Prettyboy Reservoir Watershed
Carroll County, Maryland
Interim Restoration Plan

2019

Prepared by
Carroll County Government Bureau of Resource Management

MDE Approved: May 2020

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.

Table of Contents

Prettyboy Reservoir Watershed Restoration Plan

Figures

Tables

Appendices

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

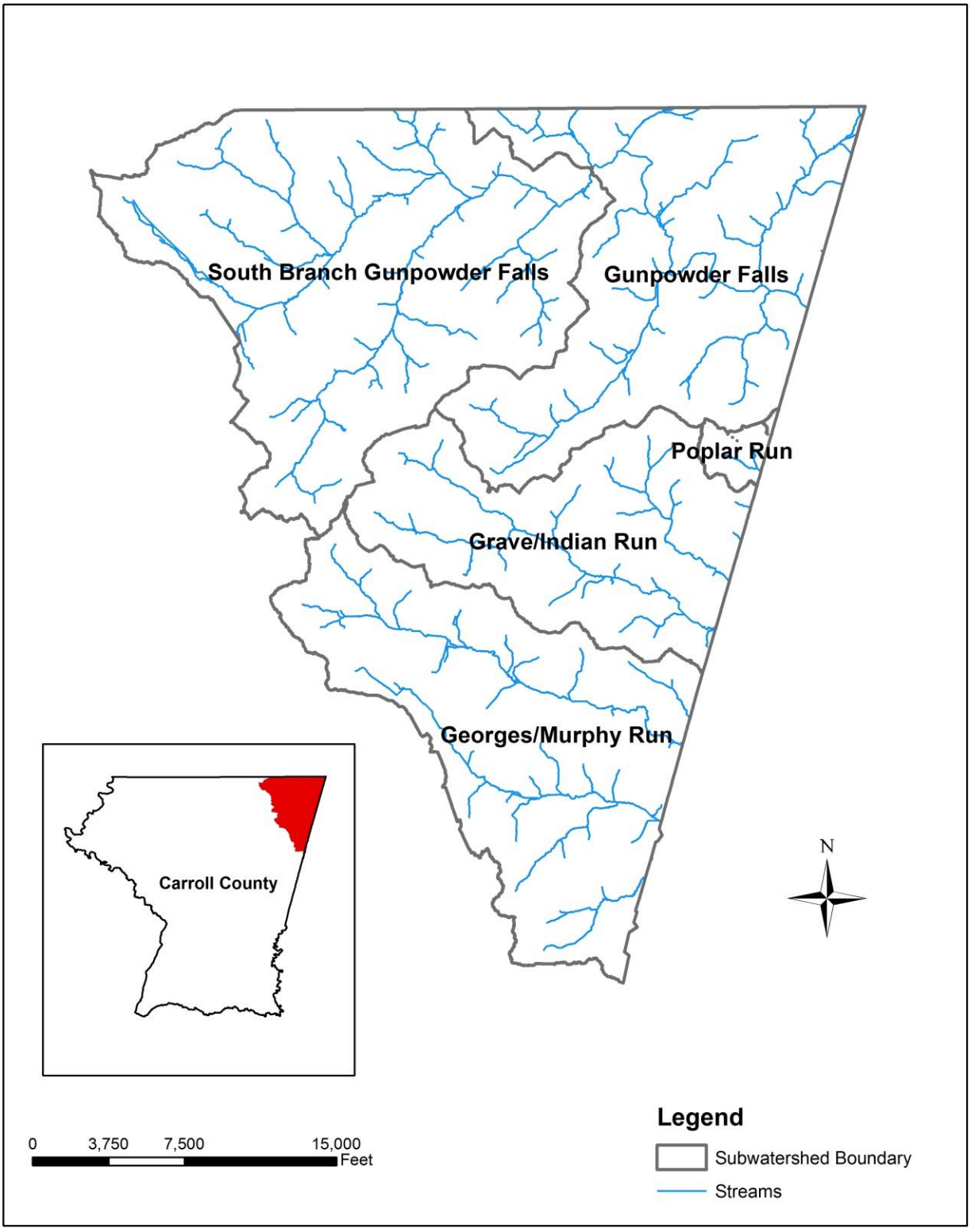

Figure 1: Prettyboy Watershed and Subwatersheds Map

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**

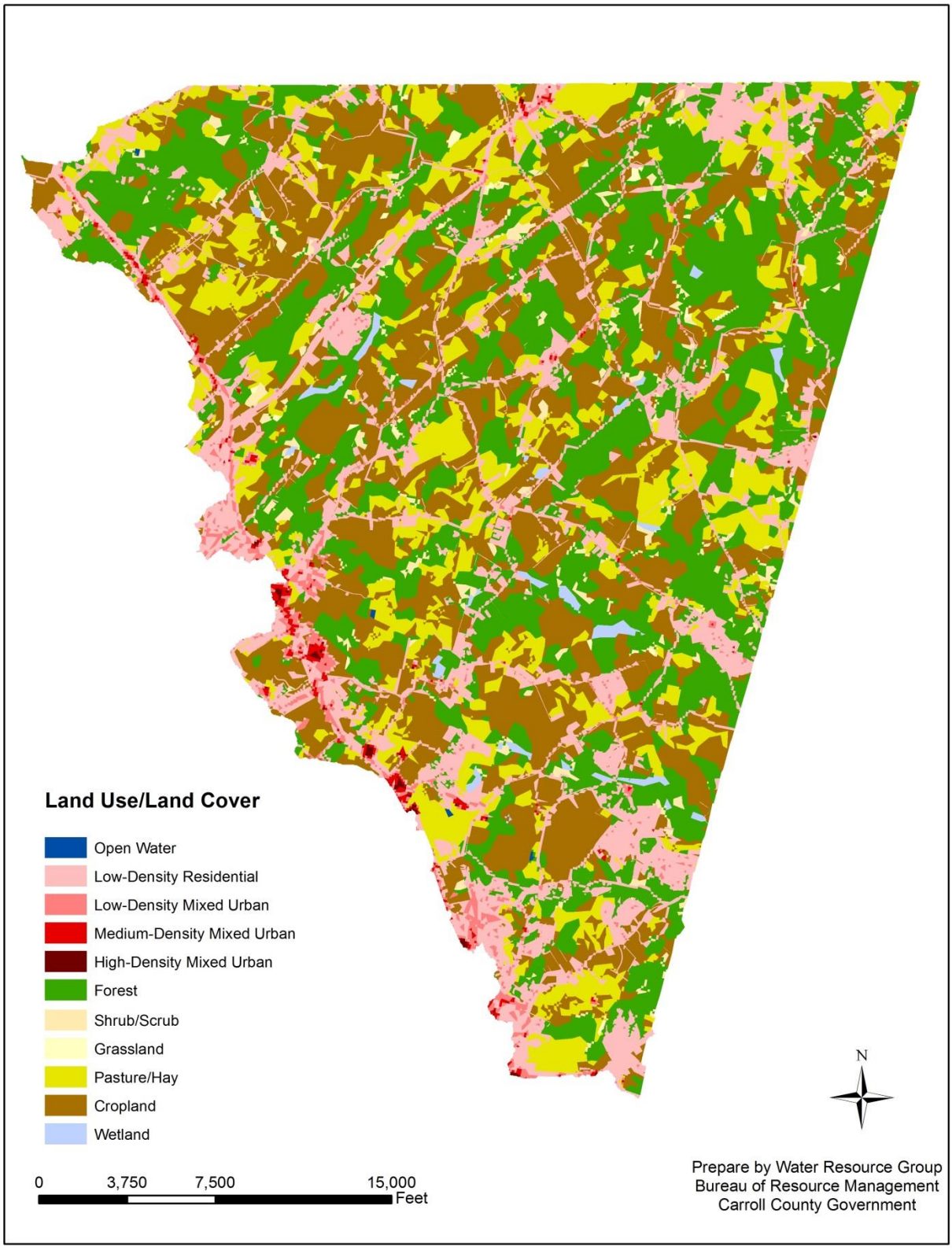

Figure 2: Prettyboy Watershed Land Use/Land Cover

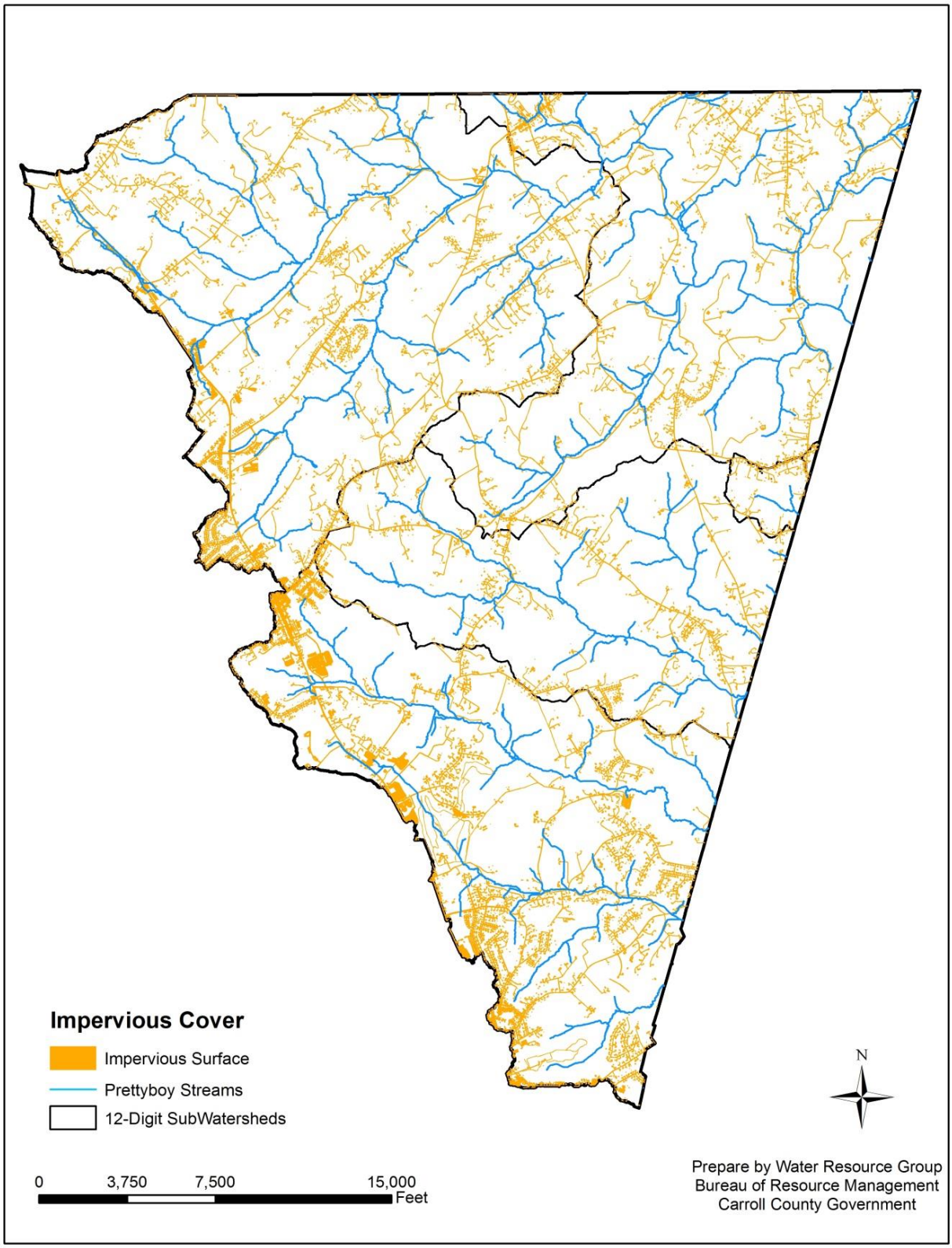

Figure 3: Prettyboy Watershed Impervious Surface Area

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.

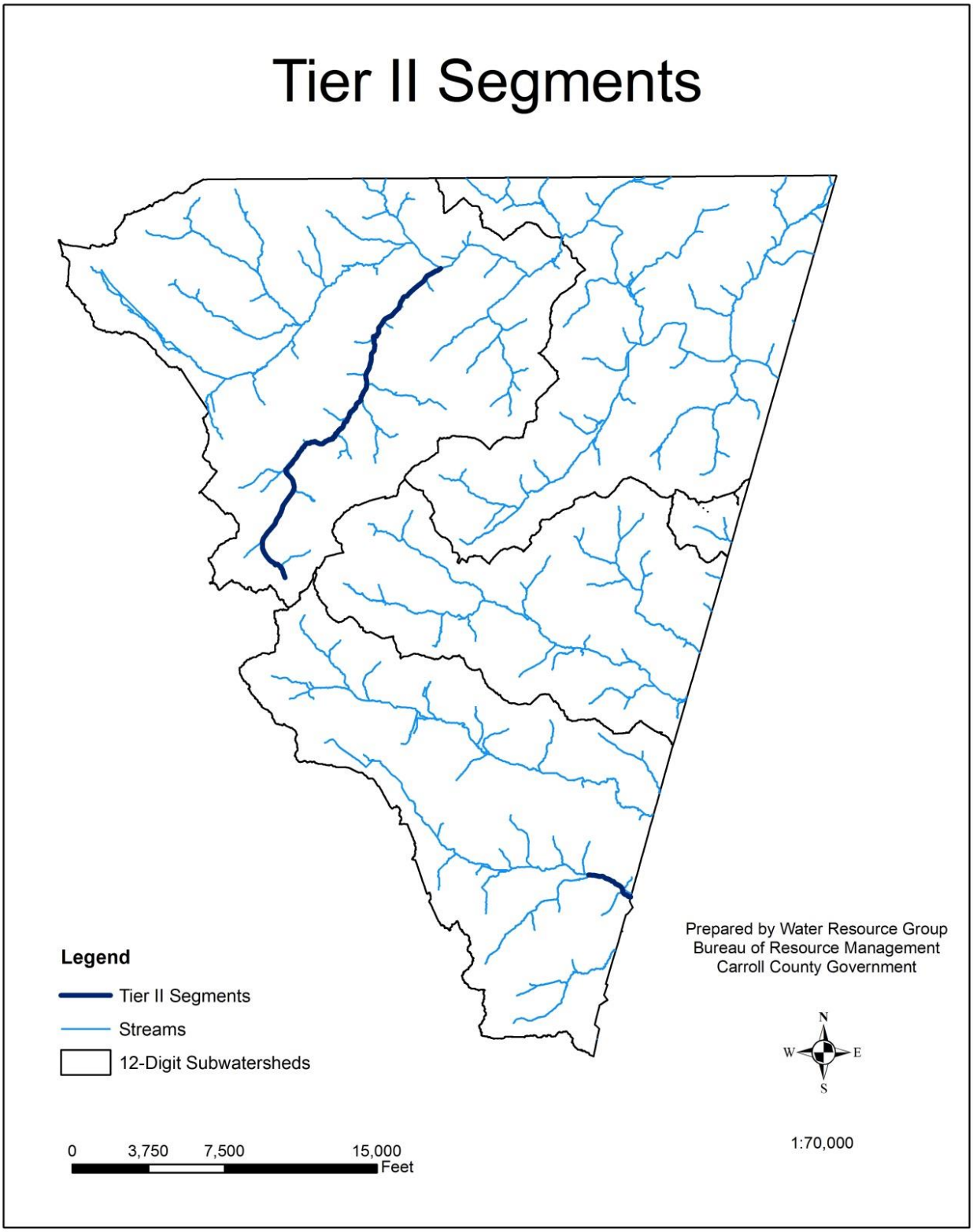

Figure 4: Tier II Waters

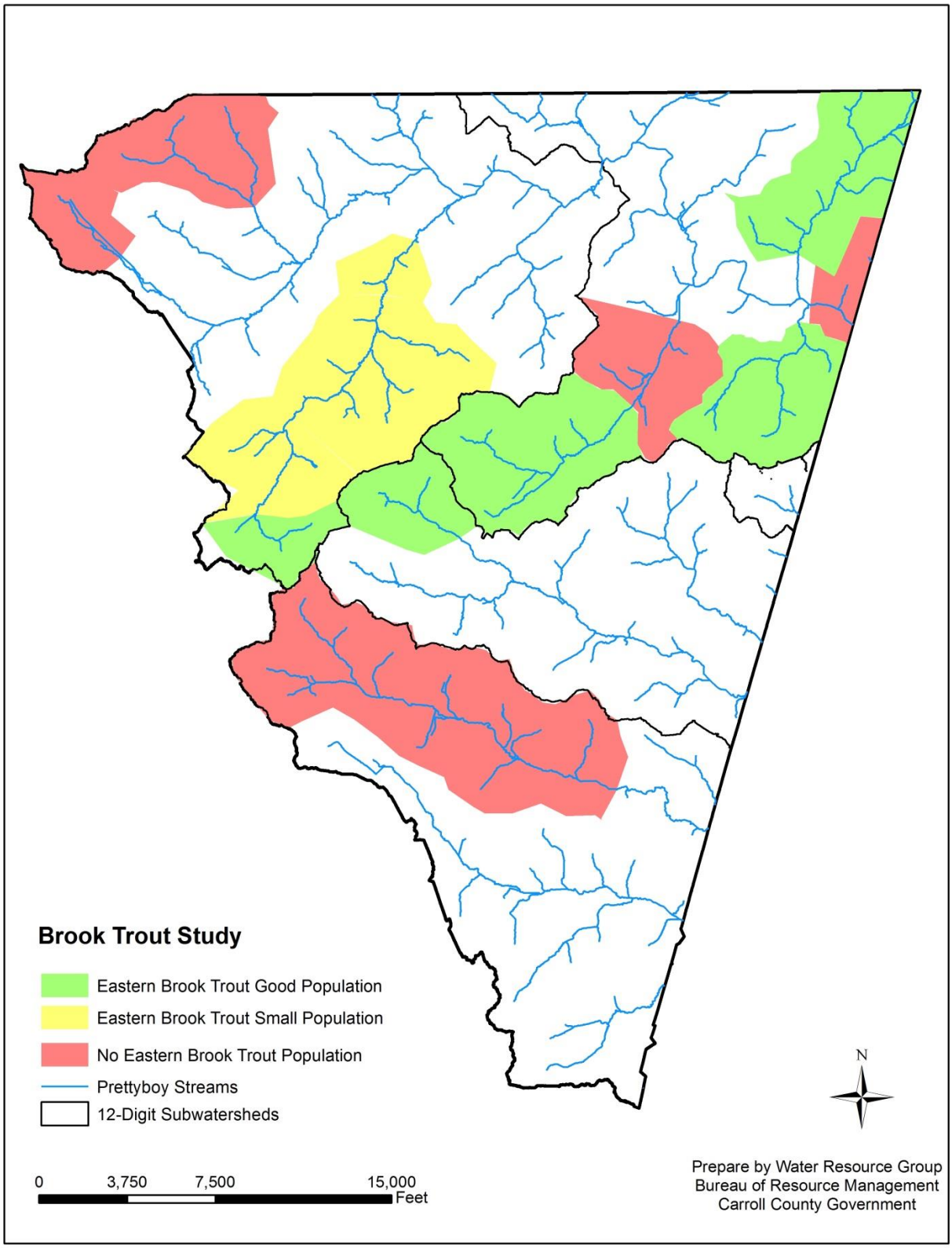

Figure 5: Brook Trout Study

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.

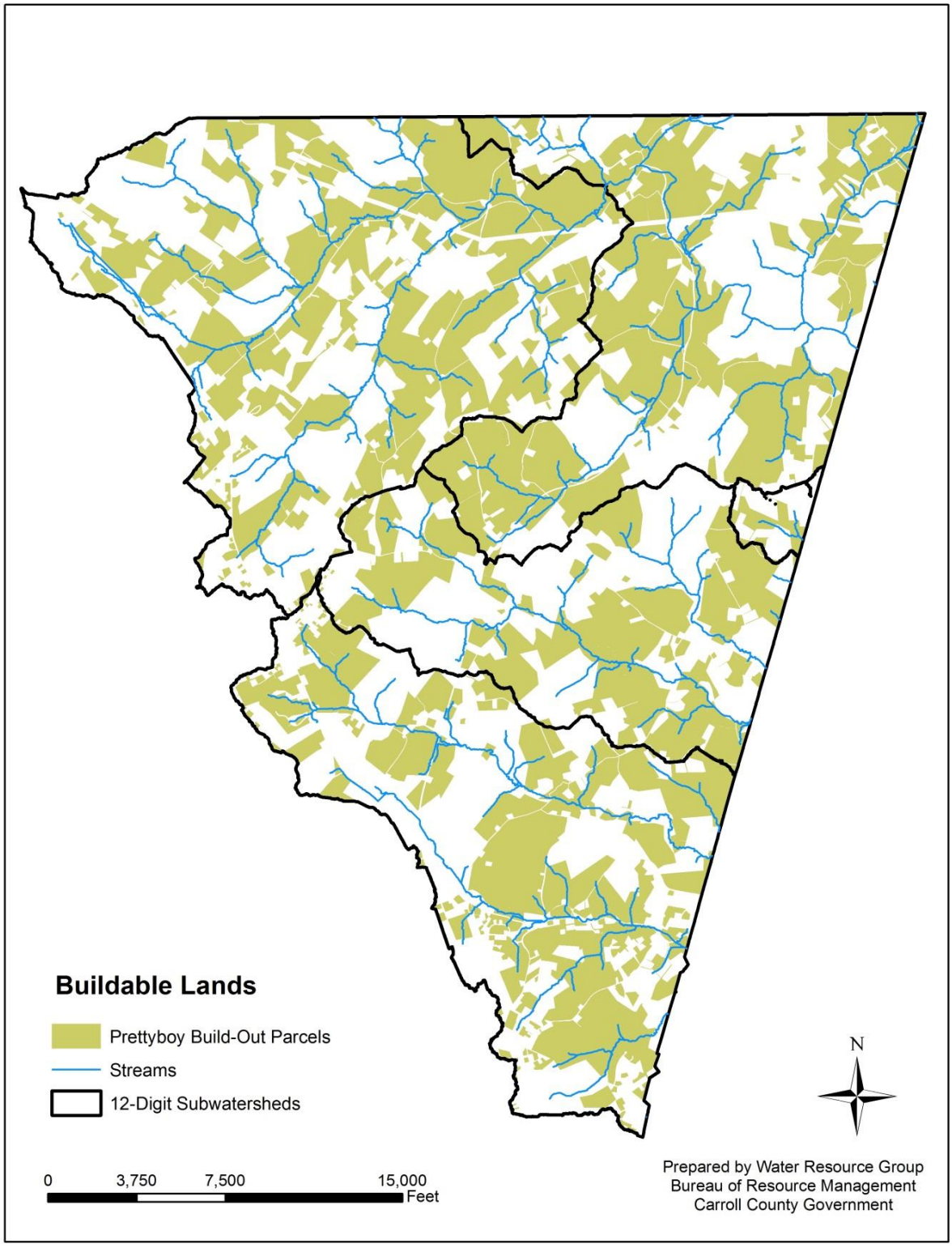

Figure 6: Prettyboy Watershed Build-Out Parcels

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.

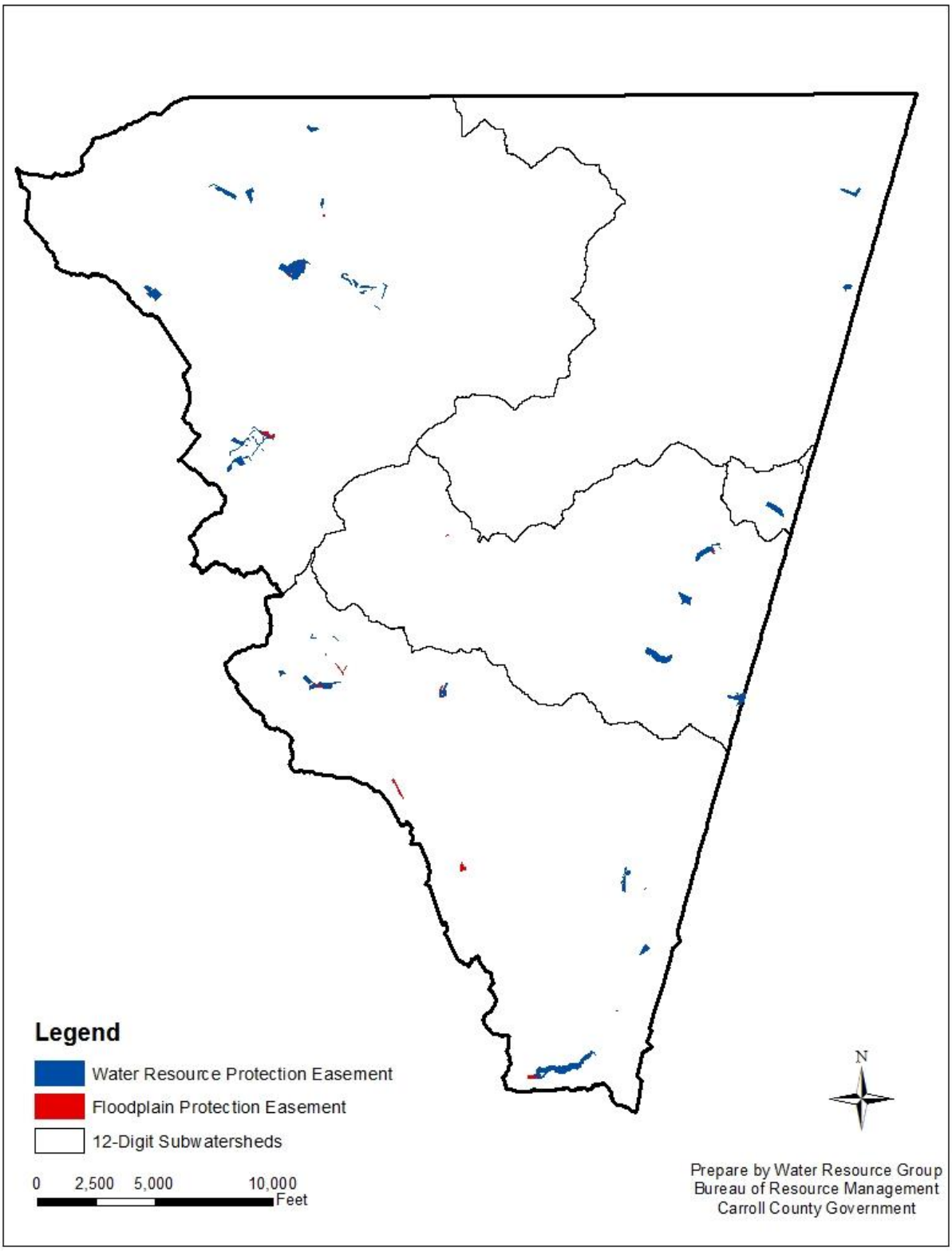

Figure 7: Water Resource and Floodplain Protection Easement Locations

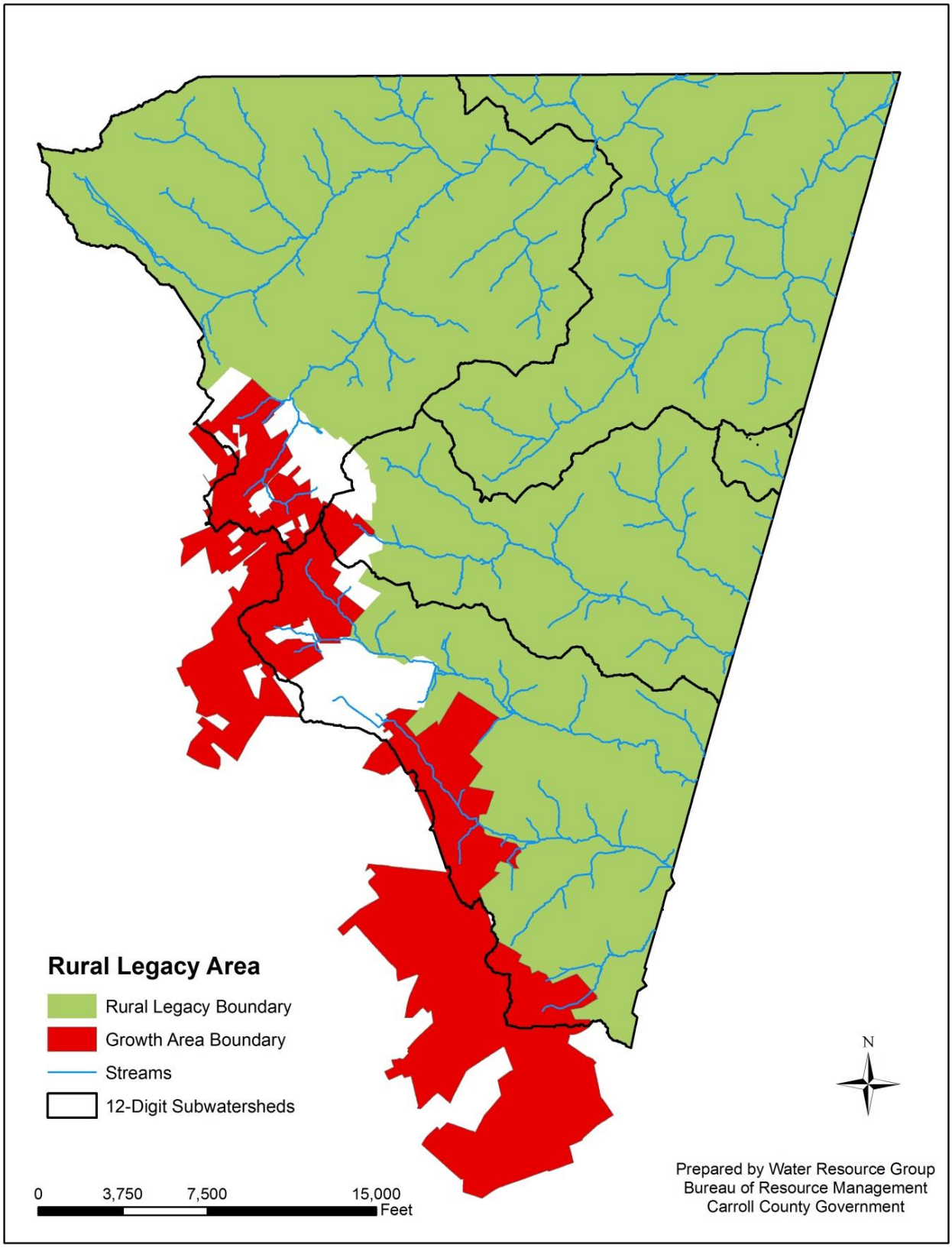

Figure 8: Upper Patapsco Rural Legacy Area

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.

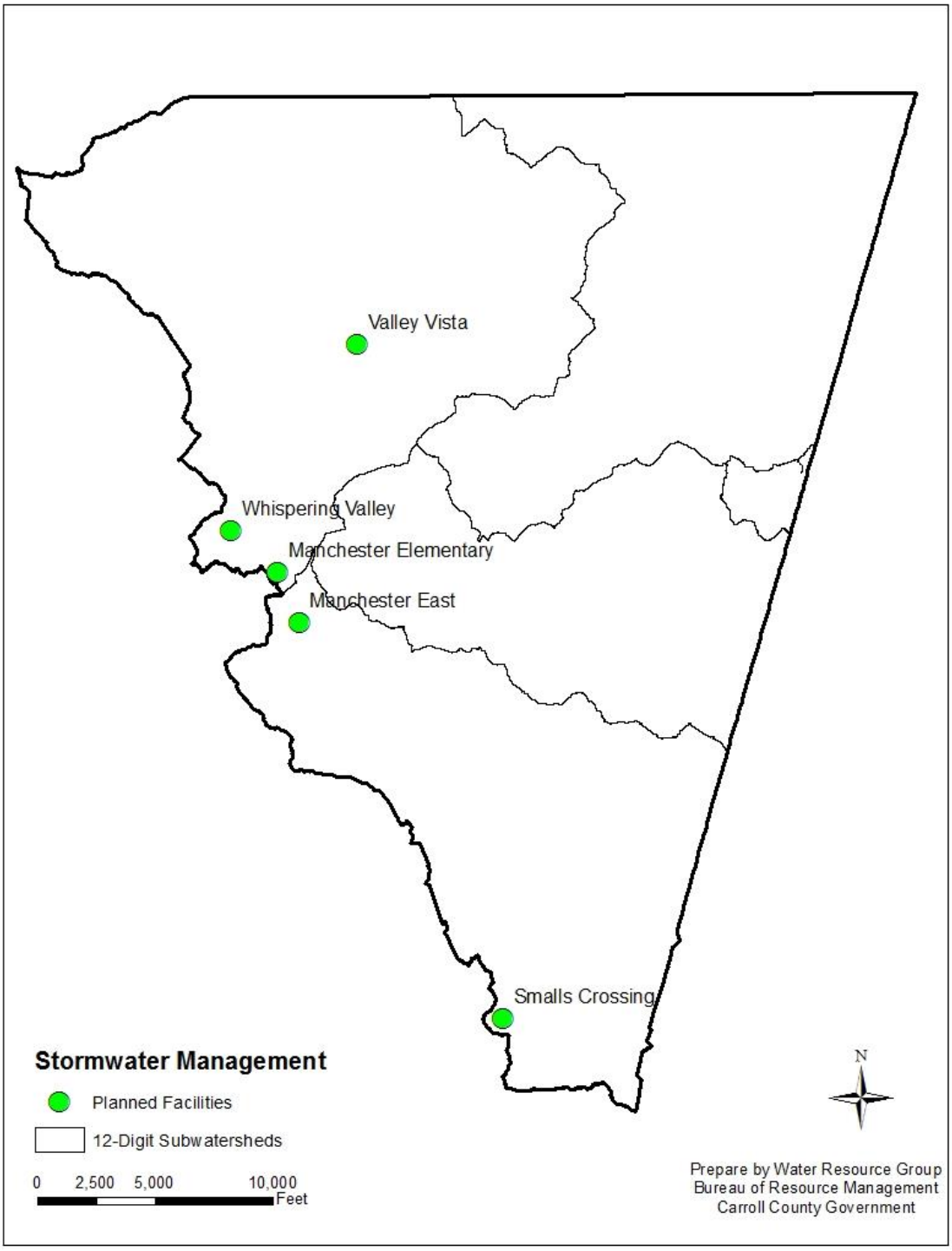

Figure 9: Stormwater Management Locations

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.

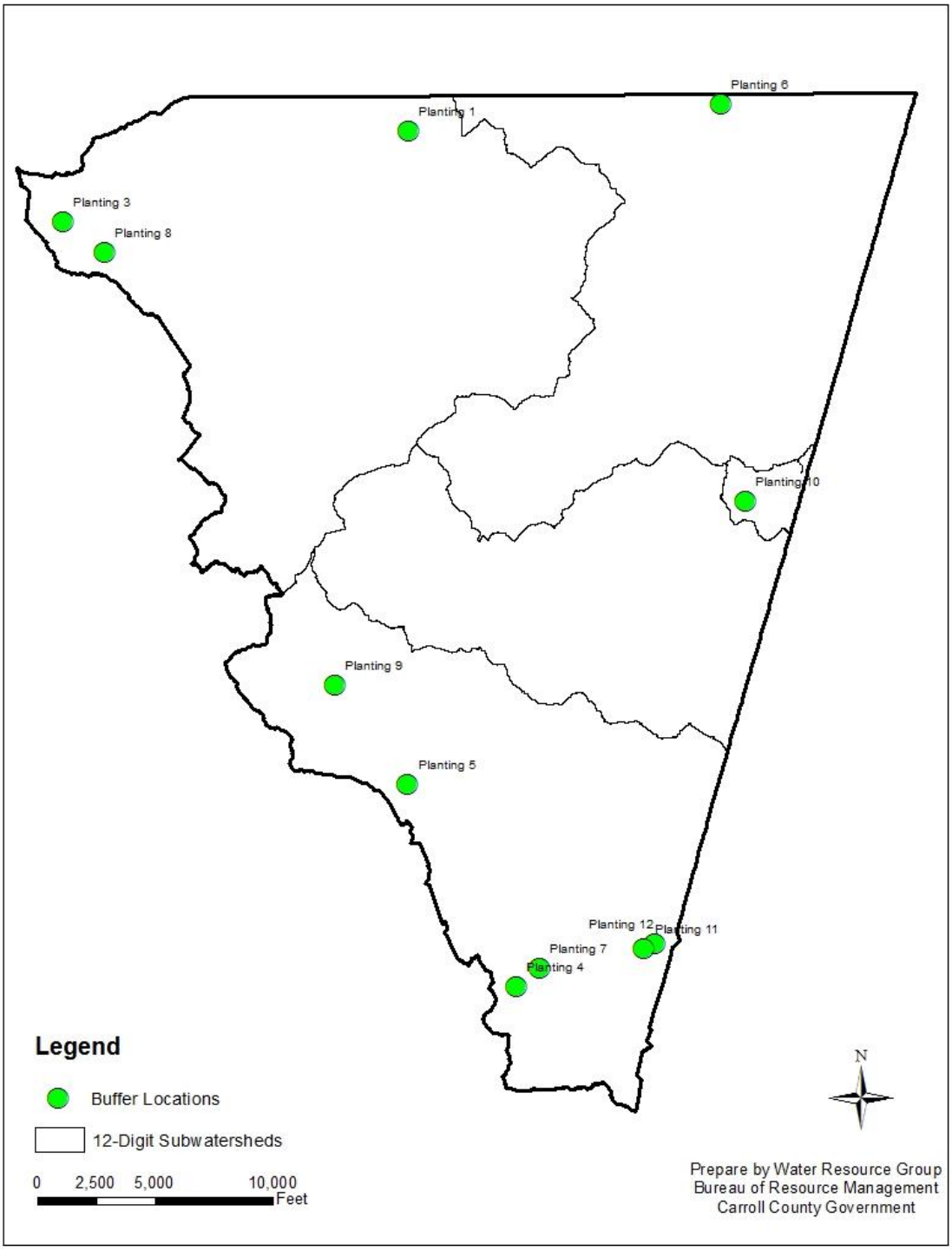

Figure 10: Stream Buffer Initiative Locations

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

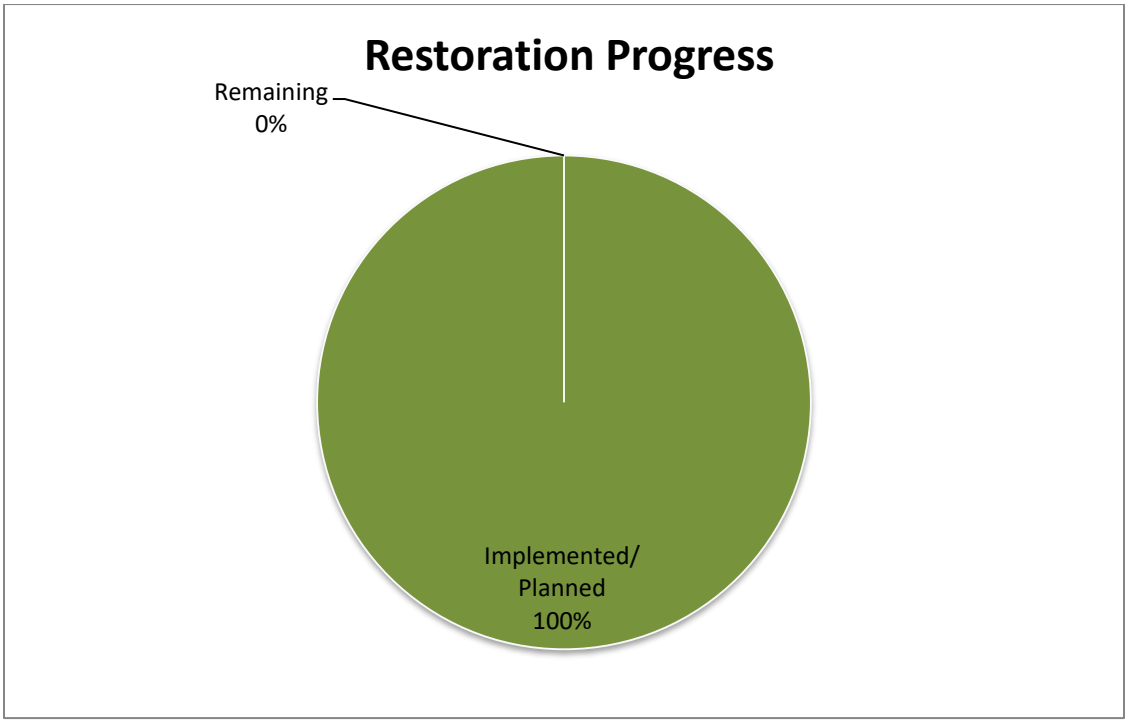

Figure 11: 2019 Restoration Progress

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

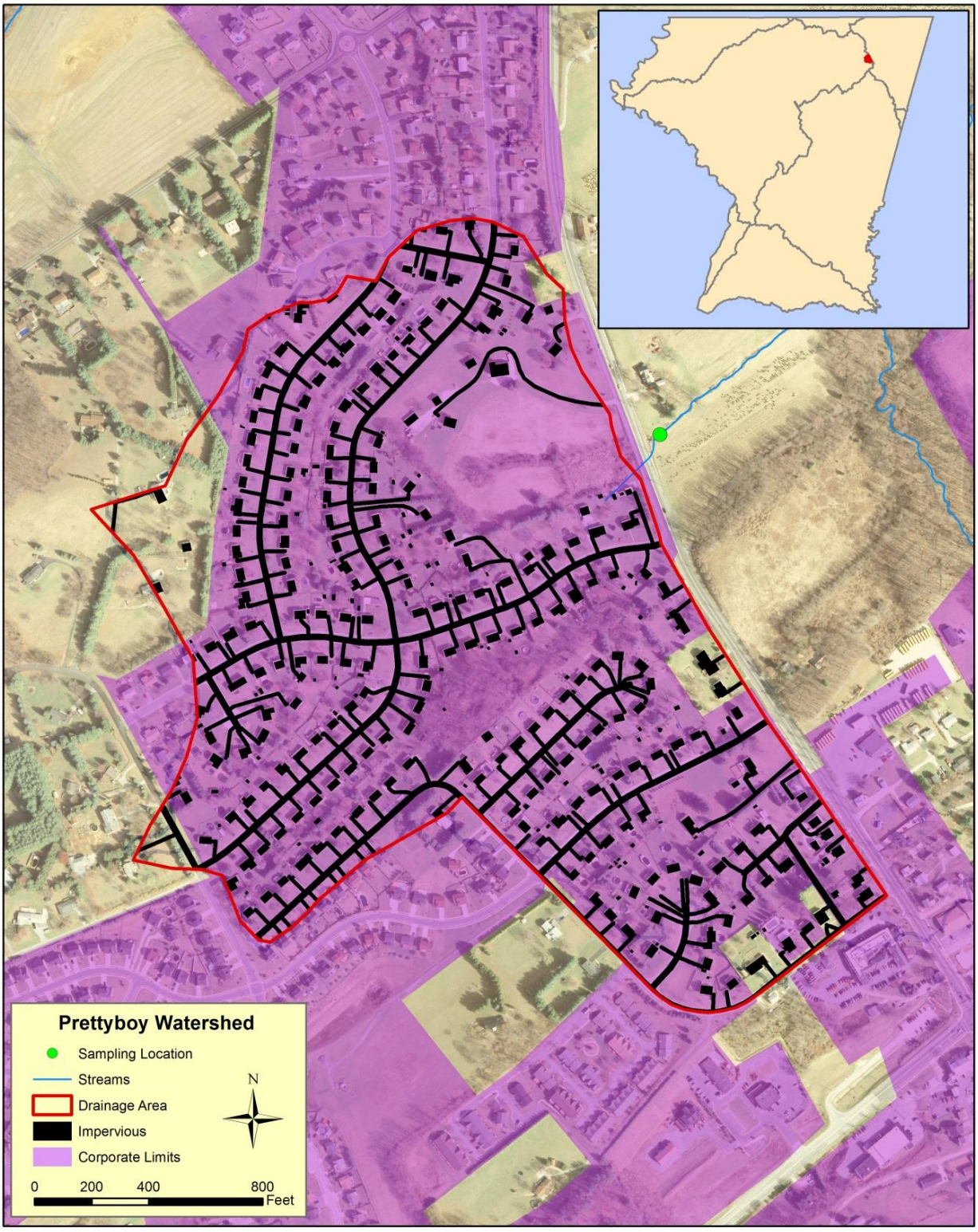

Figure 12: Whispering Valley Monitoring Location

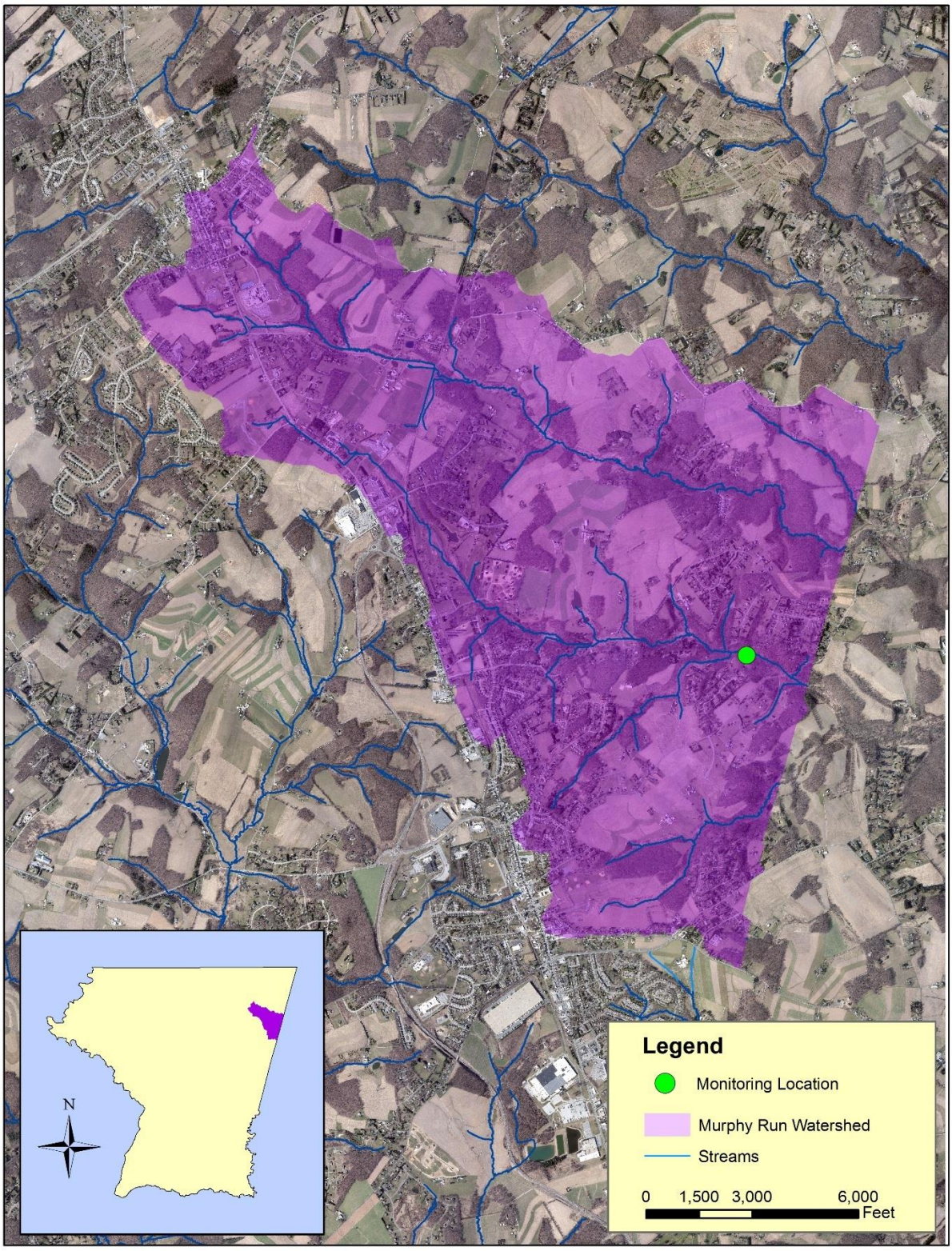

Figure 13: Bacteria Monitoring Location

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.

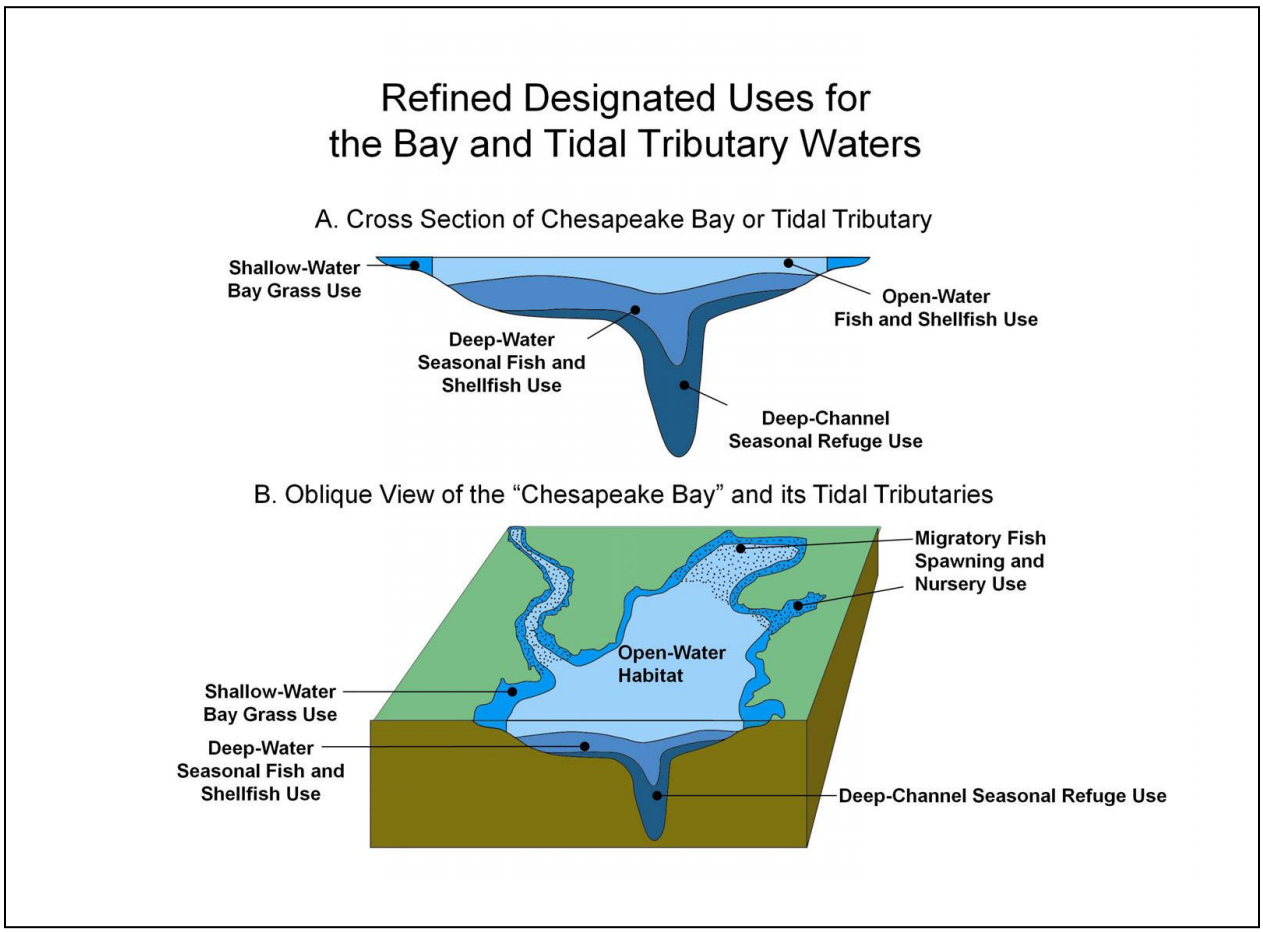

Figure 14: Chesapeake Bay Tidal Water Designated Use Zones (source: USEPA2003d)

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.

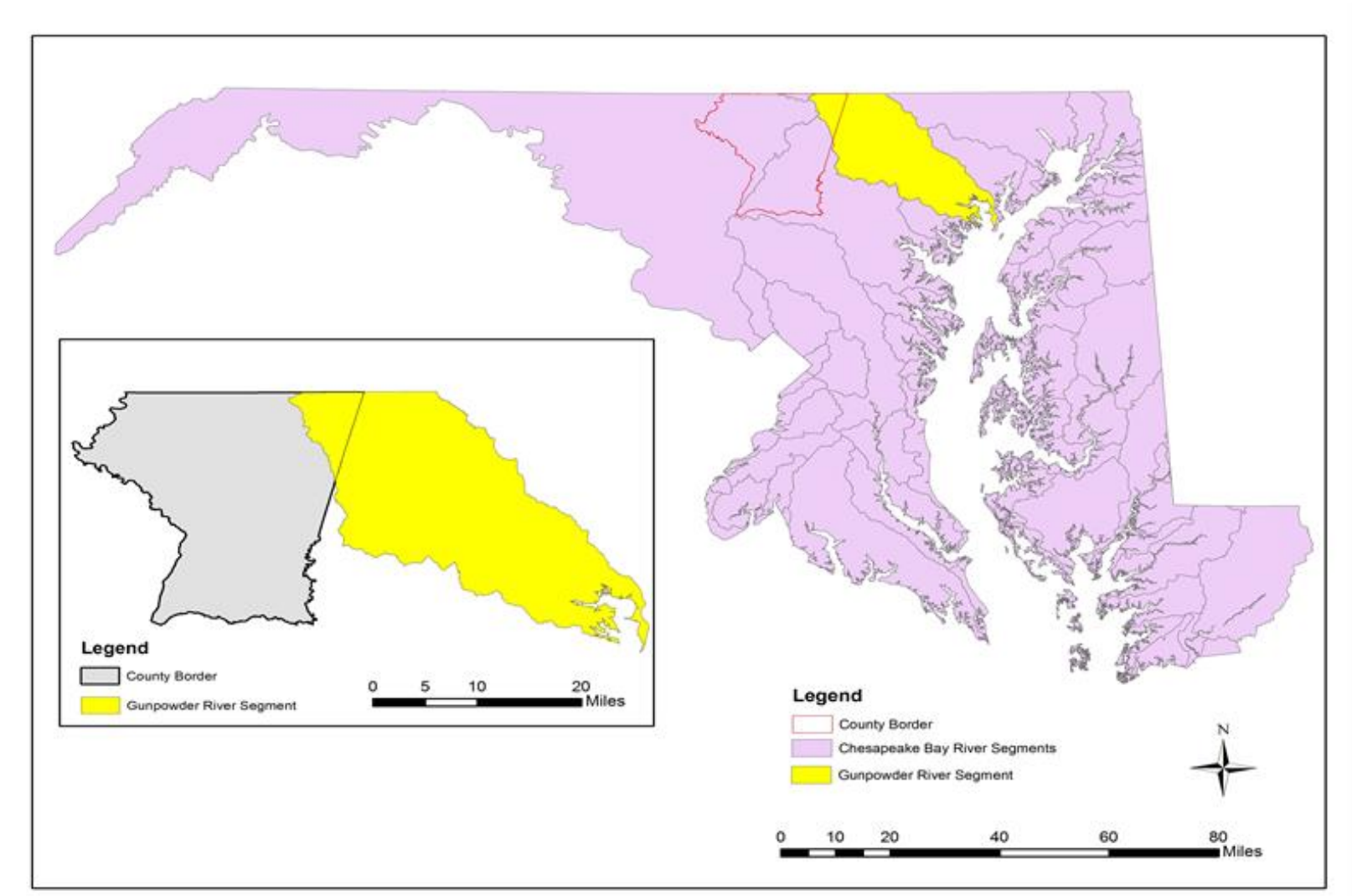

Figure 15: Chesapeake Bay River Segments

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.

XI. References

Betz, D-E, B. Evans. 2015. Using MapShed Model for the Christina Basin TMDL Implementation and Water Quality Restoration. Villanova Urban Stormwater Partnership Symposium. Retrieved from https://www1.villanova.edu/content/dam/villanova/engineering/vcase/sym-presentations/2015/Presentationpdfs/3C4-Betz%20VILLANOVA10%2014%2015.pdf

CADMUS. 2009. Total Maximum Daily Load (TMDL) for Phosphorus in Summit Lake. The CADMUS Group, Inc., Waltham, MA. Retrieved from http://www.dec.ny.gov/docs/water_pdf/tmdlsummitlk09.pdf

Clary, J., Jones, J. E., Urbonas, B. R., Quigley, M. M., stecker, E., & Wagner, T. (2008, May). Can Stormwater BMPs Remove Bacteria? New findings from the International Stormwater BMP Database. *Stormwater Magazine*. Retrieved from http://www.stormh2o.com/SW/Articles/Can_Stormwater_BMPs_Remove_Bacteria_203.aspx

CEC (Chesapeake Executive Council). 1987. *Chesapeake Bay Agreement*. Chesapeake Bay Program, Annapolis, MD.

Coyle, K. (2005). Environmental Literacy in America. Retrieved from http://www.neefusa.org/pdf/ELR2005.pdf

Dollar, E.S.J. 2000. Fluvial geomorphology. Progress in Physical Geography 24(3): 385-406.

Environmental Protection Agency. (2012, March 6). *Water: Monitoring & Assessment; 5.11 Fecal Bacteria*.

Evans, B. M., K. J. Corradini. 2015. MapShed Version 1.3 Users Guide. Penn State Institutes of Energy and the Environment. Retrieved from http://www.mapshed.psu.edu/Downloads/MapShedManual.pdf

Kemp, W.M., W.R. Boynton, J.E. Adolf, D.F. Boesch, W.C. Boicourt, G. Brush, J.C. Cornwell, T.R. Fisher, P.M. Glibert, J.D. Hagy, L.W. Harding, E.D. Houde, D.G. Kimmel, W.D. Miller, R.I.E. Newell, M.R. Roman, E.M. Smith, and J.C. Stevenson. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. *Marine Ecology Progress Series* 303:1–29.

Klein, R. 1979. Urbanization and stream quality impairment. Water Resources Bulletin 15:948–963.

MapShed [Computer Software]. 2015. Retrieved from http://www.mapshed.psu.edu/download.htm.

Maryland Assessment and Scenario Tool (MAST). 2016. MAST Source Data. Retrieved from http://www.mastonline.org/Documentation.aspx.

Maryland Department of the Environment (MDE). (2000). Maryland Stormwater Design Manual , Volumes I and II.

Maryland Department of the Environment (MDE). (2006). Total Maximum Daily Loads of Phosphorus and Sediments for Loch Raven Reservoir and Total Maximum Daily Loads of Phosphorus for Prettyboy Reservoir, Baltimore, Carroll and Harford Counties, Maryland.

Maryland Department of the Environment (MDE). (2008). Total Maximum Daily Loads of Fecal Bacteria for the Prettyboy Reservoir Basin in Baltimore and Carroll Counties, Maryland.

Maryland Department of the Environment (MDE). (2011). Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, Guidance for National Pollution Discharge Elimination System Stormwater Permits. Retrieved from: http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/Documents/NPDES%20Draft%20Guidance%206_14.pdf.

Maryland Department of the Environment (MDE). (2014). Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated. Retrieved from: http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/Documents/NPDES%20MS4%20Guidance%20August%2018%202014.pdf

Paul, M. J., and J. L. Meyer. 2001. Streams in the urban landscape. Annual Review of Ecology and Systematics 32:333-65.

Penn State. 2016. Mapshed Overview. Retrieved from http://www.mapshed.psu.edu/overview.htm

Smith, D.E., M. Leffler, and G. Mackiernan, eds. 1992. *Oxygen Dynamics in the Chesapeake Bay: A Synthesis of Recent Research.* Maryland and Virginia Sea Grant College Program, College Park, MD.

Soar, P.J., and C.R. Thorne. September 2001. Channel restoration design for meandering rivers. U.S. Army Corp of Engineers. Report ERDC/CHL.

Southerland, M., L. Erb, G. Rogers, R. Morgan, K. Eshleman, M. Kline, K. Kline, S. Stranko, P. Kazyak, J. Kilian, J. Ladell, and J. Thompson. 2005. Maryland Biological Stream Survey 2000-2004, Volume 14: Stressors Affecting Maryland Streams (CBWP-MANTA-EA-05-11). Report prepared for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, Annapolis, MD.

Scott Stranko, Dan Boward, Jay Kilian, Andy Becker, Matthew Ashton, Mark Southerland, Beth Franks, William Harbold, and Jason Cessna. 2014. Maryland Biological Stream Survey: Round Four Field Sampling Manual

Tetra Tech Inc. 2014. Land Use Loading Literature Review Task Summary and Results. Retrieved from http://www.chesapeakebay.net/channel_files/21151/attachment_f--tetra_tech_urban_loads_literature_review_memo_20140331.pdf.

USEPA (U.S. Environmental Protection Agency). 2005. *Fact Sheet for public education and outreach minimum control measure revised.* EPA 833-F00-005.

USEPA (U.S. Environmental Protection Agency). 2003a. *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries*. EPA 903-R-03-002. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.

USEPA (U.S. Environmental Protection Agency). 2003d. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability*. EPA 903-R-03-004. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.

USEPA (U.S. Environmental Protection Agency). 2004e. *Technical Support Document for Identification of Chesapeake Bay Designated Uses and Attainability–2004 Addendum.* EPA 903-R-04-006. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.

USEPA (U.S. Environmental Protection Agency). 2010a. *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries: 2010 Technical Support for Criteria Assessment Protocols Addendum*. May 2010. EPA 903-R-10-002. CBP/TRS 301-10. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.

Walker, S., Mostaghimi, S., Dillaha, T. A., & Woeste, R. E. (1990). MODELING ANIMAL WASTE MANAGEMENT PRACTICES: IMPACTS ON BACTERIA LEVELS IN RUNOFF FROM AGRICULTURAL LANDS. *American Society of Agricultural Engineers VOL. 33(3): MAY-JUNE 1990*

Yetman, K.T. 2001. Stream Corridor Assessment Survey, SCA Survey Protocols. Watershed Restoration Division, Annapolis, MD.

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 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 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