0.414818	2012
Long Reach Farm	1.531348	2012
Piney Run	1.987609	2012
Piney Run	1.06957	2012
Piney Run	1.446789	2012
Long Reach Farm	3.544568	2012
Long Reach Farm	0.004898	2012
Long Reach Farm	0.359786	2012
South Branch Patapsco Ri*	3.17226	2012
Piney Run	1.205462	2012
Piney Run	0.000125	2012
Long Reach Farm	0.002101	2012
Long Reach Farm	0.002101	2012
Long Reach Farm	0.000632	2012
Long Reach Farm	0.000632	2012
Twin Arch Business Park	0.906687	2013
Twin Arch Business Park	0.857872	2013
Twin Arch Business Park	0.154163	2013
South Branch Patapsco	0.003644	2013
South Branch Patapsco	1.615119	2013
Twin Arch Business Park	1.096177	2013
Arrington Estates Parcel*	0.003019	2015
Arrington Estates Parcel*	0.000182	2015
Piney Run	1.323136	2015
Piney Run	0.005942	2015
Piney Run	0.954976	2015
Piney Run	0.141169	2015

Piney Run	0.032681	2015
Arrington Estates Parcel*	0.025172	2015
Arrington Estates Parcel*	0.115895	2015
Charles Ray Acres Sec 2	1.504309	2017
Clnl. Pipl. Drsy. Junc.	0.862396	2018
Colonial Pipeline	0.939278	2019