Middle Patuxent River Watershed Assessment

November 2015

Prepared for:
Howard County,
Department of Public Works,
Stormwater Management Division

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EXECUTIVE SUMMARY

Howard County, Maryland, is required to develop Watershed Assessments to identify specific restoration opportunities to provide greater treatment of stormwater from urban impervious areas and to reduce pollutant loads associated with urban runoff. In 2014-2015, Howard County's Stormwater Management Division sponsored this assessment of the Middle Patuxent Watershed within Howard County in order to (1) assess current conditions and (2) recommend watershed restoration opportunities. Employing GIS and field investigations, the project team recommended a suite of opportunities including upgrades to existing stormwater Best Management Practices (BMPs), new BMPs, tree plantings, stream restoration, and stabilization of stormwater outfalls. In all, this assessment yielded 193 potential projects and produced concept plans for 39 of the top-ranked opportunities identified.

The Middle Patuxent Watershed in Howard County encompasses an area of 58 square miles. Impervious cover represents about 9.9% of the watershed, a level at which streams are sensitive to becoming degraded. Agriculture land use makes up the largest proportion of area (33.7%), followed by residential use (33.1%). Forest cover makes up 26.7% of the watershed area, much of that along stream corridors and the Middle Patuxent mainstem. Overall, 24% of sites assessed historically were in Good biological condition and 48% were rated as Fair, with the remainder rated as Poor to Very Poor.

GIS data, including data compiled from studies previously conducted within the Middle Patuxent watershed, were used as the first step to identify candidate retrofit and restoration sites for further investigation in the field. Candidates initially selected were reviewed by Howard County staff to finalize the suite of field sites to be visited. In all, 85 sites and 28 stream miles were selected for field investigation, and another 14 sites previously assessed in other studies were slated for desktop assessments.

Field data collection was customized for each of the five site types and focused on assessing current conditions and identifying and describing restoration opportunities. Field data were collected with mobile tablet devices via an ESRI ArcCollector application. Some previously visited sites were evaluated via desktop assessment only, making use of prior data collected. In total, 120 sites and 29.2 stream miles were assessed. More than 200 initial watershed restoration recommendations were proposed based on field and desktop observations.

A standardized method was developed for comparing, ranking, and prioritizing the proposed project opportunities identified. Projects were ranked in two ways. First, each project was ranked against all other projects of the same type. Second, all projects were pooled together and ranked against one another, to enable ranking across project type, and to determine those projects that should be taken to the next design stage.

Ranking criteria were developed within the following categories of factors:

- Permit contribution – how a project will help towards the County meeting the impervious surface treatment requirements and pollutant reduction goals;

- Biological uplift – if a project will provide additional benefits, such as building onto existing green infrastructure or protecting wetlands;
- Programmatic benefit – how project has added value such as visible demonstration projects or public education; and
- Feasibility – estimation of the ease or difficulty of project implementation, including public versus private ownership, site accessibility, or whether a repair is already required at a site.

For the pooled project type ranking, scores were based on permit contribution criteria—specifically, acres of impervious treatment, pollutant load reduction, and cost per acre of impervious treatment—along with a combined score for the remaining three factor categories.

Ranking scores were used to select the 39 highest-ranked projects for concept plan development at this time, out of 193 potential projects. A four-page concept plan was developed for each of the projects, providing location information, description of existing condition (including photos), details of the proposed project (including a design drawing), implementation information (such as utility constraints and other nearby projects), potential impervious treatment credits, and cost estimate. The following numbers of project concepts were developed: 5 BMP Conversions, no New BMPs, 13 Tree Plantings, 6 Outfall Stabilizations, and 15 Stream Restorations.

A pollutant load model was created first to quantify nitrogen, phosphorus, and sediment loadings and loading rates to the Middle Patuxent River with the watershed's existing and planned BMPs, based on the County's BMP inventory geodatabase as of November 12, 2015. Further, this model was used to calculate the expected nutrient and sediment loading reductions that would occur based on implementation of restoration opportunities identified as part of the watershed assessment. Pollutant load calculations and removals by BMPs were completed for the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment.

Results included a summary of estimated pollutant load reductions for the implementation of recommended projects, including how reductions were credited, pollutant removal efficiencies, potential load reductions, and units available for restoration. Results for the Bay TMDL indicate that the target load reduction for total phosphorus of 17.2% is easily met with a 67% load reduction; the sediment load reduction target is also met since the phosphorus target is met. These goals are met primarily due to stream restoration and its associated reductions using the interim reduction rates. Actual phosphorus and sediment reduction could be different, depending on the actual design implemented for these projects. The total nitrogen target of 9.4% is not met by the full suite of recommended projects, since there is only a 5.8% reduction achieved if all BMPs are implemented.

The assumed implementation of potential restoration BMPs show how they would approach or exceed the required percent reduction for nitrogen, phosphorus, and sediment loads needed to meet water quality standards for this watershed as specified by the Chesapeake Bay TMDLs. Additional reductions may also be achieved through restoration actions not included in this analysis such as street sweeping, erosion and sediment control, downspout disconnection, and public education and outreach efforts (e.g., watershed trash and recycling campaign, conservation landscaping, pet waste education). These may be added as progress toward TMDL goals is tracked over the next several years.

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1.1 Overview

Howard County, Maryland, is required to develop Watershed Assessments to identify specific restoration opportunities to provide greater treatment of stormwater from urban impervious areas and to reduce pollutant loads associated with urban runoff. In 2014-2015, Howard County's Storm Water Management Division sponsored this assessment of the Middle Patuxent River Watershed within Howard County in order to (1) assess current conditions and (2) recommend watershed restoration opportunities. This report documents the Watershed Assessment for Middle Patuxent River Watershed, which yielded 193 potential projects and produced concept plans for 39 of the top-ranked opportunities identified. The suite of recommended opportunities includes upgrades to existing Best Management Practices, BMPs, new BMPs, tree plantings, stream restoration opportunities, and stabilization of stormwater outfalls.

1.2 Background

Howard County continues to implement significant controls on stormwater discharges under its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit (MDE 2014a) and other Clean Water Act requirements. In addition, the County conducts programs supporting watershed restoration and environmental sustainability that include (1) protection of water resources, (2) public outreach, (3) new investment in stormwater management, (4) development of a Watershed Protection and Remediation Fee, (5) development of a Countywide Implementation Strategy for addressing pollutant reductions and (6) preparation of assessments for individual watersheds.

Howard County programs

- Protect water resources
- Welcome public input and feedback
- Invest in stormwater management
- Remediate stormwater
- Assess, prioritize, and fund restoration opportunities

As Howard County continues to increase its watershed planning efforts to comply with its MS4 permit and meet other waterresource goals, detailed watershed plans will be developed for the entire county. While previous watershed assessments have been completed for many areas of the county, the current round of assessments and plans incorporate a focus on addressing MS4 permit requirements. Plans include development of a detailed inventory of projects that can be undertaken to restore impervious surface area that has not already been restored to the maximum extent practicable (MEP) and to reduce nutrients and sediment in stormwater runoff. In addition, the expected pollutant load reductions of proposed projects are modeled, and the amounts of impervious surface area equivalent acres restored are calculated.

The Middle Patuxent Watershed is located in the center of Howard County (Figure 1-1). The MS4 area under the jurisdiction of Howard County includes the majority of the County, with the exception of state and federal lands, as shown, and other properties which have industrial stormwater discharge NPDES permits, not visible at this map scale.

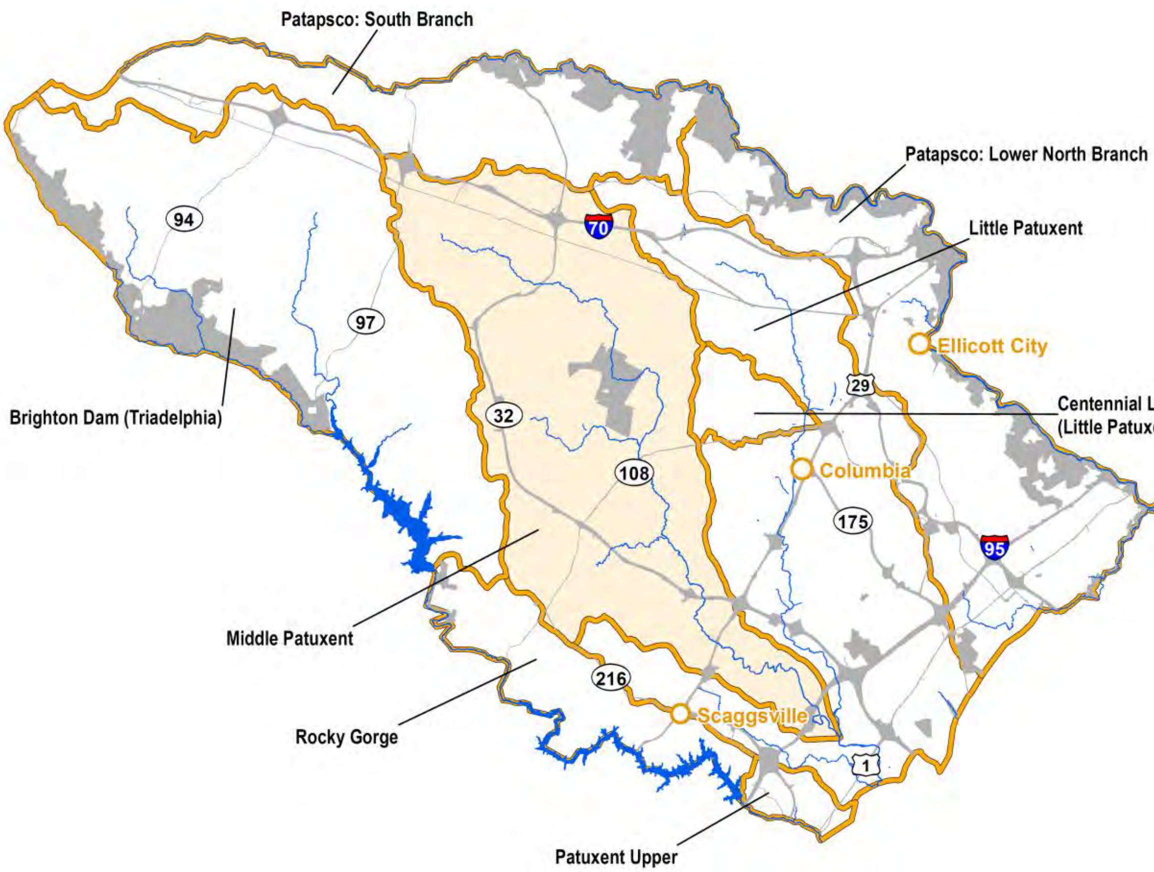

Figure 1-1. Major watersheds of Howard County, Maryland, with Middle Patuxent Watershed highlighted. The MS4 permit for Howard County includes the entire county with the exception of areas under other jurisdictions. On this map, federal lands, state highway lands, and other state lands are shown in gray; other properties which have industrial stormwater discharge NPDES permits are also not within the County MS4, but are not visible at this map scale.

Previously, Howard County prepared the following assessments and plans within the Middle Patuxent Watershed. Results and recommendations from these projects were incorporated into the present study.

- General Watershed Restoration Assessments and Strategy (WRAS) and Stream Corridor Assessments (SCAs) for
  - Middle Patuxent (Maryland Department of Natural Resources 2002)
  - Columbia Watershed Management Plan (Versar 2009)
- Specific watershed plans with restoration projects
  - Countywide Dry Pond and Extended Detention Pond Retrofit study (Versar 2013a)

- Countywide identification of Low Impact Development (LID) Retrofit and Tree Planting opportunities on County properties (Versar 2013b)

Citizen complains also provided a source of potential restoration projects and were included in the current study.

1.3 Regulatory Context

Howard County has several watersheds where pollutant loading limits have been established by the State of Maryland and approved by the U.S. Environmental Protection Agency (EPA), through quantitative assessment studies under the Clean Water Act.

1.3.1 Water Quality Impairments

Section 303(d) of the 1972 Clean Water Act requires states to develop and periodically update a list of impaired waters that fail to meet applicable state water quality standards, which are defined by their designated uses. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the impaired waters 303(d) list. According to EPA, a TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet state water quality standards. TMDLs can be developed for a single pollutant or group of pollutants of concern which generally include nutrients, sediment, bacteria, metals, and pesticides. To meet TMDL targets, pollutant loads from point and nonpoint sources must be reduced by implementing a variety of control measures.

Several watersheds in Howard County are listed as impaired for various pollutants in the Maryland 2014 Integrated Report (formerly known as the 303(d) list of impaired waters) prepared by the Maryland Department of the Environment (MDE 2014b, http://www.mde.maryland.gov/programs/Water/TMDL/Integrated303dReports/Pages/2014IR.aspx). Impairment listings reflect the inability to meet water quality standards for the designated uses for a water body. Impairment in tidal receiving waters is related to pollutants coming from entire watersheds; therefore, TMDLs developed for these segments will require watershed pollutant load reductions. Water Quality Assessments (WQAs) are performed to determine if the pollutant of concern is actually impairing the waters. If it is determined that the pollutant of concern is not contributing to water impairment, a report documenting the findings is submitted to EPA for concurrence.

There are three water body listings for the Middle Patuxent watershed that MDE has identified as potentially impaired (Table 1-1). Of these, all three have had water quality assessments performed, showing that they are not impaired, and therefore do not require a TMDL. Within Middle Patuxent Watershed, there are no local TMDLs.

Table 1-1. MDE Water Quality Impairment Listings and Status of Water Quality Assessment studies in the Middle Patuxent Watershed for Howard County, not including the overall Chesapeake Bay TMDL

Impairment	Applicable Segment	Status	Approval Date
Sediment	Middle Patuxent	WQA – Not Impaired	December 2010
Zinc	Middle Patuxent	WQA – Not Impaired	July 2009
Eutrophication	Middle Patuxent	WQA – Not Impaired	February 2007

1.3.2 Local Total Maximum Daily Loads (TMDLs)

Nitrogen, phosphorus and sediment reductions are driven by federal and state regulations under the Clean Water Act. Overall, Howard County must address seven approved local TMDLs in six of its watersheds, as well as the Chesapeake Bay Watershed TMDL (Table 1-2). There are no local TMDLs within the Middle Patuxent Watershed. The present project addressed the nitrogen, phosphorus, and sediment Chesapeake Bay TMDLs Middle Patuxent River Watershed in Howard County.

Table 1-2. Approved TMDLs in Howard County (as of September 8, 2015). Those affecting the Middle Patuxent Watershed are shown in bold text.

Watershed	TMDL Constituent
Patapsco Lower North Branch	Fecal coliform (Dec. 2009) Sediment (Sept. 2011)
Baltimore Harbor* (assumed superseded by Bay TMDL)	Nitrogen/Phosphorus (Dec. 2007)
Little Patuxent	Sediment (Sept. 2011)
Little Patuxent – Centennial Lake	Sediment (Apr. 2002) Phosphorus (Apr. 2002)
Patuxent River Upper	Sediment (Sept. 2011)
Patuxent River Upper – Brighton	Phosphorus (Nov. 2008) Sediment (Nov. 2008)
Patuxent River Upper – Rocky Gorge	Phosphorus (Nov. 2008) Sediment (Nov. 2008)
Chesapeake Bay	**Nitrogen (Dec. 2010)** **Phosphorus (Dec. 2010)** **Sediment (Dec. 2010)**

1.3.3 Chesapeake Bay Total Maximum Daily Load (TMDL)

The Chesapeake Bay TMDL, established by the EPA in 2010, sets pollution limits for nitrogen, phosphorus, and sediment in the Chesapeake Bay Watershed. These bay-wide pollution limits are a response to the slow progress by states within the watershed to limit their pollutants to levels which meet water quality standards in the Bay and its tidal tributaries. Total limits set in the Bay TMDL for the states of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia are "185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year—a 25% reduction in nitrogen, 24% reduction in phosphorus and 20% reduction in sediment" (EPA 2010). The TMDL also sets "rigorous accountability measures" for state compliance.

When EPA established the Chesapeake Bay TMDL, a historic and comprehensive "pollution diet" for nutrients and sediment, it set forth rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks, and rivers (EPA 2010). Concurrent with the development of the Bay TMDL, EPA charged the Bay watershed states and the District of Columbia with developing watershed implementation plans (WIPs) to provide adequate "reasonable assurance" that the jurisdictions can and will achieve the nutrient and sediment reductions necessary to implement the TMDL within their respective boundaries. Maryland's Phase 2-WIP provided a series of proposed strategies that will collectively meet the 2017 target (60% of the total nutrient and sediment reductions needed to meet final 2025 goals).

Stormwater runoff is a primary contributor of nutrients and sediment from watersheds in Howard County. Substantial nitrogen, phosphorus, and sediment reductions from stormwater runoff will be required to meet local and Chesapeake Bay TMDLs for these watersheds. (TMDLs for other pollutants will be addressed later.) The Chesapeake Bay TMDL analysis determined that a roughly 15% reduction in nitrogen and phosphorus loads from urban stormwater discharges in Howard County is necessary to meet Bay water quality standards. A roughly 20% reduction in sediment is needed from the urban portions of the watersheds to meet water quality standards in the local streams and rivers.

1.3.4 Pollutant Load Reduction Targets

Within Middle Patuxent Watershed, the load reductions in sediment and nutrients needed within the urban portion of the watershed to achieve the reduction targets in the Chesapeake Bay TMDL are summarized in Table 1-3.

Table 1-3. Watershed load reductions required by Chesapeake Bay TMDL for Middle Patuxent Watershed (from wlat.mde.state.md.us/ByMS4.aspx)

River Basin/TMDL name	% Reduction	Baseline Year
Middle Patuxent		
Bay Total Nitrogen	9.4	2009
Bay Total Phosphorus	17.2	2009
Bay Sediment	**	2009

** Bay sediment TMDL assumed met if TP target is met

1.3.5 Howard County MS4 Permit

Howard County is one of five medium and five large municipalities in Maryland that are regulated by a Phase I MS4 permit (Section 402(p) of the Water Quality Act of 1987 and NPDES Permit Application Regulations for Storm Water Discharges of November 16, 1990).

The Maryland State Highway Administration also is under an NPDES MS4 permit. Howard County's first permit went into effect on April 17, 1995.

Under Howard County's current MS4 permit (Permit Number 11-DP-3318, MD0068322, issued December 18, 2014), the County is required to develop Watershed Assessments and Restoration Plans to identify specific restoration opportunities to address pollutant reductions in approved TMDLs. One condition of the County's MS4 permit is implementation of TMDL load reduction allocations in the County's watersheds. This applies to all current local TMDLs, as well as any new TMDLs approved by EPA. Such new TMDLs could be developed for any watersheds in the County that have listed water quality impairments.

Specifically, the 2014 MS4 permit for Howard County (MDE 2014a) states:

> *Howard County shall annually provide watershed assessments, restoration plans, opportunities for public participation, and TMDL compliance status to MDE. A systematic assessment shall be conducted and a detailed restoration plan developed for all watersheds within Howard County. … watershed assessments and restoration plans shall include a thorough water quality analysis, identification of water quality improvement opportunities, and a schedule for BMP and programmatic implementation to meet stormwater WLAs included in EPA approved TMDLs.*

In concert with these efforts, the County has developed a Countywide Implementation Strategy (CIS). The CIS evaluates potential management recommendations and anticipated pollutant reduction strategies and is being updated concurrently with this watershed assessment. As described previously, several past watershed-specific plans have recommended restoration projects that have already been completed, while other restoration projects are currently being implemented.

These past and ongoing efforts contributed to the preparation of the current Watershed Assessment for the Middle Patuxent Watershed, which was tailored to address the latest MS4 requirements. This assessment and plan were specifically designed to assess current water quality conditions and identify the most effective management measures to reduce stormwater pollutant loads to address the Chesapeake Bay TMDL in Middle Patuxent Watershed. The assessment and plan have been developed in accordance with the new permit requirements and provides Howard County with a list of projects where restoration of impervious surface area can be achieved.

Howard County's MS4 permit, PART IV.E.1, includes the following provisions regarding watershed assessments:

a. *By the end of the permit term, Howard County shall complete detailed watershed assessments for the entire County. Watershed assessments conducted during previous permit cycles may be used to comply with this requirement, provided the assessments include all of the items listed in PART IV.E.1.b below. Assessments shall be performed at an appropriate watershed scale (e.g., Maryland's hierarchical eight or twelve-digit sub-basins)* *and be based on MDE's TMDL analysis or an equivalent and comparable County water quality analysis.*

b. Watershed assessments by the County shall:

i. Determine current water quality conditions;

ii. Include the results of a visual watershed inspection;

iii. Identify and rank water quality problems;

iv. Prioritize all structural and nonstructural water quality improvement projects; and

v. Specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs.

The permit also requires an impervious area assessment, prepared by the County, which sets the target for treatment of 20% of the County's impervious area that has not been treated to the Maximum Extent Practicable (MEP). This target was considered in development of the watershed plan, such that the benefits of implementing individual projects were computed in terms of impervious acres treated, or equivalent acres treated, as per MDE guidance (MDE 2014c), and the suite of recommended projects is able to be evaluated against the 20% goal.

In the permit, PART IV.E.2.b includes the following specifications for restoration plans:

b. Within one year of permit issuance, Howard County shall submit to MDE for approval a restoration plan for each stormwater WLA approved by EPA prior to the effective date of the permit. The County shall submit restoration plans for subsequent TMDL WLAs within one year of EPA approval. Upon approval by MDE, these restoration plans will be enforceable under this permit. As part of the restoration plans, Howard County shall:

i. Include the final date for meeting applicable WLAs and a detailed schedule for implementing all structural and nonstructural water quality improvement projects, enhanced stormwater management programs, and alternative stormwater control initiatives necessary for meeting applicable WLAs;

ii. Provide detailed cost estimates for individual projects, programs, controls, and plan implementation;

iii. Evaluate and track the implementation of restoration plans through monitoring or modeling to document the progress toward meeting established benchmarks, deadlines, and stormwater WLAs; and

iv. Develop an ongoing, iterative process that continuously implements structural and nonstructural restoration projects, program enhancements, new and additional programs, and alternative BMPs where EPA approved TMDL stormwater WLAs are not being met according to the benchmarks and deadlines established as part of the County's watershed assessments.

The CIS described previously in this section will serve to meet the requirement for a restoration plan.

This report provides details on the methods and results of a comprehensive process for identifying, assessing, and prioritizing existing and new restoration opportunities in the Howard County portion of the Middle Patuxent Watershed.

1.4 Report Structure

This report documents the process employed for identifying, assessing, and prioritizing existing and new restoration opportunities in the Howard County portions of the Middle Patuxent Watershed. The report is organized into seven chapters along with four appendices, each highlighting an aspect of the overall project.

Chapter 1: Introduction provides context for the project and describes the regulatory drivers for watershed assessment and pollutant reduction planning, as well as the overall structure of this report.

Chapter 2: Assessment of current watershed condition highlights key information regarding the condition of the Middle Patuxent Watershed. This condition includes information aboutphysical characteristics such as land use, impervious cover, existing stormwater BMPs, and assessments of stream biota and habitat, e.g., the Benthic Index of Biotic Integrity (BIBI) and Rapid Bioassessment Protocol (RBP) habitat assessments. This chapter also provides background information about the Middle Patuxent Watershed and brief summary information from previous assessments completed in the study area. Finally, it describes the five types of potential restoration opportunities considered in this study for assessment, ranking, prioritization, and estimated pollutant load reduction. These restoration opportunity types are (1) BMP conversion, (2) proposed new BMPs, (3) tree planting, (4) stream restoration, (5) outfall stabilization.

Chapter 3: Desktop analysis explains the process used to synthesize and analyze past data in order to select sites for field investigation. It also describes the creation of a geodatabase to be populated by consultant teams in the field.

Chapter 4: Field assessments delves into the field work methodology, calibration, and QA/QC employed by consultant teams conducting the fieldwork within the geographic scope of this study. Assessment data, including the desktop revisits of previously assessed sites and public input/feedback, are reported for each of the five types of potential restoration opportunities in the Middle Patuxent Watershed, and are depicted spatially and in tabular form.

Chapter 5: Restoration project ranking and prioritization sequences the steps and results of scoring and ranking individual potential restoration opportunities among all the individual opportunities of that type (e.g., BMP conversions, new BMPs, etc.). Further, this chapter details the scoring and comparative ranking of individual opportunities across all five types of potential restoration for prioritization. By identifying the high priority opportunities, this process produced a more limited set of candidates for development of Concept Plans, which are included as four-page summaries in Appendix H.

Chapter 6: Pollutant load modeling reports the calculations of potential pollutant loading reductions. Pollutant loads for nitrogen, phosphorus, and sediment were modeled at the planning level for the Middle Patuxent Watershed. Anticipated pollutant load reductions were modeled based on the Chesapeake Bay TMDL targets.

Chapter 7: References documents other works cited throughout the report.

Appendices: Additional details are provided in nine appendices. These include:

A. Inventory of GIS Data
B. Descriptions of BMP Types
C. Field Protocols and Data Collection Guide
D. Electronic Data Collection Protocols
E. Landowner Notification Letter
F. Field Reports from Consultant Field Teams
G. Tables Listing Individual Retrofit and Restoration Opportunities, with Scores and Rankings
H. Individual Concept Plans for Top-ranked Opportunities
I. Stormwater BMP Conversions and New Stormwater BMPs Proposed for the Middle Patuxent Watershed and Potential Pollutant Load Reductions, for Individual Sites

2. ASSESSMENT OF CURRENT WATERSHED CONDITIONS

This chapter describes the current conditions in the Middle Patuxent Watershed, including information from geographic information system (GIS) data and existing stream monitoring efforts. GIS data were compiled from Howard County and other sources for use throughout the watershed assessment and planning process; see Appendix A for an inventory of GIS data gathered. The initial watershed characterization and desktop assessment step is described in this chapter. Subsequent chapters detail the remaining steps of the project, for which GIS was integral: GIS screening analysis to select sites for field visits, planning and conducting field investigations, prioritization of restoration opportunities identified, and development of concept plans.

2.1 General Information

Middle Patuxent Watershed in Howard County (Figure 2-1) encompasses an area of 58 square miles (37,074 acres). The watershed includes 3,675 impervious acres, 12,367 acres of woods, and 227 miles of streams.

2.2 Impervious Surfaces

Studies have shown a correlation between the amount of impervious surface within a watershed and stream quality (e.g., Schueler et al. 2009). Impervious surfaces, including roads, parking areas, roofs, and other paved surfaces, prevent precipitation from naturally infiltrating the ground. This prohibits the natural filtration of pollutants and conveys concentrated, accelerated stormwater runoff directly to the stream system. Consequently, stormwater runoff from impervious surfaces can cause stream erosion and habitat degradation from the high energy flow. Furthermore, such runoff is likely more polluted than runoff generated from pervious areas.

Percent impervious cover is the most commonly used single measure of urban impacts to streams. Schueler (2008) defines the following general categories, using the Impervious Cover Model (Figure 2-2, adapted from Schueler et al. 2009) describing the general relationship between the amount of impervious cover in a watershed and stream quality:

- Sensitive Streams: 2 - 10% impervious cover
- Impacted: 10 - 24%
- Damaged (Non-Supporting): 25 - 59%
- Severely Damaged (Urban Drainage): 60% or more

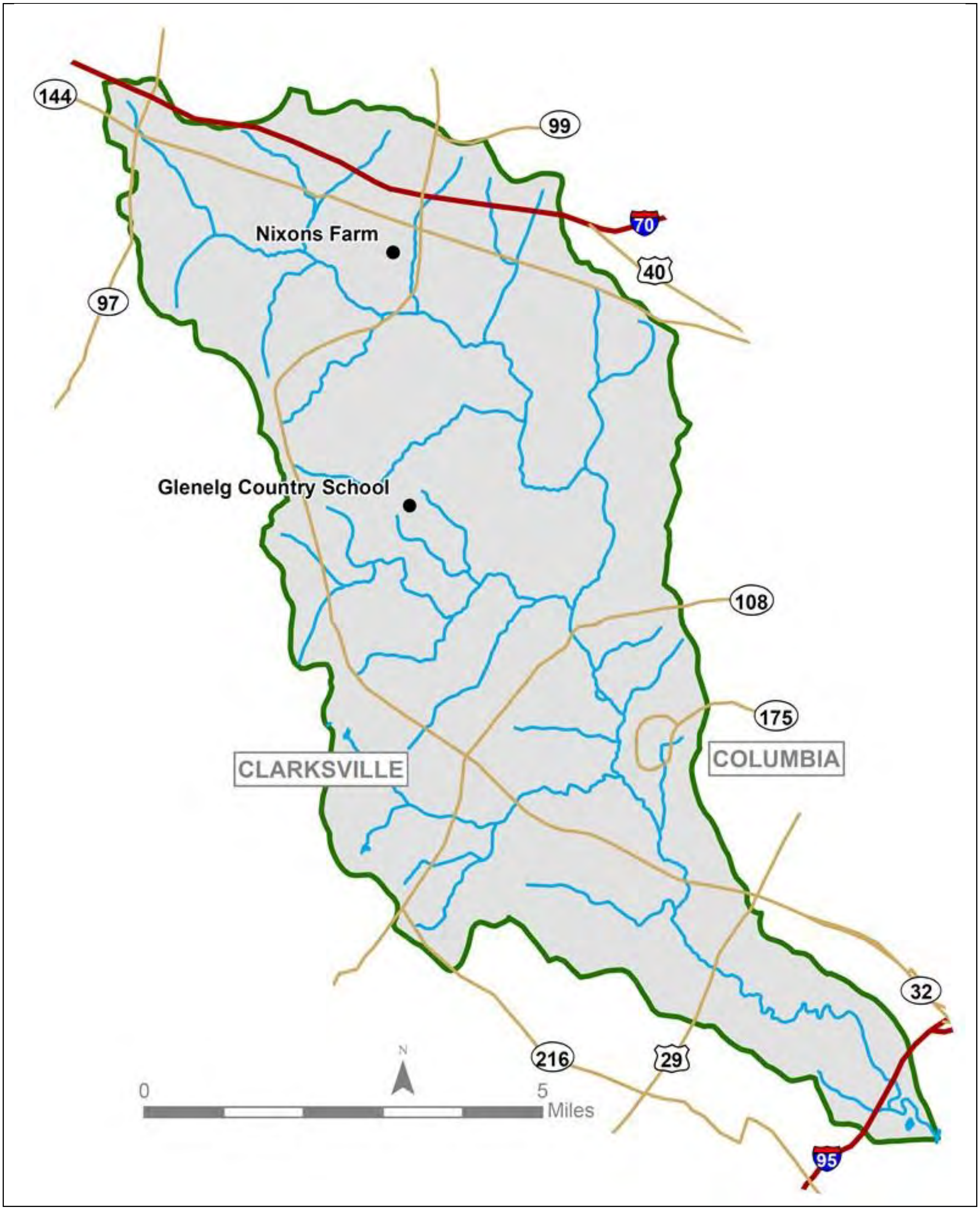

Figure 2-1. Middle Patuxent River Watershed in Howard County, Maryland

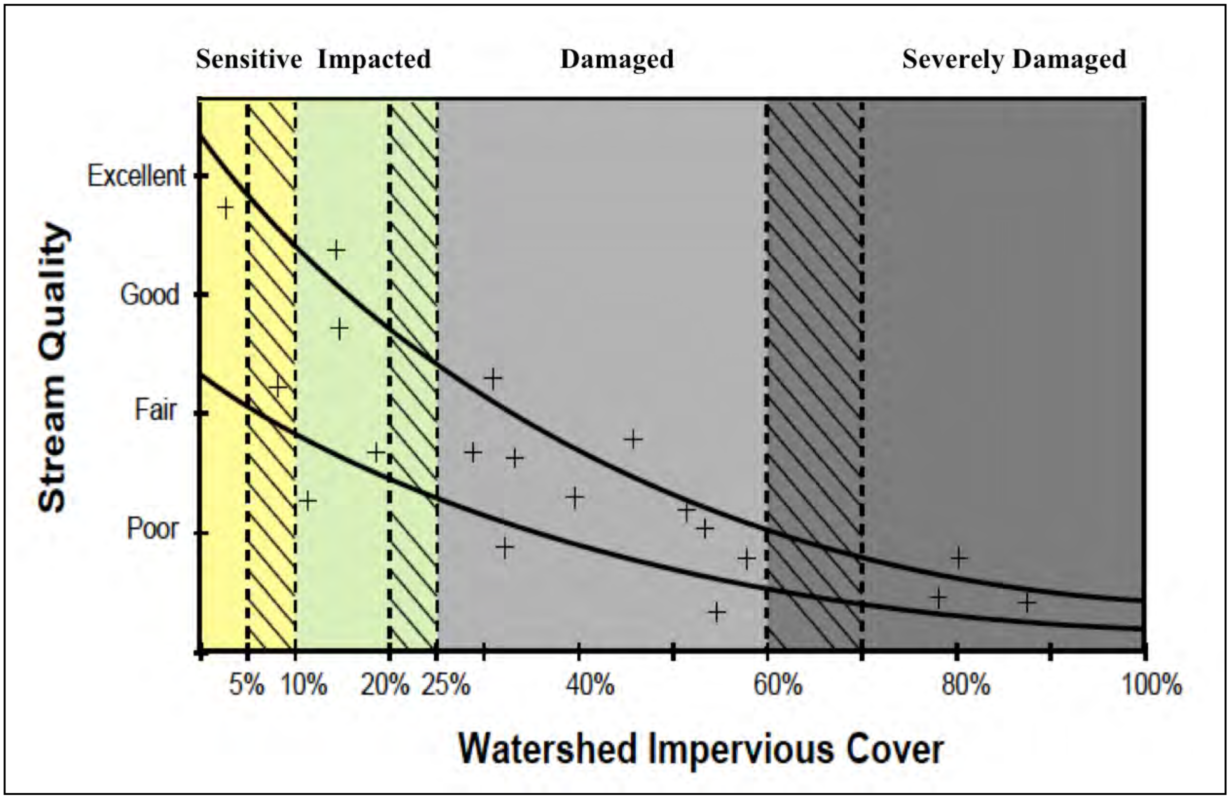

Figure 2-2. Impervious Cover Model (adapted from Schueler et al. 2009)

Howard County's impervious cover data were used to map and quantify impervious cover within the Middle Patuxent Watershed (Figure 2-3). The 2014 impervious layer, based on 2013 planimetric data, includes roads, parking lots, driveways, major buildings, bridge decks, sidewalks, pathways, and swimming pools. In all, impervious cover represents about 9.9% of the Middle Patuxent Watershed.

While the Impervious Cover Model provides a general indication of stream conditions under varying degrees of impervious cover, it does not explicitly account for the effectiveness of BMPs that are in place to treat runoff from those impervious areas. Existing BMPs provide treatment of water quantity and/or quality for much of the developed, impervious area in Middle Patuxent. According to recent Howard County data, there are 593 stormwater BMPs treating approximately 40% of the impervious area in Middle Patuxent Watershed. Figure 2-4 shows impervious cover and areas treated by existing BMPs (based on BMP drainage areas available in Howard County's database, as of June 2015).

Howard County's current MS4 permit requires restoration of an additional 20% of impervious cover, countywide, not already restored to the MEP. Following MDE guidance (MDE 2014c), impervious cover not restored to the MEP can be defined, in practice, as any impervious acres not draining to BMPs constructed after 2001. After 2002, Maryland regulations and local ordinances began requiring BMPs to address a specific suite of volumes equivalent to providing water quality treatment to the MEP.

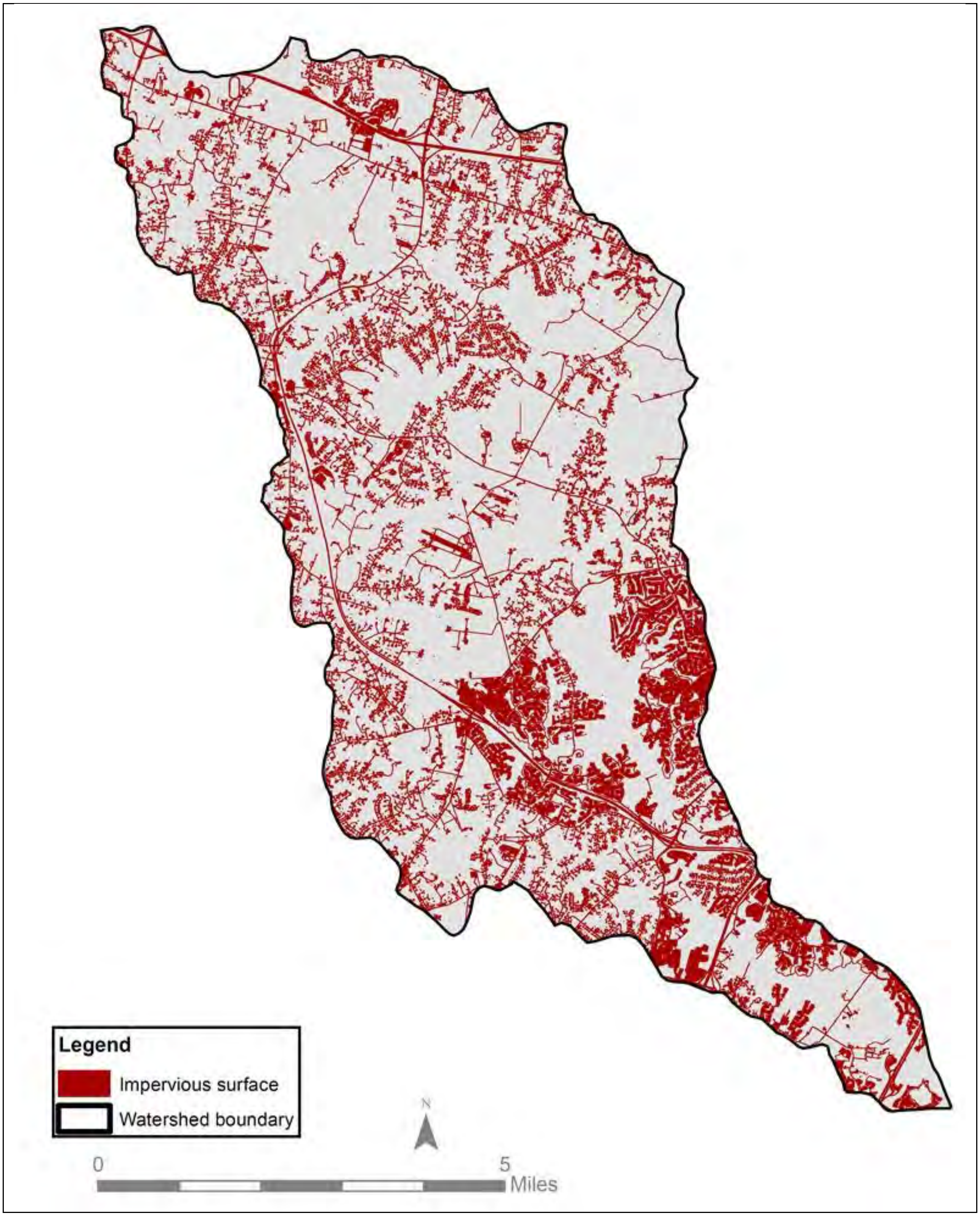

Figure 2-3. Impervious surface in Middle Patuxent Watershed (Howard County 2014 impervious data)

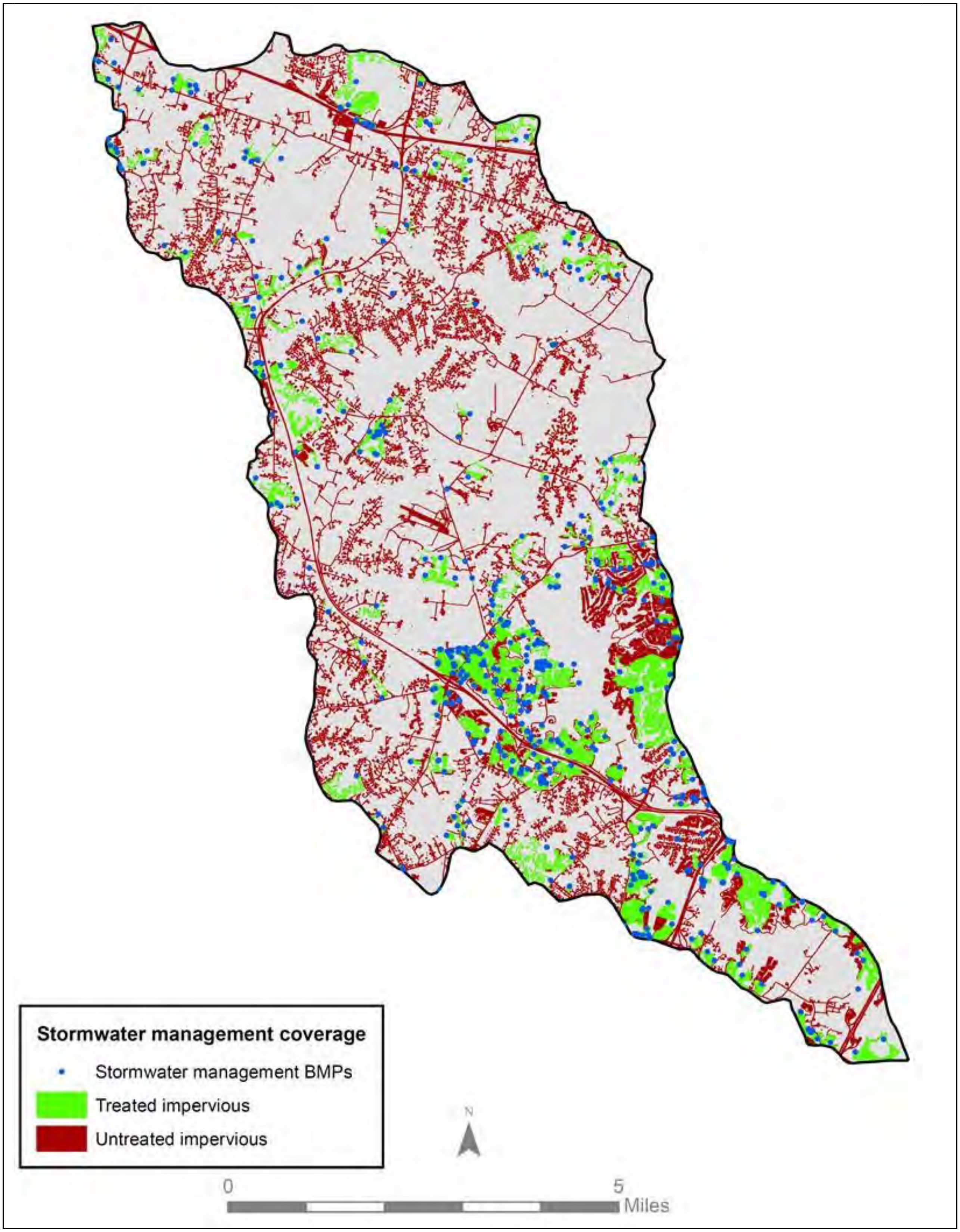

Figure 2-4. Treated and untreated impervious surface in Middle Patuxent Watershed, along with stormwater BMP locations

2.3 Land Use

Land use within Middle Patuxent Watershed was derived from Maryland Department of Planning, 2010 data (Figure 2-5). Agriculture land use makes up the largest proportion of area (33.7%), followed by residential use (33.1%). Forest cover makes up 26.7% of the watershed area, much of that along stream corridors and the Middle Patuxent mainstem.

Future land use will be influenced by zoning (Figure 2-6). The area is largely categorized as Rural Residential, as well as the New Town designation for the planned community of Columbia in the southeastern part of the watershed. Some areas in the southern part of the Middle Patuxent Watershed are designated as Low, Medium, and High Density Residential.

2.4 Soils

Soil conditions are important when evaluating how a watershed affects water quantity and quality in streams and rivers. Soil type and moisture conditions impact how land may be used and its potential for infiltration or various types of plants. Howard County's GIS soils layer was used for the soils data analysis and is a representation of the Howard County Soil Survey.

The Natural Resource Conservation Service (NRCS) classifies soils into four hydrologic soil groups based on runoff potential. Runoff potential refers to the tendency of soils to produce surface runoff; it is the opposite of infiltration capacity (i.e., the ability for the soil to absorb precipitation). Soils with high infiltration capacity will have low runoff potential, and vice versa. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile (e.g., land development activities). For example, urbanization in watersheds with high infiltration rates (e.g., sands and gravels) will have a greater impact than urbanization in watersheds consisting mostly of silts and clays, which have low infiltration rates. Factors that affect infiltration rate include soil permeability (influenced mostly by texture and structure), slope, degree of soil saturation, and percentage of leaf litter cover. The four hydrologic soil groups are A, B, C, and D, where group A soils generally have the lowest runoff potential and Group D soils have the greatest.

Brief descriptions of each hydrologic soil group are provided as follows. Further explanation of each can be found in the U.S. Department of Agriculture (USDA)/NRCS publication, Urban Hydrology for Small Watersheds, also called Technical Release 55 (USDA 1986).

- Group A soils include sand, loamy sand, or sandy loam types. These soils have a high infiltration rate and low runoff potential even when thoroughly wet. These consist mainly of deep, well to excessively drained sands or gravel. These soils have a high rate of water transmission.
- Group B soils include silt loam or loam types. They have a moderate infiltration rate when thoroughly wet. These soils mainly consist of somewhat deep to deep, moderately well to well drained soils with moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

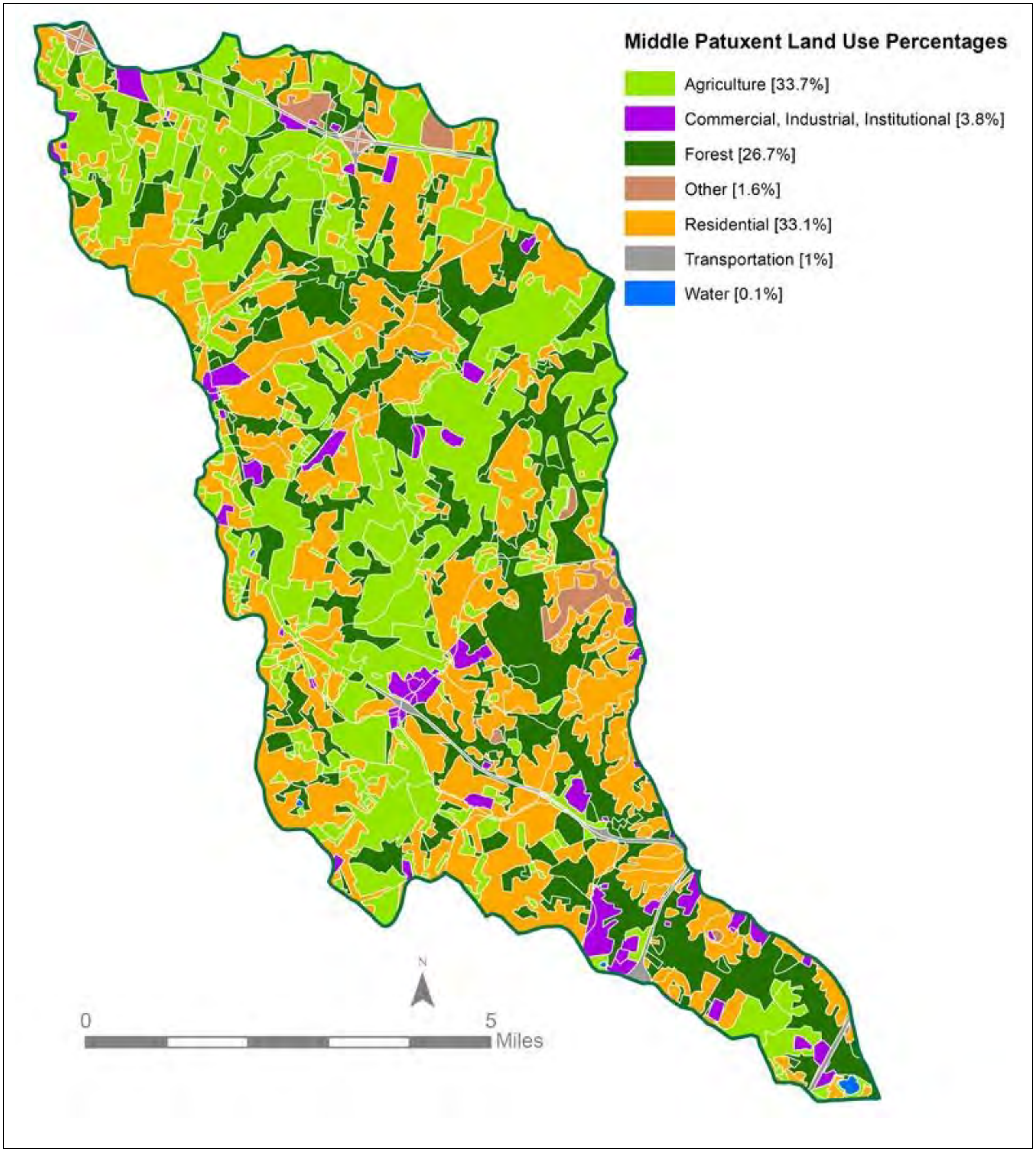

Figure 2-5. Land use in Middle Patuxent Watershed

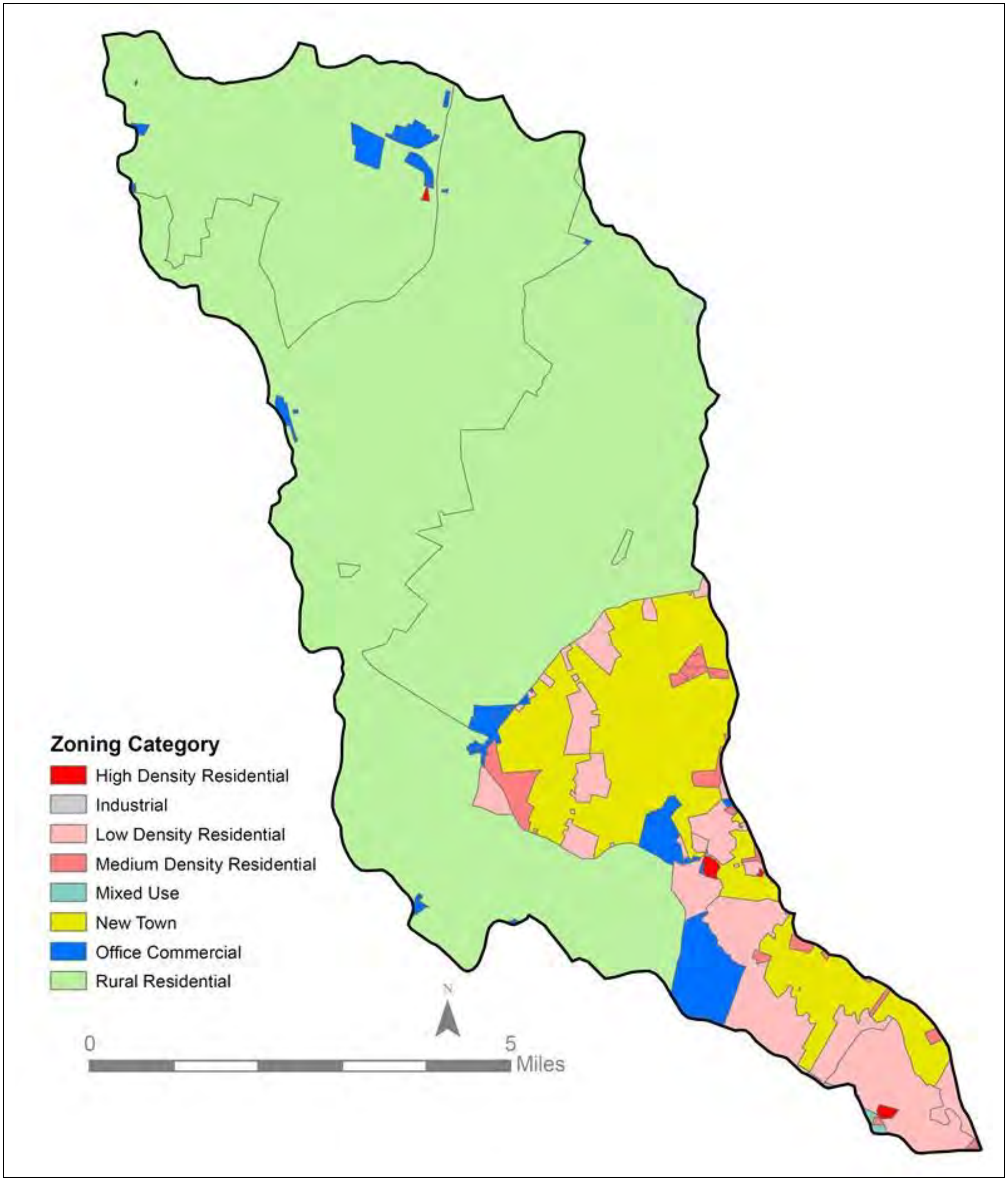

Figure 2-6. Zoning in Middle Patuxent Watershed

- Group C soils are sandy clay loam. These soils have a low infiltration rate when thoroughly wet. These types of soils typically have a layer that hinders downward movement of water and soils with moderately fine or fine texture. These soils have a low rate of water transmission.
- Group D soils include clay loam, silty clay loam, sandy clay, silty clay, or clay types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

As shown in Figure 2-7, the majority of area in the Middle Patuxent Watershed falls into soil groups with lower runoff potential, in hydrologic group B. The moderate infiltration rates of these soils mean that they are less susceptible to flooding and provide a good porous medium for stormwater ponds and Environmental Site Design (ESD) opportunities. Stormwater pond and ESD opportunities located in areas with C and D soils should be considered carefully, using local-scale information. Much of the southeastern portion of the watershed has a predominance of poorly drained, D soils.

2.5 Stream Condition

Howard County conducts biological monitoring at randomly selected stations in its Countywide monitoring program which began in 2001. The Middle Patuxent Watershed consists of the Lower Middle Patuxent, Middle Middle Patuxent, and Upper Middle Patuxent subwatersheds. The watershed was sampled most recently by the County in 2014. In addition, the Maryland Department of Natural Resources (DNR) Maryland Biological Stream Survey (MBSS) has performed stream monitoring statewide since 1995, using similar monitoring methods as the County. Since 2000, the DNR Stream Waders volunteer program has performed benthic macroinvertebrate monitoring throughout the County. The results of these assessments are shown in Figure 2-8. Of the 149 sites in the Middle Patuxent Watershed, 35 (24% of sites) were in Good condition, 68 (46%) were rated Fair, 28 (19%) were rated Poor, and 18 (12%) rated Very Poor. More good sites were found in the Upper Middle Patuxent subwatershed, while the Middle and Lower Middle Patuxent subwatersheds had a relatively even distribution of stream conditions.

Stream habitat condition was also evaluated by Howard County using EPA's Rapid Bioassessment Protocol (RBP) for habitat assessment (Figure 2-9). Of the 88 sites assessed, no sites were rated as comparable to reference condition (the highest scoring category). Fifteen (17%) sites were rated as supporting, 37 (42%) as partially supporting, and 36 (41%) as not supporting (the lowest scoring category), indicating that many streams in the Middle Patuxent Watershed show evidence of habitat degradation.

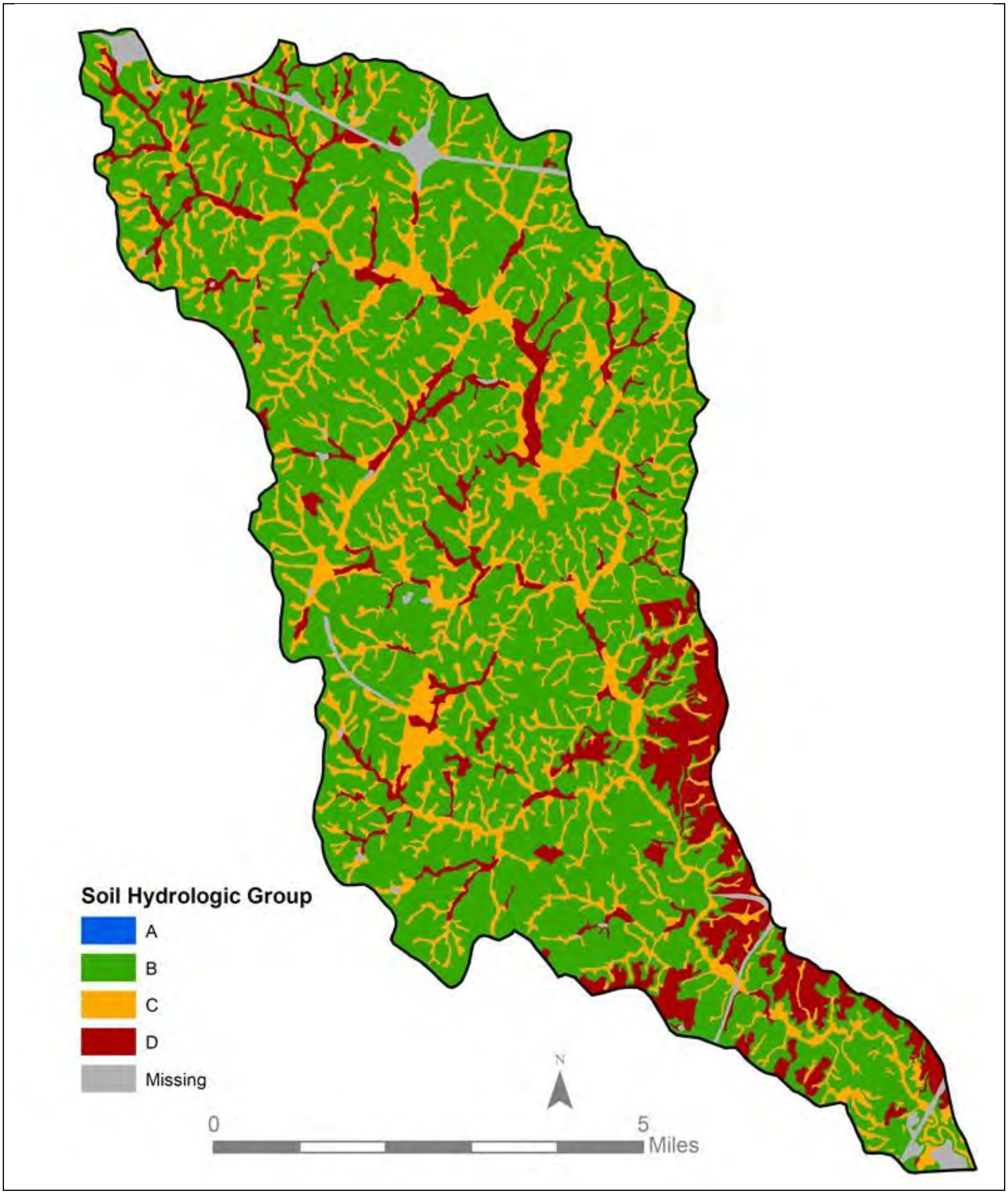

Figure 2-7. Soil hydrologic groups in Middle Patuxent Watershed

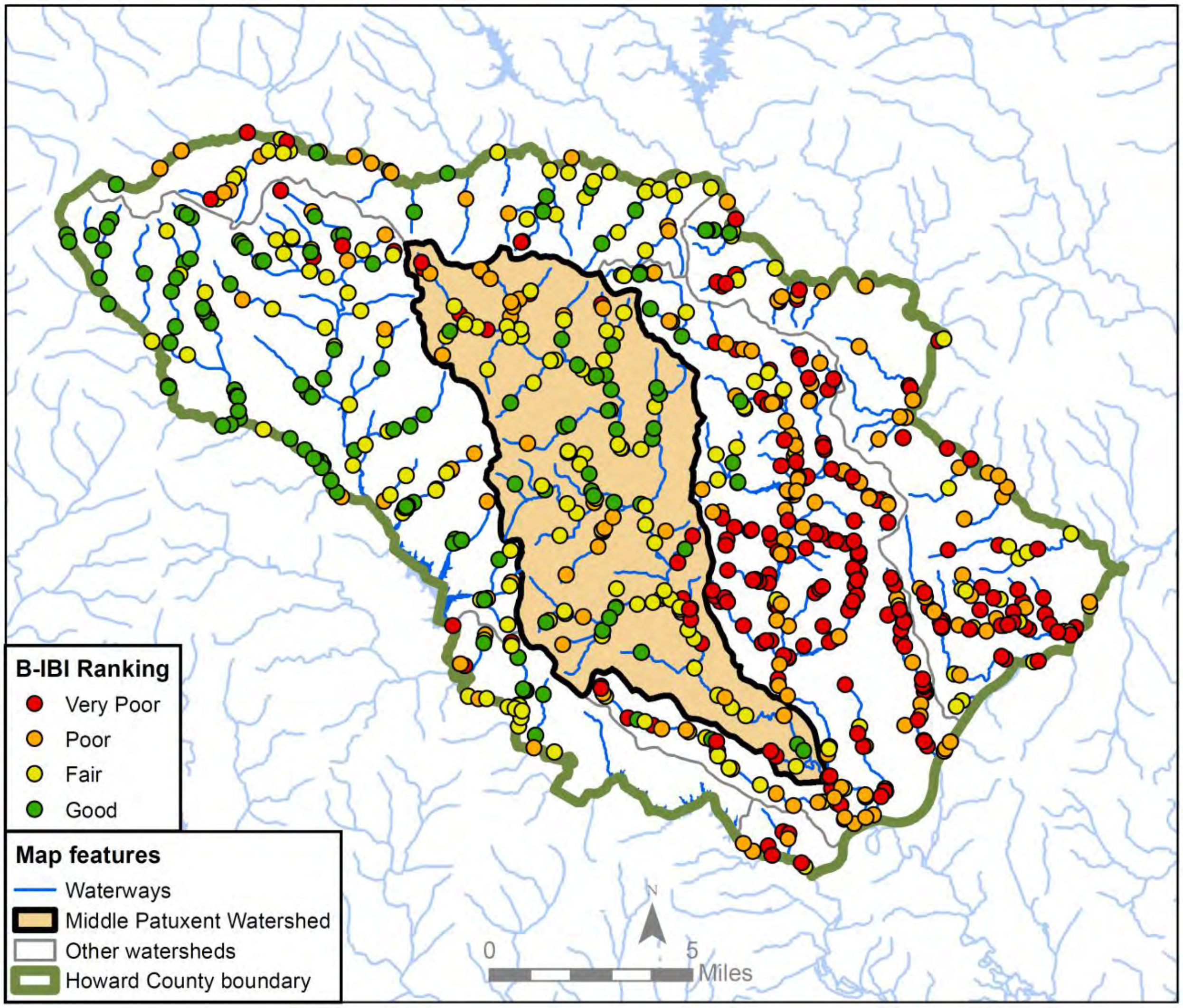

Figure 2-8. Benthic Index of Biotic Integrity ratings, at sites assessed by Howard County, MBSS, and Stream Waders in Middle Patuxent Watershed, 1995 - 2013

While stream conditions vary across the county, degradation is more prevalent in the heavily developed urban areas. This reflects the history of urban and suburban development prior to effective stormwater management regulations. Watershed condition is generally better in the more rural parts of the county, but stream degradation still occurs in these areas as a result of large lot development and agricultural impacts. By reducing the adverse effects of stormwater runoff throughout the county, the process of watershed assessment, restoration planning, and implementation of prioritized BMPs should improve the water quality condition in Middle Patuxent Watershed over time.

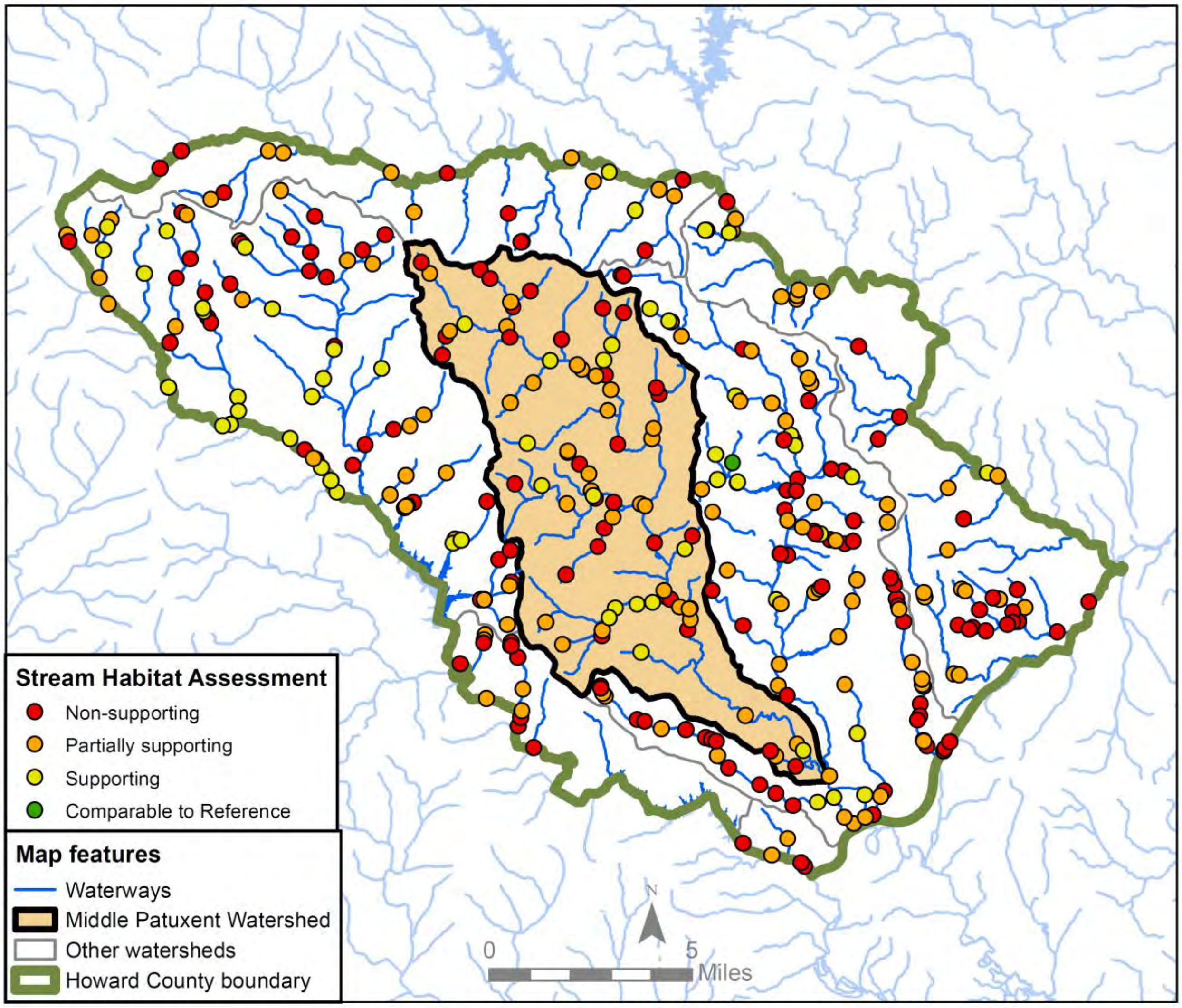

Figure 2-9. Habitat Assessments based on Rapid Bioassessment Protocol for habitat, at sites monitored by Howard County in Middle Patuxent Watershed, 2003-2013

2.6 Previous Assessments Completed in the Study Area

As previously described, Howard County has been developing inventories of restoration projects since 1999. These include individual projects, some of which have already been completed, and others identified in the following watershed plans that covered portions of the Middle Patuxent Watershed:

<u>Stream Corridor Assessment (SCA) of the Middle Patuxent River (Maryland DNR 2002)</u>

A SCA was conducted as part of an overall assessment of the condition of the Middle Patuxent Watershed and the streams within it. The assessment identified 322 environmental problems within the watershed, which included pipe outfalls, tree blockages, inadequate buffers, erosion sites, fish barriers, channel alterations, exposed pipes, unusual conditions, and trash dumping. A total of one pond and 49 representative habitat sites were also documented during the assessments. GIS data for all environmental problems, ponds, and representative sites were available for the desktop analysis portion of this Middle Patuxent watershed assessment study.

In 2013, Howard County completed the following two comprehensive surveys for potential restoration projects:

Howard County LID Retrofits and Tree Planting Study (Versar 2013a)

In 2012 and 2013 Howard County conducted a study to identify Low Impact Development (LID) opportunities on Howard County-owned properties, including Board of Education land, in order to meet NPDES permit and Chesapeake TMDL impervious area treatment and pollutant load reduction obligations. RRI assessments were conducted at 80 sites throughout the County. Concept plans were developed for 34 unique LID (or micro-BMP) opportunities on 22 different parcels. These LID projects would treat 73 acres, including 42 acres of impervious cover. In addition to the LID projects, 32 tree sites were selected for tree planting projects. GIS data for all sites investigated during the course of the study were available for the desktop analysis portion of this Middle Patuxent Watershed assessment study.

Howard County Dry Pond and Extended Detention Pond Retrofits Study (Versar 2013b)

In 2012 and 2013 Howard County conducted a study to identify existing private and public flood control dry-ponds and existing extended detention flood control ponds that could be upgraded to provide or enhance water quality control, in order to meet NPDES permit and Chesapeake TMDL impervious area treatment and pollutant load reduction obligations. RRI assessments were conducted at 140 ponds throughout the County. Concept plans were developed for 52 ponds, which treat 1,184 acres, including 343 acres of impervious cover. GIS data for all sites investigated during the course of the study were available for the desktop analysis portion of this Middle Patuxent Watershed assessment study.

2.7 Best Management Practices: Opportunities for Retrofit and Restoration

There were five types of retrofit and restoration opportunities considered for the current watershed assessment: (1) upgrading or retrofitting existing BMPs, (2) proposing new BMPs, (3) planting trees, (4) restoring streams, and (5) stabilizing storm drain outfalls. Howard County has implemented BMPs and other watershed management practices since the 1980s. The initial focus of stormwater management was detention of large flows to reduce flooding. Subsequent designs addressed water quality treatment and stream channel protection in accordance with revised State and County design criteria. Most recently, "green" BMPs known as ESD or green stormwater infrastructure are being encouraged for new development and to facilitate restoration of watersheds. Maryland stormwater regulations for new and re-development will require that stormwater management provide for control of water quantity and quality using the latest guidelines.

The following categories of stormwater and watershed management practices were considered in this watershed assessment study as the major strategies to address Howard County's Chesapeake Bay TMDL goals and NPDES MS4 impervious surface area restoration requirements. Each has the potential to yield quantifiable benefits in stormwater quality and in quantity control for channel protection and flooding.

1. Conversion of dry ponds and extended detention dry ponds to modern facilities with greater pollutant removal efficiencies, which include:
    - Extended detention dry ponds (if dry pond is present and no other viable option is available)
    - Extended detention wet ponds / wetlands (ED, WP), shallow wetlands
    - Bioretention
    - Non-bioretention filtering practices
    - Infiltration practices
    - Swales
    - Addition of pre-treatment or post-treatment BMPs within existing dry or wet pond boundaries
    - New BMP retrofits outside of existing dry or wet pond boundaries but which would drain into an existing pond or capture and treat stormwater just outside of the existing pond (e.g. step pool conveyance).
2. Retrofitting untreated impervious with new stormwater BMP facilities, which include:
    - Extended detention dry ponds
    - Extended detention wet ponds / wetlands (ED, WP), shallow wetlands
    - Bioretention
    - Non-bioretention filtering practices
    - Infiltration practices
    - Swales
    - Green roofs
    - Replacement of impervious cover with pervious pavement
    - Impervious cover removal
    - Rain barrels
    - Rain gardens
    - Rooftop disconnection
3. Reforestation of stream buffers and upland areas
4. Restoring degraded stream channels for erosion control and enhanced nutrient processing
5. Restoring degraded ephemeral and intermittent outfall channels through stabilization techniques which include:
    - Rip Rap stabilization

- Step Pool Stormwater Conveyance (SPSC) / Regenerative Stormwater Conveyance (RSC) stabilization
- Installing a drop structure or other stabilization of the outfall channel

2.7.1 BMP Conversions

Stormwater pond conversions can include the following general options for the re-design of existing stormwater ponds to provide additional water quantity control or water quality treatment:

- Increasing storage capacity by additional excavation.
- Providing water quality treatment features at facilities that currently have only water quantity control, if the space is available. Examples include: micropools, sediment forebays, or constructed stormwater wetlands.
- Modifying or replacing existing outlet controls to reduce the discharge rate from the stormwater management facility.
- Where soil types are appropriate, adding infiltration (sometime referred to as exfiltration) features to promote groundwater recharge and improve pollutant removal.
- Where water quality flows can be split or separated from larger events, vegetated areas with engineered soils and underdrain, referred to as bioretention, can sometimes be retrofit into an existing pond as pretreatment or post treatment and yield a significant increase in pollutant removal efficiency.
- Installing proprietary settling, filtering or hydrodynamic devices in parking lots or other areas with a large percentage of impervious area to trap sediments, trash and petroleum products before they flow into a pond. These tend to have low pollutant removal efficiencies but can be good options in the highly urban context, particularly where subterranean treatment is the only option.

Specifically, the following types of conversions are recommended.

- ***Conversion of Dry Stormwater Management Detention Ponds*** to extended detention dry ponds or extended detention wet pond/wetlands or conversion to ponds with infiltration capability, where soils permit. These BMPs typically treat the largest area of impervious cover because they have the largest drainage areas and were originally built as a low cost option for flood control, channel protection and/or water quality control. Conversion of these existing devices is among the most cost effective of pollutant reduction measures because the existing ponds do not require acquisition of new property, the pipe infrastructure is already in place, most of the excavation is already complete, maintenance responsibilities and easements have already been established and because stormwater flows already concentrate at these devices. Pollution reduction credits may depend on specific design characteristics affecting both runoff time and treatment. Possible constraints regarding these options include acceptance by local residents and pond owners of the proposed pond's aesthetics, the revised maintenance, and the costs.

- Dry and Wet Extended Detention (ED) Basins are depressions that temporarily store ("detain") runoff and release it at a prescribed rate via surface flow or groundwater infiltration following storms. Dry ED basins are designed to dry out between storm events, in contrast with wet ED ponds, which contain standing water permanently. As such, they (ED type) are similar in construction and function to simple dry or wet detention basins which are primarily for flood control or channel protection, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness by increasing residence time of pollutants which encourages settling of sediments and allows more time for biological and physical processing of nutrients.
- Urban Infiltration Practices are depressions created to allow the collection and infiltration of stormwater in order to trap sediments and nutrients in soil media and simultaneously recharge groundwater aquifers. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Infiltration basins and trenches cannot be constructed on poor soils, such as C and D soil types. These urban infiltration practices may include vegetation and sand which increases the removal of phosphorus by 5% on average compared to infiltration practices without sand or vegetation.

2.7.2 New BMPs

New stormwater management features involve placing new stormwater management ponds, including extended detention dry ponds, urban infiltration ponds, and constructed wetlands and wet ponds at locations that currently have no stormwater quantity or quality controls or where existing BMPs are inadequate and where space is available for a new BMP. Ponds are the traditional method of controlling stormwater flows and the opportunity to retrofit new SWM ponds is not common in the developed environment. However, the resulting benefits to flow volume, velocity control, and water quality improvement can be significant. Benefits may vary depending on the specific design features of the individual ponds.

Micro-BMPs (LID) include the use of innovative practices designed to mimic natural flows by reducing the volume of stormwater runoff at the source. Distributed Micro-BMPs features are a series of smaller landscape features that function as retention/detention areas integrated with developed areas. Micro-BMPs include bioretention areas and rain gardens created by excavating a depression and backfilling with engineered media, mulch, and vegetation. These planted shallow basins temporarily pond stormwater runoff, filter it through the bed components and treat it through biological and biochemical reactions within the soil matrix and root zones of the plants. Micro-BMPs are suitable for stormwater runoff control for new development and re-development projects, which strive to mimic "woods in good condition" and are often paired with ponds in order to meet flood control and channel protection objectives. Practices in this category are variously called ***green stormwater infrastructure***, ***ESD***, or ***LID***. These also include such practices as bioswales or wet swales which both treat and convey stormwater.

The suite of available ESD practices is diverse and many are advocating for a more expansive use of lower-cost vegetation and tree-based practices, especially near outfalls, within existing conveyances, adjacent to parking lots, and as green streets. In general, ESD practices most conducive to residential landscapes include rain gardens (typically in front yards), permeable pavement (typically for driveways), rainbarrels or cisterns, turf conversion or sustainable landscaping, dry wells, green roofs, tree canopy, soil decompaction, and pavement removal. ESD opportunities in rights-of-way may include bioretention (in medians, cul-de-sac islands, street bump outs, adjacent open space, as well as behind curbs or sidewalks), permeable pavement (in parking or bike lanes, sidewalks), turf conversion or sustainable landscaping, street trees (including tree pits), and step-pool stormwater conveyances in roadside channels.

Impervious cover removal may be an option in areas where existing parking surfaces or other paved surface are not currently needed. In some cases, large parking surfaces were previously built in commercial and institutional developments for events that occur very infrequently. Potentially, these areas could be converted to turf, thus reducing overall impervious cover and thereby reducing runoff. Pervious concrete or asphalt surfaces are another option that can be employed where appropriate.

2.7.3 Tree Planting

Reforestation consists of the following two types of tree planting, both of which provide ancillary benefits of enhancing wildlife and amenity values. Planting trees reduces runoff through interception and uptake/transpiration of precipitation, while also providing soil stability, heat island reduction and wildlife habitat benefits.

- Riparian Forest Buffers are areas of trees, shrubs, and other vegetation adjacent to a body of water. The riparian area, typically at least 35 feet wide (on each side of a stream), is managed to maintain the integrity of stream channels, and to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediment, nutrients, and other chemicals. Planting trees and enhancing existing streamside vegetation with native varieties of trees, shrubs, and wildflowers restores many of the water quality, wildlife, and aesthetic benefits associated with riparian buffers. Vegetation filters sediments and other pollutants from stormwater runoff, moderates water temperatures in streams, and provides shelter and food to both terrestrial and stream organisms. This BMP converts urban or agricultural land to forest land and provides a nitrogen, phosphorus, and sediment reduction benefit proportional to the amount of land converted.

- Upland Tree Planting is planting trees on currently urban or other open pervious areas at a rate that would produce a forest-like condition over time. Benefits include reductions in nutrient and sediment runoff as well as improvements in wildlife habitat and aesthetics.

2.7.4 Stream Restoration

Stream restoration is used to improve the ecosystem condition in degraded streams by restoring the natural hydrology and landscape of a stream and by enhancing habitat and water quality. Streams damaged by erosive flows, excess sedimentation, and disruptive human activities are often not capable of re-establishing a stable form. Preferred techniques to repair these damaged or degraded streams are based on mimicking natural stream channels and the range of natural variability exhibited by nearby stable streams. Termed ***natural stream channel design***, such repairs focus on establishing natural stream channel shape, size, and habitat features. Restoration can range from minor repairs to restore bank stability to complete reconstruction of the stream channel. Stream restoration also provides significant ancillary benefits through habitat enhancement and improved ecosystem services.

Incised stream channels are often targeted for stream restoration projects due to the accelerated stream bank erosion and loss of aquatic habitat caused by the instability of incised channels. Rosgen (1997) proposes four priority channel design options for restoring incised stream channels, where Priority 1 is the most preferred, and Priority 4 is the least preferred:

- **Priority 1.** Re-establish the stream channel on the historic floodplain.

- **Priority 2.** Establish a lower floodplain elevation and a new stream channel at the existing channel-bed elevation.

- **Priority 3.** Widen the floodplain at the existing bankfull stage elevation by excavating a new floodplain bench on one or both sides of the existing incised channel

- **Priority 4.** Stabilize the existing stream bed and banks in place using typical stabilization structures and methods.

Credits may vary depending on the type of stream restoration undertaken. According to MDE's accounting guidance for impervious area credits (MDE 2014c), stream restoration is credited at a rate of 1 acre impervious equivalent per 100 linear feet of stream restored. Nutrient and sediment load reductions associated with stream restoration may be estimated using rates derived from regional studies. The Chesapeake Bay Program's Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (Schueler and Stack 2014) has defined these rates, which are acceptable for watershed planning purposes (for further details, see Section 6.7). However, recognizing that every stream restoration project is unique with respect to its design, stream order, landscape position and function, the Panel developed four protocols for determining pollutant reduction credits for individual projects, once site-specific design details are known. These protocols are as follows (from Schueler and Stack 2014):

- ***Protocol 1: Credit for Prevented Sediment during Storm Flow.*** *This protocol provides an annual mass nutrient and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream.*

- ***Protocol 2: Credit for Instream and Riparian Nutrient Processing during Base Flow.*** *This protocol provides an annual mass nitrogen reduction credit for qualifying projects that include design features to promote denitrification during base flow within the stream channel through hyporheic exchange within the riparian corridor.*

- ***Protocol 3: Credit for Floodplain Reconnection Volume.*** *This protocol provides an annual mass sediment and nutrient reduction credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events.*

- ***Protocol 4: Credit for Dry Channel Regenerative Stormwater Conveyance (RSC) as an Upland Stormwater Retrofit****. This protocol provides an annual nutrient and sediment reduction rate for the contributing drainage area to a qualifying dry channel RSC project. The rate is determined by the degree of stormwater treatment provided in the upland area using the retrofit rate adjustor curves developed by the Stormwater Retrofit Expert Panel.*

An individual stream restoration project may qualify for credit under one or more of the protocols, depending on its design and overall restoration approach.

2.7.5 Outfall Stabilization

Step Pool Stormwater Conveyances / Regenerative Stormwater Conveyances are open-channel conveyance systems that convert surface stormwater flow to shallow ground water flow through surface pools and subsurface sand seepage filters (Anne Arundel County 2012). These practices can be used to stabilize degraded ephemeral and intermittent channels while also providing water quality treatment for the contributing drainage area, allowing for pollutant removal opportunities that do not exist with traditional outfall stabilization techniques. Specific site conditions will dictate whether these practices are appropriate. Pollutant reductions for regenerative stormwater conveyances will be credited using the Expert Panel's Protocol 4, as described previously.

Other Stabilization Practices. Where step pool conveyances are not feasible, simpler outfall channelization practices such as riprap or drop structures may be implemented to reduce erosion.

3. DESKTOP ANALYSIS AND FIELD SITE SELECTION

3.1 Identifying and Assembling GIS Data

A suite of GIS data, including data compiled from studies previously conducted within the Middle Patuxent Watershed, was used to identify and select candidate retrofit and restoration sites for further investigation in the field. Section 2.6 contains a list of those prior studies along with a description of the types of GIS data that were available to be used in this desktop analysis, while Appendix A lists GIS data compiled from Howard County and other sources.

3.2 Conducting Desktop Analysis - Methods

3.2.1 BMP Conversion Assessment

Howard County GIS data were used to identify BMPs that could be converted to a design with increased pollutant removal efficiencies. Recent improvements to the County's stormwater BMP facility database were available, including BMP drainage area polygons, indicators of conversion status, and other updates that had been completed by Howard County in 2014 and early 2015. This desktop analysis was conducted with the most complete BMP database update available at the time, in early January 2015.

Age of BMPs was a key factor in selection of facilities with conversion potential. MDE's Impervious Accounting guidance (MDE 2014c) reflects the stormwater design guidelines instituted with the Maryland 2000 Stormwater Manual:

> *The baseline year for the impervious area assessment shall be 2002, which is the year that the Manual was fully implemented. BMPs designed in compliance with the water quality volume (WQv) treatment criteria found in the Manual are considered to provide quality treatment to the MEP. Therefore, the impervious area draining to BMPs designed and approved in accordance with the Manual is considered treated and does not need to be counted toward restoration requirements.*

Therefore, as an initial step, all dry pond and extended detention dry ponds in the County's stormwater BMP facility database with pre-2002 built dates qualified as BMP conversion candidate sites. To further narrow down the pool of remaining BMP conversion candidates, all BMPs located in parcels with plan year dates of 2002 or later—i.e., as noted on the County's Site Development Plan (SDP) and Final Plan for public roads (F-Plan)—were eliminated from consideration. Of the remaining BMPs, those with a conversion status in the County's project database of planned, selected for concept, under construction, or complete were removed, which reduced the total number of BMP conversion candidates.

During a two day review of all sites selected via the GIS desktop analysis, Howard County Stormwater Management staff had a chance to remove sites where conditions were known to be not conducive for a project. The County also had a chance to add sites that citizens had brought to the County's attention. In the end, a total of 27 sites in Middle Patuxent were selected for BMP Conversion assessment field visits, and 14 sites were selected for BMP Conversion desktop assessments. Desktop assessments were reserved for sites of interest that had been previously visited during two recent County studies conducted to identify retrofit and restoration opportunities: Howard County Low Impact Development (LID) and Tree Planting Summary Report (Versar 2013a), and Howard County Dry Pond and Extended Detention Pond Retrofits Summary Report (Versar 2013b). These desktop assessments were included to put all previously studied sites into the same frame of reference, so that previously identified opportunities could be ranked and evaluated alongside the new opportunities identified during this Watershed Assessment.

3.2.2 New BMP Assessment

Prior to 1982, when the State's first Stormwater Management law was passed, there were no requirements for quantity or quality control of urban runoff. This means that when land development occurred before this law's enactment there were very few BMPs built to control the runoff from new impervious surfaces. Controlling runoff from impervious surfaces in areas of older development presents unique challenges – there must be adequate open space available for a new BMP and the open space must be in the correct landscape location for receiving impervious runoff (or costly changes need to be made to site grading or stormwater infrastructure to re-direct runoff to the available open space). Because of this, when selecting assessment sites for new BMPs, efforts were made to limit assessments to areas where implementation of new practices would allow for treatment of significant areas of impervious surface.

The County's latest planimetric GIS layers (including buildings, parking lots, driveways and major sidewalks) were combined to identify where there were contiguous blocks of impervious surface. These blocks of impervious were then overlaid with the drainage areas treated by current or planned BMPs; the potential pool of candidates was limited to those areas not treated by an existing or planned BMP, as per the County's BMP and Water Quality Improvement Projects data. A list and geodatabase of candidate sites were prepared for presentation to Howard County staff during a site-by-site review of opportunities selected by the GIS desktop analysis.

After initial site identification, in an effort to identify candidate sites distributed across the study area, different size thresholds for candidate sites were considered (ranging from 0.5 to 2 acres). These thresholds corresponded to the variations in age of development across the study area, i.e., areas with more recent development had fewer and smaller blocks of uncontrolled impervious cover and therefore a smaller size threshold would be required to generate a number of candidate sites comparable to other areas. In the end, during the desktop site review, it was decided to set a universal threshold of greater than one acre for candidate impervious block size, in order to concentrate new BMP implementation to where it would be most beneficial and cost effective.

Initially, County-owned secondary roads and minor highways with a 50 foot pervious buffer were considered for the candidate pool. Per discussions with Howard County during the GIS desktop review, road site candidates would be limited to those with median strips wide enough for BMP installation. Upon further review, the determination was made to not include road sites as candidates for assessment in this study, because of the anticipated difficulties in identifying large enough impervious areas and finding sufficient space for water quality treatment.

The final selection of candidate new BMP sites yielded 19 sites in Middle Patuxent Watershed for field investigation.

3.2.3 Stream Restoration Assessment

Howard County GIS data were used to isolate stream segments within the Middle Patuxent Watershed where environmental problems are known to exist. First, Howard County's stream centerline layer was used to select stream segments for restoration consideration. A stream segment was defined as a stream polyline that is uninterrupted by junctions or confluences with other stream polylines, whether it be a lower order stream flowing into the segment of interest, or this segment flowing into a higher order stream. A total of 1,090 stream segments were identified within the Middle Patuxent Watershed using this method.

Specific GIS data were used to identify stream segments containing known problems, particularly where erosion had been observed, such that sites would be good candidates for further investigation of restoration potential. Past data that were used as the first step to flag potential sites included: erosion and channel alteration points from past stream corridor assessment (SCA) studies, bank stability scores collected during annual Countywide biological monitoring surveys conducted every spring (years 2001-2014), and open pervious areas within 35 foot riparian buffers contained within the County's MS4 area. A complete list of GIS layers used in this analysis, including the corresponding study if applicable, is presented in Table 3-1.

The presence of one or more SCA erosion, SCA channel alteration, or Countywide biological sites within a stream segment that met the scoring criteria noted in Table 3-1 qualified the associated stream segment as a stream restoration assessment candidate site. A total of 63 segments extending approximately 22 miles were identified as candidates using these criteria. Stream segments that lacked a forested riparian buffer were also considered for the final pool of stream restoration assessment candidate sites. The acreage of open pervious area within the 35 foot riparian buffer was calculated for each stream segment within the study areas. This value, normalized by dividing by stream length, was assigned as one indicator of the stream segments' potential for restoration. Stream segments that had an open pervious acreage to stream segment length (miles) ratio of 6 or greater were retained as candidate sites. In addition to the segments already identified for erosion and alteration issues, a total of 55 segments extending approximately 7 miles were retained as candidates for their lack of forested riparian area.

During a two-day review of sites selected by the GIS desktop analysis, staff from Howard County's Stormwater Management Division had a chance to remove sites where stream restoration work was already completed or planned, or sites where conditions were known to be not conducive for a restoration project. The County staff also had a chance to add sites that citizens had brought to the County's attention that had not made the initial list of candidates. In the end, a total of 116 sites within the Middle Patuxent Watershed extending approximately 28 miles were selected for stream restoration assessment field visits.

Table 3-1. Past studies and GIS data used to identify stream channel problems

Study Name	GIS Data Used	Criteria for Problem Sites
Middle Patuxent SCA	Layer of erosion and channel alteration points collected during SCA	Erosion points with Severity of 1, 2 or 3 Channel Alteration points with Severity of 1, 2 or 3
Countywide Biological Monitoring	Layers of sites visited as part of the County's biological monitoring program	Bank Stability score of 1-5 for either the right or left bank.
County Open Pervious Land Cover	Layer of open pervious area within Howard County	Open pervious area occurring within the 35 foot riparian buffer contained within the County's MS4 area.

3.2.4 Tree Planting Assessments

Howard County GIS data were used to identify parcels that are good candidates for tree planting projects. The Countywide property layer was used to select all public and County-owned property within the Middle Patuxent Watershed that also fall within the County's MS4 area. Of the public and County-owned properties, those that had one or more of the following characteristics were selected:

- Parcels containing large open pervious area(s), particularly adjacent to existing forest. This was noted via visual inspection of aerial photographs
- Properties that had been visited in previous tree planting studies or efforts, but did not have a project status of proposed, concept, or completed
- Parcels containing a point representing an inadequate buffer in the County's SCA data sets
- Parcels containing a wetland of palustrine forested, shrub/scrub, or emergent types, as identified within MD DNR's wetland GIS data layer
- Parcels containing an open pervious streamside area of significant length or connectivity to existing forest. This was noted via visual inspection of aerial photography and through analyzing 35-foot stream buffers in the MDP GIS data for Agriculture or Urban pervious areas.

During a comprehensive review of sites selected by the GIS desktop analysis, Howard County Stormwater Management Division staff had a chance to remove sites where conditions were known to be not conducive for a tree planting project. As an additional step following this meeting, staff of the Howard County Recreation and Parks department were also provided with maps and given the opportunity to review the candidate sites and remove/add sites based on their local knowledge of sites and proximity to known Forest Conservation Areas (FCAs). Parcels with FCAs were not necessarily excluded, since in many cases the FCA made up a portion of the property, while potential opportunities for additional tree planting were located elsewhere on the parcel. In the end, a total of 17 sites within the Middle Patuxent Watershed were selected for Tree Planting assessment field visits.

3.2.5 Outfall Stabilization Assessments

GIS data from previous watershed studies, BMP inspections, and Illicit Discharge Detection and Elimination (IDDE) investigations were used to identify an initial pool of outfall stabilization candidates. The GIS data were used to select outfalls that had been previously identified as having an erosion issue. Table 3-2 provides a list of the studies and their associated GIS data used to obtain an initial pool of 26 candidate outfalls within the Middle Patuxent Watershed. Outfalls were removed from the initial pool of candidates if they were associated with an outfall stabilization project identified in Howard County's Water Quality Improvement Project database as a planned or completed project. The stream restoration projects listed in Howard County's Water Quality Improvement Project database were also considered as projects that may narrow down the pool of candidates. Howard County Stormwater Management staff determined that additional outfalls were to be excluded from the pool of candidate sites due to their proximity to planned stream restoration projects, which further narrowed down the candidate pool.

Table 3-2. Past studies and GIS data used to identify candidate outfalls

Study Name	GIS Data Used	Criteria for Problem Sites
2000, 2002-2014 IDDE*	IDDE Outfalls Geodatabases	Erosion = Moderate or Severe
BMP Inspections*	Howard County BMP inspection spreadsheet	Candidate = 3 or 4 on a 4 point scale
Dry Pond Study –2013*	Layers of ponds visited during Task 1 and Task 2 of Dry Pond Study	Ponds that fell within the Middle Patuxent Watershed that had outfall channel issues noted during the assessments

* Study identified additional outfalls that fell outside of the study areas. Results were clipped to the study area.

Several of the candidate outfalls were close enough to another candidate outfall that it was possible that they were the same outfall surveyed during multiple studies or over multiple IDDE investigations. All obvious duplicate outfalls were removed prior to the merging of candidate outfall GIS layers from previous studies, but the duplication of several proximate outfalls could not be verified due to a lack of a unique identifier and inconsistencies with surveyed outfalls matching the location of outfalls and pipes contained within the County's stormwater infrastructure GIS layers. In order to get a sense of which outfalls might be duplicates, a 25-foot buffer was created around each candidate outfall. A count of the number of candidate outfalls that fell within each 25-foot buffer was calculated, and buffers with a count of greater than one resulted in the removal of the assumed duplicate outfall points. In the end, a total of 22 outfalls within the Middle Patuxent Watershed were selected for Outfall Stabilization Assessments.

3.3 Desktop Analysis Summary - Results

Tables 3-3 and 3-4 show the final breakdown of sites selected for field and desktop assessments. The final number of sites that were actually assessed, which are presented in Chapter 4, do not match the numbers shown in these tables for two reasons. First, in addition to the sites selected through the desktop analysis, field teams had the ability to add new sites that they found in the field, increasing the number of assessed sites. Second, some of the sites selected through the desktop analysis were not able to be visited due to issues such as property owner constraints and sites not being found, decreasing the number of assessed sites. Explanations of why sites could not be assessed can be found in the consultant field reports located in Appendix A.

Table 3-3. Number of sites selected for field assessments in the Middle Patuxent Watershed

Assessment Type	Number of Sites (or Stream Miles)
BMP Conversions (# of BMP facilities)	27
New BMPs for untreated impervious (# of sites)	19
Stream Restorations (# of stream miles)	28
Tree Planting (# of sites)	17
Outfall Stabilization (# of outfalls)	22
Total	**85 sites + 28 stream miles**

Table 3-4. Number of sites selected for desktop assessments in the Middle Patuxent Watershed

Assessment Type	Total
BMPs Conversion	14
Total	**14**

4. FIELD ASSESSMENTS

Field assessments were conducted in early 2015 to gather data on existing conditions in the Middle Patuxent Watershed and to recommend sites with potential restoration and stormwater retrofit opportunities. Teams from three consultant groups were assigned portions of the Middle Patuxent Watershed to assess (Figure 4-1). Northern Middle Patuxent was assessed by McCormick Taylor and Southern Middle Patuxent by Biohabitats, with additional desktop assessments performed in both study areas by Versar.

4.1 Field Methods and Calibration

4.1.1 Field Protocols

Howard County Watershed Assessment field protocols were developed by Versar, in consultation with Howard County Stormwater Management Division and the other three consultant teams. Data collection was customized for each of the five site types and focused on (1) assessing current conditions and (2) identifying and describing restoration opportunities.

Specific protocols for each type in many instances drew from existing methodologies, but with customization to ensure that data collected in the field met the needs for this project. Custom data collection protocols were developed to document the following types of assessments and recommendations.

- **Conversion of existing stormwater BMPs** - methods were derived from the Center for Watershed Protection's Retrofit Reconnaissance Investigation (RRI) protocol, from the Urban Subwatershed Restoration Manual 3 (CWP 2007);
- **Establishment of new stormwater BMPs for impervious surfaces not currently treated** - also from RRI (CWP 2007);
- **Tree planting** - methods were drawn from Pervious Area Assessments (PAA), Unified Subwatershed and Site Reconnaissance, Manual 11 (CWP 2005) and Urban Reforestation Site Assessment (URSA), Urban Watershed Forestry Manual, Part 3: Urban Tree Planting Guide (CWP 2006);
- **Stream restoration** - methods were a combination of Stream Corridor Assessment (SCA, Yetman 2001) for characterizing erosion and other stream features, EPA's Rapid Bioassessment Protocol (RBP, Barbour et al. 1999) for habitat assessment, Rosgen (1996, 2001) methods for Bank Erosion Hazard Index (BEHI) and other geomorphic indicators; and
- **Outfall stabilization** - methods were primarily derived from the SCA protocols.

A complete field packet was distributed to each of the consultant teams to ensure that assessments were being conducted in a consistent manner. The packet included guidance on naming sites added in the field, a list of sites with special notes that field crews were to read prior to assessing the sites, a field assessment decision flow chart, field names and domains for field

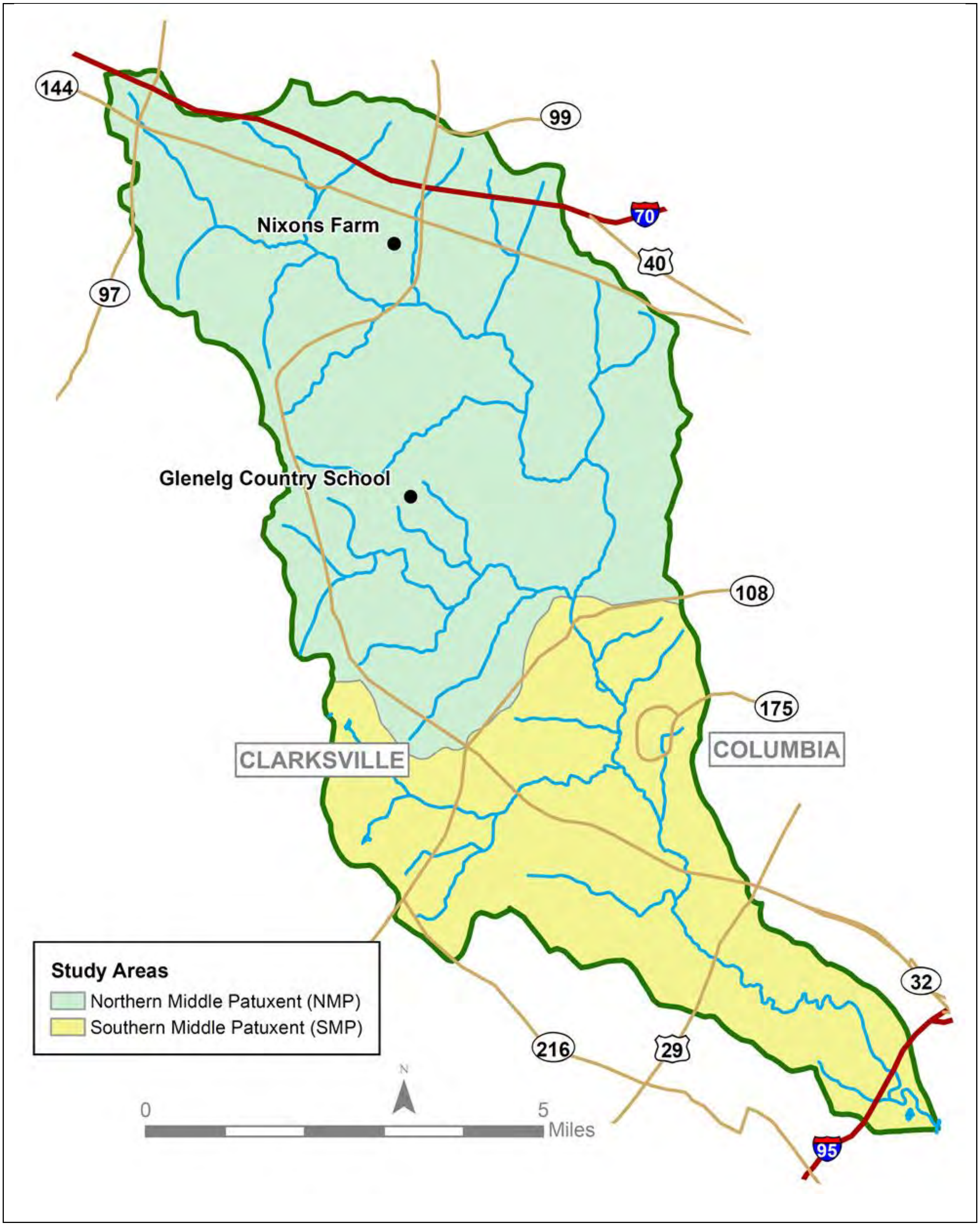

Figure 4-1. Study areas for spring 2015 site assessments within the Middle Patuxent Watershed

assessment layers, Rapid Bioassessment Protocol habitat scoring sheets, and Bank Erosion Hazard Index (BEHI) diagrams. A complete copy of the packet can be found in Appendix C.

4.1.2 Electronic Data Collection

Field assessment data were collected with mobile tablet devices through the ESRI ArcCollector application. Digital photographs were taken at each assessment site and appended to the database. The electronic collection of data allowed for data to be entered directly into a geodatabase in the field and removed the step of having to manually enter data from paper datasheets in the office. ESRI Web Maps that were linked to the field assessment geodatabases were accessed from desktop computers to complete desktop assessment data entries, and to edit the field data. An ArcCollector Field Data Collection Instructions packet was developed and distributed to each of the consultant teams to be used as a reference guide while working with the geodatabases and the associated background data layers. A complete copy of the packet can be found in Appendix D.

4.1.3 Calibration of Field Teams

Prior to beginning data collection, two field assessment calibration days were held to ensure that field personnel from each of the consultant teams were familiar with the methods being used to collect field data and to create a consistent perspective among all consultant personnel for recording field observations. The first calibration day covered BMP Conversion, New BMP, and Tree Planting field assessment protocols, and was held on January 22, 2015. The second calibration day covered Stream Restoration and Outfall Stabilization field assessment protocols, and was held on January 29, 2015. Each of the calibration days consisted of a review, discussion, and revisions to field assessment protocols in the morning, followed by a review of data download, collection, and upload procedures with the tablets and the ArcCollector application in the afternoon. Brief visits to representative field sites for each of the five assessment types were also conducted.

4.1.4 Landowner Permissions

Once the complete list of field sites was created (see Section 3.3), an Excel file was created listing all properties containing field sites, along with property ownership data derived from county tax assessment data. The parcel address was used to identify the owner or local resident who would be contacted via a notification letter. The following steps were taken to refine the mailing list:

- For public property (e.g., county-owned parklands, schools), County staff confirmed that sites were accessible and no letter was sent.
- School system personnel were contacted separately, through the Howard County Public Schools Assistant Manager for Grounds. Field staff were also instructed to visit the school office, upon arrival at each school site, in order to present identification and sign in.
- Parcels containing more than one site were reduced to a single entry, to avoid duplicate mailings.

- For multiple-tenant commercial properties, a single letter was sent for the whole unit.
- Multi-owner or publicly accessible facilities (e.g., a commercial complex that would be readily accessible from a parking lot) were removed from the mailing list.
- Howard County staff reviewed the list and removed a small number of properties that would not be amenable to site visits. These parcels were clearly noted for the field crews' information, within the ArcCollector application.
- Howard County staff developed an umbrella agreement with Columbia Association, providing blanket permission for all sites on Columbia Association properties.
- Sites on agricultural properties were reviewed by the Soil Conservation District staff, who helped identify appropriate sites to visit, prior to letters being sent.
- In a few cases, County staff made direct contact with managers of larger properties (e.g., Turf Valley golf course, Alpha Ridge landfill) to coordinate permission and access to those sites.
- Parcels without address information were removed from the mailing list.

Howard County Stormwater Management Division staff developed a letter to send to property owners (see Appendix E). All letters sent, or the landowner review process performed by the County, were tracked in an Excel table for all sites and parcels. County staff sent out letters and field staff were instructed to wait an initial period of two weeks after letters were sent before beginning field work on private properties, to allow time for responses to be received by the County.

A web-based map was developed by the project team for County staff to use in recording permission responses and kept up-to-date as responses were received. Data fields were added to the data for each parcel to capture permission status (Granted, Notify Prior to Accessing, or Denied), comments, and contact name, address, and phone/email information. The map was color-coded to reflect parcel permission status. All information was readily available to field crews through the web map and ArcCollector application.

4.1.5 Field and Desktop Data Collection

The four field teams collected data during the period of March through May 2015. Teams communicated with Versar and County staff as needed to answer questions that arose about BMP data, site access, or other issues. Data were collected using field tablets, by working locally (with daily backups) or by collecting data live, on-line, and saving directly to the server.

In addition to the field assessments, Versar conducted desktop reviews of BMP Conversion sites that were visited during the Howard County Dry Pond study. Data for desktop assessment sites were entered using the same data system along with field data, based on information available from prior studies and, in a few cases, a brief field visit.

4.1.6 Field Summary Reports

At the conclusion of the field visits, the consultant teams were asked to prepare a field summary report, summarizing field and desktop assessments completed, including the following information:

- Summary of the number of field assessments completed, by type;
- If there were sites that could not be assessed in the field, a summary of primary reasons;
- Comments about data or assumptions made;
- Summary of the number of recommendations made at field sites, with initial field rating of restoration potential (high, medium, or low);
- General comments about the types of recommendations made;
- List of sites reported to Howard County for follow-up because of suspected illicit discharges, safety concerns, or other reasons;
- Other comments/explanations related to data collected; and
- Summary of sites evaluated via desktop assessments.

Consultant team Field Summary Reports are included in Appendix F.

4.1.7 Field Data Quality Assurance/Quality Control

At the completion of the field and desktop assessments, all of the data for a given area were copied from the ESRI ArcGIS Server and sent to each of the consultant teams in the form of a file geodatabase. Each team had an opportunity to make any additions or edits to the geodatabases before they were sent to Versar for Quality Assurance/Quality Control (QA/QC). Once the file geodatabases were received, Versar went through each and checked for logical data (e.g., checking for stream bed particle size distributions that do not sum to 100%), use of correct site IDs, matching assessment and recommendation data, and overall completeness. Once the QA/QC process was complete, all of the file geodatabases were merged into a single personal geodatabase that could be used for the prioritization analysis.

4.2 Summary - Middle Patuxent Watershed Field and Desktop Site Assessments

Table 4-1 provides a tally of the assessments conducted in Middle Patuxent Watershed, for each of the five assessment types. Examples of field conditions observed are shown in the photographs in Figures 4-2 to 4-6. Locations of BMP Conversion, New BMP, Stream Restoration, Tree Planting, and Outfall Stabilization Assessment sites are shown in Figures 4-7 and 4-8. All field and desktop assessment site locations are shown in these maps.

Table 4-1. Number of assessments completed in the Middle Patuxent Watershed

Type	Number of Sites (or miles) Assessed
BMP Conversion Field Assessments	27
New BMP Field Assessments	18
Stream Restoration Field Assessments	29.2
Tree Planting Field Assessments	36
Outfall Stabilization Field Assessments	26
Total Field Assessments	**107 sites + 29.2 stream miles**
BMP Conversion Desktop Assessments	13
New BMP Desktop Assessments	0
Tree Planting Desktop Assessments	0
Total Desktop Assessments	**13 sites**
Total Assessments	**120 sites + 29.2 stream miles**

Figure 4-2. Typical Dry Pond (left) and Extended Detention Dry Pond (right) evaluated during BMP Conversion Assessments

Figure 4-3. Typical untreated impervious surface (left) and a potential location for a new BMP facility (right) observed during New BMP Assessments

Figure 4-4. Typical degraded stream channels observed during Stream Restoration Assessments

Figure 4-5. Typical tree planting opportunities found along stream corridors (left) and adjacent to existing forest (right)

Figure 4-6. Typical degraded outfall channels observed during Outfall Stabilization Assessments

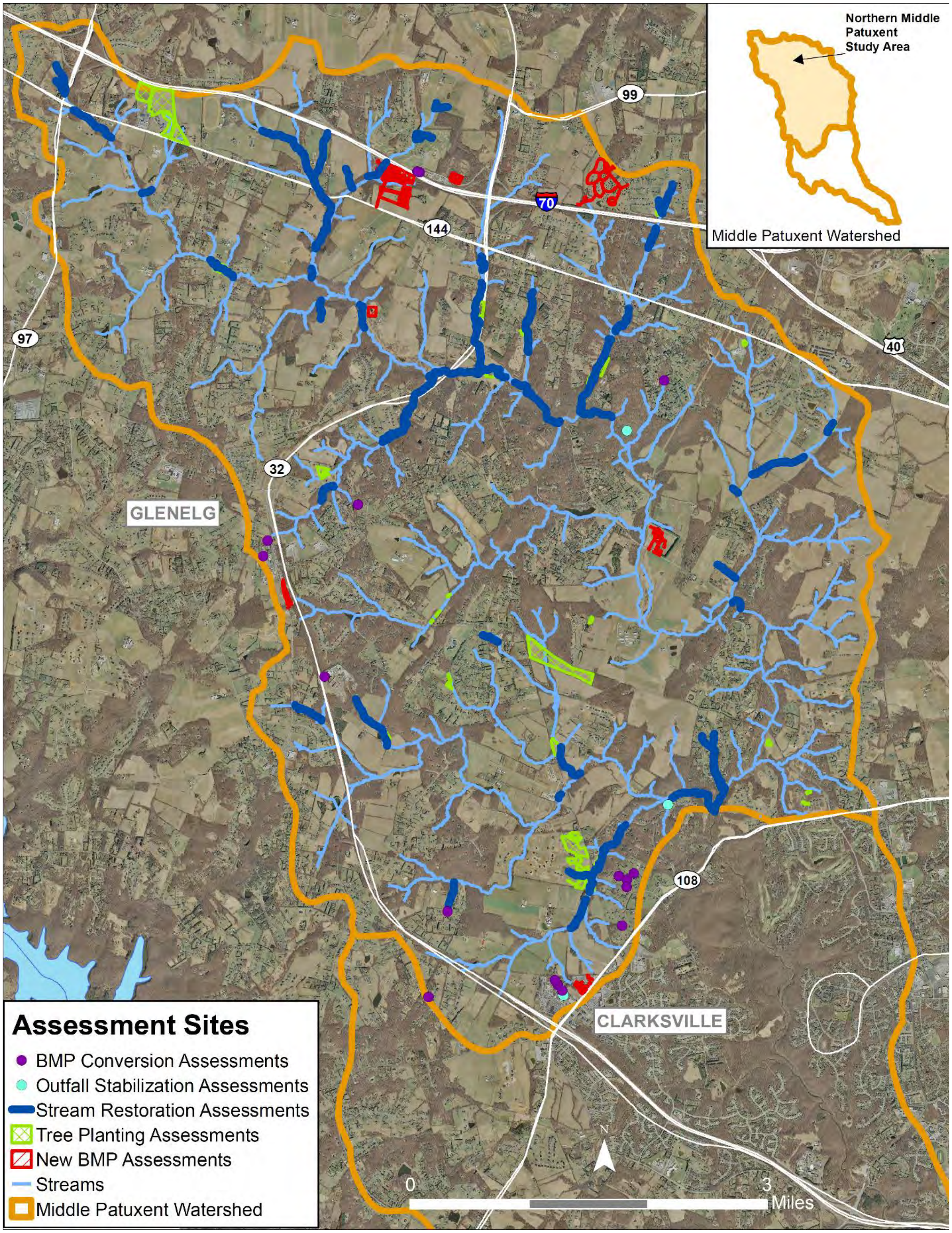

Figure 4-7. Location of assessments conducted in the Northern Middle Patuxent Study Area

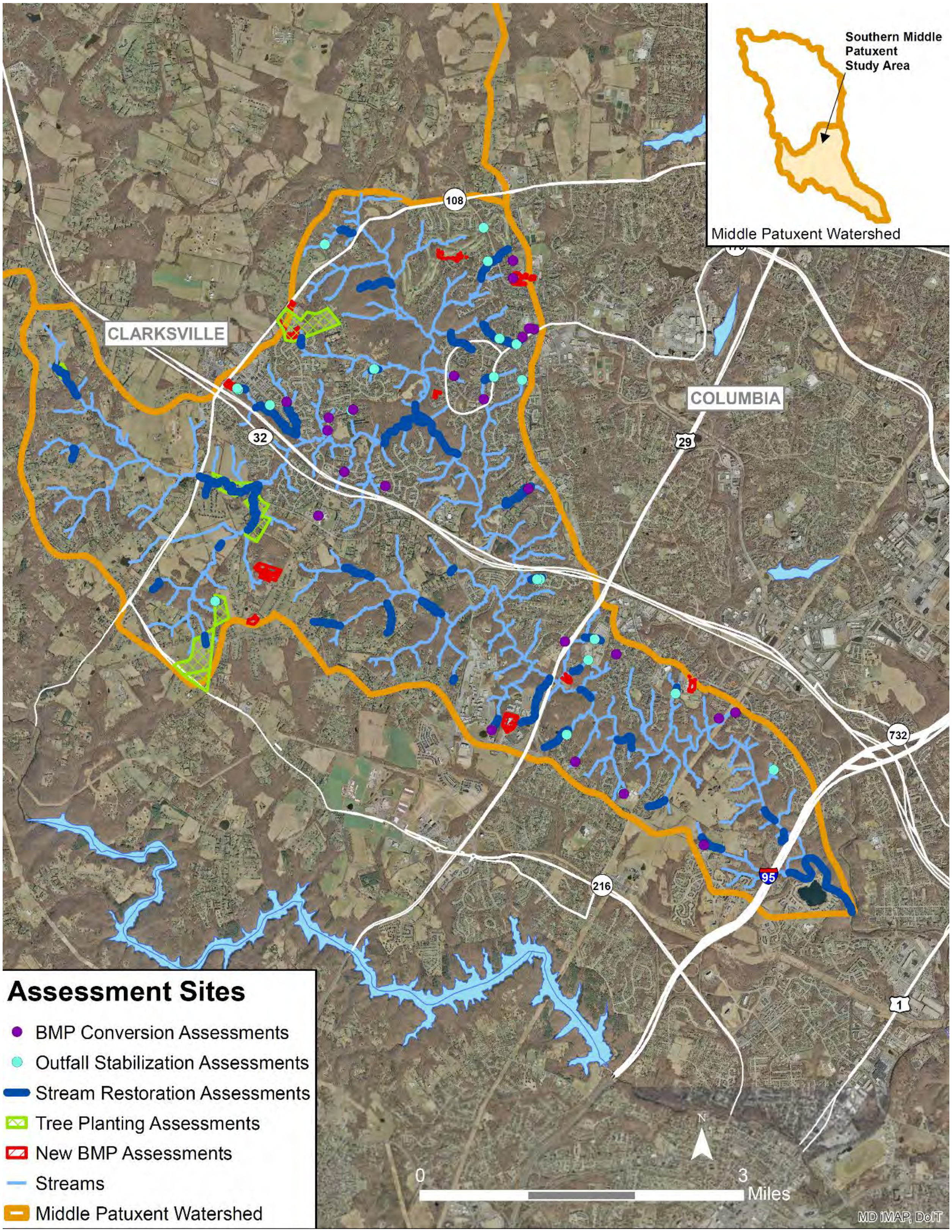

Figure 4-8. Location of Assessments Conducted in the Southern Middle Patuxent Study Area

4.2.1 BMP Conversion Assessments

A total of 27 BMP Conversion Assessments were conducted in the field, and an additional 13 BMP Conversion Assessments were conducted as desktop assessments. All BMP facilities evaluated for conversion potential were existing dry ponds (Figure 4-2, left) or extended detention dry ponds (Figure 4-2, right), with the exception of one wet pond. Types of BMP conversion options proposed during field and desktop assessments are discussed in Section 2.7. The majority of BMP Conversion Assessment sites were located in the Southern Middle Patuxent study area due to its higher density of impervious surfaces.

4.2.2 New BMP Assessments

A total of 18 New BMP Assessments were conducted in the field. No additional New BMP desktop assessments were performed. The majority of areas evaluated for BMP retrofits consisted of business parks with large buildings surrounded by parking and driving surfaces for employees, customers, and deliveries. Other types of sites evaluated included schools, community centers, and apartment buildings. Representative photos of New BMP Assessment sites are shown in Figure 4-3. Similar to BMP conversion Assessment sites, the majority of New BMP Assessment sites were located in the Southern Middle Patuxent study area due to its high density of untreated impervious surfaces.

4.2.3 Stream Restoration Assessments

A total of 29.2 miles of Stream Restoration Assessments were conducted in the field. The majority of stream channels evaluated consisted of degraded 1st and 2nd order perennial streams (Figure 4-4). Several intermittent and ephemeral channels were also evaluated, as well as a short section of the mainstem of the Middle Patuxent River.

4.2.4 Tree Planting Assessments

A total of 36 Tree Planting Assessments were conducted in the field. No additional desktop Tree Planting Assessments were conducted. Tree Planting Assessments conducted for sites selected during the desktop analysis primarily consisted of open pervious space located on County-owned land (Figure 4-5, right). Several Tree Planting Assessments were conducted in riparian open pervious areas (Figure 4-5, left) that were noted while conducting Stream Restoration Assessments; these riparian sites added were primarily on private property.

4.2.5 Outfall Stabilization Assessments

A total of 26 Outfall Stabilization Assessments were conducted in the field. The assessed outfalls ranged in size from 15 to 60 inches in diameter. Photos of representative outfalls assessed during the study are shown in Figure 4-6. The majority of the outfalls assessed during the study were located in the Southern Middle Patuxent due to its higher density of impervious surfaces and stormwater infrastructure.

4.3 Summary - Middle Patuxent Watershed Restoration and Retrofit Recommendations

Locations of recommendations for BMP Conversion, New BMPs, Stream Restoration, Tree Planting, and Outfall Stabilization made based on field and desktop assessments are shown in Figures 4-9 and 4-10. For all recommendations made, field crews assigned an initial assessment of restoration potential, rating the recommendation as High, Medium, or Low potential, based on field findings and other available information and observations. Table 4-2 summarizes the total numbers and restoration potential ratings for all recommendations made within the Middle Patuxent Watershed.

Table 4-2. Summary of recommendations in the Middle Patuxent Watershed

Type	Number of Recommendations	High Potential Sites	Medium Potential Sites	Low Potential Sites
BMP Conversion Field Recommendations	23	6	10	7
New BMP Field Recommendations	38	7	18	13
Stream Restoration Field Recommendations	134	28	74	32
Tree Planting Field Recommendations	50	23	19	8
Outfall Stabilization Field Recommendations	16	6	8	2
Total Field Recommendations	**261**	**70**	**129**	**62**
BMP Conversion Desktop Recommendations	11	8	2	1
New BMP Desktop Recommendations	0	0	0	0
Tree Planting Desktop Recommendations	0	0	0	0
Total Desktop Recommendations	**11**	**8**	**2**	**1**
Total Recommendations	**272**	**78**	**131**	**63**

4.3.1 BMP Conversion Recommendations

A total of 23 BMPs were recommended for conversion in the field, and an additional 11 BMPs were recommended for conversion during the desktop assessments. The majority of the proposed BMP conversion options consisted of wet ponds, wetlands, extended detention, bioretention, and non-bioretention filtering practices. Multiple conversion options were identified at the majority of the assessed sites.

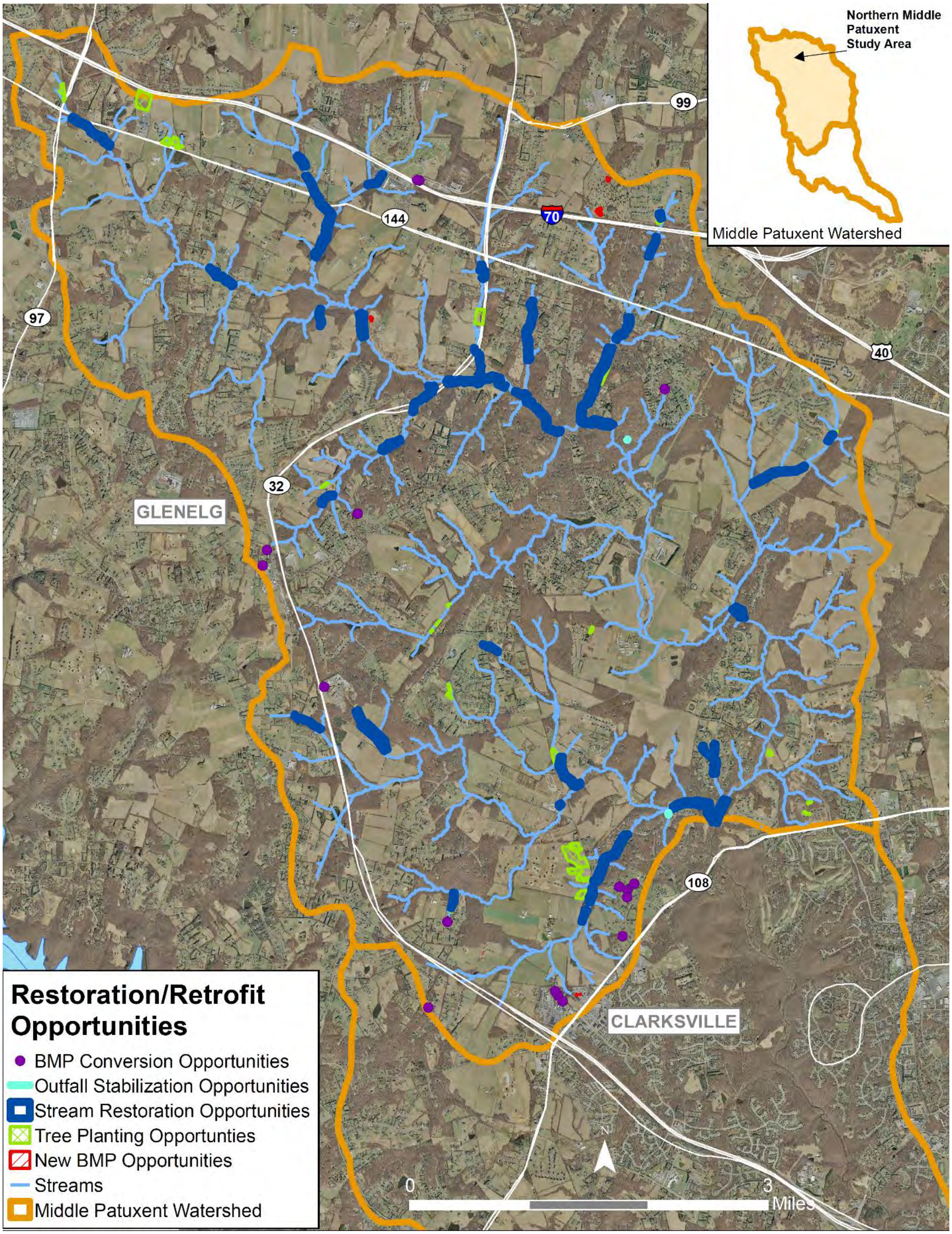

Figure 4-9. Location of restoration and retrofit opportunities in the Northern Middle Patuxent Study Area

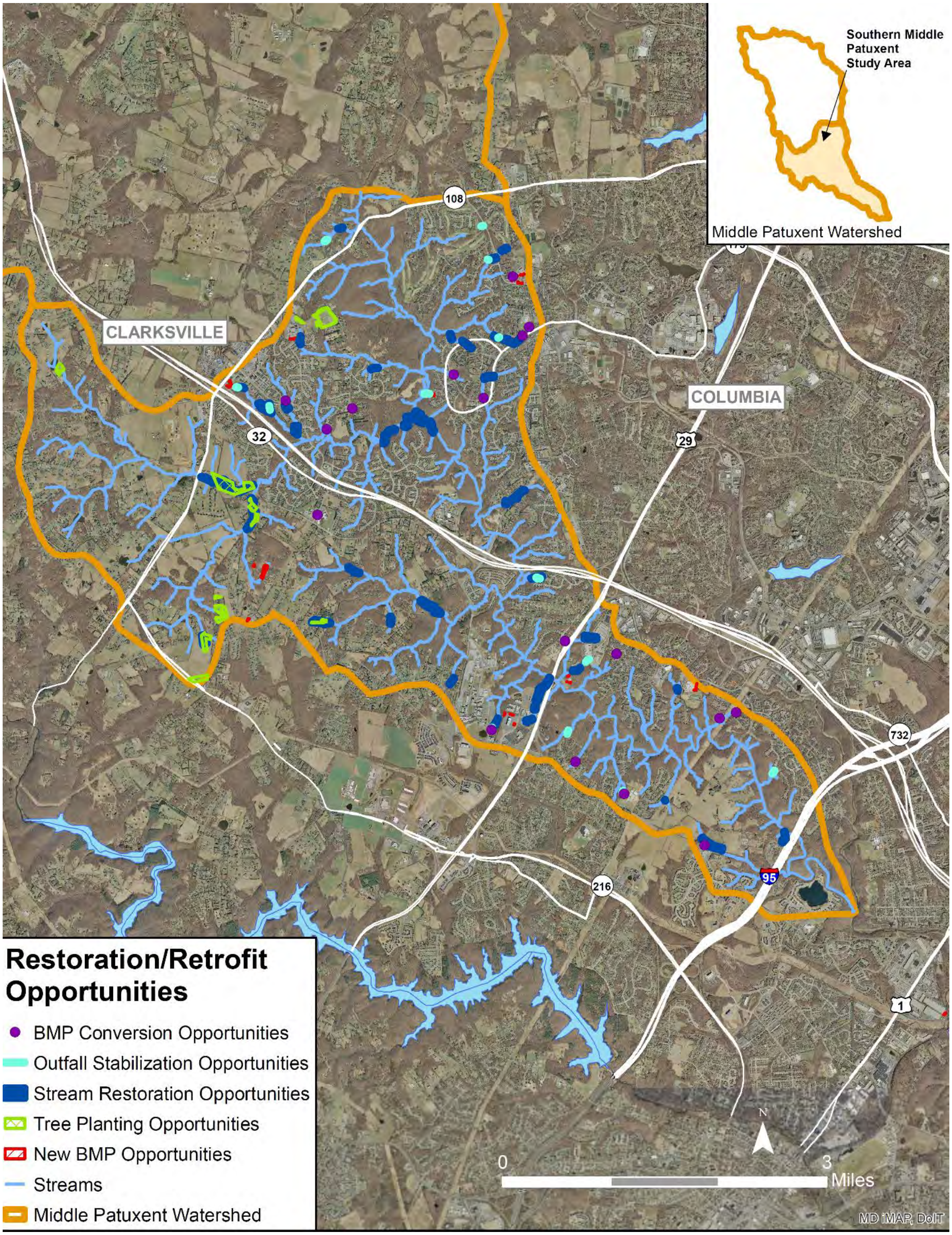

Figure 4-10. Location of restoration and retrofit opportunities in the Southern Middle Patuxent Study Area

4.3.2 New BMP Recommendations

A total of 38 New BMP Recommendations were proposed in the field. The majority of the proposed BMP facilities consisted of bioretention and non-bioretention filtering practices. Multiple New BMP facilities were recommended at most of the assessed sites.

4.3.3 Stream Restoration Recommendations

A total of 134 Stream Restoration Recommendations were proposed in the field. The total length of the proposed projects is approximately 17 miles. In general, stream reaches recommended for restoration contained either one (or multiple) instance(s) of severe bank erosion, or consistent minor to moderate bank erosion along with unsuitable instream habitat and threatened infrastructure (e.g., exposed utility pipes, power line poles located in the stream channel, etc.). In addition, several concrete channels were recommended for removal.

4.3.4 Tree Planting Recommendations

A total of 50 Tree Planting Recommendations were proposed in the field. Tree planting areas ranged in size from approximately 0.25 acres to 18 acres. The majority of the Tree Planting Recommendations were between 1 and 5 acres in planting area, and the total area of all proposed tree planting projects is approximately 122 acres.

4.3.5 Outfall Stabilization Recommendations

A total of 16 Outfall Stabilization Recommendations were proposed in the field. The majority of the proposed outfall stabilization projects consisted of regenerative stormwater conveyances and were located in areas with high amounts of impervious cover.

4.4 Public Input and Feedback (Additional Sites)

Field assessment results were presented during a set of public meetings that were held by Howard County Stormwater Management Division in June 2015. During the meetings, citizens had the opportunity to review assessment findings and recommendations developed to date, and to bring issues to the attention of the County that could be investigated as additional BMP Conversion, New BMP, Stream Restoration, Tree Planting, or Outfall Stabilization Assessment sites. Meetings included a County presentation of background information, an overview of the watershed assessment process, and highlights of findings to date. During an interactive discussion period, County and consultant team staff were available to talk with participants about particular sites or concerns. Large map display posters and data tablets were available for viewing field assessment data and recommendations. As a result of the citizen input, six additional sites were assessed, and one of those site was recommended as a potential project location.

5. RESTORATION PROJECT RANKING AND PRIORITIZATION

5.1 Ranking Methods - Overview

During the various field assessments, crews determined which locations were best suited for potential projects, as reported in Chapter 4. In all, 193 potential projects were identified. The large list of possible projects they generated, as well as the multiple goals this watershed assessment aims to address (e.g., impervious surface treatment, pollutant reductions, etc.), makes it challenging to select the best projects for implementation. To address this challenge, an automated, standardized method was developed for comparing, ranking, and prioritizing the projects. This method relied on a combination of data collected in the field, the known costs and benefits of various BMP types, and GIS analyses. The method was applied to select a set of projects for which concept designs were developed; it can be used in the future to choose additional project for design, as needed.

Projects were ranked in two different ways, the details of which will be discussed in more detail in the next sections. First, each project was ranked against all other projects of the same type. This will allow Howard County, for example, to target grant funding that must be applied to forest canopy improvement to the areas in the watershed that were identified as having the best tree planting opportunities. This type of ranking also allows for the incorporation of more specialized ranking factors. For example, the length and severity of erosion at an outfall is a useful way to compare stabilization projects, but would not apply to rankings that also include tree planting sites or locations for new BMP installations.

Second, all projects were pooled together and every potential project was ranked against each other. In this way, the County can compare the relative costs and benefits of the complete project list. This list can help to determine those projects which have the highest potential value and should be taken to the next design stage, as well as aid in modeling scenarios to determine which combination of projects will help to meet TMDL and other goals, and at what cost.

Ranking factors included the amount of impervious area restoration that would be achieved by the project (Table 5-1) and other benefits and constraints. There were some factors that were generally applicable across all project types (see details noted as level "A" in Tables 5-2 through 5-5). Level "A" factors were divided into four main categories:

- Permit contribution – how a project will help towards the County meeting the impervious surface restoration requirements in its NPDES MS4 permit, as well as its TMDL goals
- Biological uplift – if a project will provide additional benefits, such as building onto existing green infrastructure or protecting wetlands
- Programmatic benefit – if a project has value beyond its primary functional purpose, such as visible demonstration projects or public education

- Feasibility – estimation of the ease or difficulty of project implementation, including public versus private ownership, site accessibility, or whether a repair is already required at a site providing an opportunity to minimize costs by upgrading the facility during the course of other required construction activities

Each factor was scored according to various criteria (see Tables in Section 5.2 and 5.3). The sum of all the factor scores was used to rank each project, with higher total scores representing higher priority projects. A table of all projects, with scores, is found in Appendix G.

5.1.1 Impervious Area Credits

For all opportunities identified, the potential benefits in terms of impervious area restoration credit were calculated in accordance with MDE's accounting guidance (MDE 2014c). For stormwater BMPs, according to MDE criteria the target is treatment of the water quality volume (WQv), typically associated with the 1-inch rainfall event. When the practice is able to provide treatment for the full WQv, full impervious area credit is given based the total impervious area within the BMP drainage area. When less than 1 inch of rainfall is treated, impervious area treatment credit is based on the proportion of the full WQv treated. For alternative BMPs such as tree plantings and stream restoration, impervious acre equivalents were calculated based on factors provided by MDE (2014c), as summarized in Table 5-1. Impervious acre credits (and impervious acre equivalents, for alternative BMPs) are used to plan for and estimate progress toward meeting the 20% impervious area restoration requirement in Howard County's MS4 Permit (MDE 2014a).

Table 5-1. Impervious acre credits for alternative BMPs (from MDE 2014c)

BMP	Notes	Impervious Acre Equivalent
Reforestation on Pervious Urban	Survival rate of 100 trees/acre or greater; at least 50% of trees have two-inch diameter or greater (4.5 feet above ground).	0.38 acre credit / acre reforested
Impervious Urban to Pervious	Remove pavement and provide vegetative cover for 95% of area.	0.75 acre credit / acre revegetated
Impervious Urban to Forest	Survival rate of 100 trees/acre or greater; at least 50% of trees have two-inch diameter or greater (4.5 feet above ground).	1.00 acre credit / acre reforested
Regenerative Step Pool Storm Conveyance (SPSC)	Located in dry or ephemeral channels; impervious area credit is based on runoff depth treated. When less than 1 inch of rainfall is treated, a proportion of credit is taken.	1.00 acre credit / impervious acre treated, based on treating 1 inch of rainfall.
Stream Restoration	Planning level estimate	0.01 acre credit / linear foot restored
Outfall Stabilization	Stabilization or repair of localized areas of erosion below a storm drain outfall; max credit is two acres per project.	0.01 acre credit / linear foot restored

5.2 Ranking and Prioritization Within Project Types

5.2.1 BMP Conversions and New BMPs

The similar nature of these two project categories led to them sharing a set of ranking criteria (Table 5-2), though they were ranked separately. Prior to scoring and ranking, some projects were eliminated from the candidate pool. Pond conversion candidates that seemed to be naturally converting to a wetland facility were not included in the ranking, as it was unlikely that the County would want to disturb an area that was already providing additional water quality benefits. Howard County intends to focus on projects that would have larger-scale benefits, and so new BMP projects that were determined to address less than 2 acres of impervious surface were also removed from the ranking.

Table 5-2. Ranking factors, criteria and scoring for BMP conversion and new BMP projects.

	Factor	Criteria	Score
A.	**Factors for all site types**		
1.	***Permit contribution***		
1.a	Acres of impervious treatment	> 10 acres	20
		5 - 10 acres	15
		1 - 5 acres	10
		< 1 acre	5
1.b	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	181 - 260	10
		101 - 180	6
		0 - 100	3
1.c	Cost per acre of impervious treatment	< \$50,000	10
		\$50,000 - \$100,000	8
		\$100,000 - \$200,000	5
		> \$200,000	2
2.	***Biological uplift***		
2.a	BMP in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	BMP is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
3.	***Programmatic benefit***		
3.a	Site has educational value and/or is visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
4.	***Feasibility***		
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3

Table 5-2. (Continued)

	Factor	Criteria	Score
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Pond/infrastructure already in need of repair	Yes	15
4.f	Field assessment – high potential for restoration/retrofit	Yes	5

5.2.2 Tree Plantings

In the case of tree plantings, there were a few minor variations from the standard factor scoring. In the case of structural and pond BMPs, there are many different types, allowing for a wide range of pollutant reduction efficiencies per drainage acre and costs per unit treatment across different projects. In the case of tree planting projects, these values would be the same across all projects; for this reason factors 1.b and 1.c were not scored (Table 5-3). Additionally, for tree planting projects, where the impact to surrounding trees would not be a concern, the level of site preparation required for planting was substituted as a factor (see 4.c in Table 5-3).

Table 5-3. Ranking factors, criteria and scoring for tree planting projects

	Factor	Criteria	Score
A.	**Factors for all site types**		
	1. Permit contribution		
1.a	Acres of impervious treatment	> 2 acres	20
		0.75 - 2 acres	15
		0.38 - 0.75 acres	10
		< 0.38 acres	5
1.b	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	N/A – same for all sites	
1.c	Cost per acre of impervious treatment	N/A – same for all sites	
	2. Biological uplift		
2.a	Planting in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	Planting is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	10
		No	0
2.c	Planting is within 100 feet of wetlands	Yes	5
		No	0
	3. Programmatic benefit		
3.a	Site has educational value/visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
	4. Feasibility		
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3

Table 5-3. (Continued)

	Factor	Criteria	Score
4.c	Site preparation required before planting	None	10
		Minimal	8
		Moderate	5
		Extensive	2
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Infrastructure in need of repair	N/A	
4.f	Field assessment – high potential for restoration/retrofit	Yes	5

5.2.3 Outfall Stabilizations

Outfall stabilization projects, for the purposes of ranking, were divided into broad categories: traditional stabilizations (e.g., riprap) and step pool stormwater conveyances (SPSC, or regenerative stormwater conveyances, RSC). These two methods of stabilization vary greatly from one another in both cost and benefit and were thus used to help differentiate the projects in scoring (Table 5-4). Beyond the standard level "A" ranking factors, an additional level "B" factor was included, in order to characterize the length and severity of erosion each project would address.

Table 5-4. Ranking factors, criteria and scoring for outfall stabilization projects

	Factor	Criteria	Score
A.	**Factors for all site types**		
	1. Permit contribution		
1.a	Acres of impervious treatment	1.5 - 2 acres	20
		1 - 1.5 acres	15
		0.5 - 1 acres	10
		< 0.5 acres	5
1.b	Pollutant load reduction factor (Note: standard outfall stabilizations receive no pollution reduction credits)	SPSC	10
		All other types	0
1.c	Cost per acre of impervious treatment (Note: Riprap is the less expensive option and receives more points)	Riprap	10
		SPSC	3
		All other types	0
	2. Biological uplift		
2.a	Stabilization in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0
2.b	Stabilization is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
2.c	Stabilization is within 100 feet of wetlands	Yes	5
		No	0
	3. Programmatic benefit		
3.a	Site has educational value/visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3

Table 5-4. (Continued)

	Factor	Criteria	Score
	4. Feasibility		
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	10
		Some	6
		Many	3
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Outfall/infrastructure already in need of repair	Yes	15
4.f	Field assessment – high potential for restoration/retrofit	Yes	5
B.	**Erosion factor**		
1	Length and severity of erosion (Length of erosion in feet x erosion severity rating)	> 1,000	15
		500 – 1,000	10
		< 500	5

5.2.4 Stream Restorations

As noted for the tree planting project ranking discussed in Section 5.2.1, pollutant reduction efficiencies and costs per unit treatment are the same among all stream restoration projects, and therefore 1.b and 1.c were not scored (Table 5-5). Beyond the standard level "A" ranking factors, two additional levels of factors were incorporated into the stream restoration prioritization. A level "B" factor was included, similar to that used for the outfall stabilization ranking, which characterizes the length and severity of erosion each project would be able to address. Three level "C" factors were also included, which address factors unique to streams, such as habitat quality and other problems identified during stream corridor assessments.

Table 5-5. Ranking factors, criteria and scoring for stream restoration projects

	Factor	Criteria	Score
A.	**Factors for all site types**		
	1. Permit contribution		
1.a	Acres of impervious treatment	> 9 acres	20
		6 – 9 acres	15
		3 – 6 acres	10
		< 3 acres	5
1.b	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	N/A – same for all sites	
1.c	Cost per acre of impervious treatment	N/A – same for all sites	
	2. Biological uplift		
2.a	Restoration in a subwatershed with 45-65% of sites with IBI scores below degradation threshold	Yes	5
		No	0

Table 5-5. (Continued)

	Factor	Criteria	Score
2.b	Restoration is within 500 feet of Green Infrastructure Network or Tier II waters	Yes	5
		No	0
2.c	Restoration is within 100 feet of wetlands	Yes	5
		No	0
	3. Programmatic benefit		
3.a	Site has educational value/visible for public demonstration	Yes	2
3.b	Site is near 2 or more other potential projects allowing for easier monitoring and demonstration of benefit	Yes	3
	4. Feasibility		
4.a	Ease of access	Easy	10
		Moderate	6
		Difficult	3
4.b	Conflicts with infrastructure or other site constraints	None	5
		Some	3
		Many	1
4.c	Adverse impacts to nearby trees	Minimal	10
		Moderate	6
		Significant	3
4.d	Ownership – public vs. private	Public	10
		Private, other	0
4.e	Already in need of repair	N/A	
4.f	Field assessment – high potential for restoration/retrofit	Yes	5
	B. Erosion factor		
1	Length and severity of erosion (Length of bank erosion in feet x erosion severity rating)	> 300	15
		100 - 300	10
		< 100	5
	C. Stream condition factors		
1	Average BEHI score (length-weighted) along reach	46 - 50	10
		40 - 45	8
		30 - 39	6
		20 - 29	4
		< 20	2
2	Average Habitat Assessment score (length-weighted) within a reach rated site as non-supporting or only partially supporting aquatic biota	Yes	5
3	Number of other problems along reach (exposed pipes, pipe outfalls, unusual conditions, etc.)	Other problems > 2	10

5.3 Ranking and Prioritization Across All Project Types

In order for a fair comparison of all projects, factors were limited to those that were common to all project types (level "A"), as shown in Table 5-6. Due to minor variations in the number of factors used for the different project types (e.g., factor 4.e, which determines if repairs are already recommended at an existing facility, only applied to outfalls and BMP conversions) the sum of individual scores for categories 2 through 4 were converted to a proportion so that each project was judged based on highest possible score for its own project type. After looking at the final ranked list of all projects, the County determined a cut-off score, above which all projects would be considered for concept plans.

Table 5-6. Ranking factors, criteria and scoring used for ranking all projects and selecting projects for concept plans

	Factor	Criteria	Score
A. Factors for all site types			
	1. Permit contribution		
1.a	Acres of impervious treatment	> 10 acres	10
		5 – 10 acres	8
		3 – 5 acres	5
		1 – 3 acres	4
		< 1 acre	2
1.b	Pollutant load reduction factor (Sum of % load reductions for TN, TP, and sediment)	201 - 260	10
		151 - 200	6
		1 - 150	3
		0	0
1.c	Cost per acre of impervious treatment	< $50,000	10
		$50,000 - $100,000	8
		$100,000 - $200,000	5
		> $200,000	2
	2. Biological uplift ***3. Programmatic benefit*** ***4. Feasibility***		
2.a – c 3.a – c 4.a – f	Sum of scores, as a proportion of total possible points (Note: Total possible points is dependent of type of site)	> 0.8	10
		0.6 - 0.8	8
		0.4 - 0.6	6
		0.2 - 0.4	4
		0.01 - 0.2	2
		0	0

5.4 Concept Plans

After the County approved the results of the ranking (Table 5-7), a four-page concept plan was developed for each of the highest ranked projects. These concept plans included:

- Location information (including a site locator map),
- Existing site conditions (including photos),
- Details of the proposed project (including a concept design drawing),
- Implementation information, such as utility constraints and other nearby projects,
- Potential impervious treatment and pollutant reduction credits, and
- Cost estimate.

Each concept plan provides a complete picture of the potential project, including costs and benefits. They may be used by the County to communicate with the public about a particular project, to apply for a grant for funds to move forward with project implementation, or to aid in the allocation of funds during the County's budget process. The complete set of concept plans is available in Appendix H.

Table 5-7. Number of projects, by type, selected for concept plans in Middle Patuxent Watershed

Project Type	Number of Concept Plans Developed
BMP Conversions	5
New BMPs	0
Tree Plantings	13
Outfall Stabilizations	6
Stream Restorations	15
Total	39

6. POLLUTANT LOAD MODELING

Howard County has implemented stormwater BMPs since the 1980s. The initial focus of stormwater management was retention and detention of large flows to reduce flooding. Subsequent designs have addressed water quality treatment, infiltration, and stream channel protection. Here, calculations are presented of the nitrogen, phosphorus, and sediment loadings and loading rates to the Middle Patuxent River with the existing and planned BMPs, based on the County's BMP database as of November 12, 2015. Existing BMPs are those that have already been installed while planned BMPs are those indicated as "planned" in the database but have not yet been built. Further, calculations are presented of the nutrient and sediment loading reductions that would occur based on implementation of restoration opportunities that were identified as part of the watershed assessment presented herein (see Chapters 1-5).

Existing pollutant loads and projected reductions in loads were calculated for the application of various BMPs. The pollutant load model is spreadsheet-based and is comparable to the Maryland Assessment Scenario Tool (MAST) for calculating annual pollutant loads. The models account for the reductions by a suite of BMPs. As the first step, the model calculated existing pollutant loads using MAST loading rates at the scale of the Maryland-designated 8-digit watershed (i.e., Middle Patuxent), combined with the latest county watershed land use (explained in detail below), followed by treatment with existing and planned stormwater management practices. In the second step, the model subtracted the reductions expected from future practices from the remaining existing loads using the pollutant reduction values provided in MAST, derived from the Chesapeake Bay Watershed Model. Each future practice type was compared to the pollution load reduction targets to estimate implementation effectiveness.

The pollutant load calculations and removals by BMPs were completed for the watershed for the Chesapeake Bay TMDLs. Note that Howard County land use was used in conjunction with the MAST model loading rates to calculate the loads of nitrogen, phosphorus and sediment for the Middle Patuxent Watershed.

For each pollutant, the model was run under existing conditions with existing and planned BMPs to determine the baseline load, which for the Bay TMDL is 2010. Each BMP installed as of the baseline year was assumed to be operating as intended and included in the baseline based on the "as-built date". Next, model runs were conducted for each restoration practice and its associated pollutant load reductions. For simplicity, the restoration options for each TMDL target are shown in tables with the incremental and cumulative reductions associated with the following BMPs:

- Baseline of projects completed or planned after the TMDL baselines
- Proposed conversion of dry ponds to various upgraded practices
- Proposed conversion of extended detention ponds to various upgraded practices
- Proposed New Structural BMPs
- Proposed Tree Plantings
- Proposed Stream Restoration
- Proposed Outfall Stabilization

Using these models, provisional sets of the BMPs most likely to be feasible and cost-effective are included for the watershed. The selected combination of BMPs are thus evaluated against all TMDL targets in the watershed. The sections that follow describe this process in detail, but the basic steps are listed as follows:

1. MAST output of watershed-specific and land use-specific pollutant loadings were used to calculate baseline loading rates in pounds per acre for pervious and impervious urban areas (combined County MS4 and non-regulated urban categories for these areas). Federal, State Highway Administration (SHA), other State lands, agriculture, and water areas were included in the total area for comparison, but only forested area rates were applied where needed for some of the calculations.

2. A custom modeling spreadsheet was prepared to present the baseline calculations with watershed-specific loading rates as described above.

3. For the Bay TMDL baseline, the benefit was estimated for BMPs installed or planned for installation since the Bay TMDL model run, based on the county database of BMPs from 2010 to present.

4. To estimate future load reductions, the benefits were calculated for proposed new BMPs, dry pond and extended detention pond conversions, tree plantings, stream restoration, and outfall stabilization (regenerative stormwater conveyances).

6.1 Loads and Rates (Model Tab T0)

Pollutant loading analyses for Maryland-designated 8-digit watersheds located entirely or in part within Howard County (e.g., Middle Patuxent Watershed) are intended to assess the impacts of current development on water quality. To support these analyses, watershed-specific pollutant loading rates were derived for nitrogen, phosphorus, and sediment based on MAST for Howard County (www.mastonline.org). MAST results from the 2010 Progress scenario were used to develop current loadings rates for all land uses. Land use types were aggregated as listed in Table 6-1.

Detailed land use information for the Howard County watersheds was derived from a combination of Howard County's land use (received from Howard County Department of Planning and Zoning in June 2011), forest cover, and larger waterways and water body’s data sets; and the MDP’s 2010 Land Use/Land Cover data set. For areas where the County land use data set was missing information, or identified parcels as undeveloped, for urban and agricultural types, the associated MDP data were used to complete the data coverage. Approximately 30% of the parcels with MDP land use classifications were confirmed with comparisons to aerial photography of the same time period before accepting the data set elements as replacements for the missing County data. For the purposes of watershed-scale pollutant loading analyses, a consolidated version of land use classifications was used, since loading rates do not differ significantly between certain land use classes (e.g., various forest types). The land use/land cover categories present in the study-area-wide data set and the corresponding MAST land use classes used for the pollutant loading analyses are summarized in Tables 6-2a and 6-2b.

Table 6-1. MAST (Devereaux, 2011) land use aggregations for calculating pollutant loading rates for total Nitrogen, total Phosphorus, and sediment

MAST Land Use Name	Aggregated Land Use Group
Alfalfa	Agriculture
Animal feeding operations	Agriculture
County Phase I/II MS4 impervious*	Impervious
County Phase I/II MS4 pervious*	Pervious
Degraded riparian pasture	Agriculture
Federal impervious	Impervious
Federal pervious	Pervious
Forest*	Forest
Harvested forest	Forest
Hay with nutrients	Agriculture
Hay without nutrients	Agriculture
Hightill with manure	Agriculture
Hightill without manure	Agriculture
Nonregulated extractive	Impervious
Nonregulated impervious developed*	Impervious
Nonregulated pervious developed*	Pervious
Nursery	Agriculture
Pasture	Agriculture
Regulated construction	Impervious
Regulated extractive	Impervious
Regulated industrial facility impervious	Impervious
Regulated industrial facility pervious	Pervious
SHA Phase I/II MS4 impervious	Impervious
SHA Phase I/II MS4 pervious	Pervious
State Phase II MS4 impervious	Impervious
State Phase II MS4 pervious	Pervious
Water	Water

* These land uses were used for estimating the loading rates for BMP benefit estimation

Table 6-2a. Reclassification of Howard County 2011 land use data groups to MAST land use for Howard County watersheds

Howard County Land Use Groups	MAST Land Use Type
11, 12, 13, 14, 15, 16, 17, 18, 19 Residential	Urban*
21 Commercial	Urban*
31 Industrial	Urban*
32 Manufacturing	Urban*
33 Transportation, communication, and utilities	Urban*
41 Government	Urban*
42, 43 Institutional	Urban*
44 Recreation, parks, courses, and clubs	Urban*
45 Institutions, hospitals, churches, and cemeteries	Urban*
51-1 Farmland	Agriculture
51-2 Woodland	Forest and wetlands
61 Miscellaneous	Urban*
10, 20, 30, 40 Undeveloped	N/A

* These categories were split into pervious urban and impervious urban areas using Howard County's impervious cover (roads and buildings, parking lots, driveways, sidewalks, paved paths, etc.) GIS layers.

Table 6-2b. Reclassification of Howard County 2011 land use data and MDP 2010 Land Use/Land Cover to MAST land use for Howard County watersheds

MDP Land Use/Land Cover Classification	MAST Land Use Type
191 Very low density residential (agriculture)	Urban*
192 Very low density residential (forest)	Urban*
11 Low density residential	Urban*
12 Medium density residential	Urban*
13 High density residential	Urban*
14 Commercial	Urban*
15 Industrial	Urban*
16 Institutional	Urban*
17 Extractive	Urban*
18 Open urban land	Urban*
21 Cropland	Agriculture
22 Pasture	Agriculture
41 Deciduous forest	Forest and wetlands
43 Mixed forest	Forest and wetlands
44 Brush	Forest and wetlands
50 Water	Water
60 Wetlands	Forest and wetlands
73 Bare ground	Urban*
80 Transportation	Urban*

* These categories were split into pervious urban and impervious urban areas using Howard County's impervious cover (roads and buildings, parking lots, driveways, sidewalks, paved paths, etc.) GIS layers.

Consolidated land uses were used to determine the total acreage for each land use category in the watershed. These were multiplied by the corresponding loading rates derived from MAST. Resulting annual pollutant loads for total nitrogen, total phosphorus, and sediment from the watershed are summarized by land use. Estimates provide baseline nutrient and sediment loads before implementation of restoration projects and will allow a better assessment of both progress made to date and further progress needed to meet TMDL goals for urban stormwater runoff pollutant reduction. Annual nutrient and sediment loads for the Middle Patuxent Watershed Bay TMDL are summarized in Table 6-3. These tables also include nitrogen, phosphorus, and sediment loading rates (lbs/ac/yr). The total pollutant load estimate will be used to estimate necessary reductions to meet Chesapeake Bay TMDL goals.

Table 6-3. Existing (2010) Annual Pollutant Loads within Middle Patuxent Watershed (02131106) for the Chesapeake Bay TMDL

Land Use	County Area (acres)	Nitrogen		Phosphorus		Sediment	
		Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)	Rate (lbs/ac/yr)	Load (lbs/yr)
Impervious Urban	2825	16.03	45,297	2.10	5,929	3,126	8,832,963
Pervious Urban	13738	9.93	136,382	0.29	4,010	330	4,539,629
Agricultural	5868	7.81	45,825	0.97	5,670	852	4,997,933
Forest	12709	3.49	44,334	0.08	993	258	3,277,975
Water	342	9.37	3,207	0.61	209	0	0
Totals	35,483	46.62	275,046	4.05	16,812	4,566	21,648,500
Total Urban	16,564	25.96	181,680	2.39	9,939	3,457	13,372,592

6.2 Existing Stormwater Management (Model Tab T1)

The following sections present a quantitative analysis of pollutant removal capabilities of existing and potential BMPs to estimate reduction in nutrient loads from urban runoff in this watershed. The removal efficiencies used to estimate pollutant reductions are based on the August 5, 2015 version of MAST (www.mastonline.org). Table 6-4 presents the removal efficiency rates used in this analysis for structural BMPs except as noted elsewhere in the text; where there are multiple rates for a BMP type based on soil group and the soil group is not known, the removal rate used was for the soil group most likely to be proposed for that BMP type. Also note that the calculations and estimates presented in the following subsections represent maximum potential pollutant reduction capabilities. A summary of overall pollutant load reduction estimates is presented at the end of this section.

Table 6-4. BMP efficiencies used in MAST for the land use and hydro-geomorphic region applicable to Howard County. From http://www.mastonline .org/Documentation.aspx.

BMP	BMP Short Name	Nitrogen Effectiveness (%)	Phosphorus Effectiveness (%)	Sediment Effectiveness (%)
Bioretention/raingardens - A/B soils, no underdrain	BioRetNoUDAB	80	85	90
Bioretention/raingardens - A/B soils, underdrain	BioRetUDAB	70	75	80
Bioretention/raingardens - C/D soils, underdrain	BioRetUDCD	25	45	55
Bioswale	BioSwale	70	75	80
Dry Detention Ponds and Hydrodynamic Structures	DryPonds	5	10	10
Dry Extended Detention Ponds	ExtDryPonds	20	20	60
MS4 Permit-Required Stormwater Retrofit	RetroSWM	25	35	65
Permeable Pavement w/ Sand, Veg. - A/B soils, no underdrain	PermPavSVNoUD AB	80	80	85
Permeable Pavement w/ Sand, Veg. - A/B soils, underdrain	PermPavSVUDAB	50	50	70
Permeable Pavement w/ Sand, Veg. - C/D soils, underdrain	PermPavSVUDCD	20	20	55
Permeable Pavement w/o Sand, Veg. - A/B soils, no underdrain	PermPavNoSVNoU DAB	75	80	85
Permeable Pavement w/o Sand, Veg. - A/B soils, underdrain	PermPavNoSVUD AB	45	50	70
Permeable Pavement w/o Sand, Veg. - C/D soils, underdrain	PermPavNoSVUD CD	10	20	55
Stormwater Management by Era 1985 to 2002 MD	SWMEra8502	17	30	40
Stormwater Management by Era 2002 to 2010 MD	SWMEra0210	30	40	80
Stormwater to the Maximum Extent Practicable (SW to the MEP)	E3SWMNew	50	60	90
Street Sweeping 26 times a year-acres (formerly called Street Sweeping Mechanical Monthly)	StreetSweep	3	3	9
Urban Filtering Practices	Filter	40	60	80
Urban Forest Buffers	ForestBufUrban	25	50	50
Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	InfiltWithSV	85	85	95
Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	Infiltration	80	85	95
Vegetated Open Channels - A/B soils, no underdrain	VegOpChanNoUD AB	45	45	70
Vegetated Open Channels - C/D soils, no underdrain	VegOpChanNoUD CD	10	10	50
Wet Ponds and Wetlands	WetPondWetland	20	45	60

Howard County has implemented many capital improvement projects in the county's various watersheds including stream restoration, stormwater facility conversions, and retrofits (new BMPs in drainage areas where none were previously installed). Pollutant loads were estimated based on the contributing drainage area (DA) and the corresponding project type's land use-specific pollutant loading rates. Load reduction is calculated as the product of the pollutant load and removal efficiency. For existing and planned BMPs, pollutant removals are shown in Table 6-5. For stream restoration projects, nutrient reduction credits are based on the length of stream restored. Existing SWM facilities in the county's watersheds include dry ponds, infiltration and filtration practices, extended detention, proprietary BMPs, and other types of SWM facilities (e.g., underground detention). For local TMDLs, some of which were developed based on data collected more than 10 years ago, existing and planned BMPs that were added to the county database since development of that TMDL were included in the calculations. Here, "planned" BMPs refers to those listed in Howard County's BMP database as planned, but that are not yet built. This does not include newer recommendations, such as those BMPs proposed as a result of the current watershed assessment. The work done to create the Bay TMDL takes into account all BMPs implemented through 2009; this was the most recent year that there was BMP implementation data at the time that the Bay TMDL was published. All BMPs on the ground at that time were credited toward the allocations. Any BMPs added after 2009 are included in the calculations presented here (Table 6-5).

Pollutant reductions for existing and planned BMPs were calculated based on the approximate pollutant load received from the DA and removal efficiencies (RE) used in MAST for the various types of SWM faculties. The equation used to estimate nutrient and sediment load reductions for a particular type of SWM facility is expressed as

$$[\#(\text{lbs/ac/yr})*\text{DA (acres)}]*\text{RE (\%)}$$

The pollutant load received from the drainage area contributing to the SWM facility is denoted by the first expression in brackets in the previous equation. The pollutant loading rates shown for Total Nitrogen, Total Phosphorus, and Sediment, each expressed as number of lbs/ac/yr, represent the impervious and pervious urban rates used in the pollutant loading analysis for each watershed (Table 6-3) since this represents the likely sources of runoff being treated. Note that impervious and pervious urban loading rates are based on MAST. The percent pollutant removal efficiency depends on the type of facility and is based on the values shown in Table 6-4. The total pollutant load reduction expected from existing and planned BMPs is a sum of the removal capacities of the individual facilities. A summary of existing SWM load reduction calculations and results are shown in Table 6-5.

Table 6-5. Existing Stormwater Management Practices in the Middle Patuxent Watershed installed after 2009, showing potential pollutant load reductions applicable to the Bay TMDL.

Chesapeake Bay TMDL Sheet for Middle Patuxent River (2010 - Present)												
SWM Facility Type	Impervious DA (acres)	Pervious DA (acres)	Total Nitrogen			Total Phosphorus			Sediment		
			Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)
BioRetention, A/B soils, no underdrain	0.00	0.00	0.00	80%	0.00	0.00	85%	0.00	0	90%	0
BioRetention, A/B soils, with underdrain	9.77	14.09	296.56	70%	207.59	24.62	75%	18.47	35,210	80%	28,168
BioRetention, C/D soils, with underdrain	2.81	3.81	82.84	25%	20.71	7.00	45%	3.15	10,034	55%	5,519
BioSwale	9.29	35.79	504.17	70%	352.92	29.94	75%	22.45	40,862	80%	32,689
Dry Ponds	1.73	3.20	59.54	5%	2.98	4.57	10%	0.46	6,479	10%	648
Extended Dry Ponds	13.06	8.08	289.52	20%	57.90	29.76	20%	5.95	43,489	60%	26,093
Urban Filtering Practices	0.20	0.07	3.89	40%	1.56	0.44	60%	0.27	651	80%	521
Urban Infiltration Practices, w/o S/V, A/B soils	5.21	1.73	100.70	80%	80.56	11.44	85%	9.73	16,864	95%	16,021
Urban Infiltration Practices, w/o S/V, C/D soils	0.00	0.00	0.00	80%	0.00	0.00	85%	0.00	0	95%	0
Permeable Pavement, w/o S/V, no underdrain, A/B soils	0.60	0.00	9.62	80%	7.70	1.26	80%	1.01	1,876	85%	1,594
Vegetated Open Channel - C/D soils, no underdrain	8.19	4.47	175.64	10%	17.56	18.49	10%	1.85	27,078	50%	13,539
Wet Ponds	44.64	235.94	3,057.88	20%	611.58	162.54	45%	73.14	217,516	60%	130,510
Total	95.50	307.16	4,580.36		1,361.06	290.07		136.47	400,059		255,302

6.3 Stormwater Management Pond Conversions (Model Tab T2)

This analysis calculates the anticipated pollutant load reductions that would result from implementing stormwater facility conversions, as per the opportunities identified in the watershed assessment (see Section 4.3.1). Results are presented for all opportunities identified, including those with and without concept plans.

Some dry ponds and extended detention dry ponds can be converted to facilities with higher capacity for nutrient removal. Pollutant reductions for these SWM pond conversions are calculated based on the approximate pollutant load received from the DA and the increase in RE based on BMP efficiencies used in MAST for detention and extended detention facilities (See Table 6-4). The equation used to estimate nutrient and sediment load reductions for SWM pond conversion is expressed as

[#(lbs/ac/yr)*DA (acres)]*RE (%)

The pollutant load received from the drainage area contribution to the SWM pond is denoted by the first expression in brackets in the equation above. Similar to existing SWM, the pollutant loading rates, # lbs Total Nitrogen/ac/yr, # lbs Total Phosphorus/ac/yr, or # lbs Sediment ac/yr, represent the impervious and pervious urban rates in the pollutant loading analysis (Table 6-3) since this represents the likely sources of runoff being treated. The increased pollutant removal capacity is represented by the third expression in the equation above. This is the difference between percent pollutant removal efficiencies of the facilities, based on CBP guidance shown in Table 6-4. A summary of SWM pond conversion load reduction calculations and results are shown in Table 6-6.

Additionally, each individual BMP conversion project is listed in Appendix I, Table I-1.

Table 6-6. Stormwater Management Facility (SWM) conversions proposed for the Middle Patuxent Watershed and potential pollutant load reductions, summarized by MAST category

Pollutant	Impervious DA for Conversion (acres)	Pervious DA for Conversion (acres)	Original Removal Efficiency	New Removal Efficiency	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)
Dry Ponds to Extended Detention Ponds, with concepts						
TN	19.82	26.99	5%	20%	15%	87.8
TP	19.82	26.99	10%	20%	10%	4.9
Sediment	19.82	26.99	10%	60%	50%	35,434
Dry Ponds to Urban Filtering Practices, with concepts						
TN	3.19	7.77	5%	40%	35%	44.9
TP	3.19	7.77	10%	60%	50%	4.5
Sediment	3.19	7.77	10%	80%	70%	8,769

Table 6-6. (Continued

Pollutant	Impervious DA for Conversion (acres)	Pervious DA for Conversion (acres)	Original Removal Efficiency	New Removal Efficiency	Increase in Efficiency	Max Potential Load Reduction (lbs/yr)
Extended Detention Pond to Urban Filtering Practices, with concepts						
TN	1.06	2.82	20%	40%	20%	9.0
TP	1.06	2.82	20%	60%	40%	1.2
Sediment	1.06	2.82	60%	80%	20%	847
Dry Ponds to Bioretention, with underdrain on AB soils, no concepts						
TN	0.29	3.00	5%	70%	65%	22.4
TP	0.29	3.00	10%	80%	70%	1.0
Sediment	0.29	3.00	10%	80%	70%	1,323
Dry Ponds to Bioretention, with underdrain on CD soils, no concepts						
TN	1.03	1.24	5%	25%	20%	5.8
TP	1.03	1.24	10%	45%	35%	0.9
Sediment	1.03	1.24	10%	55%	45%	1,639
Dry Ponds to Bioswale, no concepts						
TN	2.46	1.22	5%	70%	65%	33.5
TP	2.46	1.22	10%	80%	70%	3.9
Sediment	2.46	1.22	10%	80%	70%	5,656
Dry Ponds to Filter, no concepts						
TN	16.42	14.01	5%	40%	35%	140.8
TP	16.42	14.01	10%	60%	50%	19.3
Sediment	16.42	14.01	10%	80%	70%	39,171
Dry Ponds to Infiltration, no concepts						
TN	4.18	34.91	5%	80%	75%	310.2
TP	4.18	34.91	10%	85%	75%	14.2
Sediment	4.18	34.91	10%	95%	85%	20,925
Dry Ponds to Step Pool Stormwater Conveyance (SPSC), no concepts						
TN	0.65	1.05	5%	57%	52%	10.9
TP	0.65	1.05	10%	66%	56%	0.9
Sediment	0.65	1.05	10%	70%	60%	1,436
Dry Ponds to Wet Pond, no concepts						
TN	58.30	135.84	5%	20%	15%	342.5
TP	58.30	135.84	10%	45%	35%	56.7
Sediment	58.30	135.84	10%	60%	50%	113,581
Extended Dry Ponds to Urban Filtering Practices, no concepts						
TN	5.11	5.77	20%	40%	20%	27.9
TP	5.11	5.77	20%	60%	40%	5.0
Sediment	5.11	5.77	60%	80%	20%	3,579
Extended Dry Ponds to Wet Ponds, no concepts						
TN	19.10	15.99	20%	20%	0%	0.0
TP	19.10	15.99	20%	45%	25%	11.2
Sediment	19.10	15.99	60%	60%	0%	0

6.4 New Stormwater Control Measures (Model tab T3)

This analysis calculates the anticipated pollutant load reductions that would result from implementing new BMPs, as per the opportunities identified in the watershed assessment (see Section 4.3.2). Results are presented for all opportunities identified, including those with and without concept plans.

New BMPs are proposed to capture and treat runoff from impervious surfaces (e.g., buildings, parking lots, alleys) which are currently untreated. Pollutant reductions for new BMPs are calculated based on the approximated pollutant load received from the DA and RE of these structural BMPs. The equation used to estimate nutrient and sediment load reductions for new BMPs is expressed as

$$[\# \text{ (lbs/ac/yr)} * \text{DA (acres)}] * \text{RE (\%)}$$

The pollutant load received from the drainage area contributing to the BMP is denoted by the first expression in brackets in the equation above. The pollutant loading rates shown, # lbs Total Nitrogen/ac/yr, # lbs Total Phosphorus/ac/yr, or # lbs Sediment/ac/yr, are the pervious and impervious urban rates used in the pollutant loading analysis (Table 6-3) since this represents the source of runoff being treated. Pollutant removal efficiencies are those from Table 6-4. A summary of these BMP load reduction calculations and results are shown in Table 6-7.

Additionally, each individual new BMP project is listed in Appendix I, Table I-2.

Table 6-7. Proposed Stormwater Management (SWM) facilities for the Middle Patuxent Watershed showing potential pollutant load reductions summarized by MAST category type

			Total Nitrogen			Total Phosphorus			Sediment		
SWM Facility Type	**Imper-vious DA (acres)**	**Pervious DA (acres**	**Load from DA (lbs/yr)**	**RE**	**Max Potential Load Reduction (lbs/yr)**	**Load from DA (lbs/yr)**	**RE**	**Max Potential Load Reduction (lbs/yr)**	**Load from DA (lbs/yr)**	**RE**	**Max Potential Load Reduction (lbs/yr)**
Bioretention, A/B soils	2.63	1.51	57.1	70%	39.99	6.29	75%	4.72	9,096	80%	7,276
Bioretention, C/D soils	1.36	0.09	22.7	25%	5.69	3.26	45%	1.47	4,711	55%	2,591
Bioswale	5.03	2.52	105.6	70%	73.93	12.02	75%	9.02	17,385	80%	13,908
Urban Filtering Practices	15.82	10.48	357.6	40%	143.03	37.81	60%	22.69	54,677	80%	43,741
Permeable Pavement, no SV, UD, C/D soils	0.03	0.02	0.6	10%	0.06	0.06	20%	0.01	87	55%	48
Wet Pond	1.74	21.67	243.0	20%	48.61	4.16	45%	1.87	6,010	60%	3,606
TOTAL	26.60	36.28	787		311	64		40	91965		71170

6.5 Impervious Surface Reduction (Model Tab T4)

Impervious cover removal would involve converting impervious surfaces to pervious surfaces; therefore, the loading rate would be reduced by a factor equal to the difference between impervious and pervious urban loading rates in the watershed pollutant loading analysis. The approximate reduction in pollutant load is then the reduced loading rate multiplied by the area proposed for impervious cover removal, as shown in Tables 6-8 and 6-9.

Table 6-8. Existing impervious surface reduction projects in the Middle Patuxent Watershed showing potential pollutant load reductions

Pollutant	Impervious Urban Loading Rate (lbs/ac/yr)	Pervious Urban Loading Rate (lbs/ac/yr)	Reduction in Loading Rate (lbs/ac/yr)	Impervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	16.03	9.93	6.11	0.45	2.75
TP	8.00	0.29	7.71	0.45	3.47
Sediment	3,126	330	2,796	0.45	1,258

Table 6-9. Proposed impervious surface reduction projects in the Middle Patuxent Watershed showing potential pollutant load reductions

Pollutant	Impervious Urban Loading Rate (lbs/ac/yr)	Pervious Urban Loading Rate (lbs/ac/yr)	Reduction in Loading Rate (lbs/ac/yr)	Impervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	16.03	9.93	6.11	0.19	1.15
TP	2.10	0.29	1.81	0.19	0.34
Sediment	3,126	330	2,796	0.19	525

6.6 Urban Tree Plantings (Model Tab T6)

Open pervious areas with reforestation potential (forest buffers and urban tree plantings) were identified in the watershed. Pollutant reductions for pervious area reforestation are calculated based on land use conversion from pervious urban to forest. The equation used to estimate nutrient and sediment load reductions for pervious area reforestation is expressed as

Land Use Conversion load reduction = [pervious urban (lbs/ac/yr) - forest (lbs/ac/yr)]* Open Pervious Area (acres)

Pervious area reforestation would involve converting open pervious area to forest; therefore, the loading rate would be reduced by a factor equal to the difference between pervious urban and forest loading rates used in the watershed pollutant analysis (Table 6-3) as shown in the first expression in brackets in the equations above. The approximate reduction in pollutant load is then the reduced loading rate multiplied by the open pervious area available for reforestation. A summary of pervious area reforestation reduction calculations and results are shown in Tables 6-10 through Table 6-12 for the watershed, for all opportunities identified, including those with and without concept plans.

Table 6-10. Existing (post-2009) Urban tree planting in the Middle Patuxent Watershed - potential pollutant load reductions

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Open Pervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	9.93	3.49	6.44	4.81	31
TP	0.29	0.08	0.21	4.81	1
Sediment	330	258	73	4.81	349

Table 6-11. Proposed urban tree planting in the Middle Patuxent Watershed potential pollutant load reductions for sites without concept plans

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Open Pervious Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	9.93	3.49	6.44	34.89	225
TP	0.29	0.08	0.21	34.89	7
Sediment	330	258	73	34.89	2,530

Table 6-12. Urban tree planting in the Middle Patuxent Watershed potential pollutant load reductions for sites with concept plans

Pollutant	Pervious Urban Loading Rate (lbs/ac/yr)	Forest Loading Rate (lbs/ac/yr)	Reduced Loading Rate (lbs/ac/yr)	Urban Tree Planting Area (acres)	Max Potential Load Reduction (lbs/yr)
TN	9.93	3.49	6.44	83.75	539
TP	0.29	0.08	0.21	83.75	18
Sediment	330	258	73	83.75	6,072

6.7 Stream Restoration (Model Tab T7)

Nutrient and sediment reduction benefits were estimated for existing stream restoration sites from the County's BMP database and for the potential new stream restoration sites identified as part of the watershed assessments. Results are presented for all opportunities identified, including those with and without concept plans. Credits for stream restoration are based on the Chesapeake Bay Program's Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (Schueler and Stack 2014). For general watershed planning, the Panel Report recommends using a factor of 0.075 pounds/linear foot of reach length (RL) for nitrogen, 0.068 pounds/linear foot for phosphorus, and 44.88 pounds/linear foot for sediment as the edge-of-stream loading reduction potential. The equation used to estimate total nitrogen reductions for stream restoration is expressed as

$$0.075 \text{ (lbs/ft)} * \text{RL (ft)}$$

The equation used to estimate total phosphorus load reductions for stream restoration is expressed as

$$0.068 \text{ (lbs/ft)} * \text{RL (ft)}$$

The equation used to estimate sediment load reductions for stream restoration is expressed as

$$44.88 \text{ (lbs/ft)} * \text{RL (ft)}$$

A summary of stream restoration reduction calculations and results for existing and proposed stream restoration projects are shown in Tables 6-13 through 6-15.

Table 6-13. Existing Stream Restoration practices in the Middle Patuxent Watershed installed after 2009, showing potential pollutant load reductions applicable to the Bay TMDL.

Pollutant	Reduction in Loading Rate (lbs/ft)	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.075	173	13
TP	0.068	173	12
Sediment	44.88	173	7,775

Table 6-14. Proposed Stream Restoration practices in the Middle Patuxent Watershed with concept plans, showing potential pollutant load reductions applicable to the Bay TMDL.

Pollutant	Reduction in Loading Rate (lbs/ft)	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.075	33,760	2,532
TP	0.068	33,760	2,296
Sediment	44.88	33,760	1,515,149

Table 6-15. Proposed Stream Restoration practices in the Middle Patuxent Watershed without concept plans, showing potential pollutant load reductions applicable to the Bay TMDL.

Pollutant	Reduction in Loading Rate (lbs/ft)	Potential Stream Restoration Length (ft)	Max Potential Load Reduction (lbs/yr)
TN	0.075	56,971	4,273
TP	0.068	56,971	3,874
Sediment	44.88	56,971	2,556,856

6.8 Regenerative Step-Pool Storm Conveyance (Model Tab T10)

Regenerative Step Pool Storm Conveyance (SPSC) practices can be used for retrofitting unstable and degraded stormwater conveyance channels (MDE 2014c). The Anne Arundel County SPSC design guidelines (2012) define this practice as "open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow." When these practices are used in ephemeral or dry channels as retrofits to capture the runoff from one inch of rainfall, the pollutant removal efficiencies from the most similar BMP type may be used. Because these practices apply to dry conveyance channels, they are located in small drainage areas (e.g., 10 acres). The SPSC performs very similar to a filtration practice, therefore, the pollutant removal efficiencies for micro-bioretention can be applied to the drainage area treated (values in Table 6 from MDE 2014c were used for efficiencies assuming a 1" runoff treatment depth).

The equation used to estimate nutrient and sediment load reductions for SPSC practices is expressed as

$$[\# \text{ (lbs/ac/yr)*DA (acres)]*RE (\%)}$$

The pollutant load received from the drainage area contributing to the SPSC is denoted by the first expression in brackets in the equation above. The pollutant loading rates shown, # lbs Total Nitrogen/ac/yr, # lbs Total Phosphorus/ac/yr, or # lbs Sediment/ac/yr, are the pervious and impervious urban rates used in the pollutant loading analysis (Table 6-3) since this represents the source of runoff being treated. A summary of these load reduction calculations and results are shown in Tables 6-16 and 6-17.

Table 6-16. Proposed Regenerative Step Pool Conveyance projects with concept plans showing potential pollutant load reductions

Pollutant	Impervious Acre Equivalent	Impervious Urban Loading Rate (lbs/ac/yr)	Loads from DA (lbs/yr)	RE %	Max Potential Load Reduction (lbs/yr)
TN	8.50	16.03	136.27	57%	77.7
TP	8.50	2.10	17.84	66%	11.77
Sediment	8.50	3126	26,573.60	70%	18,602

Table 6-17. Proposed Regenerative Step Pool Conveyance projects without concept plans showing potential pollutant load reductions

Pollutant	Impervious Acre Equivalent	Impervious Urban Loading Rate (lbs/ac/yr)	Loads from DA (lbs/yr)	RE %	Max Potential Load Reduction (lbs/yr)
TN	3.39	16.03	54.35	57%	31.0
TP	3.39	2.10	7.11	66%	4.70
Sediment	3.39	3126	10,598.18	70%	7,419

6.9 Overall Pollutant Loading Reductions (Model Tab FinalSummary)

The sum of maximum potential pollutant load reductions calculated for individual BMPs represent the overall pollutant removal capacity for a maximum implementation scenario (i.e., 100% of the projects are implemented). Table 6-18 presents a summary of estimated pollutant load reductions for the maximum projected implementation of each BMP type, including how reductions were credited, pollutant removal efficiencies, potential load reductions, and units available for restoration. Also included are some additional credits for rain barrels, rooftop disconnects, and non-rooftop disconnects. These credits were calculated as part of the Countywide Implementation Strategy presented in a separate report (KCI 2015). Results for the Bay TMDL indicate that the target load reduction for total phosphorus of 17.2% is easily met with a 67% load reduction if all potential projects are included; the sediment load reduction target is also met since the phosphorus target is met. If only new projects with concept plans are included, the total phosphorus goal is still exceeded with a nearly 27% reduction. These goals are met primarily due to stream restoration and its associated reductions using the interim reduction rates. Actual phosphorus and sediment reduction could be different, depending on the actual design implemented for these projects. The total nitrogen target of 9.4% is not met, even if all potential projects in this analysis are included, since there is only a 5.8% reduction achieved if all BMPs are implemented. An additional 3.6% reduction would be required to meet the target goal. If only new projects with concept plans are considered, there is a 2.7% reduction in total nitrogen. As noted on individual concept plans, there are a number of constraints to project implementation. Other constraints may include citizen acceptance and permitting concerns.

The assumed implementation of potential restoration BMPs shows how they would approach or exceed the required percent reduction for nitrogen, phosphorus, and sediment loads needed to meet water quality standards for this watershed as specified by the local and Chesapeake Bay TMDLs. Additional reductions may also be achieved through restoration actions not included in this analysis such as street sweeping, erosion and sediment control, and public education and outreach efforts (e.g., watershed trash and recycling campaign, conservation landscaping, pet waste education). These types of actions are not included in the pollutant removal analysis because they require additional site-specific analyses, or reduction efficiencies are not well known and are difficult to estimate. These may be added as more information becomes available.

Table 6-18. Summary of potential pollutant load reductions for the Middle Patuxent Watershed for existing and proposed stormwater management practices to meet the Bay TMDL

Stormwater Management Practice Type	How Credited	TN Efficiency	TP Efficiency	Sediment Efficiency	Max Potential TN Load Reduction	Max Potential TP Load Reduction	Max Potential Sediment Load Reduction	Units Available	
Existing SWM	Efficiency	varies	varies	varies	1,361	136	255,302	403	acres
Existing Stream Restoration	lbs per Ln Ft	0.075	0.068	45	13.0	11.8	7,774.6	173	ft
Existing Tree Plantings	LU Conversion	N/A	N/A	N/A	31.0	1.0	349.1	4.8	acres
Existing Impervious Surface Reduction	LU Conversion	N/A	N/A	N/A	2.7	3.5	1,258.1	0.5	acres
				Total	1,408	153	264,684		
				Total Existing Urban Load (lbs/yr)	181,680	9,939	13,372,592		
				Reduction Achieved by Existing Practices	0.8%	1.5%	2.0%		
Impervious Surface Reduction	Efficiency				1.1	0.3	525.2	0.19	acres
				Additional Reduction Achieved	0.001%	0.003%	0.004%		
SWM Conversions	Efficiency	varies	varies	varies	1,036	124	232,360	382	acres
				Additional Reduction Achieved	0.6%	1.2%	1.7%		
Regenerative Step Pool Conveyance	Efficiency	0.57	0.66	0.7	109	16	26,020	12	acres
				Additional Reduction Achieved	0.06%	0.17%	0.19%		
New Pervious Area Reforestation	LU Conversion	N/A	N/A	N/A	764	25	8,602	119	acres
				Additional Reduction Achieved	0.4%	0.3%	0.1%		
New Stream Restoration	lbs per Ln Ft	0.075	0.068	45	6,805	6,170	4,072,004	90,731	ft
				Additional Reduction Achieved	3.7%	62.1%	30.5%		
New BMPs	Efficiency	varies	varies	varies	311	40	71,170	63	acres
				Additional Reduction Achieved	0.2%	0.4%	0.5%		
Rain Barrels					2.21	0.30			
					0.001%	0.003%			
Rooftop Disconnects					32.34	38.81	58.21		
					0.018%	0.390%	0.000%		
Nonrooftop Disconnects					84.25	101.1	151.65		
					0.046%	1.017%	0.001%		
				Total Reduction Achieved	5.8%	67.1%	35.0%		
		Total Potential Load Reduction			10,433	6,528	4,675,366		
		Reduction Target			9.4	17.2	**		
		** met if TP target met							

6.10 Proposed Implementation Timeframe

Howard County's MS4 permit requires that watershed assessments "specify pollutant load reduction benchmarks and deadlines that demonstrate progress toward meeting all applicable stormwater WLAs." To this end, an implementation timeline is presented in Tables 6-19 and 6-20 to assist the County in implementing recommended projects and tracking the program's progress toward WLA and MS4 goals.

Table 6-19. Pollutant load reduction benchmarks associated with TMDLs and impervious area restoration target, for Middle Patuxent Watershed in Howard County

TMDL	Benchmarks: Pollutant Reduction	Benchmark Timeframe
Chesapeake Bay TMDLs	9.4% reduction in TN from 2009 baseline	60% of reduction by 2017 100% of reduction by 2025
	17.2% reduction in TP from 2009 baseline	60% of reduction by 2017 100% of reduction by 2025
	X% reduction in TSS **	
	Impervious Area Restoration	
MS4 Permit	20% of impervious area restored, countywide	20% of impervious area restored, countywide by December 2019

** Bay sediment TMDL assumed met if TP target is met

Table 6-19. Proposed implementation timeline to meet TMDL pollutant reduction and MS4 permit deadlines, for the Middle Patuxent Watershed

Action	Date Completed By	Milestone
MS4 Permit Issued	December 2014	
Completion of Middle Patuxent Watershed Assessment	December 2015	
Completion of Countywide Restoration Plan (CIS)	December 2015	
Project design and implementation; annual tracking of progress toward TMDL targets	December 2016	
Continued project design and implementation; annual tracking	December 2017	Implement suite of projects and alternative BMPs providing 60% of the required TN and TP reductions in Middle Patuxent Watershed, to meet Chesapeake Bay 2017 TMDL targets
Continued project design and implementation; annual tracking	December 2018	
Continued project design and implementation; annual tracking	December 2019	From December 2014 to December 2019, implement suite of projects and alternative BMPs providing 20% of impervious area restoration, countywide
New MS4 Permit	Estimated to be issued December 2019	
Continued project design and implementation; annual tracking	December 2020	
Continued project design and implementation; annual tracking	December 2021	
Continued project design and implementation; annual tracking	December 2022	
Continued project design and implementation; annual tracking	December 2023	
Continued project design and implementation; annual tracking	December 2024	From December 2019-December 2024, implement suite of projects and alternative BMPs providing impervious area restoration, countywide, to meet 2019 MS4 permit requirements (if applicable)
Continued project design and implementation; annual tracking	December 2025	Implement suite of projects and alternative BMPs providing 100% of the required TN and TP reductions in Middle Patuxent Watershed, to meet Chesapeake Bay TMDL targets

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Appendices

A. Inventory of GIS Data Compiled for Howard County Watershed Assessments January 2015

Hydrologic Unit Boundaries:

Maryland 8-digit watershed names [MDE8NAME] and numbers [MDE8DIGT]
Maryland 12-digit watershed numbers [DNR12DIG]
Howard County's 15 watershed names [Subshed_Ho]
Centennial Lake, Wilde Lake, Lake Kittamaqundi [CA_shed]
66 catchments: G:\GIS-Data\Howard_County\Working\Howard_County\subwatersheds_HoCo_0508 _Countywide_and_Columbia_subshed_names.shp.
CIS watersheds: G:\GIS-Data\Howard_County\Working\Howard_County\CIS_PreAssessments\HoCo_CIS _watersheds.shp, contains a unique ID [CISshednum]
HUC14 characteristics: G:\GIS-Data\Howard_County\Working\Howard_County\subwatersheds_HoCo_0508 _Countywide_subshed_names.shp

Analysis data sets:

Data set	Date	Comment	Versar file information
Historic aerial photography	Various		
Current aerial photography	2011, March	Data in tiles; refer to grid files for 200 series	G:\GIS-Data\Howard_County\Archive_data\2013 _April \ftpDownload2011Aerials\2011\SID
Impervious areas	2014	Paved and unpaved, combined. Created in 2014, based off 2013 planimetric layers.	G:\GIS-Data\Howard_County\Working\Howard _County \Impervious_surface_2014planimetrics _HoCo_V0914_paved_unpaved1.shp
Land use	2010	Use MDP	G:\GIS-Data\Howard_County\Archive_data \LandUse _LandCover\2010_MDP_LULC
Property	2014	Received property data (with ownership) from the County	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Property_parks_open_space_zoning _easements\property.shp
Zoning	2014, assumed	Received data from the County	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Property_parks_open_space_zoning _easements\zoning_current_region.shp
Forest conservation areas	2014, assumed	Received data from the County	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Property_parks_open_space_zoning _easements\ForestConservationEasements.shp
Natural resource areas	2014, assumed	Received data from the County	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Property_parks_open_space_zoning _easements\NaturalResourceOpenSpace.shp
County parks	2014, assumed	Received data from the County	G:\GIS-Data\Howard_County\Archive_data \2014_December\Property_parks_open_space _zoning_easements\Parks_County.shp
Non-County open space	2014, assumed	Received data from the County	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Property_parks_open_space_zoning _easements\NonCountyOpenSpace.shp
Storm drain pipes	2014		G:\GIS-Data\Howard_County\Archive_data\2014 _September\BMPs_AnnualReport_fromCounty& McT\McT FTP Download_082014 \final_pipes_polyline.shp

Data set	Date	Comment	Versar file information
Storm drain inlets	2014		G:\GIS-Data\Howard_County\Archive_data \2014_September\BMPs_AnnualReport_fromCounty&McT\McT FTP Download_082014 \final_inlet_cent_point.shp
Storm drain outlets	2014		G:\GIS-Data\Howard_County\Archive_data \2014_September\BMPs_AnnualReport_fromCounty&McT\McT FTP Download_082014 \final_outlet_cent.shp
Public water system	2012		G:\GIS-Data\Howard_County\Archive_data \2012_February\Water_master\MasterWater.shp
Public sewer system	2012		G:\GIS-Data\Howard_County\Archive_data \2012_February\Sewer_master\MasterSewer.shp
Streams	2014, assumed	Stream and river centerlines	G:\GIS-Data\Howard_County\Archive_data \2014_December\Stream_centerlines_and_Watershed_DAs_2009\Stream_Centerline
Forest cover	2014, assumed		G:GIS-Data\Howard_County\Archive_data \2014_November\Email_CSmith_112514\Tree_Line.shp
Drainage complaints (frequent flooding)	Unknown	Data records have only location	G:\GIS-Data\Howard_County\Archive_data \2014_December\Flooded_roads_download\FrequentFlooders_font_point.shp
MS4 Boundary	2011		G:\GIS-Data\Howard_County\Archive_data \2011_June\VTownes_Versar_Ftp\HoCo_MS4_Boundary.shp
Soils	2002		G:\GIS-Data\Howard_County\Archive_data\Soils\ Soils_HowardCo_with_hydgrp_MDSP83ft.shp
Howard County biological monitoring program data	2014		G:\GIS-Data\Howard_County\Working \Howard_County\HowardCo_Stream_Survey_Countywide_Master.mdb
MBSS IBI Scores	Thru 2014	Maryland DNR	
SCA data	2012	MainPatux has only severity ranking in point files; HowardCo_pointlist _master.shp has a concentration of points in Upper Little Patuxent sub-watershed	G:\GIS-Data\Howard_County\Archive_data \2012_March\Stream_Corridor_Assessment_data _sets\ - separate folders for watersheds plus Hammond Branch and Dorsey Run
Contour lines	2014, assumed	Two-foot and ten-foot intervals	G:\GIS-Data\Howard_County\Archive_data\2014 _December\Contours_download\Contours2011 .gdb
BMPs	2015	new data set from McCormick Taylor	G:\GIS-Data\Howard_County\Archive_data \2014_December\BMP_Cleanup_update _McCormick_Taylor\HoCo_BMP_CleanUp.mdb
Potential BMP restoration projects	2015	new data set from McCormick Taylor	G:\GIS-Data\Howard_County\Archive_data \2014_December\BMP_Cleanup_update _McCormick_Taylor\HoCo_BMP_CleanUp.mdb

Data set	Date	Comment	Versar file information
Stream restoration projects	2015	new data set from McCormick Taylor	G:\GIS-Data\Howard_County\Archive_data \2014_December\BMP_Cleanup_update _McCormick_Taylor\HoCo_BMP_CleanUp.mdb
READY Program projects	2015	new data set from McCormick Taylor	G:\GIS-Data\Howard_County\Archive_data \2014_December\BMP_Cleanup_update _McCormick_Taylor\HoCo_BMP_CleanUp.mdb
DNR Wetlands Inventory	2005	Maryland DNR website	
Green Infrastructure	2012	Howard's GI Plan (based on MD GI Plan)	
Tier II Streams and Catchments	2012	MDE website	
Howard County IDDE Geodatabases	2000, 2002-2014	Received from the County	
Road Centerlines		Received from the County	

Data from Previous Studies:

Upper Little Patuxent Watershed Management Plan (Howard County/KCI 2009)
Columbia Watershed Management Plan - Lake Elkhorn (Columbia Association/Versar 2009)
Centennial Lake and Wilde Lake in Little Patuxent (Howard Co./CWP 2005)
Downtown Columbia - Symphony Stream/Lake Kittamaqundi (General Growth Properties/Biohabitats 2008)
Howard County Dry Pond retrofit report (Versar 2013)
Howard County LID and Tree Planting report (Versar 2013)
Little Patuxent SCA 2001
Dorsey Run SCA 2003
Hammond Branch SCA 2003
Middle Patuxent SCA

B. Descriptions of BMP Types

Appendix B: Stormwater Treatment BMP Definitions

BMP definitions are taken from the Maryland Assessment and Scenario Tool (MAST) guidance as provided on mastonline.org and edited, with the exception of regenerative step pool conveyance (RSC) which is provided by Anne Arundel County (2012); green roofs, whose definition is taken from the MDE Stormwater Design Manual (2009); and outfall stabilization, described in the August 2014 MDE guidance entitled Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated. Names in "()" next to BMP types are the MAST BMP Short Name. Not all BMPs considered here have been recognized by MAST and therefore may not have an official MAST-designated Short Name.

Extended Detention Dry Pond (ExtDryPonds)

Dry extended detention (ED) basins are depressions created by excavation or berm construction that temporarily store stormwater runoff and release it slowly via surface flow to the receiving stream or stormsewer system, at a specified rate, and / or via groundwater infiltration following storms. Dry ED basins are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. As such, they are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness.

Wet Ponds and Wetlands (WetPondWetland)

A wet pond and stormwater treatment wetland are water impoundment structures that intercept stormwater runoff then release it to the receiving stream or stormsewer system at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached nutrients/toxics. Until recently, these practices were designed specifically to meet water quantity, not water quality objectives. There is little or no vegetation living within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal.

Bioretention

Bioretention/raingardens - A/B soils, no underdrain (BioRetNoUDAB)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These excavated, planted areas are installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components consisting of the engineered media, topsoil, mulch, and vegetation, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has no underdrain and is in A or B soil which assumes that all water will infiltrate into the subsoils.

Bioretention/raingardens - A/B soils, underdrain (BioRetUDAB)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has an underdrain and is in A or B soil, in order to more carefully control dewatering of the system.

Bioretention/raingardens - C/D soils, underdrain (BioRetUDCD)

An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP is in C or D soil and has an underdrain in order to more assure dewatering of the system in timely fashion in these poorly draining soils.

Non-Bioretention Filtering Practices

Permeable Pavement w/ Sand, Veg. - A/B soils, no underdrain (PermPavSVNoUDAB)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils. This BMP has no underdrain, has sand as part of the filtration media to increase surface area and pollutant removal efficiency and/or vegetation in surface voids, and is in A or B soil.

Permeable Pavement w/ Sand, Veg. - A/B soils, underdrain (PermPavSVUDAB)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain. This BMP has an underdrain to more carefully control dewatering of the system, which will preclude infiltration of some stormwater, has sand as part of the filtration media to increase surface area and pollutant removal efficiency and/or vegetation, and is in A or B soil.

Permeable Pavement w/ Sand, Veg. - C/D soils, underdrain (PermPavSVUDCD)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain. This BMP has an underdrain to more carefully control dewatering of the system, which will preclude infiltration of some stormwater, has sand as part of the filtration media to increase surface area and pollutant removal efficiency and/or vegetation, and is in C or D soil.

Permeable Pavement w/o Sand, Veg. - A/B soils, no underdrain (PermPavNoSVNoUDAB)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain. This BMP has no underdrain allowing for infiltration into subsoils, no sand or vegetation, and therefore lower pollutant removal rates than a system with sand and/or vegetation, and is in A or B soil.

Permeable Pavement w/o Sand, Veg. - A/B soils, underdrain (PermPavNoSVUDAB)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain. This BMP has an underdrain to more carefully control dewatering of the system, which will preclude infiltration of some stormwater, no sand or vegetation and therefore lower pollutant removal rates than a system with sand and/or vegetation, and is in A or B soil.

Permeable Pavement w/o Sand, Veg. - C/D soils, underdrain (PermPavNoSVUDCD)

Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an underdrain. This BMP has an underdrain to more carefully control dewatering of the system, which will preclude infiltration of some stormwater, no sand or vegetation and therefore lower pollutant removal rates than a system with sand and/or vegetation, and is in C or D soil.

Urban Filtering Practices (Filter)

These are practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity (CEC) achieved by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit.

Urban Filter Strip Runoff Reduction (UrbFilterRR)

Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet-flow and must enter at a non-erosive rate for the site-specific soil conditions. A 0.4 design ratio of filter strip length to impervious flow length is recommended for runoff reduction urban filter strips. These filter strips allow for infiltration into subsoils and therefore significant pollutant removal compared to Urban Filter Strip Storm Water Treatment.

Urban Filter Strip Storm Water Treatment (UrbFilterST)

Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet-flow and must enter at a non-erosive rate for the site-specific soil conditions. A 0.2 design ratio of filter strip length to impervious flow length is recommended for stormwater treatment urban filter strips. These filter strips do not allow for infiltration of subsoils and therefore only allow for reductions in sediment load.

Regenerative Step Pool Storm Conveyance (SPSC)

Regenerative Step Pool Storm Conveyance (SPSC) practices developed by Anne Arundel County Department of Public Works, Bureau of Engineering, have been used for retrofitting unstable and degraded stormwater conveyance channels in steep conveyance circumstances. SPSC systems are open-channel conveyance structures that convert, through attenuation ponds and a sand seepage filter, surface storm flow to shallow groundwater flow. These systems safely convey, attenuate, and treat the quality of storm flow. These structures utilize a series of constructed shallow aquatic pools, riffle grade control, native vegetation, and an underlying sand/woodchip mix filter bed media. The physical characteristics of the SPSC channel are best characterized by the Rosgen A or B stream classification types, where "bedform occurs as a step/pool, cascading channel which often stores large amounts of sediment in the pools associated with debris dams" (Rosgen, 1996). The pretreatment, recharge, and water quality sizing criteria closely follow the State of Maryland's criteria for a typical stormwater filtering device. These structures feature surface / subsurface runoff storage seams and an energy dissipation design that is aimed at attenuating the flow to a desired level through energy and hydraulic power equivalency principles.

Green Roof

Green roofs are alternative surfaces that replace conventional construction materials and include a protective covering of planting media and vegetation. Also known as vegetated roofs, roof gardens, or eco-roofs, these may be used in place of traditional flat or pitched roofs to reduce impervious cover and more closely mimic natural hydrology. Green roofs produce less heat than conventional systems. Therefore, they may be used to help mitigate stormwater impacts and temperature increases caused by new development.

There are two basic green roof designs that are distinguished by media thickness and the plant varieties that are used. The more common or "extensive" green roof is a lightweight system where the media layer is between two and six inches thick. This limits plants to low-growing, hardy herbaceous varieties. An extensive green roof may be constructed off-site as a modular system with drainage layers, growing media, and plants installed in interlocking grids.

Conventional construction methods may also be used to install each component separately. "Intensive" green roofs have thicker soil layers (eight inches or greater) and are capable of supporting more diverse plant communities including trees and shrubs. A more robust structural loading capacity is needed to support the additional weight of the media and plants. Intensive green roofs are more complex and expensive to design, construct, and maintain, are less commonly used, and are therefore not covered in the Maryland Stormwater Design manual.

Vegetated Channels

Vegetated Open Channels - A/B soils, no underdrain (VegOpChanNoUDAB)

Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, and includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain, allowing for infiltration into subsoils; however, because the system is within A or B soil infiltration is better than in a similar channel in C or D soils and allows for higher pollutant removal rates.

Vegetated Open Channels - C/D soils, no underdrain (VegOpChanNoUDCD)

Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain, allowing for infiltration into subsoils; however, C or D soils have lower infiltration rates and therefore lower pollutant removal rates relative to vegetated open channels in A or B soils.

Bioswale (BioSwale)

With a bioswale the load is reduced because, unlike other open channel designs, there is now treatment through the soil. A bioswale is designed to function as a bioretention area and therefore has much higher pollutant removal rates compared to the vegetated open channels in A/B and C/D soils.

Infiltration Practices

An infiltration practice generally is a depression to form an infiltration basin where sediment is trapped and water infiltrates into the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil (A/B soils). They are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approved to build is issued. To receive credit over the longer term, jurisdictions must conduct yearly inspections to determine if the basin or trench is still infiltrating runoff.

Urban Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain (InfiltWithSV)

A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Sand provides additional surface area for more complete filtration and vegetation provides root system uptake and additional biological activity for more complete pollutant processing.

Urban Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain (Infiltration)

A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Sand or vegetation are not included in these system.

Appendix B: Stormwater Treatment BMP Definitions

Impervious Surface Reduction (ImpSurRed)

Reducing impervious surfaces to promote infiltration and percolation of runoff storm water by removing pavement and providing vegetative cover for 95% of the area that was previously impervious surface. MDE 2014 guidance offers 0.75 impervious acre equivalent credit for every acre of impervious cover removed and replaced with vegetation.

Urban Stream Restoration (UrbStrmRest)

Stream restoration is a change to the stream corridor that improves the stream ecosystem by restoring the natural hydrology and landscape of a stream, and helps improve habitat and water quality conditions in degraded streams. Credit is provided in the form of 0.01 impervious reduction equivalents of 0.01 acre per linear foot of outfall stabilization.

Urban Tree Planting (UrbanTreePlant)

Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting. Credit given is 0.38 impervious equivalent removed per acre planted with a survival rate of 100 trees/acre or greater and where at least 50% of trees have two-inch diameter or greater when measured at 4.5 ft. above ground level. (MDE 2014)

Urban Forest Buffers (ForestBufUrban)

An urban forest buffer is area of trees at least 35 feet wide on one side of a stream, usually accompanied by trees, shrubs, and other vegetation that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals.

Outfall stabilization

Outfall stabilization or repair of localized areas of erosion below a storm drain outfall will received a maximum credit is 2 acres per project as per MAST. Credit is provided in the form of 0.01 impervious reduction equivalents of 0.01 acre per linear foot of outfall stabilization. No direct pollutant reduction credits are appropriated.

CITATIONS

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MAST 2015. Maryland Assessment and Scenario Tool. http://www.mastonline.org/

MDE 2009. Maryland Stormwater Design Manual 2000, Volumes I and II, 2009 Edition. Water Management Administration.

MDE 2014. Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated. Guidance for National Pollutant Discharge Elimination System Stormwater Permits. August 2014.

Rosgen, D., 1996, Applied River Morphology, Wildland Hydrology.

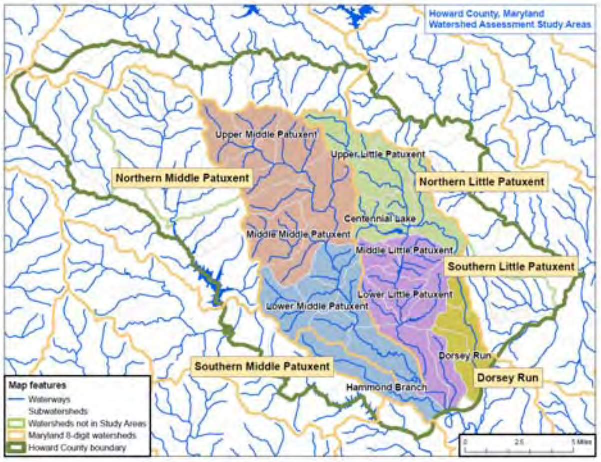
Appendix B: Stormwater Treatment BMP Definitions

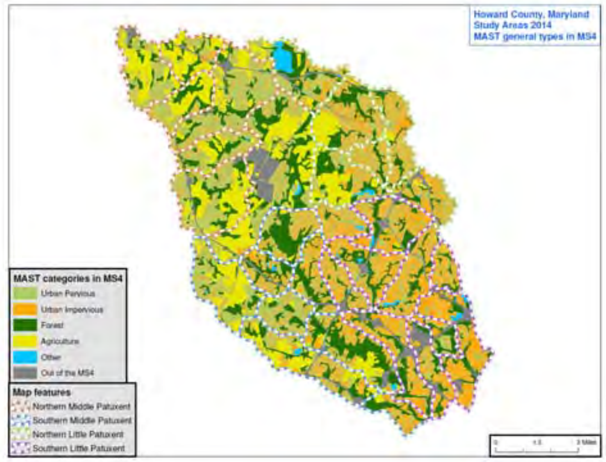
C. Field Protocols: Data Collection Guide

Field Protocols and Data Collection Guide

Howard County Watershed Assessments 2015

Middle and Little Patuxent River





Prepared for
Howard County Watershed Management Program
Howard County Department of Public Works
Bureau of Environmental Services
Stormwater Management Division

Prepared by
Versar, Inc.
Ecological Sciences and Applications
9200 Rumsey Road
Columbia, MD 21045

March 2015

Howard County Watershed Assessments in 2015

Study Areas and Consultant Assignments for Field Assessments

March 3, 2015 UPDATED

Watershed Assessment Study Area	**Includes These Howard County Watersheds**	**Consultant for Field Assessments**
Northern Middle Patuxent (NMP)	• Upper Middle Patuxent • Middle Middle Patuxent	McCormick Taylor
Southern Middle Patuxent (SMP)	• Lower Middle Patuxent • Hammond Branch	Biohabitats
Northern Little Patuxent (NLP)	• Upper Little Patuxent • Centennial Lake (part of Middle Little Patuxent)	KCI
Southern Little Patuxent (SLP)	• Middle Little Patuxent (except for Centennial Lake) • Lower Little Patuxent	Versar
Dorsey Run (DOR)	• Dorsey Run	McCormick Taylor

Note that Howard County Watersheds nest within Maryland 8-digit watersheds as follows:

02131106, Middle Patuxent River includes

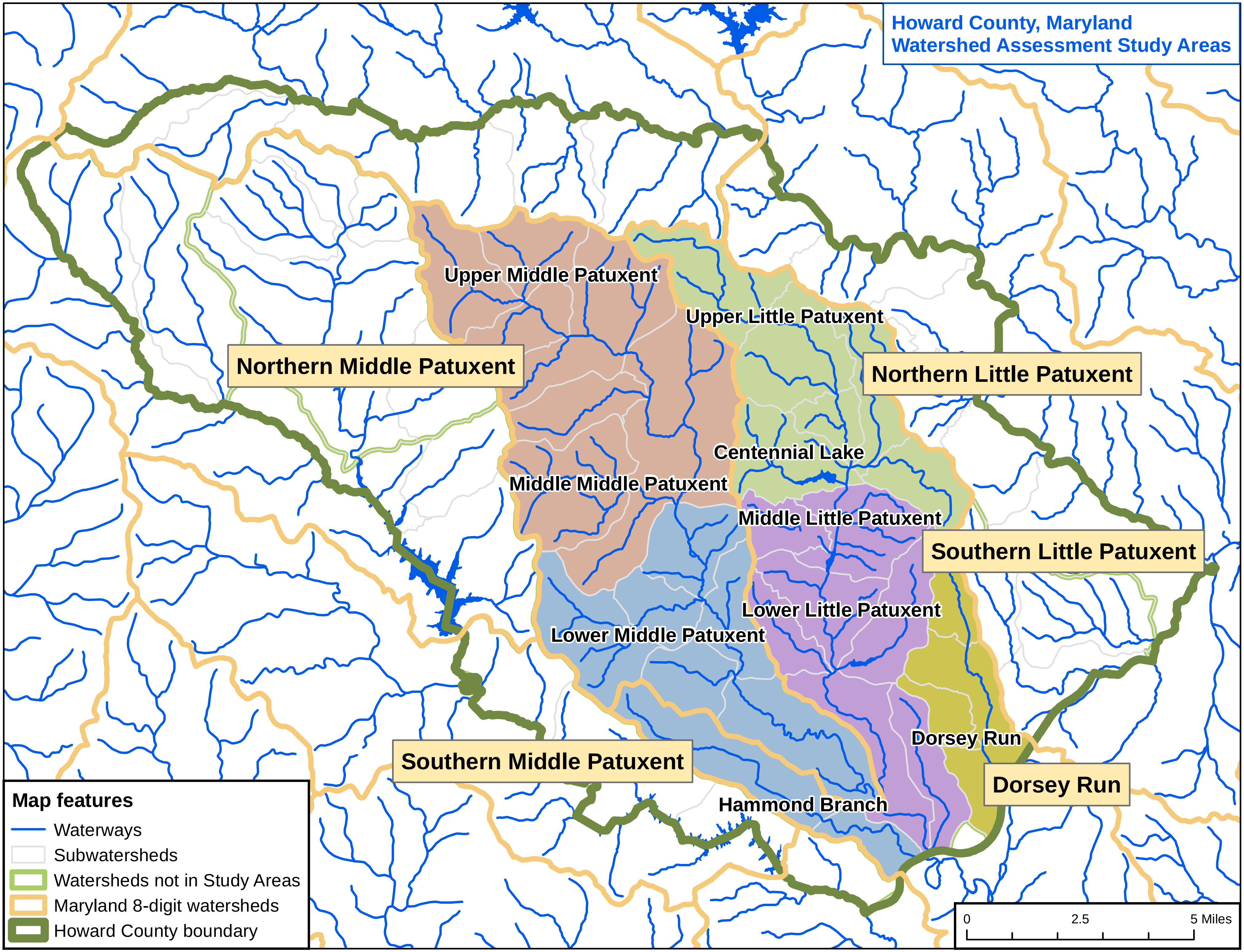
- Upper Middle Patuxent
- Middle Middle Patuxent
- Lower Middle Patuxent
- Hammond Branch

02131105, Little Patuxent River includes

- Upper Little Patuxent
- Middle Little Patuxent (includes Centennial Lake)
- Lower Little Patuxent
- Dorsey Run

Field sites identified in the desktop assessment will be properly labeled with site identifiers, before giving to the field teams. Site names will include the 3-letter Watershed Assessment Study Area identifier.

For data analysis, subwatershed designations may also be employed to aid in data organization. These subwatersheds correspond to the set of “66 Howard County subwatersheds” that nest within the 15 watersheds. Data will be managed so that all field data can be readily tied to the appropriate Study Area, 8-digit watershed, Howard County watershed, or subwatershed.



Howard County, Maryland
Watershed Assessment Study Areas
Upper Middle Patuxent
Upper Little Patuxent
Northern Middle Patuxent
Northern Little Patuxent
Centennial Lake
Middle Middle Patuxent
Middle Little Patuxent
Southern Little Patuxent
Lower Little Patuxent
Lower Middle Patuxent
Dorsey Run
Southern Middle Patuxent
Dorsey Run
Hammond Branch
Map features
Waterways
Subwatersheds
Watersheds not in Study Areas
Maryland 8-digit watersheds
Howard County boundary
0
2.5
5 Miles

Howard County Watershed Assessments Site Naming Conventions

March 3, 2015 UPDATED

Purpose: to name all field sites so they are readily recognizable by their location, site type, and unique identifier.

1. Standard site names

AAA-SS-Fxxx (Example NMP-SR-F101)

AAA = Study Area (which will also point us to which consultant team collected the data, should there be any questions)

- NMP = Northern Middle Patuxent
- SMP = Southern Middle Patuxent
- NLP = Northern Little Patuxent
- SLP = Southern Little Patuxent
- DOR = Dorsey Run

SS = Site type for the 5 types of opportunities

- BC = BMP Conversion (to upgrade existing stormwater BMP)
- NB = New BMP for currently untreated areas
- TP = Tree Planting
- OF = Outfall Stabilization
- SR = Stream Restoration

F = Field or desktop assessment

- F = Field assessment
- D = Desktop assessment (this applies to only a small number of sites that Versar and KCI will be evaluating based on past data)

xxx = 3-digit number that will be unique identifier within each type of opportunity (101, 102, etc.). These will be assigned as described in the following table. To avoid duplication, use the following guidance for any new site names added in the field:

Site numbering convention		
Consultant	Series starting with:	Study Area and Site Type (pre-assigned v. added in the field)
McCormick Taylor	101	NMP pre-assigned sites
	201	NMP sites added in the field
Biohabitats	301	SMP pre-assigned sites
	401	SMP sites added in the field
KCI	501	NLP pre-assigned sites
	651	NLP sites added in the field
Versar	701	SLP pre-assigned sites
	851	SLP sites added in the field
McCormick Taylor	901	DOR pre-assigned sites
	951	DOR sites added in the field

2. For specific types of data, there will be additional codes added:

AAA-SS-FxxxL (Example NMP-BC-F105A)

L = Letter for multiple recommendations/options (BMP conversion or new BMP Assessment) or reaches (Stream Restoration Assessment) within a site

- A = First recommendation/option or reach
- B = Second recommendation/option or reach
- C = Third recommendation/option or reach, etc.

2a. For BMP opportunities, there may be a need to keep track of multiple recommendations/options for the same site. Append A, B, C as needed to distinguish separate options.

- Example: NMP-BC-F105 has two options. Call them NMP-BC-F105A and NMP-BC-F105B

2b. For stream reaches, the first reach break along a reach will be named at the downstream end with the letter A. The upstream end will be named with the letter Z.

- Example: For stream reach NMP-SR-F101, the reach break at the downstream end will be called NMP-SR-F101A. A final reach break will be placed at the upstream end of the entire reach and be called NMP-SR-F101Z. No additional data is collected at F101Z.

If conditions vary within the reach, field crew should break the pre-selected stream restoration reach into two or more separate reaches if stream conditions warrant it.

- Example: if NMP-SR-F101 is broken into two reaches, the reach breaks at the bottom end of each will be named NMP-SR-F101A and NMP-SR-F101B. The reach break at the upstream end of Reach B will be marked NMP-SR-F101C, unless this is the final reach break, in which case it will be mark NMP-SR-F101Z.

2c. For stream assessment data, names will include additional digits as follows.

AAA-SS-FxxxL-TTyyy   - For example at a stream restoration site (NMP-SR-F101A) with 3 erosion points, the erosion points would be recorded as NMP-SR-F101A-ES101, NMP-SR-F101A-ES102, NMP-SR-F101A-ES103]

TT = site type for specific stream data

- RE = Representative site - Habitat assessment
- ES = Erosion Site point
- CA = Channel Alteration point
- IB = Inadequate Buffer point
- EP = Exposed Pipe point
- UC = Unusual Condition or Comment
- PO = Pipe Outfall point
- XS = representative cross-section data

yyy = 3-digit number that will be unique identifier within each type of specific data (101, 102, etc.)

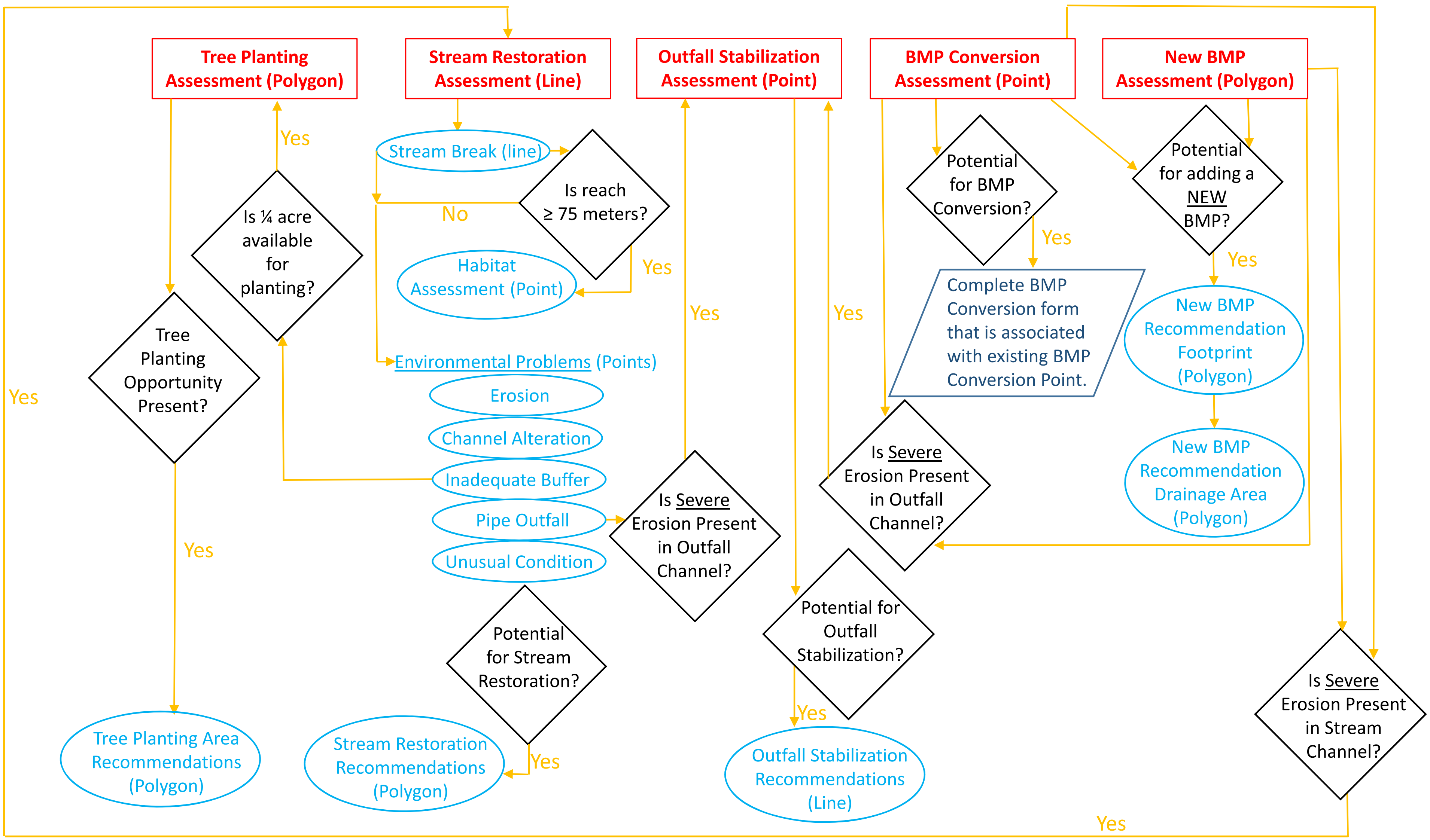
Special Notes For Field Teams

Site ID	STUDY AREA	CONTRACTOR	COMMENTS
SMP-BC-F311	Southern Middle Patuxent	Biohabitats	BMP near Engineering CIP area: U.S. Route 29 NB improvements
SMP-BC-F321	Southern Middle Patuxent	Biohabitats	On County Master List from Wilde Lake Study; listed as wet pond, but appears to be dry
SMP-NB-F303	Southern Middle Patuxent	Biohabitats	New BMP opportunities near Engineering CIP area: Hall Shop Road improvements (Site B
SMP-NB-F307	Southern Middle Patuxent	Biohabitats	New BMP opportunities near Engineering CIP area: Whiskey Bottom Road improvements
SMP-NB-F308	Southern Middle Patuxent	Biohabitats	New BMP opportunities near Engineering CIP area: Whiskey Bottom Road improvements
SMP-NB-F310	Southern Middle Patuxent	Biohabitats	New BMP opportunities near Engineering CIP area: Whiskey Bottom Road improvements
SMP-OF-F302	Southern Middle Patuxent	Biohabitats	Site is adjacent to Top Secret property; surveillance is possible for field operations
SMP-OF-F304	Southern Middle Patuxent	Biohabitats	Site is adjacent to Top Secret property; surveillance is possible for field operations
SMP-OF-F329	Southern Middle Patuxent	Biohabitats	Outfall near Engineering CIP area: Sanner Road improvements
SMP-OF-F332	Southern Middle Patuxent	Biohabitats	May be information available through MPEA
SMP-SR-F310	Southern Middle Patuxent	Biohabitats	Reach is near an Engineering CIP: Hall Shop Road at Simpson Road
SMP-SR-F320	Southern Middle Patuxent	Biohabitats	Split this section at the property line; retain downstream portion for field investigation
SMP-SR-F327	Southern Middle Patuxent	Biohabitats	On County Master List; citizen complaint of erosion; add note for field crew
SMP-SR-F328	Southern Middle Patuxent	Biohabitats	Reach crosses Engineering CIP: Stephens Road Bridge replacement
SMP-SR-F329	Southern Middle Patuxent	Biohabitats	BGE ROW - remove section that runs through ROW; retain remaining sections of the reach
SMP-SR-F351	Southern Middle Patuxent	Biohabitats	On County Master List; citizen complaint of bank erosion
SMP-SR-F354	Southern Middle Patuxent	Biohabitats	On County Master List; citizen complaint of bank erosion; private property
SMP-SR-F355	Southern Middle Patuxent	Biohabitats	On County Master List; citizen complaint of bank erosion; private property
SMP-SR-F356	Southern Middle Patuxent	Biohabitats	On County Master List; citizen complaint of bank erosion; private property
SMP-SR-F362	Southern Middle Patuxent	Biohabitats	On County Master List (Middle Patuxent WRAS); skip site if the property is a secure federal facility
SMP-TP-F301	Southern Middle Patuxent	Biohabitats	Parks review: Board of Ed. (contact before site visit)
SMP-TP-F303	Southern Middle Patuxent	Biohabitats	Parks review: No, MPEA: Mark R later confirms that Biohabitats can contact MPEA for guidance
SMP-TP-F304	Southern Middle Patuxent	Biohabitats	Parks review: No, MPEA; Mark R later confirms that Biohabitats can contact MPEA for guidance
SMP-TP-F305	Southern Middle Patuxent	Biohabitats	Biohabitats is studying MPEA; this may identify opportunities and refine field effort; Parks: No; Mark R later approve
NLP-BC-F502	Northern Little Patuxent	KCI	Believe BMP point is in the wrong location; may be Little Patuxent Study concept plan (FH1_04A); fill in form for rankin
NLP-NB-D557	Northern Little Patuxent	KCI	Good opportunity from Little Patuxent Study (FH1_04B or C); salt dome is out of MS4 - look for treatment op
NLP-NB-D558	Northern Little Patuxent	KCI	Little Patuxent Study created a concept plan; fill out forms to conform to ranking standards
NLP-NB-D560	Northern Little Patuxent	KCI	Little Patuxent Study created a concept plan (PT1_04); fill out forms to conform to ranking standards
NLP-NB-D561	Northern Little Patuxent	KCI	Little Patuxent Study created a concept plan (PT1_03); fill out forms to conform to ranking standards
NLP-NB-D562	Northern Little Patuxent	KCI	Little Patuxent Study created a concept plan (LPX3_13); fill out forms to conform to ranking standards
NLP-NB-F503	Northern Little Patuxent	KCI	GIS Tech: Site appears to be under construction as a residential development; new homes have small BMPs
NLP-NB-F504	Northern Little Patuxent	KCI	GIS Tech: Site appears to be under construction as a residential development; new homes have small BMPs
NLP-NB-F542	Northern Little Patuxent	KCI	Home owner (3038 Southview Rd) would like drainage from the west edge of Southview to be re-routed into the County Open Space at the end of Southview
NLP-NB-F551	Northern Little Patuxent	KCI	GIS Tech: These parcels may already be treated by BMP along the entrance road; field crew could confirm
NLP-OF-F507	Northern Little Patuxent	KCI	The property owner is complaining about undermined trees and eroding banks; County wants it rated relative to others in the stud
NLP-OF-F527	Northern Little Patuxent	KCI	Area could possibly use additional review for blown out area
NLP-SR-F507	Northern Little Patuxent	KCI	Reach crosses Engineering CIP: Marriottsville Road improvements
NLP-SR-F512	Northern Little Patuxent	KCI	Reach crosses Engineering CIP: Marriottsville Road improvements
NLP-SR-F515	Northern Little Patuxent	KCI	Reach is close to Engineering CIP: Marriottsville Road Bridge
NLP-SR-F517	Northern Little Patuxent	KCI	Reach is close to Engineering CIP: Marriottsville Road Bridge
NLP-SR-F519	Northern Little Patuxent	KCI	Reach crosses Alpha Ridge Park (Engineeriing CIP)
NLP-SR-F521	Northern Little Patuxent	KCI	Split segment at I-70; retain upstream section for field investigation
NLP-SR-F522	Northern Little Patuxent	KCI	Split segment at I-70; retain upstream section for field investigation
NLP-SR-F523	Northern Little Patuxent	KCI	Split the segment at the point; upstream is on ag-land (remove); retain downstream portion for field investigation
NLP-SR-F551	Northern Little Patuxent	KCI	Have field crew evaluate area on J. Schneider property for tree planting (perhaps purchase and plant)
NLP-SR-F558	Northern Little Patuxent	KCI	Remove sections downstream of Centennial Lane; retain upstream sections
NLP-SR-F559	Northern Little Patuxent	KCI	Remove sections downstream of Centennial Lane; retain upstream sections
NLP-SR-F560	Northern Little Patuxent	KCI	Split this section at the property line; retain downstream portion for field investigation
NLP-SR-F561	Northern Little Patuxent	KCI	Split this section at the property line; retain downstream portion for field investigation
NLP-SR-F562	Northern Little Patuxent	KCI	Split segment at I-70; retain upstream section for field investigation
NLP-SR-F571	Northern Little Patuxent	KCI	Retain southern extent of reach as a candidate for field investigation
NLP-SR-F573	Northern Little Patuxent	KCI	On County Master List; citizen complaint of bank erosion
NLP-SR-F591	Northern Little Patuxent	KCI	On County Master List; citizen complaint of bank erosion
NLP-SR-F593	Northern Little Patuxent	KCI	Project has been completed on the reach; split at Windflower Dr. and retain segment to the north for field investigation
NLP-SR-F601	Northern Little Patuxent	KCI	Split this reach at the point; southern section has a project; retain section to the north for field investigation
NLP-SR-F602	Northern Little Patuxent	KCI	Good opportunity from Little Patuxent Study (PT2_12)
NLP-TP-D517	Northern Little Patuxent	KCI	Little Pat. Study concept plan to enhance buffer (1752A (RHB)) - fill in form for ranking; Parks: FCA, supp. planting
NLP-TP-D518	Northern Little Patuxent	KCI	Little Pat. Study concept plan (BF_21) - fill in form for ranking; Parks: private property; Mark R confirms his approval
NLP-TP-D519	Northern Little Patuxent	KCI	Little Patuxent Study concept plan (BF_30) - fill in form for ranking; Parks: Yes

NLP-TP-D521	Northern Little Patuxent	KCI	Little Patuxent Study concept plan (BF_63) - fill in form for ranking
NLP-TP-D522	Northern Little Patuxent	KCI	Little Patuxent Study concept plan (BF_2) - fill in form for ranking; looks bare (2007 aerial) - good opportunit
NLP-TP-F514	Northern Little Patuxent	KCI	Parks review: Talk to DPW
DOR-BC-F922	Dorsey Run	McCormick Taylor	BMP near Engineering CIP area: Gateway at Robert Fulton intersection improvements
DOR-NB-F907	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F908	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F910	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F911	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F917	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F920	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F923	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Dorsey Run Road improvements
DOR-NB-F927	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
DOR-NB-F928	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
DOR-NB-F931	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
DOR-NB-F932	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
DOR-NB-F933	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
DOR-NB-F943	Dorsey Run	McCormick Taylor	New BMP opportunity near Engineering CIP areas: Gateway at Robert Fulton intersection improvements and Snowden River Pkwy improvement
DOR-OF-F912	Dorsey Run	McCormick Taylor	Outfall near Engineering CIP area: Dorsey Run Road improvements
DOR-OF-F921	Dorsey Run	McCormick Taylor	Outfall near Engineering CIP area: Dorsey Run Road improvements
DOR-OF-F923	Dorsey Run	McCormick Taylor	Good opportunity; on County Master Plan; citizen complaint of bank erosion
DOR-OF-F926	Dorsey Run	McCormick Taylor	Outfall near Engineering CIP area: Snowden River Pkwy improvements
DOR-SR-F904	Dorsey Run	McCormick Taylor	Reach crosses Engineering CIP: Dorsey Run Road improvements
DOR-SR-F912	Dorsey Run	McCormick Taylor	Reach crosses Engineering CIP: Snowden River Pkwy improvements
NMP-NB-F104	Northern Middle Patuxent	McCormick Taylor	Lagoon being considered for improvement; retrofitting up to BMP standards
NMP-SR-F120	Northern Middle Patuxent	McCormick Taylor	Split this section at I-70; retain downstream portion for field investigation
NLP-BC-D543	Northern Little Patuxent	Versar	Concept plan from Little Patuxent Study; fill out form for ranking
SLP-BC-D782	Southern Little Patuxent	Versar	BMP near Engineering CIP area: Snowden River Pkwy widening
SLP-BC-F717	Southern Little Patuxent	Versar	BMP near Engineering CIP area: U.S. Route 29 NB improvements
SLP-BC-F734	Southern Little Patuxent	Versar	BMP near Engineering CIP area: Snowden River Pkwy widening
SLP-BC-F757	Southern Little Patuxent	Versar	BMP near Engineering CIP area: U.S. Route 29 NB improvements
SLP-NB-D777	Southern Little Patuxent	Versar	General note in County Master List to add bioretention; Versar confirms interest in revisiting site for opportunitie
SLP-NB-F701	Southern Little Patuxent	Versar	New BMP opportunity near and in Engineering CIP area: Cradlerock Channel improvements
SLP-NB-F716	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Guilford Road from U.S. Route 1 to Dorsey Run
SLP-NB-F720	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Oakland Mills Road widening
SLP-NB-F734	Southern Little Patuxent	Versar	CA is redesigning a sand filter here, but the rest of it is still potential for new BMP
SLP-NB-F739	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Snowden River Pkwy improvements
SLP-NB-F740	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Snowden River/Brokenland Pkwy intersection
SLP-NB-F744	Southern Little Patuxent	Versar	General note in County Master List to add bioretention; Versar confirms interest in revisiting site for opportunitie
SLP-NB-F755	Southern Little Patuxent	Versar	New BMP opportunities near Engineering CIP area: U.S. Route 29 NB improvements
SLP-NB-F756	Southern Little Patuxent	Versar	New BMP opportunities near Engineering CIP area: U.S. Route 29 NB improvements
SLP-NB-F765	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Oakland Mills Road widening
SLP-NB-F767	Southern Little Patuxent	Versar	New BMP opportunity near Engineering CIP area: Snowden River/Brokenland Pkwy intersection
SLP-NB-F770	Southern Little Patuxent	Versar	New BMP opportunity is in an Engineering CIP area: Oakland Mills Road interchange
SLP-NB-F771	Southern Little Patuxent	Versar	New BMP opportunities near Engineering CIP area: U.S. Route 29 NB improvements
SLP-NB-F772	Southern Little Patuxent	Versar	New BMP opportunity near Engineeing CIP area: Cedar Lane ped improvements
SLP-OF-F717	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F718	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F719	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F720	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F721	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F722	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F723	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F724	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F725	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F726	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F727	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F728	Southern Little Patuxent	Versar	Outfalls throughout this reach should be inspected; new sheet pile weirs installed and CA is designing a repair for the most downstream devic
SLP-OF-F739	Southern Little Patuxent	Versar	Outfall near Engineering CIP areas: Guilford Road from U.S. Route 1 to Dorsey Run
SLP-OF-F742	Southern Little Patuxent	Versar	Outfall near Engineering CIP areas: Guilford Road from U.S. Route 1 to Dorsey Run
SLP-OF-F743	Southern Little Patuxent	Versar	Outfall near Engineering CIP areas: Guilford Road Ped/bike improvements and Mission Road sidewalk

SLP-OF-F785	Southern Little Patuxent	Versar	Citizen concern area
SLP-OF-F787	Southern Little Patuxent	Versar	CA is designing an imbricated wall at the upstream end to protect a home foundatior
SLP-OF-F788	Southern Little Patuxent	Versar	CA is designing an imbricated wall at the upstream end to protect a home foundatior
SLP-OF-F789	Southern Little Patuxent	Versar	CA is designing an imbricated wall at the upstream end to protect a home foundatior
SLP-SR-F704	Southern Little Patuxent	Versar	CA is doing a stream restoration on the tributary that enters this reach from along Oakland Mills Roac
SLP-SR-F720	Southern Little Patuxent	Versar	EPA-installed sheet pile weirs (3) in the stream reach to Jackson Pond. CA will repair the most downstream weir
SLP-SR-F721	Southern Little Patuxent	Versar	EPA-installed sheet pile weirs (3) in the stream reach to Jackson Pond. CA will repair the most downstream weir
SLP-SR-F722	Southern Little Patuxent	Versar	EPA-installed sheet pile weirs (3) in the stream reach to Jackson Pond. CA will repair the most downstream weir
SLP-SR-F723	Southern Little Patuxent	Versar	EPA-installed sheet pile weirs (3) in the stream reach to Jackson Pond. CA will repair the most downstream weir
SLP-SR-F724	Southern Little Patuxent	Versar	Split segment at upstream pond; retain upstream segment for field investigatior
SLP-SR-F726	Southern Little Patuxent	Versar	Reach is near Engineering CIP: Oakland Mills Road widening
SLP-SR-F727	Southern Little Patuxent	Versar	Reach is near Engineering CIP: Oakland Mills Road widening
SLP-SR-F736	Southern Little Patuxent	Versar	On County Master List; citizen complaint
SLP-SR-F737	Southern Little Patuxent	Versar	Reach crosses Engineering CIP: U.S. 29 NB improvements
SLP-SR-F738	Southern Little Patuxent	Versar	On County Master List; citizen complaint of bank erosior
SLP-SR-F741	Southern Little Patuxent	Versar	On County Master List; citizen complaint of bank erosior
SLP-SR-F748	Southern Little Patuxent	Versar	On County Master List; citizen complaint of bank erosior
SLP-SR-F751	Southern Little Patuxent	Versar	CA is designing an imbricated wall at the upstream end to protect a home foundation; reach crosses Eng. CIP:US 29 impr
SLP-SR-F752	Southern Little Patuxent	Versar	On County Master List; citizen complaint of bank erosior
SLP-SR-F755	Southern Little Patuxent	Versar	Evaluate stream, including area upstream toward Thicket Lane
SLP-SR-F758	Southern Little Patuxent	Versar	EPA-installed sheet pile weirs (3) in the stream reach to Jackson Pond. CA will repair the most downstream weir
SLP-TP-F703	Southern Little Patuxent	Versar	Parks review: HCC, has forest conservation plan; GIS Tech: May ask HCC about more opportunities

Howard County Field Assessment Decision Flow Chart



Howard County Watershed Assessments
BMP Conversion Assessment – Data Collection Field Protocol
March 6, 2015

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Kelly Hargadin (khargadin@howardcountymd.gov, Office 410-313-0844 or Cell 720-979-1519). Provide location, information about the problem observed, and a photograph.
- Locate site on map layer for BMP Conversion Assessment **(*point*)** and fill in data for the fields below.

Fields - BMP Conversion Assessment *(Point)*

Overall

- Site ID (pre-assigned, unique number. Example: SLP-BC-F701)
- Field Crew [initials]
- Create a site name [This will be considered the common name for the site. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, BMP does not exist at present
    - No, another reason
- Other reason site cannot be evaluated (describe)
- Can existing BMP be converted? [Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.]
    - Yes
    - No
- Notes: Reason BMP cannot be converted

General Site Description – Existing Conditions

- BMP Structure ID of existing pond [pre-filled from GIS data]
- BMP type from database [e.g., Dry Pond or Extended Detention Dry Pond]
- Owner Name [pre-filled from GIS data]
- BMP Address [pre-filled from GIS data]
- Drainage Area of Existing BMP (ac) [pre-filled from GIS data]
- Impervious Area of Existing BMP Drainage Area (ac) [pre-filled from GIS data]
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Site Note [pre-filled from GIS data; information for field crew]
- Ownership [In most cases, this should be evident in GIS parcel layer.]
    - County School
    - County Parks
    - County – other

- Private
- Other
- Unknown

- Notes, if ownership other
- Existing Pond Type (as YOU see it in field)
  - Dry Pond
  - Wet Pond
  - Other
- Describe type, if Other
- Is pond type same as listed in County database?
  - Yes/no
- Is repair needed?
  - Yes/No
- Other information describing existing pond condition (describe) [Such as need for maintenance, invasive vegetation removal, under construction, etc.]
- Existing Drainage area land use (predominant type)
  - Residential – single family homes <1 ac lots
  - Residential – single family homes > 1 ac lots
  - Townhouses
  - Multi-Family
  - Institutional
  - Industrial (not necessarily related to 02-SW or 12-SW permits)
  - Commercial
  - Transport-Related
  - Park
  - Undeveloped
  - Other
- Other information related to land use type within existing drainage area (describe) [This is a super-hotspot, lots of floatables or pet/goose waste, or other major issue.]

Downstream or Outfall Condition

Note: sites with < 200 feet of erosion below outfall will be considered *outfall channels*. Sites with >200-300 feet of erosion below outfall will be considered for stream restoration and evaluated for *downstream condition*.)

- Condition of outfall channel
  - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
  - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
  - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion typically recent/active. (Fill out Outfall Stabilization Evaluation form)
- Reason Condition of outfall channel could not be inspected
  - Not applicable - discharges directly into MS4
  - Not applicable – discharges directly into large perennial stream
  - Could not inspect outfall [If behind fence etc.]
- Length of outfall channel erosion (ft.)

- Condition of stream channel [extending beyond 200 feet from discharge point]
    - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
    - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
    - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10. (Fill in Stream Restoration Assessment Form)
- Reason Condition of stream channel could not be inspected
    - Not applicable [make N/A the default]
    - Too far to warrant inspection
- Length of stream erosion (ft.)
- Notes: Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance

Candidate BMP Constraints

- Property for Sale or Lease?
    - Yes/No
- Are there many constraints to new BMP project?
    - None
    - Some
    - Many
- Type (check all that apply)
    - Slope
    - Utilities
    - Structures
    - Space insufficient
    - Significant impact to trees
    - Specimen tree removal
    - Property Ownership
    - Access
    - Proximity to neighboring properties
    - Other adjacent landowner issues
    - Safety
    - Aesthetics
    - Other
- Other information on BMP project constraints or conflicts (describe)
- Impact to Existing Trees
    - Minimal
    - Moderate
    - Significant
- Ease of access
    - Easy
    - Moderate
    - Difficult
- Conflicts with Existing Utilities – Sewer
    - Yes
    - No
    - Possible
- Conflicts with Existing Utilities – Water
    - Yes

- No
- Possible

- Conflicts with Existing Utilities – Gas
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Cable
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Electric
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Electric to Streetlights
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Overhead Wires
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Other
  - Yes
  - No
  - Possible
- Other information on conflicts with existing utilities (describe)

[Whatever additional details you can think of which are relevant to conflicts which cannot be answered by YES or NO]

Potential Permitting Factors

- Dam Safety Permits Necessary [make "not probable" the default] (height of the pond measured from the upstream toe to the top of dam is more than 20 feet)
  - Probable
  - Not probable
- Impacts to Wetlands [make "not probable" the default]
  - Probable
  - Not probable
- Impacts to a Stream [make "not probable" the default]
  - Probable
  - Not probable
- Floodplain Fill [make "not probable" the default] (Will new BMP cause changes to floodplain elevation?)
  - Probable
  - Not probable
- Impacts to Specimen Trees ($\geq$30 inch DBH)
  - Probable
  - Not probable
- Number of Trees Impacted (number)
- Other permitting or impact factors (describe)

Soils

- Evidence of poor infiltration [clays, fines]

    - Yes/No/Unknown
- Evidence of shallow bedrock
    - Yes/No/Unknown
- Evidence of high water table [gleying, saturation]
    - Yes/No/Unknown
- Notes on soils

Other Project Types

- Is Site a Candidate for Other Restoration Projects?
    - No
    - Yes, BMP conversion
    - Yes, Tree planting
    - Yes, Stream restoration
    - Yes, Outfall stabilization
- Other Types of Projects Appropriate Here (describe)

Recommendations Summary

Proposed BMP Conversion Recommendations

- Proposed Treatment Option within pond boundary (check all that apply)
    - Extended Detention
    - Wet Pond
    - Created Wetland
    - Bioretention
    - Step Pool Conveyance
    - Filtering Practice other than Bioretention
    - Infiltration (not recommended for hotspots)
    - Swale (engineered)
    - Other
- If other type, describe proposed treatment option

- Will new BMP drainage area be the same as existing drainage area?
    - Yes/No
- If no, describe area to be treated by newly converted BMP

- Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance. Give a short narrative of BMP conversion to be done, as would be given on the first page of construction drawings.

- Notes on BMP conversion proposed. [Space for anything more that could not fit above.]

- Initial Feasibility and Construction Considerations (describe)

  Summarize some of the above criteria such as utility conflicts, neighborhood aesthetics consideration, treatment trains, technical complexity such as need for flow splitters etc.

- BMP Conversion Potential [This is a quick evaluation of "convertibility", not the pollutant removal efficiency gains anticipated.]
    - High
    - Medium
    - Low

- Optional: Sketch the proposed BMP conversion and attach sketch as photo. Sketch elements may include existing head available, surface area, minimum depth of treatment, conveyance, inlet, outlet, utility lines / other constraints, flow lines, property lines

Howard County Watershed Assessments
New BMP Assessment – Data Collection Field Protocol
March 6, 2015

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Kelly Hargadin (khargadin@howardcountymd.gov, Office 410-313-0844 or Cell 720-979-1519). Provide location, information about the problem observed, and a photograph.

- Locate site on map layer for New BMP Assessment **(*polygon*)** and fill in data for the fields below.

Fields – New BMP Assessment *(Polygon)*

Overall

- Site ID (pre-assigned, unique number. Example: SLP-NB-F701)
- Field Crew [initials]
- Create a site name [This will be considered the site's common name. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, another reason
- Other reason site cannot be evaluated (describe)
- Is a new BMP retrofit possible on this site? Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.
    - Yes
    - No, too many constraints

General Site Description – Existing Conditions

- Owner Name [If known]
- BMP Address
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Site Note [pre-filled from GIS data; information for field crew]
- Site Area - acres [prefilled from GIS]
- Ownership [In most cases, this should be evident in GIS parcel layer]
    - County School
    - County Parks
    - County – other
    - Private
    - Other
    - Unknown
- Notes, if ownership other
- Existing Land Use in Site Vicinity [predominant type]
    - Residential – single family homes <1 ac lots
    - Residential – single family homes > 1 ac lots
    - Townhouses
    - Multi-Family

- Institutional
- Industrial (not necessarily related to 02-SW or 12-SW permits)
- Commercial
- Transport-Related
- Park
- Undeveloped
- Other

- Additional information about the land use type within existing drainage area (describe)
- Adjacent Land Use (check all that apply)
  - Residential
  - Commercial
  - Institutional
  - Industrial
  - Transport-Related
  - Park
  - Undeveloped
  - Other
- Other information on adjacent land use (describe)
- Is repair/replacement of an existing structure needed? [example: older pipe or parking lot in need of replacement]
  - Yes/No
- Other information describing existing conditions (describe) such as need for maintenance, invasive vegetation removal.

Downstream or Outfall Condition

Note that sites with < 200 feet of erosion below outfall will be considered *outfall channels*. Sites with >200-300 feet of erosion below outfall will be considered for stream restoration and evaluated for *downstream condition*.

- Condition of outfall channel
  - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
  - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
  - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion typically recent/active. [Fill out Outfall Stabilization Assessment form]
- Reason Condition of outfall channel could not be inspected
  - Not applicable – discharges directly into MS4
  - Not applicable – discharges directly into large perennial stream
  - Could not inspect outfall [If behind fence etc.]
- Length of outfall channel erosion (ft.)
- Condition of stream channel [extending beyond 200 feet from discharge point]
  - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
  - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
  - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10. [Fill in Stream Restoration Assessment Form]
- Reason Condition of stream channel could not be inspected

- Not applicable
- Too far away, no access, to warrant inspection

- Length of stream erosion (ft.)
- Notes: Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance

Candidate BMP Constraints

- Property for Sale or Lease?
  - Yes/No
- Are there many constraints to new BMP project?
  - None
  - Some
  - Many
- Constraint Type [check all that apply]
  - Slope
  - Utilities
  - Structures
  - Space insufficient
  - Significant impact to trees
  - Specimen tree removal
  - Property Ownership
  - Access
  - Proximity to neighboring properties
  - Other adjacent landowner issues
  - Safety
  - Aesthetics
  - Other
- Other information on BMP project constraints or conflicts (describe)
- Impact to Existing Trees
  - Minimal
  - Moderate
  - Significant
- Ease of access
  - Easy
  - Moderate
  - Difficult
- Conflicts with Existing Utilities – Sewer
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Water
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Gas
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Cable
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Electric
  - Yes
  - No
  - Possible
- Conflicts with Existing Utilities – Electric to Streetlights

- o Yes
- o No
- o Possible

- Conflicts with Existing Utilities – Overhead Wires
  - o Yes
  - o No
  - o Possible
- Conflicts with Existing Utilities – Other
  - o Yes
  - o No
  - o Possible

- Other information on conflicts with existing utilities (describe)

<u>Potential Permitting Factors</u>

- Dam Safety Permits Necessary [make "not probable" the default] (height of the pond measured from the upstream toe to the top of dam is more than 20 feet)
  - o Probable
  - o Not probable
- Impacts to Wetlands [make "not probable" the default]
  - o Probable
  - o Not probable
- Impacts to a Stream [make "not probable" the default]
  - o Probable
  - o Not probable
- Floodplain Fill [make "not probable" the default] (Will new BMP cause changes to floodplain elevation?)
  - o Probable
  - o Not probable
- Impacts to Specimen Trees [≥30 inch DBH]
  - o Probable
  - o Not probable
- Number of Trees Impacted (number)
- Other permitting or impact factors (describe)

<u>Soils</u>

- Evidence of poor infiltration [clays, fines]
  - o Yes/No/Unknown
- Evidence of shallow bedrock
  - o Yes/No/Unknown
- Evidence of high water table [gleying, saturation]
  - o Yes/No/Unknown
- Notes on soils

<u>Other Project Types</u>

- Is Site a Candidate for Other Restoration Projects?
  - o No
  - o Yes, BMP conversion
  - o Yes, Tree planting
  - o Yes, Stream restoration
  - o Yes, Outfall stabilization
- Other Types of Projects Appropriate Here (describe)

Recommendations: New BMP (Polygon) and Drainage Area (DA) (Polygon) [This will be 2 polygons – one for the project footprint, one for the DA.]

- Draw footprint of proposed project – on tablet in layer called "Sketch – Proposed New BMP Footprint"
- Draw proposed Drainage Area in layer called "Sketch – Proposed New BMP – Drainage Area"
- Comments
- Drainage Area Estimate [No need to enter - will be calculated with hand drawn polygon.]

NEW BMP Recommendation Summary – complete the form in the layer "New BMP Recommendation Footprint" (polygon)"

- Site ID (Example: NMP-NB-F101A)
- Proposed Treatment Option (check all that apply)
  - Extended Detention
  - Wet Pond
  - Created Wetland
  - Bioretention
  - Step Pool Conveyance
  - Filtering Practice other than Bioretention
  - Infiltration
  - Swale
  - Green roof
  - Impervious surface removal
  - Impervious pavement replacement
  - Other
- If other proposed treatment, describe type.
- Demonstration/Education value?
  - Yes/no
- Notes: Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance.

  Give a short narrative of BMP to be built, as would be given on the first page of construction drawings

- Initial Feasibility and Construction Considerations (describe)

  Summarize some of the above criteria such as utility conflicts, neighborhood aesthetics consideration, technical complexity such as need for flow splitters etc.

- Other notes on new BMP proposed: [Space for anything more that could not fit above.]
- New Stormwater BMP – Retrofit Potential [This is quick evaluation of retrofitability / feasibility of constructing this BMP - not a ranking of quality of the BMP to remove pollutants]
  - High
  - Medium
  - Low

- Optional: Sketch the proposed BMP and attach sketch as photo. Sketch elements may include existing head available, surface area, minimum depth of treatment, conveyance, inlet, outlet, utility lines / other constraints, flow lines, property lines.

NEW BMP Recommendation Drainage Area – complete the form in the layer “New BMP Recommendation Drainage Area” (Polygon)”

- Site ID (Example: NMP-NB-F101A)
- Comments

Howard County Watershed Assessments
Tree Planting Assessment – Data Collection Field Protocol
March 6, 2015

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Kelly Hargadin (khargadin@howardcountymd.gov, Office 410-313-0844 or Cell 720-979-1519). Provide location, information about the problem observed, and a photograph.
- Locate site on map layer for opportunity for Tree Planting Assessment **(*polygon*)** and fill in data for the fields below.

Fields – Tree Planting Assessment *(Polygon)*

Overall

- Site ID (pre-assigned, unique number. Example: SLP-TP-F701)
- Field Crew [Initials]
- Create a site name [This will be considered the common name of the site. Example: name of school, business, or nearest road.]
- Can site be evaluated? (if no, do not fill out other data)
  - Yes
  - No, landowner did not grant access
  - No, fence or other barrier
  - No, another reason
- Other reason site cannot be evaluated (describe)
- Is tree planting possible on this site? Answer this question after assessing the site and constraints. Use CONSTRAINTS SECTION BELOW to document constraints.
  - Yes
  - No, too many constraints
- Is tree planting opportunity at least 0.25 acres?
  - Yes/No

General Site Description

- Owner Name [prefilled from GIS]
- Owner Address [prefilled from GIS]
- Ownership [In most cases, this should be evident in GIS parcel layer.]
  - County School
  - County Parks
  - County – other
  - Private
  - Other
  - Unknown
- Notes, if ownership other
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Site Note [pre-filled from GIS data; information for field crew]
- Parcel size: ____ acre(s) [prefilled - from GIS]
- Access to site (check all that apply)

- Foot access
- Vehicle access
- Heavy equipment access

- Current Management
  - School District
  - Charter School
  - Park
  - Tot Lot
  - Public Right-of-way
  - Private Right-of-way
  - Vacant land
  - Other

Climate

- Sunlight exposure
  - Full sun (6 hours or more of direct sun per day)
  - Part sun or filtered light (<6 hours per day)
  - Shade (<3 hours of direct sun per day)
- Microclimate features: High wind exposure (Yes/No)
- Microclimate features: Re-reflected heat load (Yes/No)
- Microclimate features: Other (describe)

Topography

- Any slopes >15% present in proposed planting area? (Yes/No)
- If yes, estimate slope
- Any low-lying areas present in proposed planting area? (Yes/No)
- If yes, notes on low lying area

Vegetation

- Regional forest association or dominant species from reference site
- Current vegetative cover (estimate percent)
  - Mowed Turf _______% [1,2,3,4,5, 10, 15, 20, 25, 30 …100 by 5's]
  - Other Herbaceous ______% [as above]
  - Trees/Shrubs ______% [as above]
  - None (bare soil) ______% [as above]
- Note species to be preserved
- Are invasive species or noxious weeds present in proposed planting area? (Yes/No)
- % coverage by invasives in proposed planting area: __________
- List dominant types of invasive species in proposed planting area, if any ____________
- Adjacent vegetative cover: is forest present? (Yes/No)
- If yes, note dominant forest species
- Are invasive species or noxious weeds present in adjacent vegetated area? (Yes/No)
- % coverage by invasives in adjacent area: __________
- List dominant types of invasive species in adjacent area, if any _____
- Is there heavy browsing by deer? (Yes/No)
- Is there beaver activity? (Yes/No)
- Evidence of previous tree planting? (Yes/No)
- Comment on success of previous tree planting, if evidence present
- Notes

Soils

- Soil texture
  - Clay
  - Loam
  - Sand
- Soil Compaction
  - None
  - Moderate
  - Severe
- Active or severe soil erosion? (Yes/No)
- Potential soil contamination? (Yes/No)
- Debris and rubble in soil? (Yes/No)
- Recent construction or other soil disturbance? (Yes/No)
- Other soil characteristics (describe)

Hydrology

- Site hydrology
  - Upland
  - Riparian
- Stormwater runoff to planting site – bypasses site in pipe? (Yes/No)
- Stormwater runoff to planting site – Upslope drainage area outfalls to site? (Yes/No)
- Note diameter of pipe outfall, if present (inches)
- Stormwater runoff to planting site – Open channel directs flow across or around site? (Yes/No)
- Stormwater runoff to planting site – Shallow concentrated flow (for example, evidence of rills, gullies, sediment deposits)? (Yes/No)
- Stormwater runoff to planting site – Sheetflow? (Yes/No)
- Contributing flow length (ft) [The distance over which runoff travels before entering planting area. For larger planting areas, distance runoff travels before leaving the planting area.]
- Contributing flow length, slope (%)
- Contributing flow length, cover type
  - Impervious
  - Pervious
- Floodplain connection (riparian areas only) – bank height (ft)
- If riparian planting is proposed on both sides of stream, explain/describe differences in hydrology or flow path.

Potential Planting Conflicts or Constraints

- Space Limitations
  - Overhead wires? (Yes/No)
  - Height of overhead wires, if present (ft)
  - Pavement? (Yes/No)
  - Structures? (Yes/No)
  - Signs? (Yes/No)
  - Height of signs, if present (ft)
  - Lighting? (Yes/No)
  - Height of lighting, if present (ft)
  - Underground Utilities? (Yes/No)

- Note type of underground utilities present
- Other space limitations (describe)

- Other limiting factors or constraints
  - Trash dumping/debris (Yes/No)
  - If trash present, note type, volume (estimated number pickup truck loads) and source if known.
  - Deer, beaver, or other animal impacts (Yes/No)
  - Site mowed regularly (Yes/No)
  - Wetland present (Yes/No)
  - Insect infestation or disease (Yes/No)
  - Access (Yes/No)
  - Ownership (Yes/No)
  - Heavy pedestrian traffic (Yes/No)
- Other limiting factors/constraints (describe)
- Notes

Planting and Maintenance Logistics

- Site Access
  - Delivery Access for planting materials present? (Yes/No)
  - Temporary storage areas for soils, mulch, etc. present? (Yes/No)
  - Heavy equipment access? (Yes/No)
  - Volunteer parking area available? (Yes/No)
  - Nearby facilities for volunteers? (Yes/No)
- Water source
  - Rainfall only? (Yes/No)
  - Stormwater runoff? (Yes/No)
  - Hose hook-up nearby? (Yes/No)
  - Irrigation system in place? (Yes/No)
  - Overbank flow from river or stream? (Yes/No)
  - Fire hydrant nearby? (Yes/No)
- Other water source (describe)
- Estimated distance to nearest water source (ft)

TREE PLANTING RECOMMENDATIONS

Tree Planting Recommendation Summary – complete the form in the layer "Tree Planting Area Recommendations" [polygon]

Sketch footprint of proposed tree planting area – on tablet, outline area(s) to be planted

- Site ID (Example: SLP-TP-F701A)
- Site Preparation Required
  - High (e.g., clearing of dumpsite)
  - Medium (e.g., extensive clearing of invasives)
  - Low
  - None
- Type of site prep needed (describe)
- Potential Demonstration/Education Project? (Is site public/highly visited v. remote location?)
  - Yes/No/Maybe
- Notes: ______________________________
- Tree Planting Areas - Restoration Potential [This is quick, overall evaluation of feasibility of tree planting at this site.]
  - High
  - Medium
  - Low
- Comments
- Optional: Sketch the proposed tree planting area and attach sketch as photo. Sketch elements may include:
  - Property boundary and features such as roads, streams, and adjacent land use/cover
  - Boundary and approximate dimensions of proposed planting area
  - Variations in sun exposure, microclimate, and topography within planting area
  - Current vegetative cover, location of trees to be preserved, and invasive species
  - Flow paths to planting area and contributing flow length
  - Above or below ground space limitations (e.g., utilities, structures)
  - Other limited factors such as trash dumping, pedestrian paths
  - Water source and access points
  - Scale bar and north arrow.

Howard County Watershed Assessments

Stream Restoration Assessment – Data Collection Field Protocol

March 6, 2015

General Data Collection Instructions

- All reaches are assessed while walking upstream
- If there is a significant change in biological, physical or geomorphic conditions within a reach, then the field team has the ability to draw a Stream Reach Break Line to designate separate reaches.
- Each reach, including new reaches designated in the field, must have a habitat assessment point if reach is at least 75 meters long.
- If a portion of a reach cannot be assessed due to access or safety issues, then place a Reach Break Line at the point in the reach where the team can no longer walk upstream. Place a new Reach Break Line when the reach is assessable again.
- Right and left bank are determined while facing downstream.
- A minimum of two photos must be taken at each feature (point, line or polygon). First photo is taken looking upstream (or upslope in the case of outfalls), second photo is taken while looking downstream. Additional photos may be taken at the discretion of the field team.
- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Kelly Hargadin (khargadin@howardcountymd.gov, Office 410-313-0844 or Cell 720-979-1519). Provide location, information about the problem observed, and a photograph.

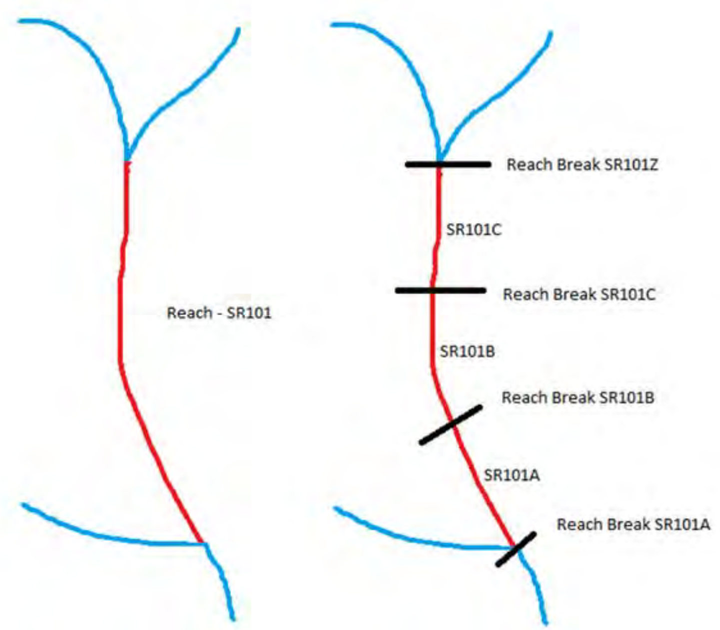
Stream Restoration Assessment Data Layers

Stream Restoration Assessment (line) – No editing; base layer with Site IDs. Check here for comments that may contain special notes for field crews.

Stream Reach Break Data *(line)*

Data Collection Instructions

Add a Stream Reach Break line at the beginning of a new stream reach assessment for either a pre-selected reach or a new reach within a pre-selected reach. This line signifies the downstream end of a new section of stream that is assessed. Each line will be perpendicular to and crossing the stream reach. Break line may be at or slightly below the downstream end of the stream reach. The last reach break will be labelled with Z to signify the upstream end of the study reach; do not fill in any other data for the "Z" reach.



Fill out all fields prior to assessing reach, except for the final field, Stream Restoration Opportunities Present, which you will complete after the assessment.

Fields

- Site ID of Stream Reach [fill in ID from the Stream Reach base layer, in which the number will be pre-assigned (e.g., NMP-SR-F101); add A for the first reach break. Add B, C, D, etc. for each additional break. Assign Z to the break at the end of reach.]
- Field Crew [Initials]
- Can site be evaluated? (if no, do not fill out other data)
  - Yes
  - No, landowner did not grant access
  - No, fence or other barrier
  - No, another reason
- Notes
- Create a site name [This wil be considered the common name for the site. Example: name of school, business, or nearest road.]
- Is this an end of reach? (if Yes, do not answer further questions)
  - Yes
  - No
- Past Weather (24 hours) – yes/no for all
  - Clear
  - Cloudy
  - Trace of Rain
  - Rain
  - Snow
  - Extreme Cold [consistently < 32 degrees F]
  - Extreme Hot ([consistently > 80 degrees F])

    - Other
- Current Weather
    - Same Options as above
- Stream Type – check one
    - Perennial
    - Intermittent
    - Ephemeral
    - Unknown
    - If stream type is unknown, explain
- Notes
- Stream Restoration Opportunities Present (Filled out after walking reach) [Note if opportunities present, then also fill in Stream Restoration Recommendations form.]
    - None
    - One
    - Several

Rapid Biology/Habitat Assessment Data *(Point)*

Data Collection Instructions

At least one Habitat Assessment point needs to be placed within each stream reach. If a reach is >1000 ft long, place a Stream Reach Break and collect another Habitat Assessment Point.

The assessment is conducted within a representative 75-meter reach. It is at the discretion of the field crew to choose a representative location for the 75-m reach assessment.

See example RBP data form for habitat parameter scoring guidance. For each RBP parameter, scale runs from 1 (worst condition) to 10 or 20 (best condition).

Fields

- Site ID (e.g. NMP-SR-F101A-RE101) [Fill in, using Stream Reach ID and adding RE###, RE for Representative Site]
- Stream Bed Particle Size (note percentage, estimate to the nearest 5%)
    - Clay
    - Silt
    - Sand
    - Gravel
    - Cobble
    - Boulder
    - Bedrock
    - Concrete
- Epifaunal Substrate/Available Cover (0-20 score)
- Embeddedness (0-20)
- Velocity/Depth Regime (0-20)
- Sediment Deposition (0-20)
- Channel Flow Status (0-20)
- Channel Alteration (0-20)
- Frequency of Riffles (or bends) (0-20)
- Bank Stability (Right) (0-10)
- Bank Stability (Left) (0-10)
- Vegetative Protection (Right) (0-10)
- Vegetative Protection (Left) (0-10)
- Riparian Vegetative Zone Width (Right) (0-10)
- Riparian Vegetative Zone Width (Left) (0-10)
- Percent Shading (estimate to nearest 10%, assuming leaf-on)
- Trash Rating (0-20)
- Notes

Erosion Site (*Point, placed at downstream end of erosion)*

Data Collection Instructions

Document all stream bank erosion that has an eroded surface of at least 2 feet high and 10 feet long. Shorter instances of erosion can be documented if the erosion is threatening a utility, property, or structure. Erosion points are placed at the downstream end of erosion. A new erosion point is placed on the map if the average height of erosion changes by more than 2-3 feet, or any of the erosion point parameters have a significant change. See BEHI diagram for guidance on collecting the applicable parameters. If there is erosion on both banks, record BEHI parameters for whichever bank is more extreme. If there are multiple areas of erosion that are vastly different in degree of erosion hazard, additional erosion points may be added if needed.

A gully associated with an outfall channel will be recorded as an erosion point. If the actual outfall is located, that will also be recorded, as a pipe outfall.

Fields

- Site ID (e.g. NMP-SR-F101A-ES101) [Fill in using Stream Reach ID and adding ES###, ES for Erosion Site]
- Type of Erosion (check all that apply)
    - Headcutting
    - Downcutting
    - Widening
    - Other
- Right Bank Length of Erosion (ft) - extending upstream of point, estimate or measure to the nearest 10 ft the length along bank
- Left Bank Length of Erosion (ft) - extending upstream of point, estimate or measure to the nearest 10 ft the length along bank
- Height of Erosion on Right Bank (ft) – to nearest 0.1 ft
- Height of Erosion on Left Bank (ft) – to nearest 0.1 ft
- Right Bank Total Height (ft) – to nearest 0.1 ft, measure from thalweg to top of bank
- Left Bank Total Height (ft) – to nearest 0.1 ft, measure from thalweg to top of bank
- Bankfull Depth (ft) – to nearest 0.1 ft, measure from thalweg to bankfull
- Note bankfull indicators
- Predominant Bank Material
    - Clay
    - Silt
    - Sand
    - Gravel
    - Cobble
    - Boulder
    - Bedrock
- Bank angle as degrees, Bank Erosion Potential category
    - 0 – 20 degrees, Very Low
    - 21 – 60 degrees, Low
    - 61 – 80 degrees, Moderate
    - 81 – 90 degrees, High
    - 90 – 119 degrees, Very High
    - >119 degrees, Extreme

- Root Density as percentage, Bank Erosion Potential category
    - 80 - 100% Very Low
    - 55 - 79% Low
    - 30 - 54% Moderate
    - 15 - 29% High
    - 5 – 14% Very High
    - <5% Extreme
- Root Depth as proportion of bank height, Bank Erosion Potential category
    - 0.90 – 1.0 Very Low
    - 0.50 – 0.89 Low
    - 0.30 - 0.49 Moderate
    - 0.15 – 0.29 High
    - 0.05 - 0.14 Very High
    - <0.05 Extreme
- Surface protection as percentage, Bank Erosion Potential category
    - 80 - 100% Very Low
    - 55 - 79% Low
    - 30 - 54% Moderate
    - 15 - 29% High
    - 10 – 14% Very High
    - <10% Extreme
- Near Bank Stress Rating [narrative category]
    - Very Low
    - Low
    - Moderate
    - High
    - Very High
    - Extreme
- Soil Stratification
    - None/Low
    - Medium
    - High

- Headcut height, ft, to the nearest 0.5 ft [if applicable]
- Headcut angle, degrees [if applicable]
    - 0 – 30 degrees
    - 31 - 60 degrees
    - 61 – 90 degrees
- Headcut length, ft [bottom to top; if applicable]
- Overall Erosion Severity Rating (1-10)
    - 1-3: Minor erosion. 2-3 feet in eroded bank height, not causing significant stream degradation. Showing signs of healing.
    - 4-6: Moderate erosion. 3-5 feet in eroded bank height. Relatively recent/raw.
    - 7-10: Severe Erosion. 5 ft or greater eroded bank height. Erosion typically recent/active. Obvious instream degradation. If threatening utilities or structures rate 9-10.
- Notes

Channel Alteration Site *(Point, placed at downstream end of channel alteration)*

Data Collection Instructions

Document instances of the channel bed, bank, or nearby floodplain being altered by placing a Channel Alteration point at the downstream extent of the alteration and completing the electronic form. Only document instances where the alteration is detrimental to the stream (e.g. concrete-lined channel) or needs to be fixed (e.g. failing bank stabilization project). Do not document stable utility line protection or successful stream restoration projects. Channel Alteration points are placed at the downstream end of erosion.

Fields

- Site ID (e.g. NMP-SR-F101A-CA101) [Fill in using Stream Reach ID and adding CA###, CA for Channel Alteration]
- Type
  - Concrete
  - Riprap
  - Gabion Basket
  - Earthen Channel
  - Channelization/Straightening
  - Other
- Alteration Length (ft) (extending upstream of point, estimate or measure to the nearest 10 ft)
- Alteration Width (ft) (Bed only)
- Alteration Location
  - Bed
  - Bank
  - Bed and Bank
  - Floodplain
- Signification vegetation in channel?
  - Yes, No, Unknown
- Signification Aggradation
  - Yes, No, Unknown
- Significant Degradation
  - Yes, No, Unknown
- Associated with a Road Crossing
  - Yes, No, Unknown
- Alteration Severity (1-10)
  - 1-3: Alteration is detrimental to the health of the stream, but alteration is relatively short and is not causing any current channel instability.
  - 4-6: Alteration is causing noticeable channel instability (e.g. channel starting to erode around riprap placed on bank or channelized stream banks slumping in stream) and should be corrected.
  - 7-10: Alteration is relatively long, causing significant channel instability/loss of habitat and should be corrected as soon as possible.
- Notes

Inadequate Buffer Site *(Point, placed at downstream end of inadequate buffer)*

Data Collection Instructions

Document non-natural areas with a minimum length along the stream (parallel to the channel) of 100 feet. A buffer will be considered adequate if it is tree-covered within 75 ft of the stream.

A more detailed assessment of the area can be completed with the Tree Planting Area form (polygon feature) if adequate space is available for planting (at least 0.25 acre).

Inadequate buffer points are placed at the downstream end of the inadequate buffer.

Fields

- Site ID (e.g. NMP-SR-F101A-IB101) [Fill in using Stream Reach ID and adding IB###, IB for Inadequate Buffer]
- Inadequate buffer length – Right (ft)
- Inadequate buffer length – Left (ft)
- Existing Buffer width – Right (ft) (to 150 ft maximum)
- Existing Buffer width – Left (ft) (to 150 ft maximum)
- Opportunity for tree planting project? (yes/no) – If Yes, fill out Tree Planting assessment form
- Notes

Pipe Outfall Site *(Point)*

Data Collection Instructions

Document all outfall pipes or channels that can be seen from the stream by placing an outfall point on the map. If the outfall is a pipe then place the point at the opening of the pipe, if the outfall is a channel then place the point at the termination of the formal conveyance (i.e. do not place point at end of erosional gully, this will be documented within the field form).

Use this form to record unmapped outfalls and problematic outfalls observed while conducting stream assessment. This is not intended to be a comprehensive inventory of outfalls.

Fields

- Site ID (e.g. NMP-SR-F101A-PO101) [Fill in using Stream Reach ID and adding PO###, PO for Pipe Outfall]
- Mapped outfall number, if available [from GIS]
- Type of Outfall
  - Stormwater BMP Outfall
  - Stormwater Outfall, no BMP
  - BMP Overflow Channel / Spillway
  - Agricultural Drainage Pipe
  - Roof Drains (only record if there are major problems to address)
  - Sewage Plant
  - Unknown
  - Other
- Enclosed Pipe or Open Channel (choose one)
- Material
  - Earth Channel
  - Concrete Channel
  - Concrete Pipe
  - Smooth Metal Pipe
  - Corrugated Metal Pipe
  - Smooth Plastic Pipe
  - Corrugated Plastic Pipe
  - Unknown
  - Other
- Pipe Diameter [inside – inches]
- Lcoation in relation to stream channel (choose one)
  - Right side
  - Left side
  - In-line with stream
- Evidence of dry weather flow (e.g. staining, excessive vegetation, oil sheen, etc.)?
  - Yes, No
- Is there a suspected illicit discharge that needs to be addressed?
  - Yes, No – If yes, notify Howard County
- Trash Rating (0-20)
- Evidence of Erosion below outfall?
  - Yes, No - If yes, erosion is observed, fill out Outfall Stabilization Assessment form [point feature].
- Notes

Unusual Condition/Other *(Point)*

Data Collection Instructions

Document any unusual conditions found during the stream assessments. These may not necessarily be good indicators for targeting restoration sites, but these conditions may be leading to (or indicative of) instream degradation and are worth documenting for the County's use if the condition is severe. Place a new point on the map where the unusual condition is found.

Fields

- Site ID (e.g. NMP-SR-F101A-UC101) [Fill in using Stream Reach ID and adding UC###, UC for Unusual Condition]
- Near-stream construction with poor ESC (yes/no)
- Suspected illicit discharge (yes/no)
- Illegal Dumping (yes/no)
- Exposed Pipe (yes/no)
- Unusual Water Color (yes/no)
- Unusual Water Clarity (yes/no)
- Unusual Water Odor (yes/no)
- Excessive Algae (yes/no)
- Excessive Bacteria Indicators (yes/no)
- Severe Fish Blockage/Barrier (yes/no)
- Other (describe) (yes/no)
- Notes

Stream Restoration Recommendations *(Polygon)*

Data Collection Instructions

Use this feature to indicate the location and extent of one or many potential stream restoration projects within the assessed reach. Draw a polygon that includes the extent of stream length to be restored, including side tributaries if they are to be included in project.

Also, document the potential of adding one or many restoration projects in the Stream Reach Break line shapefile.

Fields

- Site ID (e.g., NMP-SR-F101A)
- Instream Restoration Potential
  - High
  - Medium
  - Low
- Restoration Length (ft) [will be calculated later in GIS]
- Are there many constraints to restoration project?
  - None
  - Some
  - Many
- Stream Restoration Project Constraints - Type
  - Utility
  - Roadway
  - Buildings
  - Other Structure
  - Ownership
  - Access
  - Significant Impact to Trees
  - Specimen Tree Removal
  - Wetland Impacts
  - Other
- Approximate length of project affected by constraint (ft)
- Impact to Existing Trees
  - Minimal
  - Moderate
  - Significant
- Ease of access
  - Easy
  - Moderate
  - Difficult
- Potential Demonstration/Educational Value? (yes/no)
- Notes

Howard County Watershed Assessments
Outfall Stabilization Assessment (Point) – Data Collection Field Protocol
March 6, 2015

General Data Collection Instructions

- If any illicit discharges or other safety concerns (e.g., missing manhole cover) are observed in the field, notify the County as soon as possible by contacting Kelly Hargadin (khargadin@howardcountymd.gov, Office 410-313-0844 or Cell 720-979-1519). Provide location, information about the problem observed, and a photograph.

- Edit an existing (preselected) outfall stabilization point OR add a new outfall stabilization point. If adding a new point and the outfall is a pipe then place the point at the opening of the pipe. If the outfall is a channel then place the point at the termination of the formal conveyance (i.e. do not place point at end of erosional gully, this will be documented within the field form).

Fields – Outfall Stabilization Assessment *(Point)*

- Site ID (prefilled) (example: NMP-OF-F101). If site was a Pipe Outfall Site in Stream Restoration reach, use that outfall point site ID (example: SR-F101-PO103).
- Field Crew [Initials]
- Create a site name [This will be considered the common name of the site. Example: name of school, business, or nearest road.]
- Study Area [pre-filled from GIS data]
- Contractor [pre-filled from GIS data]
- Comments [pre-filled from GIS data; information for field crew]
- Site Note [pre-filled from GIS data; information for field crew]
- Can site be evaluated? (if no, do not fill out other data)
    - Yes
    - No, landowner did not grant access
    - No, fence or other barrier
    - No, another reason
- Notes
- Past Weather (24 hours) – yes/no for all
    - Clear
    - Cloudy
    - Trace of Rain
    - Rain
    - Snow
    - Extreme Cold (consistently < 32 degrees F)
    - Extreme Hot (consistently > 80 degrees F)
    - Other
- Current Weather
    - Same Options as above
- Outfall Pipe Height (inches)
- Outfall Pipe Width (inches)
- Outfall Pipe Shape
    - Round
    - Rectangular
- Outfall Type
    - Pipe
    - Headwall
- Is repair needed?
    - Yes/No

- Is sediment removal needed?
  - Yes/No
- Is there baseflow?
  - Yes/No
- Outfall Material
  - Earth Channel
  - Concrete Channel
  - Concrete Pipe
  - Smooth Metal Pipe
  - Corrugated Metal Pipe
  - Smooth Plastic Pipe
  - Corrugated Plastic Pipe
  - Unknown
  - Other
- Trash Rating (0-20)
- Evidence of Erosion below outfall?
  - Yes, No
- Location of Erosion
  - Outfall Channel (yes/no)
  - Main Stream Channel (yes/no)
- Length of outfall channel erosion (ft)
- Length of stream channel erosion that is attributable to the outfall (ft)
- Distance from outfall to Stream Channel (ft)
- Height of pipe above stream bed (ft)
- Severity of outfall channel Erosion/degradation (1-10)
  - 1-3: Minor erosion. Less than 1 foot of eroded banks. Healing may be present.
  - 4-6: Moderate erosion. Eroded banks are 1-2 feet in height. Erosion looks relatively recent.
  - 7-10: Severe Erosion. Eroded banks are greater than 2 feet in height. Erosion is typically recent/active.
- Does this site have potential for outfall stabilization?
  - Yes (if yes, go to Outfall Stabilization Recommendation, add line, and fill out form)
  - No
- Does this site have potential for stream restoration?
  - Yes (if yes, go to Stream Restoration Assessment, beginning with Stream Reach Break Data and fill out forms, including Erosion Site form)
  - No
- Notes

<u>Outfall Stabilization Recommendation</u> ***<u>(Line)</u>***

<u>Data Collection Instructions</u>

Add line to map and fill out the form below if "Yes" was answered for "potential for outfall stabilization". Draw line to indicate proposed location and length of outfall stabilization project. Note: portions of Outfall Stabilization projects that extend beyond 200-300 feet will be categorized as stream restoration projects.

<u>Fields</u>

- Site ID (e.g. NMP-OF-F101) (match Outfall Stabilization Assessment Site ID)
- Overall Outfall Stabilization Potential
  - High
  - Medium
  - Low
- Type of Outfall Stabilization Project
  - Rip Rap
  - Drop Structure
  - Regenerative Stormwater Conveyance
  - Other
- Describe Other type of stabilization
- Proposed project length (ft) (estimate to nearest 10 ft)
- Are there many constraints to an outfall stabilization project?
  - None
  - Some
  - Many
- Outfall Stabilization Project Constraints - Type
  - Utility
  - Roadway
  - Buildings
  - Other Structure
  - Ownership
  - Access
  - Draining a hotspot
  - Significant impact to trees
  - Specimen tree removal
  - Wetland Impacts
  - Other
- Approximate length of project affected by constraint (ft)
- Impact to Existing Trees
  - Minimal
  - Moderate
  - Significant
- Ease of access
  - Easy
  - Moderate
  - Difficult
- Potential Demonstration/Educational Value? (yes/no)
- Notes

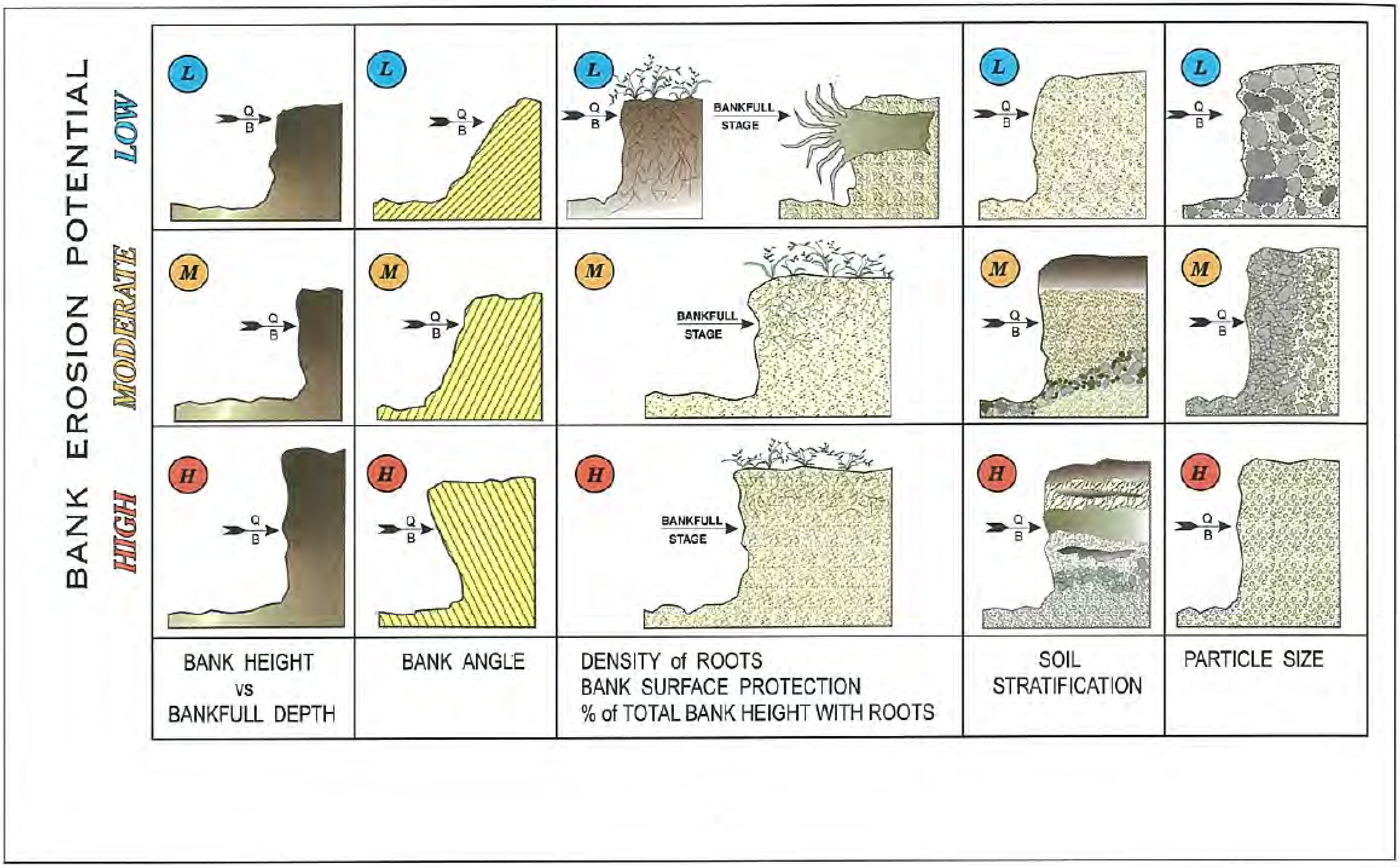
Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated broader than sampling reach

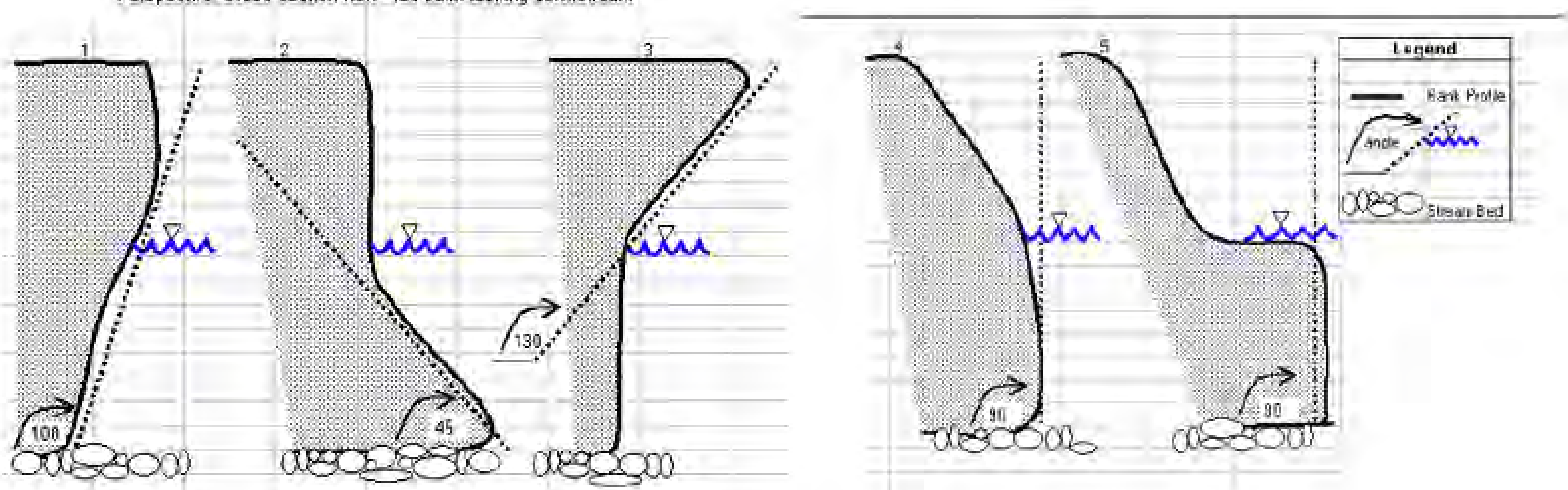
Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Habitat Parameter	**Optimal** **16-20**	**Sub-Optimal** **11-15**	**Marginal** **6-10**	**Poor** **0-5**
Trash Rating	Little or no human refuse visible from stream channel or riparian zone	Refuse present in minor amounts	Refuse present in moderate amounts	Refuse abundant and unsightly


BANK EROSION POTENTIAL
LOW
MODERATE
HIGH
L
M
H
Q
B
BANKFULL
STAGE
BANK HEIGHT
vs
BANKFULL DEPTH
BANK ANGLE
DENSITY of ROOTS
BANK SURFACE PROTECTION
% of TOTAL BANK HEIGHT WITH ROOTS
SOIL
STRATIFICATION
PARTICLE SIZE

Five Common Bank Angle Scenarios

Perspective: Cross section view - left bank looking downstream

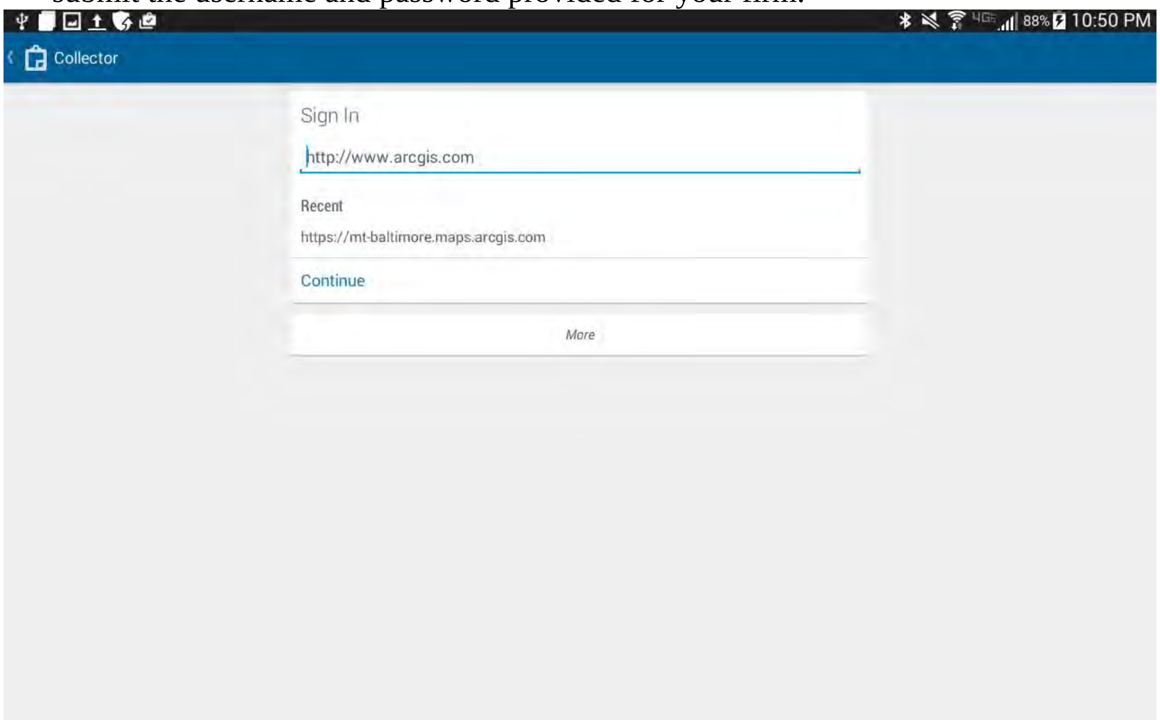


D. Electronic Data Collection Protocols

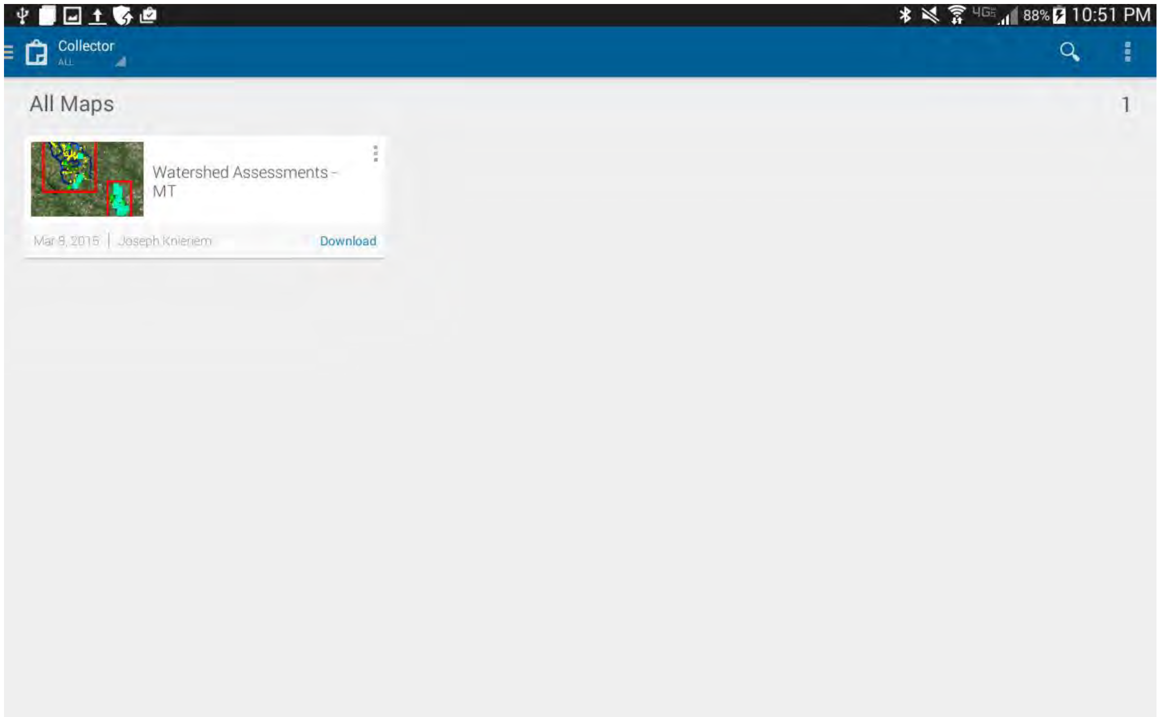
Howard County Watershed Assessments
March 9, 2015

Arc Collector Field Data Collection Instructions

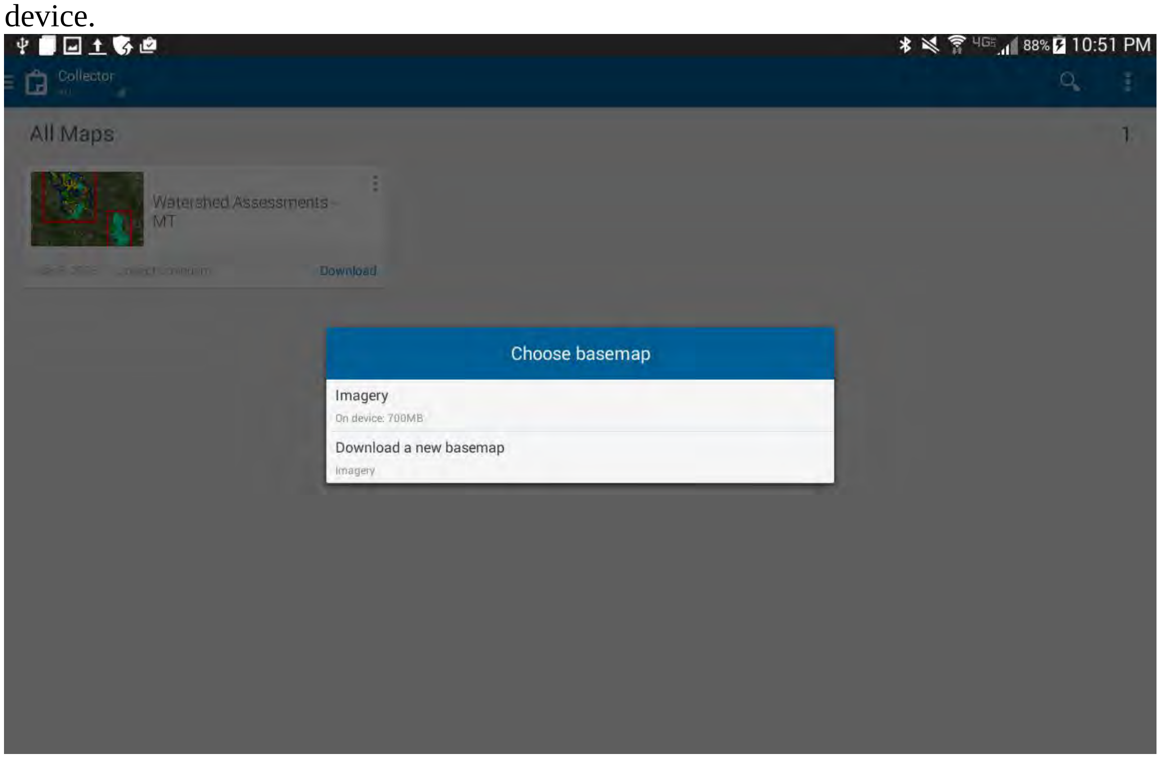
1. **Logging into ArcGIS Online with the tablet.**
Open the Arc Collector app and create a new account. Type in the URL https://mt-baltimore.maps.arcgis.com and click continue. On the next screen, submit the username and password provided for your firm.



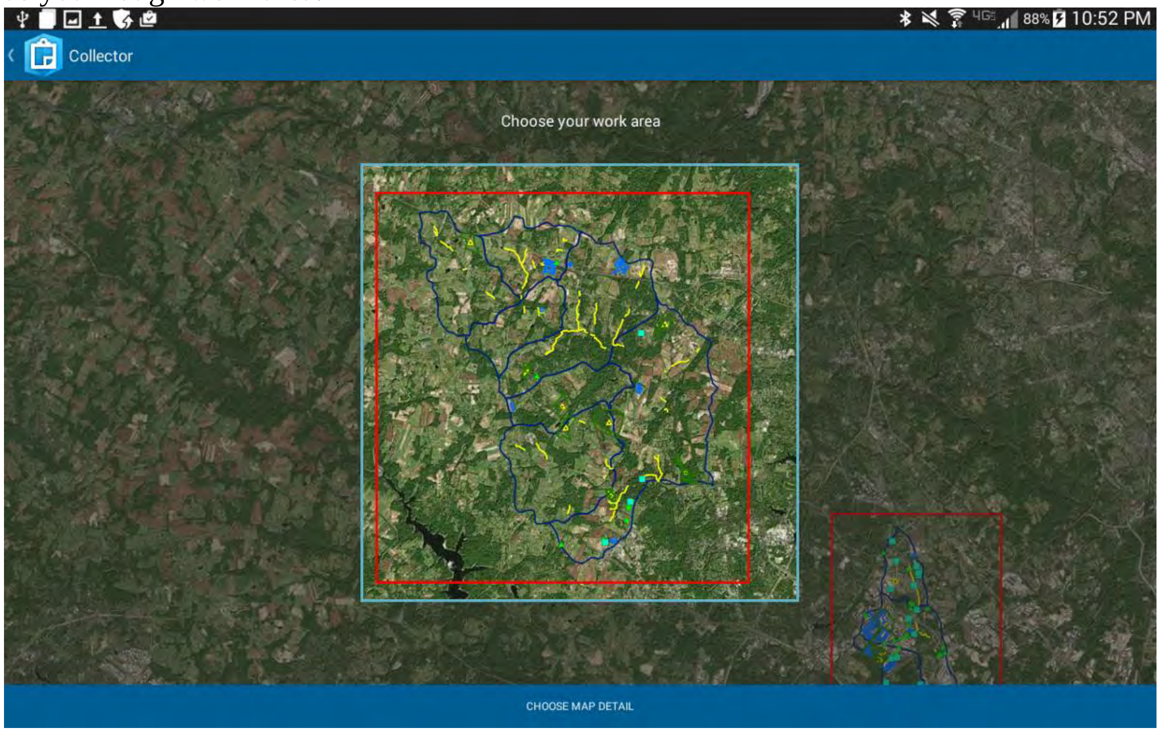
2. **Downloading data to the device for offline use.**
   a. When you sign into Collector, you will see one map available for your firm. To use the map in offline mode, click the "Download" button at the bottom right



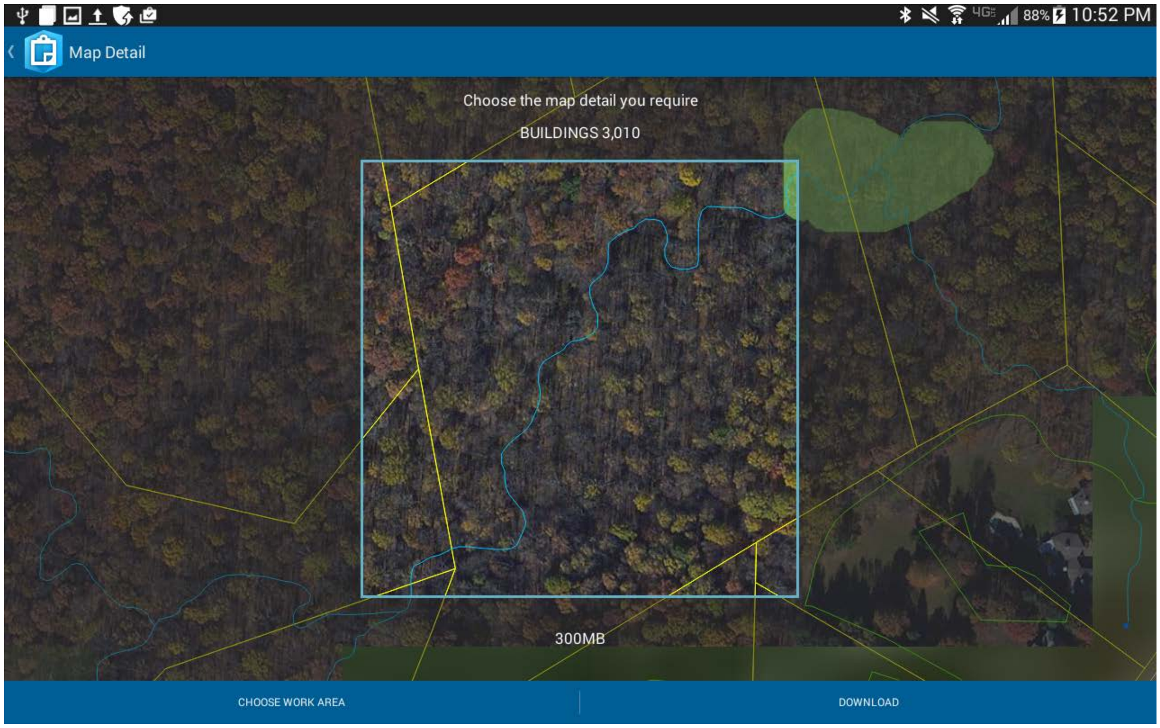
b. If you're downloading the map for the first time, you will be asked to download a new basemap. If you have downloaded a basemap previously, you may opt to reuse a previously downloaded basemap. In the screenshot below, the "Imagery" layer represents a basemap already stored on the device.



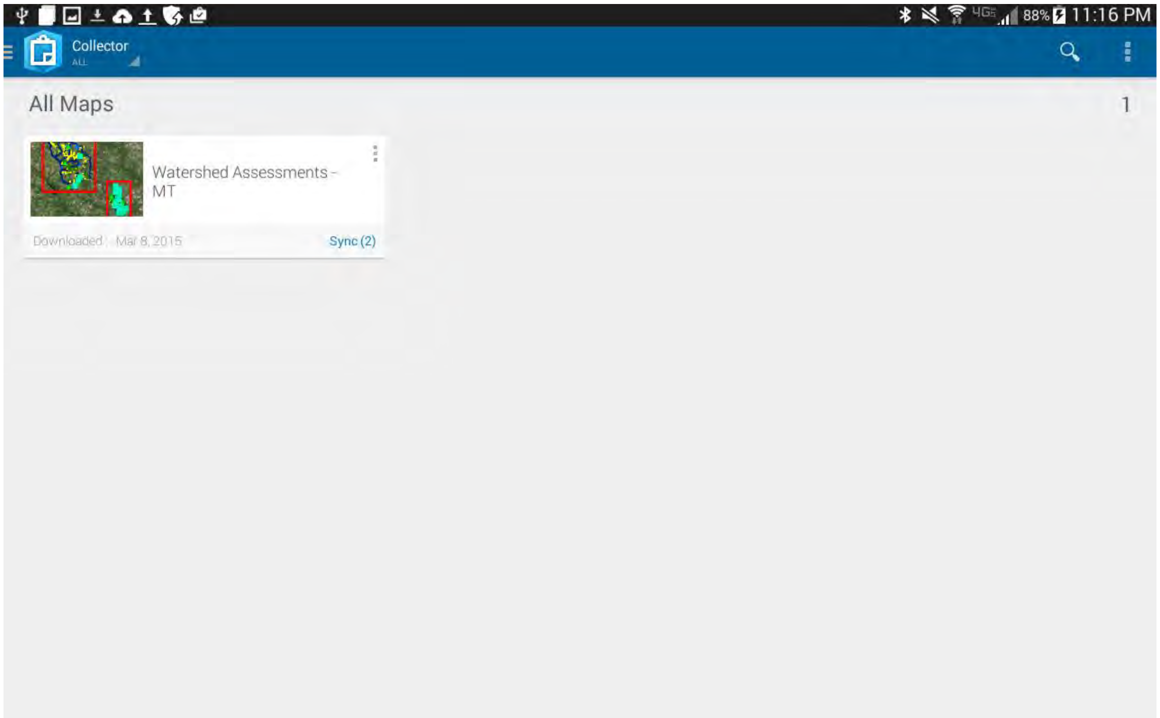
c. To download data to your device, you must specify the “work area” for which you wish to download data. Once data is downloaded to the device, if you venture outside of your work area, you won’t have any data available. In each web map, there is a large red box representing the extent of all your available data. It is recommended that you use this box as your rough work area.



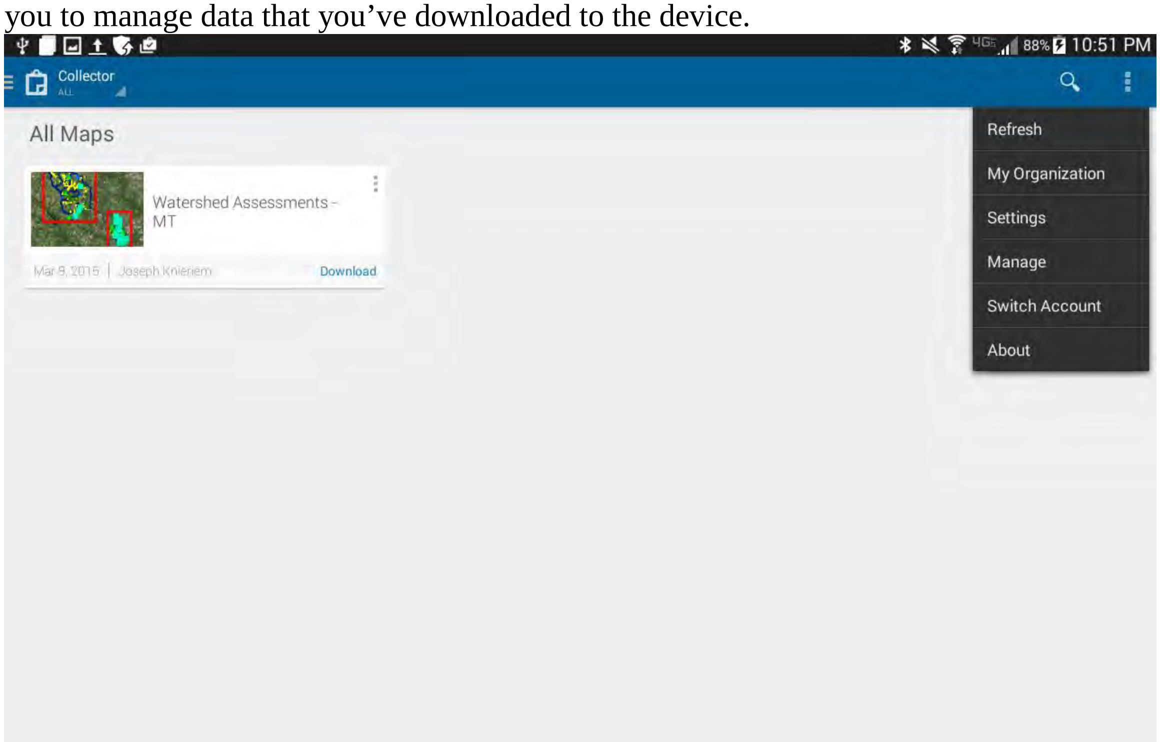
d. Once you select your work area, if you are downloading a base map, you will be asked to choose the level of detail for the base map. This level of detail affects how far you will be able to zoom in on the aerial before it gets blurry in offline mode. It is recommended that you zoom in to at least 3600 scale (1” = 300’). The more detail you want, the larger the download will be. It is recommended that you download a high resolution aerial for your study area just once and then reuse it each time.



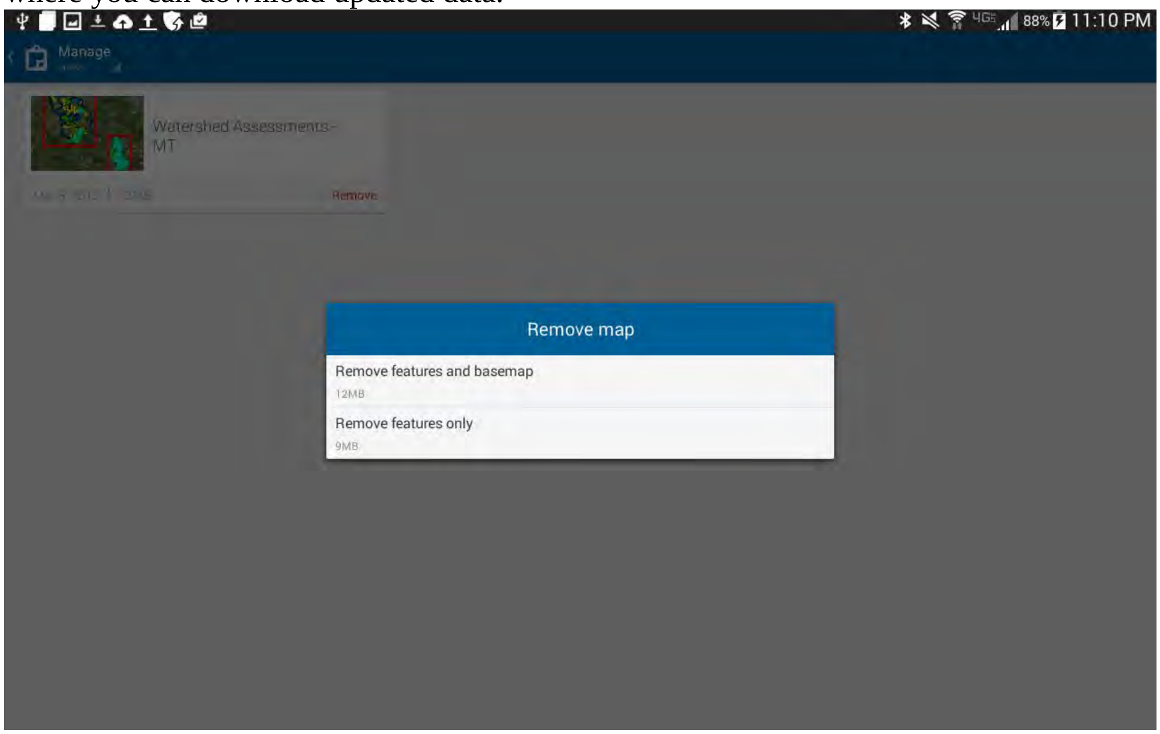
3. **Syncing Collected data**
Once you have finished collecting data for the day, if you back out to the main map screen of the Collector app, you will see a sync button at the bottom right with a number in parenthesis indicating the number of edits you made in offline mode. Pressing the sync button will upload all of your changes to the master database on the server. This requires an internet connection. Once your data has been synced back to the master database, it is recommended that you check the web map to ensure that the data was synced properly.



4. **Managing device data**
   - **a.** Once your data has been synced, you can remove it from the device so that you can download the latest available dataset for the next day's work. Clicking the 3 dots button at the top right of the main screen brings up a menu. Clicking the Manage option takes you to a screen which allows you to manage data that you've downloaded to the device.



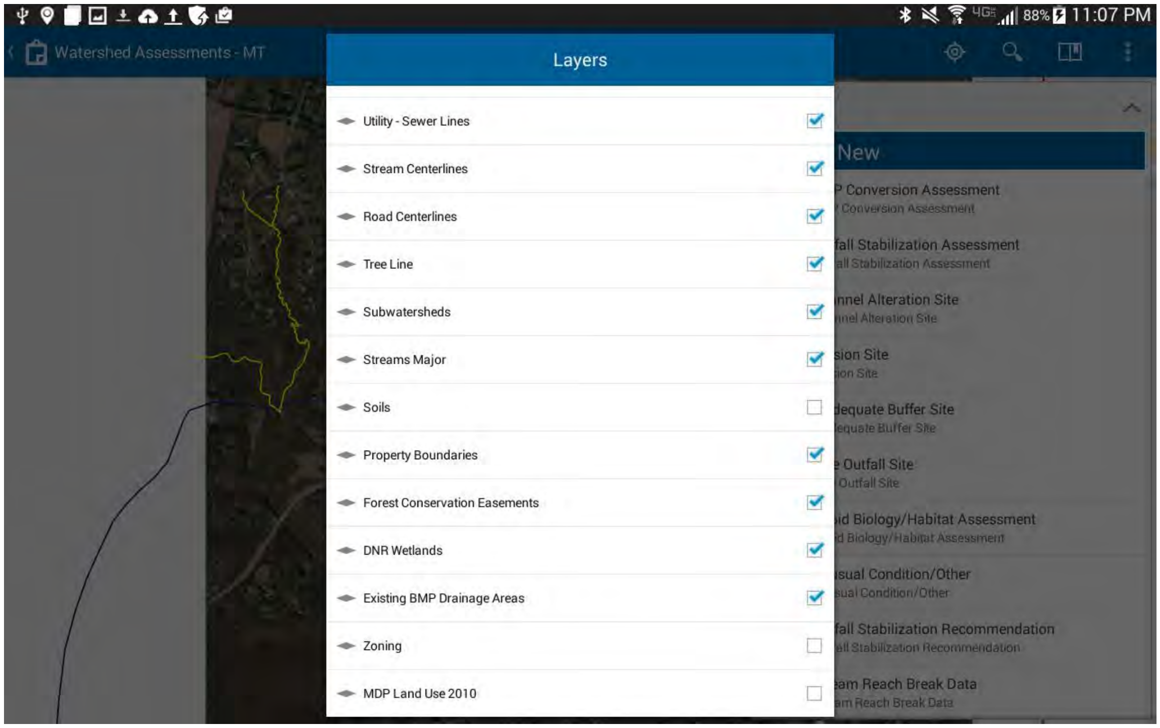
b. The maps shown on this Manage screen represent data you have downloaded to your device. Before you can download updated data to your device, you must first remove any data you currently have stored on the device. To do that, click the "Remove" button at the bottom right. A dialog box like the one below will pop up and ask if you wish to remove only the features or feature and basemap. It is recommended that you choose "remove features only". This will reduce the amount of data you have to download each time. Once your data has been removed, you may hit the back arrow at the top left to take you back to the main map page, where you can download updated data.



5. Working within the map

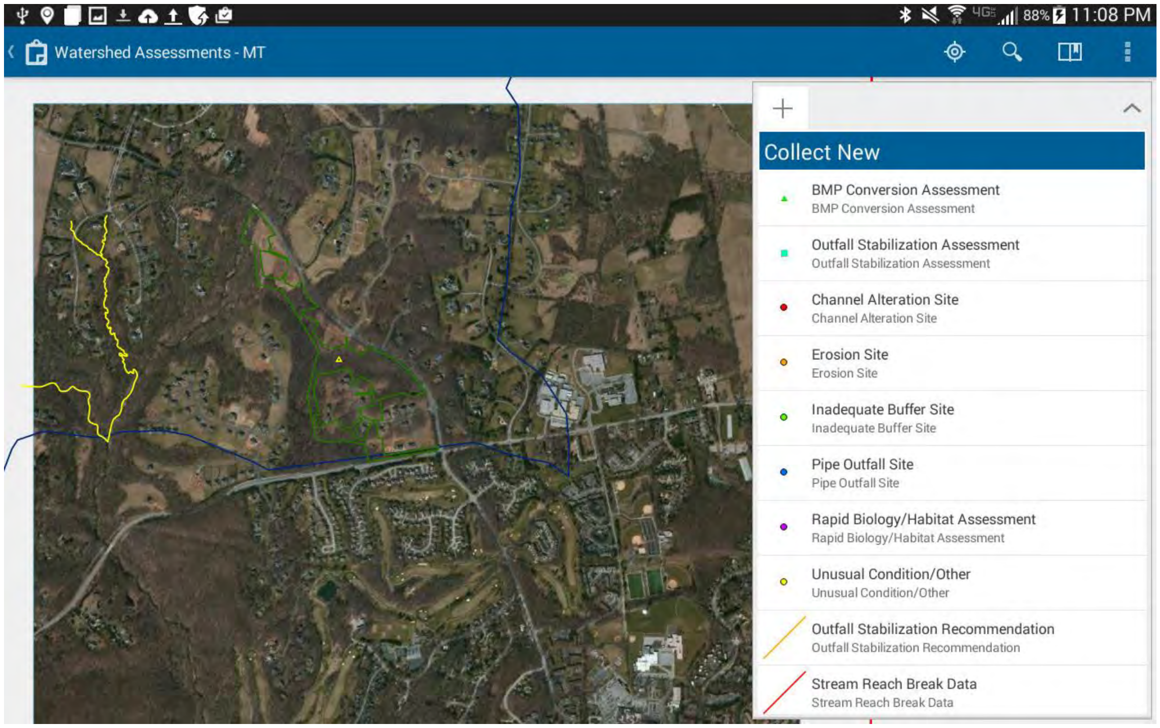
a. Toggling layers on and off

To toggle layers on and off, click the 3 dots at the top right and click the "Layers" option. This brings up a list of all layers available in the current map. Checking or unchecking a layer will make it visible or hidden respectively.



b. **Collecting New Features** (used for collecting data for Stream Reach Break Data, stream features such as Erosion Points and Inadequate Buffer, and all types of Recommendations)
On the right side of your screen you will see a list of available features that you can collect. Only layers that are visible will be shown in this list, so by hiding layers, you can trim down the number of options you see here. Clicking one of the feature types will collect a new feature of that type.

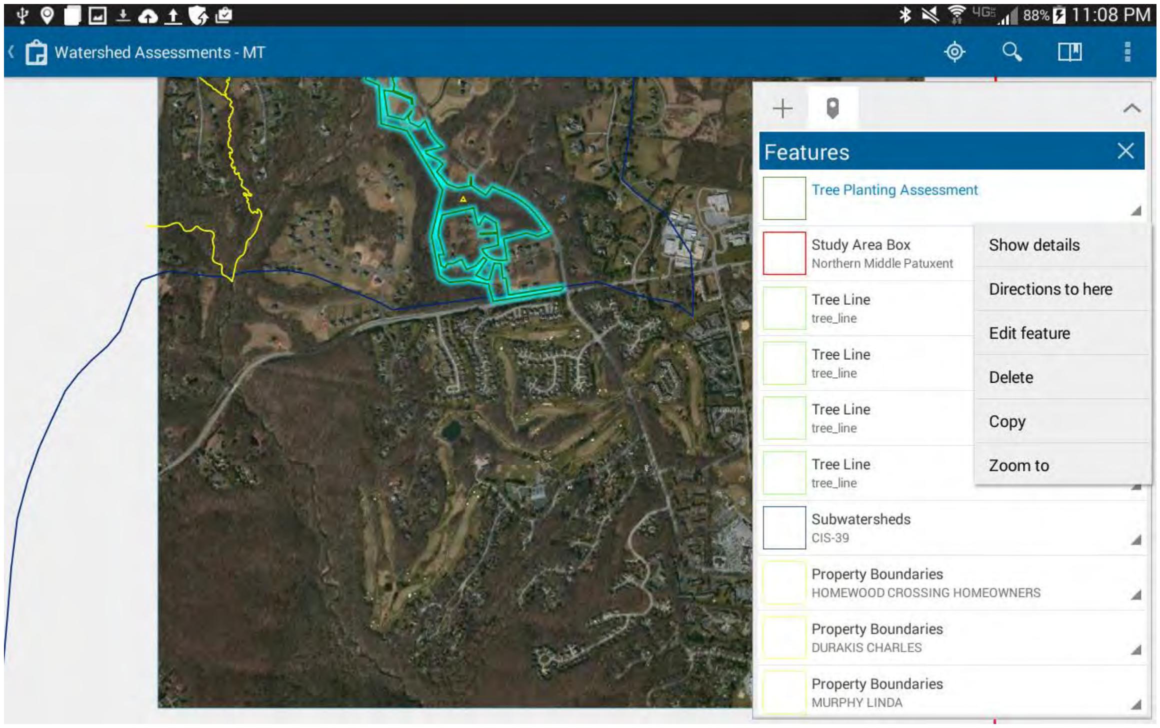
Warning: *When collecting new features, touching the map accidentally will move the location of the feature you are collecting to wherever you touched. You can hit the undo button (U shaped arrow) at the top right to undo any accidental movement of features.*



c. **Updating existing features** (used for collecting data for BMP Conversion Assessments, New BMP Assessments, Tree Planting Assessments, and Outfall Stabilization Assessments)
Clicking on the map will select all features near where your finger touched the map. It brings up a new tab on the right panel with a marker symbol at the top. You may click the gray triangle at the bottom right of a feature and click the "Edit Feature" option to enter edit mode on that feature.

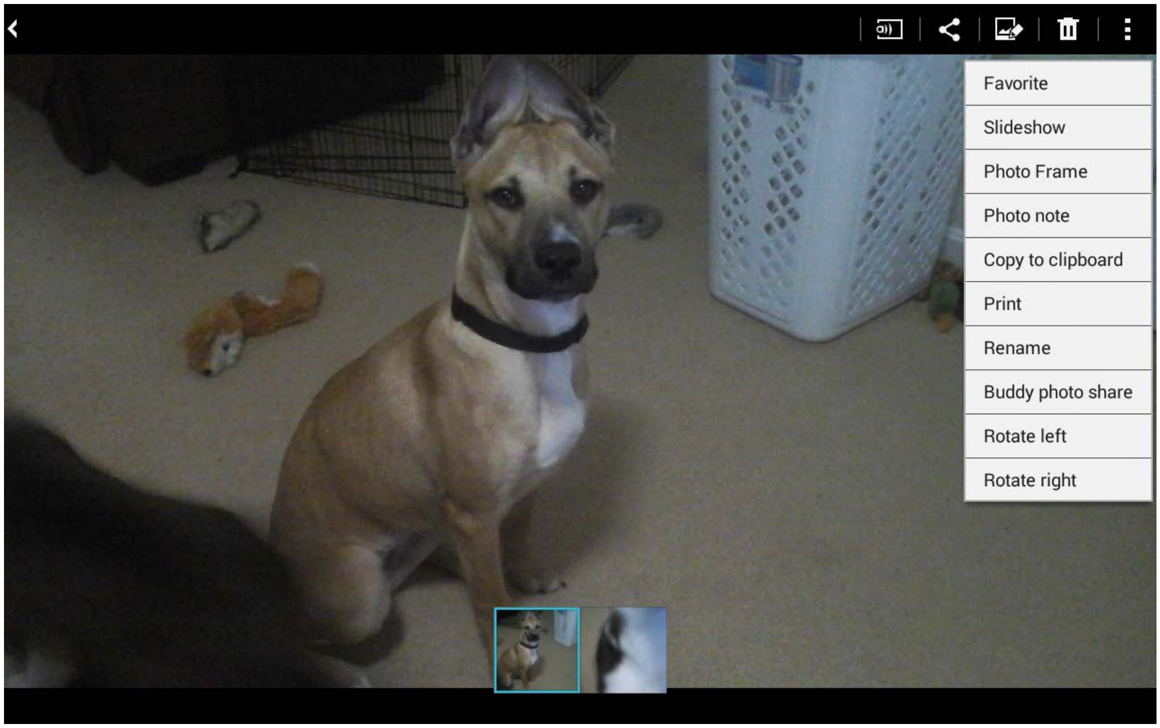
Warning: *When collecting new features, touching the map accidentally will move the location of the feature you are updating to wherever you touched. You can hit the undo button (U shaped arrow) at the top right to undo any accidental movement of features.*

The location of existing features should not be updated in the field. *If an existing feature is at the incorrect location, it is recommended that you collect a new feature of the same type, give it the same ID, and note in the comments that the location should be updated. Your assessment should still be performed on the existing feature.*

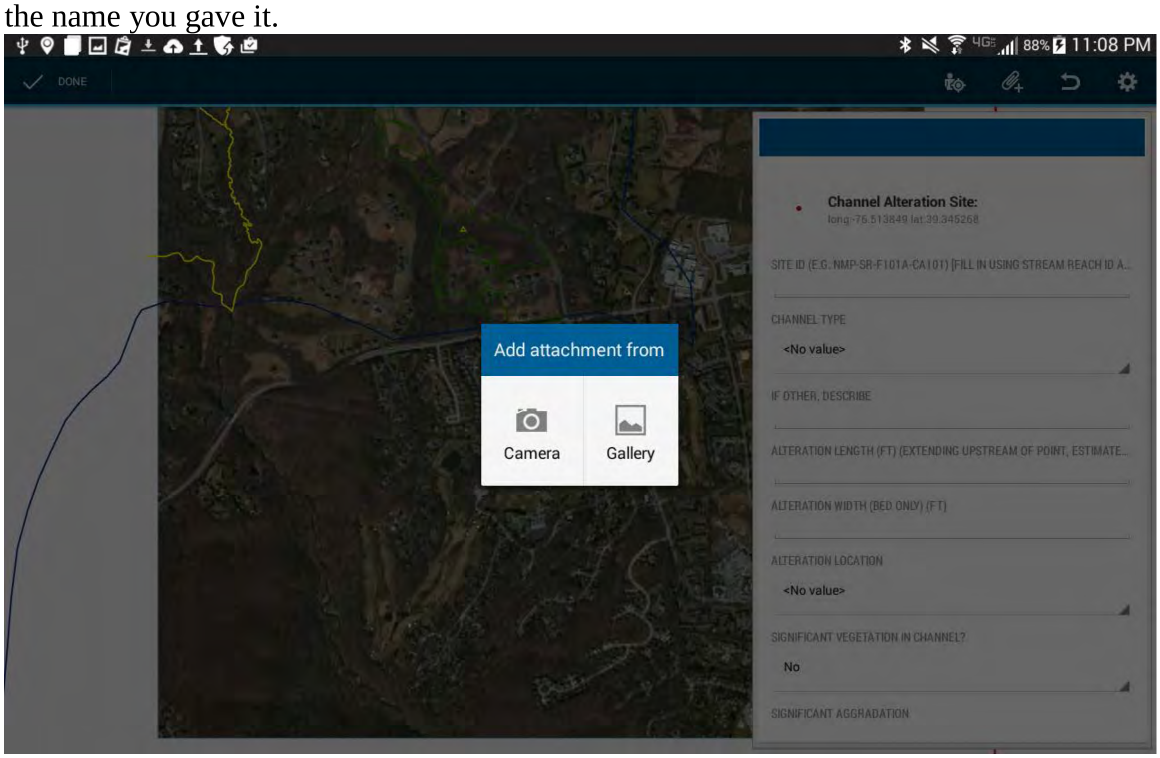


d. Renaming Photos

Renaming photos is a two part process. Specific instructions vary from device to device, so your device may differ slightly from the screenshots shown below. First, you must take the photo using the camera app on your device. This saves the photo to the device. Next, you must navigate to the photo using the Gallery app on your device. Opening the photo in this way should allow you the option to rename the photo. In the screenshot below, the 3 dot symbol at the top right brings up a menu that has a “Rename” option. We recommend naming with site name and description, e.g., “SLP-OF-F701 downstream”.

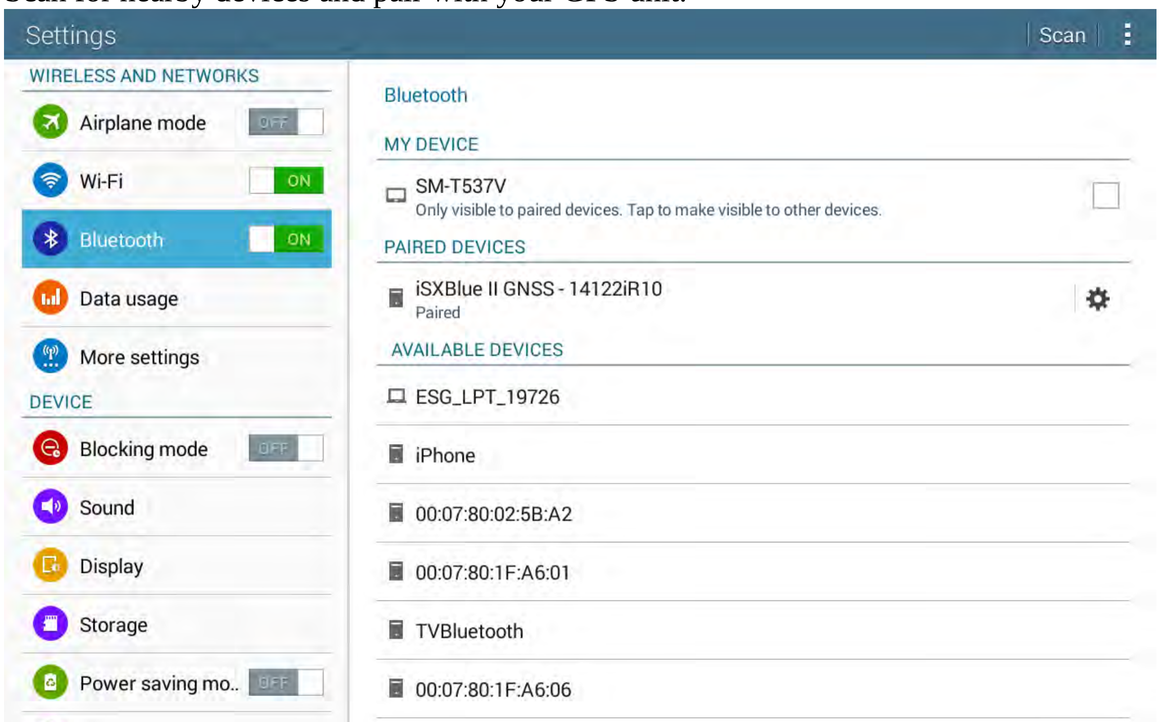


Once the photo is taken and renamed, return to the Collector app and click the paper clip button at the top right. Choose the "Gallery" option and navigate to the photo you just renamed. This will attach the photo with the name you gave it.



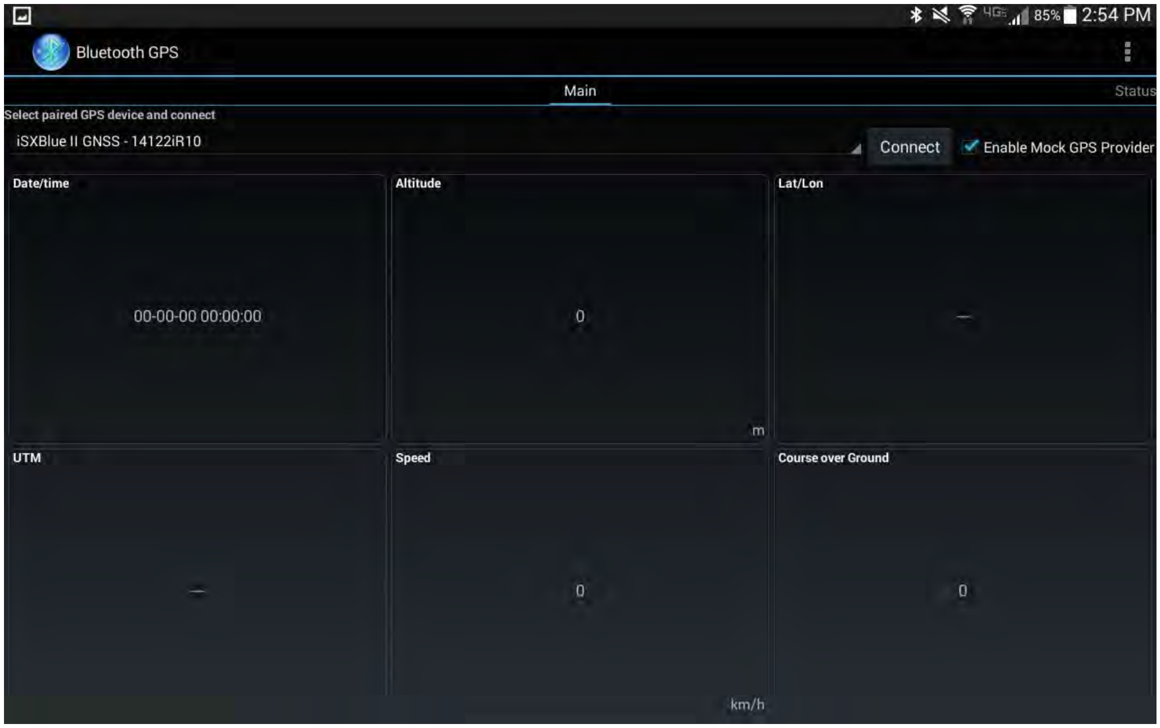
Alternatively, if you aren't concerned with the name of the photo, you can take the photo directly through the Collector app by selecting the "Camera" option from the screenshot above. Photos captured in this manner won't be able to be renamed.

6. **Connecting GPS Device to an Android Tablet** (Note that these instructions may vary slightly depending on your tablet and GPS)
   a. **Install the Bluetooth GPS App**
   b. **Pair your Bluetooth enabled GPS to your tablet.**
   On your Android device, open your settings and click the Bluetooth tab. Scan for nearby devices and pair with your GPS unit.



   c. **Using the Bluetooth GPS app**
   Once your device is successfully paired, open the Bluetooth GPS app. At the top left, you will see a dropdown to select the paired device. Select your GPS device. Ensure that "Enable Mock GPS Provider" is checked, then click the "Connect" button. If successful and your GPS is getting a signal, the Datetime, Altitude, and Lat/Long boxes will populate with actual values.

   To test that your GPS device is indeed overwriting the internal GPS of the tablet, you can lay your GPS down and walk away from it with the tablet. If your position on the map remains stationary, then the pairing is successful. If your position updates as you walk, that means the device is still pulling from the internal GPS.



Contact Info:
Author: Joe Knieriem
Firm: McCormick Taylor
E-Mail: jpknieriem@mtmail.biz
Office Line (preferred): 410-662-7464 (ext. 1640)
Cell Phone (emergencies): 443-670-7392

Alternate Contact:
Field Coordinator: Mark Voli
Firm: Versar
E-Mail: mvoli@versar.com
Office Line: 410-740-6062
Cell Phone (if urgent): 610-517-0985

E. Landowner Notification Letter

HOWARD COUNTY DEPARTMENT OF PUBLIC WORKS
6751 Columbia Gateway Drive, Suite 514 ▪ Columbia Maryland 21046 ▪ 410-313-6444

Mark DeLuca, P.E., Deputy Director
Chief, Bureau of Environmental Services
mdeluca@howardcountymd.gov

FAX 410-313-6490
TDD 410-313-2323

February 25, 2015

Re: Little Patuxent River and Middle Patuxent River Watershed Study

Dear Occupant:

The Howard County Department of Public Works will soon be undertaking a comprehensive watershed assessment within the Middle Patuxent River and the Little Patuxent River watersheds. The watershed assessment is being performed to create an inventory of the natural resources as well as existing problems (erosion, trash, lack of wooded stream buffers, etc.) within these watersheds. Another result of the assessment will be a list of potential projects that can be done to protect and restore these resources, address the problems, and ultimately improve water quality in our streams and water bodies.

The County welcomes participation in development of the study from watershed residents, businesses, and organizations. Public workshops will be planned after the initial field work has been completed to present the results from the assessment and to discuss proposed restoration projects suggested by the study. Exact workshop dates will be advertised when the dates are finalized.

Field crews of two or three County employees or consultants will conduct their assessments on public property to the extent possible but there may be a need for them to be on private property briefly to access certain sites. You may see a crew briefly in your neighborhood. The field crews will be there only to assess existing conditions through visual observations, taking photos, and preparing sketches. Field crews will use extreme care when on private property.

The County anticipates that the majority of the field assessment work will occur during the March to May 2015 time frame with the possibility of a quick second visit to verify field information later in summer 2015.

If you have any specific questions or concerns or would like additional information regarding the watershed assessment, please contact the County by emailing khargadin@howardcountymd.gov or calling 410-313-6444.

F. Field Reports from Consultant Field Teams

Howard County Watershed Assessments Field Summary Report

Northern Middle Patuxent and Dorsey Run Watersheds

June 1, 2015

Prepared for:

Howard County Government

Stormwater Management Division

Bureau of Environmental Services

6751 Columbia Gateway Drive, Suite 514

Columbia, Maryland 21046-3143

Prepared by:

McCORMICK TAYLOR

509 South Exeter Street, 4th Floor

Baltimore, Maryland 21202

1.

Table 1.1 Number of field assessments completed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Northern Middle Patuxent**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	12	12	0	12
New BMP	7	7	0	7
Stream Restoration	16.8 miles	15.9 miles	0 miles	15.9 miles
Tree Planting	10	10	18	28
Outfall stabilization	4	4	0	4

Table 1.2 Number of field assessments completed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Dorsey Run**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	43	43	0	43
New BMP	43	42	0	42
Stream Restoration	4.3 miles	3.9 miles	0.4 miles	4.3 miles
Tree Planting	5	5	3	8
Outfall stabilization	30	26	3	29

2. If there were sites that could not be assessed in the field, please summarize primary reasons.

<u>BMP Sites:</u>

- One site could not be assessed in the field due to denied access to the property by the landowner.

<u>Stream Restoration Sites:</u>

- Portions of 19 stream restoration sites could not be evaluated in the field.
- Primary reasons assessments could not be made include:
  - Access not granted by the landowner.
  - Site was not associated with a stream, but with a wetland system or pond.

- Livestock (bull or electric fences) present on site.
- One stream site was not assessed as it was noted to be a citizen erosion complaint, but no erosion was found and the downstream portion was a wetland system. In this case the adjacent unmarked stream, which appeared to have been the intended target of the citizen erosion complaint, was assessed instead.

Tree Planting Sites:

- All sites were evaluated.

Outfall Stabilization Sites:

- 4 sites were not assessed.
- Primary reasons assessments could not be made include access not granted by the landowner, fencing, and/or no outfall in vicinity of point.

3. Other comments about data or assumptions made.

BMP Sites:

The following information should be noted for BMP Sites:

- Facilities that did not exist:
  - DOR-BC-F902 (Grass space behind Montgomery Irrigation facility)
  - DOR-BC-F923 (Parking lot on site of Bowles Fluidics)
- Facility already under design for conversion:
  - DOR-BC-F933 (CSX property)
- Facilities that were moved:
  - NMP-BC-F104 to 12056 Broad Meadow Lane, Clarksville, MD (was at facility on 12106 Dusk View Ct where NMP-BC-F105 is located)
  - NMP-BC-F108 to 12975 Livestock Rd, Sykesville, MD (was on side of I-70 where existing BMP point is still located)
- Sites with new facilities/already treated:
  - DOR-NB-F909 recently reconstructed entire site. Two Bioretention facilities, underground storage, stormceptors found.
  - DOR-NB-F935 several existing facilities are on site but drainage areas may not be represented. Several underground facilities/stormceptors located in parking lots.
  - DOR-NB-F922 and DOR-NB-F918 entire site drains to recently reconstructed facility (pond is in database as existing facility, drainage area is just incorrect)

Tree Planting Sites:

- 3 capped landfill sites were assessed from the gated fence line.

Outfall Stabilization Sites:

- Outfall stabilization points at 11 sites were moved from a pond riser or inlet structure to a nearby outfall. Additionally, 2 pond inlets were assessed at the original outfall stabilization assessment location before adding 2 site assessments at outfalls from that pond. In 3 cases, the pond outfall could either not be found or accessed due to landowner constraints; instead the pond structures were assessed.

4.

Table 2.1 Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Northern Middle Patuxent**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	12	4	5	3
New BMP recommendations	6	0	1	5
Stream Restoration recommendations	79	14	48	17
Tree Planting recommendations	38	15	15	8
Outfall stabilization recommendations	2	0	1	1

Table 2.2 Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**McCormick Taylor**			
Study Area Name*	**Dorsey Run**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	40	21	13	6
New BMP recommendations	170	21	74	75
Stream Restoration recommendations	24	13	7	4
Tree Planting recommendations	13	2	2	9
Outfall stabilization recommendations	10	2	7	1

5. **General comments about the types of recommendations made.**

BMP Sites:

- Recommended conversions include wet ponds, wetlands, bioretention facilities, sand filters, and rain gardens. These facilities were recommended based on the land use in the area, existing conditions (soil, standing water, vegetation, etc.), and depth of outfall, riser, or inlet structure.
- Recommended new BMP sites include wet ponds, wetlands, bioretention facilities, sand filters, tree box filters, swales, pavement removal, underground sand filters, and rain gardens. New BMP sites were recommended based on available space with a reasonable drainage area, existing utilities (avoiding significant visible conflicts), storm drain location, and existing land use.
- A number of sites in both the BMP conversions and new BMP sites have high potential based on the need for repair, the feasibility of construction and access, minimal conflicts, size of impervious drainage area, and land use in vicinity.

Stream Restoration Sites:

- Stream restoration is generally recommended in reaches with active erosion, threatened infrastructure, and limited habitat.
- Overall, 14 stream reaches in the Northern Middle Patuxent watershed and 13 stream reaches in the Dorsey Run watershed have high stream restoration potential. Of these high priority reaches, those with the most potential are listed below:
    - DOR-SR-F906 is a heavily incised and actively eroding channel which is currently threatening private property as the stream continues to erode and meander.
    - DOR-SR-F909, DOR-SR-F910, and DOR-SR-F911 are experiencing moderate to severe erosion, an abundance of depositional areas, and pools filled with fine sediment (primarily silt) indicating large sediment loads upstream. There may be good restoration potential north of Tamar Drive as well.
    - DOR-SR-F912 has moderate to severe erosion throughout include degradation and lateral migration. Restoration could include outfall stabilization and BMPs in several locations and the length may be extended further downstream.
    - NMP-SR-F133, NMP-SR-F136, and NMP-SR-F145 have severe bank erosion, numerous tree falls, lack of riparian vegetation, and moderate bar deposition. Access may be relatively easy.
    - NMP-SR-F135 has moderate to severe erosion including headcuts and is highly sinuous.
    - NMP-SR-F152 is experiencing severe active erosion along the left bank. Homeowners mow to top of bank, but expressed interest in the County planting a stream buffer.
    - NMP-SR-F168 and NMP-SR-F-169 are the mainstem of the Northern Middle Patuxent and a large tributary to the mainstem, both experiencing severe erosion throughout. This is likely a more expensive restoration opportunity than lower-order streams.

Tree Planting Sites:

- Tree planting recommendations were ranked high when located in cleared areas within or adjacent to existing Howard County Forest Conservation Easements and some sites that are located in areas adjacent to highly erosive stream segments. Cleared areas containing recent tree plantings that exhibited low species survivability were specifically recommended for replacement plantings.

Outfall Stabilization Sites:

- Outfall stabilization recommendation types include riprap, outfall and apron replacement, and regenerative stormwater conveyance.
- Overall, only 2 outfalls located in the Dorsey Run watershed have high outfall stabilization potential. One is in need of structure replacement and riprap, while the other is not recommended at the outfall itself, but a regenerative stormwater conveyance upstream of the inlet.

6. **List of sites reported to Howard County because of suspected illicit discharges, safety concerns, or other reasons for County followup.**
   - Homeless campsite found at DOR-SR-F901, near the intersection of I-95 and MD-175.
   - Recommend county coordination with the Columbia Association stream assessments. A field crew ran into a U.S. Fish and Wildlife employee working for the Columbia Association at DOR-SF-F912. The Columbia Association assessment appears to be similar to the Howard County assessment.
   - Homeless camp located in the woods on north side of Holiday Inn parking lot at MD 175 and US 1 and small wooded area bordered by Holiday Inn, Exxon Station, Burger King, and La Quinta Inn and Suites.

7. **Other comments/explanations related to data collected.**
   - May be helpful to understand site selection process. Some selected stream sites appeared to completely stable with no problems while other streams not selected appeared to have more problems or showed some form of impairment. Due to schedule constraints and property owner permissions, these additional stream sites were not assessed. Some segments were very short with difficult access and it was challenging to understand how the site could be considered for a restoration project.
   - Consider performing stream assessments on entire drainage network within local drainage areas or subwatershed areas.
   - Consider simplifying database entries and/or incorporating automated data population for some fields that are populated multiple times for a given site (e.g. weather). Utilities, particularly for new BMP sites, are another example where data on utilities could include one entry for the type of utilities that conflict or possibly conflict with BMP opportunity.

Biohabitats
The Stables Building
2081 Clipper Park Road
Baltimore, MD 21211
410.554.0156
www.biohabitats.com

MEMORANDUM

Date: June 4, 2015

To: Nancy Roth, Versar
Kelly Hargadin, Howard County, Storm Water Management Division

From: Biohabitats, Inc.
Stormwater Maintenance & Consulting

RE: **Howard County Watershed Assessments in 2015**

Subject: **Southern Middle Patuxent Field Summary Report**

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1. Number of Field Assessments Completed

Table 1. Number of field assessments completed				
Consultant Firm Name	**Biohabitats and Stormwater Maintenance and Consulting**			
Study Area Name	**Southern Middle Patuxent**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	21	21	1	22
New BMP	29	28	0	28
Stream Restoration	18.42 miles	18.37 miles	0 miles	18.37 miles
Tree Planting	11	7	7	14
Outfall stabilization	36	36	8	44

2. Primary Reasons that Sites Could Not be Assessed

Stream Restoration

- SMP-SR-F312 (0.05 miles) was visited but not assessed. Construction of a bottomless arch culvert crossing and associated stabilization work was in progress at the time of the assessment.

Tree Planting

- SMP-TP-303, 304, & 305 in the Middle Patuxent Environmental Area (MPEA) were not assessed. MPEA is actively managing these sites as meadow or old field for American woodcock habitat.
- SMP-TP-310 has already been planted with the exception of utility and SWM easements.

Outfall Stabilization

- SMP-OF-F311 is a duplicate site; no outfall was found. (Assessed SMP-OF-F314)
- SMP-OF-F315 is a duplicate site; no outfall was found. (Assessed SMP-OF-F314)
- SMP-OF-F320, no outfall to assess.
- SMP-OF-F316, no outfall to assess.

New BMP Opportunities

- SMP-NB-F322 was not assessed as access was denied at the gate.

3. Other Comments about Data or Assumptions Made

Stream Restoration

- The assessed reaches along the mainstem of the Middle Patuxent (SMP-SR-F306, F307, F308, F352, F353, F359, and F361) exhibit a channel form characteristic of a post agricultural age alluvial stream channel. These channels have historically accreted 4-6 feet of fine sediments across the valley bottom and have subsequently incised through that sediment as the supply of sediment from the watershed reduced with better land use practices. The contemporary channels typically exhibit raw 4-6' high banks and a high fine sediment load. For these reasons, restoration opportunities were not identified for the individual reaches assessed; however a focused phased restoration of the mainstem of the Middle Patuxent may be feasible and yield significant nutrient and sediment load reductions.
- In cases where the bank erosion was similar in character and flip flopped from left bank to right bank the length of erosion on left and right banks summed for the respective banks and a total length of erosion was included in the notes. This total length of erosion may be less than the sum of erosion on left and right banks if overlap occurred.
- An additional 12 Stream Restoration Assessment reaches totaling approximately 1.35 miles were added in post-processing to account for outfall restoration opportunities that exceeded the 200 LF threshold or outfall reaches that flowed to a significantly degraded receiving stream. Reach assessments were not completed for these reaches, but Stream Restoration Opportunity polygons were placed to delineate the opportunities.

Tree Planting

- Private property sites, we assumed that property owner was okay with planting.
- Watering was assessed as onsite sources available or access for a truck.
- Additional sites added in the field were identified during the stream restoration assessment. The tree planting assessment polygon for the additional sites did not always match property boundaries like the assigned sites. Since the additional sites were identified during the stream restoration assessment, the tree planting assessment polygons for additional sites could cross several properties and/or only include portions of properties adjacent to a stream.
- Regional forest association was based on USDA Forest Service Potential Natural Vegetation Groups, version 2000, available at http://www.firelab.org/sites/default/files/images/downloads/pnv2000.pdf.
- No optional sketches of the tree planting areas were completed.

Outfall Stabilization

- It was assumed that 'distance from outfall to stream channel' was the vertical distance from the invert of the outfall pipe to the immediate receiving channel (outfall channel).
- 'SMP-OF-F313' is the outfall for a newly constructed underground sand filter.

New BMP Opportunities

- 'River Hill Rain Garden' is an existing BMP, not a new recommendation, but was created as a recommended footprint to bring to County's attention
- Base maps were outdated and did not reflect active construction sites, new buildings, new BMPs, and/or had incorrect drainage areas, etc. It was assumed that a newly developed site or active construction site meets current stormwater standards for water quality. See below for summary.

Site ID	**Active or New Construction not reflected in GIS**
SMP-NB-307	Southern portion of facility drains to an existing detention structure
SMP-NB-F310	Site drains to an existing wet pond and bioretention facility
SMP-NB-F315	Site is treated; drains to an existing wet pond.
SMP-NB-F316	Site drains to newly constructed wet pond.
SMP-NB-F317	Site has an approved redevelopment plan with approved BMPs
SMP-NB-F318	Site is treated; drains to an existing wet pond.
SMP-NB-F319	Site is treated; drains to newly constructed wet pond (same as F326).
SMP-NB-F321	Site is under active development.
SMP-NB-F326	Site is treated; drains to newly constructed wet pond (same as F319).
SMP-OF-F313	Newly constructed underground sand filter and outfall.

BMP Conversions

- Four sites assessed have insufficient capacity and do not offer retrofit opportunities (SMP-BC-F305; SMP-BC-F313; SMP-BC-F317; SMP-BC-F321)

4. Number of Recommendations Made At Field Sites

Table 2. Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**Stormwater Maintenance and Consulting**			
Study Area Name	**Southern Middle Patuxent**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	21	4	7	10*
New BMP recommendations	55	8	31	16
Stream Restoration recommendations	91	28	45	18
Tree Planting recommendations	20	13	7	0
Outfall stabilization recommendations	18	8	9	1

5. General Comments about the Types of Recommendations Made

Stream Restoration

- Over 9 miles of stream restoration opportunities were identified by the field crews. The average project length was approximately 1000 LF. These opportunities varied widely from livestock fencing and straight forward gully or bank repairs to significant restoration projects along the higher order stream reaches. Field crews generally thought that tree impacts could be minimized and only 4 sites (F328, F329, F335, and F363) totaling about 0.5 miles of opportunities would result in significant tree impacts. The overall access ratings were moderate to easy, with only 12 sites (approximately 1.2 miles) rating in the significant range.
- Twelve additional stream restoration opportunities totaling over 1 mile were associated with the outfall and BMP assessments. The average length of these opportunities was approximately 500 LF and the restoration potential generally scored medium with some constraints and moderate tree impacts.

Tree Planting

- Of the sites that were rated high restoration potential, five (SMP-TP-F308, F307, F402, F403, and F406) appeared to be the best opportunities. Sites F308 and F307 were at churches, so some coordination of the planned use of these spaces will be necessary.

Outfall Stabilization

- Ten of the eighteen outfall stabilization recommendations were proposed as Regenerative Stormwater Conveyance. Twelve of the assessed outfalls were candidates for stream restoration and accounted for with stream restoration recommendation polygons.

New BMP Opportunities

- New BMP Recommendations were typically filtering practices or bioretention (39). If space was very limited green roofs were recommended but prioritized as low (4). Some site recommendations require parking spot elimination.

BMP Conversions

- BMP Conversion recommendations were typically sand filter or bioretention for existing dry pond conditions. If soils appear hydric with wetland vegetation, recommended to convert to wet pond or wetland.

6. List of Sites Reported To Howard County Because Of Suspected Illicit Discharges, Safety Concerns, or Other Reasons for County Follow-Up

- County was notified of a turbidity issue in Hammond Branch on April 17, 2015. Before and after photos showing a rapid increase in turbidity was sent to the County. These were taken at Hammond Parkway between 3:45pm (before pictures) and 3:55pm (after pictures). This information was forward to Construction Inspection, which visited the site and found that the increase in turbidity was due to construction and sediment control measures installed per the grading permit.
- County was notified of a sinkhole directly above the outfall barrel of a pond while assessing ‘SMP-BC-F317’. County was previously aware of this issue and working with the property owner.
- County was notified that a pond near assessment ‘SMP-NB-F316’ had missing manhole lids on the outlet control structure (2).
- County was notified of piping along with severe corrosion of an outfall barrel at a pond on River Hill High School property. Issue was found while assessing ‘SMP-NB-F328’. County and school was previously aware of the issue.
- County was notified of illicit discharge at the Joseph Square Shopping Center 5467 Harpers Farm Road, Columbia, MD 21044 while assessing ‘SMP-BC-310’. The message was forwarded to Angela M. who handles illicit discharges for the county.

7. Other Comments/Explanations Related to Data Collected

Overall

- Unless a unique opportunity was presented, photos were not generally attached to Stream Restoration Opportunities, New BMP Recommendations, and Outfall Stabilization Recommendations because they are attached to the relevant assessment features.

Stream Restoration

- During QA/QC, it was determined that three site assessment forms (SMP-SR-F322B-ES002, SMP-SR-F330C-ES007, and SMP-SR-F303B-PO001) do not have photos in the geodatabase submitted on June 4, 2015. These sites will be revisited and photos will be uploaded to the web map or forward via email for upload within the next week.
- SMP-SR-F347-UC001 – This point was recorded to document potential erosion within a stream channel adjacent to an assessed reach (SMP-SR-F347). The assessed reach exhibited no signs of erosion, so we were not sure if it may have been mapped incorrectly.
- SMP-SR-F326A-ES001 – The channel was braided in this section and only the cutoff channel was mapped for assessment. The mapped channel was stable; however, the channel to the east exhibited significant channel erosion as documented by this point.

Outfall Stabilization

- Some outfall stabilization assessment sites require local repair or stabilization, but did not warrant a full outfall stabilization recommendation as the receiving channel appears stable. These include:

Site ID	**Name**	**Local Repair required**
SMP-OF-F310	Trotter Ridge	minor roadside rills
SMP-OF-F302	River Wood Dr	corroded, barrel, associated with SR-F362
SMP-OF-F307	New Hope Church	right side of Gabion, New Church
SMP-OF-F328	Rosemont HOA	Local Stabilization (headwall, channel ok)
SMP-OF-F326	Palace Hall	downstream end of apron
SMP-OF-F331	Linden Chapel	Budget for Pipe Repair
SMP-OF-F327	Palace Hall	right side of gabion, recent development
SMP-OF-F312	9549 Washington Blvd	headwall undermined

New BMP Opportunities

- Some sites appear to be industrial sites and may be subject to NPDES 12SW General Permit: SMP-NB-F304 and SMP-NB-F305 both (12070 and 12024 Hall Shop Road respectively); SMP-NB-F310 Nestle Factory, SMP-NB-F323 (9549 Washington Blvd). The auto salvage yard, SMP-NB-F305, likely has illicit discharges during runoff events.

Attachment: Numbers of Field and Desktop Sites Assigned

Table A. Estimates of field effort for identifying opportunities, total and by watershed study area - based on site selection (REVISED 25FEB2015)						
		Watershed Study Area				
	Total for Five Watershed Study Areas	Northern Middle Patuxent	Southern Middle Patuxent	Norther n Little Patuxent	Southern Little Patuxent	Dorse y Run
	# sites	# sites	# sites	# sites	# sites	# sites
	(or miles)	(or miles)	(or miles)	(or miles)	(or miles)	(or miles)
Convert existing BMPs (# BMP facilities)	160	12	21	11	73	43
Opportunities for new BMPs for untreated impervious areas (# sites)	207	7	29	52	76	43
Potential stream restoration (# stream miles)	78	17	18	24	15	4
Potential tree planting sites (# sites)	46	10	11	16	4	5
Outfall stabilization (# outfalls)	202	4	36	37	95	30
Total (counting 1 stream mile = 1 site)	693	50	115	140	263	125

Field Data Summary

Howard County Watershed Assessments 2015

Southern Little Patuxent River Watershed

Prepared for
Howard County Watershed Management Program
Howard County Department of Public Works
Bureau of Environmental Services
Stormwater Management Division

Prepared by
Versar, Inc.
Ecological Sciences and Applications
9200 Rumsey Road
Columbia, MD 21045

June 2015

Southern Little Patuxent Field Summary
June 22, 2015

1. Number of field assessments completed

Table 1. Number of field assessments completed				
Consultant Firm Name	**Versar**			
Study Area Name*	**Southern Little Patuxent**			
Type	**# Sites (or Stream Miles) Assigned (from Table A below)**	**# Pre-Assigned Sites (or Stream Miles) that Were Completed**	**# Additional Sites (or Stream Miles), Added in the Field and Completed**	**Total # Sites (or Stream Miles) Completed**
BMP conversion	73	69	2	71
New BMP	76	72	1	73
Stream Restoration	15 miles	13.7 miles	1.2 miles	14.9 miles
Tree Planting	4	4	6	10
Outfall stabilization	95	82	14	96

2. If there were sites that could not be assessed in the field, please summarize primary reasons.

BMP Conversion Assessments: All sites were visited, but 4 BMPs either could not be found or did not exist. A total of 8 sites did not have potential for conversion due to either already being state of the art facilities, having safety issues, or are back-up type flood control without the correct elevations to treat the first flush. One site was evaluated during a past study and was thus completed as a desktop assessment.

New BMP Assessments: Four sites (SLP-NB-F708, SLP-NB-F714, SLP-NB-F763, and SLP-NB-F775) that were only rooftops were merged with adjacent parking surfaces to create a single site. The number of pre-selected sites assessed were thus reduced by 4 to 72. Some sites or portions of sites appeared to be in error. For example, Oakland Mills High School (SLP-NB-F759) had a portion of an impervious surface on a parking lot subtracted out but there appeared to be no reason for including a patch nearby as they were both in the same drainage area.

Stream Restoration Assessments: One pre-assigned stream reach (SLP-SR-F728) that totaled 1.23 miles in length was not assessed because it is located on FCC property. Versar confirmed with the County that this reach was to be left out of the assessment pool.

Tree Planting Assessments: All pre-assigned sites were assessed, and several additional sites were assessed.

Outfall Stabilization Assessments: All of the 95 pre-assigned sites were visited, but 9 sites were duplicates (either the duplicate point was marking the same outfall twice, or the duplicate point was marking the downstream extent of the erosion surveyed during a previous SCA study), two sites could not be located (SLP-OF-F705 and SLP-OF-F788), one site was marking infrastructure that was not an outfall (SLP-OF-F755), and one site was marking a potentially submerged pond infall (SLP-OF-F712).

3. Other comments about data or assumptions made.

BMP Conversion Assessments: Two additional dry ponds were assessed due to their close proximity to a pre-assigned pond.

New BMP Assessments: One additional site was assessed due to its close proximity to a pre-assigned pond. The site consists of a large overflow parking lot that appears to get very little use and was thus recommended for impervious surface removal. The one Desktop New BMP Assessment Site that was assigned to Versar was evaluated in the field.

Stream Restoration Assessments: One additional stream reach located next to a Tree Planting Assessment site was fully assessed, and two additional stream reaches adjacent to BMP Conversion sites were photodocumented and added as Stream Restoration Recommendation sites due to the severity and longevity of erosion. The total length of stream assessed also includes outfall stabilization recommendations that extended beyond 200 feet.

Tree Planting Assessments: Six additional tree planting sites were found, three of which were discovered while conducting Stream Restoration Assessments, and the remaining three were discovered while conducting BMP Conversion Assessments.

Outfall Stabilization Assessments: A total of 14 additional outfalls were assessed during the study. 9 of these were added during Stream Restoration Assessments, 3 were added during New BMP Assessments, and two were added during BMP Conversion Assessments.

4. Number of site recommendation forms completed for field sites assessed

Table 2. Number of site recommendation forms completed for field sites assessed				
Consultant Firm Name	**Versar**			
Study Area Name*	**Southern Little Patuxent**			
		Field Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	62	38	23	1
New BMP recommendations	144	91	50	3
Stream Restoration recommendations	37 (23,920 ft)	22 (14,950 ft)	14 (8,920 ft)	1 (50 ft)
Tree Planting recommendations	21	17	2	2
Outfall stabilization recommendations	44 (4,005 ft)	22 (2,210 ft)	19 (1,630 ft)	3 (165 ft)

5. General comments about the types of recommendations made.

BMP Conversion Recommendations: The following BMP conversion types are recommended: 33 Wet Pond, 27 Non-Bioretention Filtering Practice, 23 Created Wetland, 12 Bioretention, 7 Infiltration, 7 Extended Detention, 4 Swale, and 1 Step Pool Conveyance. The total number of recommended conversions exceeds the number of assessed BMPs because multiple BMP conversion options are feasible at several sites.

New BMP Recommendations: The following new BMP types are recommended: 59 Bioretention, 48 Non-bioretention filtering practices, 24 Underground Storage, 23 Impervious Pavement Replacement, 12 Impervious Surface Removal, 3 Green Roof, 2 Infiltration, 1 Swale, 1 Wet Pond, and 1 Buffer Enhancement. The total number of recommended BMP facilities exceeds the number of assessed sites because multiple BMP opportunities are feasible at several sites.

Stream Restoration Recommendations: In general, stream reaches recommended for restoration contained either one (or multiple) instance(s) of severe bank erosion, or consistent minor to moderate bank erosion along with unsuitable instream habitat and threatened infrastructure (e.g. exposed utility pipes, power line poles located in the stream channel, etc.). In addition, several concrete channels were recommended for removal.

Tree Planting Recommendations: Tree Planting recommendations that are rated High or Medium typically target riparian areas and areas of existing forest that can be expanded. A few areas of open pervious land were also recommended for planting, but were rated lower due to the smaller potential for biological uplift at these sites.

<u>Outfall Stabilization Recommendations:</u> The following Outfall Stabilization types are recommended: 32 Regenerative Stormwater Conveyance, 7 Rip Rap, and 5 Drop Structure.

6. List of sites reported to Howard County because of suspected illicit discharges, safety concerns, or other reasons for County followup.

A sudsy discharge was observed while conducting an Outfall Stabilization Assessment for the outfall (SLP-OF-F708) associated with BMP HO101950 on 5/8/15. Field personnel inspected the BMP's drainage area, but could not identify a definitive source for the sudsy discharge. The County was notified of the issue immediately, and photos of the outfall were sent to County personnel at the end of the field day.

Field personnel discovered an unusual amount of water flowing over a stream bank in the vicinity of Rommel Drive and Gerwig Lane while conducting a Stream Restoration Assessment for SLP-SR-F732 on 5/13/15. The flow was followed up to a point where water was bubbling out of the ground approximately 100 feet east of the stream and 100 feet west of Rommel Drive. The County was notified of the issue immediately, and eventually discovered that a problem with a potable water line was the source of the bubbling water.

Outdoor washing of vehicles was observed at an auto care business located at 7248 Cradlerock Way, Columbia, MD while field personnel were conducting a BMP Conversion Assessment on 5/14/15. The County was notified of the issue immediately.

A sediment-laden discharge was discovered while conducting an Outfall Stabilization Assessment along Green Mountain Circle (SLP-OF-F766) on 5/19/15. The source of the discharge was discovered to be a pile of dirt associated with construction occurring along Twin Rivers Road, between Green Mountain Circle and Lynx Lane. The silt fence that was in place was compromised and allowing sediment to spill into the road and wash into a storm drain. The County was notified of the issue immediately.

Field personnel discovered a homeless camp within an outfall channel while conducting an Outfall Stabilization Assessment (SLP-OF-F716) behind 6560 Dobbin Rd. Columbia, MD on 5/19/15. The County was notified of the discovery the following morning.

7. Other comments/explanations related to data collected.

Ten of the 63 assigned desktop analysis sites were not previously visited by Versar, and thus full desktop assessments could not be performed.

8. Number of desktop assessments completed

Table 3. Number of desktop assessments completed			
Consultant Firm Name	**Versar**		
Study Area Name	**Southern Little Patuxent**		
Type	**# Sites (or Stream Miles) Assigned – see Table B below**	**Total # Sites (or Stream Miles) For Which Desktop Assessment was Completed**	**For These Sites, Number of Concept Plans Previously Prepared**
BMP conversion	63	53	25
New BMP	1	1*	0
Stream Restoration	NA miles	NA miles	NA miles
Tree Planting	NA	NA	NA
Outfall stabilization	NA	NA	NA
*evaluated in the field.			

9. Number of site recommendation forms completed for desktop assessment sites

Table 4. Number of site recommendation forms completed for desktop assessment sites				
Consultant Firm Name	**Versar**			
Study Area Name	**Southern Little Patuxent**			
		Desktop Assessment of Restoration/Retrofit Potential (# Sites)		
Type	**# Recommendations**	**High**	**Medium**	**Low**
BMP conversion recommendations	50	39	9	2
New BMP recommendations	NA	NA	NA	NA
Stream Restoration recommendations	NA	NA	NA	NA
Tree Planting recommendations	NA	NA	NA	NA
Outfall stabilization recommendations	NA	NA	NA	NA

Attachment. Numbers of field and desktop sites assigned.

Table A. Estimates of field effort for identifying opportunities, total and by watershed study area - based on site selection (REVISED 25FEB2015)

		Watershed Study Area				
	Total for Five Watershed Study Areas	Northern Middle Patuxent	Southern Middle Patuxent	Northern Little Patuxent	Southern Little Patuxent	Dorsey Run
	# sites (or miles)	# sites (or miles)	# sites (or miles)	# sites (or miles)	# sites (or miles)	# sites (or miles)
Convert existing BMPs (# BMP facilities)	160	12	21	11	73	43
Opportunities for new BMPs for untreated impervious areas (# sites)	207	7	29	52	76	43
Potential stream restoration (# stream miles)	78	17	18	24	15	4
Potential tree planting sites (# sites)	46	10	11	16	4	5
Outfall stabilization (# outfalls)	202	4	36	37	95	30
Total (counting 1 stream mile = 1 site)	693	50	115	140	263	125

Table B. Assigned "desktop/office visit" sites for Versar and KCI - data sheets to be filled out for sites assessed in previous studies, without field visit (or with only minimal field check).

	Total for Five Study Areas	Northern Middle Patuxent	Southern Middle Patuxent	Northern Little Patuxent	Southern Little Patuxent	Dorsey Run
Total "desktop/office visit" sites - Versar	64	5	15	10	30	4
Total "desktop/office visit" sites - KCI	22			22		

G. Tables Listing Individual Retrofit and Restoration Opportunities, with Scores and Rankings

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
NMP-BC-D115	BMP Conversion	Versar	13.5	10	6	8	8	32	
SMP-TP-F402	Tree Planting	Biohabitats	7.0	8	6	10	8	32	Yes
SMP-SR-F301	Stream	Biohabitats	14.7	10	3	8	10	31	Yes
NMP-TP-F107A	Tree Planting	McCormick Taylor	7.0	8	6	10	6	30	Yes
SMP-BC-D330	BMP Conversion	Versar	8.2	8	3	10	8	29	Yes
SR-12	Stream	McCormick Taylor	32.4	10	3	8	8	29	Yes
NMP-TP-F103D	Tree Planting	McCormick Taylor	5.4	8	6	10	4	28	Yes
SMP-BC-D329	BMP Conversion	Versar	4.5	6	6	8	8	28	
SMP-BC-F308	BMP Conversion	Biohabitats	3.8	6	6	8	8	28	Yes
SMP-OF-F306	Outfall	Biohabitats	2.0	4	6	10	8	28	Yes
SMP-OF-F309	Outfall	Biohabitats	1.0	4	6	10	8	28	Yes
SMP-OF-F330	Outfall	Biohabitats	1.0	4	6	10	8	28	Yes
SMP-TP-F301	Tree Planting	Biohabitats	1.7	4	6	10	8	28	Yes
SMP-TP-F407	Tree Planting	Biohabitats	1.0	4	6	10	8	28	Yes
NMP-BC-D113	BMP Conversion	Versar	7.6	8	3	10	6	27	Yes
NMP-BC-D117	BMP Conversion	Versar	3.2	6	10	5	6	27	
SMP-BC-F306	BMP Conversion	Biohabitats	1.0	4	10	5	8	27	Yes
SMP-SR-F313	Stream	Biohabitats	21.4	10	3	8	6	27	Yes

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
SMP-SR-F316	Stream	Biohabitats	28.3	10	3	8	6	27	Yes
SR-11	Stream	McCormick Taylor	15.1	10	3	8	6	27	Yes
SR-13	Stream	McCormick Taylor	23.7	10	3	8	6	27	Yes
SR-16	Stream	McCormick Taylor	19.5	10	3	8	6	27	Yes
SR-27	Stream	Biohabitats	19.9	10	3	8	6	27	Yes
SR-28	Stream	Biohabitats	15.4	10	3	8	6	27	Yes
SR-39	Stream	Biohabitats	17.4	10	3	8	6	27	Yes
SR-5	Stream	McCormick Taylor	16.8	10	3	8	6	27	Yes
SR-7	Stream	McCormick Taylor	11.6	10	3	8	6	27	Yes
SR-8	Stream	McCormick Taylor	32.7	10	3	8	6	27	Yes
SR-9	Stream	McCormick Taylor	17.5	10	3	8	6	27	Yes
NMP-OF-F102	Outfall	McCormick Taylor	0.9	2	6	10	8	26	Yes
NMP-SR-F101	Tree Planting	McCormick Taylor	0.9	2	6	10	8	26	Yes
NMP-SR-F123A	Tree Planting	McCormick Taylor	2.0	4	6	10	6	26	Yes
NMP-SR-F152B	Tree Planting	McCormick Taylor	1.1	4	6	10	6	26	Yes
NMP-TP-F104	Tree Planting	McCormick Taylor	0.2	2	6	10	8	26	Yes
NMP-TP-F106	Tree Planting	McCormick Taylor	1.1	4	6	10	6	26	Yes

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
SMP-BC-F303	BMP Conversion	Biohabitats	3.2	6	6	8	6	26	Yes
SMP-OF-F304	Outfall	Biohabitats	2.0	4	6	10	6	26	Yes
SMP-OF-F334	Outfall	Biohabitats	1.6	4	6	10	6	26	Yes
SMP-TP-F306	Tree Planting	Biohabitats	1.6	4	6	10	6	26	Yes
SMP-TP-F308	Tree Planting	Biohabitats	2.6	4	6	10	6	26	Yes
SMP-TP-F401	Tree Planting	Biohabitats	1.7	4	6	10	6	26	Yes
SMP-BC-D327	BMP Conversion	Versar	3.3	6	3	10	6	25	
SMP-OF-F333	Stream	Biohabitats	6.1	8	3	8	6	25	
SMP-OF-F405	Stream	Biohabitats	5.5	8	3	8	6	25	
SMP-SR-F302A	Stream	Biohabitats	6.1	8	3	8	6	25	
SMP-SR-F322C	Stream	Biohabitats	9.9	8	3	8	6	25	
SMP-SR-F345B	Stream	Biohabitats	9.2	8	3	8	6	25	
SMP-SR-F351B	Stream	Biohabitats	7.2	8	3	8	6	25	
SR-1	Stream	McCormick Taylor	22.7	10	3	8	4	25	
SR-14	Stream	McCormick Taylor	15.6	10	3	8	4	25	
SR-15	Stream	McCormick Taylor	36.3	10	3	8	4	25	
SR-17	Stream	McCormick Taylor	28.4	10	3	8	4	25	
SR-18	Stream	McCormick Taylor	18.7	10	3	8	4	25	
SR-19	Stream	McCormick Taylor	24.4	10	3	8	4	25	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
SR-2	Stream	McCormick Taylor	35.1	10	3	8	4	25	
SR-20	Stream	McCormick Taylor	40.2	10	3	8	4	25	
SR-21	Stream	McCormick Taylor	15.7	10	3	8	4	25	
SR-23	Stream	McCormick Taylor	30.9	10	3	8	4	25	
SR-26	Stream	Biohabitats	8.9	8	3	8	6	25	
SR-3	Stream	McCormick Taylor	21.8	10	3	8	4	25	
SR-4	Stream	McCormick Taylor	9.7	8	3	8	6	25	
SR-40	Stream	Biohabitats	17.2	10	3	8	4	25	
SR-44	Stream	Biohabitats	4.4	6	3	8	8	25	
SR-60	Stream	McCormick Taylor	10.2	10	3	8	4	25	Yes
NMP-SR-F104B	Tree Planting	McCormick Taylor	0.2	2	6	10	6	24	
NMP-SR-F105A	Tree Planting	McCormick Taylor	0.7	2	6	10	6	24	
NMP-SR-F124A	Tree Planting	McCormick Taylor	0.6	2	6	10	6	24	
NMP-SR-F133	Tree Planting	McCormick Taylor	0.1	2	6	10	6	24	
NMP-SR-F135B	Tree Planting	McCormick Taylor	0.2	2	6	10	6	24	
NMP-SR-F136	Tree Planting	McCormick Taylor	2.0	4	6	10	4	24	
NMP-SR-F141A-TP101	Tree Planting	McCormick Taylor	0.3	2	6	10	6	24	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
NMP-SR-F154A	Tree Planting	McCormick Taylor	0.3	2	6	10	6	24	
NMP-SR-F163	Tree Planting	McCormick Taylor	1.0	2	6	10	6	24	
NMP-SR-F166	Tree Planting	McCormick Taylor	2.0	4	6	10	4	24	
NMP-TP-F102A	Tree Planting	McCormick Taylor	0.2	2	6	10	6	24	
NMP-TP-F108A	Tree Planting	McCormick Taylor	0.2	2	6	10	6	24	
NMP-TP-F109	Tree Planting	McCormick Taylor	0.5	2	6	10	6	24	
NMP-TP-F110A	Tree Planting	McCormick Taylor	0.5	2	6	10	6	24	
SMP-NB-F305B	BMP New Footprint	Biohabitats	4.5	6	6	8	4	24	
SMP-NB-F323A	BMP New Footprint	Biohabitats	4.1	6	6	8	4	24	
SMP-OF-F403	Outfall	Biohabitats	1.9	4	6	10	4	24	
SMP-OF-F407	Outfall	Biohabitats	0.7	2	6	10	6	24	
SMP-TP-F403	Tree Planting	Biohabitats	1.4	4	6	10	4	24	
SMP-TP-F404	Tree Planting	Biohabitats	0.4	2	6	10	6	24	
NMP-BC-F103	BMP Conversion	McCormick Taylor	0.1	2	10	5	6	23	
NMP-BC-F110	BMP Conversion	McCormick Taylor	2.1	4	3	10	6	23	
NMP-SR-F121	Stream	McCormick Taylor	8.8	8	3	8	4	23	
NMP-SR-F128	Stream	McCormick Taylor	8.1	8	3	8	4	23	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
NMP-SR-F130	Stream	McCormick Taylor	6.5	8	3	8	4	23	
NMP-SR-F131D	Stream	McCormick Taylor	5.5	8	3	8	4	23	
NMP-SR-F137A	Stream	McCormick Taylor	9.7	8	3	8	4	23	
NMP-SR-F139A	Stream	McCormick Taylor	9.4	8	3	8	4	23	
NMP-SR-F148	Stream	McCormick Taylor	6.1	8	3	8	4	23	
NMP-SR-F151A	Stream	McCormick Taylor	8.5	8	3	8	4	23	
NMP-SR-F163	Stream	McCormick Taylor	4.9	6	3	8	6	23	
NMP-SR-F164	Stream	McCormick Taylor	6.5	8	3	8	4	23	
SMP-OF-F304	Stream	Biohabitats	4.7	6	3	8	6	23	
SMP-OF-F309	Stream	Biohabitats	3.2	6	3	8	6	23	
SMP-OF-F332	Stream	Biohabitats	3.6	6	3	8	6	23	
SMP-OF-F334	Stream	Biohabitats	5.7	8	3	8	4	23	
SMP-OF-F408	Stream	Biohabitats	4.4	6	3	8	6	23	
SMP-SR-F323A	Stream	Biohabitats	4.0	6	3	8	6	23	
SMP-SR-F351C	Stream	Biohabitats	3.3	6	3	8	6	23	
SMP-SR-F362A	Stream	Biohabitats	6.3	8	3	8	4	23	
SMP-SR-F363D	Stream	Biohabitats	2.9	4	3	8	8	23	
SR-22	Stream	McCormick Taylor	7.6	8	3	8	4	23	
SR-24	Stream	Biohabitats	9.3	8	3	8	4	23	
SR-25	Stream	Biohabitats	5.9	8	3	8	4	23	
SR-41	Stream	Biohabitats	3.1	6	3	8	6	23	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
SR-42	Stream	Biohabitats	8.0	8	3	8	4	23	
SR-6	Stream	McCormick Taylor	9.4	8	3	8	4	23	
NMP-BC-D114	BMP Conversion	Versar	2.5	4	10	2	6	22	
NMP-BC-F101	BMP Conversion	McCormick Taylor	0.5	2	6	8	6	22	
NMP-BC-F107	BMP Conversion	McCormick Taylor	0.1	2	6	8	6	22	
NMP-BC-F111	BMP Conversion	McCormick Taylor	0.9	2	6	8	6	22	
NMP-SR-F121	Tree Planting	McCormick Taylor	0.8	2	6	10	4	22	
NMP-SR-F128A	Tree Planting	McCormick Taylor	0.3	2	6	10	4	22	
NMP-SR-F131F	Tree Planting	McCormick Taylor	0.7	2	6	10	4	22	
NMP-SR-F149A	Tree Planting	McCormick Taylor	0.9	2	6	10	4	22	
SMP-BC-F310	BMP Conversion	Biohabitats	0.5	2	6	8	6	22	
SMP-NB-F303	BMP New Footprint	Biohabitats	2.5	4	6	8	4	22	
SMP-NB-F327A	BMP New Footprint	Biohabitats	2.2	4	10	2	6	22	
SMP-NB-F328A	BMP New Footprint	Biohabitats	2.6	4	10	2	6	22	
SMP-OF-F404	Outfall	Biohabitats	0.8	2	6	10	4	22	
NMP-BC-F102	BMP Conversion	McCormick Taylor	0.3	2	10	5	4	21	
NMP-BC-F104	BMP Conversion	McCormick Taylor	0.6	2	10	5	4	21	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
NMP-BC-F105	BMP Conversion	McCormick Taylor	0.2	2	10	5	4	21	
NMP-SR-F122	Stream	McCormick Taylor	1.3	4	3	8	6	21	
NMP-SR-F129A	Stream	McCormick Taylor	4.9	6	3	8	4	21	
NMP-SR-F129B	Stream	McCormick Taylor	4.0	6	3	8	4	21	
NMP-SR-F139B	Stream	McCormick Taylor	4.4	6	3	8	4	21	
SMP-SR-F303A	Stream	Biohabitats	0.2	2	3	8	8	21	
SMP-SR-F305A	Stream	Biohabitats	1.6	4	3	8	6	21	
SMP-SR-F309B	Stream	Biohabitats	1.7	4	3	8	6	21	
SMP-SR-F323B	Stream	Biohabitats	2.7	4	3	8	6	21	
SMP-SR-F360B	Stream	Biohabitats	2.2	4	3	8	6	21	
SMP-SR-F364A	Stream	Biohabitats	3.4	6	3	8	4	21	
NMP-BC-F108	BMP Conversion	McCormick Taylor	1.0	2	6	8	4	20	
SMP-OF-F303	Outfall	Biohabitats	2.0	4	0	10	6	20	
SMP-OF-F331	Outfall	Biohabitats	2.0	4	0	10	6	20	
SMP-OF-F401	Outfall	Biohabitats	1.2	4	0	10	6	20	
SMP-OF-F402	Outfall	Biohabitats	2.0	4	0	10	6	20	
NMP-SR-F136C	Stream	McCormick Taylor	2.2	4	3	8	4	19	
NMP-SR-F141	Stream	McCormick Taylor	2.9	4	3	8	4	19	
SMP-BC-D324	BMP Conversion	Versar	8.3	8	3	2	6	19	
SMP-BC-F307	BMP Conversion	Biohabitats	20.1	10	3	2	4	19	

Rankings and Scores for Middle Patuxent Watershed Project Recommendations

Site ID	Type	Contractor	Acres of Impervious Treated	Acres of Impervious Treated Score	Pollutant Load Reduction Score	Cost Per Acre Score	Biological uplift - Programmatic Benefit - Feasibility Proportional Score	Total Score Combined Metrics	Concept 2015
SMP-OF-F329	Stream	Biohabitats	1.7	4	3	8	4	19	
SMP-SR-F348	Stream	Biohabitats	2.0	4	3	8	4	19	
SMP-SR-F351B1	Stream	Biohabitats	2.8	4	3	8	4	19	
SMP-SR-F363B	Stream	Biohabitats	2.2	4	3	8	4	19	
NMP-OF-F104	Outfall	McCormick Taylor	0.1	2	0	10	6	18	
SMP-OF-F405	Outfall	Biohabitats	0.8	2	0	10	6	18	
SMP-OF-F406	Outfall	Biohabitats	0.5	2	0	10	6	18	
NMP-BC-D118	BMP Conversion	Versar	5.3	8	3	2	4	17	
SMP-BC-F311	BMP Conversion	Biohabitats	2.0	4	3	2	8	17	
SMP-BC-F319	BMP Conversion	Biohabitats	4.5	6	3	2	6	17	
SMP-BC-D328	BMP Conversion	Versar	1.1	4	3	5	4	16	
SMP-BC-F312	BMP Conversion	Biohabitats	7.4	8	3	2	2	15	
SMP-BC-D325	BMP Conversion	Versar	0.6	2	6	2	4	14	
NMP-BC-F106	BMP Conversion	McCormick Taylor	2.8	4	3	2	4	13	
SMP-BC-F302	BMP Conversion	Biohabitats	1.8	4	3	2	4	13	
SMP-BC-F318	BMP Conversion	Biohabitats	1.0	2	3	2	4	11	

H. Individual Concept Plan for Top-Ranked Opportunities

List of Concept Plans in Middle Patuxent River Watershed

Site ID	Site Name	Project Type
NMP-BC-D113	Ten Oaks	BMP Conversion - Previous Study
NMP-OF-F102	Chapel Estates Drive	Outfall Stabilization
NMP-SR-F101	Rover Mill Road	Tree Planting
NMP-SR-F123a	Sheppard Field	Tree Planting
NMP-SR-F152b	Sheppard Lane	Tree Planting
NMP-TP-F103d	Woodmont Drive	Tree Planting
NMP-TP-F104	Folly Quarter	Tree Planting
NMP-TP-F106	Running Fence Lane	Tree Planting
NMP-TP-F107a	Preakness Circle Lane	Tree Planting
SMP-BC-D330	Moving Water Lane	BMP Conversion - Previous Study
SMP-BC-F303	8495 Kings Meade	BMP Conversion
SMP-BC-F306	Winter Grain Path	BMP Conversion
SMP-BC-F308	Columbia Commons Apartments	BMP Conversion
SMP-OF-F304	Shady Glen Townhomes	Outfall Stabilization
SMP-OF-F306	Twin Oaks	Outfall Stabilization
SMP-OF-F309	5th District VFD North Outfall	Outfall Stabilization
SMP-OF-F330	Hobbits Glen Golf Club Hole #2	Outfall Stabilization
SMP-OF-F334	Tolling Belle Ct	Outfall Stabilization
SMP-SR-F301	Murray Hill Middle School	Stream Restoration
SMP-SR-F313	Guilford Road	Stream Restoration
SMP-SR-F316	Guilford Road - Horse Farm	Stream Restoration
SMP-TP-F301	River Hill High School	Tree Planting
SMP-TP-F306	Mt Zion Methodist Church	Tree Planting
SMP-TP-F308	New Hope Seventh-Day Adventist Church	Tree Planting
SMP-TP-F401	Hall Shop and Browns Bridge	Tree Planting
SMP-TP-F402	Stonebrook Horse Farm	Tree Planting
SMP-TP-F407	Triadelphia Mill Road	Tree Planting
SR-5	Rover Mill Road	Stream Restoration
SR-7	Farm Museum	Stream Restoration
SR-8	Wynfield Road	Stream Restoration
SR-9	Stiles Way	Stream Restoration
SR-11	Terrapin Branch	Stream Restoration
SR-12	Gossage Property	Stream Restoration
SR-13	Triadelphia Road	Stream Restoration
SR-16	Ericole Court	Stream Restoration
SR-27	Middle Patuxent Environmental Area	Stream Restoration
SR-28	Cedar Lane	Stream Restoration
SR-39	Montpelier Research Park	Stream Restoration
SR-60	Eacker Property Stream	Stream Restoration

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F303

Site Name: 8495 Kings Meade

Contractor: Biohabitats

Watershed: Middle Patuxent River

Proposed BMP Type: Sand Filter

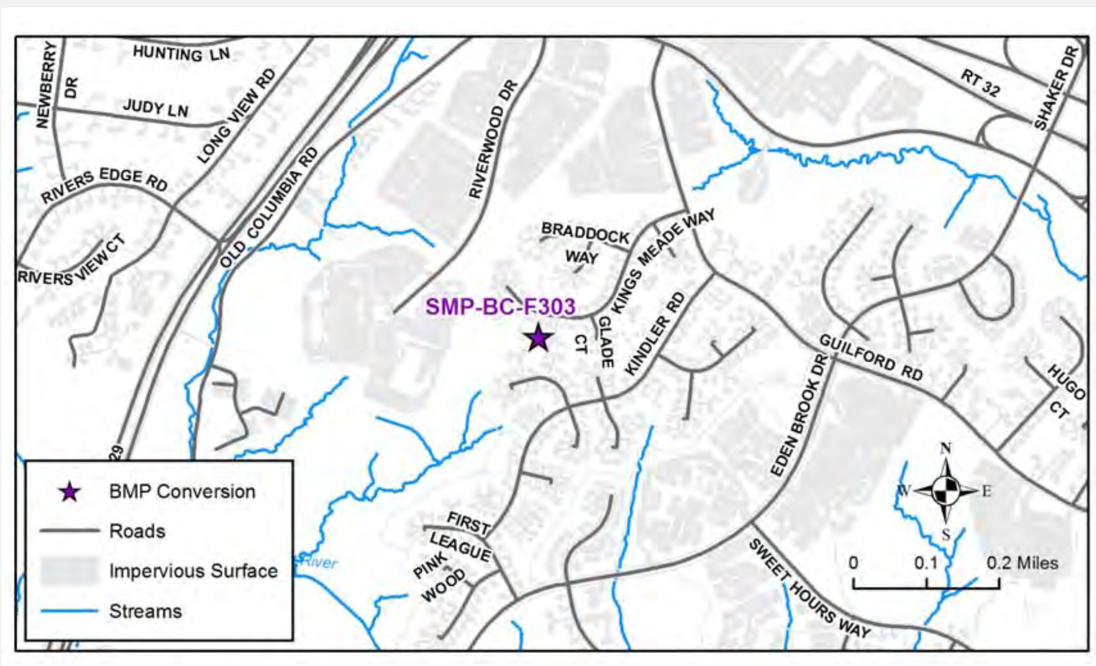
Ownership: Private- Residential
Multiple Owners

BMP Structure ID: HO100522

Existing BMP Type: Dry Pond

Existing Conditions:

The current facility is a dry pond with one storm drain infall that manages a 10.96 ac. drainage area containing 21% impervious surface from a residential area. The infall discharges to a low flow channel and then into an existing concrete riser with a 24 in. reinforced concrete pipe (RCP). The 24 in. RCP then discharges onto a 20 ft. wide drainage easement on a downstream residential property. The property to the south west of the pond, owned by the Columbia Association, may potentially provide some tree planting opportunities. The pond itself is located on HOA property (Pleasant Grove Assoc. Inc.).



Site ID: SMP-BC-F303

Site Name: 8495 Kings Meade

Contractor: Biohabitats

Watershed: Middle Patuxent River

Basin overview looking west.

Basin overview with tree planting opportunity site in background.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F303

Site Name: 8495 Kings Meade

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

A sewer line is located adjacent to the pond on the eastern side. Regrading will be required within the drainage easement on the downstream property to lower the outfall channel. Work would require permission from HOA.

Concept Description:

The existing dry pond could be converted to a dry pond with sand filter by lowering the pond basin by 2 ft. and by lowering the outfall by 4 ft. A forebay berm would be constructed near the facility infall using the existing excavated material. The outfall channel below the embankment would also need to be lowered within the 20 ft. drainage easement on the downstream property. An emergency spillway would need to be constructed and could be constructed at the south western edge in original ground. Project construction will require additional work to meet current standards.

Nearby Opportunities:

None recommended

Proposed Project Credit

Drainage Area (ac.):	10.96
Impervious Area within Drainage (ac.):	3.18
Impervious Area Treated (ac.):	3.18
Impervious Area Treated Credit (ac.):	3.18

Water Quality Volume

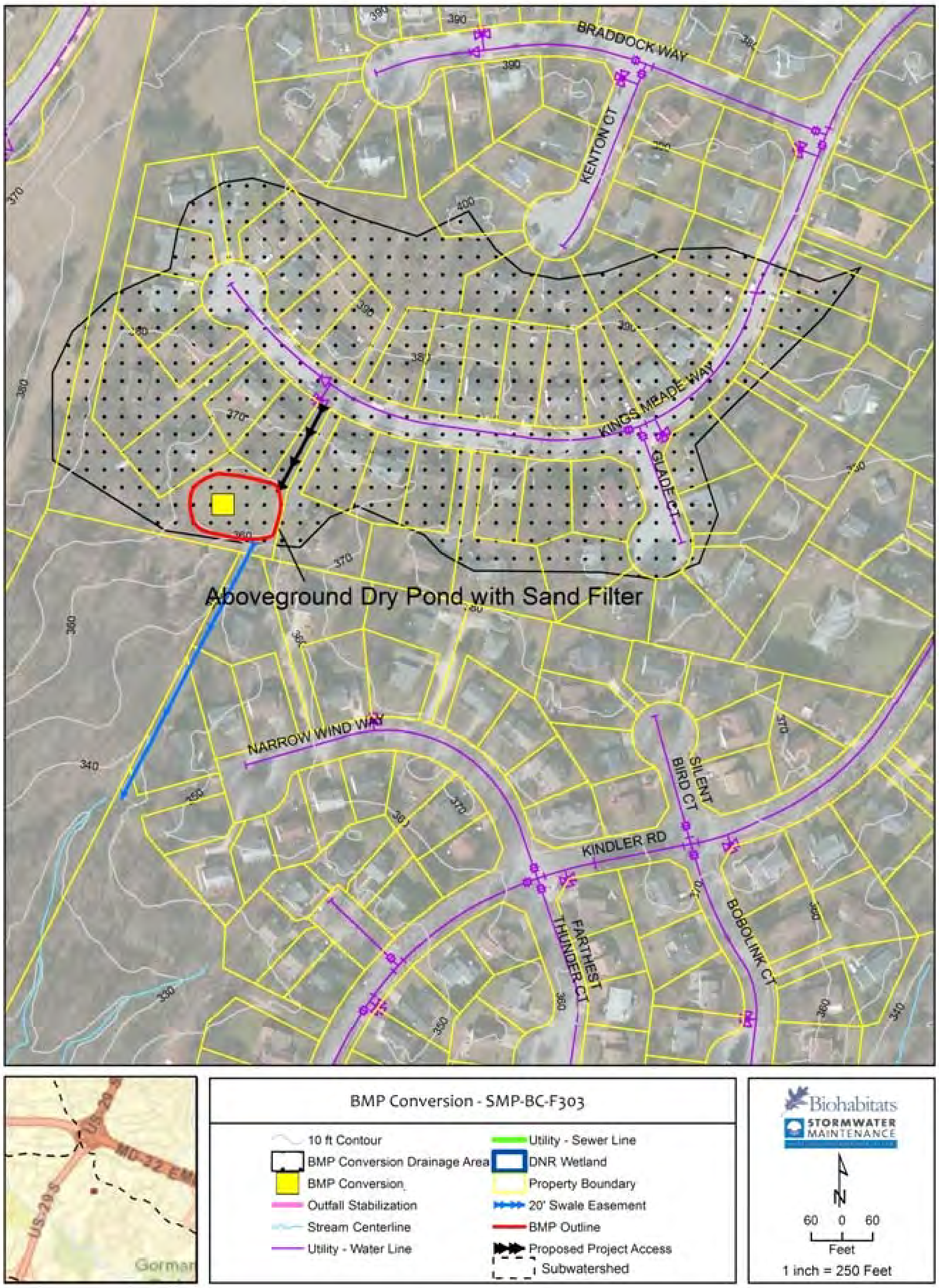
WQVolume Target (cft.):	12,378
Max Treated (cft.):	12,378
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs

Estimated Design Cost:	$220,000.00
Estimated Construction Cost:	$213,578.00
30% Contingency:	$64,073.40
Estimated Total Cost	$497,651.40
Cost per Impervious Credit Acre:	$156,494.15

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F303
Site Name: 8495 Kings Meade
Contractor: Biohabitats
Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F306

Site Name: Winter Grain Path

Contractor: Biohabitats

Watershed: Middle Patuxent River

Proposed BMP Type: Sand Filter

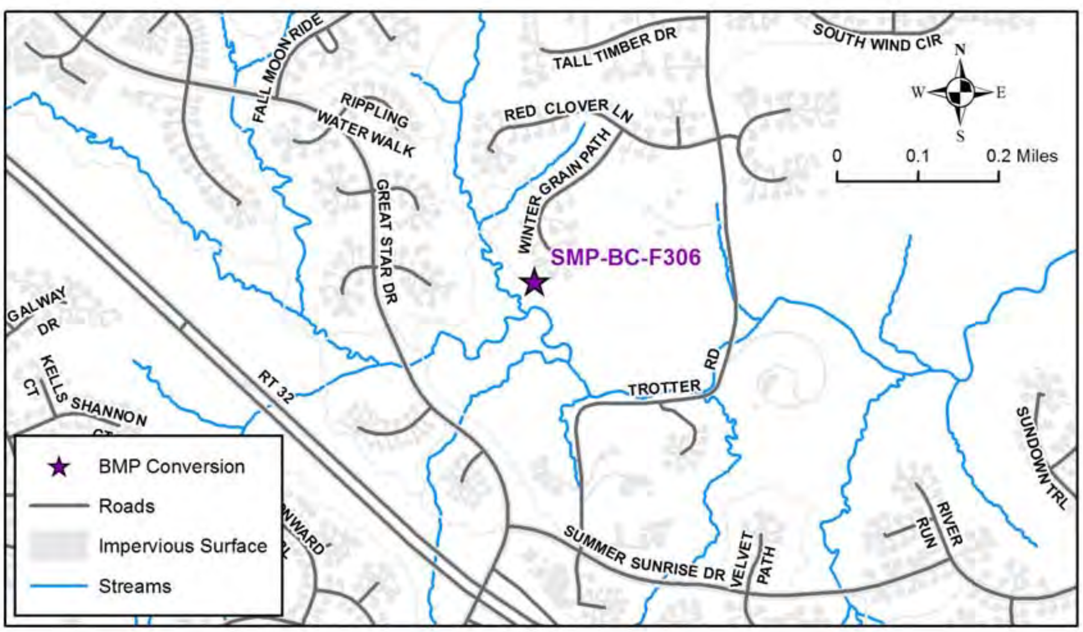
Ownership: Columbia Association
Single Owner

BMP Structure ID: HO100554

Existing BMP Type: Extended Detention

Existing Conditions:

The current facility is a sediment basin that was converted into a water quality feature. The upstream slope is severely eroded and threatening to undermine the adjacent pedestrian path. The facility manages a 3.94 ac. drainage area containing 21% impervious area from a residential area. Runoff enters through a concrete structure and overland flow, flows through the basin and outfalls through a stone weir. The outfall channel below the stone weir is severely eroded and in need of immediate repair. The basin also appears to be filled with sediment to a depth of approximately 1 ft. The drainage area delineation for this facility was modified as it was incorrectly including the drainage area to the facility just north on Winter Grain Path.



Infall to facility and eroded upstream slope.

Looking upstream at outfall erosion just downstream of weir.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F306

Site Name: Winter Grain Path

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

There is a sewer line near the BMP that crosses the access path. Cautionary steps will need to be taken during the construction of both the access path and the BMP.

Concept Description:

The existing facility can be converted to a dry pond with sand filter by placing the sand filter media below the infall low flow invert and excavating all sediment that has accumulated in the basin. A concrete weir is to be constructed with an underdrain and to manage the channel protection volume and bypass larger storms. Two sections of the outfall channel approximately 35 lf. in total length (25 lf. and another 10 lf. at the confluence with the mainstem) will need to be stabilized below the outfall. A berm to provide a forebay would be constructed at the facility infall using existing excavated material. The sand filter would require 2 ft. of ponding depth to treat 1 in. of runoff. Access to the pond can be provided through the existing stormwater easement.

Nearby Opportunities:

None recommended

Proposed Project Credit

Drainage Area (ac.):	3.94
Impervious Area within Drainage (ac.):	0.82
Impervious Area Treated (ac.):	0.82
Impervious Area Treated Credit (ac.):	0.82

Water Quality Volume

WQVolume Target (cft.):	3,394
Max Treated (cft.):	3,394
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs

Estimated Design Cost:	$100,000.00
Estimated Construction Cost:	$100,000.00
30% Contingency:	$30,000.00
Estimated Total Cost	$230,000.00
Cost per Impervious Credit Acre:	$280,487.80

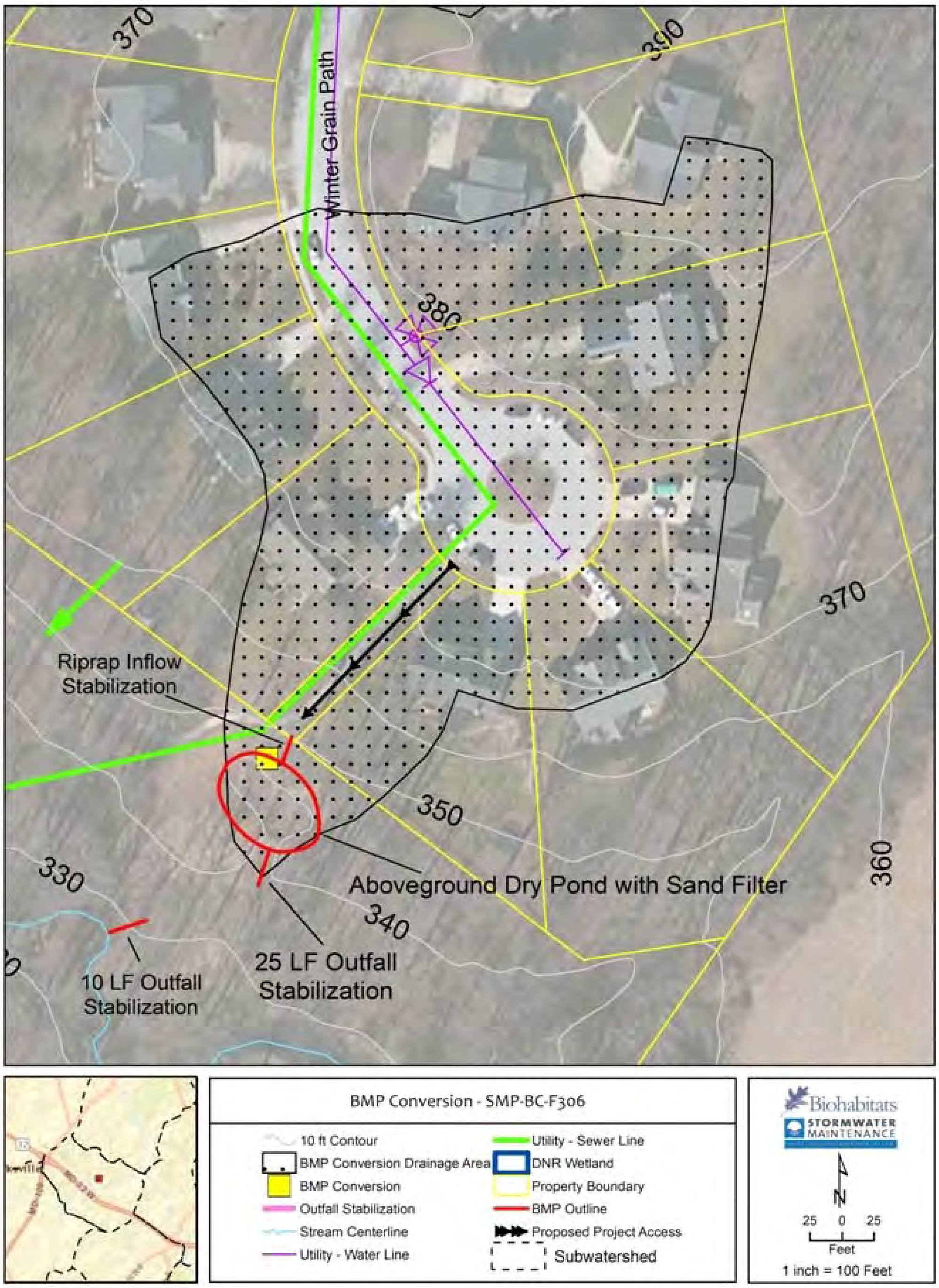
Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F306

Site Name: Winter Grain Path

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F308

Site Name: Columbia Commons Apartments

Contractor: Biohabitats

Watershed: Middle Patuxent River

Proposed BMP Type: Micropool Extended Detention Pond

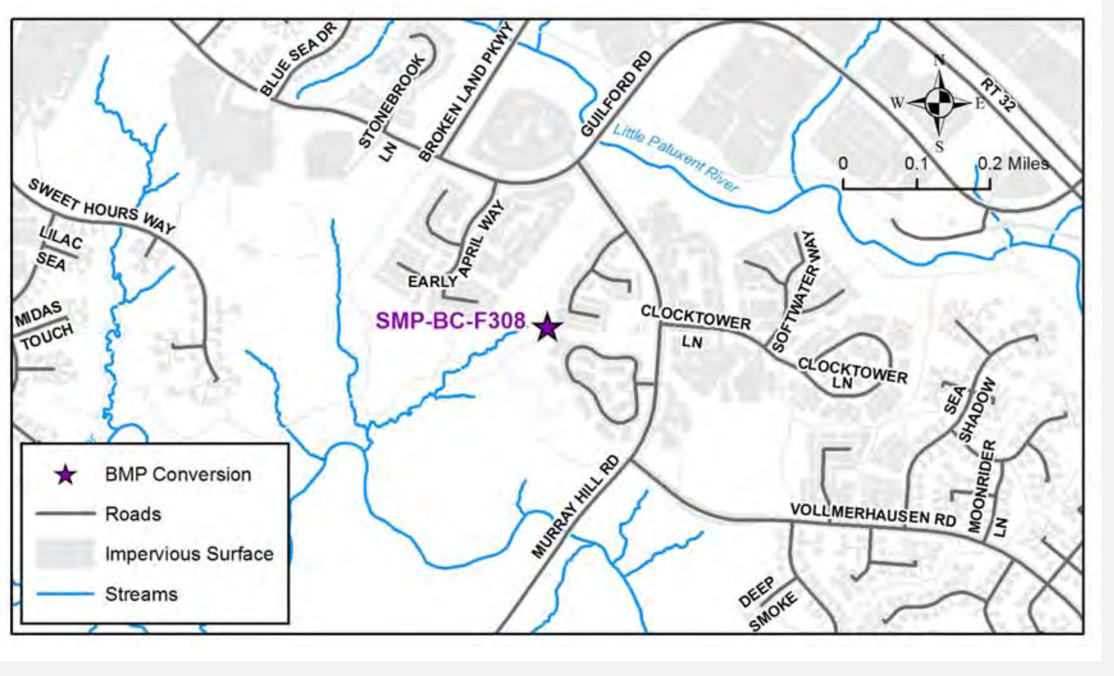
Ownership: Columbia Association
Single Owner

BMP Structure ID: HO100805

Existing BMP Type: Dry Pond

Existing Conditions:

The current pond, a dry pond with two storm drain infalls, manages a 12.58 ac. drainage area containing 31% impervious area from a residential development. The pond was observed to have some aquatic vegetation and woody growth is present throughout the basin. The existing CMP outfall barrel is severely corroded and requires County follow-up. The stormwater as-built or design plans for this facility were unable to be located. The southeastern outfall was located on SDP-91-029 and indicates the existing pond has filled with sediment to a 4 ft. depth.



Pond basin looking north.

Riser structure looking south.

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F308

Site Name: Columbia Commons Apartments

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Sewer manholes and lines are near the pond, but unlikely they will affect the reconstruction of the pond. Several of the trees in the pond basin will need to be removed to increase the depth of the pond. Coordination with BGE for access.

Concept Description:

The existing dry pond could be converted to a extended detention pond with a micropool by excavating the pond to original ground which will lower the pond basin up to 4 ft. A new riser and outfall barrel would need to be installed and several trees will need to be removed from the pond basin. Access to the pond for large equipment will need to be through the 250 ft. wide BGE utility easement.

Nearby Opportunities:

None recommended

Proposed Project Credit

Drainage Area (ac.):	12.58
Impervious Area within Drainage (ac.):	3.88
Impervious Area Treated (ac.):	3.88
Impervious Area Treated Credit (ac.):	3.88

Water Quality Volume

WQVolume Target (cft.):	14,959
Max Treated (cft.):	14,959
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

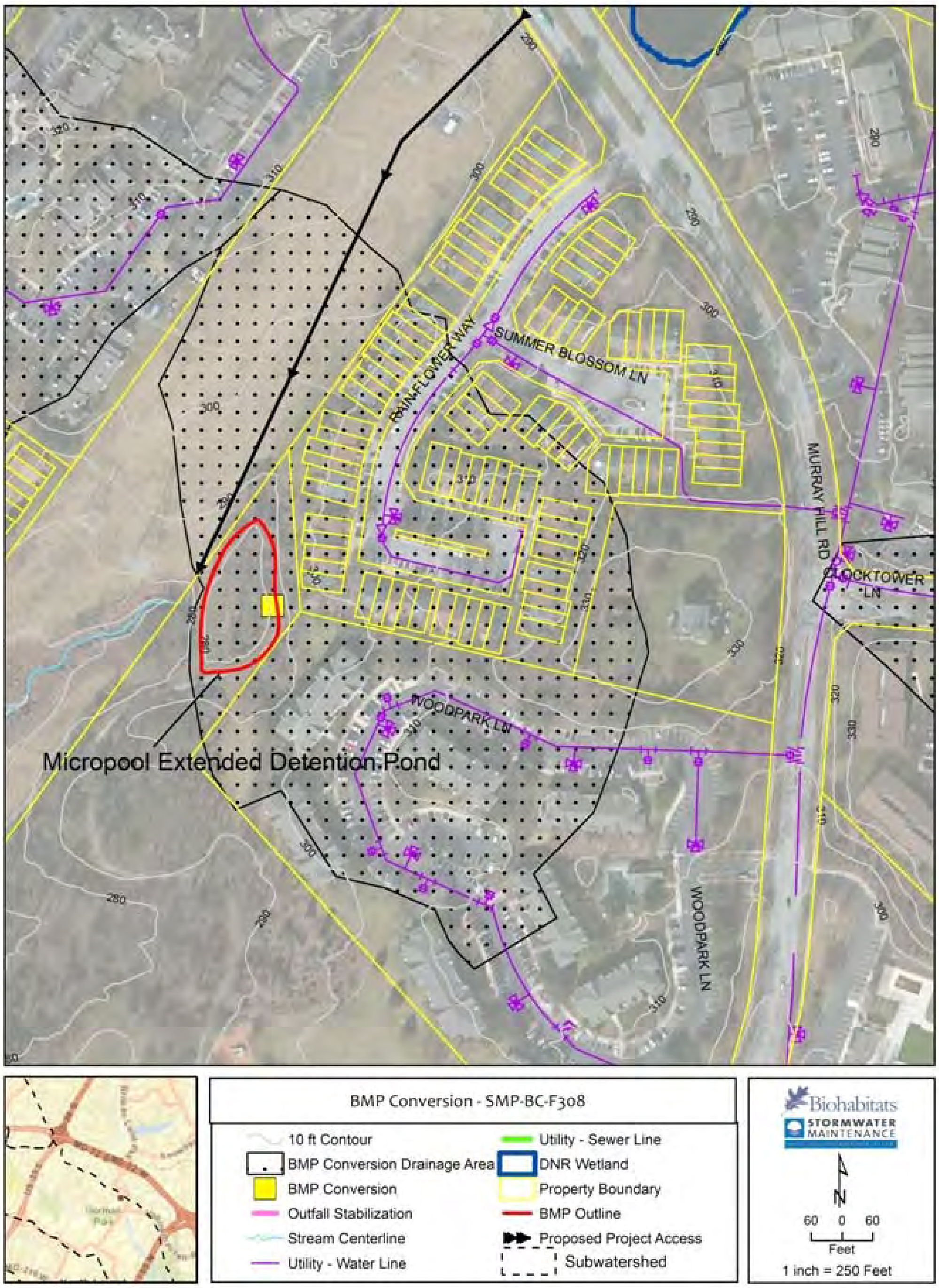
Costs

Estimated Design Cost:	$220,000.00
Estimated Construction Cost:	$246,470.00
30% Contingency:	$73,941.00
Estimated Total Cost	$540,411.00
Cost per Impervious Credit Acre:	$139,281.19

Howard County Watershed Assessment Concept Plan: BMP Conversion

Site ID: SMP-BC-F308 **Contractor:** Biohabitats

Site Name: Columbia Commons Apartments **Watershed:** Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F301

Site Name: Murray Hill Middle School

Contractor: Biohabitats

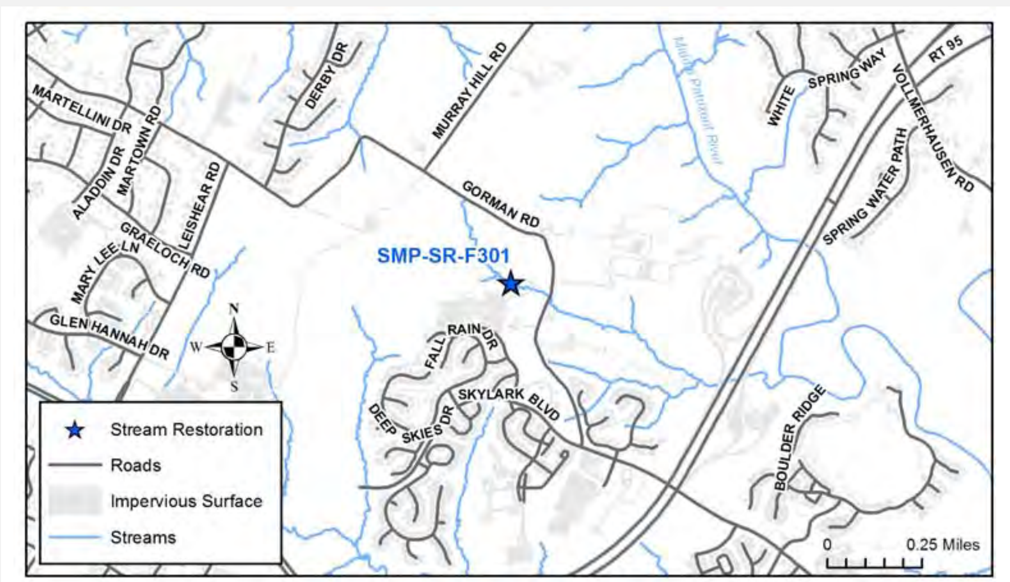
Watershed: Middle Patuxent River

Ownership: Board of Education
Single Owner

Existing Conditions:

An extended detention dry pond outlet discharges through a 36 in. enclosed concrete pipe and onto a small concrete splash pad. Below the concrete splash pad is a riprap outlet which connects to a small discharge channel. The discharge channel continues for approximately 300 ft. downstream until it creates a confluence with a mainstem channel. The discharge channel is currently enduring significant headcutting from the pond outlet. The mainstem is approximately 1350 ft. long and is incised with eroding banks.The instream habitat within the discharge channel scored in the poor range.

The epifaunal substrates consists of less than 20% stable habitat with extremely high embeddedness (~75%) making these substrates even less available for colonization. The velocity/depth regime of the channel is consistently poor due to a lack of deep pools, runs, and riffles. Sediment deposition in the form of bar features is not a concern; however, the overall sediment supply did influence the embeddedness score. The channel flow status is marginal with water filling half of the channel (25-75%) and some riffle substrates exposed. Both stream banks are extremely unstable, raw, and eroding with limited vegetation. Vegetative protection along the stream bank is marginal with only 50-70% of the surface covered by vegetation. Shading along the discharge channel is extremely poor (10%).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F301

Site Name: Murray Hill Middle School

Contractor: Biohabitats

Watershed: Middle Patuxent River

Facing upstream, the pond outlet and eroded discharge channel.

At the confluence of the discharge channel with the mainstem, looking downstream at the mainstem.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F301
Site Name: Murray Hill Middle School
Contractor: Biohabitats
Watershed: Middle Patuxent River

Constraints/Utilities:

Minimal constraints were observed during the field assessment. Both the discharge channel and mainstem are located on school property. Access would be better from Gorman Road instead of through the school property. There are two road crossings along the mainstem, as well as a water line crossing. Minimal impact to trees and wetlands throughout the discharge channel and mainstem are anticipated.

Concept Description:

The objective for this project is to reduce bank erosion and improve instream habitat for aquatic organisms. Because of the massive head cutting occurring within the discharge channel, the channel should be stabilized and a regenerative stormwater conveyance (RSC) design is one option. The mainstem is also incised; however, opportunities to raise its invert might be limited due to the downstream road crossing. If the mainstem invert cannot be raised, the banks should be graded back to a stable angle and stabilized with native vegetation to hold soil in place. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at the tight meander bends. In addition, establishing riparian buffer will increase shading, reduce stream temperature and provide needed litter inputs and woody debris. This channel restoration has the potential to reduce sediment supply, improve habitat and provide opportunities for nutrient uptake. Because of the location of this facility, this project could be used as a demonstration and educational site for the children and faculty at Murray Hill Middle School. The site can be accessed from Gorman Road. There are no nearby project recommendations for concurrent implementation.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,471	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	14.7	Estimated Construction Cost:	$661,950.00
Cost per Impervious Credit Acre:	$78,894.29	30% Contingency:	$198,585.00
		Estimated Total Cost:	$1,160,535.00

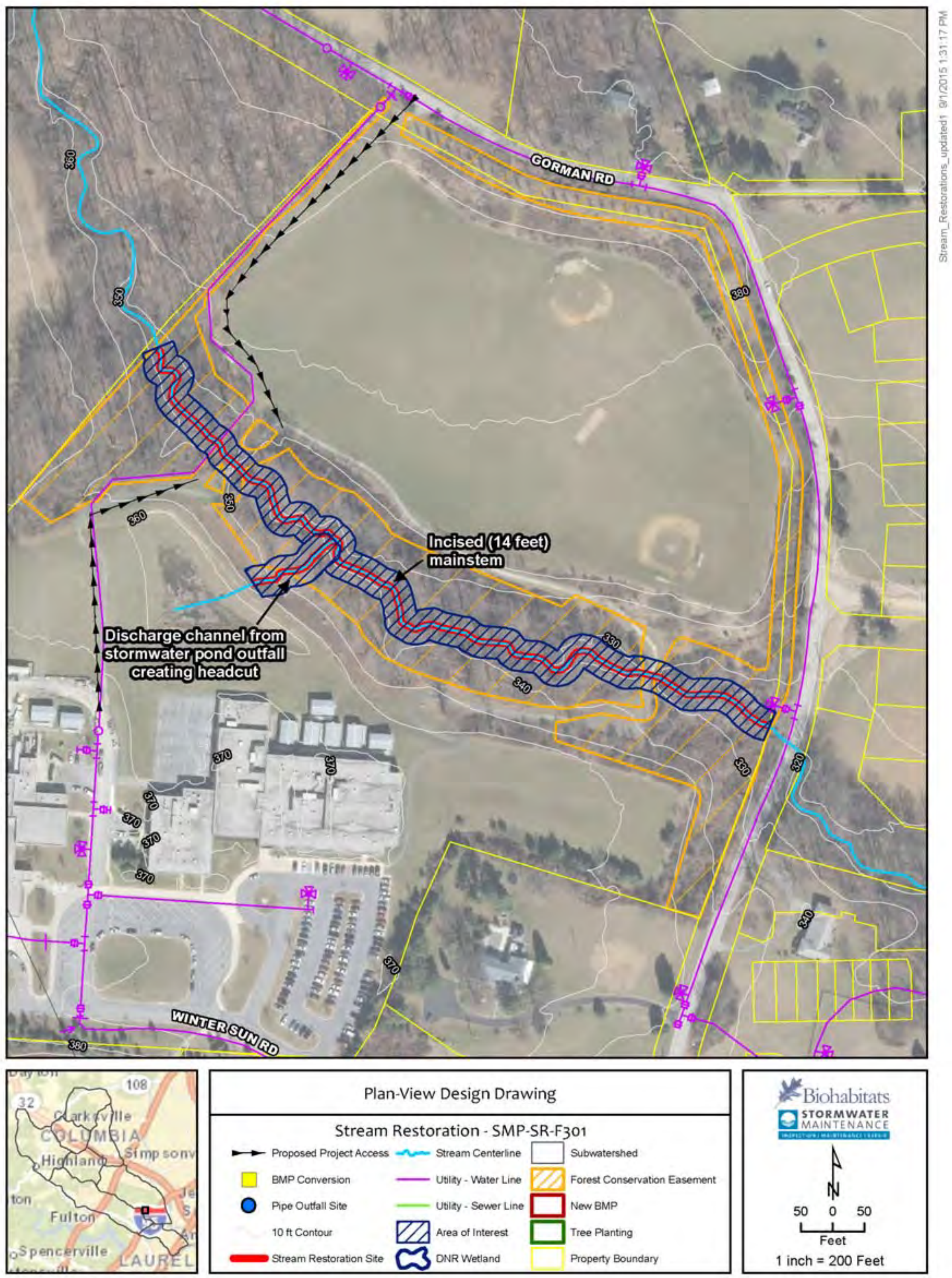
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F301

Site Name: Murray Hill Middle School

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F313

Site Name: Guilford Road

Contractor: Biohabitats

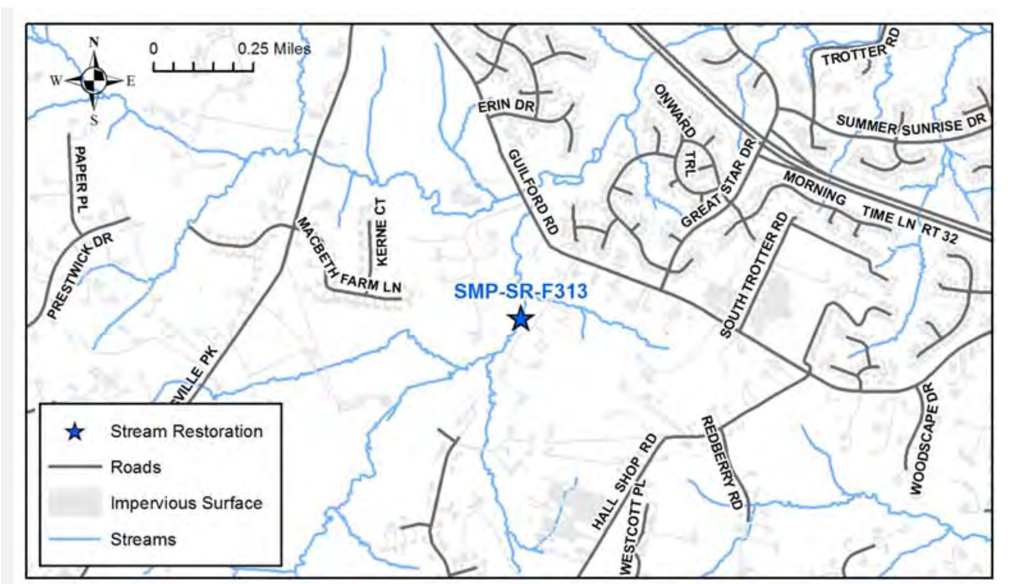
Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The existing channel runs through multiple private properties (6372, 6376, 6384, 6388, 6392 W Route 32 and 6368, 6372, 6396, Guilford Road) in Clarksville, MD. The existing channel has persistent erosion throughout its extent, with alternating stream bank erosion between the left and right banks. Looking downstream at the eroding channel, the right bank appears to be worse due to inadequate buffer impacts. Along the left bank, a small inadequate buffer is encountered; however, a separate inadequate buffer extends 1,350 ft. along the right bank. These inadequate buffers are large open fields that are not presently used for pasture or farmland. The existing channel currently exhibits moderate erosion with 3-5 ft. eroding banks, tight bends, deep pools, with recent bank erosion and deposition evident.

The instream habitat within the existing channel scored in the marginal range. The epifaunal substrates consists of 40-70% stable habitat well suited for full colonization and adequate habitat with some embeddedness (25-50%) making these substrates available for colonization. The velocity/depth regime of the channel is suboptimal with all velocities present minus fast-deep. Moderate sediment deposition throughout the channel is evident based on recent bank failure which is creating alternating bars throughout the channel. The overall sediment supply did not influence the embeddedness score. The channel flow status is marginal with water filling 75% of the channel and some riffle substrates exposed. Both stream banks are moderately unstable and eroding with limited vegetation. Vegetative protection along the right bank is poor due to less than 50% of the surface covered by vegetation, with more vegetative protection along the left bank. Shading along the existing channel is poor (30%).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F313

Site Name: Guilford Road

Contractor: Biohabitats

Watershed: Middle Patuxent River

Facing downstream at a tight bend within the existing channel displaying poor bank protection, lack of vegetative protection and lack of riparian vegetation.

Facing upstream at another tight bend within the existing channel displaying poor bank protection, lack of vegetative protection and lack of riparian vegetation.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F313

Site Name: Guilford Road

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

The existing channel is located on multiple private properties; therefore, coordination between all the properties owners may be a major constraint. Proposed access could be via a private driveway that runs along the channel; this will also require coordination with multiple private property owners. No utilities were observed near the existing channel. Minimal impacts are expected to existing trees and no specimen trees and wetlands should be impacted.

Concept Description:

The objective for this project is to reduce bank erosion and improve instream habitat for aquatic organisms. This will be accomplished by grading banks back to a stable angle and stabilizing them with native vegetation to hold soil in place. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at the tight meander bends. In addition, establishing the maximum riparian buffer will increase shading, reduce stream temperature and provide needed litter inputs and woody debris. This channel restoration has the potential to reduce the sediment supply, improve habitat and provide opportunities for nutrient uptake. The site can be accessed from a private driveway located along Guilford Road in Clarksville, MD between Spring Lake Drive and Great Star Drive. The driveway is located on private property, but is the best option to reach the stream. SMP-TP-F403 is a nearby tree planting project that should be considered with this project to help establish a riparian buffer for the stream. SMP-SR-F316 is a nearby stream restoration potential that could also be considered for concurrent implementation with SMP-SR-F313.

Nearby Opportunities:

SMP-TP-F403, SMP-SR-F313

Proposed Project Credit		Costs	
Length Restored (ft):	2,143	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	21.4	Estimated Construction Cost:	$964,350.00
Cost per Impervious Credit Acre:	$72,499.07	30% Contingency:	$289,305.00
		Estimated Total Cost:	$1,553,655.00

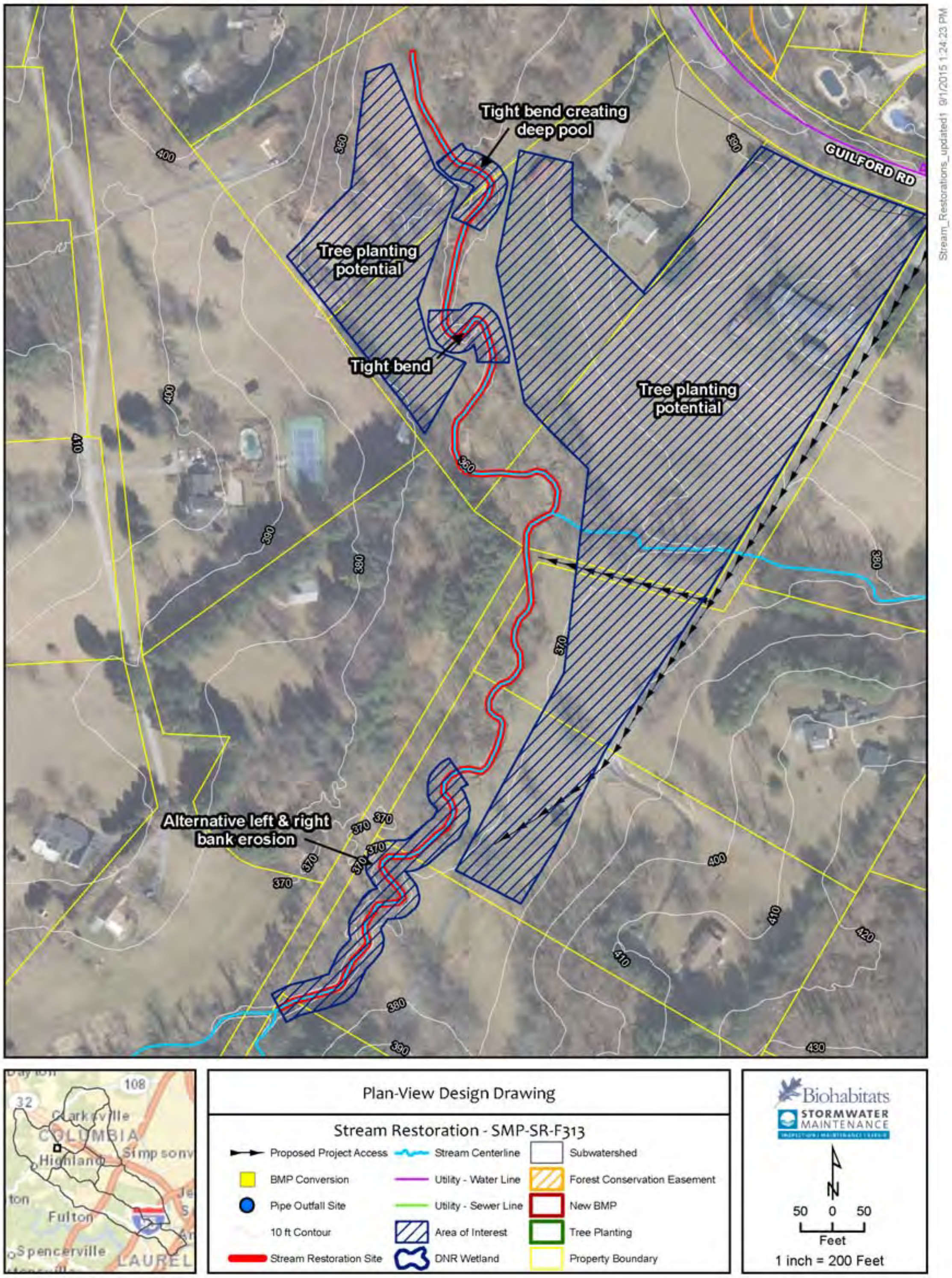
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F313

Site Name: Guilford Road

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F316

Site Name: Guilford Road - Horse Farm

Contractor: Biohabitats

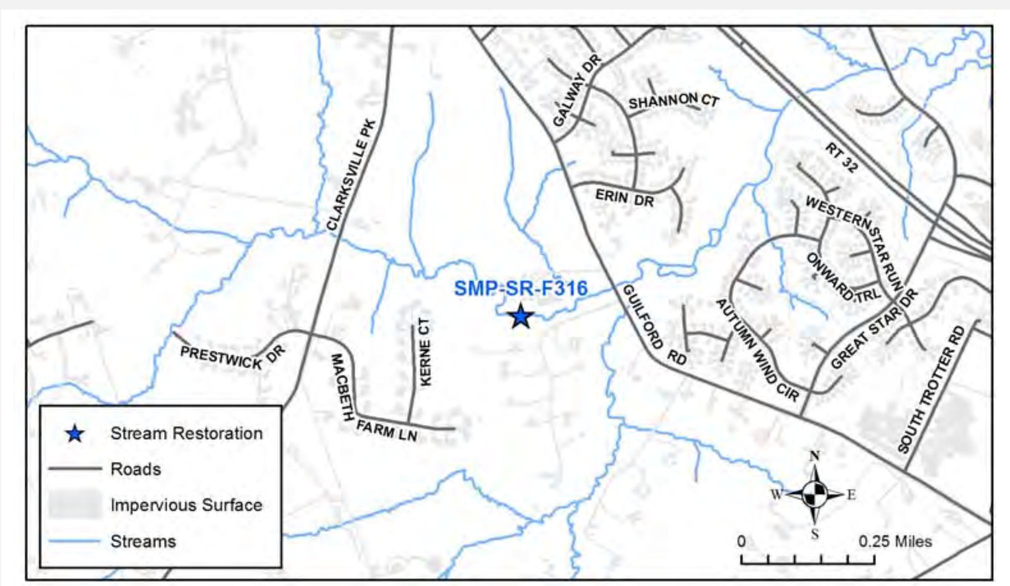
Watershed: Middle Patuxent River

Ownership: Private- Residential
Single Owner

Existing Conditions:

The channel runs through a private property located at 6300 Guilford Road, Clarksville, MD 21029 and is just north of SMP-SR-F313. The private property is a horse farm with pasture and inadequate buffer on both banks. There is a fence that surrounds the property, the horse stables, and other buildings; however, no fence surrounds the existing channel, allowing horses to access the channel and graze up to the channel's edge. Bank erosion is extreme due to open stream access and lack of adequate vegetation along both stream banks. Recent erosion and bank failure was witnessed during stream assessment. Various debris jams were encountered throughout the channel as well as bar formations due to recent bank failure. The existing channel currently exhibits moderate erosion with 3-5 ft. eroding banks and tight bends with recent bank erosion and deposition evident.

The instream habitat within the existing channel scored in the marginal range. The epifaunal substrates consists of 40% stable habitat suited for some colonization and habitat less adequate with high embeddedness (50-75%) making these substrates less desirable for colonization. The velocity/depth regime of the channel is suboptimal with all velocities present minus fast-deep. Moderate sediment deposition throughout the channel is evident based on recent bank failure which is creating lateral and point bar formations throughout the channel. The overall sediment supply did influence the embeddedness score. The channel flow status is marginal with water filling 75% of the channel and some riffle substrates exposed. Both stream banks are moderately unstable and eroding with limited vegetation. Both banks have 50% of their surface covered by vegetation which is impacted by heavy grazing. Shading along the existing channel is poor (25%).



Facing upstream at a tight bend within the existing channel displaying the poor bank protection.

Facing upstream at a recent bank failure. Poor vegetative protection and heavy grazing up to the stream bank is also evident.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F316

Site Name: Guilford Road - Horse Farm

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

The stream is located on private property that uses the land as a pasture for horses. Stream restoration on this site will require landowner coordination regarding grazing strategies to minimize stream impacts and permission to perform more active restoration of the stream. Minimal impact to trees is expected due to the lack of trees along the stream. No utilities were observed.

Concept Description:

The objective for this project is to reduce bank erosion and improve the instream habitat for aquatic organisms. This will be accomplished by grading banks back to a stable angle and stabilizing them with native vegetation to hold soil in place. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at the tight meander bends. In order to prevent horse access to the stream, a fence should be offset from the existing channel a minimum of 25 ft. Along with a fence, multiple designated horse crossings should be added along the existing channel to prevent further damage to the stream but still allow access to all pasture areas. In addition, establishing the maximum riparian buffer will increase the shading to reduce the stream temperature and provide needed litter inputs and woody debris to the channel overtime to maintain the habitat complexity and quality. This channel restoration has the potential to reduce the sediment supply, improve habitat and provide opportunities for nutrient uptake. The site can be accessed from Spring Lake Drive in Clarksville, MD as well as from a private driveway that is located along Guildford Road just north of Spring Lake Drive. The fence would make access from Spring Lake Drive more difficult; therefore, access from the private driveway would be the best option. SMP-TP-402 and SMP-TP-403 are nearby tree planting projects that should be considered with this project to help establish a riparian buffer for the stream. SMP-SR-F313 is a nearby stream restoration potential that could also be considered for concurrent implementation with SMP-SR-F316.

Nearby Opportunities:

SMP-TP-F402, SMP-TP-F403, SMP-SR-F313

Proposed Project Credit		Costs	
Length Restored (ft):	2,831	**Estimated Design Cost:**	$300,000.00
Impervious Area Treated Credit (ac.):	28.3	**Estimated Construction Cost:**	$1,274,400.00
Cost per Impervious Credit Acre:	$69,117.63	**30% Contingency:**	$382,320.00
		Estimated Total Cost:	$1,956,720.00

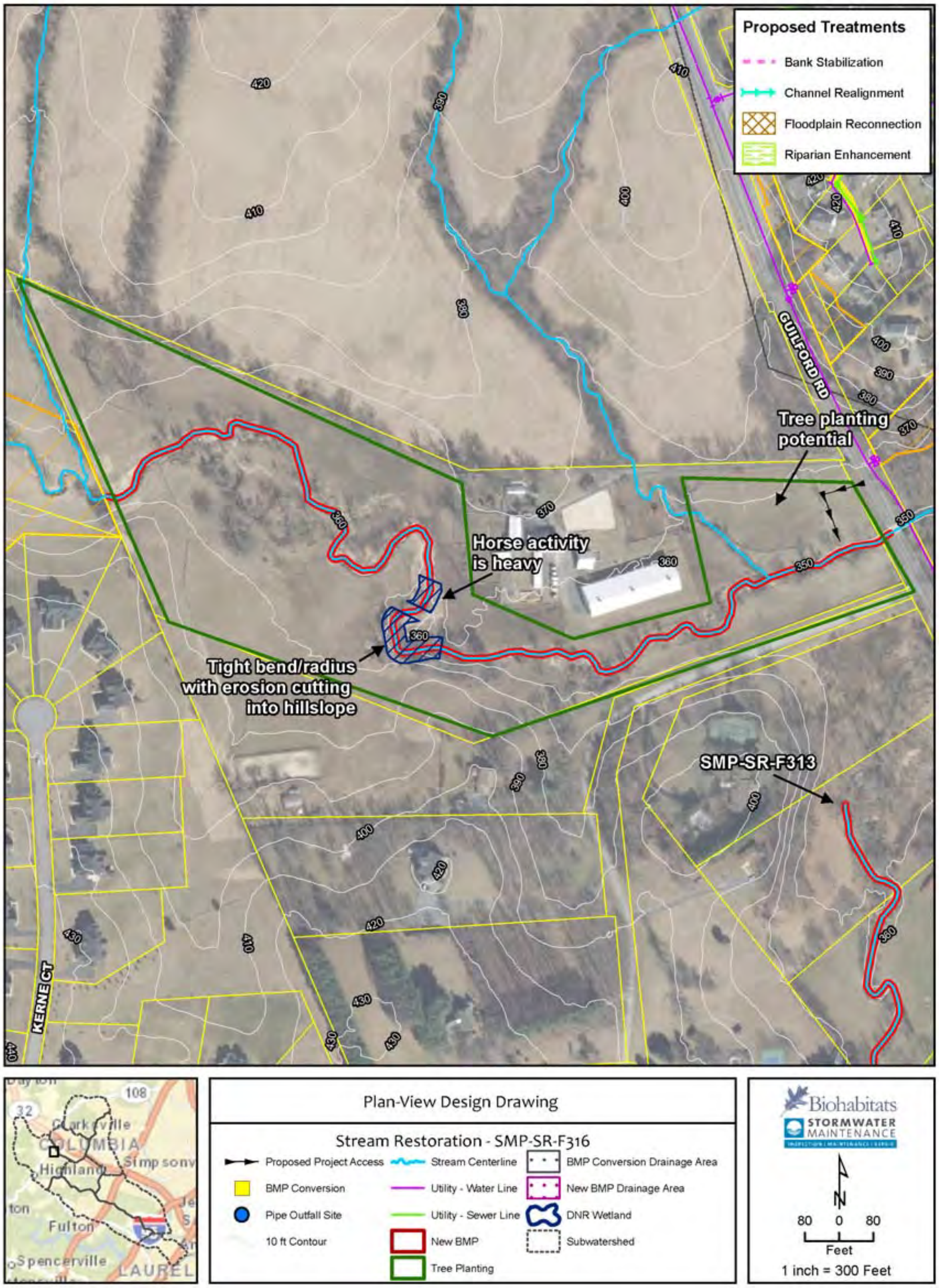
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SMP-SR-F316

Site Name: Guilford Road - Horse Farm

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-5

Site Name: Rover Mill Road

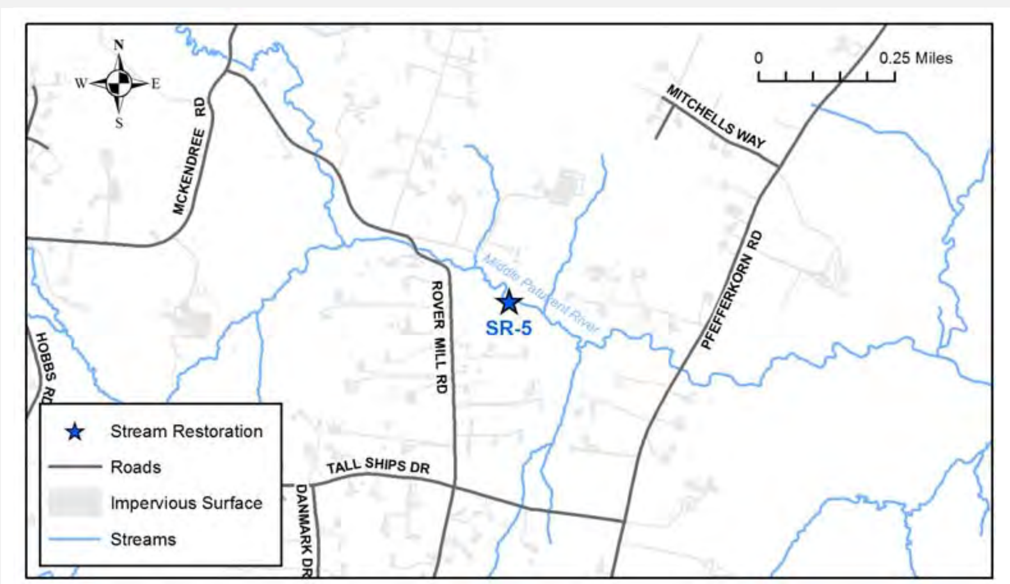
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

SR-5 consists of three stream assessment reaches (NMP-SR-F101A, NMP-SR-F101B, and NMP-SR-101C) associated with the Middle Patuxent River. Land use surrounding the project site is primarily residential and agricultural land associated with seven privately owned properties. The stream restoration site begins approximately 100 lf. east of a culvert at Rover Mill Road, about 0.5 miles southeast of the intersection of Rover Mill Road and McKendree Road. In general, the channel has a predominately cobble/gravel/sand substrate with bank heights ranging between 3 to 5 ft. Approximately 910 lf. of the stream banks are currently eroding, primarily causing lateral migration and widening of the channel. A majority of the eroded banks of the channel are nearly vertical, lack surface protection or vegetation, and are comprised of a sand, silt and clay. Areas containing the greatest lengths of erosion are found along outside meander bends and one portion of the channel where livestock have direct access to the stream. The riparian buffer is sparse along a majority of the stream site and is in need of tree plantings. Currently there are two existing forest conservation easements on the right and left sides of the channel in the middle portion of the site. The easement along the left bank floodplain has previous plantings within it, but only about half of the plantings appear to be surviving. The forest conservation easement on the right bank floodplain appears to be establishing well on the west parcel, but is not very successful on the east parcel. There are existing emergent and scrub/shrub wetlands located on the right bank floodplain adjacent to and within the forest conservation easement.



SR-5 facing upstream at moderate bank erosion.

SR-5 facing upstream at moderate bank erosion that threatens existing infrastructure.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-5

Site Name: Rover Mill Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include private property ownership, access, fencing, and active pasture/grazing fields.

Concept Description:

The proposed stream restoration project consists of three reaches associated with approximately 2,350 lf. of the Middle Patuxent River. The stream restoration primarily includes bank stabilization measures, areas for floodplain reconnection and riparian buffer enhancements, and livestock exclusion fencing. Bank stabilization areas are mostly associated with meander bends that lack surface protection and/or associated with areas that have little or no riparian buffer. Bank stabilization areas on the left side of the channel along a majority of the existing agricultural fields would likely require removal of existing fencing and installation of new fencing. One agricultural field would require fencing to exclude livestock. Four floodplain reconnection areas are proposed along the project extent. Two of these areas are located adjacent to an existing wetland on the right floodplain that could provide additional sources of hydrology for the wetland and increase flood flow retention and nutrient processing. The other two floodplain reconnection areas are located at the downstream extent along the right and left sides of the stream towards the perennial tributary on the right side of the channel. There is also one channel realignment proposed for the project at the upstream end to relocate the channel off of Rover Mill Road where it is currently eroding into the road. The most direct access route for the upstream end of the project is off of Rover Mill Road on the right side (south side) of the channel. An additional access route includes the driveway off of Rover Mill Road that services the agricultural properties on the north side of the site. This route would require permission from property owners to allow access through the agricultural fields. The extent of the proposed stream restoration may be extended farther downstream based on observations noting additional bank erosion. The tributary located at the downstream extent that drains from the south could also be considered for additional stream restoration. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

NMP-SR-F101

Proposed Project Credit		Costs	
Length Restored (ft):	2,353	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	23.5	Estimated Construction Cost:	$1,058,850.00
Cost per Impervious Credit Acre:	$71,249.68	30% Contingency:	$317,655.00
		Estimated Total Cost:	$1,676,505.00

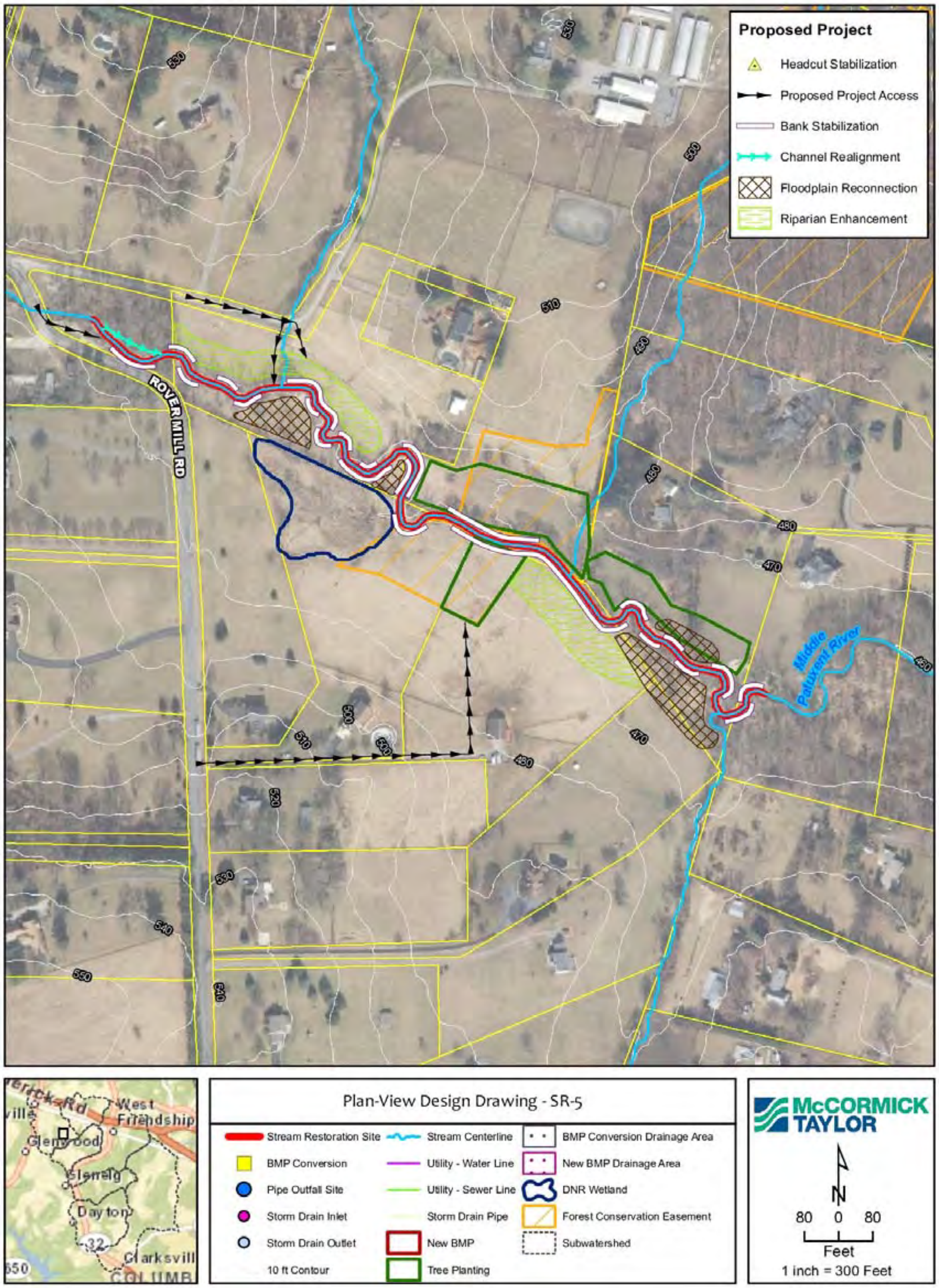
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-5

Site Name: Rover Mill Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-7

Site Name: Farm Museum

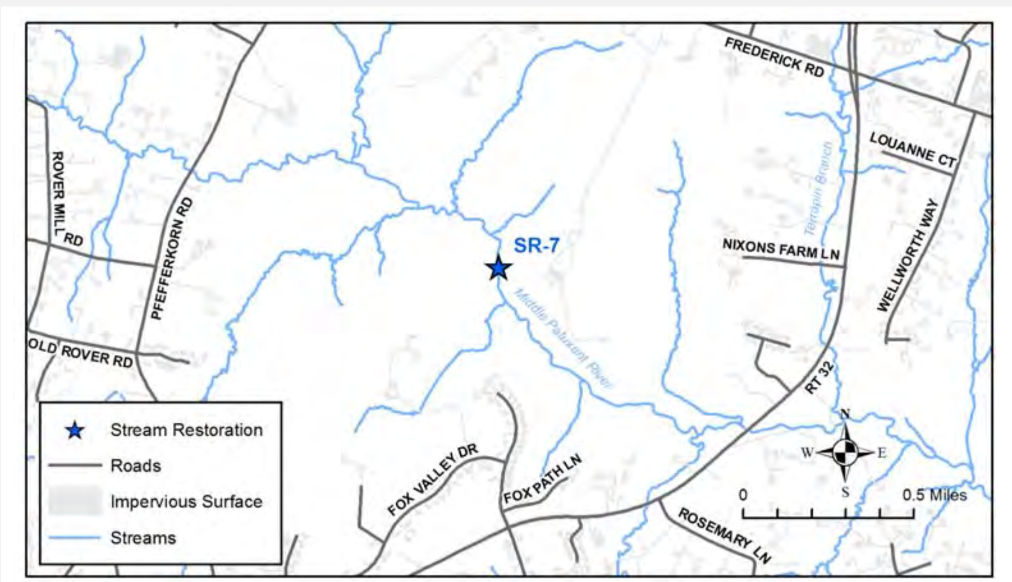
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: County Owned
Single Owner

Existing Conditions:

SR-7 consists of two stream assessment reaches (NMP-SR-F147A and NMP-SR-147B) associated with the mainstem of the Middle Patuxent River. Approximately 1,400 lf. was added to the project downstream of the two reaches assessed in Spring 2015 and approximately 500 lf. was added upstream of the original reaches. Land use surrounding the project site is primarily agricultural and forested land that is entirely on property owned by Howard County. The stream restoration site begins approximately 1,600 ft. northwest of the Howard County Living Farm Heritage Museum main parking lot and extends downstream (south) about 3,143 lf. In general, the channel has a gravel/cobble substrate and bank heights ranging between 4-10 ft. Many of the eroded banks are nearly vertical or undercut, lack surface protection or vegetation, and are comprised of primarily of silt. Some of the exposed eroded banks also have gravel lenses that are more prone to erosion. The multiple cobble/gravel bars present throughout the channel indicate a large sediment load from upstream sources. The project site is associated with three existing forest conservation easements located on the east side of the channel. The east or left floodplain of the project site is also associated with an existing emergent and scrub-shrub wetland system.



SR-7 facing downstream at severe bank erosion.

SR-7 facing downstream at severe bank erosion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-7
Site Name: Farm Museum
Contractor: McCormick Taylor
Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include potential impacts to trees and temporary impacts to wetlands.

Concept Description:

The proposed stream restoration project consists of approximately 3,143 lf. of the Middle Patuxent River. The proposed restoration primarily includes bank stabilization treatments and two minor channel realignment areas. Some of the bank treatments could include minor grading and heavy plantings of woody vegetation or live stake cuttings while other areas of bank stabilization would include more substantial grading due to the existing high banks that are nearly vertical in several locations. One of the channel realignment areas is located at the upstream extent. The realignment will focus on correcting tight planform geometry and relocation of the channel off of the valley wall on the left side. The second channel realignment is located toward the downstream end of the site which could be included with the bank stabilization treatment on the left bank in that area. A third channel realignment area could be considered at the downstream bank stabilization treatment area to relocate the channel further off of the valley wall in that location. There is an existing knickpoint toward the upstream end of the project associated with an existing bedrock outcrop. The outcrop is acting as a pinch point to the channel which is causing some major erosion on the left bank in this location and should be incorporated with the restoration design. A potential option for the project is to include the grading of an overflow channel that would provide relief from high flows and additional hydrology to the existing wetlands located on the left floodplain. This opportunity could also provide sediment and nutrient retention and processing. In addition to the proposed treatments along the mainstem of the project, there is an ephemeral/intermittent channel located near the upstream extent that may also benefit from stream restoration techniques such as step pool structures. Access to the proposed project would include the main road utilized for the Living Farm Heritage Museum and then existing trails to access areas of the channel. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

NMP-NB-F104

Proposed Project Credit		Costs	
Length Restored (ft):	3,144	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	31.4	Estimated Construction Cost:	$1,414,800.00
Cost per Impervious Credit Acre:	$68,063.63	30% Contingency:	$424,440.00
		Estimated Total Cost:	$2,139,240.00

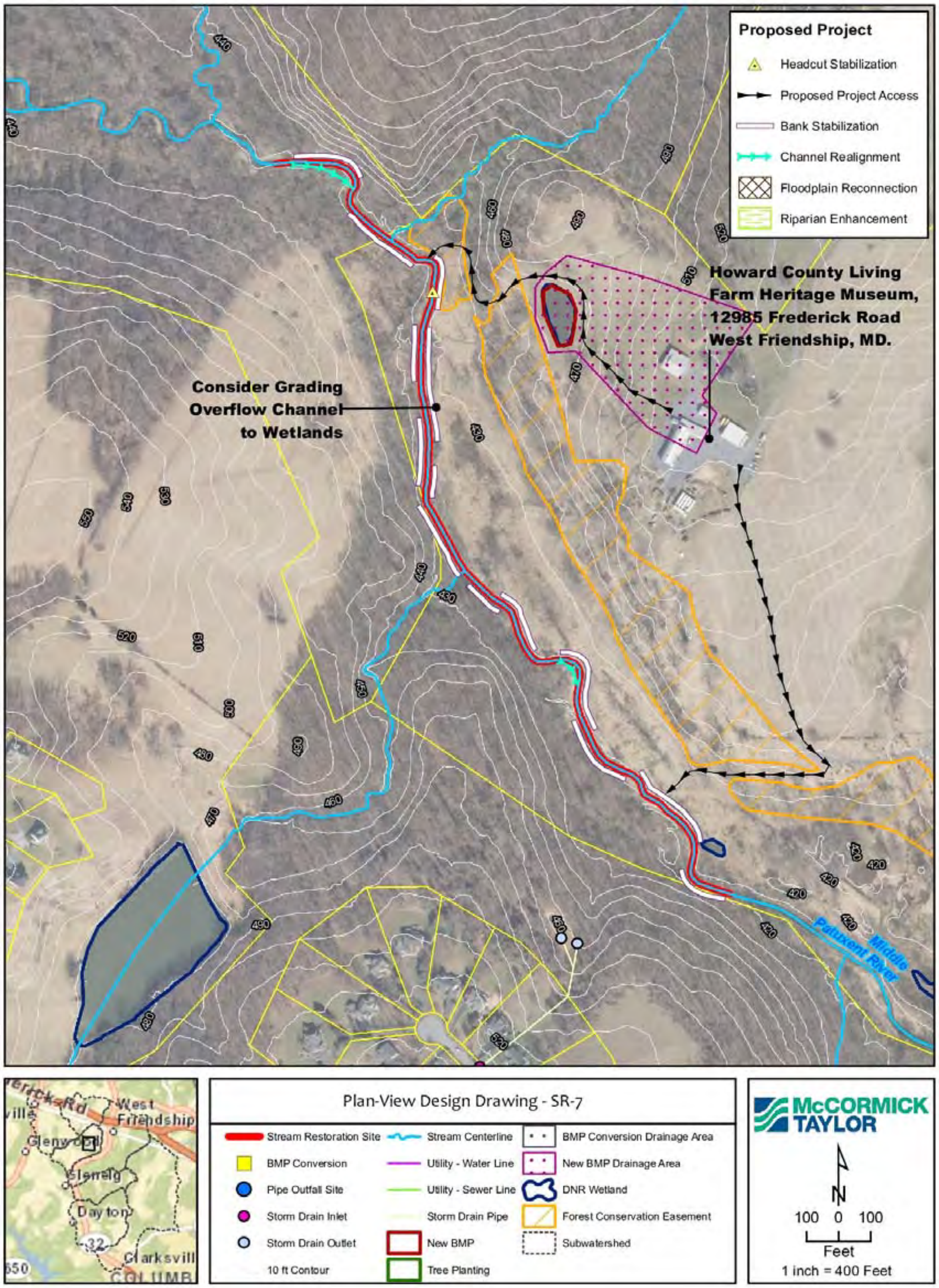
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-7

Site Name: Farm Museum

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-8

Site Name: Wynfield Road

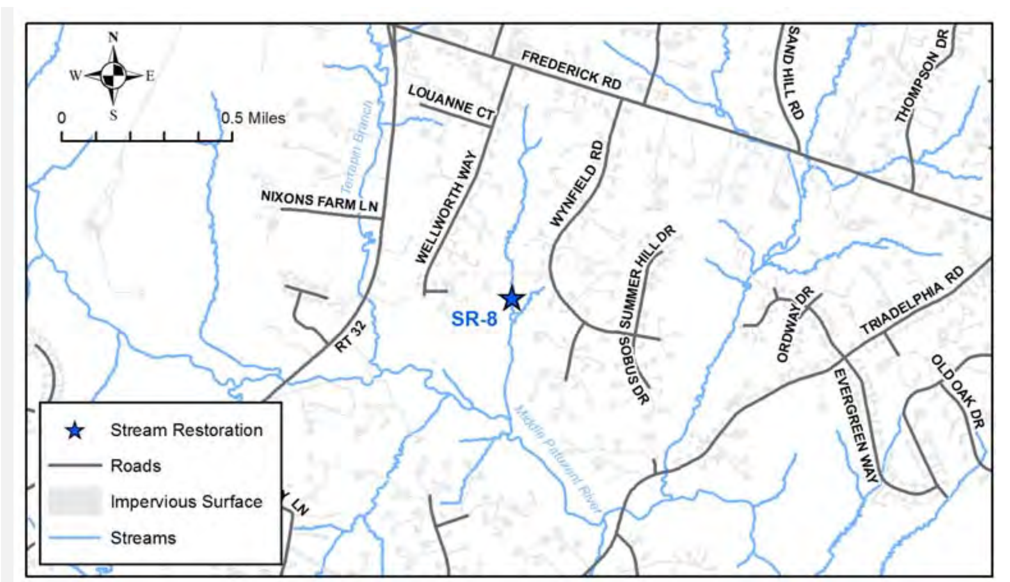
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

SR-8 consists of four stream assessment reaches (NMP-SR-F135A, NMP-SR-135B, NMP-SR-135C, and NMP-SR-F135D) of an unnamed tributary to the Middle Patuxent River. Land use surrounding the project site is primarily residential and forested land, and associated with up to 10 residential property owners. The stream restoration site begins approximately 1,200 lf. south of Frederick Road and extends downstream (south) about 2,829 lf. In general, the channel has a gravel/sand/silt substrate with bank heights ranging between 2 to 5 ft. The project site is sinuous with many tight meander bends that are associated with moderate to severe bank erosion. Approximately 1,500 lf. of the stream banks are currently eroding, primarily causing lateral migration and widening of the channel. The eroded banks are nearly vertical, contain moderate tree root densities, lack adequate surface protection, and are comprised primarily of sand and silt. Two headcuts were identified within the project toward the lower half of the stream site. One headcut is associated with an approximate 1 ft. drop in grade that is currently being controlled by existing tree roots. The second headcut is associated with a bedrock outcrop with an approximate 4 ft. drop in grade of the channel bed. There is also a headcut associated with a wetland outlet channel at the upstream extent of the project site that is eroding and increasing drainage of an existing wetland system.



SR-8 facing downstream at moderate bank erosion.

SR-8 facing upstream at a 4 ft. headcut.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-8

Site Name: Wynfield Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include access, ownership, and impacts to existing trees and forested areas.

Concept Description:

The proposed stream restoration project consists of approximately 2,829 lf. of an unnamed tributary of the Middle Patuxent River. Proposed treatments for stream restoration primarily include bank stabilization along with two areas for floodplain reconnection and two potential channel realignment segments. Bank stabilization areas are mostly associated with outside meander bends that lack surface protection and/or little to no woody vegetation. Two floodplain reconnection areas are proposed toward the upstream extent of the project. The upstream area is small and could be incorporated with bank stabilization treatments in this area of the channel. The second floodplain connection area is located on the left floodplain and could possibly be incorporated with an existing wetland located downstream. The proposed channel realignment located upstream would improve the existing tight meander geometry. This realignment could be designed with flood prone benches that would also provide better relief for high energy storm flows. The second channel realignment is located in the downstream reach along a stretch of severe meander bends that are in close proximity to the left valley wall. Realignment of the channel within this area would stabilize bank erosion areas into the valley wall and provide better relief for flood flows. The realignment would also be able to address the downstream 4 ft. headcut identified in this area. Erosion towards the end of the project reach is minimal and may only require some minor grading and heavy plantings of woody vegetation or live stake cuttings. Access to the stream channel is very difficult and likely the largest constraint for the project. The proposed stream restoration length could potentially be extended farther upstream due to additional erosion observed during one of the site visits. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

NMP-SR-F135B

Proposed Project Credit		Costs	
Length Restored (ft):	2,829	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	28.3	Estimated Construction Cost:	$1,273,050.00
Cost per Impervious Credit Acre:	$69,104.45	30% Contingency:	$381,915.00
		Estimated Total Cost:	$1,954,965.00

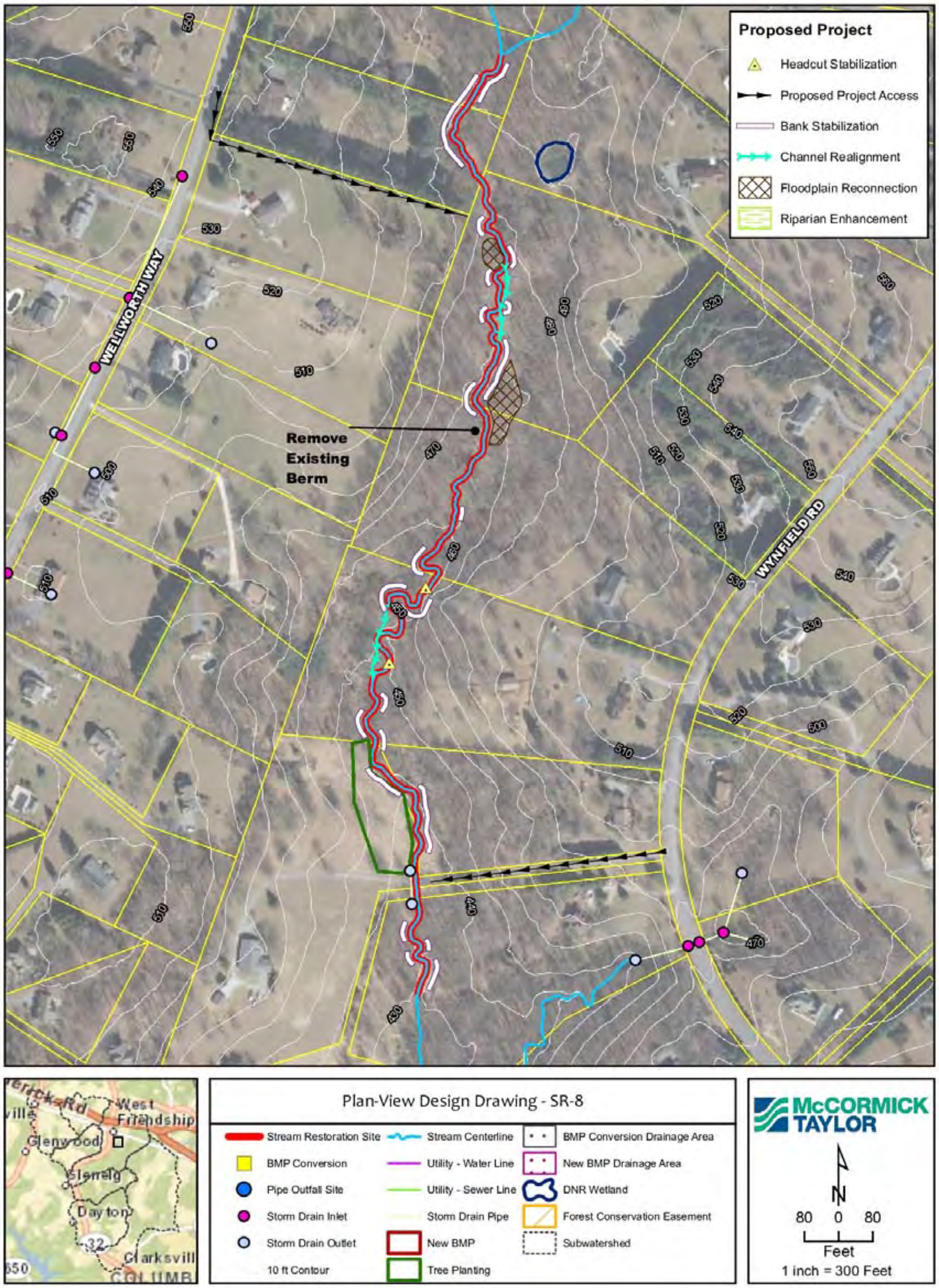
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-8

Site Name: Wynfield Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-9

Site Name: Stiles Way

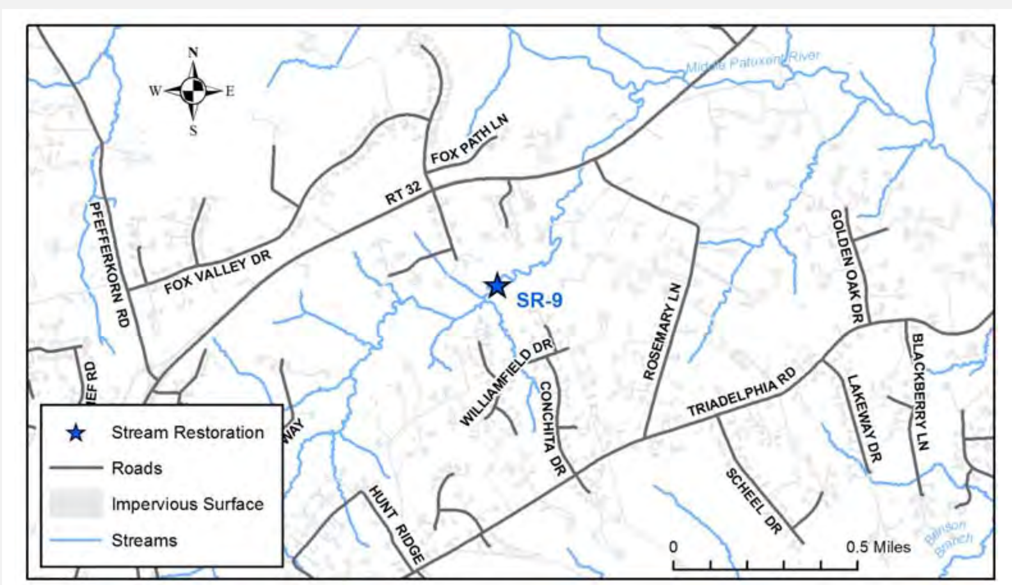
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Mixed Use
Multiple Owners

Existing Conditions:

SR-9 consists of two stream assessment reaches (NMP-SR-F131F and NMP-SR-F131G) of an unnamed tributary to the Middle Patuxent River. Land use surrounding the project site is primarily residential and forested land with three private property owners. The stream begins approximately 1,000 lf. southwest of the cul-de-sac at Stiles Way and extends about 2,168 lf. downstream. In general, the channel has a gravel/sand/silt substrate with bank heights ranging between 2-5 ft. The project reach is sinuous with the majority of meander bends being associated with moderate to severe bank erosion. There is over 1,000 lf. of the stream bank erosion causing lateral migration and channel widening. The eroded banks are nearly vertical, contain little or no woody vegetation, lack adequate surface protection, and are comprised mainly of sand and silt material. Some areas of the channel banks have already slumped and are starting to get established with herbaceous vegetation. However, some of the slumped banks will continue to erode and would benefit from installation of woody vegetation. There are existing wetland areas along portions of the left and right floodplains. A majority of the site is also contained within an existing forest conservation easement. The left floodplain along the upstream portion of the project includes an abundance of Japanese stiltgrass (Microstegium vimineum) which is an exotic invasive species.



Site ID: SR-9

Site Name: Stiles Way

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

SR-9 facing downstream at moderate bank erosion.

SR-9 facing upstream at moderate bank erosion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-9

Site Name: Stiles Way

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include access, ownership, invasive species and potential impacts to existing trees, forested areas and wetlands.

Concept Description:

The proposed stream restoration project consists of approximately 2,168 lf. of an unnamed tributary of the Middle Patuxent River. Proposed treatments for stream restoration primarily include bank stabilization along with several areas that could include floodplain reconnection and riparian buffer enhancements. Bank stabilization areas are mostly associated with outside meander bends that lack surface protection and have little or no woody vegetation. Floodplain reconnection areas are proposed along a majority of the right and left bank floodplains as bank heights are not very high and the channel could benefit greatly from reduced shear stresses associated with storm flows. There is evidence in some areas of existing floodplain access which could be increased in combination with bank stabilization treatments. Some of the banks along the proposed project have already slumped and are vegetating with herbaceous vegetation. Floodplain access could be achieved with some limited grading of the banks and floodplain to create overflow channels or design of flood prone benches in areas with higher banks. The most direct access route for the project would be the existing easement off of Stiles Way that is utilized for maintenance of the existing stormwater facility. The proposed stream restoration length could potentially be extended further upstream and/or downstream due to additional erosion observed during one of the site visits. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

NMP-SR-F131F

Proposed Project Credit		Costs	
Length Restored (ft):	2,169	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	21.7	Estimated Construction Cost:	$976,050.00
Cost per Impervious Credit Acre:	$72,364.62	30% Contingency:	$292,815.00
		Estimated Total Cost:	$1,568,865.00

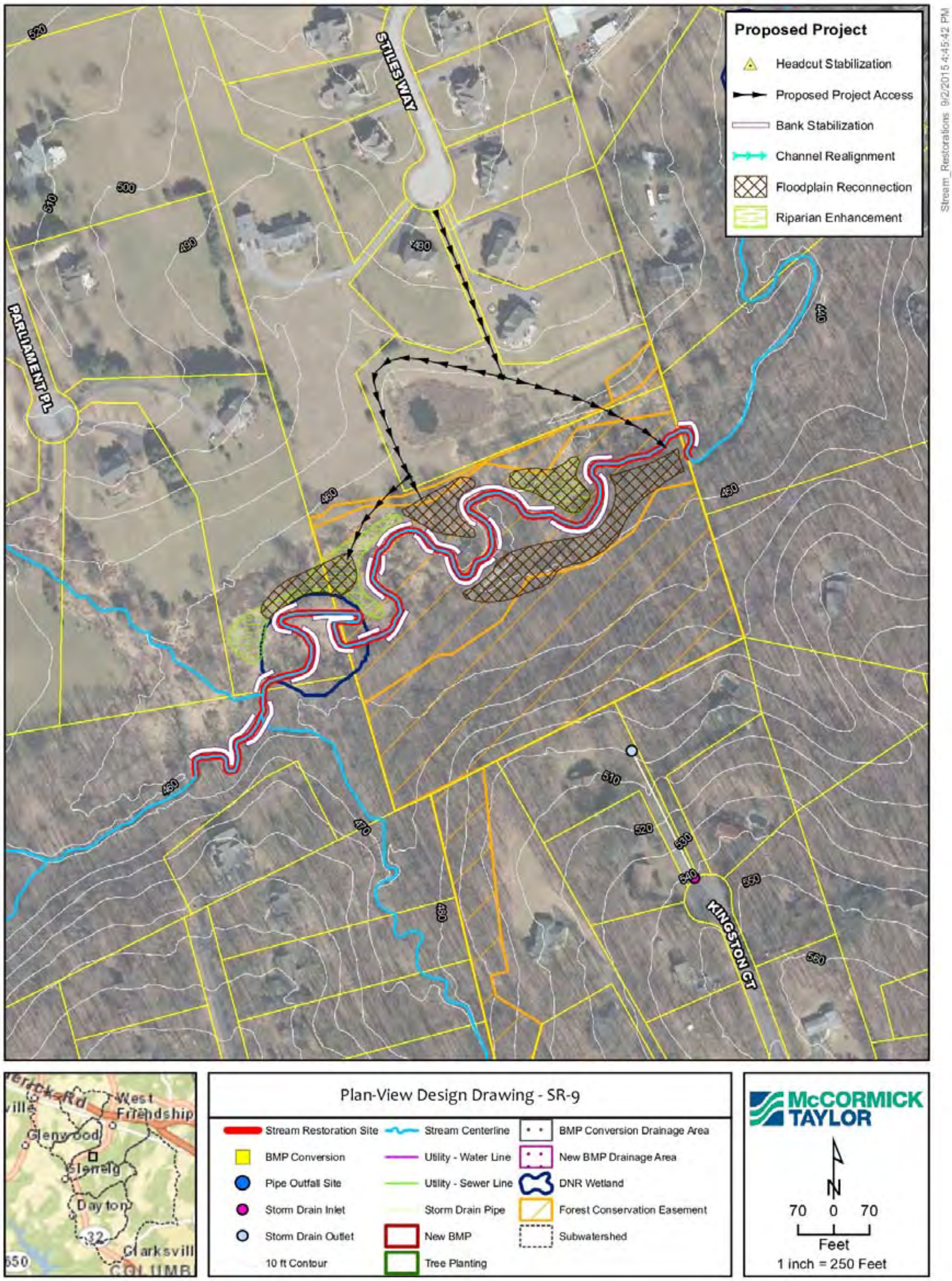
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-9

Site Name: Stiles Way

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-11

Site Name: Terrapin Branch

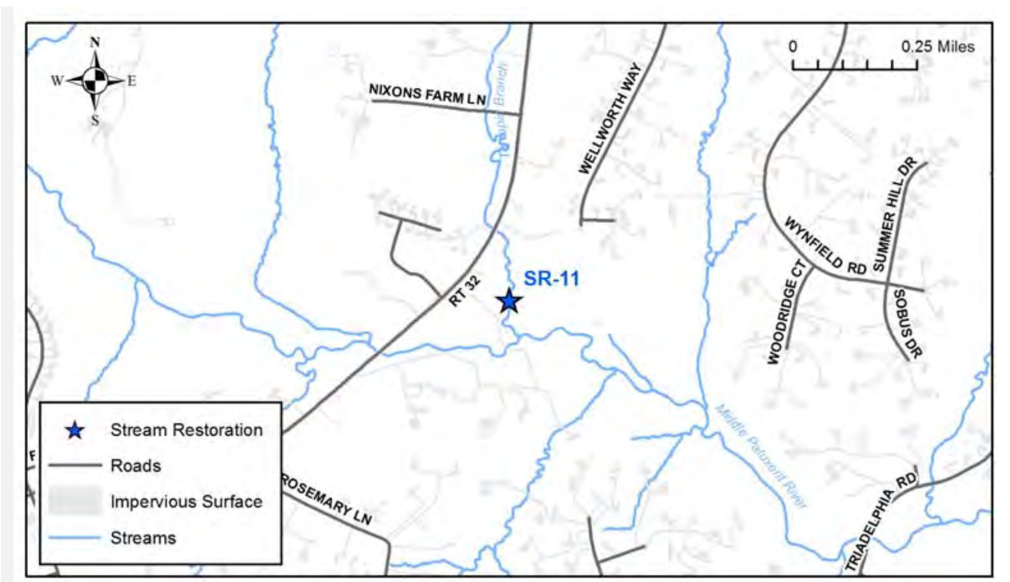
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Mixed Use
Multiple Owners

Existing Conditions:

SR-11 consists of two stream assessment reaches (NMP-SR-F136A, NMP-SR-F136B) that are associated with the mainstem of Terrapin Branch which drains directly to the Middle Patuxent River. Land use adjacent to the project site is primarily agricultural. A majority of the project site is associated with two parcels owned by a private owner and SHA. The stream restoration site begins at a culvert crossing under MD 32 just northeast of the intersection with Fox Chase Road, and extends downstream (south) approximately 1,420 lf. to the confluence with the Middle Patuxent River. In general, the channel has a gravel/sand/silt substrate with bank heights ranging between 4-6 ft. Approximately 520 ft. of the stream banks are currently eroding, primarily causing lateral migration and widening of the channel. A majority of the eroded banks are nearly vertical, contain low to moderate tree root densities, lack surface protection, and are comprised of a large percentage of sand. The stream receives a considerable amount of sediment input from upstream sources as evidenced by depositional features within the project site and in the culvert at MD 32. There is an outfall stabilization or BMP opportunity associated with a pipe outfall located adjacent to MD 32 at the upstream end of the project. The outfall is associated with an eroded perennial channel that carries flow under a farm road and into the mainstem of Terrapin Branch. Two existing forest conservation easements are located along the left floodplain of the project site that extends in a north/south direction.



SR-11 facing downstream moderate bank erosion.

SR-11 facing downstream at moderate bank erosion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-11

Site Name: Terrapin Branch

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include private property ownership, moderate access, and impacts to existing trees and forested areas.

Concept Description:

The proposed stream restoration project is associated with Terrapin Branch that extends from the culvert at MD-32 downstream approximately 1,420 lf. to the confluence with the Middle Patuxent River. Proposed treatments for stream restoration include bank stabilization, floodplain reconnection, one potential channel realignment segment, and riparian buffer enhancement areas. Bank stabilization areas are mostly associated with outside meander bends that are undergoing lateral migration and lack vegetation or surface protection. Stabilization or a new BMP is also recommended along an incised outfall channel that is located at the upstream end of the project adjacent to MD 32. The outfall channel drains to the channel on the left bank facing downstream. One floodplain reconnection area is proposed on the right bank of the stream at the downstream end of the project near the confluence with the Middle Patuxent River. Riparian buffer enhancement opportunities have also been identified along portions of the project. It is also recommended that the two existing forest conservation easements along the left bank or east side of the channel be inspected and may require maintenance activities and/or supplemental plantings. A significant knickpoint or headcut is located within the channel bed about halfway through the project reach that is being held by mature tree roots. It is recommended that a grade control structure be designed downstream of the headcut feature in order to maintain the channel grade upstream. Upstream access can be obtained using a farm access road off of MD 32 that is adjacent to the outfall channel stabilization opportunity. Downstream access can be obtained through permitted use of a private driveway on the east side of MD 32 that is also associated with access for SR-12, which could be considered for concurrent implementation. The project would likely include some impacts to existing trees and forested areas, primarily for access, which would be minimized to the greatest extent possible if the project moves forward. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

NMP-SR-F136B-PO101; SR-12; NMP-SR-F133a

Proposed Project Credit		Costs	
Length Restored (ft):	1,420	**Estimated Design Cost:**	$300,000.00
Impervious Area Treated Credit (ac.):	14.2	**Estimated Construction Cost:**	$639,000.00
Cost per Impervious Credit Acre:	$79,626.76	**30% Contingency:**	$191,700.00
		Estimated Total Cost:	$1,130,700.00

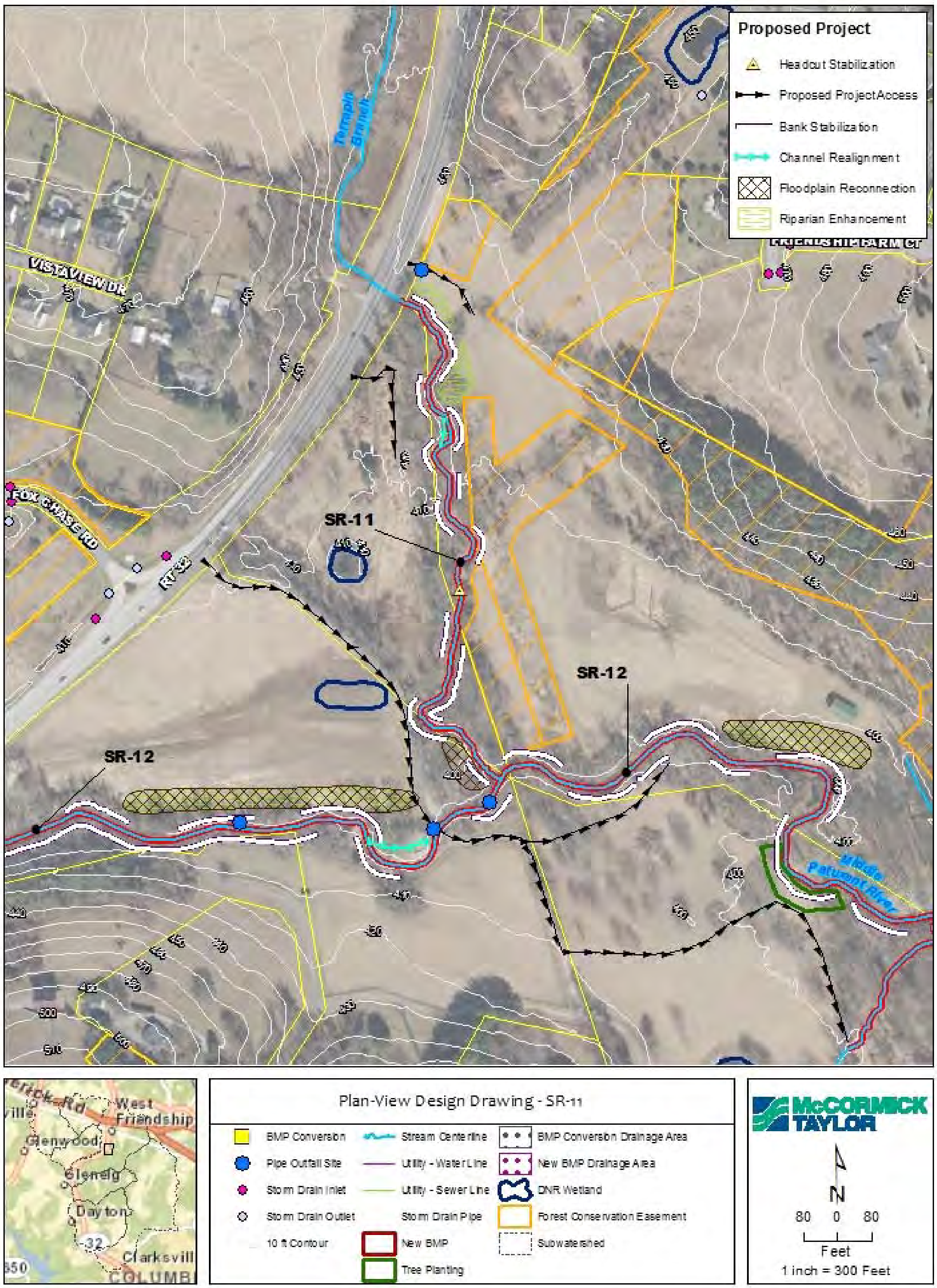
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-11

Site Name: Terrapin Branch

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-12

Site Name: Gossage Property

Contractor: McCormick Taylor

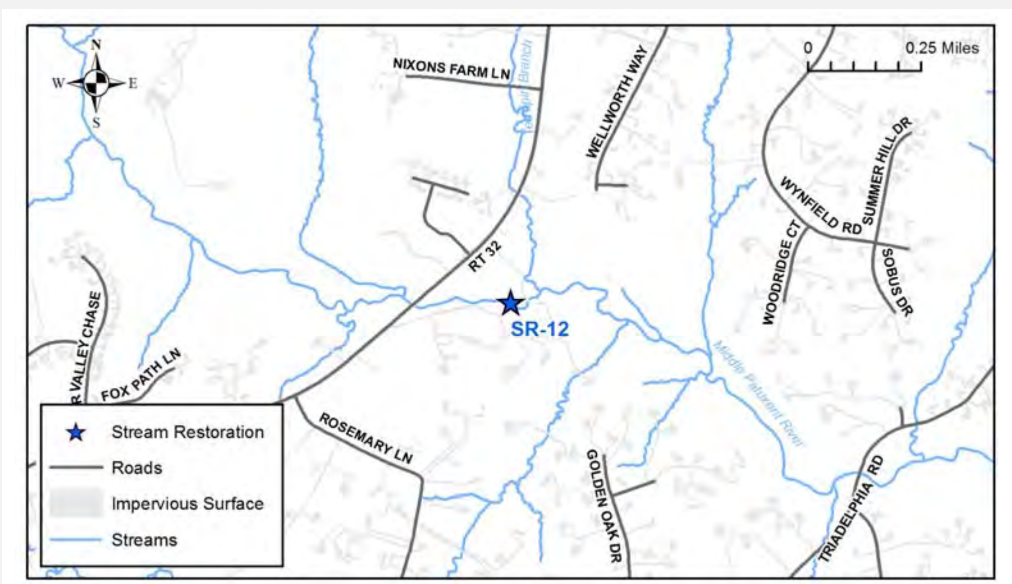
Watershed: Middle Patuxent River

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

SR-12 consists of four stream assessment reaches (NMP-SR-F133A, NMP-SR-F133B, NMP-SR-145A, and NMP-SR-145B) that are associated with the mainstem of the Middle Patuxent River. Land use adjacent to the project site is primarily agricultural and forested land that is associated with four parcels owned by the same family. The stream restoration site begins at the culvert crossing beneath MD 32 and extends approximately 3,366 lf. downstream. In general, the channel has a cobble/gravel substrate with bank heights ranging between 4 to 6 ft. The site also contains some instream features (riffles and depositional bars) that appear to be relatively stable. Approximately 996 ft. of the stream banks are currently eroding, primarily causing lateral migration and widening of the channel. A majority of the eroded banks are nearly vertical, lack surface protection or vegetation, and are comprised of a large percentage of sand. There is also an existing ford crossing toward the downstream end of the project that is utilized to gain access between agricultural fields and associated with some minor erosion.

Stabilization with riprap, salvaged concrete, and bricks has been attempted in the middle portion of the channel just upstream of the driveway. Some of this stabilization appears to be protecting the banks in some areas and failing or increasing erosion in other areas. The upstream portion of the site before the confluence with Terrapin Branch is characterized by riffle/pool habitat with large trees scattered along the top of bank; however, it lacks an adequate riparian buffer zone in some areas and is in need of bank stabilization in many areas. The downstream portion of the stream contains moderate sand/gravel bar deposition, numerous failing/fallen trees, and multiple meander bends that are associated with severe erosion. There are two existing forest conservation easements along a small portion of the left floodplain just past the confluence with Terrapin Branch (SR-11).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-12

Site Name: Gossage Property

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

SR-12 facing upstream at severe bank erosion.

SR-12 facing upstream at severe bank erosion that is threatening existing infrastructure.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-12

Site Name: Gossage Property

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include private property ownership, moderate to difficult access, and impacts to existing trees and forested areas.

Concept Description:

The proposed stream restoration project consists of four stream reaches associated with the Middle Patuxent River that extend approximately 3,636 lf. downstream from the culvert crossing at MD 32. The stream restoration primarily includes bank stabilization measures, but could also include a few areas for improved floodplain connection and riparian buffer enhancement. Bank stabilization areas are mostly associated with outside meander bends that are undergoing lateral migration and lack vegetation or surface protection. The ford crossing located toward the downstream end of the project could be improved with the project and help reduce some minor erosion along that portion of the channel. Two floodplain reconnection and riparian enhancement areas are proposed along the left bank of the project reach facing downstream. One segment of the channel may benefit from a minor channel realignment just upstream of the existing driveway where there has been previous measures of bank stabilization using riprap, salvaged concrete, and bricks. The channel alignment could also help improve channel planform and flows approaching the driveway bridge. The stream alignment associated with the culvert crossing at MD 32 is poor and flow is currently being directed at the valley wall on the right side of the channel. Coordination with SHA is recommended prior to initiating the stream restoration project based on an ongoing planning study associated with improvements along this portion of MD 32. Upstream and downstream access can be gained through permitted use of the private driveway off of MD 32. The project may require a temporary access bridge across the stream channel as the existing bridge may not be adequate to support heavy construction equipment. The project would likely include some impacts to existing trees and forested areas that would be minimized to the greatest extent possible if the project moves forward. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

SR-11; NMP-SR-F133a; SR-13

Proposed Project Credit		Costs	
Length Restored (ft):	3,636	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	36.4	Estimated Construction Cost:	$1,636,200.00
Cost per Impervious Credit Acre:	$66,750.83	30% Contingency:	$490,860.00
		Estimated Total Cost:	$2,427,060.00

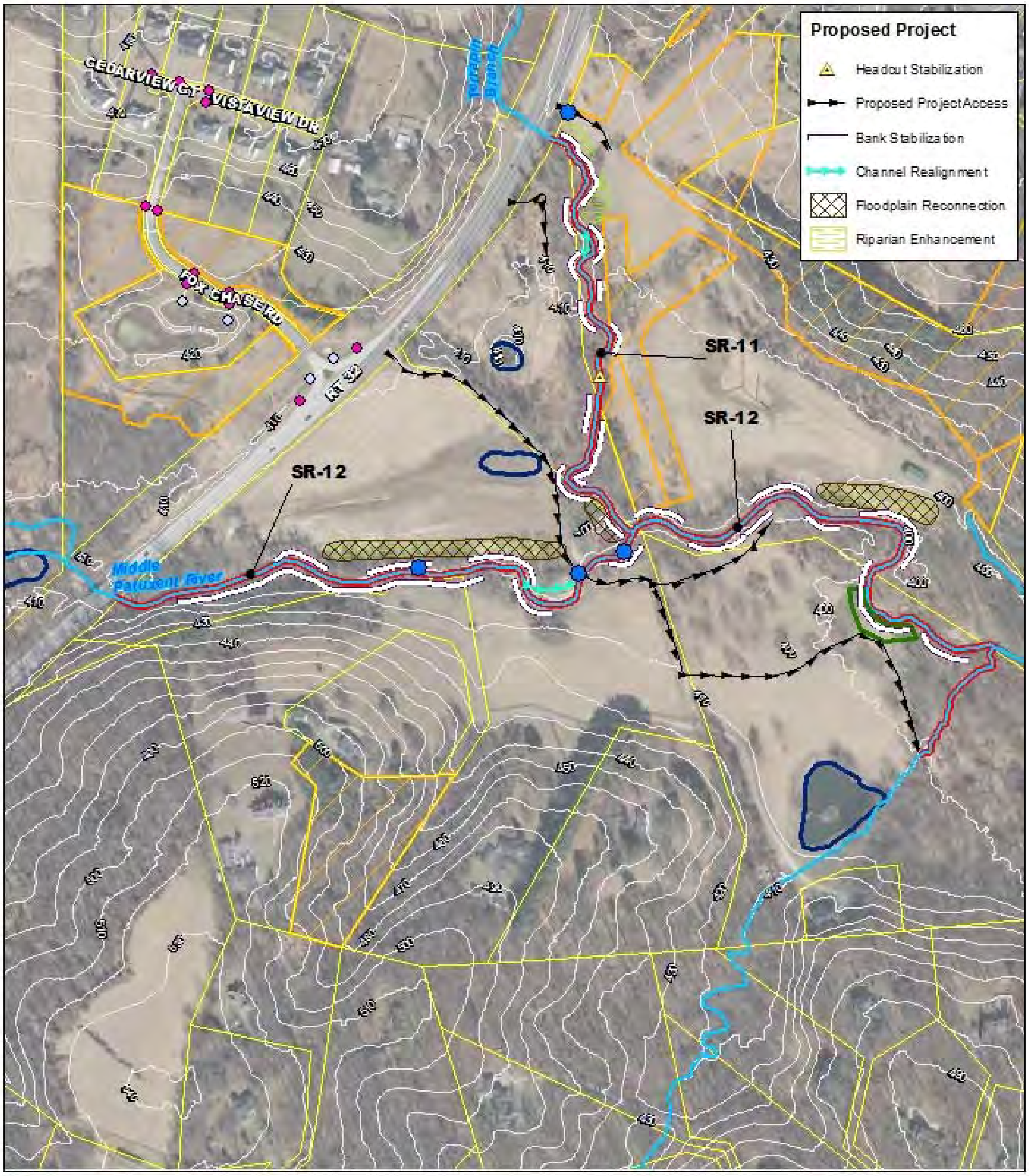
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-12

Site Name: Gossage Property

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Plan-View Design Drawing - SR-12

BMP Conversion	Stream Centerline	BMP Conversion Drainage Area
Pipe Outfall Site	Utility - Water Line	New BMP Drainage Area
Storm Drain Inlet	Utility - Sewer Line	DNR Wetland
Storm Drain Outlet	Storm Drain Pipe	Forest Conservation Easement
10 ft Contour	New BMP	Subwatershed
	Tree Planting	

McCORMICK TAYLOR

N

100 0 100

Feet

1 inch = 400 Feet

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-13

Site Name: Triadelphia Road

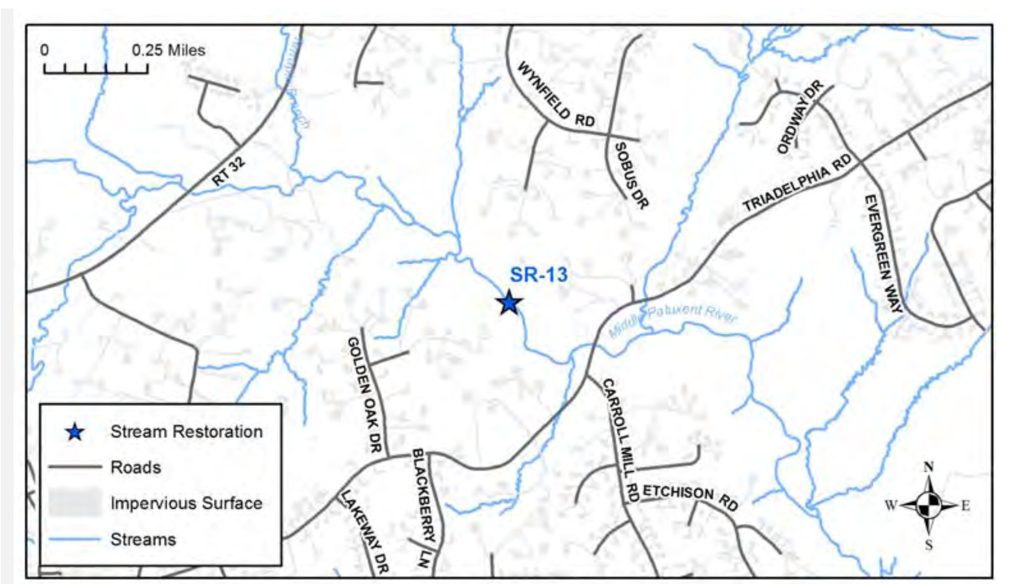
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

SR-13 consists of three stream assessment reaches (NMP-SR-F144A, NMP-SR-F144B, and NMP-SR-144C) associated with the mainstem of the Middle Patuxent River. Land use adjacent to the project site is primarily forested and residential land associated with ten privately owned properties. The stream restoration site begins at a culvert crossing located approximately 400 ft. north of the intersection of Triadelphia Road and Carroll Mill Road that extends upstream (northwest) about 3,260 lf. In general, the channel has a predominately cobble/gravel/sand substrate with bank heights ranging between 4-8 ft. A majority of the channel bed material is covered with a layer of silt and algal growth. Approximately 1,414 ft. of the stream banks are currently eroding primarily causing lateral migration and widening of the channel. A majority of the eroded banks are nearly vertical, lack surface protection or vegetation, and are comprised of a large percentage of sand. There are also some segments of the channel along the toe of banks with exposed gravel lenses that are also prone to erosion. The entire project site is located within a forest area with many large trees. Several trees have fallen or are in the process of falling due to bank erosion. The channel has many large depositional features suggesting that the stream receives a considerable amount of sediment input from upstream sources. Field observations indicate the presence of existing forested wetlands along portions of the floodplain.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-13

Site Name: Triadelphia Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

SR-13 facing downstream at severe bank erosion.

SR-13 facing downstream at severe bank erosion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-13

Site Name: Triadelphia Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include property ownership, access, potential impacts to trees, forested areas and wetlands.

Concept Description:

The proposed stream restoration project consists of three stream reaches associated with the mainstem of the Middle Patuxent River that extend approximately 3,260 lf. upstream from the culvert crossing at Triadelphia Road. The project primarily includes bank stabilization, floodplain reconnection, and headcut stabilization treatments. Proposed bank stabilization treatments are mostly associated with actively eroding meander bends that are undergoing lateral migration and lack protection. Two floodplain reconnection areas are proposed along the project area. One is located just upstream of a Department of Natural Resources mapped wetland area on the right bank floodplain toward the upstream end of the project. The second is located towards the downstream end of the project and is adjacent to a meander bend that is recommended for channel realignment. The slight channel realignment is proposed to move the channel off the right bank where it is eroding into the valley wall and allow for bank stabilization treatment. Another severe meander is located at the upstream end of the project; however, the channel has already started to cutoff from the tight meander geometry. This area of the project could benefit from bank stabilization, some slight channel grading and installation of grade control structures due to the recent channel avulsion and soft, steep, unstable riffle features which may cause continued channel degradation upstream. The unnamed tributary that drains from the left bank at the top end of the project site would also benefit from a grade control structure just upstream of the confluence with the Middle Patuxent River. The tributary has a knickpoint at the confluence area that is controlled by a felled tree which if destabilized could cause further degradation and increase erosion rates of the channel. The most direct access to the site would be to create a haul road off of Triadelphia Road. It is likely that there would be some major impacts to existing trees for creation of a haul road to construct the project. This proposed stream restoration project is located just downstream from SR-12 and could be considered to be linked with this stream restoration site, which may provide another option for access. The project would include additional stream assessment and design phases to determine specific channel treatments, construction sequence and minimization of forest impacts.

Nearby Opportunities:

SR-12; NMP-SR-F133a; SR-11

Proposed Project Credit		Costs	
Length Restored (ft):	3,259	**Estimated Design Cost:**	$300,000.00
Impervious Area Treated Credit (ac.):	32.6	**Estimated Construction Cost:**	$1,466,550.00
Cost per Impervious Credit Acre:	$67,705.28	**30% Contingency:**	$439,965.00
		Estimated Total Cost:	$2,206,515.00

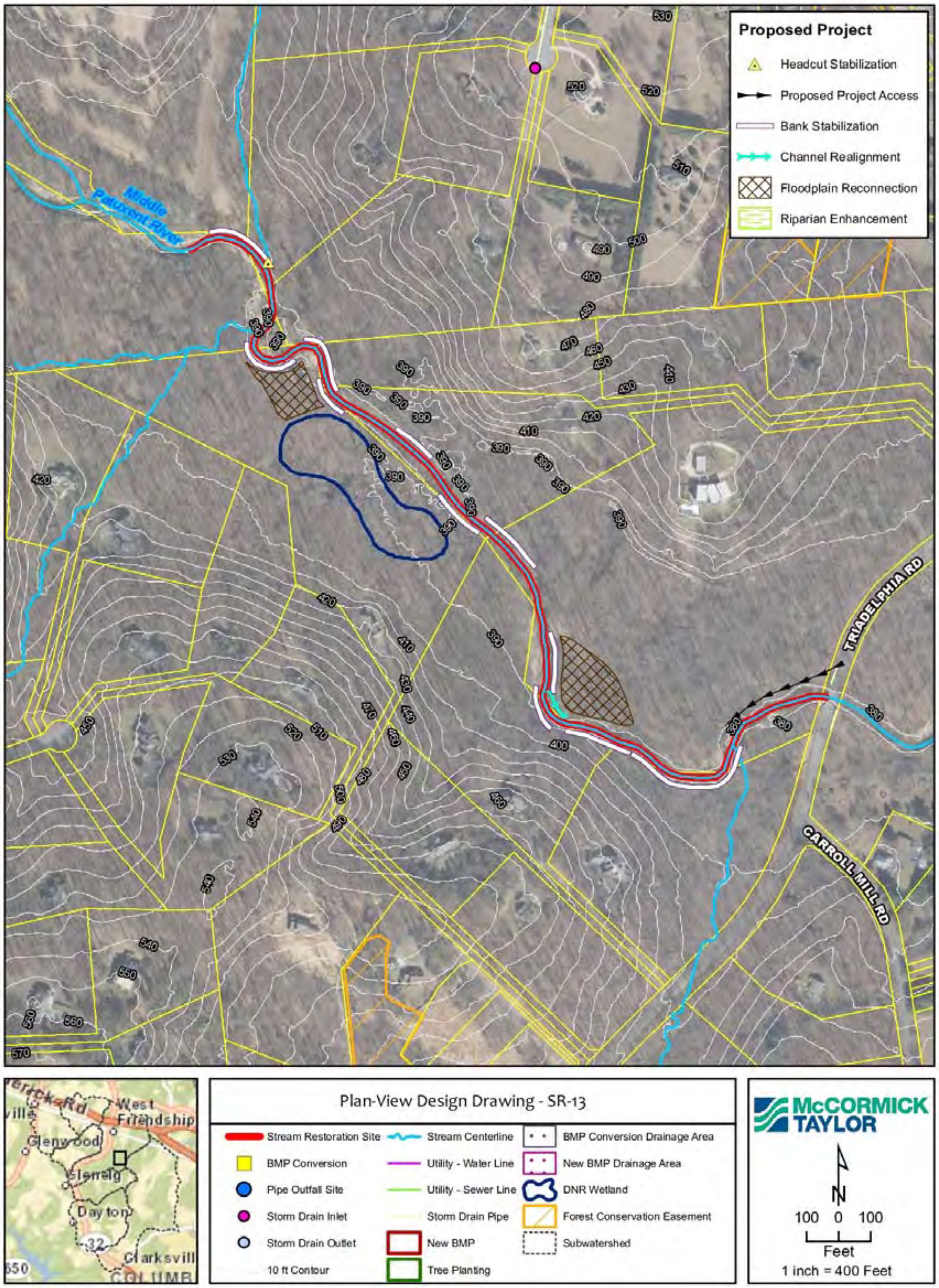
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-13

Site Name: Triadelphia Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-16

Site Name: Ericole Court

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

SR-16 consists of three assessed stream reaches (NMP-SR-F165A, NMP-SR-F165B, and NMP-SR-166A) associated with an unnamed tributary and the mainstem of the Middle Patuxent River. Land use surrounding the project site is primarily forested and residential land associated with 10 privately owned properties. The stream restoration site begins at a tributary of the Middle Patuxent River located approximately 150 ft. east of the intersection of Triadelphia Road and Ericole Court. The tributary continues approximately 600 lf. downstream (south) to the confluence with the Middle Patuxent River and the site extends about 1,600 lf. farther downstream (east) on the Middle Patuxent River. The tributary channel has a predominantly sand and gravel substrate with bank heights ranging between 3 to 5 ft. The channel of the Middle Patuxent River has a predominately cobble/gravel/sand substrate with bank heights ranging between 5 to 7 ft. Approximately 946 ft. of the stream banks are currently eroding, primarily causing lateral migration and widening of the channel. A majority of the eroded banks are nearly vertical, lack woody vegetation and surface protection, and are comprised of a large percentage of sand. The entire project site is associated with a mature forest and numerous large trees; however, there are multiple failing/fallen trees along the channel. Erosion of the channel banks is primarily located on outside meander bends that are high with little or no floodplain relief. Large bar formations are also abundant within the upstream and downstream reaches of the channel, suggesting that the stream receives a considerable amount of sediment load.

SR-16 facing upstream at severe bank erosion.

SR-16 facing upstream at moderate bank erosion near Triadelphia Road.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-16

Site Name: Ericole Court

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include property ownership, access, and potential impacts to trees and forested areas.

Concept Description:

The proposed stream restoration project consists of three stream reaches. The upstream reach is associated with an unnamed tributary that begins at a culvert underneath Triadelphia Road and extends approximately 600 lf. downstream to the confluence with the Middle Patuxent River. The project site continues along the Middle Patuxent River from approximately 250 lf. upstream of the confluence and extends approximately 1,350 lf. downstream. The proposed restoration primarily includes bank stabilization treatments and floodplain reconnection or the design of floodplain benches with bank stabilization treatments. Bank stabilization treatments are mostly associated with actively eroding meander bends that are undergoing lateral migration and lack floodplain relief. Three floodplain reconnection areas are proposed along the project area. One is located along the upstream extent on the right floodplain of the unnamed tributary, adjacent to a meander bend that is also proposed for bank stabilization. The other two areas are located downstream on the right and left floodplains of the Middle Patuxent River. An incised outfall tributary located on the south side of Triadelphia Road, directly across from Ericole Court could also be included for stabilization and/or a BMP opportunity for TMDL credit. The Middle Patuxent River upstream of the project site to Triadelphia Road could also be considered for additional restoration, but property access was not allowed during the watershed assessments. Site access is difficult for this site due to the mature forest that surrounds the entire restoration area. The most direct access to the site would be to create a haul road off of Triadelphia Road just east of the culvert crossing for the unnamed tributary. The project would include additional stream assessment and design phases to determine specific channel treatments, construction sequence and minimization of forest impacts.

Nearby Opportunities:

SR-13

Proposed Project Credit		Costs	
Length Restored (ft):	2,214	**Estimated Design Cost:**	$300,000.00
Impervious Area Treated Credit (ac.):	22.1	**Estimated Construction Cost:**	$996,300.00
Cost per Impervious Credit Acre:	$72,050.14	**30% Contingency:**	$298,890.00
		Estimated Total Cost:	$1,595,190.00

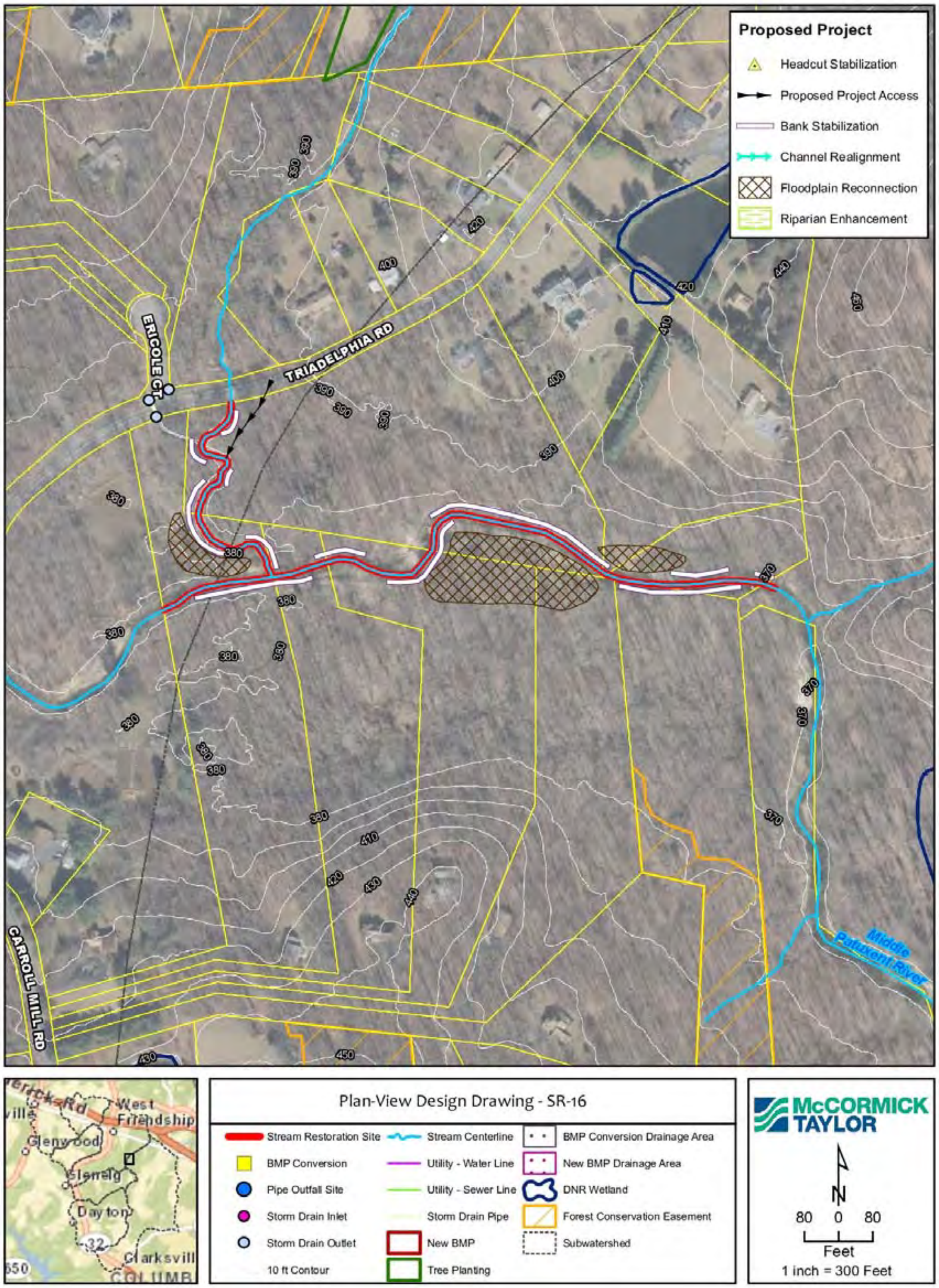
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-16

Site Name: Ericole Court

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-27

Site Name: Middle Patuxent Environmental Area

Contractor: Biohabitats

Watershed: Middle Patuxent River

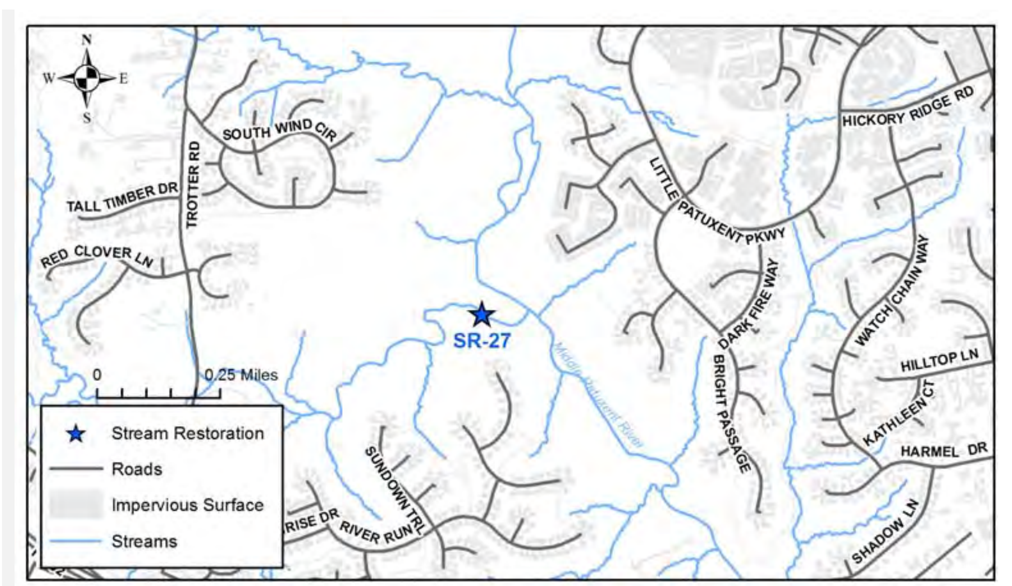
Ownership: County Park

Single Owner

Existing Conditions:

This site is located within the Middle Patuxent Environmental Area, a 1,021 ac. wildlife area in Clarksville, MD. The tributary is currently an over-wide channel with 5 ft. or greater eroded bank height on both the left and right banks. Large point and central bars have formed along the over wide channel. The floodplain along the tributary is forested with trees along both banks; however, some trees are unstable due to the eroded tributary and could cause debris jams if the trees fall within the tributary. The eroded banks are less severe on the main channel than the tributary, with more patchy cover rather than long, alternating raw banks as seen in the tributary. Trees along the banks are more stable compared to the trees found within the tributary and provide stability for the stream banks.

The instream habitat within the site scored in the suboptimal range overall. The velocity/depth regime of the site is suboptimal with all velocities present minus fast-deep. Some new sediment deposition throughout the channel is evident based on recent bank failure which is creating new bar formations along the tributary more than the mainstem, but is only affecting the bottom of the channel within the upstream portion of the mainstem. The channel flow status is suboptimal with water filling more than 75% of the channel and less than 25% of the riffle substrate exposed along the mainstem; however, channel flow status within the tributary is marginal with water only reaching 50% of the available stream bed. All stream banks within the site are moderately unstable with about 30-60% of the banks eroded and having a higher erosion potential during floods. The vegetative protection and riparian vegetative zone throughout this area is great with forest surrounding all the streams; therefore, shading within this area is high (80%).



Facing upstream along the tributary (SMP-SR-F360A) showing little bank vegetative cover and protection along with large lateral bar formation.

Facing upstream along the downstream mainstem (SMP-SR-F353A) showing patchy bank erosion due to loss of vegetative bank protection.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-27

Site Name: Middle Patuxent Environmental Area

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Due to the location of the mainstem and tributary, access and tree impact are the biggest constraints for this stream restoration. The stream could be accessed using the sewer line easements that run along the stream and the nearby neighborhoods; however, the entrance to the sewer line easement is close to existing homes. Also, with this access, there is a lack of staging area for the restoration. These streams are within an environmental area where tree cover is extensive; therefore, impacts to trees could be significant in order to reach and restore the stream. Removing trees along the stream would worsen the stability of the banks. Sewer lines and water lines do run across the stream in four separate locations.

Concept Description:

The objective for this project is to reduce bank erosion and improve instream habitat for aquatic organisms. This will be accomplished by grading banks back to a stable angle and stabilizing them with native vegetation to hold soil in place on the mainstem. Along the tributary, taking the existing channel and creating a nested channel with a bench along both banks will help to improve flow status and sediment transport. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary at the tight meander bends. In addition, establishing the maximum riparian buffer will increase the shading to reduce the stream temperature and provide needed litter inputs and woody debris to the channel overtime to maintain the habitat complexity and quality. This channel restoration has the potential to reduce the sediment supply, improve habitat and provide opportunities for nutrient uptake. The site can be accessed from a nearby sewer line easement that runs along the stream. The access point to the sewer line easement is close to existing homes. There are no surrounding project recommendations that could be concurrently implemented with this restoration project.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,993	**Estimated Design Cost:**	$300,000.00
Impervious Area Treated Credit (ac.):	19.9	**Estimated Construction Cost:**	$896,850.00
Cost per Impervious Credit Acre:	$73,552.68	**30% Contingency:**	$269,055.00
		Estimated Total Cost:	$1,465,905.00

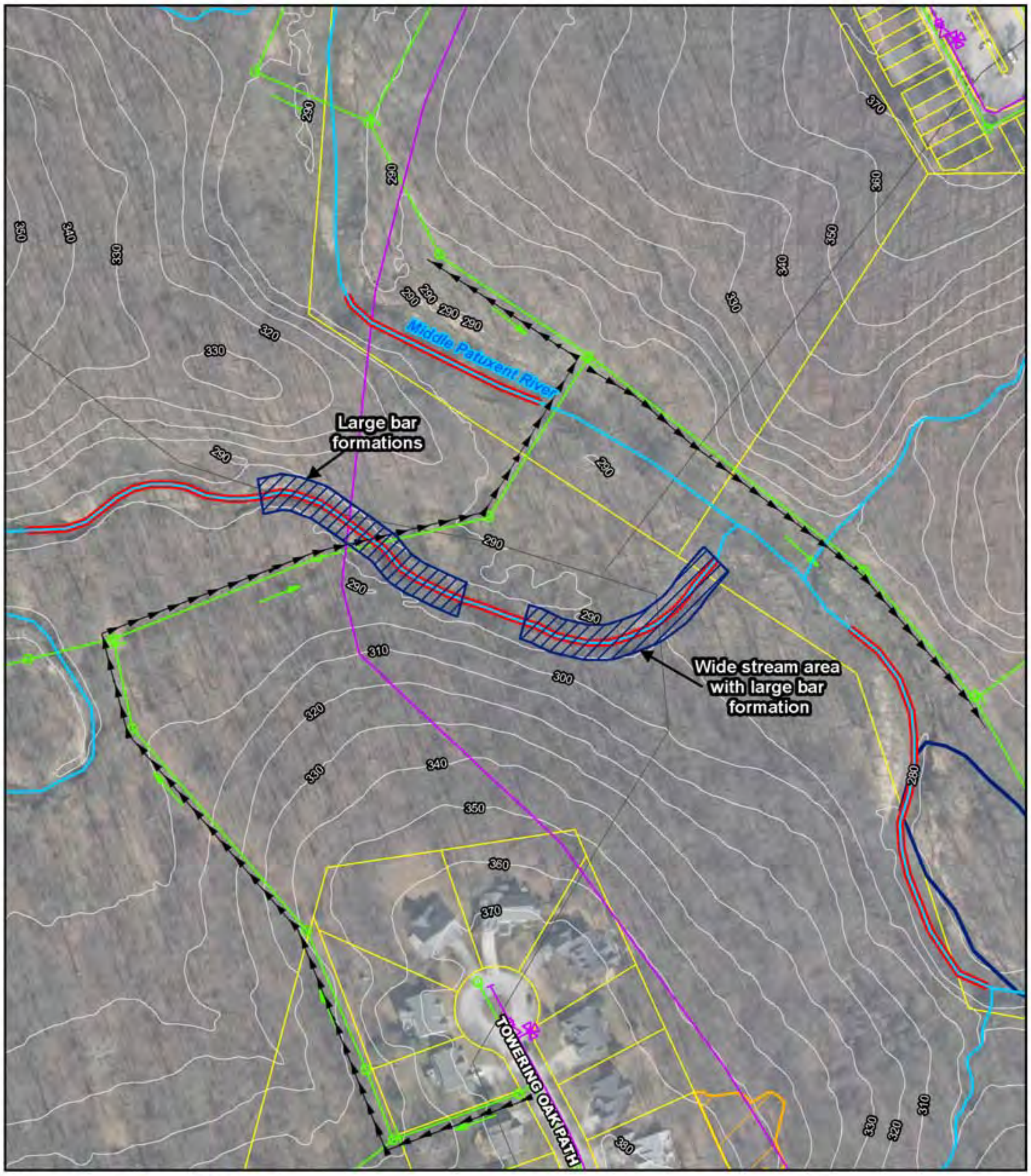
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-27

Site Name: Middle Patuxent Environmental Area

Contractor: Biohabitats

Watershed: Middle Patuxent River



Plan-View Design Drawing

Stream Restoration - SR-27

Proposed Project Access	Stream Centerline	Subwatershed
BMP Conversion	Utility - Water Line	Forest Conservation Easement
Pipe Outfall Site	Utility - Sewer Line	New BMP
10 ft Contour	Area of Interest	Tree Planting
Stream Restoration Site	DNR Wetland	Property Boundary

Biohabitats
STORMWATER MAINTENANCE

N

50 0 50
Feet
1 inch = 200 Feet

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-28

Site Name: Cedar Lane

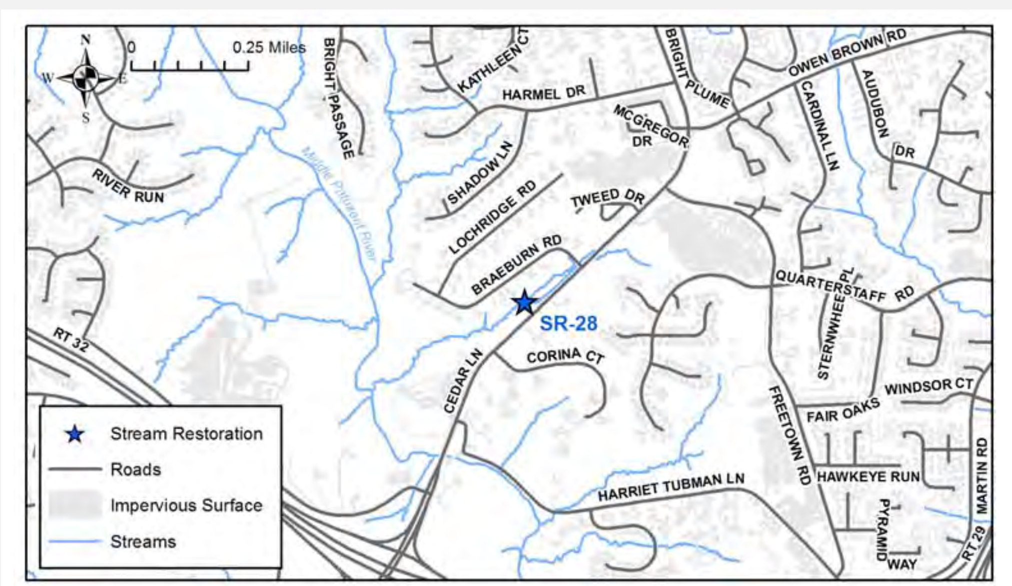
Contractor: Biohabitats

Watershed: Middle Patuxent River

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

Both SMP-SR-F354A and SMP-SR-F355A are low flow streams that receive most of its flow during large rain events from stormwater outfalls. These two streams confluence at SMP-SR-F356A. The instream habitat within the site scored in the marginal range overall. The epifaunal substrates consists of 40-70% stable habitat well suited for full colonization and adequate habitat throughout all sites with relatively low embeddedness (25-50%) occurring along the SMP-SR-F355A and SMP-SR-F356A, but a higher embeddedness (75%) occurring within SMP-SR-F354A. The velocity/depth regime of the site is relatively poor with only one or two velocities present, typically slow-deep and slow-shallow. Sediment deposition throughout the channel is evident based on recent bank failure which is creating new bar formations and affecting the bottom of all the channels. The channel flow status is suboptimal with water filling more than 75% of the channel and less than 25% of the riffle substrate exposed along SMP-SR-F354A and SMP-SR-F355A; however, channel flow status downstream of these sites is marginal with water only reaching 50% of the available stream bed. All stream banks within the site are moderately unstable with about 30-60% of the banks eroded and having a higher erosion potential during floods. The vegetative protection and riparian vegetative zone throughout this area is poor due to residential lawns coming up to the stream edge with little tree cover throughout. The upstream portion SMP-SR-F354A is a small channel with low flow; however, as the stream flows downstream, the stream becomes extremely incised exposing pipes and cable lines. As the stream approaches the confluence, the stream widens and becomes somewhat stable. SMP-SR-F355A upstream is also a smaller channel with low flow that runs along Cedar Lane. As the channel approaches the confluence, there is a pipe outfall that is creating bank erosion and exposing the outfall structure. Downstream of the pipe outfall undercut banks and a tight bend have formed due to the discharge coming from the pipe. Both SMP-SR-F354A and SMP-SR-F355A converge into SMP-SR-F356A where there is minor erosion occurring for approximately 200 ft. moving downstream. Moderate erosion with eroding banks between 3-5 ft. begins to occur with increased bar formation and more tight bends forming throughout SMP-SR-F356A. The stream is widening out as it moves downstream, which is taking away property from landowners.



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-28

Site Name: Cedar Lane

Contractor: Biohabitats

Watershed: Middle Patuxent River

Facing upstream on SMP-SR-F354A showing evidence of high eroded banks forming an incised channel.

Facing downstream on SMP-SR-F355A where the stream converges with a pipe outfall creating a knickpoint. Recent left bank (looking downstream) erosion is evident where the pipe outlet and geotextile is exposed.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-28
Site Name: Cedar Lane
Contractor: Biohabitats
Watershed: Middle Patuxent River

Constraints/Utilities:

The site is located on six separate private properties which is the major constraint for this site. The stream could be accessed from Braeburn Road near the intersection with Cedar Lane. Sewer lines and water lines are not a constraint to the site. Some trees might be impacted as well as small foot bridges that are found throughout the stream. No sewer lines and/or water lines will be impacted, because they are located under Cedar Lane; however, there are exposed cables and a small pipe located within SMP-SR-F354A that could be a constraint during construction.

Concept Description:

The objective for this project is to reduce bank erosion and improve instream habitat for aquatic organisms. This will be accomplished by raising the stream invert, grading banks back to a stable angle, and stabilizing them with native vegetation to hold soil in place. By raising the invert, houses and other improvements are all well up slope of the stream; therefore, if residents are concerned with potential flooding, the stream bed should be armored in place or a floodplain bench should be added. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment may be necessary to avoid further erosion near the existing exposed pipe outfall. In addition, establishing the maximum riparian buffer will increase the shading to reduce the stream temperature and provide needed litter inputs and woody debris to the channel overtime to maintain the habitat complexity and quality. An invasive management plan would prevent further growth of bamboo and other invasive species within this area. This channel restoration has the potential to reduce the sediment supply, improve habitat and provide opportunities for nutrient uptake. The site can be accessed from Braeburn Road near the intersection with Cedar Lane. There are no nearby project recommendations that could be concurrently implemented with this project.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,541	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	15.4	Estimated Construction Cost:	$693,900.00
Cost per Impervious Credit Acre:	$78,005.84	30% Contingency:	$208,170.00
		Estimated Total Cost:	$1,202,070.00

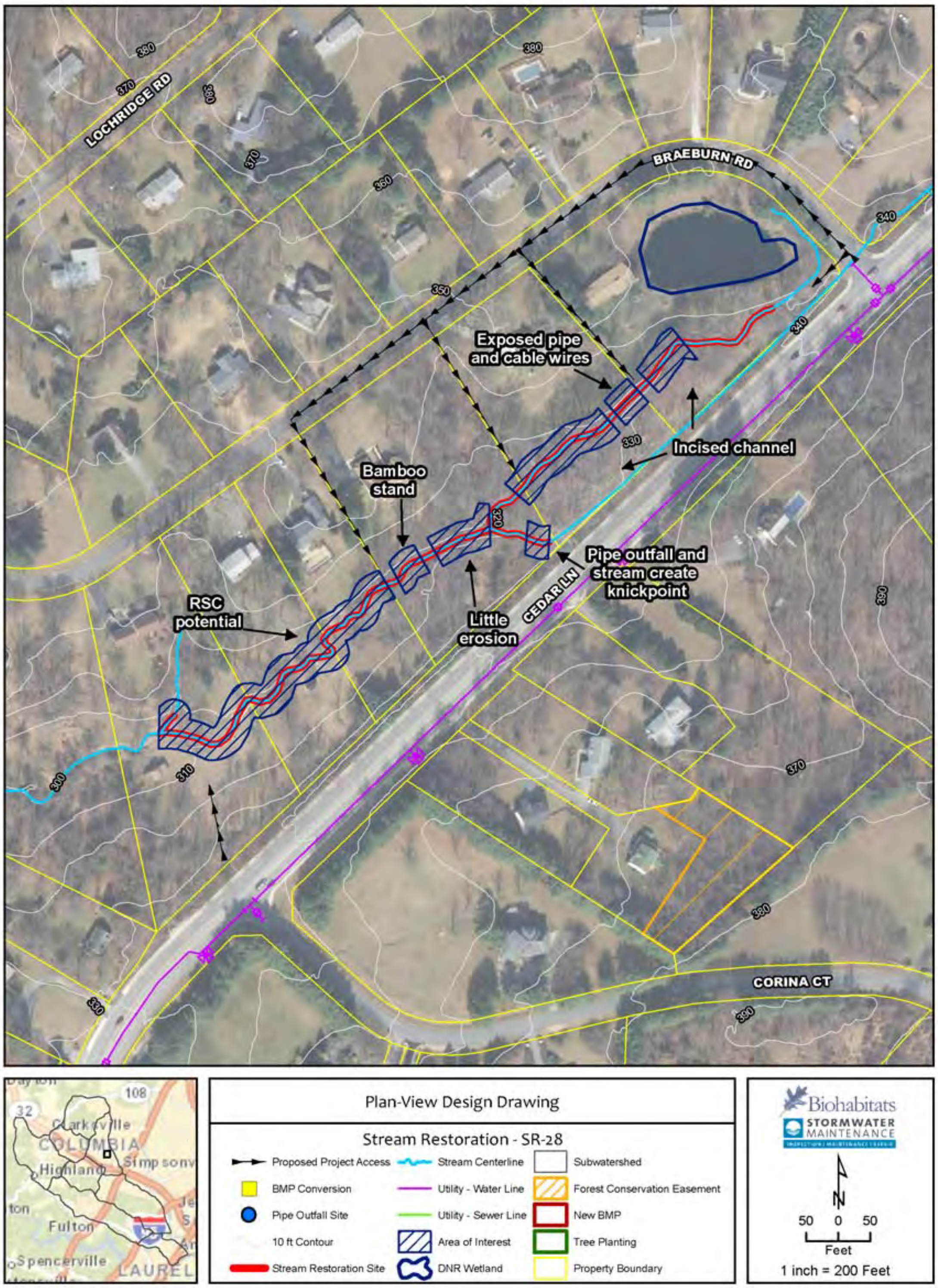
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-28

Site Name: Cedar Lane

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-39

Site Name: Montpelier Research Park

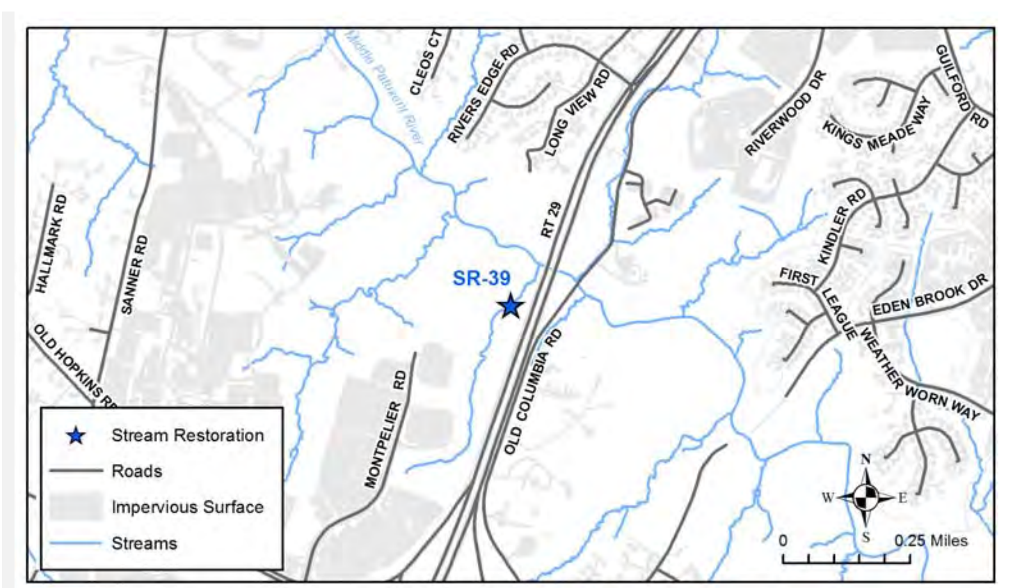
Contractor: Biohabitats

Watershed: Middle Patuxent River

Ownership: County Owned
Single Owner

Existing Conditions:

This stream is located between Montpelier Road and Old Columbia Road (Route 29) in Laurel, MD. The stream is a small perennial channel that receives drainage from several stormwater facilities treating runoff from adjacent commercial development. The stream is currently surrounded by the Montpelier Research Park Forest Conservation Easement (F-00-049). A sewer line runs along the stream and crosses it at multiple points. At these sewer line crossings, riprap has been placed along the stream bed and banks to protect the pipe; however, the riprap has been washed away and the geotextile is exposed. Another channel alteration location is downstream near the confluence with the Middle Patuxent River where a 100 ft. trapezoidal concrete channel is located along Old Columbia Road. The concrete channel is used to capture road runoff and convey it to the Middle Patuxent River. The stream converges with the concrete channel; scour is occurring where these two meet exposing the channel and creating a bigger issue. The concrete channel also has significant sediment deposits along the left bank covering most of the channel, along with debris and sand bars throughout, and algae growing on the surface. A 4 ft. head cut was encountered along the stream, creating a large pool and eroding both the left and right banks. The instream habitat within the existing channel scored in the marginal range overall. Embeddedness throughout the stream is higher at the upstream end and continues to decrease as the stream moves downstream with an average of 25-50% of gravel, cobble, and boulder particles surrounded by fine sediment. The velocity/depth regime of the channel is marginal with two velocities present throughout the stream. Moderate sediment deposition occurs within the stream where more deposition occurs within the upstream portion of the stream with 30-50% of the bottom affected and bar formations are occurring along the stream banks. The channel flow status is marginal at the upstream end of the stream with water filling on average 25-75% of the available channel; however, as the stream moves downstream, the channel flow status becomes suboptimal with the channel filling 75% of the available channel and less riffle substrate is exposed. Bank stability is moderately unstable on both the left and right side of the stream with 30-60% of the stream banks having some cover and increased erosion during floods. Vegetative protection along the left and right bank is marginal with an average of 70% of the stream bank surface covered. Shading along the existing channel is suboptimal (50%).



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-39
Site Name: Montpelier Research Park
Contractor: Biohabitats
Watershed: Middle Patuxent River

Looking downstream showing high eroding banks along the right side of the stream.

Looking downstream at a tight bend that has created an extremely high and raw left bank.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-39

Site Name: Montpelier Research Park

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Two sewer lines run along the stream and cross the stream at several locations. Access is fairly easy due to the sewer line easement. The stream is within a forest conservation easement; therefore, tree impacts need to be minimized.

Concept Description:

The objectives for this project are to reduce bank and bed erosion and to improve instream habitat for aquatic organisms. This will be accomplished by grading banks back to a stable angle and stabilizing them with native vegetation to hold soil in place. Adding woody debris, cobble riffles, pools, and other nature-like habitat structures will reinforce the stream bed and banks, improve the flow diversity and structural complexity of the stream bed, and uplift the instream habitat. The existing concrete channel should be removed and replaced with a natural stream bank and bottom. The proposed channel restoration work would occur predominately on the existing channel alignment; however, some minor realignment will be necessary at tight meander bends and near sewer line crossings. Riffle grade controls or other forms of bed protection will be located to protect the sewer line. In addition, maximizing riparian buffer will increase the shading to reduce the stream temperature and provide needed litter inputs and woody debris to the channel overtime to maintain the habitat complexity and quality. This channel restoration has the potential to reduce the sediment supply, improve habitat and provide opportunities for nutrient uptake. The site can be accessed via a sewer line easement that runs along the entire stream. The entrance to the sewer line easement is off of Montpelier Road within the Montpelier Research Park. There are no other nearby project recommendations that could be implemented concurrently.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,738	Estimated Design Cost:	$300,000.00
Impervious Area Treated Credit (ac.):	17.4	Estimated Construction Cost:	$782,550.00
Cost per Impervious Credit Acre:	$75,794.88	30% Contingency:	$234,765.00
		Estimated Total Cost:	$1,317,315.00

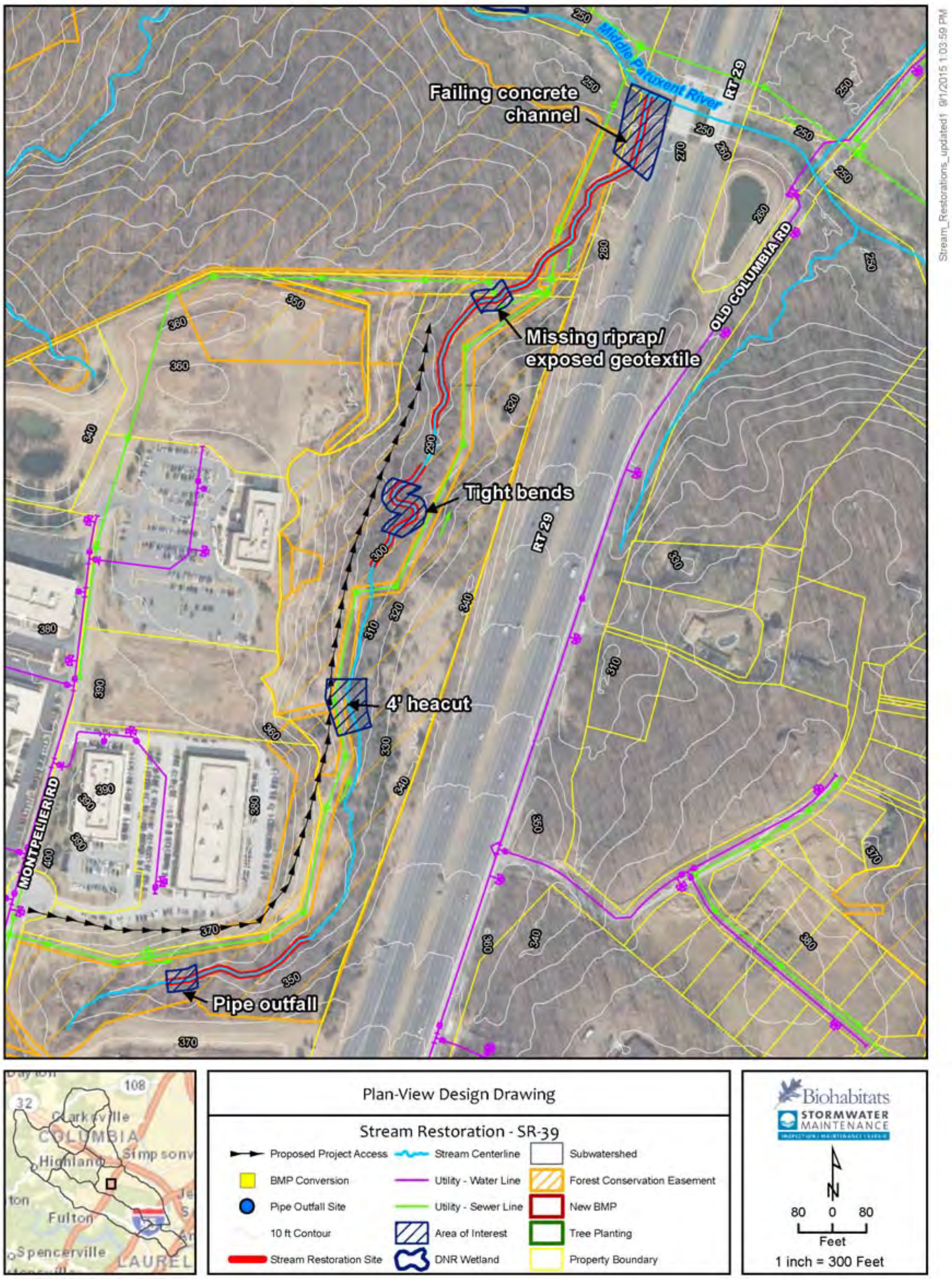
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-39

Site Name: Montpelier Research Park

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-60

Site Name: Eacker Property Stream

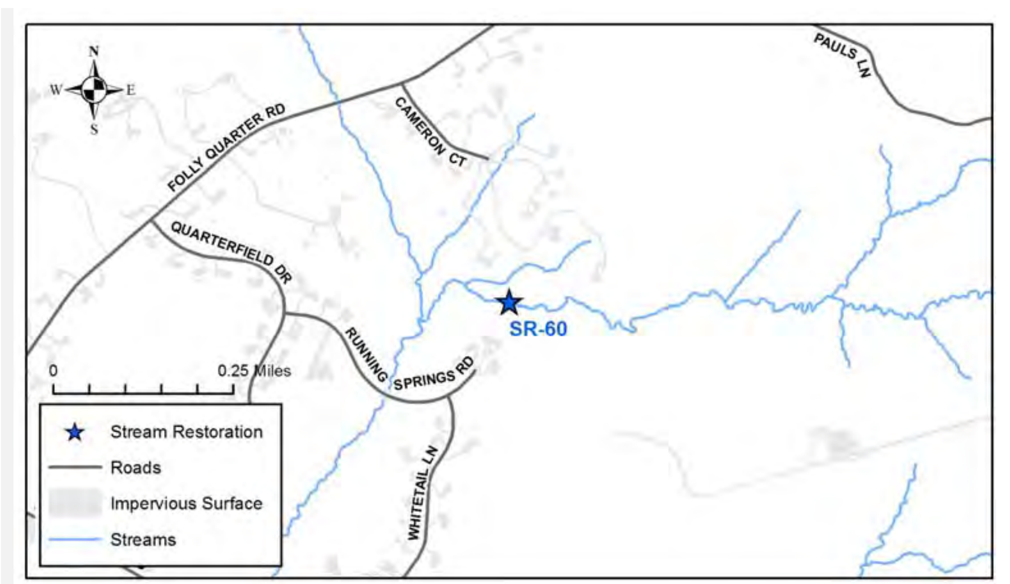
Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Ownership: Private- Residential
Single Owner

Existing Conditions:

SR-60 consists of two stream assessment reaches (NMP-SR-GE101 and NMP-SR-GE102) of an unnamed tributary to the Middle Patuxent River. Land use surrounding the project site is primarily residential and forested land with one private property owner. The northernmost stream segment (NMP-SR-GE101) begins approximately 600 lf. southwest of the cul-de-sac at Cameron Court and extends downstream (southwest) about 100 lf. The proposed stream restoration site generally has a sand/silt substrate with bank heights ranging between 3 to 4 ft. The entire reach of the stream banks are currently eroding, primarily causing channel widening. The eroded banks are nearly vertical, lack adequate surface protection or vegetation, and are comprised of large percentages of clay and sand. A 0.5 ft. headcut located at the upstream end of the stream reach will likely cause further channel degradation. The western stream reach (NMP-SR-GE102) is located south of a large pond that is approximately 270 lf. southeast of the first reach. The proposed stream restoration site extends about 920 lf. from east to west. This portion of the project site generally has a gravel/sand/silt substrate with bank heights ranging between 3-10 ft. Approximately 275 ft. of the stream banks are currently eroding, primarily causing lateral migration and channel widening. The eroded banks are nearly vertical, contain low to moderate densities of tree roots, lack surface protection, and are comprised of large percentages of clay or sand. In addition, the project reach contains a headcut at a rock cascade structure located near the upstream extent of the reach. Large depositional bars are present throughout the channel, suggesting that the stream receives a considerable amount of sediment load.



SR-60 facing upstream at severe bank erosion.

SR-60 facing downstream at moderate bank erosion.

Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-60

Site Name: Eacker Property Stream

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints with the project include access, ownership, the existing pond embankment, and impacts to existing landscaping, trees, forested areas and wetlands.

Concept Description:

The proposed project is associated with two unnamed tributaries of the Middle Patuxent River that total approximately 1,020 lf. of stream restoration. The project site is currently degraded, evidenced by a significant amount of bank erosion causing widening. It is recommended that bank stabilization, floodplain reconnection, and headcut stabilization techniques be employed to the proposed project in order to reduce erosive energies of storm flows and increase resistance of the channel. Floodplain reconnection areas are proposed along the entire length of the northern tributary in conjunction with bank stabilization techniques. Stabilization of a headcut is also recommended at the upstream end of the northern reach. The southern project area has multiple proposed bank stabilization areas that are mostly associated with actively eroding meander bends. The beginning of the upstream end of the southern tributary includes a headcut stabilization opportunity at an existing rock cascade sequence. Direct access can be obtained to the northern tributary by a private residential driveway. There is a grassed pathway that leads from the northern tributary to the southern tributary; however, the width of the path may not be sufficient for heavy construction equipment. A portion of the path includes the existing pond embankment. Reconstruction of the pond embankment would allow a greater opportunity to restore the southern tributary and address areas of significant erosion along the pond embankment. This would certainly increase the cost of the project and reconfiguration of the pond would need coordination and approval from the property owner. The project would include additional stream assessment and design phases to determine specific channel treatments and construction sequence.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	1,019	Estimated Design Cost:	$200,000.00
Impervious Area Treated Credit (ac.):	10.2	Estimated Construction Cost:	$458,550.00
Cost per Impervious Credit Acre:	$78,127.09	30% Contingency:	$137,565.00
		Estimated Total Cost:	$796,115.00

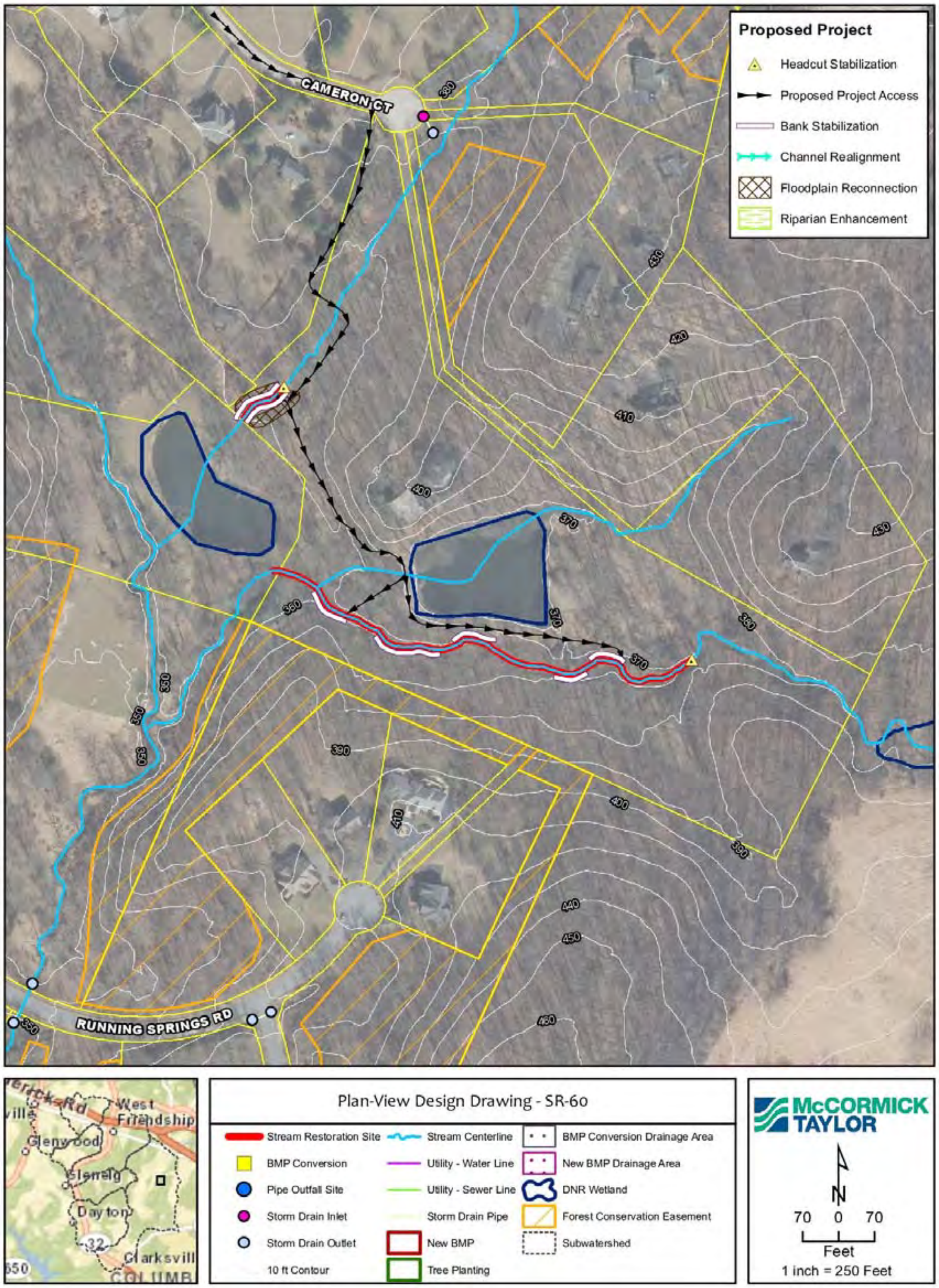
Howard County Watershed Assessment Concept Plan: Stream Restoration

Site ID: SR-60

Site Name: Eacker Property Stream

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F101

Site Name: Rover Mill Road

Contractor: McCormick Taylor

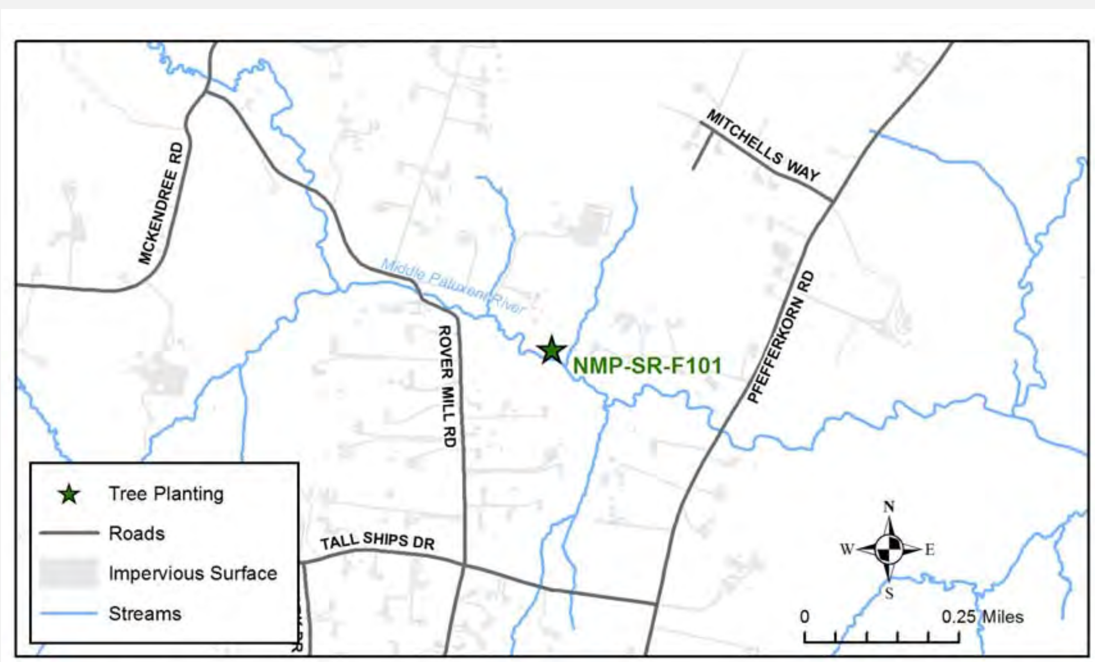
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The proposed tree planting project is comprised of three planting assessments (NMP-SR-F101a, NMP-SR-F101b, NMP-SR-F101c) that are located east of Rover Mill Road in West Friendship, MD. A fourth tree planting area could be added west of the three existing tree planting assessments along the north side of the channel associated with the stream restoration site (SR-5). The tree planting site is associated with residential and agricultural properties on four parcels. The project area is within the riparian buffer zone of the Middle Patuxent River (SR-5), which primarily receives full sunlight and is comprised mainly of mowed turf and livestock grazing areas. Dominant tree species observed include red maple (Acer rubrum), black walnut (Juglans nigra), and box elder (Acer negundo). Minimal invasive species are present within the planting areas (5% vegetative cover), including Japanese stiltgrass (Microstegium vimineum) and multiflora rose (Rosa multiflora). Soils within the project are primarily composed of loamy soils and are moderately compacted. Water sources other than rainfall include runoff from surrounding drainage areas and some areas with overbank flow from the Middle Patuxent River. The stream banks near the planting areas are approximately 4 to 6 ft. in height. All of the planting areas within the project are relatively level. There are also portions of the proposed planting areas that are associated with forest conservation easements based on available GIS data. The easement on the north side of the channel has previous plantings within it; however, only about half of the easement has good survivability. This easement is also associated with an active livestock area. The planting area on the south side of the channel is currently a fallow field with no plantings. All of the planting areas are associated with green infrastructure corridor gaps.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F101
Site Name: Rover Mill Road
Contractor: McCormick Taylor
Watershed: Middle Patuxent River

Proposed tree planting site NMP-SR-F101 facing west within an existing forest conservation easement.

Proposed tree planting site NMP-SR-F101 facing southeast towards an existing forest conservation easement.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F101

Site Name: Rover Mill Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include ownership, regular mowing in some portions of the planting site, and potential wetlands located in the vicinity of the planting areas.

Concept Description:

Approximately 1.17 ac. of agricultural and residential property will be planted with suitable tree species. Additional tree planting areas could be added to the project site if the stream restoration site associated with SR-5 is not selected to move forward (refer to the riparian enhancement areas documented on the concept plan for SR-5). As noted previously, portions of the proposed planting areas are associated with existing forest conservation easements. The existing easements should be verified and determine the proper course of action for maintenance and/or supplemental plantings. Selection of suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy from Rover Mill Road and appears to be better from the agricultural properties located on the north side of the Middle Patuxent River. Access permission will also be needed from the residential property owners. Space for temporary storage and onsite material delivery is available.

Nearby Opportunities:

SR-5

Proposed Project Credit		Costs	
Planting Acres:	1.2	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	0.4	Estimated Construction Cost:	$37,440.00
Cost per Impervious Credit Acre:	$146,680.00	30% Contingency:	$11,232.00
		Estimated Total Cost:	$58,672.00

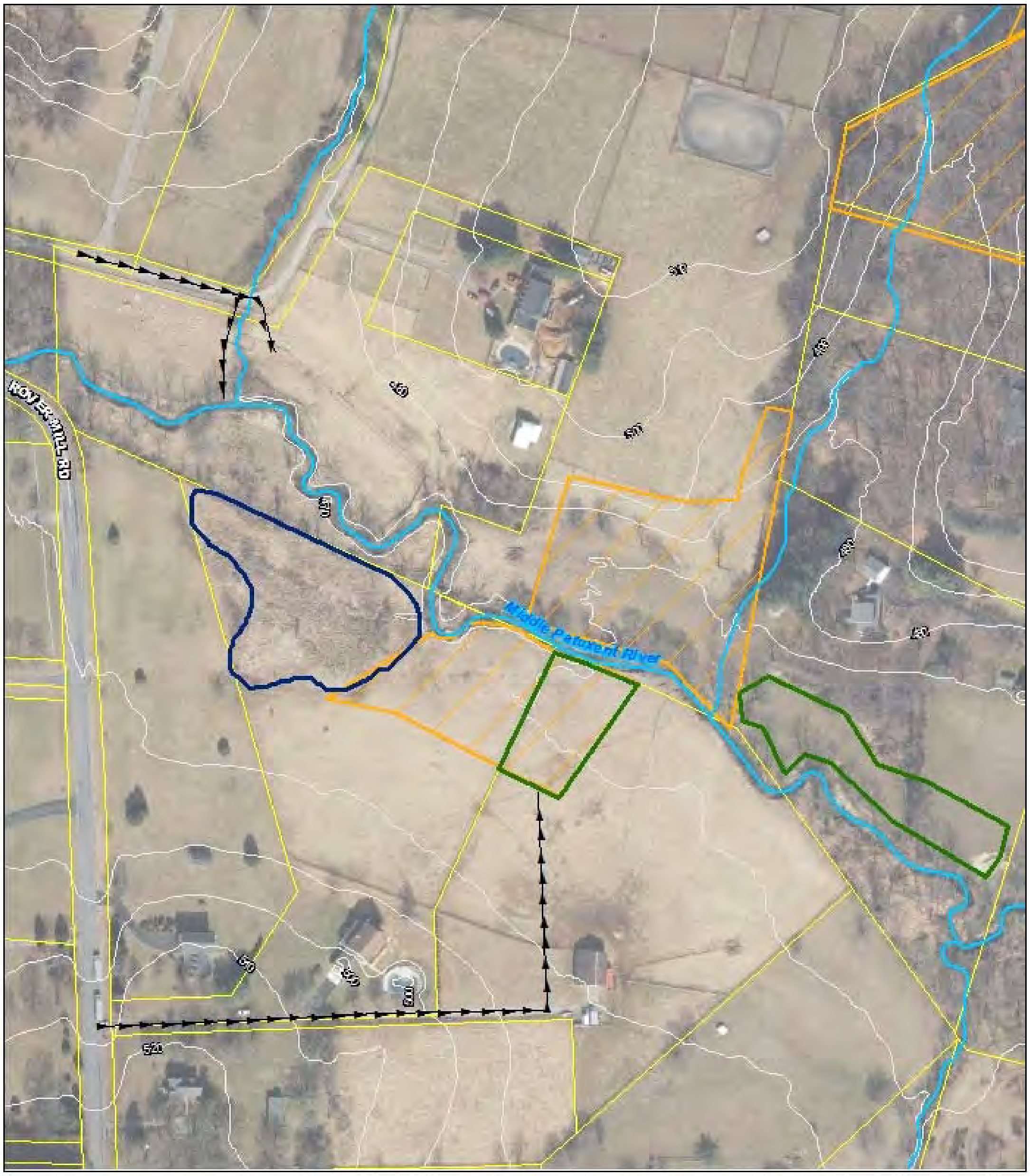
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F101

Site Name: Rover Mill Road

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



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Plan-View Design Drawing - NMP-SR-F101

Tree Planting
Proposed Project Access
Pipe Outfall Site
Storm Drain Inlet
Storm Drain Outlet
10 ft Contour
Stream Centerline
Utility - Water Line
Utility - Sewer Line
Storm Drain Pipe
DNR Wetland
Forest Conservation Easement
Property Boundary
Subwatershed

N

50 0 50

Feet

1 inch = 200 Feet

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F123a

Site Name: Sheppard Field

Contractor: McCormick Taylor

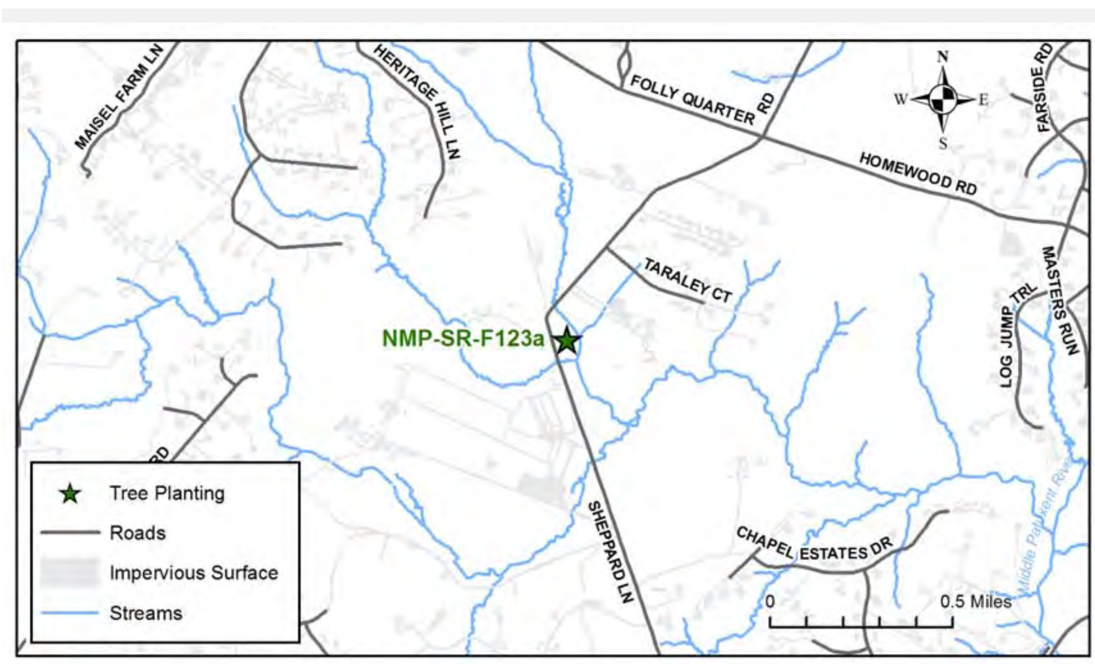
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

The proposed tree planting project is located within the riparian buffer zone of stream segment NMP-SR-F123 and is adjacent to Sheppard Lane in Ellicott City, MD. The project site is a fallow field owned by one private owner. The site receives full sun and has relatively flat slopes. The site is comprised of 85% herbaceous cover, 10% trees and shrubs, and 5% bare soil. Dominant tree species observed in adjacent forested areas include black willow (Salix nigra), American sycamore (Platanus occidentalis), and box elder (Acer negundo). Extensive invasive species are present within the planting area (55% vegetative cover), including Japanese stiltgrass (Microstegium vimineum), garlic mustard (Alliaria petiolata), Bradford pear (Pyrus calleryana), Japanese honeysuckle (Lonicera japonica), mile-a-minute (Persicaria perfoliata), and multiflora rose (Rosa multiflora). Soils within the project are primarily composed of loamy soils and are moderately compacted. Water sources other than rainfall include runoff from the surrounding drainage area and some overbank flow from the adjacent streams. The height of the adjacent stream banks within the planting area are approximately 2 ft. There is evidence of heavy deer browse within the site and no evidence of previous tree plantings.



Proposed tree planting site NMP-SR-F123a facing west towards a fallow field.

Proposed tree planting site NMP-SR-F123a facing a fallow field located east of the existing stream.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F123a

Site Name: Sheppard Field

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include ownership and potential animal impacts to the plantings. The property owner at 4652 Sheppard Lane would prefer not to have tree plantings along the road because visibility is currently limited when vehicles turn onto Sheppard Lane from the property.

Concept Description:

Approximately 5.26 ac. of commercial property and riparian buffer zone will be planted with suitable tree species. There is potential for additional planting area to be included with the planting site through further coordination with the property owner. It is recommended that American sycamore (Platanus occidentalis) be included as a suitable tree species since it is typically more resistant to deer browse. Selection of other suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy, with foot, vehicle, and heavy equipment traffic able to enter the site using Sheppard Lane and the agricultural property. Space for temporary storage and onsite material delivery is also available at the site.

Nearby Opportunities:

NMP-SR-F123 and NMP-SR-F170

Proposed Project Credit		Costs	
Planting Acres:	5.3	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	2	Estimated Construction Cost:	$168,320.00
		30% Contingency:	$50,496.00
Cost per Impervious Credit Acre:	$114,408.00	Estimated Total Cost:	$228,816.00

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F123a

Site Name: Sheppard Field

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Plan-View Design Drawing - NMP-SR-F123a

Tree Planting	10 ft Contour	DNR Wetland
Proposed Project Access	Stream Centerline	Forest Conservation Easement
Pipe Outfall Site	Utility - Water Line	Property Boundary
Storm Drain Inlet	Utility - Sewer Line	Subwatershed
Storm Drain Outlet	Storm Drain Pipe	

McCORMICK TAYLOR

N

50 0 50

Feet

1 inch = 200 Feet

Howard County Watershed Assessment Concept Plan: Tree Planting

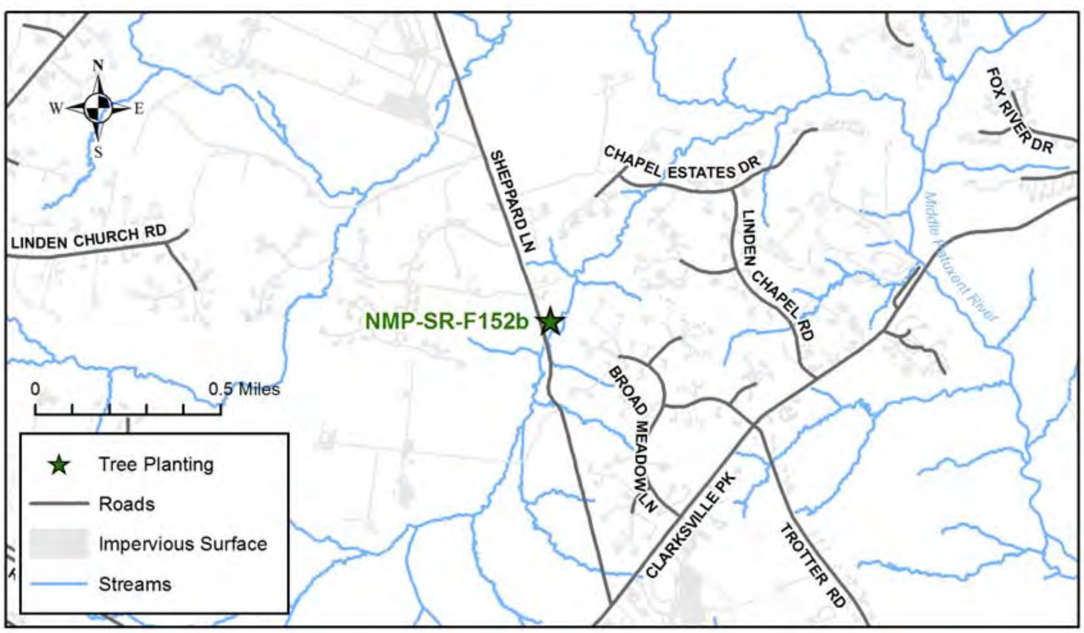
Site ID: NMP-SR-F152b
Site Name: Sheppard Lane
Contractor: McCormick Taylor
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

The proposed tree planting site is within the riparian buffer zone of NMP-SR-F152 located northeast of the intersection of Clarksville Pike (MD 108) and Sheppard Lane in Clarksville, MD. The planting area is associated with two residential properties. The site receives full sun and has relatively level slopes along the unnamed tributary. Parcels within the site are comprised of 90% herbaceous cover, 5% trees and shrubs, and 5% bare soil. Dominant tree species observed within the site and in adjacent forested areas include American sycamore (Platanus occidentalis) and black cherry (Prunus serotina). No invasive species are present within the planting areas; however, invasive species have 15% coverage within the adjacent forested areas. Soils within the project are primarily composed of loam soils and are moderately compacted. Water sources other than rainfall include runoff from the upslope drainage area and some overbank flow from the adjacent stream. The height of the adjacent stream banks within the planting area are approximately 6 to 8 ft. There is no evidence of animal impacts; however, there is evidence of previous tree plantings completed by the homeowner in the northern part of the parcel.



Proposed tree planting site NMP-SR-F152b facing southeast.

Proposed tree planting site NMP-SR-F152b facing east at adjacent streambank erosion.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F152b

Site Name: Sheppard Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include ownership and regular mowing. The property owner at 5215 Sheppard Lane has expressed interest in tree plantings to help prevent flooding within their property.

Concept Description:

Approximately 2.99 ac. of riparian buffer zone will be planted with suitable tree species. A few sparsely planted trees have been placed within the riparian buffer zone of the northern parcel of the planting area. The plantings are currently fenced in to prevent deer browse. Selection of suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy, with foot, vehicle, and heavy equipment traffic able to enter the site using Sheppard Lane and access from the residential property owners. Space for temporary storage and onsite material delivery is available.

Nearby Opportunities:

NMP-SR-F151a, NMP-SR-F152 and NMP-SR-F153; NMP-TP-F106, NMP-TP-F105, NMP-TP-F107a and NMP-TP-F107b.

Proposed Project Credit		Costs	
Planting Acres:	3	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	1.14	Estimated Construction Cost:	$95,680.00
Cost per Impervious Credit Acre:	$117,880.70	30% Contingency:	$28,704.00
		Estimated Total Cost:	$134,384.00

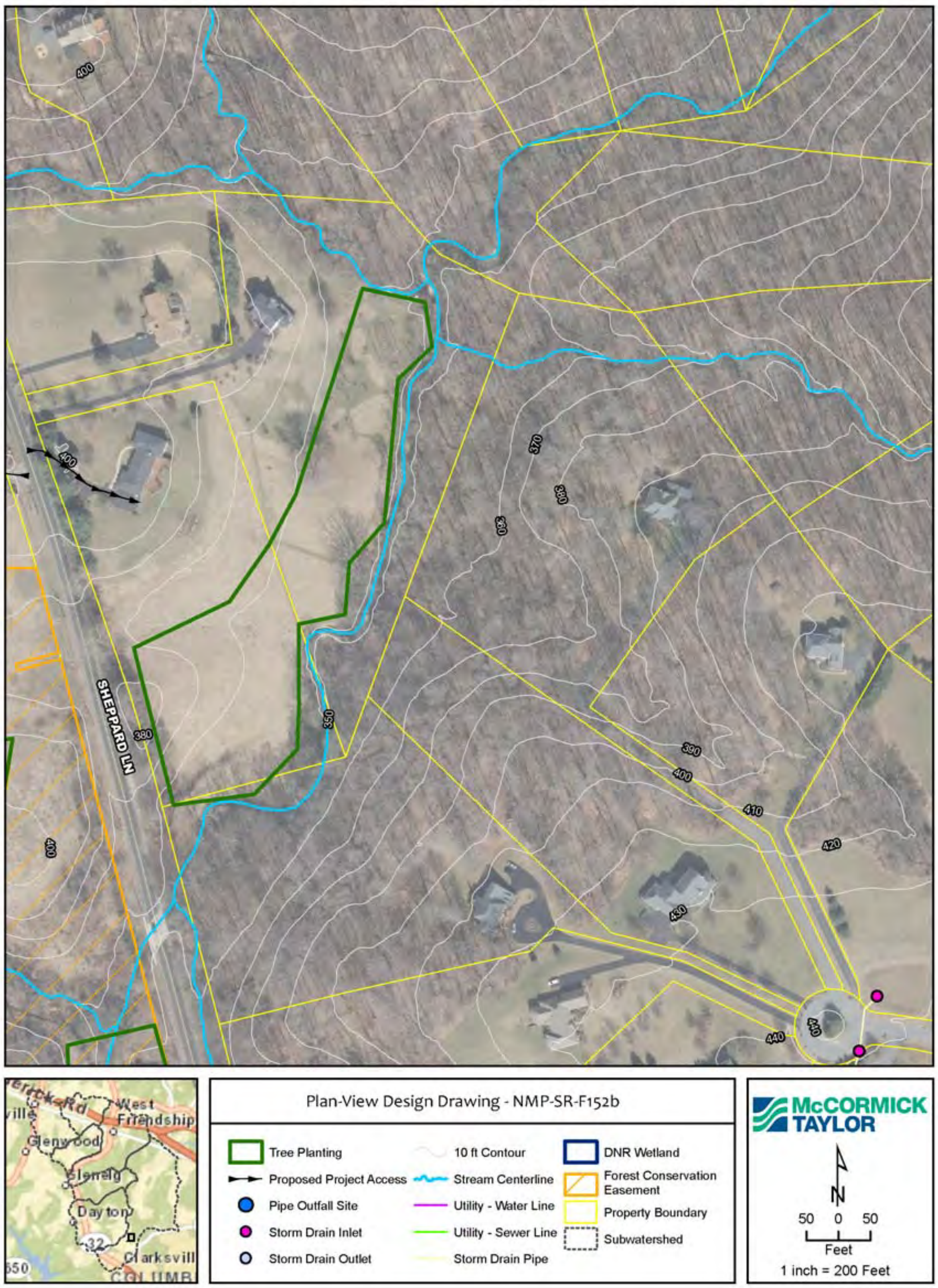
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-SR-F152b

Site Name: Sheppard Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F103d

Site Name: Woodmont Drive

Contractor: McCormick Taylor

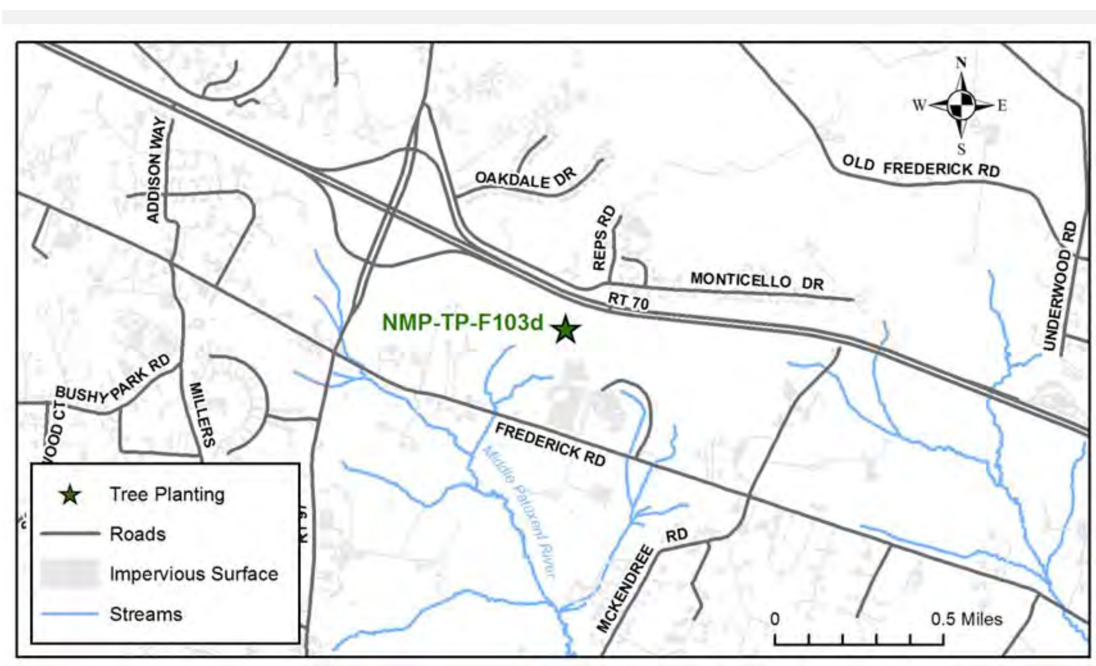
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

The proposed tree planting project is comprised of four planting areas (NMP-TP-F103b, NMP-TP-F103d) located approximately 2,000 ft. northwest of the intersection of Frederick Road and McKendree Road. Portions of the site are regularly mowed and also associated with two existing forest conservation easements located on private school property that has been closed. The planting areas primarily receive full sun and have both upland and riparian components. The eastern planting area is 50% mowed turf, 20% herbaceous cover, 25% trees and shrubs, and 5% bare soil. The middle and western planting areas are 60 to 75% herbaceous cover, 20 to 25% trees and shrubs, and 5 to 15% bare soil. Dominant tree species observed within the parcels and in adjacent forested areas include red maple (Acer rubrum), box elder (Acer negundo), white oak (Quercus alba), and American sycamore (Platanus occidentalis). Invasive species include multiflora rose (Rosa multiflora), Japanese stilt grass (Microstegium vimineum), and Japanese honeysuckle (Lonicera japonica) that range from 2% cover in the western planting area to 30% cover in the middle and eastern planting areas. Soils within the project are primarily composed of silty clay loam and sand with no restrictive features present. Water sources other than rainfall include two streams adjacent to the eastern planting areas and runoff from surrounding drainage areas. Floodplain connection occurs in the eastern and middle parcels, with bank heights of approximately 1 ft. Slopes of up to 30% can be found within the western planting area, while the other areas are relatively level. There is evidence of a high level of deer browse and previous tree plantings in the eastern and middle areas.



Proposed tree planting site NMP-SR-F103d facing east at an existing forest conservation easement.

Proposed tree planting site NMP-SR-F013d facing west at an existing forest conservation easement.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F103d

Site Name: Woodmont Drive

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints include regular mowing in portions of the eastern and middle planting areas, animal impacts (deer browse), and potential wetlands in the eastern and middle planting areas.

Concept Description:

Approximately 13.55 ac. of private property will be planted with suitable tree species. There is potential for additional planting area to be included with the planting site through further coordination with the property owner. The existing easement area adjacent to the stream has a relatively high success rate. The easement on the east side of the property has a moderate success rate. It is recommended that unsuccessful plantings be replaced and that tree species more resistant to deer browse be selected for the site. Selection of other suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy, with foot, vehicle, and heavy equipment traffic able to enter the site using Frederick Road and Woodmont Drive. Space for temporary storage and onsite material delivery is available.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Planting Acres:	14	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	5.15	Estimated Construction Cost:	$433,600.00
		30% Contingency:	$130,080.00
Cost per Impervious Credit Acre:	$111,394.17	Estimated Total Cost:	$573,680.00

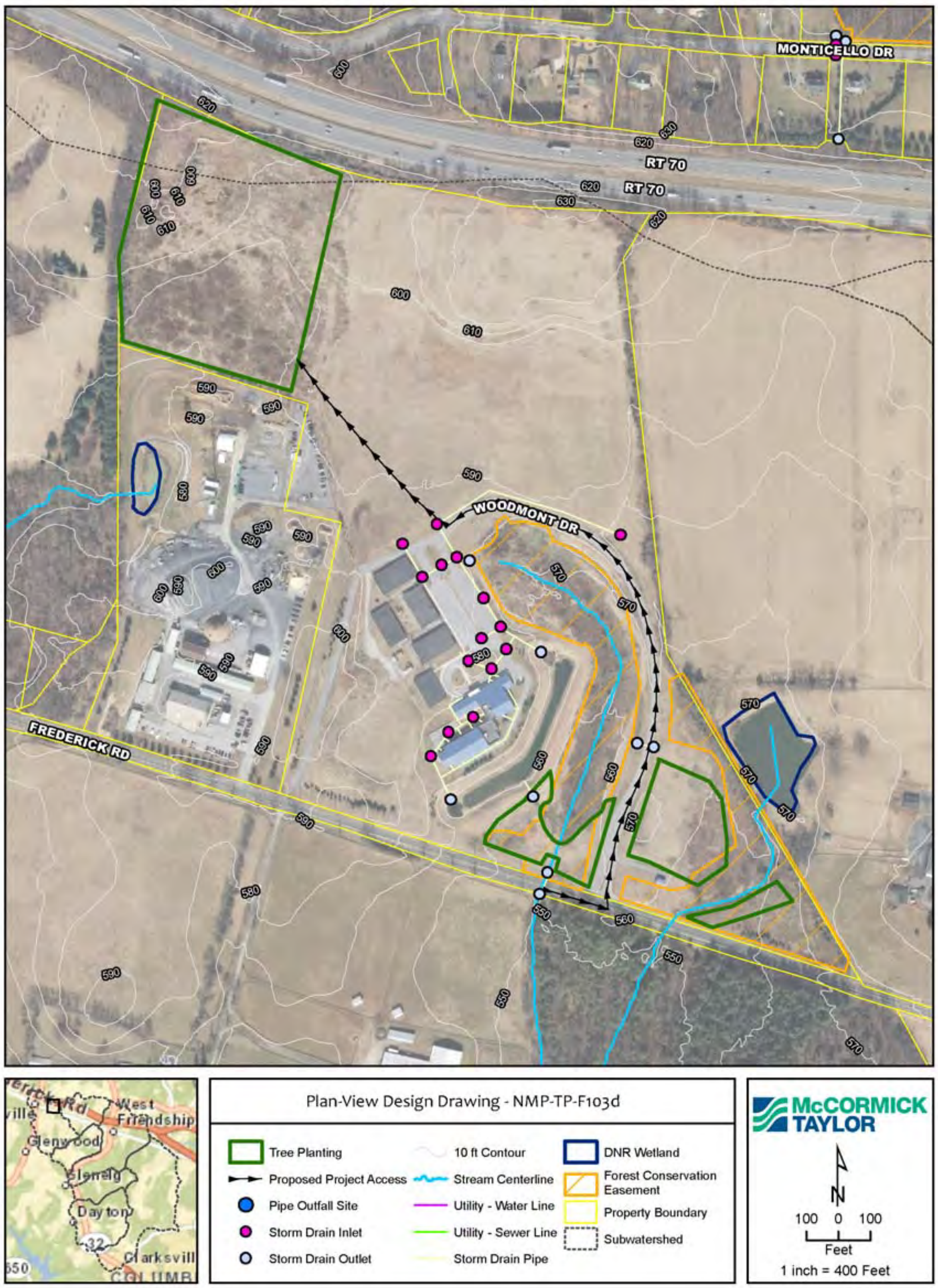
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F103d

Site Name: Woodmont Drive

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F104

Site Name: Folly Quarter

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

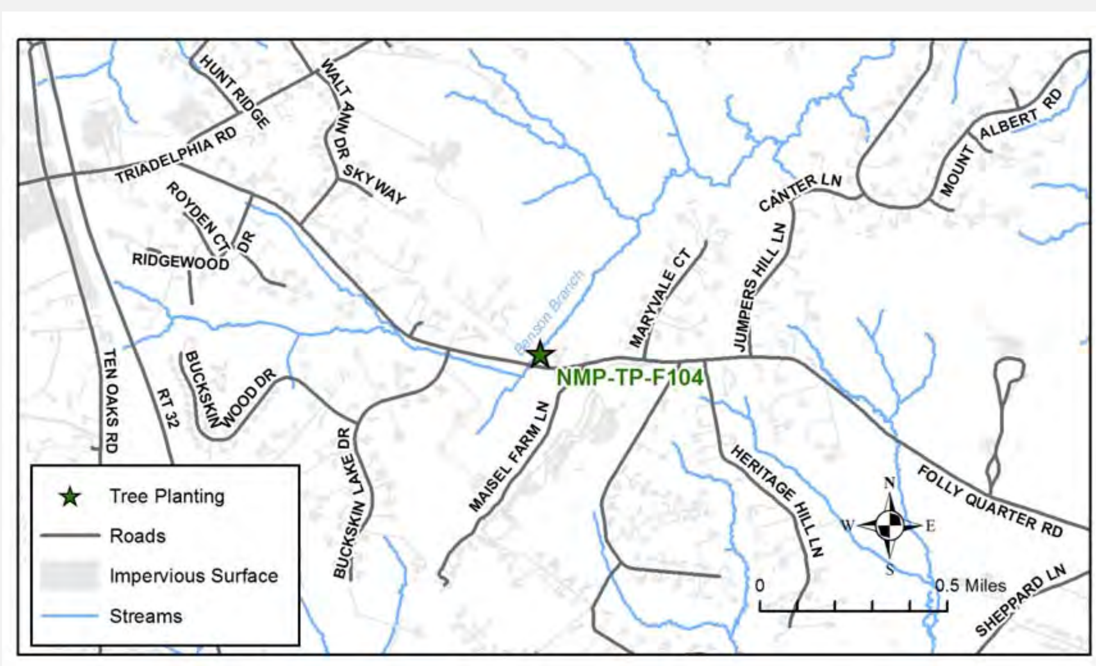
Project Type: Tree Planting

Ownership: County Owned
Single Owner

Existing Conditions:

The proposed tree planting project is comprised of three planting areas (NMP-TP-F104, NMP-TP-F104a, NMP-TP-F104b) located north of Old Rolling Road in Ellicott City, MD. A portion of the northern planting area is regularly mowed and the other planting areas are within an existing forested riparian zone. The entire property is owned by the Howard County Department of Parks and Recreation. The planting areas receive partial sun and are associated with the floodplain of Benson Branch. The northern planting area (NMP-TP-F104) is 60% mowed turf, 20% herbaceous cover, 15% trees and shrubs, and 5% bare soil. The two southern parcels (NMP-TP-F104a and NMP-TP-F104b) are 60 to 70% herbaceous cover, 25 to 35% trees and shrubs, and 5% bare soil. Dominant tree species observed within the planting parcels and in adjacent forested areas include red maple (Acer rubrum), black walnut (Juglans nigra), and American sycamore (Platanus occidentalis). Invasive species include multiflora rose (Rosa multiflora) and Japanese stilt grass (Microstegium vimineum) ranging from 15% cover in the northern area to 40-60% cover in the two southern planting areas.

Soils within the project are primarily composed of loam soils with no restrictive features present. Water sources other than rainfall include runoff from surrounding upland drainage areas, and overbank flow from Benson Branch. All of the planting areas within the site have low slopes. There is evidence of a high level of deer browse in all areas and no evidence of previous tree plantings. The northern parcel is located east of a 1 ac. forest conservation easement that extends from northeast to southwest; however, there are no current tree plantings within this easement. All three proposed planting areas are located within a green infrastructure hub and the field adjacent to the planting areas is associated with green infrastructure gaps.



Site ID: NMP-TP-F104 **Contractor:** McCormick Taylor

Site Name: Folly Quarter **Watershed:** Middle Patuxent River

Proposed tree planting site NMP-TP-F104 facing southwest at inadequate riparian buffer.

Proposed tree planting site NMP-TP-F104 facing northeast at inadequate riparian buffer.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F104

Site Name: Folly Quarter

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints include animal impacts (deer browse), difficult access to the southern planting areas, and potential wetlands and tree or forest impacts in the southern two areas.

Concept Description:

Approximately 0.52 ac. of riparian buffer zone will be planted with suitable tree species. There is no evidence of previous tree plantings within the project area. It is recommended that American sycamore (Platanus occidentalis) be included as a suitable tree species since it is typically more resistant to deer browse. Selection of other suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy, with foot, vehicle, and heavy equipment traffic able to enter the site off of Old Rolling Road. Space for temporary storage and onsite material delivery is available.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Planting Acres:	0.5	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	0.2	Estimated Construction Cost:	$16,640.00
		30% Contingency:	$4,992.00
Cost per Impervious Credit Acre:	$158,160.00	Estimated Total Cost:	$31,632.00

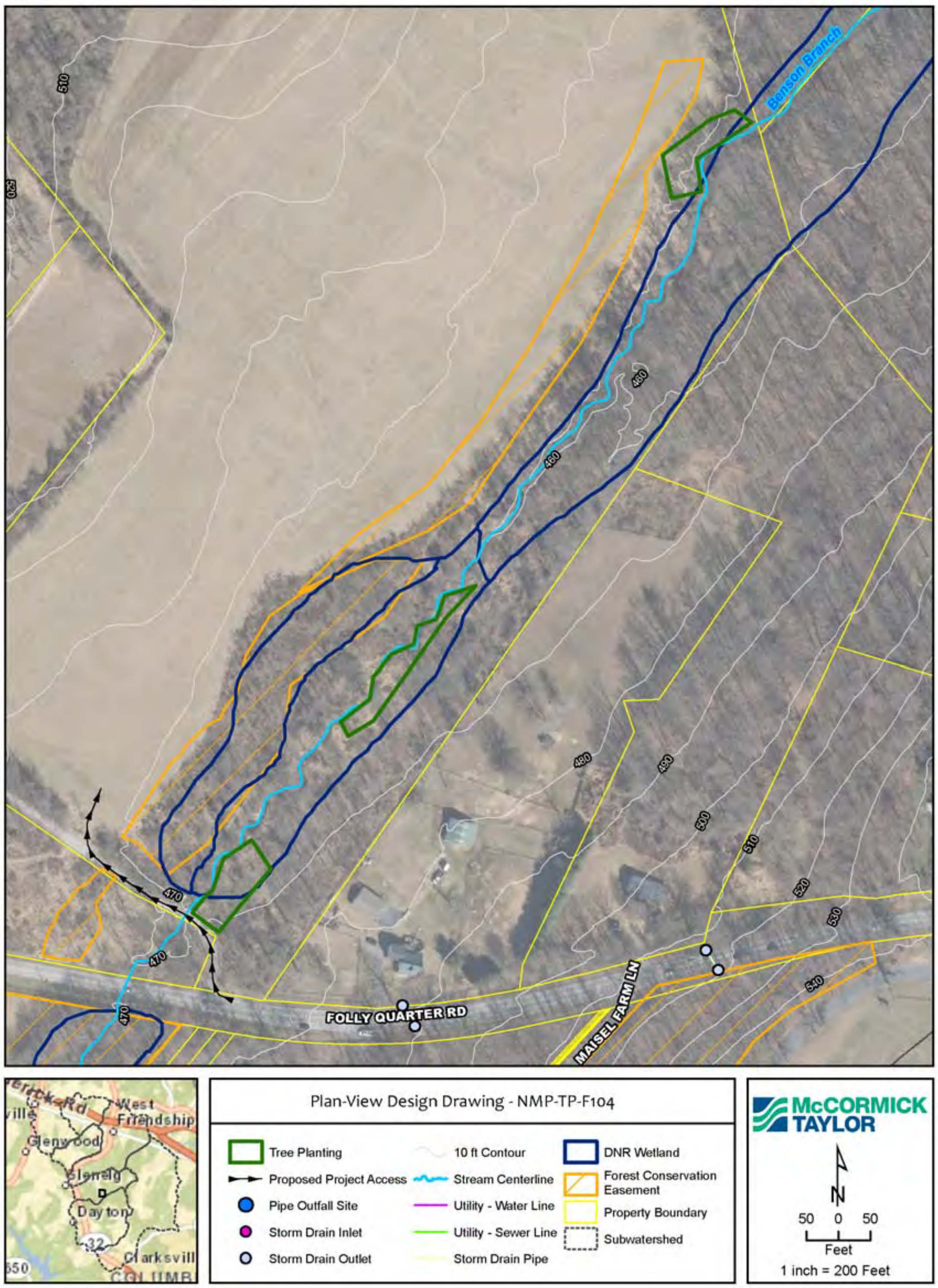
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F104

Site Name: Folly Quarter

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F106

Site Name: Running Fence Lane

Contractor: McCormick Taylor

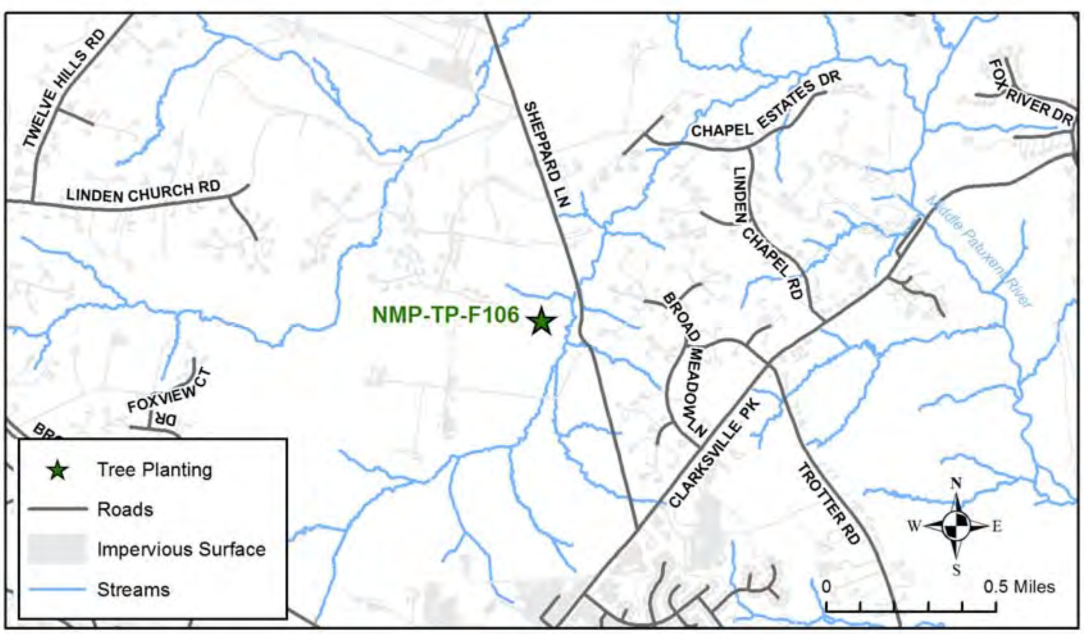
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: County Owned
Single Owner

Existing Conditions:

The proposed tree planting area is comprised of vacant upland that is adjacent to a forest conservation easement located approximately 1,400 ft. east of the intersection of Preakness Circle Lane and Running Fence Lane in Clarksville, MD. The property associated with the project site is currently owned by the Howard County Department of Public Works. The planting area receives full sun, contains 30% slopes, and is mostly comprised of shrubs and some trees. Dominant tree species observed within the planting area include red cedar (Juniperus virginiana) and black cherry (Prunus serotina). Invasive species include multiflora rose (Rosa multiflora) and Japanese honeysuckle (Lonicera japonica) that cover approximately 35% of the planting area. Soils within the project are primarily composed of loamy soil with no restrictive features present. Water sources other than rainfall include runoff from adjacent upland drainage. There is no evidence of animal activity or previous tree plantings. An existing 20 ac. forest conservation easement surrounds the entire proposed tree planting area.



Proposed tree planting site NMP-TP-F106 facing east.

Proposed tree planting site NMP-TP-F106 facing west at access easement.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F106

Site Name: Running Fence Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints include limited access road located between two residential properties, and clearing of existing vegetation and invasive species.

Concept Description:

Approximately 2.78 ac. of county owned land will be planted with suitable tree species. There is no evidence of previous tree plantings within the project area. Selection of other suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is moderately difficult and will require access between residential properties using the existing County easement at the end of Running Fence Lane. Space for temporary storage and onsite material delivery can be made available once vegetation is cleared prior to entering the planting area.

Nearby Opportunities:

NMP-SR-F151a and NMP-SR-F152; NMP-SR-F152b, NMP-TP-F105, NMP-TP-F107a and NMP-TP-F107b.

Proposed Project Credit		Costs	
Planting Acres:	2.8	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	1.06	Estimated Construction Cost:	$88,960.00
		30% Contingency:	$26,688.00
Cost per Impervious Credit Acre:	$118,535.85	Estimated Total Cost:	$125,648.00

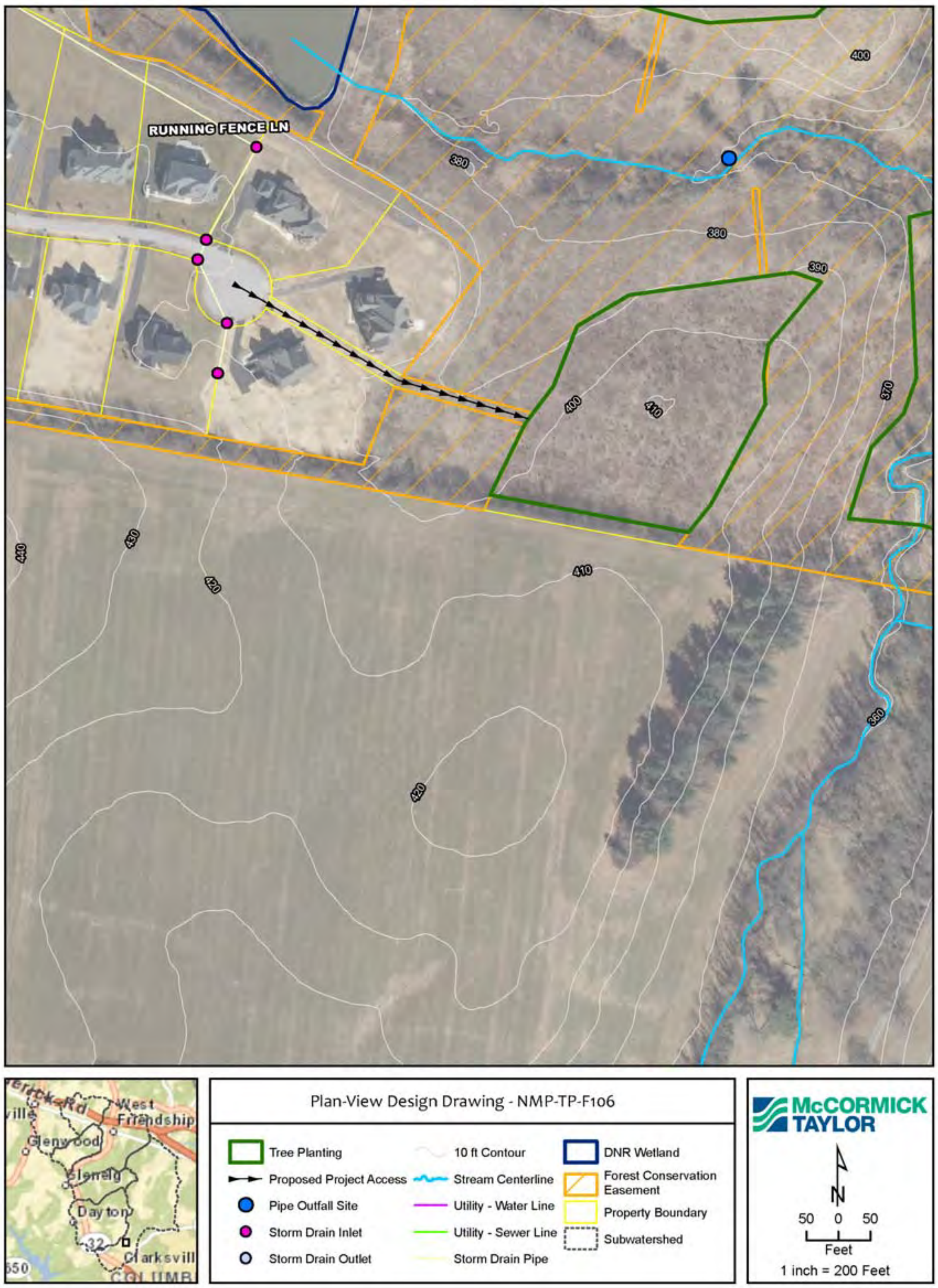
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F106

Site Name: Running Fence Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F107a

Site Name: Preakness Circle Lane

Contractor: McCormick Taylor

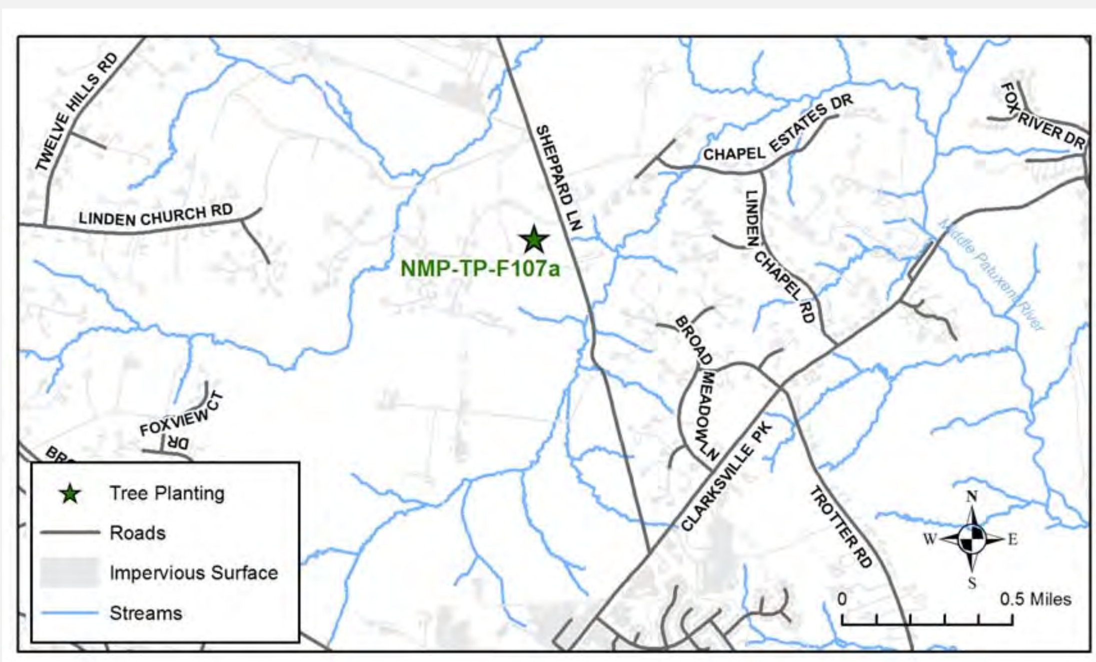
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: County Owned
Single Owner

Existing Conditions:

The proposed tree planting project is comprised of three planting areas (NMP-TP-F105, NMP-TP-F107a, NMP-TP-F107b) located north and south of Preakness Circle Lane in Clarksville, MD. The property associated with the project site is currently owned by the Howard County Department of Public Works. The site is currently comprised of regularly mowed uplands that receive full sun and is owned entirely by the Howard County Department of Public Works. The northern and middle parcels range from 90 to 95% regularly mowed turf and 5 to 10% trees and shrubs, while the southern parcel is 100% regularly mowed turf. Dominant tree species observed in adjacent forested areas include red maple (Acer rubrum), black cherry (Prunus serotina), red cedar (Juniperus virginiana), and American sycamore (Platanus occidentalis). Invasive species including Japanese honeysuckle (Lonicera japonica) and multiflora rose (Rosa multiflora) are present in adjacent forested areas, ranging from 0 to 5% cover in the northern and middle planting areas and 35% cover in the southern area. Soils within the project are primarily composed of loamy soil and no restrictive features are present. Water sources other than rainfall include runoff from the adjacent drainage areas. Slopes of up to 15% can be found within the site. There is no evidence of animal disturbance or previous tree plantings. A 20 ac. forest conservation easement is located adjacent to the southern planting area (NMP-TP-F107b). Education value is possible for this project since the planting areas are located within a residential development and are county owned.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F107a
Site Name: Preakness Circle Lane
Contractor: McCormick Taylor
Watershed: Middle Patuxent River

Proposed tree planting site NMP-TP-F107a facing east at the northernmost parcel.

Proposed tree planting site NMP-TP-F107a facing south at the southernmost parcel.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F107a

Site Name: Preakness Circle Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints include overhead wires approximately 25 ft. in height at the northern and middle planting areas and invasive species present in adjacent forested areas.

Concept Description:

Approximately 18.3 ac. of county owned land will be planted with suitable tree species. There is no evidence of previous tree plantings within the project area. Selection of other suitable tree species will be determined in a planting plan if the project is selected for planting.

Access to the site is generally easy, with foot, vehicle, and heavy equipment traffic able to enter the site using Preakness Circle Lane. Space for temporary storage and onsite material delivery is available.

Nearby Opportunities:

NMP-SR-F151a, NMP-SR-F152 and NMP-SR-F153; NMP-TP-F106 and NMP-SR-F152b.

Proposed Project Credit		Costs	
Planting Acres:	18	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	6.95	Estimated Construction Cost:	$585,600.00
Cost per Impervious Credit Acre:	$110,975.54	30% Contingency:	$175,680.00
		Estimated Total Cost:	$771,280.00

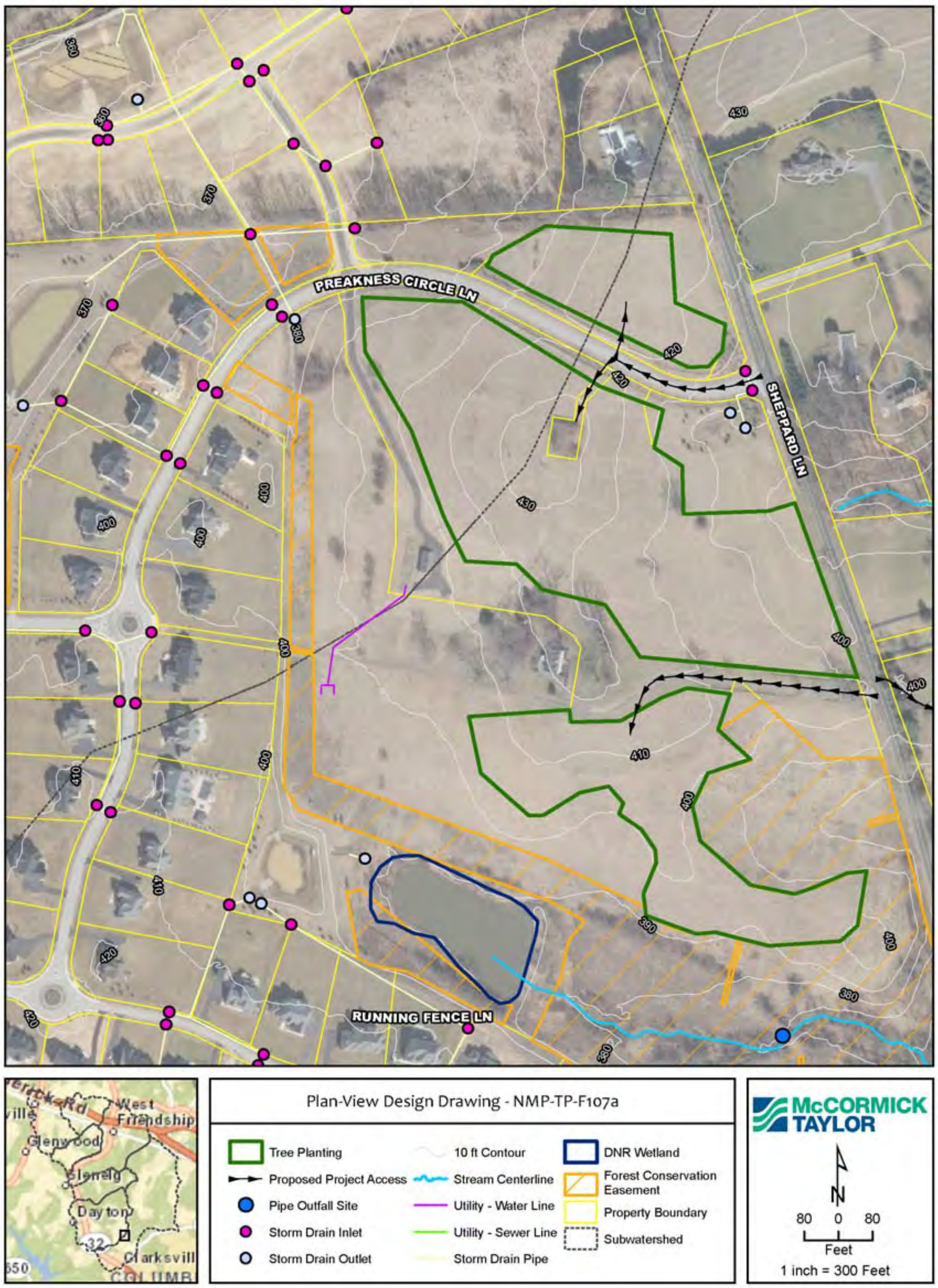
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: NMP-TP-F107a

Site Name: Preakness Circle Lane

Contractor: McCormick Taylor

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F301

Site Name: River Hill High School

Contractor: Biohabitats

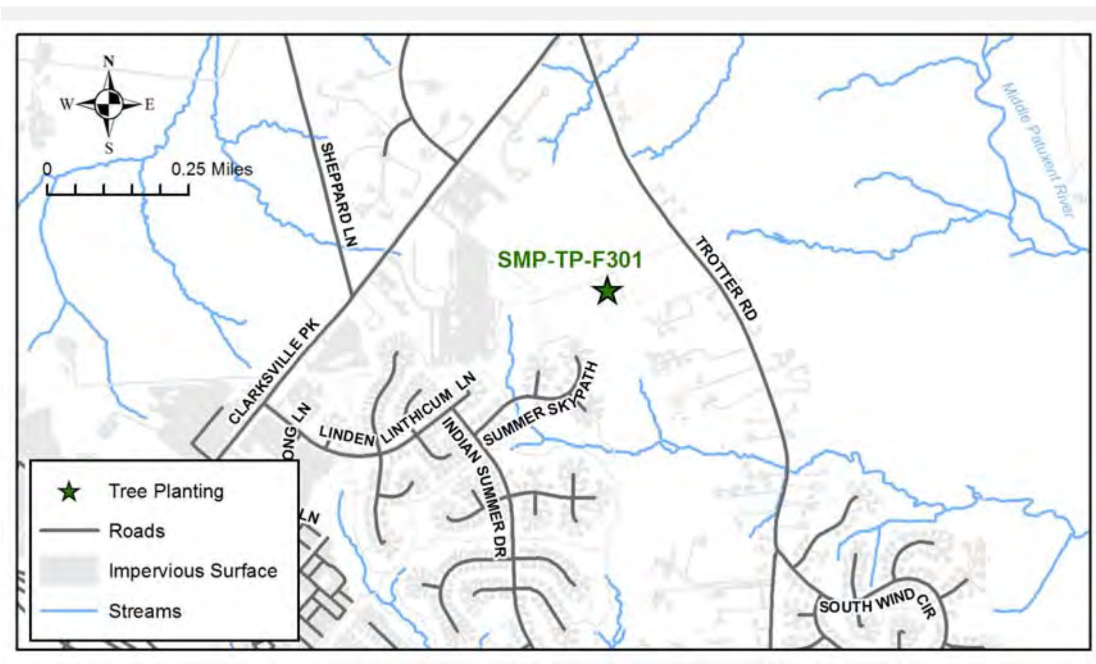
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Board of Education
Single Owner

Existing Conditions:

The site is River Hill High School, a district high school facility. Approximately half the property is occupied by the high school and parking lots while the remainder of the property is open space or athletic fields. The current vegetative cover is 20% trees and 80% turf. Forest consisting of locust (Robinia pseudoacacia), cherry (Prunus sp.), and tulip poplar (Liriodendron tulipifera) is adjacent to various portions of the site. The adjacent forest is roughly 70% covered with invasive species including Russian olive (Elaeagnus angustifolia), Japanese honeysuckle (Lonicera japonica), multiflora rose (Rosa multiflora), mile a minute (Persicaria perfoliata), and garlic mustard (Alliaria petiolata). The site is located in an upland landscape with moderately compacted and loamy textured soil. Soils within the athletic fields may have been specifically altered for that particular sport. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Tree planting area adjacent to basketball and tennis courts, looking southeast.

Example of planting area encircling baseball fields and soccer field, looking northwest along Trotter Road.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F301

Site Name: River Hill High School

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include existing paved paths for pedestrians, structures, existing signage, wildlife (i.e. deer) and current mowing practices. In addition, the planting areas are adjacent to actively used athletic fields.

Concept Description:

The proposed project consists of two tree planting areas totaling 4.59 ac. One 0.61 ac. planting area is located adjacent to tennis and basketball courts in the western portion of the site. This area currently has several mature trees and is maintained as mowed turf. A second 3.98 ac. planting area is located in the eastern portion of the site wrapping around the existing athletic fields. It includes two depressed areas that could potentially serve as stormwater management facilities, but purpose and function was not able to be confirmed. This second area is currently maintained as mowed turf separating the fields from adjacent forests and a roadway.

The proposed tree planting areas receive full sun. The low lying areas are confined to the two aforementioned depression areas. There is no evidence of erosion, contamination or debris within the proposed tree planting areas. No stormwater runoff was observed to be directed toward the tree planting areas.

The site provides access for delivery, temporary storage, as well as foot, vehicle, and heavy equipment traffic. The project has high educational potential due to its location at a school.

Potential water sources for the proposed tree planting project include rainfall, nearby hydrant hook up, tanker water delivery, and irrigation, if already in place at the school. No site preparation would be required because tree planting areas are actively mowed and maintained with no invasives present.

The concept proposes planting a mix of native tree species saplings. Deer are active in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. The existing trees could be preserved as long as trees are healthy and not an invasive species.

Nearby Opportunities:

None recommended

Proposed Project Credit	
Planting Acres:	4.6
Impervious Area Treated Credit (ac.):	1.74
Cost per Impervious Credit Acre:	$115,485.06

Costs	
Estimated Design Cost:	$10,000.00
Estimated Construction Cost:	$146,880.00
30% Contingency:	$44,064.00
Estimated Total Cost:	$200,944.00

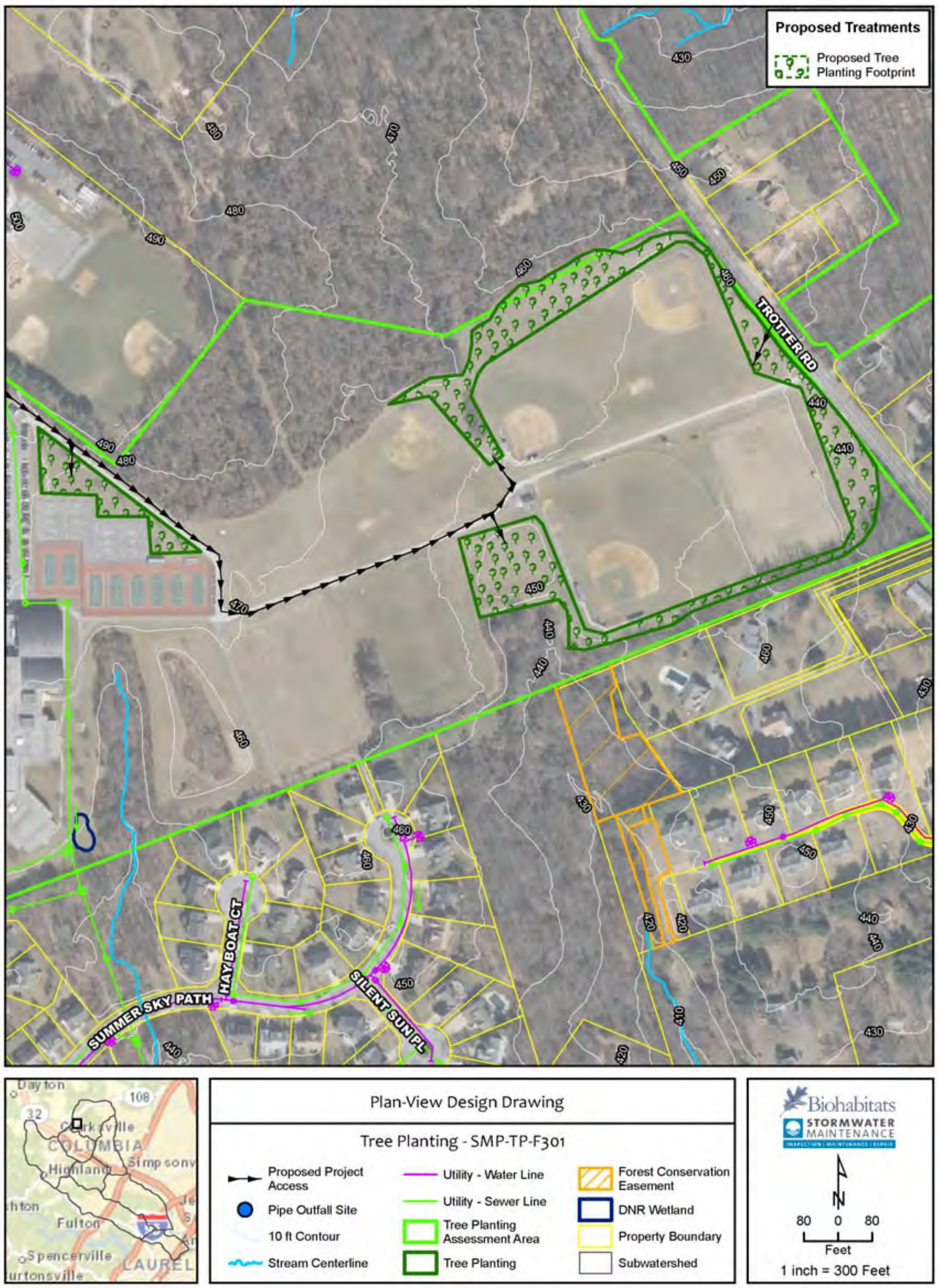
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F301

Site Name: River Hill High School

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F306

Site Name: Mt Zion Methodist Church

Contractor: Biohabitats

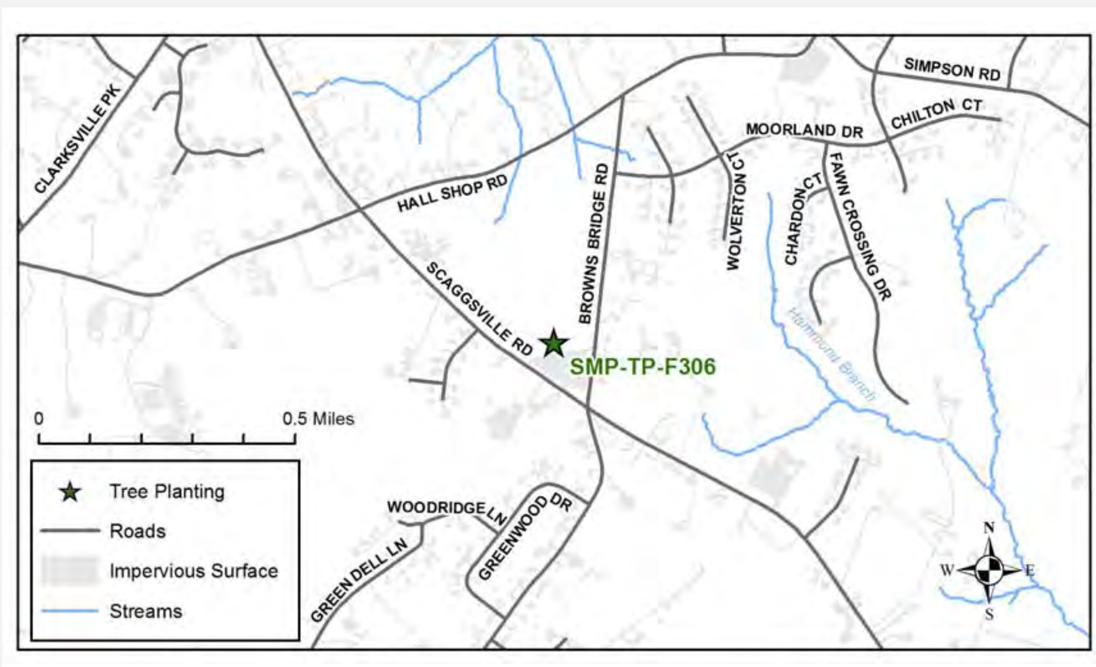
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

The site is Mt. Zion Methodist Church. Approximately half the property is occupied by the church and adjacent parking lot while the remainder of the property is open space and cropland. The current vegetative cover is 5% trees, 50% turf, and 45% agricultural crops. Invasives are absent at the site. There is no adjacent forest. The site is located in an upland landscape with non-compacted and loamy textured soil. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F306

Site Name: Mt Zion Methodist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Tree planting area looking east. Volleyball, picnic tables and garden area visible.

Tree planting area looking west from the planted garden area.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F306

Site Name: Mt Zion Methodist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include current mowing practices, existing cropland and underground utilities (i.e. natural gas and septic), and wildlife (i.e. deer). In addition, portions of the site are used for a volleyball court, picnic area, and a stormwater management facility. These space limitations and uses would need to be accommodated in the project plans.

Concept Description:

The proposed project consists of one tree planting area that is 4.16 ac. The tree planting area is bounded to the north by cropland and to the south by the church parking lot and main building. The area is currently maintained as mowed turf with landscaped trees and shrubs interspersed.

The proposed tree planting area receives full sun. One low lying area is present and is confirmed to be a stormwater management facility. Stormwater inputs are via sheet flow from the adjacent parking lot to the planting area. There is also no evidence at the site of erosion, contamination or debris within the tree planting area.

The site provides access for delivery, temporary storage, as well as foot, vehicle, and heavy equipment traffic. The project has possible educational potential due to its location on a church property.

Potential water sources for the proposed tree planting project include rainfall, stormwater runoff, nearby hose hook up, and tanker water delivery. No site preparation would be required because tree planting areas are actively mowed and maintained with no invasives present.

The concept proposes planting a mix of native tree species saplings. Deer are present in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. There is evidence of previous tree plantings and landscaping at the site that is surviving. The proposed project will preserve existing trees and flower beds as long as vegetation is healthy and not an invasive species.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Planting Acres:	2.4	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	0.9	Estimated Construction Cost:	$76,160.00
		30% Contingency:	$22,848.00
Cost per Impervious Credit Acre:	$121,120.00	Estimated Total Cost:	$109,008.00

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F306

Site Name: Mt Zion Methodist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F308

Site Name: New Hope Seventh-Day Adventist Church

Contractor: Biohabitats

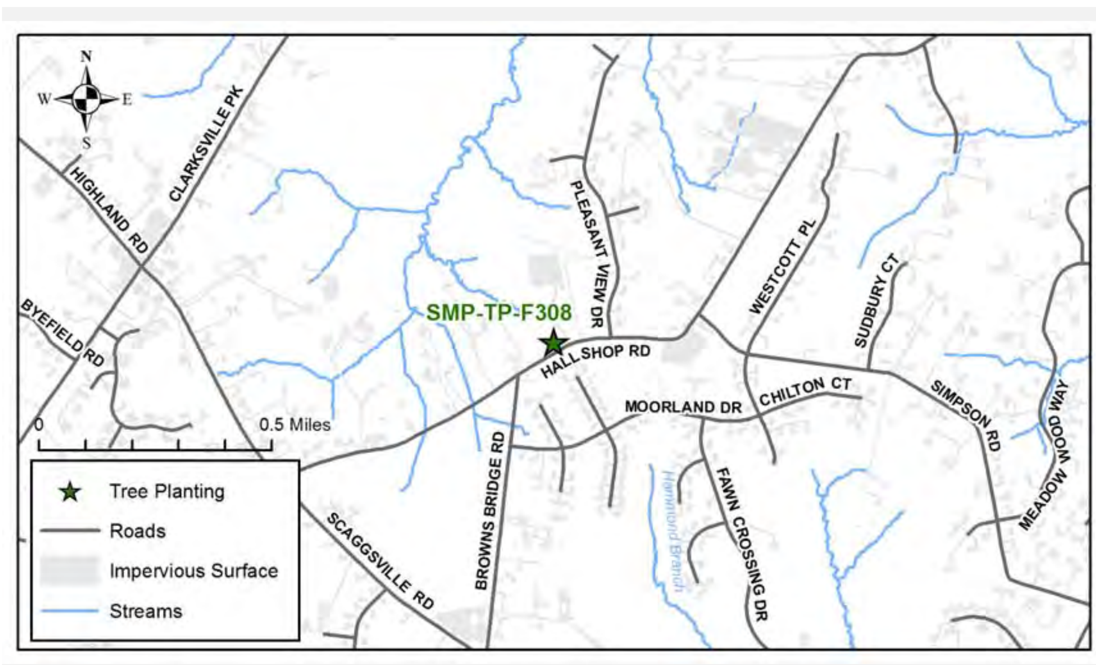
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

The site is the New Hope Seventh-day Adventist Church. Approximately a quarter of the property is occupied by the church and parking lot while the remainder of the property is open space and forest. The current vegetative cover is 20% trees and 80% turf. Forest consisting of red maple (Acer rubrum), tulip poplar (Liriodendron tulipifera), and green ash (Fraxinus pennsylvanica) is adjacent to the site to the west. The adjacent forest is 75% covered with invasive species including multiflora rose (Rosa multiflora) and Japanese honeysuckle (Lonicera japonica). The site is located in an upland landscape with non-compacted and loamy textured soil. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F308

Site Name: New Hope Seventh-Day Adventist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Tree planting areas along both sides of driveway, looking north. Hose hookup visible in foreground.

Southern portion of tree planting area adjacent to Hall Shop Road, looking west from the southeast corner of the property.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F308

Site Name: New Hope Seventh-Day Adventist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include current mowing practices, wildlife (i.e. deer), and underground natural gas utility lines. In addition, potential future outdoor church activities could be a constraint.

Concept Description:

The proposed project consists of three tree planting areas totaling 6.76 ac. One 0.49 ac. planting area is located on the northern portion of the site adjacent to a portion of the parking lot, the church, and a stormwater management facility. Two additional planting areas are located on the southern portion of the site, one to the east of the driveway consisting of 1.89 ac. and one to the west of the driveway consisting of 4.38 ac. All three areas are maintained as mowed turf. The planting area west of the driveway borders an existing forest stand.

The proposed planting areas receive full sun. There is also no evidence at the site of erosion, contamination or debris within the proposed planting areas. Stormwater inputs are via sheet flow to the planting areas. The stormwater runoff travels over the pervious, turf surfaces as a result of sloping topography within the planting areas.

The site provides access for delivery, temporary storage, as well as foot, vehicle, and heavy equipment traffic. The project has possible educational potential due to its location on a church property.

Potential water sources for the proposed tree planting project include rainfall, nearby hose hook up and tanker water delivery. No site preparation would be required because tree planting areas are actively mowed and maintained with no invasives present.

The concept proposes planting a mix of native tree species saplings. Deer are active in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. The existing trees within the planting areas could be preserved as long as trees are healthy and not an invasive species. A few existing trees noted for preservation along the driveway and located sporadically throughout the planting areas included red maple (Acer rubrum), tulip poplar (Liriodendron tulipifera), and green ash (Fraxinus pennsylvanica).

Nearby Opportunities:

None recommended

Proposed Project Credit

Planting Acres:	6.8
Impervious Area Treated Credit (ac.):	2.57
Cost per Impervious Credit Acre:	$113,313.62

Costs

Estimated Design Cost:	$10,000.00
Estimated Construction Cost:	$216,320.00
30% Contingency:	$64,896.00
Estimated Total Cost:	$291,216.00

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F308

Site Name: New Hope Seventh-Day Adventist Church

Contractor: Biohabitats

Watershed: Middle Patuxent River

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F401

Site Name: Hall Shop and Browns Bridge

Contractor: Biohabitats

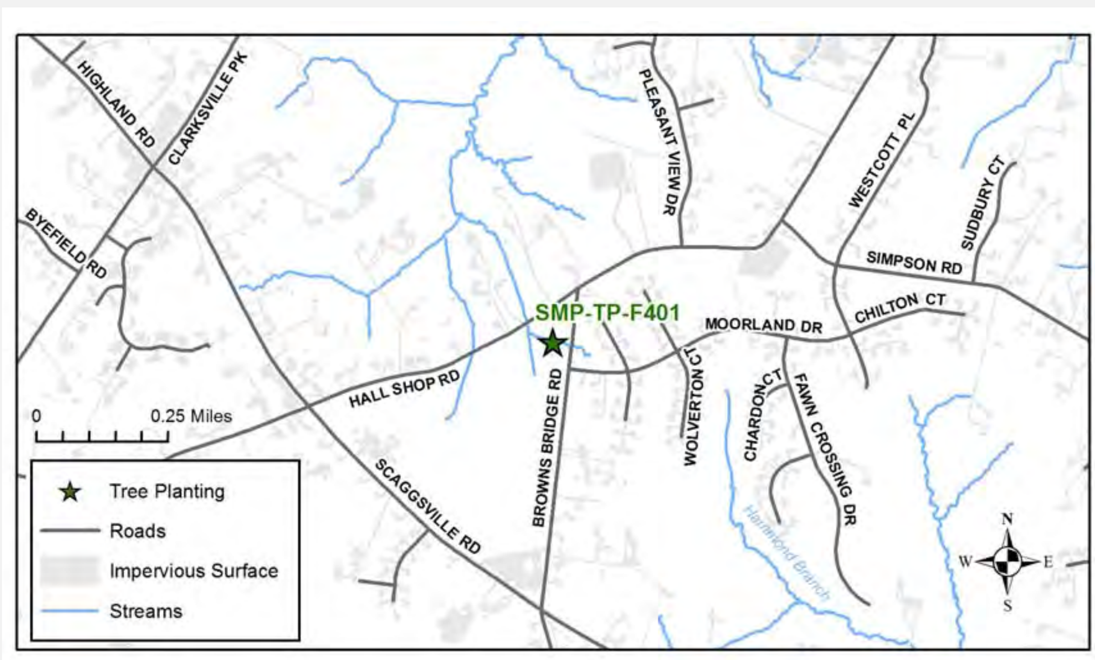
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Residential
Single Owner

Existing Conditions:

The site is a privately owned farm consisting of an agricultural field with a stream passing through the eastern portion of the field. The current vegetative cover is 10% trees and 90% with other herbaceous plants including agricultural crops. The stream has a narrow riparian buffer dominated by trees consisting of cherry (Prunus sp.), boxelder (Acer negundo), willow (Salix sp.), persimmon (Diospyros sp.), arrowwood (Viburnum dentatum), and mulberry (Morus sp.). This riparian buffer is 85% covered with invasives, primarily Japanese honeysuckle (Lonicera japonica). The majority of the site is located within the riparian area, adjacent to a stream, while the remaining portions of cropland are within an upland landscape. The site is moderately compacted with loamy textured soils. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Tree planting area looking north towards Hall Shop Road.

Tree planting area looking south from Hall Shop Road.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F401

Site Name: Hall Shop and Browns Bridge

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include current land use as cropland, private ownership, and wildlife (i.e. deer).

Concept Description:

The proposed project consists of one tree planting area that is 4.42 ac. The planting area surrounds the stream passing through the site. An expansion and improvement of the existing riparian buffer is proposed. A restoration project is recommended for the stream, and concurrent implementation of the tree planting and stream restoration projects should be explored. The average bank height along the stream is currently 3 ft. with limited floodplain connection.

The proposed planting area receives full sun and has a potential for high wind exposure. There are no steep slopes (greater the 15%) or low lying areas. There is no evidence of erosion, contamination or debris within the planting area, but there is evidence of recent road construction. Any stormwater runoff to the planting site is directed to the stream which diverts flow across the planting area.

The site provides access for delivery, as well as foot, vehicle, and heavy equipment traffic. Temporary storage may be limited due to surrounding agricultural activity. The project does not have educational potential due to its remote location.

Potential water sources for the proposed tree planting project include rainfall and tanker water delivery. No site preparation would be required.

The concept proposes planting a mix of native tree species. Deer are active in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. The existing trees in the riparian buffer within the planting areas could be preserved as long as trees are healthy and not an invasive species.

Nearby Opportunities:

SMP-SR-F310

Proposed Project Credit		Costs	
Planting Acres:	4.4	**Estimated Design Cost:**	$10,000.00
Impervious Area Treated Credit (ac.):	1.68	**Estimated Construction Cost:**	$141,440.00
Cost per Impervious Credit Acre:	$115,400.00	**30% Contingency:**	$42,432.00
		Estimated Total Cost:	$193,872.00

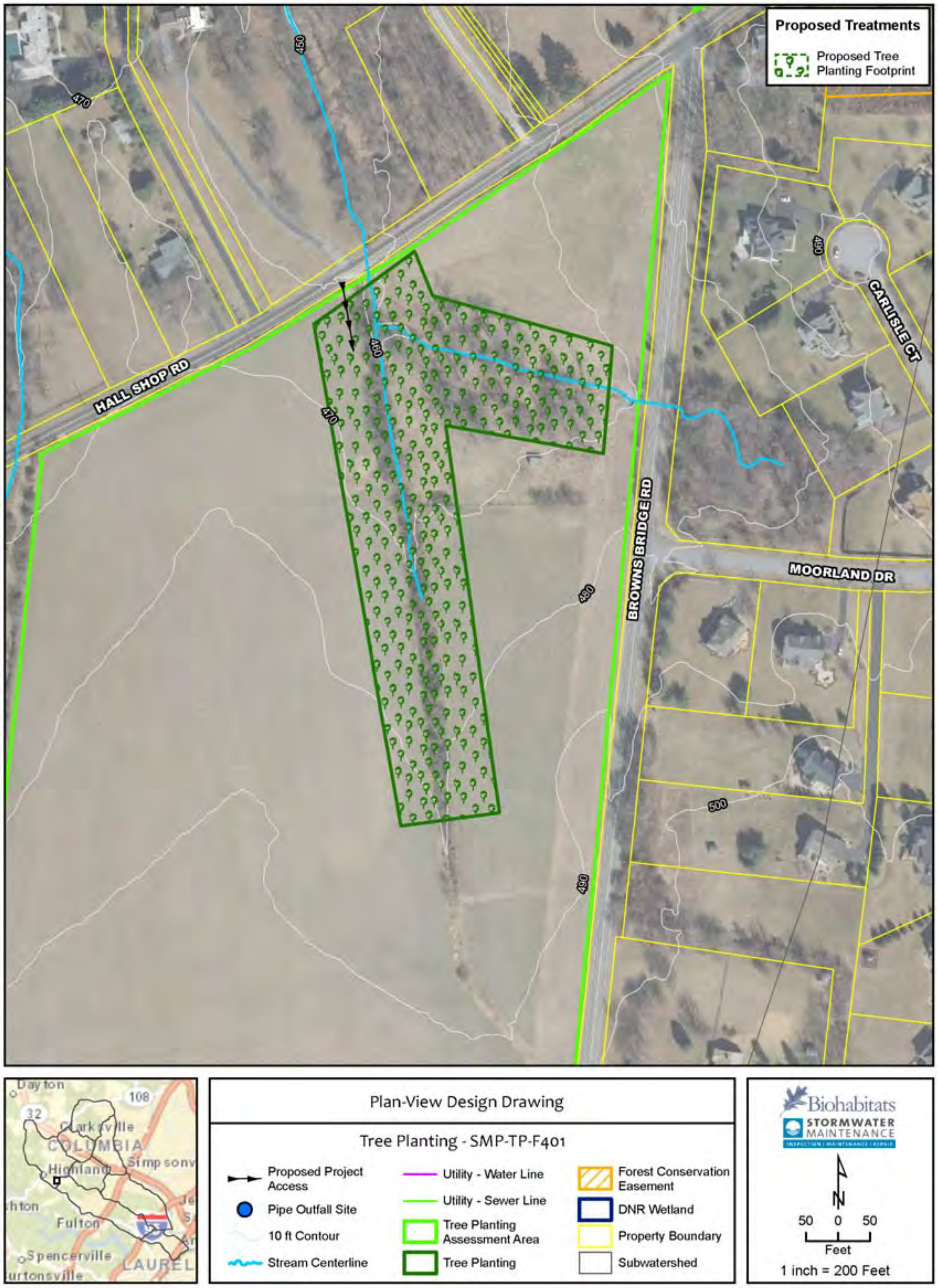
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F401

Site Name: Hall Shop and Browns Bridge

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F402

Site Name: Stonebrook Horse Farm

Contractor: Biohabitats

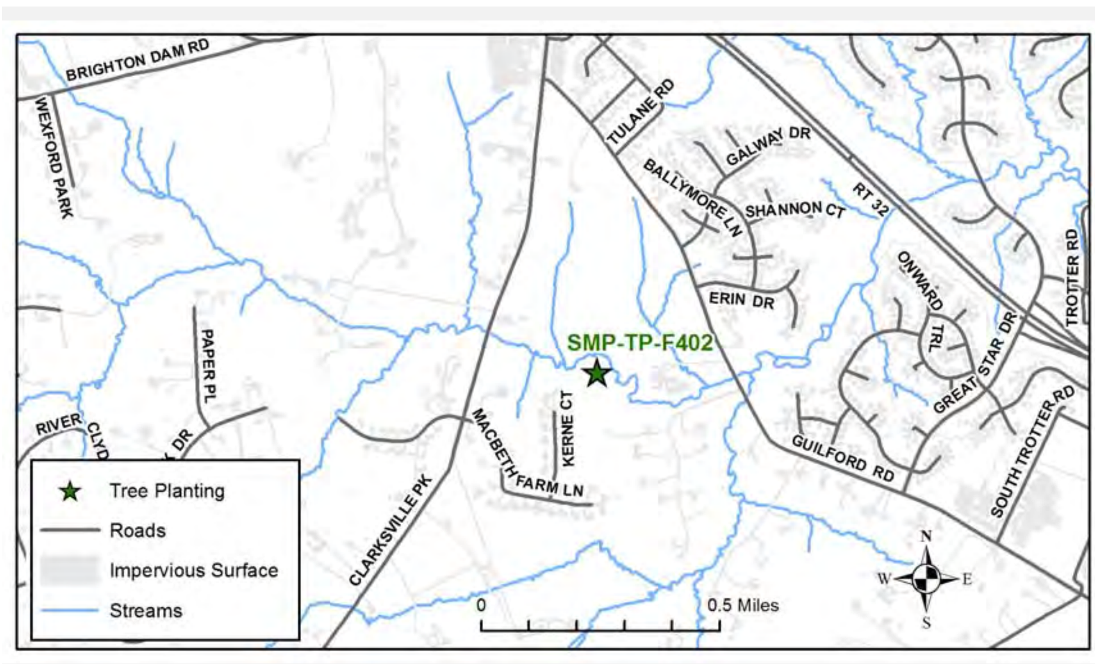
Watershed: Middle Patuxent River

Project Type: Tree Planting

Ownership: Private- Mixed Use
Single Owner

Existing Conditions:

The site is a privately owned horse farm including stables and riding center with a stream crossing the property. There is sporadic tree cover along the stream banks in the horse pasture. The current vegetative cover is 20% trees and 80% other herbaceous plants with some patches of bare ground. The majority of the site is located within the riparian area adjacent to the stream. The average bank height along the stream is currently 4 ft. with limited floodplain connection. The site is moderately compacted with loamy textured soil. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Tree planting area south of main barn looking east.

Tree planting area west of farm facilities looking east.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F402

Site Name: Stonebrook Horse Farm

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include current mowing practices and use as horse pasture, wildlife (i.e. deer), presence of wetlands, and private ownership.

Concept Description:

The proposed project consists of one tree planting area that is 18.39 ac. The planting area encompasses most of the site excluding only the area occupied and surrounding the existing buildings. A restoration project is recommended for the stream running through the site, and concurrent implementation of the tree planting and stream restoration projects should be explored. The proposed planting project would also serve to enhance the riparian buffer of the stream.

The proposed planting area receives full sun. Low lying areas consisting of floodplain depressions are present as well as erosion. There is no evidence of contamination or debris within the planting area. Approximately 20% of the planting area is covered with invasive species including bittersweet (Celastrus orbiculatus), Japanese honeysuckle (Lonicera japonica), garlic mustard (Alliaria petiolata), multiflora rose (Rosa Multiflora) and Japanese barberry (Berberis thunbergii). Any stormwater runoff to the planting site is directed to the stream which diverts flow across the planting area.

The site provides access for delivery, temporary storage, as well as foot, vehicle, and heavy equipment traffic. The project has possible educational potential due to the site's function as an active business.

Potential water sources for the proposed tree planting project include rainfall and nearby hose and hydrant hook ups. Some site preparation would be required, primarily consisting of invasives removal.

The concept proposes planting a mix of native tree species saplings. Deer are active in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. The existing trees within the planting area could be preserved as long as trees are healthy and not an invasive species.

Nearby Opportunities:

SMP-SR-F316

Proposed Project Credit		Costs	
Planting Acres:	18	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	6.99	Estimated Construction Cost:	$588,480.00
		30% Contingency:	$176,544.00
Cost per Impervious Credit Acre:	$110,876.11	Estimated Total Cost:	$775,024.00

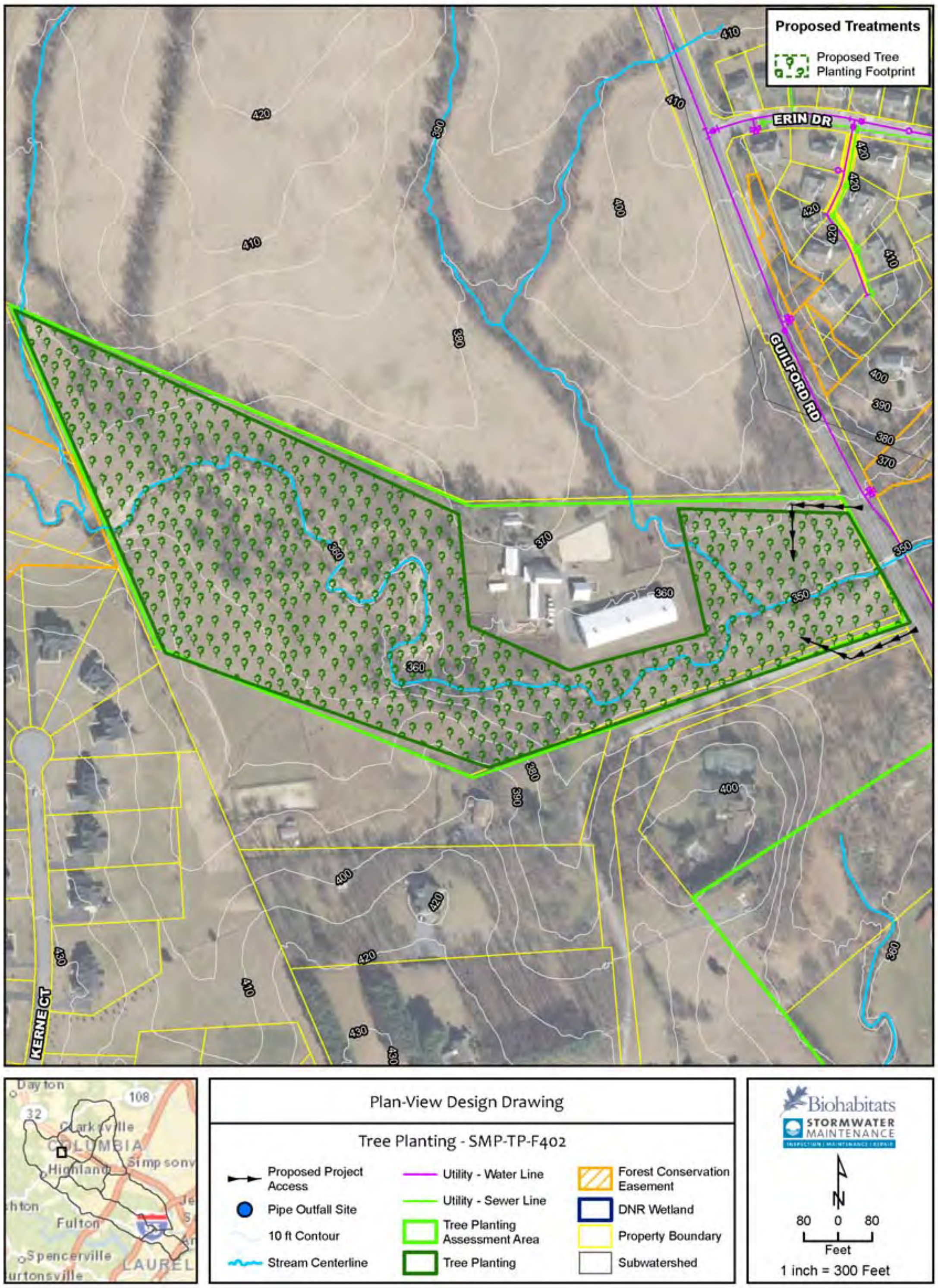
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F402

Site Name: Stonebrook Horse Farm

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F407

Site Name: Triadelphia Mill Road

Contractor: Biohabitats

Watershed: Middle Patuxent River

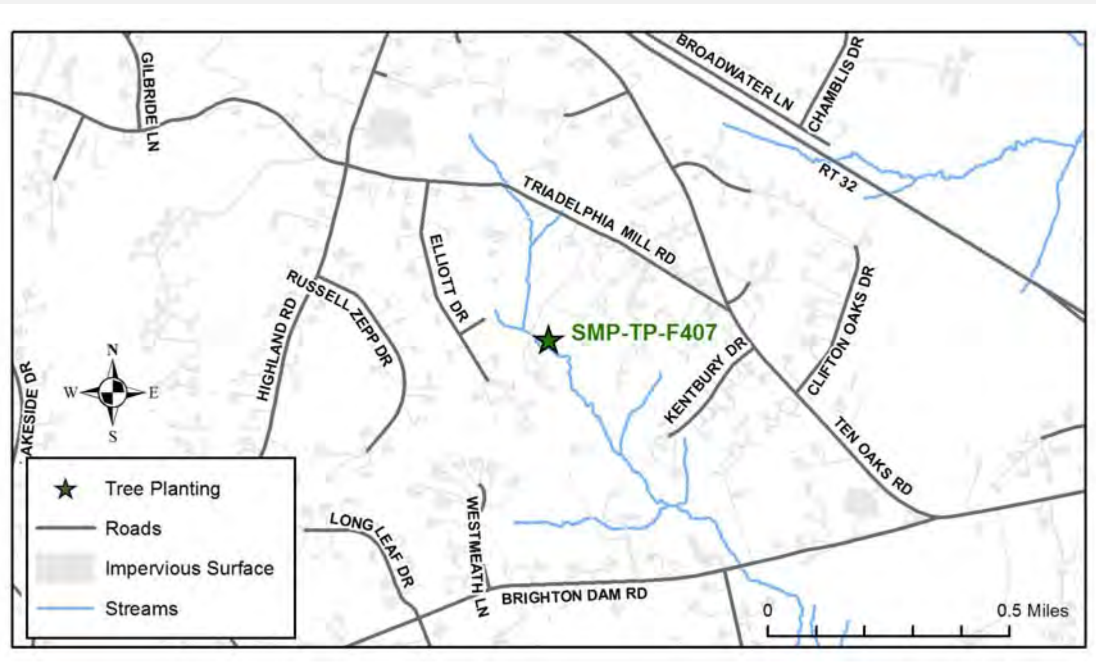
Project Type: Tree Planting

Ownership: Private- Residential
Single Owner

Existing Conditions:

The site is a privately owned property located near the beginning of Carrolls Branch. Carrolls Branch flows through the site with portions of the riparian buffer as abandoned pasture and maintained turf. The current vegetative cover is 85% other herbaceous plants, 10% turf cover, and 5% trees. Forest consisting of tulip poplar (Liriodendron tulipifera) and oak (Quercus sp.) is present adjacent to the site. The adjacent forest is roughly 35% covered also with the invasive species including bittersweet (Celastrus orbiculatus) and Japanese honeysuckle (Lonicera japonica).

The site is located in the riparian landscape with non-compacted and loamy textured soil. The average bank height along the stream is currently 2 ft. with frequent floodplain connection. The regional forest association, which indicates the climax or dominant species for an area, is Appalachian Oak.



Tree planting area south of stream looking southeast.

Tree planting area north of stream looking northeast. Driveway separating tree planting area and adjacent pond visible on the left.

Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F407

Site Name: Triadelphia Mill Road

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints at the site include current mowing practices, wildlife (i.e. deer), presence of wetlands, and private ownership.

Concept Description:

The proposed project consists of one tree planting area that is 2.64 ac. The planting area is southeast of a pond with an outfall to Carrolls Branch that bisects the planting area. The proposed planting project would create a riparian buffer for the encompassed segment of the stream.

The planting area receives full sun and low lying areas are present within the riparian buffer. There is no evidence of erosion, contamination, or debris within the proposed planting area. Approximately 5% of the planting area is covered with invasive species including bittersweet (Celastrus orbiculatus) and Japanese honeysuckle (Lonicera japonica). Any stormwater runoff to the planting site is directed to the stream which diverts flow across the planting area.

While foot, vehicle, and heavy equipment traffic access is available, the site does not have adequate space for delivery or temporary storage. The project has minimal educational potential due the site being adjacent to residential properties, thus limiting exposure and access to the public. Potential water sources for the proposed tree planting project include rainfall and water from the adjacent pond. Minimal site preparation would be required including minor invasives removal. The concept proposes planting a mix of native tree species saplings. Deer are active in the area; therefore, newly planted trees would need to be protected from potential wildlife impacts using appropriate fencing, tree protectors, repellents, etc. The existing trees within the planting area could be preserved as long as trees are healthy and not an invasive species.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Planting Acres:	2.6	Estimated Design Cost:	$10,000.00
Impervious Area Treated Credit (ac.):	1	Estimated Construction Cost:	$84,480.00
		30% Contingency:	$25,344.00
Cost per Impervious Credit Acre:	$119,824.00	Estimated Total Cost:	$119,824.00

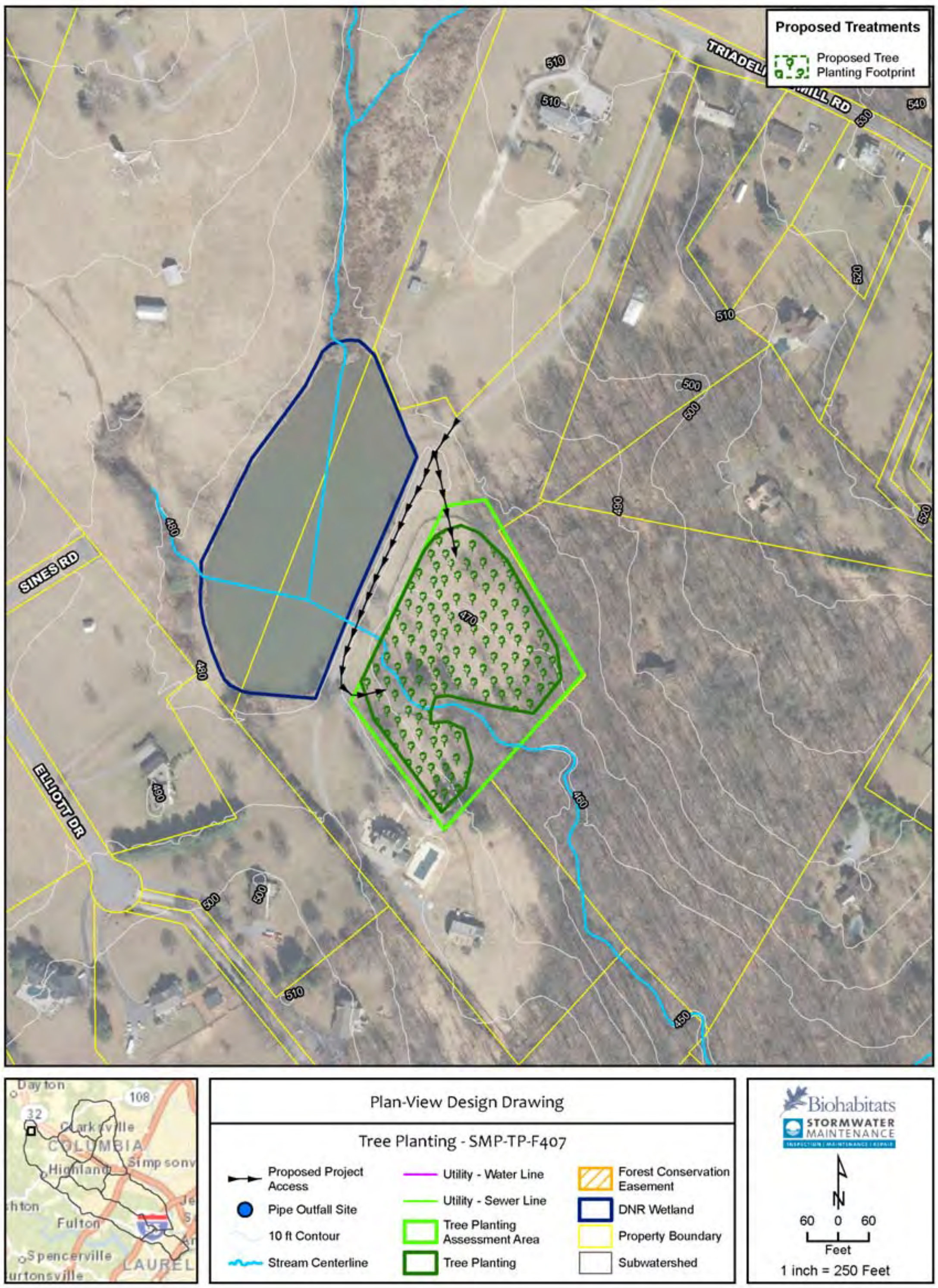
Howard County Watershed Assessment Concept Plan: Tree Planting

Site ID: SMP-TP-F407

Site Name: Triadelphia Mill Road

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: NMP-OF-F102

Site Name: Chapel Estates Drive

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

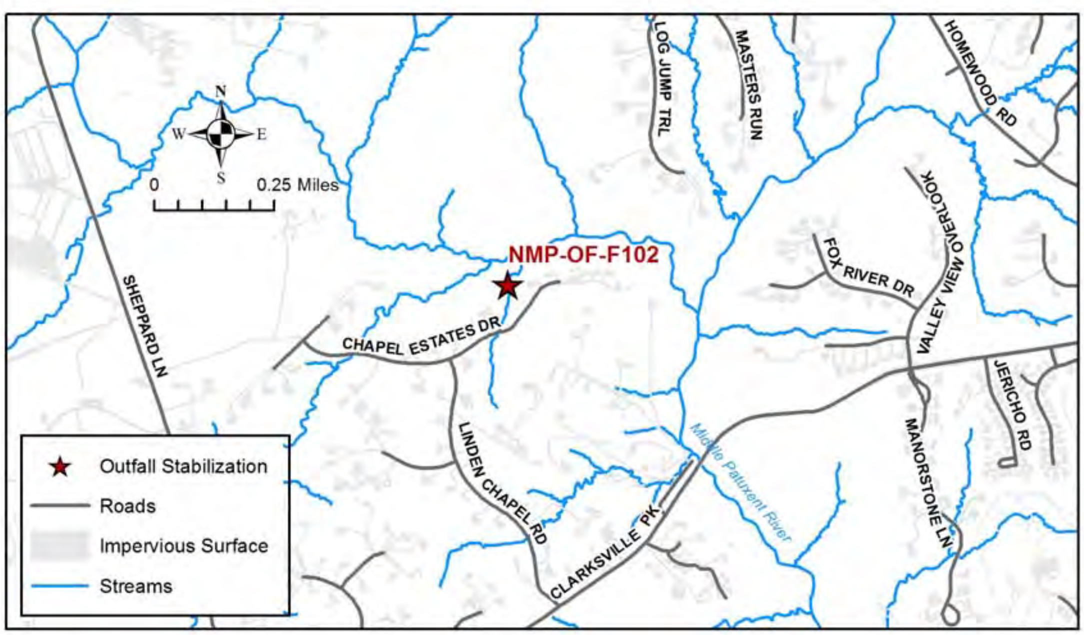
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Riprap

Ownership: Private- Residential
Single Owner

Existing Conditions:

NMP-OF-F102 is a stormwater pond outfall that drains to an unnamed tributary to the Middle Patuxent River. Land use surrounding the project site is primarily forested and residential land with the entire project site associated with property of the Chapel Woods Home Owners Association. The outfall stabilization site begins at the stormwater pond outfall located approximately 430 lf. north of Chapel Estates Drive and extends downstream (north/northeast) approximately 300 lf. The outfall pipe is a 36 in. corrugated metal pipe (CMP) that has a concrete headwall and a short apron. The apron is associated with a 4 ft. drop in elevation from the edge of the apron to the stream bed. The stream bed directly below the apron is lined with riprap that is currently unstable, as evidenced by exposed geotextiles near the culvert apron and displacement of riprap that has been transported farther downstream. The channel directly below the outfall has some minor erosion. Erosion of the receiving stream channel changes to moderate and severe erosion approximately 100 ft. downstream of the outfall. One segment of the channel is eroding into the valley wall on the right side facing downstream. The site also appears to have existing wetlands on the left side of the channel.



NMP-OF-F102 facing upstream at stormwater pond outfall and pipe outfall channel.

NMP-OF-F102 facing downstream at pipe outfall channel.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: NMP-OF-F102

Site Name: Chapel Estates Drive

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Constraints/Utilities:

Constraints within the project include private ownership, moderate access, and impacts to existing trees and possibly wetlands.

Concept Description:

Ease of access to the project is low to moderate and is associated with one private property owned by the Chapel Woods Home Owners Association. Access to the site is proposed off of Chapel Estates Drive along the existing pond and assumes that the pond embankments can be utilized. The proposed project would include approximately 20 lf. of channel stabilization with riprap and continue with stream restoration of the channel for approximately 280 lf. for a total of 300 lf. of stabilization. Stream restoration would primarily include bank grading and a small channel relocation to modify channel planform (relocation off of the valley wall). The stream restoration may also include treatment with stream structures for grade control and/or bank stabilization. A wetland delineation would be needed to evaluate design alternatives and avoid or minimize impacts to any existing wetlands. This outfall stabilization project may be reclassified as a stream restoration project if the length of channel restored exceeds 200 lf.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	300	**Estimated Design Cost:**	$100,000.00
Impervious Area Treated Credit (ac.):	3	**Estimated Construction Cost:**	$131,000.00
Cost Per Impervious Credit Acre:	$90,100.00	**30% Contingency:**	$39,300.00
		Estimated Total Cost:	$270,300.00

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: NMP-OF-F102

Site Name: Chapel Estates Drive

Contractor: McCormick Taylor

Watershed: Middle Patuxent River

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F304

Site Name: Shady Glen Townhomes

Contractor: Biohabitats

Watershed: Middle Patuxent River

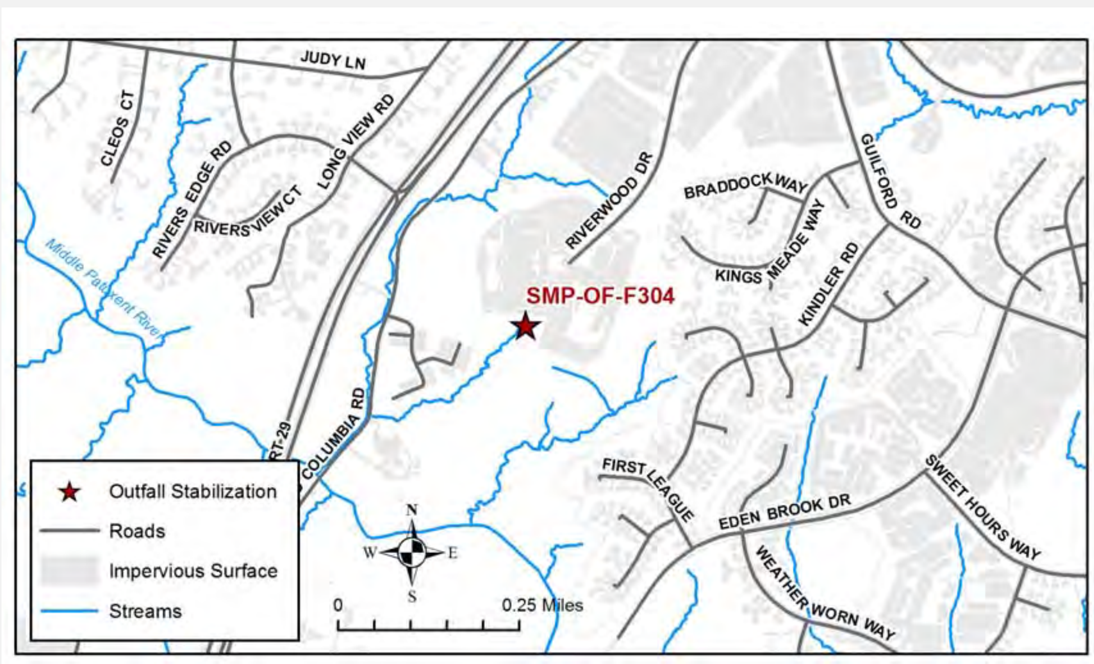
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Drop Structure

Ownership: Columbia Association
Multiple Owners

Existing Conditions:

The existing 36 in. CMP barrel (from M-5 to S-3 on sheet 6 of F-84-002 plans) is corroded. Examination of available plans and GIS, determines that the existing drainage area is 7.51 ac. of which 1.51 ac. are impervious. Land use within the drainage area is primarily commercial development. The M-5 structure is on private property. The outfall and channel are on Columbia Association Property. There are some specimen trees along the banks. Beyond the outfall stabilization reach, the channel flows through a forest retention area behind the Shady Glen Townhomes and there is an AT&T cable crossing. Downstream of the AT&T crossing the channel becomes increasingly incised with active headcuts as you move downstream.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F304

Site Name: Shady Glen Townhomes

Contractor: Biohabitats

Watershed: Middle Patuxent River

Upstream View of 36 in. CMP.

Downstream view of outfall channel.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F304
Site Name: Shady Glen Townhomes
Contractor: Biohabitats
Watershed: Middle Patuxent River

Constraints/Utilities:

There are a few specimen trees (tulip poplars). The proposed access (and a portion of the pipe replacement) is on a high security property, so access may be limited. The outfall channel has steep banks due to channel incision.

Concept Description:

Based on the current guidelines for impervious acre credits, it appears most cost effective to remove and replace the 124 lf. of corroded 36 in. CMP, replace S-3 with a drop structure to dissipate energy, and 175 lf. of riprap stabilization to protect the outfall channel from further erosion. Access is proposed from the end of Riverwood Drive through private property. The downstream channel incision and vast abandoned floodplain through the forest retention area, present an opportunity for 1,600 lf. of stream restoration down to Old Columbia Road. This larger stream restoration opportunity has not been assessed at this time.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	175	**Estimated Design Cost:**	$120,000.00
Impervious Area Treated Credit (ac.):	1.75	**Estimated Construction Cost:**	$100,000.00
Cost Per Impervious Credit Acre:	$165,562.91	**30% Contingency:**	$30,000.00
		Estimated Total Cost:	$250,000.00

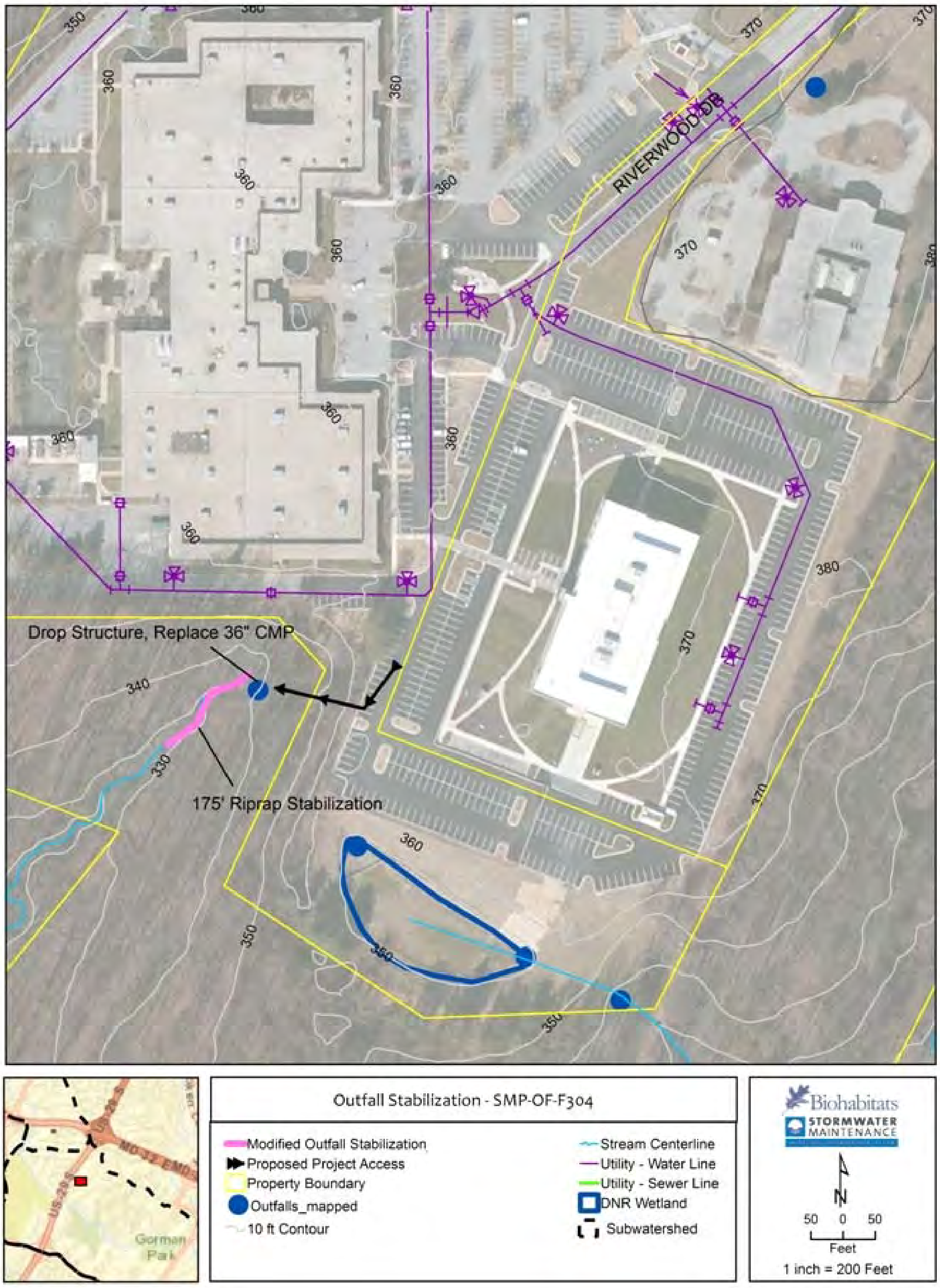
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F304

Site Name: Shady Glen Townhomes

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F306

Site Name: Twin Oaks

Contractor: Biohabitats

Watershed: Middle Patuxent River

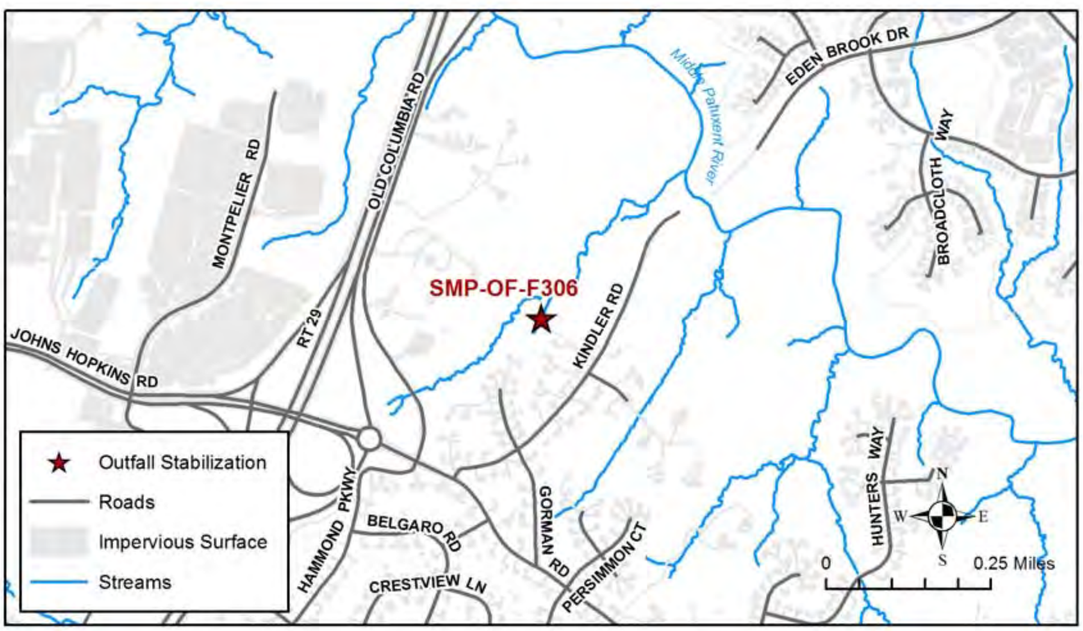
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Cascade or Boulder Step Pool

Ownership: County Park
Single Owner

Existing Conditions:

The 210 lf. outfall is located in Gorman Park. Examination of available plans and GIS determines that the existing drainage area is 25 ac. of which 3.21 are impervious. Land use within the drainage area is primarily single family residential development and wooded County Park. Stormwater discharges from the 15 in. CMP to a rock lined channel with silt fence across and along side in places. The overall channel slope appears relatively steep, approximately 10%. The outfall channel is stable for the first 100 lf. There is 60 lf. of erosion, followed by aggradation and then incision again as you near the confluence with main stem. A sewer line runs parallel along the right bank. Portions of the left bank are relatively steep with some small trees.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F306

Site Name: Twin Oaks

Contractor: Biohabitats

Watershed: Middle Patuxent River

Downstream view of upper channel.

Downstream view of lower channel.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F306

Site Name: Twin Oaks

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Sanitary sewer line runs parallel along the right bank. Access to the site requires crossing a thin privately owned residential property (Mr. Robert Mowrey).

Concept Description:

The concept design proposes to stabilize 210 lf. of channel with a cascade or step pool channel using large boulders. Applying a Step Pool Storm Conveyance (SPSC) to increase the acres of impervious treatment was not possible due to the baseflow. There is an existing access pathway through the park that can be used to access the site. This outfall stabilization project may be reclassified as a stream restoration project if the length of channel restored exceeds 200 lf.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	210	**Estimated Design Cost:**	$100,000.00
Impervious Area Treated Credit (ac.):	2	**Estimated Construction Cost:**	$100,000.00
Cost Per Impervious Credit Acre:	$115,000.00	**30% Contingency:**	$30,000.00
		Estimated Total Cost:	$230,000.00

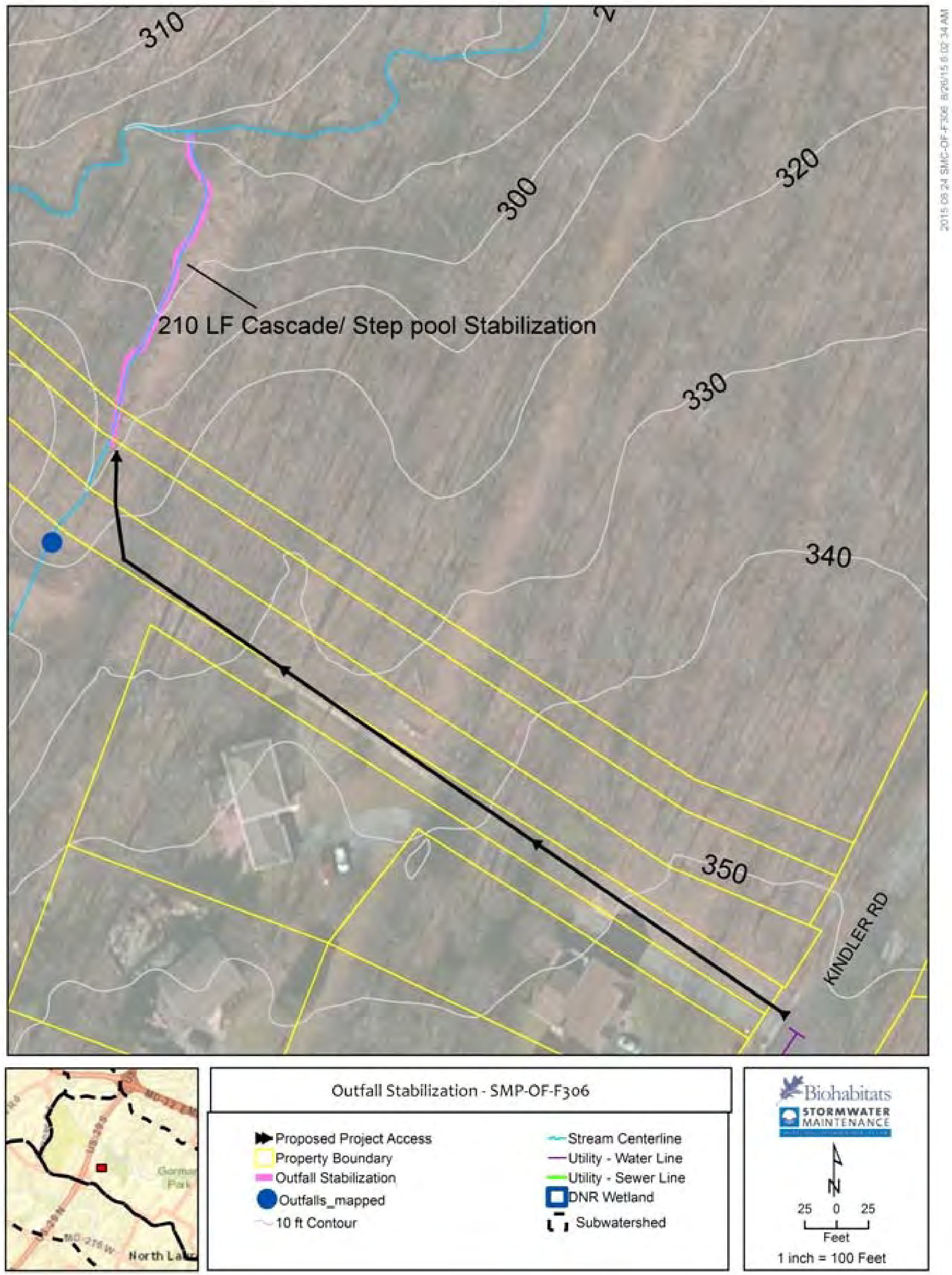
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F306

Site Name: Twin Oaks

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F309

Site Name: 5th District VFD North outfall

Contractor: Biohabitats

Watershed: Middle Patuxent River

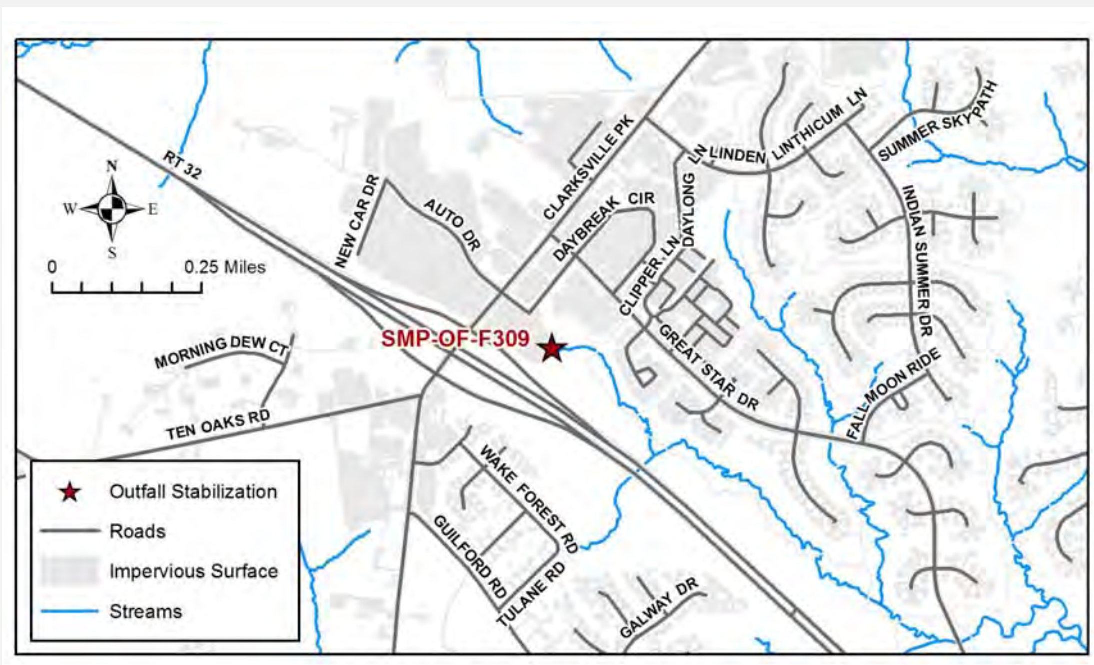
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Step Pool Storm Conveyance

Ownership: Columbia Association
Multiple Owners

Existing Conditions:

Located behind the volunteer fire department (VFD), this outfall conveys discharge from a 20.8 ac. drainage area. The drainage area is covered in 8.5 ac. of impervious surface (40.66%) dominated by commercial use. The outfall barrel is a 36 in. diameter HDPE pipe, elevated approximately 6 ft. above the channel bottom with significant scour. The slope from outfall invert to the end of the channel is about 10%. The channel is deeply incised with active bank erosion. Surrounding vegetation is low-quality forest composed of mostly brush and scrub. Ownership is VFD and Columbia Association.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F309

Site Name: 5th District VFD North outfall

Contractor: Biohabitats

Watershed: Middle Patuxent River

Downstream view from outfall bottom.

Downstream view of outfall barrel and incised channel.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F309

Site Name: 5th District VFD North outfall

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

This channel has a confluence from SMP-OF-F308 approximately 40 ft. downstream of outfall. Engineering will need to take account for additional inflow from other BMP. There is a light pole near the outfall. Otherwise, constraints are minimal.

Concept Description:

Site appears to have high potential for a Regenerative Stormwater Conveyance (RSC) system to treat full 8.5 ac. of impervious surface. This could also have educational opportunities. Access has few constraints. The channel length and slope are accommodating to RSC, and channel width can be fitted to meet WQv requirements. Propose 200 ft. RSC with 10 pools approximately 35 ft. x 20 ft. x 4 ft. and 24 in. filter bed to satisfy 32,200 cf. of storage volume and sizing to carry 100 year storm. The outfall channel SMP-OF-F308 has a sinkhole and active headcuts and will require stabilization. The cost and impervious acre treatment do not include this outfall channel.

Nearby Opportunities:

Stabilization of sink hole and headcuts along SMP-OF-F308 outfall channel. Stream restoration could extend beyond the recommended 200 lf. of outfall stabilization.

Proposed Project Credit

Drainage Area (ac.):	20.8
Impervious Area within Drainage (ac.):	8.5
Impervious Area Treated (ac.):	8.5
Impervious Area Treated Credit (ac.):	8.5

Water Quality Volume

WQVolume Target (cf.):	31,377
Max Treated (cf.):	31,377
Percent Treated:	100%
Rainfall Depth Treated (in.):	1

Costs

Estimated Design Cost:	$100,000.00
Estimated Construction Cost:	$100,000.00
30 % Contingency:	$30,000.00
Estimated Total Cost:	$230,000.00
Cost per Impervious Credit Acre:	$27,058.82

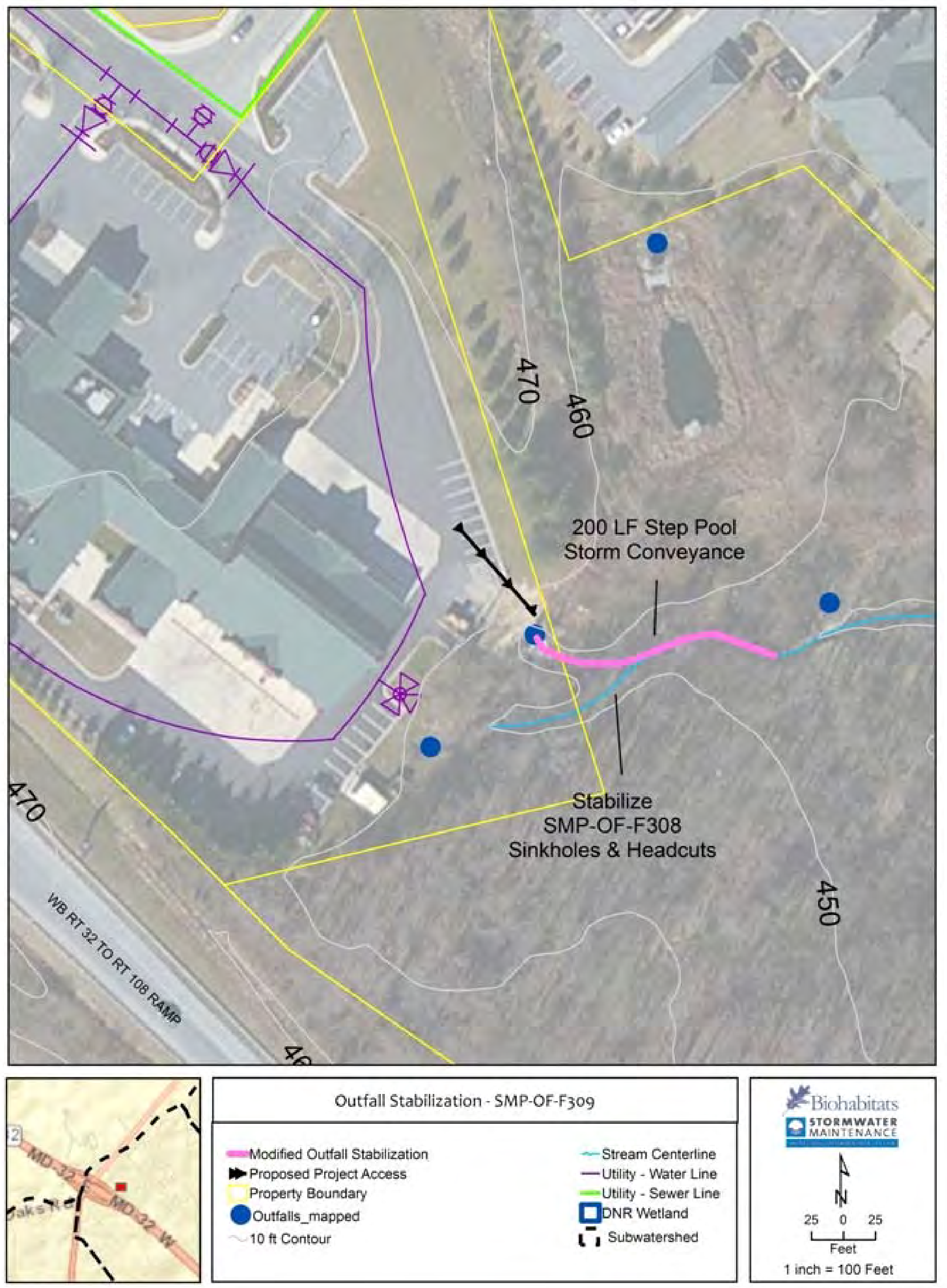
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F309

Site Name: 5th District VFD North outfall

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F330

Site Name: Hobbits Glen Golf Club Hole #2

Contractor: Biohabitats

Watershed: Middle Patuxent River

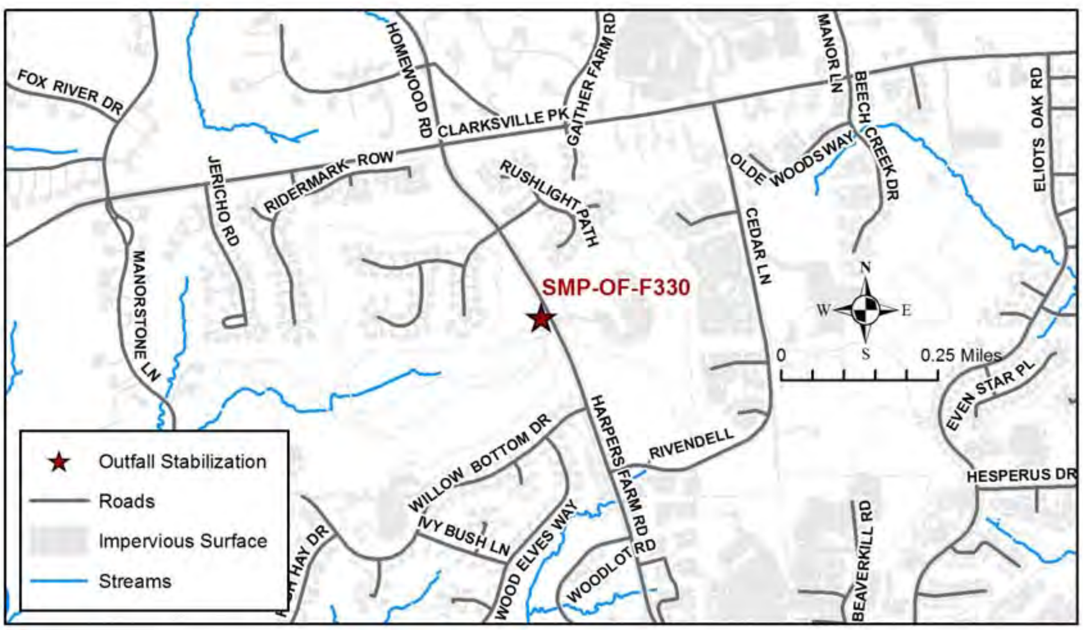
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Natural Channel Design/Daylighting

Ownership: Columbia Association
Single Owner

Existing Conditions:

Examination of available plans and GIS determines that the existing drainage area is 168 ac. of which 19.6 ac. are impervious (11.7%). Land use within the drainage area is primarily open space/park (golf course) and single family residential development. Two concrete pipes of 30 in. and 42 in. in diameter outfall into a 30 ft. wide riprap channel for 40 lf. The 30 in. pipe outfalls into a 10 ft. concrete channel. There is an additional 8 in. outfall pipe 22 in. above the channel invert. The outfall channel (perennial stream) flows through a wooded section with mature trees (tulip poplars) then discharges downstream into a corroded 3 ft. x 2 ft. elliptical CMP (~224 ft. long). Another 75 lf. channel discharges into a 24 in. CMP that is assumed to tie into the 3ft. x 2 ft. elliptical pipe. The channel daylights again for 250 lf. (stable channel) where it enters a pipe and flows into a wet pond.



Upstream view of 30 in. and 42 in. culverts at upstream end.

Upstream view of 8 in. outfall.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F330

Site Name: Hobbits Glen Golf Club Hole #2

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

The daylighting option may require golf course modifications. There are approximately six specimen trees in the outfall channel reach. Access will require traffic control and a dirt ramp due to steep road embankment.

Concept Description:

The proposed design is 538 lf. of stream restoration using natural channel design (possibly an E channel, estimated bankfull discharge of 12 cfs.). This includes 313 lf. (238 + 75) of channel restoration and 224 lf. of daylighting the corroded elliptical pipe (this would require golf course modification/adjustments). Restoration alternatives include outfall stabilization of the 313 lf. of channel and replacing the pipe for a total cost of $413,850 for 2 ac. of impervious treated. This outfall stabilization project may be reclassified as a stream restoration project if the length of channel restored exceeds 200 lf.

Nearby Opportunities:

None recommended

Proposed Project Credit		Costs	
Length Restored (ft):	538	Estimated Design Cost:	$200,000.00
Impervious Area Treated Credit (ac.):	5.4	Estimated Construction Cost:	$249,940.00
Cost Per Impervious Credit Acre:	$97,207.78	30% Contingency:	$74,982.00
		Estimated Total Cost:	$524,922.00

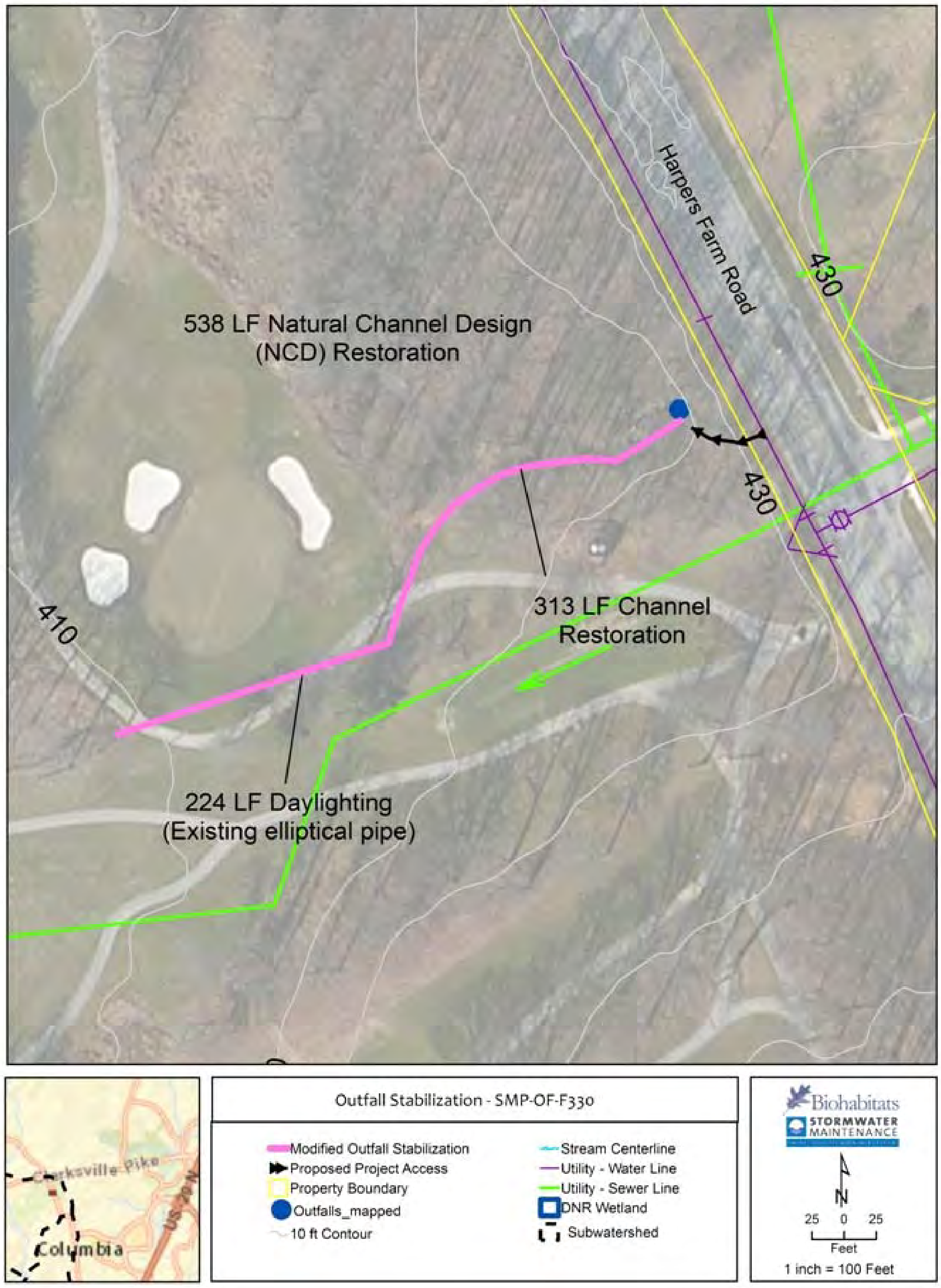
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F330

Site Name: Hobbits Glen Golf Club Hole #2

Contractor: Biohabitats

Watershed: Middle Patuxent River



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F334

Site Name: Tolling Belle Ct

Contractor: Biohabitats

Watershed: Middle Patuxent River

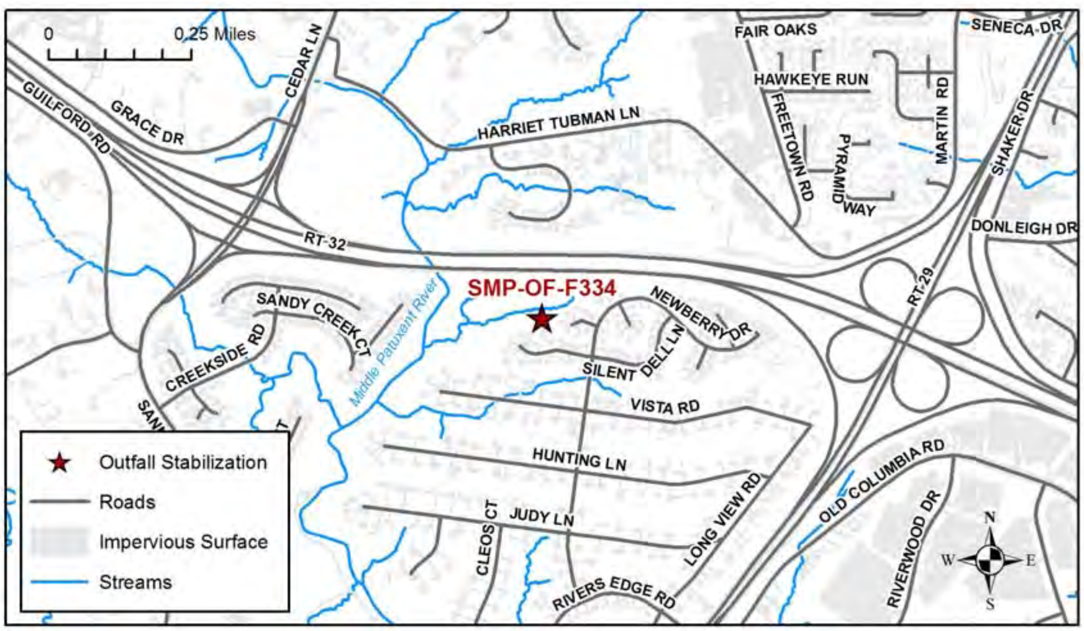
Proposed BMP Type: Outfall Stabilization

Stabilization Type: Riprap or Rock Step Pool

Ownership: Private- Residential
Multiple Owners

Existing Conditions:

Examination of available plans and GIS determines that the existing drainage area is approximately 33.1 ac. of which 7.4 ac. are impervious (22%). Land use is residential, single family homes. The wooded area surrounding the outfall channel is dominated by Tulip Poplars and garlic mustard. The 48 in. RCP outfall channel has significant erosion. The mainstem, and another outfall channel about 200 ft. west, are also actively eroding and unstable. A sanitary sewer line runs parallel to the outfall channel. The erosion has exposed the manhole and impacted trees as evident by many fallen trees.



Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F334

Site Name: Tolling Belle Ct

Contractor: Biohabitats

Watershed: Middle Patuxent River

Upstream view of 48 in. outfall and portion of the access.

View of outfall channel and exposed sewer manhole.

Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F334

Site Name: Tolling Belle Ct

Contractor: Biohabitats

Watershed: Middle Patuxent River

Constraints/Utilities:

Access will be difficult and will require traveling within existing utility easement(s) through 1 or 2 resident's yards (there is a utility easement to the west outfall to be considered as an alternative).

Concept Description:

The most cost effective way to stabilize this outfall is to provide 164 lf. of riprap or rock step pool stabilization resulting in 1.64 impervious acre treatment. Another alternative would be to provide a drop structure and pipe the outfall to the mainstem.

Nearby Opportunities:

SMP-OF-F434 (another eroding outfall 200 ft. west of this one); SMP-SR-F434 (the receiving stream is incised and unstable and should be assessed for restoration).

Proposed Project Credit		Costs	
Length Restored (ft):	164	Estimated Design Cost:	$100,000.00
Impervious Area Treated Credit (ac.):	1.64	Estimated Construction Cost:	$100,000.00
Cost Per Impervious Credit Acre:	$140,243.90	30% Contingency:	$30,000.00
		Estimated Total Cost:	$230,000.00

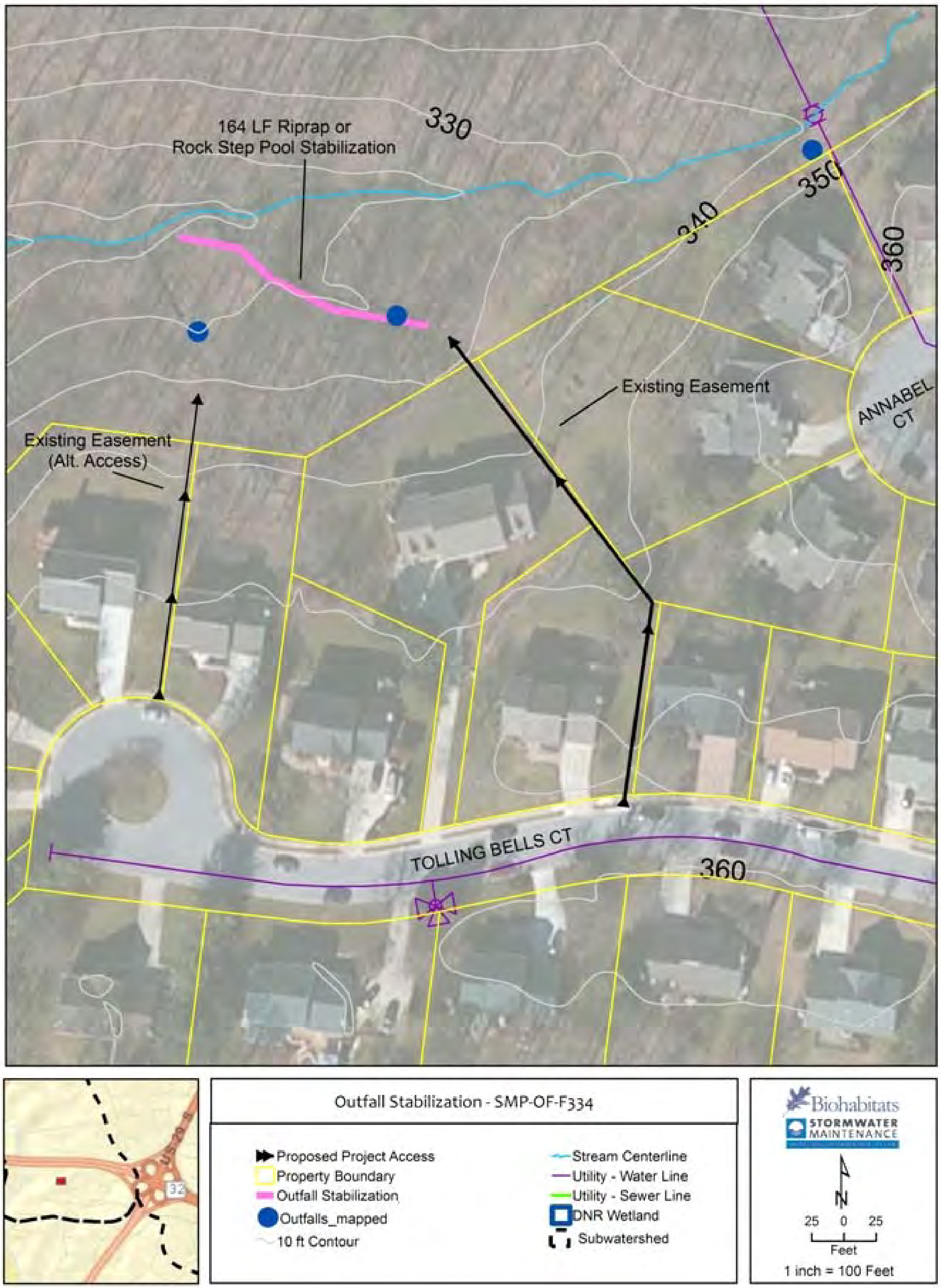
Howard County Watershed Assessment Concept Plan: Outfall Stabilization

Site ID: SMP-OF-F334

Site Name: Tolling Belle Ct

Contractor: Biohabitats

Watershed: Middle Patuxent River



Project Overview: Ten Oaks Road (NMP-BC-D113)

Project Type:	Flood control dry pond to extended detention pond with micropool and forebay
Total Cost:	$250,000 (updated according to 2015 Cost Estimation spreadsheet)
Location/Address:	Title – "Site Development Plan – 3rd Election District Subdivision – Glen Oak Center Address – 3800 Ten Oaks Road Access – 3800 Ten Oaks Rd on the right-hand side of the building ADC Map 09-H10 MS Link 1281
Land Use:	Commercial
Ownership:	Private
Maintenance Responsibility:	Private
Drainage Area:	14.66 acres
Impervious Area:	7.61 acres (51.91%)
Surface Soils:	26.0% GgB: Glenelg loam, 3-8% slopes 1.5% GgC: Glenelg loam, 8-15% slopes 44.3% GhB: Glenelg-Urban land complex, 0-8% slopes 20.6% GmB: Glenville silt loam, 3-8% slopes 7.6% MaB: Manor loam, 3-8% slopes Classification: Hydrologic Soil Group, Type B Hydrologic Soil Group, Type C

Existing Conditions

The dry pond is privately owned by the commercial property owner. Drainage is collected from the adjacent commercial building and raw materials storage yard and discharges directly into the southwest side of the flood control dry pond. The dry pond outfalls through a riser structure ultimately flowing to a nearby open field.

Conceptual Design

The proposed retrofit concept is to improve water quality performance by converting the existing dry pond to a "Micropool" Extended Detention Pond and by advising the commercial property owner on pollution prevention activities appropriate to reduce pollutants entering stormwater from exposed stock piles. The forebays, pilot channel, and Micropool will be designed to retain existing vegetation to the maximum extent possible. The pond bottom is to be excavated to increase capacity and the existing outfall structure will be modified based on the required Micropool and stormwater quantity requirements. A stable outfall also will be provided downstream of the adjusted principal spillway.

An extended detention pond with micropool was chosen because the drainage area is greater than 10 acres, adequate head is available, space is limited, and a micropool ED requires a relatively small footprint. As a result of the limited space available to increase the proposed BMPs footprint or depth, we expect to be able to provide treatment for ½ of the WQv, or about 13,761.33 ft^3.

The micropool extended detention pond layout will be similar to Figure A in Appendix B.

Design Parameter	**Value**
Drainage Area (Ac)	14.66
Percent Impervious (I)	51.91
Volumetric runoff coefficient (R_v)	0.517
Soil specific recharge factor (S)	0.23
Water quality volume (WQ_v) (ft^3)	27,522.66
Expected maximum WQv treatment	*13,761.33*
Recharge Volume (Re_v) (ft^3)	6,418.83
Pretreatment Volume (25% WQ_v) (ft^3)	6,880.67

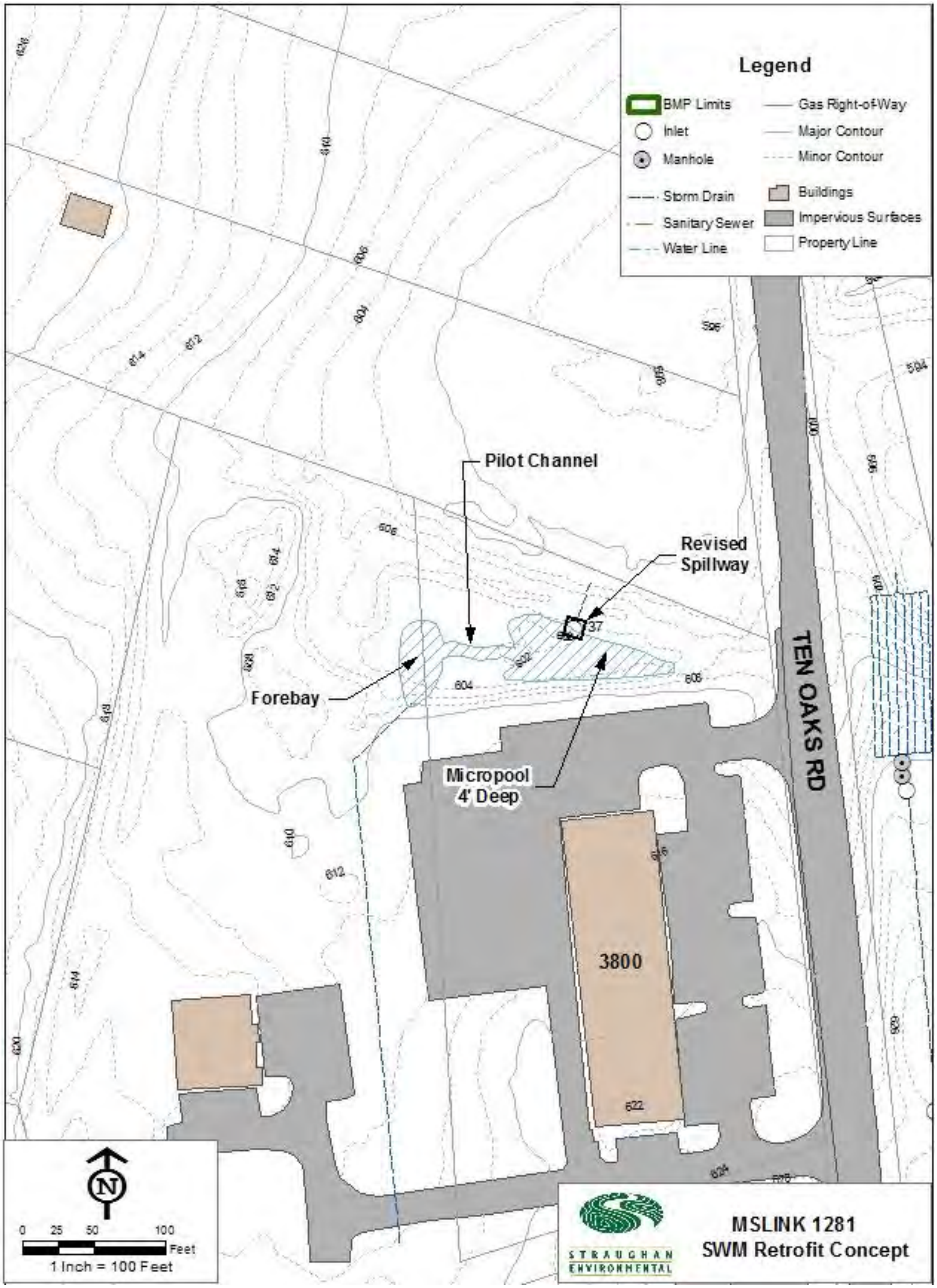


Figure 1. Concept Design Plan View at 3800 Ten Oaks Road, NMP-BC-D113

Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP				
Mobilization/Demobilization	1	LS	$10,000.00	$10,000.00
Erosion and Sediment Control	1	LS	$80,000.00	$8,000.00
EXTENDED DETENTION WITH FOREBAY				
Excavate and Remove (incl. transportation)	640	cy	$40.00	$25,600.00
Overflow Structure	1	LS	$16,000.00	$16,000.00
Plants (Seeding, Trees, Shrubs, etc.)	1	LS	$5,000.00	$5,000.00
TOTAL CONSTRUCTION COSTS				**$64,600.00**
ENGINEERING AND MANAGEMENT				
Engineering / Permitting / Construction Mgmt.				$100,000.00
Geotech / Soil Borings				$20,000.00
Contingency (30% of Total Construction)				$19,380.00
TOTAL PROJECT COSTS				**$203,980.00**

Constructability

Design & Construction:

Access: 3800 Ten Oaks Rd on the right-hand side of the building.

Utilities:

Other impacts: May be on multiple properties.

Existing Condition Photograph

Figure 2. SWM pond at 3800 Ten Oaks Road, NMP-BC-D113

Calculations

PROJECT:	Howard County Retrofit	DATE:	1/21/2013
LOCATION:	3800 Ten Oaks Road	COMPUTED BY:	ANB
DEVELOPER:		CHECKED BY:	EHF

UNIFIED SIZING CRITERIA

COMPUTE WATER QUALITY VOLUME (WQ_v):

$$(WQv) = \frac{[(1.0)(R_v)(A)]}{12}$$

= **0.6318** **acre-feet**
= **27522.66** **cubic-feet**

where:

P = 1" Rainfall Depth (Eastern Zone)
A = Total Site Area (acres)
Rv = Volumetric Runoff Coefficient
= 0.05 + 0.009 (I)
where I is % Impervious Cover
Impervious Cover = **7.61** acres
Total Site Area = **14.66** acres
% Impervious Cover = **51.91%**
therefore, Rv = **0.517**

COMPUTE RECHARGE VOLUME (Re_v):

$$(Rev) = \frac{[(S)(R_v)(A)]}{12}$$

= **0.1474** **acre-feet**
= **6418.83** **cubic-feet**

where:

S = Soil Specific Recharge Factor
A = Total Site Area (acres)
Rv = Volumetric Runoff Coefficient
= 0.05 + 0.009 (I) [as calculated above]
= **0.517**

COMPUTE SOIL RECHARGE FACTOR (S):

Acres	Hydrologic Soil Group	Soil Specific Recharge Factor (S)	A*S
	A	0.38	0.00
11.64	B	0.26	3.03
3.02	C	0.13	0.39
	D	0.07	0.00
14.66		**Computed Average S =**	**0.23**

Project Overview**: Moving Water Lane (SMP-BC-D330)**

Project Type:	Flood Control Dry Pond Conversion to Extended Detention Pond with Micropool and Forebay
Total Cost:	$250,000 (updated according to 2015 Cost Estimation spreadsheet)
Location/Address:	Title – "Village of Kings Contrivance" – Section 3, Area 2"; 6th Election District Subdivision – Village of Kings Contrivance Address – 9023 Moving Water Lane Access – 9023 Moving Water Lane, follow asphalt walkway which crosses the embankment ADC Map 19-H02 MS Link 21
Land Use:	Residential townhomes
Ownership:	HOA
Maintenance Responsibility:	Public
Drainage Area:	19.56 acres
Impervious Area:	7.68 acres (39.26%)
Surface Soils:	82.8% GhB: Glenelg-Urban land complex, 0-8% slopes 1.7% MaB: Manor loam, 3-8% slopes 5.4% MaC: Manor loam, 8-15% slopes 10.1% MaD: Manor loam, 15-25% slopes Classification: Hydrologic Soil Group, Type B

Existing Conditions

The facility is believed to be owned by the homeowners association. Drainage is collected from all main roads of the subdivision via a main stormdrain system and discharged into a stone ditch located at the southern end of the property. Stormwater runoff is conveyed to a dry stormwater management pond and ultimately discharged into the nearby steam.

Conceptual Design

The proposed retrofit concept is to improve water quality performance by converting the existing dry pond to an Extended Detention Pond with micropool and forebay. The forebay, pilot channel and micropool will be designed to retain existing vegetation to the maximum extent possible. The existing riser will be modified based on the required micropool and stormwater quantity management storages including channel protection. A stable outfall will also be provided downstream of the adjusted principal spillway.

An extended detention pond with micropool was chosen because the drainage area to the facility is greater than 10 acres, the existing facility bottom was wet and likely to support a permanent pool, and there appears to have available dry storage capacity that can be reallocated to meeting current regulation to the maximum extent practicable.

Micropool extended detention will be similar to Figure A in Appendix B, with a stable inflow channel instead of an inflow pipe. The pilot channel and micropool will be designed to retain existing mature trees to maximum extent possible.

Design Parameter	**Value**
Drainage Area (Ac)	19.56
Percent Impervious (I)	39.26
Volumetric runoff coefficient (R_v)	0.403
Soil specific recharge factor (S)	0.26
Water quality volume (WQ_v) (ft^3)	28,640.70
Recharge Volume (Re_v) (ft^3)	7,446.58
Pretreatment Volume (25% WQ_v) (ft^3)	7,160.18

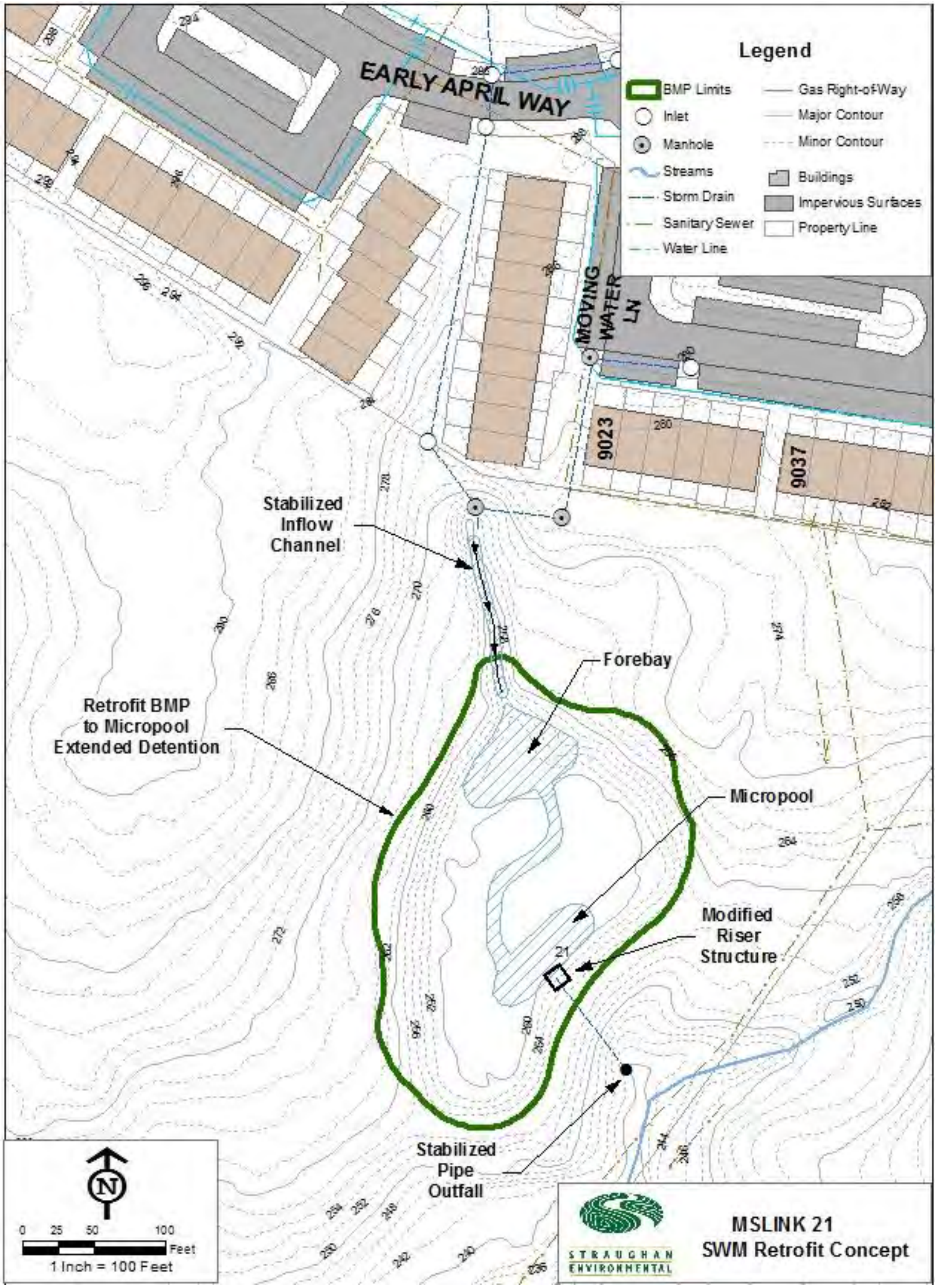


Figure 1. Concept Design Plan View for 9023 Moving Water Lane, SMP-BC-D330

Cost Estimate

Item Description	Quantity/Units		Unit Cost	Subtotal Cost
SITE PREP				
Mobilization/Demobilization	1	LS	$10,000.00	$10,000.00
Erosion and Sediment Control	1	LS	$8,000.00	$8,000.00
EXTENDED DETENTION / MICROPOOLS				
Excavate and Remove (incl. transportation)	1100	cy	$40.00	$44,000.00
Earthwork/Grading	200	cy	$16.00	$3,200.00
Modify Riser	1	ea	$5,000.00	$5,000.00
Channel Stabilization	200	sy	$65.00	$13,000.00
Planting	1	LS	$10,000.00	$10,000.00
TOTAL CONSTRUCTION COSTS				**$93,200.00**
ENGINEERING AND MANAGEMENT				
Engineering / Permitting / Construction Management				$100,000.00
Geotech / Soil Borings				$20,000.00
Contingency (30% of Total Construction)				$27,960.00
TOTAL PROJECT COSTS				**$241,160.00**

Constructability

Design & Construction:

Access: 9023 Moving Water Lane, follow asphalt walkway which crosses the embankment.

Utilities:

Other Impacts:

Existing Condition Photograph

Figure 2. SWM pond at power line R-O-W and 9023 Moving Water Lane, SMP-BC-D330

Calculations

PROJECT:	Howard County Retrofit	DATE:	1/21/2013
LOCATION:	9023 Moving Water Lane	COMPUTED BY:	ANB
DEVELOPER:		CHECKED BY:	EHF

UNIFIED SIZING CRITERIA

COMPUTE WATER QUALITY VOLUME (WQ_v):

$$(WQv) = \frac{[(1.0)(R_v)(A)]}{12}$$

= **0.6575** **acre-feet**

= **28640.70** **cubic-feet**

where:

P = 1" Rainfall Depth (Eastern Zone)

A = Total Site Area (acres)

Rv = Volumetric Runoff Coefficient

= 0.05 + 0.009 (I)

where I is % Impervious Cover

Impervious Cover = **7.68** acres

Total Site Area = **19.56** acres

% Impervious Cover = **39.26%**

therefore, Rv = **0.403**

COMPUTE RECHARGE VOLUME (Re_v):

$$(Rev) = \frac{[(S)(R_v)(A)]}{12}$$

= **0.1710** **acre-feet**

= **7446.58** **cubic-feet**

where:

S = Soil Specific Recharge Factor

A = Total Site Area (acres)

Rv = Volumetric Runoff Coefficient

= 0.05 + 0.009 (I) [as calculated above]

= **0.403**

COMPUTE SOIL RECHARGE FACTOR (S):

Acres	Hydrologic Soil Group	Soil Specific Recharge Factor (S)	A*S
	A	0.38	0.00
19.56	B	0.26	5.09
	C	0.13	0.00
	D	0.07	0.00
19.56		**Computed Average S =**	**0.26**

I. Pollutant Load Reduction Calculations for Individual BMP Projects

Table I-1. Stormwater Management Facility (SWM) conversions proposed for the Middle Patuxent Watershed and potential pollutant load reductions, for individual sites

Site ID	SWM Facility Conversion Type and Priority	IMP DA (acres)	PER-VIOUS DA (acres	Total Nitrogen			Total Phosphorus			Sediment		
				Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)
SMP-BC-F308	02131106,DryPonds to ExtDryPonds,Concept	3.88	8.70	148.5	15%	22.3	10.67	10%	1.07	14,993	50%	7,497
NMP-BC-D113	02131106,DryPonds to ExtDryPonds,Concept	7.69	6.97	192.5	15%	28.9	18.17	10%	1.82	26,337	50%	13,169
SMP-BC-D330	02131106,DryPonds to ExtDryPonds,Concept	8.25	11.31	244.6	15%	36.7	20.62	10%	2.06	29,537	50%	14,768
SMP-BC-F303	02131106,DryPonds to Filter,Concept	3.19	7.77	128.2	35%	44.9	8.95	50%	4.48	12,528	70%	8,769
SMP-BC-F306	02131106,ExtDryPonds to Filter,Concept	1.06	2.82	45.0	20%	9.0	3.04	40%	1.22	4,236	20%	847
NMP-BC-F103	02131106,DryPonds to BioRetUDAB, No Concept	0.10	0.68	8.3	65%	5.4	0.41	65%	0.26	533	70%	373
NMP-BC-F105	02131106,DryPonds to BioRetUDAB, No Concept	0.19	2.33	26.1	65%	17.0	1.07	65%	0.70	1,357	70%	950
SMP-BC-D328	02131106,DryPonds to BioRetUDCD, No Concept	1.03	1.24	28.9	20%	5.8	2.53	35%	0.89	3,642	45%	1,639
NMP-BC-D114	02131106,DryPonds to BioSwale, No Concept	2.46	1.22	51.5	65%	33.5	5.51	65%	3.58	8,080	70%	5,656
SMP-BC-F310	02131106,DryPonds to Filter, No Concept	0.53	0.20	10.5	35%	3.7	1.17	50%	0.59	1,729	70%	1,210
NMP-BC-F101	02131106,DryPonds to Filter, No Concept	0.50	4.20	49.7	35%	17.4	2.27	50%	1.13	2,940	70%	2,058
NMP-BC-F108	02131106,DryPonds to Filter, No Concept	0.97	0.30	18.5	35%	6.5	2.12	50%	1.06	3,134	70%	2,194
NMP-BC-F107	02131106,DryPonds to Filter, No Concept	0.12	0.18	3.7	35%	1.3	0.31	50%	0.15	437	70%	306
NMP-BC-F111	02131106,DryPonds to Filter, No Concept	0.90	3.56	49.8	35%	17.4	2.93	50%	1.47	4,001	70%	2,800
NMP-BC-D115	02131106,DryPonds to Filter, No Concept	13.40	5.56	270.0	35%	94.5	29.74	50%	14.87	43,718	70%	30,603
NMP-BC-F104	02131106,DryPonds to Infiltration, No Concept	0.64	1.79	28.0	75%	21.0	1.86	75%	1.40	2,590	85%	2,202
NMP-BC-F102	02131106,DryPonds to Infiltration, No Concept	0.30	4.47	49.2	75%	36.9	1.94	75%	1.45	2,419	85%	2,056
NMP-BC-D117	02131106,DryPonds to Infiltration,No Concept	3.24	28.65	336.5	75%	252.3	15.17	75%	11.38	19,609	85%	16,667
SMP-BC-D325	02131106,DryPonds to SW to the MEP - SPSC, No Concept	0.65	1.05	20.9	52%	10.9	1.68	56%	0.94	2,393	60%	1,436
SMP-BC-F302	02131106,DryPonds to WetPondWetland, No Concept	1.76	7.06	98.4	15%	14.8	5.76	35%	2.02	7,848	50%	3,924
SMP-BC-F319	02131106,DryPonds to WetPondWetland, No Concept	4.52	8.09	152.8	15%	22.9	11.85	35%	4.15	16,803	50%	8,402
SMP-BC-F311	02131106,DryPonds to WetPondWetland, No Concept	2.00	7.92	110.7	15%	16.6	6.51	35%	2.28	8,867	50%	4,433
SMP-BC-F312	02131106,DryPonds to WetPondWetland, No Concept	7.51	24.16	360.3	15%	54.0	22.82	35%	7.99	31,470	50%	15,735
SMP-BC-F307	02131106,DryPonds to WetPondWetland, No Concept	20.46	39.95	724.5	15%	108.7	54.59	35%	19.11	77,155	50%	38,577
NMP-BC-F110	02131106,DryPonds to WetPondWetland, No Concept	2.13	12.70	160.2	15%	24.0	8.17	35%	2.86	10,850	50%	5,425
NMP-BC-F106	02131106,DryPonds to WetPondWetland, No Concept	2.78	1.53	59.7	15%	9.0	6.28	35%	2.20	9,196	50%	4,598
NMP-BC-D118	02131106,DryPonds to WetPondWetland, No Concept	5.26	2.38	108.0	15%	16.2	11.74	35%	4.11	17,236	50%	8,618
SMP-BC-D324	02131106,DryPonds to WetPondWetland, No Concept	8.46	25.82	391.9	15%	58.8	25.28	35%	8.85	34,972	50%	17,486
SMP-BC-D327	02131106,DryPonds to WetPondWetland, No Concept	3.42	6.24	116.8	15%	17.5	9.01	35%	3.15	12,765	50%	6,382
SMP-BC-D329	02131106,ExtDryPonds to Filter, No Concept	5.11	5.77	139.3	20%	27.9	12.42	40%	4.97	17,896	20%	3,579
SMP-BC-F318	02131106,ExtDryPonds to WetPondWetland, No Concept	0.98	2.71	42.6	0%	0.0	2.85	25%	0.71	3,963	0%	0
SMP-BC-F320	02131106,ExtDryPonds to WetPondWetland, No Concept	5.02	8.92	168.9	0%	0.0	13.13	25%	3.28	18,627	0%	0
NMP-BC-F109	02131106,ExtDryPonds to WetPondWetland, No Concept	13.10	4.36	253.4	0%	0.0	28.77	25%	7.19	42,410	0%	0
TOTAL		132	251	4,598		1,036	349		123.4	494,270		232,360

Table I-2. Proposed Stormwater Management (SWM) facilities for the Middle Patuxent Watershed showing potential pollutant load reduction for individual sites

Site ID	SWM Facility Type	Impervious DA (acres)	Pervious DA (acres	Total Nitrogen			Total Phosphorus			Sediment		
				Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)	Load from DA (lbs/yr)	RE	Max Potential Load Reduction (lbs/yr)
SMP-NB-F301A	Bioretention,B	0.60	0.06	10.2	70%	7.16	1.44	75%	1.08	2,075	80%	1,660
SMP-NB-F301C	Bioretention,B	0.82	0.15	14.6	70%	10.25	1.96	75%	1.47	2,839	80%	2,271
SMP-NB-F301B	Bioretention,B	0.42	0.02	7.0	70%	4.88	1.01	75%	0.76	1,465	80%	1,172
SMP-NB-F302C	Bioretention,B	0.17	0.17	4.5	70%	3.16	0.42	75%	0.31	602	80%	481
SMP-NB-F302A	Bioretention,B	0.34	0.25	8.0	70%	5.60	0.82	75%	0.61	1,180	80%	944
SMP-NB-F328B	Bioretention,B	0.27	0.85	12.8	70%	8.95	0.65	75%	0.48	934	80%	747
SMP-NB-F306E	Bioretention,D	0.40	0.01	6.5	25%	1.62	0.95	45%	0.43	1,372	55%	755
SMP-NB-F329C	Bioretention,D	0.39	0.01	6.3	25%	1.59	0.93	45%	0.42	1,344	55%	739
SMP-NB-F329B	Bioretention,D	0.27	0.01	4.5	25%	1.12	0.65	45%	0.29	943	55%	519
SMP-NB-F329A	Bioretention,D	0.11	0.02	1.9	25%	0.47	0.26	45%	0.11	369	55%	203
SMP-NB-F329E	Bioretention,D	0.20	0.04	3.6	25%	0.89	0.47	45%	0.21	683	55%	376
SMP-NB-F327A	Swale	2.22	1.47	50.2	70%	35.14	5.31	75%	3.98	7,677	80%	6,142
SMP-NB-F306B	Swale	0.25	0.03	4.3	70%	3.01	0.59	75%	0.44	851	80%	681
SMP-NB-F328A	Swale	2.56	1.01	51.1	70%	35.78	6.12	75%	4.59	8,856	80%	7,085
SMP-NB-F306A	Filtering Practice other than Bioretention	0.53	0.00	8.6	40%	3.43	1.27	60%	0.76	1,840	80%	1,472
SMP-NB-F329F	Filtering Practice other than Bioretention	0.26	0.00	4.2	40%	1.70	0.63	60%	0.38	914	80%	732
SMP-NB-F320	Filtering Practice other than Bioretention	1.55	0.69	31.7	40%	12.68	3.70	60%	2.22	5,355	80%	4,284
SMP-NB-F302B	Filtering Practice other than Bioretention	0.16	0.26	5.2	40%	2.09	0.39	60%	0.24	570	80%	456
SMP-NB-F329D	Filtering Practice other than Bioretention	0.31	0.07	5.5	40%	2.22	0.73	60%	0.44	1,056	80%	845
SMP-NB-F303	Filtering Practice other than Bioretention	2.50	0.05	40.6	40%	16.22	5.97	60%	3.58	8,636	80%	6,909
SMP-NB-F305C	Filtering Practice other than Bioretention	1.04	1.42	30.7	40%	12.28	2.48	60%	1.49	3,590	80%	2,872
SMP-NB-F305A	Filtering Practice other than Bioretention	0.08	1.32	14.4	40%	5.74	0.19	60%	0.11	277	80%	221
SMP-NB-F305B	Filtering Practice other than Bioretention	4.54	1.64	89.1	40%	35.63	10.86	60%	6.51	15,701	80%	12,560
SMP-NB-F304A	Filtering Practice other than Bioretention	1.59	2.36	48.9	40%	19.56	3.79	60%	2.28	5,488	80%	4,390
SMP-NB-F304B	Filtering Practice other than Bioretention	0.67	1.54	26.0	40%	10.42	1.60	60%	0.96	2,316	80%	1,853
SMP-NB-F306D	Tree Box Filter	0.01	0.00	0.2	40%	0.07	0.02	60%	0.01	34	80%	27
NMP-NB-F103a	Filtering Practice other than Bioretention	0.34	0.55	10.8	40%	4.32	0.80	60%	0.48	1,162	80%	929
NMP-NB-F103b	Filtering Practice other than Bioretention	0.20	0.36	6.8	40%	2.72	0.48	60%	0.29	700	80%	560
NMP-NB-F106a	Filtering Practice other than Bioretention	1.93	0.22	33.1	40%	13.23	4.60	0.6	2.76	6,658	0.8	5,326
NMP-NB-F106b	Tree Box Filter	0.11	0.00	1.8	40%	0.71	0.26	0.6	0.16	382	0.8	305
SMP-NB-F306F	Impervious Pavement Replacement	0.03	0.02	0.6	10%	0.06	0.06	20%	0.01	87	55%	48
NMP-NB-F103c	Wet Pond	1.31	16.87	188.5	20%	37.69	3.13	45%	1.41	4,532	60%	2,719
NMP-NB-F104	Wet Pond	0.43	4.81	54.6	20%	10.91	1.02	45%	0.46	1,478	60%	887
	TOTAL	27	36	787		311	64		40	91965		71170