Upper Little Patuxent River Watershed Management Plan

September 2009

Howard County MARYLAND

KCI TECHNOLOGIES

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Howard County, Maryland
September 2009

Prepared for:

Howard County
Department of Public Works
Bureau of Environmental Services
Stormwater Management Division
NPDES Watershed Management Programs
6751 Columbia Gateway Drive
Columbia, Maryland 21046

Prepared by:

KCI Technologies, Inc.
936 Ridgebrook Road
Sparks, Maryland 21152

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US Army Corps of Engineers, Baltimore District

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Executive Summary

As part of Howard County's watershed management and restoration efforts the Upper Little Patuxent River Watershed Management Plan was initiated. The major goal of the plan is to implement watershed restoration efforts in a watershed or combination of watersheds to treat 10 percent of the County's impervious area.

Under the County's previous NPDES permit term (June 2000 to June 2005) the County completed the Howard County Watershed Prioritization (Howard DPW, 2004). The prioritization ranked all 62 of the County's subwatersheds and identified the highest priority subwatersheds for management planning efforts. The results selected watersheds draining to Centennial Lakes and Wilde Lakes as the preferred choices, with Plumtree Branch, the Font Hill Tributary, and portions of the Little Patuxent included as secondary choices.

Following recommendations in the prioritization, the Centennial and Wilde Lake Watershed Restoration Plan (CWP, 2005) was developed to define the issues affecting the watersheds and to prioritize solutions for watershed restoration. Under the current permit term (June 2005 to June 2010), the County has initiated watershed planning in the Upper Little Patuxent to address an additional 10 percent of the County's impervious area as required by the permit. The study area includes 5 of the County's 62 subwatersheds, 4 of which were included in the final list of highest ranking subwatersheds (Howard DPW, 2004). The planning effort has been divided into two phases. Phase 1, which was completed in 2007, represents the initial work of the watershed plan, involving compilation and review of existing data, GIS analysis, identification of gaps in the data, and a recommendation for additional monitoring or assessment needed to complete the plan. A Phase 1 Data Summary Technical Memorandum dated November 26, 2007 summarized the results.

Phase 2 was initiated in January of 2008 and has included more in depth analysis, field survey and development of specific recommendations and implementation strategies. Assessment began with a Stream Corridor Assessment (SCA) conducted for the County by the Army Corps of Engineers across the 44 miles of channel in the watershed. Land use and impervious analysis, pollutant loading estimates and an evaluation of land ownership followed and the resulting data characterized the watershed and subwatersheds and prioritized areas and sites for additional field investigation. Field visits were conducted to identify candidate sites for restoration. Major treatment practices include reforestation, bioretention, stream restoration/outfall stabilization, pond retrofits and new ponds or shallow marshes. The resulting list of sites was ranked based on the benefits (improvements in water quality, aquatic habitat, etc.) and constraints (property ownership, safety, access, etc.) of each site. The top ranked sites were moved forward with the completion of detailed concept plans and cost estimates.

An initial public meeting to introduce the study and initial findings was held in June of 2008. A follow up meeting in March of 2009 presented the results and potential projects. The County is providing materials related to the watershed study on the County website http://www.co.ho.md.us/DPW/wras.htm.

This report includes the methods and results of the study and an implementation plan.

1 Introduction

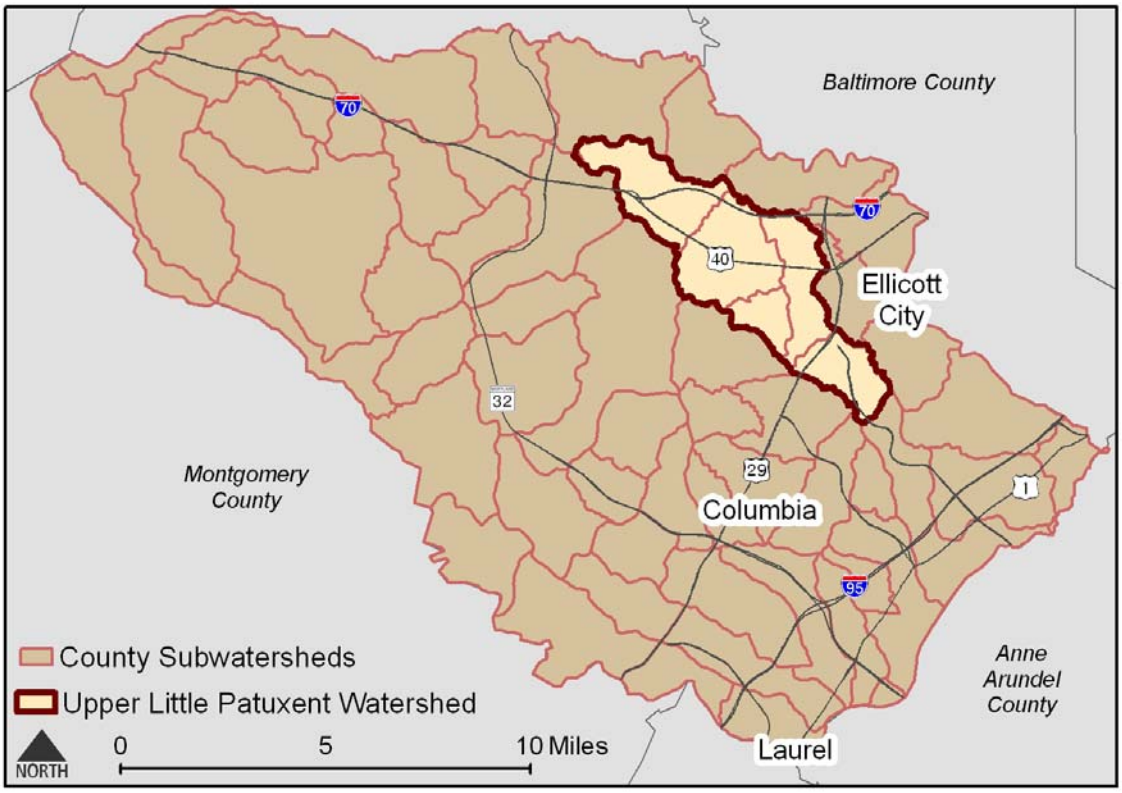
1.1 Background, Goals and Process

Background

As part of its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, Howard County is required to implement watershed restoration efforts in a watershed or combination of watersheds to restore 10 percent of the County's impervious area. Under the County's previous NPDES permit term (June 2000 to June 2005) a countywide watershed prioritization was completed which identified portions of the Little Patuxent River Watershed as a potential area for focused watershed planning efforts. Four of the five Upper Little Patuxent River (ULPR) subwatersheds (Font Hill Tributary, Plumtree Branch, Little Patuxent below Font Hill Tributary and the Little Patuxent Headwaters) were included in the final list of the top 19 (out of 62) highest ranking subwatersheds in the Howard County Watershed Prioritization (Howard County, 2004) (see Figure 1).

In addition, County bioassessment results have consistently rated the watershed as impaired with average ratings of Poor and Very Poor. Segments within the watershed have been listed on

Figure 1: Howard County Subwatersheds



Maryland's Integrated Report of Surface Water Quality (303(d) list) for biological impairment, cadmium, nutrients and sediment.

Based on the prioritization, level of impairment, location in the headwaters of the Little Patuxent and the opportunity to coordinate with the Columbia Association's watershed planning efforts, the County initiated watershed planning under the current permit term (June 2005 to June 2010) for the ULPR in the form of this Watershed Management Plan (WMP).

Goals

The overall goals of the WMP are to restore, enhance and protect the Upper Little Patuxent River Watershed's natural resources. More specifically to:

- Reduce the negative impact of impervious surfaces,
- Reduce the levels of pollutants in the waterways,
- Reduce streambank erosion,
- Increase forest area and connectivity of riparian habitats,
- Increase public awareness of their personal effect on water quality and positive behaviors to reduce those effects, and
- Protect private property.

Howard County has a total area of 162,037.3 acres. Using County GIS planimetric data, which provides a detailed outline of impervious surfaces in the County, including roadways, rooftops, parking lots and sidewalks, the County's impervious acres total 18,330.5, or 11.3% of the land surface. These values include all public and private properties and include areas owned and maintained by Maryland State Highway Administration. After factoring in the amount of MSHA impervious area (2,114.7 acres) and the areas already treated by MSHA and County stormwater best management practices (BMPs), which combine to total 8,668.5 acres, the total untreated impervious area is 9,662.1 acres. Therefore the County's permit goal is to develop plans to treat 10 percent of 9,662.1 acres, or 966.2 acres.

Within the ULPR watershed there are 1,810 total acres of impervious area. Of that, 1,139 acres are untreated (through either County or State Highway BMPs). Projects and measures presented in this Watershed Management Plan will play a part in satisfying the County's permit condition requiring 10 percent impervious treatment. Other County activities will need to make up the remaining difference.

In addition to these goals the implementation of recommended projects will serve to make progress towards meeting possible future Total Maximum Daily Loads (TMDLs). Broad goals such as the Chesapeake 2000 Agreement and the recent Federal Government and Environmental Protection Agency initiatives to have strategies in place to restore the Chesapeake Bay by 2025 will also be served by the implementation of this WMP.

Process

The planning effort has been divided into two phases. Phase 1, which was completed in 2007, represents the initial work of the watershed plan, involving compilation and review of existing data, GIS analysis, identification of gaps in the data, and a recommendation for additional monitoring or assessment needed to complete the plan. A Phase 1 Data Summary Technical Memorandum dated November 26, 2007 summarized the results.

Phase 2 was initiated in January of 2008. It included an in depth watershed analysis, field survey, and development of specific recommendations and implementation strategies. Assessment began with a Stream Corridor Assessment (SCA) conducted for the County by the Army Corps of Engineers across the 44 miles of channel in the watershed.

Land use and impervious analysis, pollutant loading estimates and an evaluation of land ownership followed and the resulting data was used to characterize the watershed and subwatersheds and prioritized areas and sites for additional field investigation. Field visits were conducted to identify candidate sites for restoration. Major treatment practices include reforestation, bioretention, stream restoration/outfall stabilization, pond retrofits and new ponds or shallow marshes. The resulting list of sites was ranked based on the benefits (improvements in water quality, aquatic habitat, etc.) and constraints (property ownership, safety, access, etc.) of each site. The top ranked sites were moved forward with the completion of detailed concept plans and cost estimates.

Community Involvement

Community input is an important part of the WMP process and a key element of a successful watershed management plan. During the development of the WMP, public meetings, websites and site visits to individual homeowners were the primary means of distributing information to the public and receiving their comments and suggestions.

Public meetings are a primary method of communicating information to the public and soliciting input from citizens who may be affected by decisions made as a result of the final watershed plan. The first of two public meetings was held on June 3, 2008. The focus of the meeting was on defining the WMP process, providing an overview of the watershed conditions and soliciting feedback and known problem areas from the group. The goals of the second meeting, which was held on March 24, 2009, were to present the results of the study and provide details on the selected projects and concept plans. Feedback was solicited at both meetings.

The County website was updated regularly, and specifically at the time of each public meeting with information about the plan. Copies of the presentation, maps, reports, and concept plans were all posted on the website. http://www.co.ho.md.us/DPW/wras.htm

Throughout the development of the WMP and particularly following the first public meeting, County staff made site visits to individual properties to review the site conditions and determine what action should be taken.

More details on community involvement are included in Sections 3.5 and 4.4 of this report.

1.2 Upper Little Patuxent Watershed Background

The Upper Little Patuxent River Watershed lies entirely in the Piedmont Physiographic Province. The northern half of the Watershed is crossed by Interstate 70, US Route 40 and Maryland State Route 144. The southern portion is bisected by US Route 29 and Maryland Route 100 (see Figure 2). The Howard County Alpha Ridge Landfill (which is the only MDE-permitted point source discharge in the watershed) and Turf Valley Country Club are in the most upstream portion of the Watershed. The downstream end of the Watershed is just northeast, and upstream, of the most densely developed residential and commercial areas in Columbia. The watershed lies within the County's planned water and sewer service area. The exception to this is the Carroll Farm property in the Font Hill Trib 2 subwatershed, for which there is no planned service.

In the total study area (approx. 11,000 acres) there are approximately 2,500 acres (22.6 percent) of forest with 208 acres (0.02 percent) in forest conservation easements. Additionally, there are 125 acres (0.01 percent) in preservation easements. The watershed has just over 1,300 acres (12 percent) of parks and open space, which includes forests.

The approximately 44 miles of stream within the Watershed are designated by the Maryland Department of the Environment (MDE) in the Code of Maryland Regulations (COMAR) as use I-P, for water contact recreation, protection of aquatic life and public water supply. There are several stream segments within the ULPR Watershed that do not support their designated use and are listed as "impaired" on the Maryland 303(d) list of impaired waters (MDE, 2006). Seven reaches are listed as impaired based on biological sampling conducted by the Maryland Biological Stream Survey (MBSS), Maryland Department of Natural Resources (DNR). Five of these areas are on the mainstem of the Little Patuxent River and two are on Plumtree Branch, a tributary to the Little Patuxent. The Little Patuxent River in Howard and Anne Arundel Counties was listed in 1996 as Category 5 (impaired) for cadmium, nutrients and sediment as non-point, natural sources. The listing was later dropped to Category 2 due to a lack of evidence of cadmium impairment. Additionally, recent study by Maryland Department of Environment (MDE, 2009) examining causes of biological impairment did not identify nutrients as a direct stressor to biological communities, but rather point to total suspended solids as an impairing substance. This data will be presented as evidence to support a revision from Category 5 to Category 2 for nutrients when MDE proposes revisions to the Integrated Report.

1.3 Previous Studies

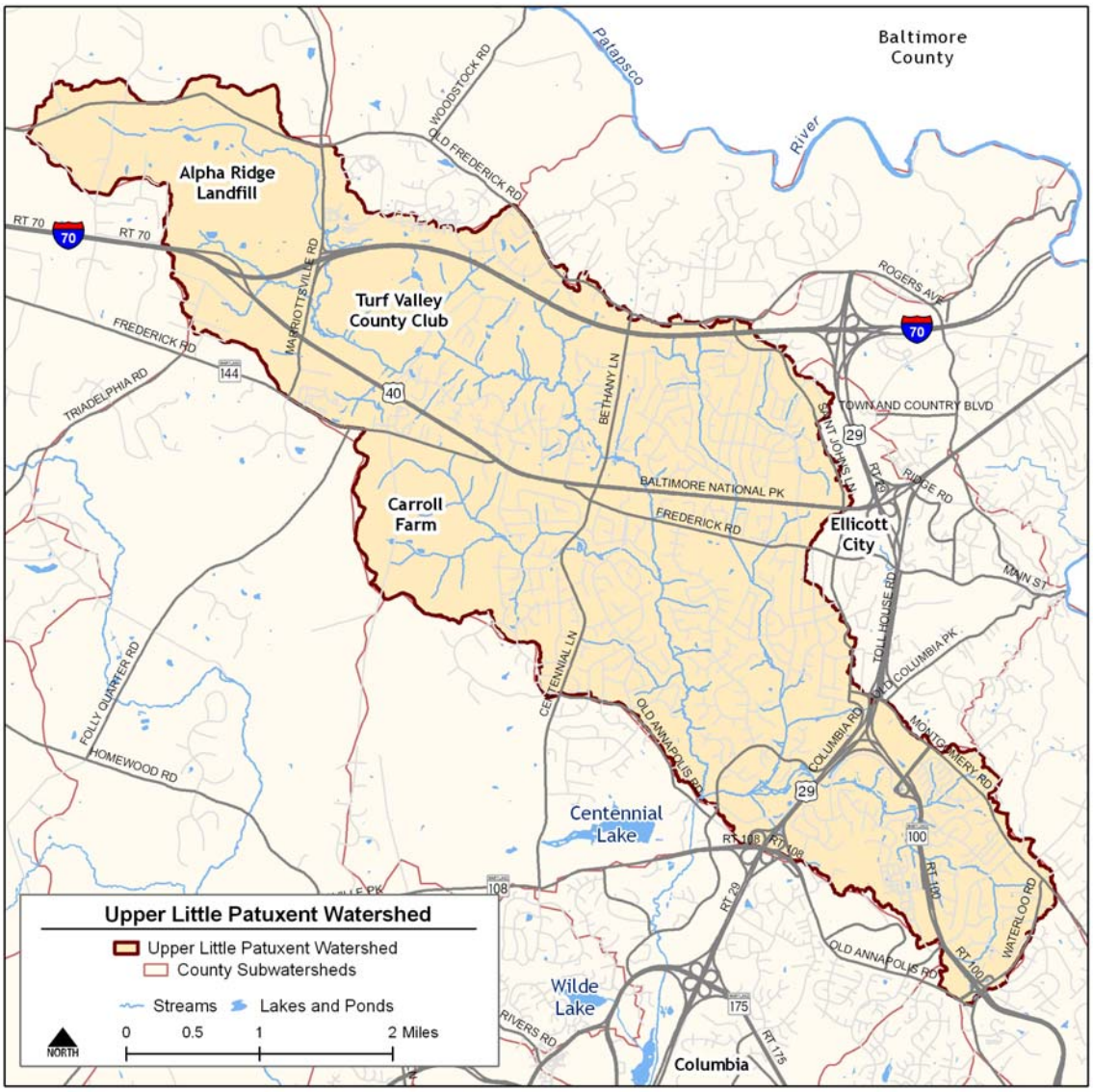
In 1998 the Maryland Clean Water Action Plan identified the Little Patuxent as a priority watershed in need of restoration. This designation prompted the Watershed Restoration Action Strategy (WRAS). The County was one of five counties participating in the first round of the WRAS program. The following section discusses the results of the Little Patuxent WRAS and information collected for the WRAS as well as ongoing monitoring by the County and volunteer organizations that occurs throughout Howard County.

Watershed Restoration Action Strategy (WRAS) 2002

The WRAS program is part of the Clean Water Action Plan, a federal initiative that guides states in protecting water resources. The DNR partners with local governments by providing technical and financial assistance in completing the WRAS. The local government is responsible for leading the process, garnering public interest and involvement and implementing any management objectives that are a product of the WRAS process. A WRAS generally defines the goals and objectives for water quality, habitat and public outreach in the watershed of interest and includes a watershed restoration plan and implementation strategy.

The WRAS was completed in 2002 for the Little Patuxent Watershed. It established goals for water quality, habitat and public outreach to be achieved by implementing 10 restoration tools and related actions. These tools include land conservation, establishing and protecting riparian

Figure 2: Upper Little Patuxent Watershed



buffers, better site design techniques, erosion and sediment control at construction sites, stormwater BMPs, management of other discharges (outfalls and septics), stream channel stabilization and restoration, habitat and wildlife management, watershed stewardship programs and subwatershed studies (Howard County 2002).

In the development of the Little Patuxent WRAS, DNR provided a stream corridor assessment, a watershed characterization report and a stream synoptic survey. The results of these DNR services and other individual portions of the WRAS are outlined below.

Stream Corridor Assessment (1999): The stream corridor assessment was conducted in 1999 by the Maryland Conservation Corps. The assessment identified 1,098 problem riparian conditions including: inadequate buffers, eroding banks, fish blockages, channelization, pipe outfalls, trash, exposed pipes and unusual conditions. Of these, the WRAS identified 157 priority problem sites from this collected data. Forty-nine of these points lie within the ULPR Watershed.

Little Patuxent River Watershed Characterization (2001): In July 2002, the Maryland Department of Natural Resources completed the characterization of the Little Patuxent Watershed. The study found that water quality issues were mostly of local origin requiring local action. Although there was no quantitative estimate of non-point source loads, the report suggests significant nonpoint source nutrient loads based on the nutrient summary, 303(d) listing and eutrophication issues in the lakes around Columbia.

Significant stressors to aquatic resources in the watershed at the time of assessment included manipulation of habitat, excessive movement of sediment through streams and excessive nutrients. The characterization scored the watershed based on landscape and living resource indicators. The Little Patuxent Watershed (as a whole, not specifically the ULPR) failed on the following landscape indicators: impervious surface, population density, unforested stream buffer and soil erodibility. It also failed on the following living resource indicators: Nontidal Benthic Index of Biotic Integrity (B-IBI), Nontidal Fish Index of Biotic Integrity (F-IBI) and Nontidal In-stream Habitat Index.

A forest assessment conducted by the County as part of the characterization found limited diversity with forests being even-aged and of similar composition – primarily 75 – 100 year old bottomland hardwoods (poplars, oaks and maples) with limited understory. Deer browsing, invasive species and human impacts were thought to be the most important factors affecting forest health. Without intervention to control these impacts, forest sustainability is believed to be limited.

Synoptic Survey: The synoptic survey for the Little Patuxent was incorporated into the 2001 biological assessment (Tetra Tech, 2001). In situ water quality parameters (dissolved oxygen, pH, temperature, turbidity and conductivity) were collected at each of 30 benthic macroinvertebrate collection sites. Water chemistry grabs were collected between March 13 and March 26, 2001. The results of the grab samples are included in the biological assessment report (Tetra Tech, 2001).

Impervious Cover Assessment (2001)

An in-depth land-use based impervious cover assessment was conducted by Howard County as part of the WRAS and also for the Howard County Watershed Prioritization Report (Howard County, 2004). Refer to Figure 3 for subwatershed locations. The following are the findings as presented in the WRAS in 2002:

- The assessment used impervious area coverage as an indicator of expected water quality and habitat health. Each subwatershed was grouped according to the following 3 categories based on imperviousness: sensitive (<10% impervious), impacted (10 – 25% impervious), and non-supporting (>25% impervious).

- The Little Patuxent Headwaters (which approximately corresponds to Little Patuxent 4 and 5 and the upstream half of Little Patuxent 3 under the delineation for the current study, see Figure 3 pg. 16) was 11.2% impervious (existing). Future impervious at the time of the study was expected to be 22.6%. This level of impervious placed the area in the "impacted" category under both existing and future scenarios. This area is expected to experience the largest increase in impervious area in the entire Little Patuxent River Watershed.

- Font Hill Branch (which approximately corresponds to Font Hill Tributaries 1&2, Little Patuxent 2, and the downstream half of Little Patuxent 3 under the delineation for the current study, see Figure 3 pg. 16) was 19.0% existing impervious and 21.5% expected future impervious. This places the area in the "impacted" for both existing and future scenarios.

- Plumtree Branch (which corresponds to Plumtree Branch 1&2 under the delineation for the current study, see Figure 3 pg. 16) was 28.5% existing impervious and 29.2% expected future impervious. This places the area in the "non-supporting" category for both existing and future scenarios.

- Little Patuxent below Font Hill (which approximately corresponds to the Little Patuxent 1 under the delineation for the current study, see Figure 3 pg. 16) was 25.4% existing impervious and 25.1% expected future impervious. This places the area in the "non-supporting" category for both existing and future scenarios.

Watershed Prioritization (2004)

The Howard County Watershed Prioritization Report (2004) divided the County into 62 subwatersheds. A land use and impervious analysis was completed for the entire County based on Maryland Department of Planning 1997 land uses and average imperviousness estimated from sampled parcels within Howard County. The average subwatershed imperviousness combined with other factors was used to categorize and rank subwatersheds in order to select those most optimal for restoration activities. Two subwatersheds in the ULPR Watershed, Font Hill Tributary and Plumtree Branch, were considered to have medium or high interest for inclusion in the top ten priority watersheds in the County. An additional two, the Little Patuxent

below Font Hill Tributary and the Little Patuxent Headwaters, were listed in the top 19 highest-ranking watersheds, but were considered to have low interest for inclusion in the final list.

MBSS

The Maryland Biological Stream Survey (MBSS) is conducted by Maryland Department of Natural Resources and was developed to provide an overall picture of stream and watershed health across the state of Maryland using physical habitat assessments and sampling of aquatic communities (fish and macroinvertebrates). Each of the 18 drainage basins in the state is sampled on a three year rotating basis. The Little Patuxent was sampled in 1997 and 2000 for Rounds 1 and 2 of the survey, respectively. It is scheduled to be sampled under Round 3 in 2009.

> *First Round – 1997*: There were three sites within the ULPR Watershed sampled by MBSS during the first round of sampling in 1997. Two of these were in the Plumtree Branch subwatershed and one was along the mainstem of the Little Patuxent approximately 0.5 miles upstream of its confluence with Plumtree Branch. All three sites scored in the poor range for benthic macroinvertebrate sampling and in the fair to good range for fish sampling (with one site lacking a score for fish).
>
> *Second Round – 2000*: Four sites were sampled by MBSS in 2000 under the second round of sampling. All four sites were along the mainstem of the Little Patuxent River. The most downstream of these is located just below the confluence of the Little Patuxent River with Plumtree Branch. These four sites ranged from fair to good for the benthic macroinvertebrate community, with the most upstream site, located just upstream of the Howard County Landfill, receiving the highest score. The scores for the fish sampling also ranged from poor to good, with the highest score received at the most downstream site.

Streamwaders

Streamwaders, a volunteer program sponsored by the Department of Natural Resources, began in February 2000. Under this program, benthic macroinvertebrate samples are collected by citizen volunteers to supplement data collected by DNR. Data is then analyzed by DNR in a process similar to that used for MBSS.

There were 13 valid sites sampled in 2000 by Streamwaders (the mapping coordinates for an additional site were incorrect and not mappable). Scores for these sites ranged from 1.29 (very poor) to 4.43 (good). Six of the Streamwader sites were in the Font Hill subwatershed. Five were along the mainstem of the Little Patuxent and two were on Plumtree Branch. There were no sites located in the headwaters of the Little Patuxent.

Howard County – Countywide Bioassessment

The Countywide Biological Monitoring and Assessment Program involves monitoring the biological health of the County's 15 watersheds on a rotating basis (Pavlik et al, 2001). This monitoring consists of the collection of benthic macroinvertebrates using MBSS methods (Southerland et al, 2005), instream water quality data collection, cross-section analysis, particle

size distribution, and a physical habitat assessment using the United States Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (RBP) (Barbour et al, 1999).

County Bioassessment – 2001: Howard County first sampled the ULPR in 2001 under the first round of the countywide sampling program. Sampling was conducted at eleven randomly selected sites within the ULPR Watershed. In 2001, the overall watershed was rated as poor for benthic macroinvertebrates and non-supporting for physical habitat.

A fish survey was also conducted as part of this bioassessment. The survey sampled fish at 11 sites. The number of species at each site ranged from 3 to 18 with an average of 10 species per site. The most abundant species found was the pollution-tolerant blacknose dace.

County Bioassessment – 2006: The ULPR was again sampled in 2006 by the County as part of the second round of the countywide monitoring program. Results of this sampling indicate an average benthic macroinvertebrate rating in the very poor range, a decrease from the 2001 results. The overall average RBP habitat assessment score was in the partially supporting range for the ten sites sampled in the Watershed.

Stream Team (Volunteer Monitoring)

This volunteer program is managed by the Howard County Department of Recreation and Parks (HCDRP). Available data was compiled for sampling occurring between 1992 and 2005. For this program, citizen volunteers conduct benthic macroinvertebrate sampling at sites selected by the County. Samples are generally collected monthly from April through October although sampling may occur at any time throughout the year. There are six sites within the ULPR subwatershed with quality ranging from fair to excellent.

Font Hill Monitoring

As part of the County's NPDES MS4 permit, the County conducted extensive monitoring at an unnamed tributary to the Little Patuxent River referred to as Font Hill Tributary. This monitoring occurred from 1996 to 2005. From 1996 to 2000 monitoring consisted of a physical stream assessment including cross-sectional surveys, habitat and biological assessment and in situ water quality measurements. Between 2001 and 2005 monitoring efforts increased with the addition of longitudinal profiles, hydrology & hydraulics analyses, and Rosgen characterization. Biological monitoring and habitat assessments continued as did in situ water quality measurements. Additional water quality/quantity parameters were also added: continuous flow measurements, storm sampling, and pollutant loading calculations. Overall, results of the monitoring indicate an unstable stream system with moderately disturbed biological community and physical habitat. Measured regulated water quality parameters were within acceptable COMAR limits. Chemical monitoring and pollutant load estimates for the Font Hill Tributary were considered lower than the average found for its land use in other areas of Maryland.

Illicit Discharge Sampling

Howard County also conducts illicit discharge sampling yearly at 100 outfalls as a requirement for their NPDES MS4 discharge permit. The field sampling has been conducted by KCI since 2002 and all data is readily available for inclusion in other phases of the study. Data for sampling conducted prior to 2002 was not available.

> *Illicit Discharge Sampling Results 2002 – 2008:* Between 2002 and 2006, there were 50 outfalls within the ULPR Watershed that were inspected for illicit discharge. Of these, 25 were flowing at the time of inspection. Phenols were not found at any tested site. Chlorine was found at six sites: two in Font Hill Trib 1, one in Plumtree Branch 2 that was found positive 2 years in a row (flowing into a stormwater management pond behind Target and Unos), and 1 in Red Hill Branch. Detergents were found at 4 sites: two sites in Plumtree Branch 2 (1 tested positive 2 years in a row), one site in Plumtree Branch 1 and one site in Little Patuxent 1. Copper was found at one site in Red Hill Branch which is also listed above as testing positive for chlorine. All of these sites are in the downstream half of the watershed. During 2007 one outfall within the ULPR Watershed was inspected for illicit discharge, but it was not flowing. In 2008, 54 outfalls were inspected for illicit discharge. Fewer than half of those outfalls were flowing at the time of inspection and none of the parameters tested fell outside of the acceptable range.

2 Current Watershed Conditions

2.1 Study Area Overview – Delineation

Under Phase 1 of the project, KCI reviewed GIS data provided by the County to identify appropriate subwatersheds for the modeling and data analysis presented here. The study area includes 5 of the original 62 County subwatersheds used in the prioritization. The study area was then divided into 10 smaller subwatersheds. This subdivision allowed for finer analysis and modeling of conditions and recommendations. The confluence of Plumtree Branch and the Little Patuxent River was selected as the most downstream point in the study area.

The starting point for the subwatersheds was the layer developed in the previous Countywide prioritization work. It included the USGS 14-digit HUC. Because the drainage area delineations in these layers are fairly coarse they were re-delineated at a finer scale. Both the outermost study area boundary and the delineation of individual subwatersheds were updated.

The delineation was conducted manually at 1:3000 scale using 2004 topography, 2006 orthophotography and the county GIS storm drain layer. The storm drains are essential for accurate delineation in developed areas where runoff may not follow the contours of the land due to impervious surfaces and the related infrastructure.

Subwatersheds were delineated in an effort to follow the 14-digit HUCs, have consistent areas and stream lengths, and have generally homogeneous landuse within each area. Areas of specific interest that were not divided between subwatersheds were Carroll Farm and the Turf Valley Country Club. It was not possible to contain the Alpha Ridge Landfill within a single subwatershed, however, the active and inactive cells of the landfill are almost entirely contained within the Little Patuxent 5 subwatershed. The Little Patuxent 4 subwatershed contains buildings and ponds associated with the landfill.

The results of the delineation and subdivision are a 17.29 square mile study area, with 10 subwatersheds averaging 1.73 square miles and ranging from 0.93 to 2.74 square miles. There are a total of 44.21 miles of stream in the study area. Five subwatersheds are along the mainstem of the Little Patuxent River, two on the Font Hill Tributary, two on Plumtree Branch and one on Red Hill Branch. The results of the delineation are provided in Figure 3 and Table 1.

Figure 3: Upper Little Patuxent Subwatersheds

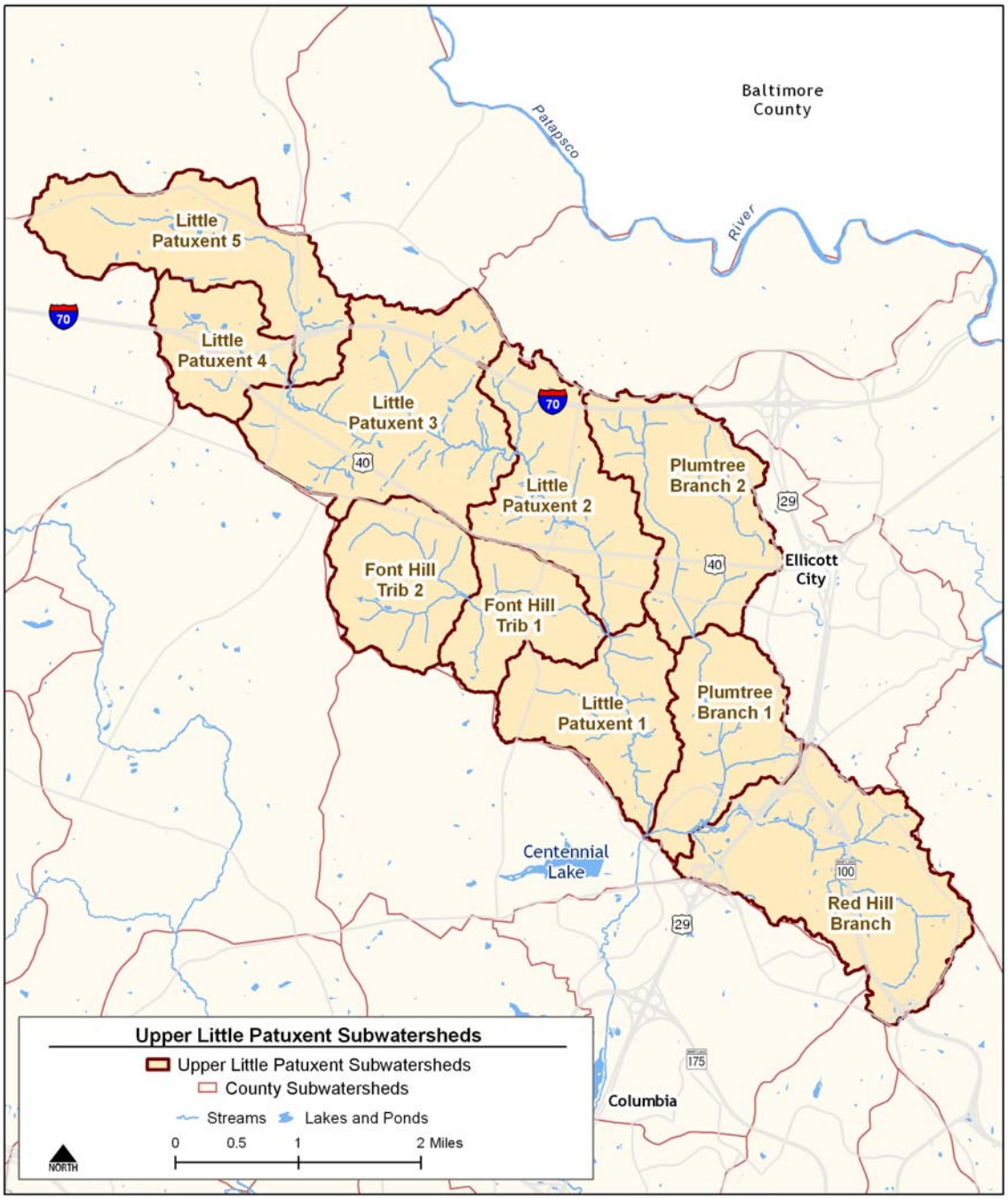


Table 1: Subwatershed Delineation Results

Subwatershed Name	Area (acres)	Area (square miles)	Length of Stream (miles)	Prioritization Name	Prioritization Code	MDNR 12-digit*
Font Hill Trib 1	640.05	1.00	2.58	Font Hill Trib	6010060B	0957
Font Hill Trib 2	839.37	1.31	4.87	Font Hill Trib	6010060B	0957
Little Patuxent 1	934.67	1.46	2.68	Little Pax below Font Hill Trib	6010060C	0957
Little Patuxent 2	1,174.45	1.84	3.73	Font Hill Trib	6010060B	0957
Little Patuxent 3	1,753.77	2.74	7.71	Little Patuxent Headwaters / Font Hill Trib	6010060A / 6010060B	0957
Little Patuxent 4	597.67	0.93	2.03	Little Patuxent Headwaters	6010060A	0957
Little Patuxent 5	1,293.73	2.02	3.94	Little Patuxent Headwaters	6010060A	0957
Plumtree Branch 1	865.72	1.35	3.46	Plumtree Branch	6010061A	0956
Plumtree Branch 2	1,245.09	1.95	6.03	Plumtree Branch	6010061A	0956
Red Hill Branch	1,718.13	2.68	7.18	Red Hill Branch	6010061B	0956
Total	11,062.6	17.29	44.21			

*Note: Only the four digit code is shown, the preceding 8-digit code is 02131105

2.2 Land Use Analysis

For the land use analysis, the Maryland Department of Planning (MDP) 2007 (Draft) land use was used. Results of the land use analysis including the estimated imperviousness by land use are presented in Table 2 and Figure 4. Direct comparison between the land use results for subwatersheds in the prioritization report using 1997 MDP data and the subwatersheds of the current study using 2007 data is not possible because the subwatersheds were redrawn for this study and therefore do not entirely match. For the current study, imperviousness was derived from planimetric data and is discussed in the following section.

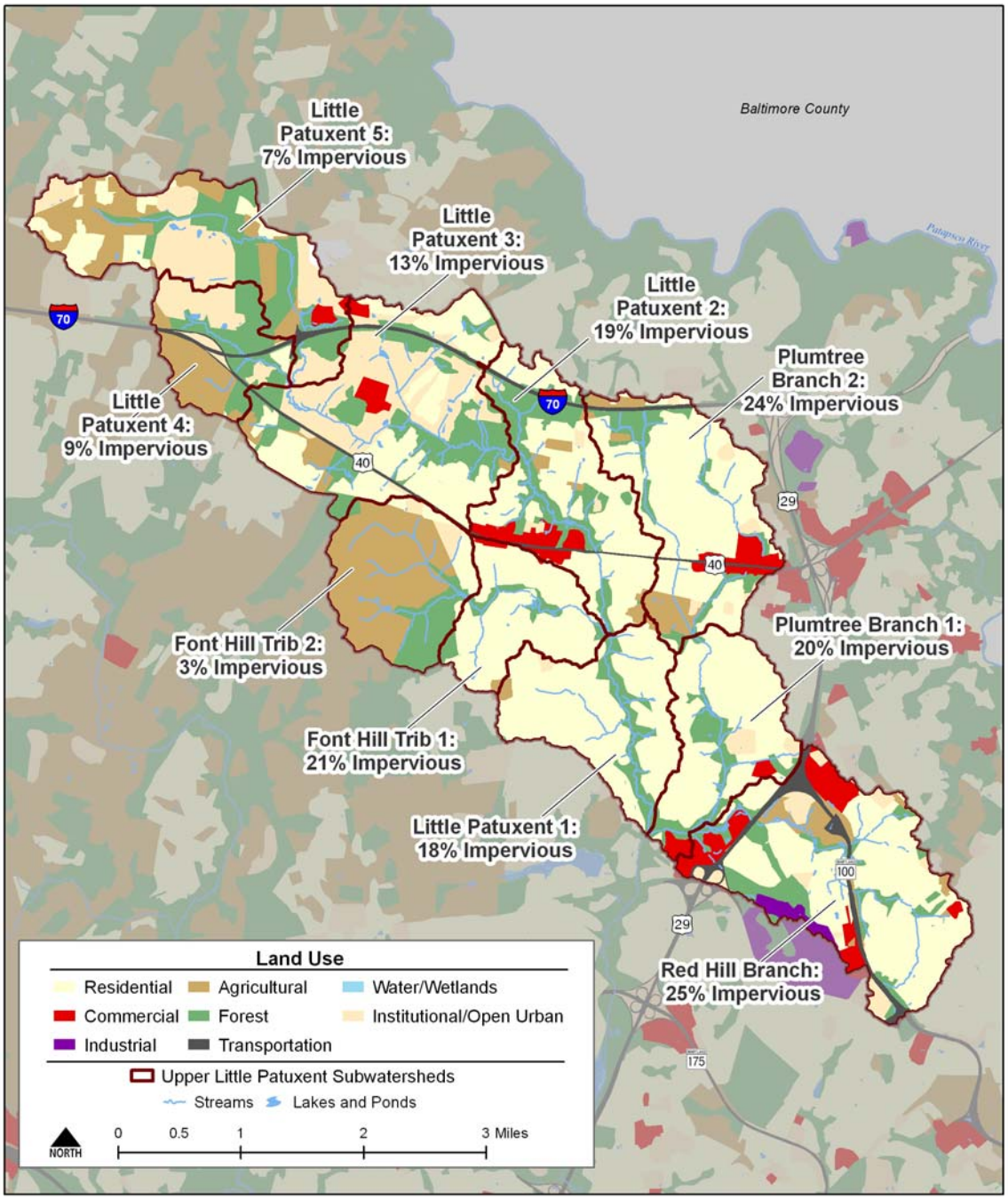
Forty-eight percent of the watershed is in residential land uses, with medium-density residential making up 32 percent of the total watershed area. Forest makes up another 16 percent and 14 percent is in agricultural land uses. Commercial areas are distributed throughout the watershed with the largest commercial areas located along Route 40 and near US 29. There is only one industrial area in the watershed located along the edge of the Red Hill Branch subwatershed.

Table 2: Percentage of Land Uses by Subwatershed

	Estimated Land Use Imperviousness	Font Hill Trib 1	Font Hill Trib 2	Little Patuxent 1	Little Patuxent 2	Little Patuxent 3	Little Patuxent 4	Little Patuxent 5	Plumtree Branch 1	Plumtree Branch 2	Red Hill Branch	Entire Watershed
Low-density Residential East[1]	19.5	4%	6%	17%	18%	2%	<1%		26%	12%	20%	11%
Low-density Residential West[1]	8.0	2%				2%	<1%	13%				2%
Medium-density Residential	31.3	81%	3%	67%	38%	24%	2%		43%	51%	29%	32%
High-density Residential	42.1				1%	6%			5%	4%	6%	3%
Commercial	69.9	1%			8%	3%		2%	4%	6%	10%	4%
Industrial	53.6										3%	<1%
Institutional	34.9	<1%	1%	1%	1%	1%	3%	4%	5%	3%	3%	2%
Extractive	11.0							1%				<1%
Open Urban Land	10.9		3%		2%	29%	24%	28%		<1%	2%	10%
Large Lot Agricultural	15.0	1%		1%	2%	1%	28%	5%			1%	3%
Large Lot Forest	15.0			<1%		1%	2%	2%			2%	1%
Cropland	1.5		68%	1%	2%	3%	3%	21%		8%		9%
Pasture	1.5			<1%	<1%	<1%					5%	1%
Orchards/vineyards/horticulture	1.5										<1%	<1%
Deciduous Forest	0.0	11%	19%	14%	25%	19%	31%	11%	17%	12%	10%	16%
Evergreen Forest	0.0								<1%			<1%
Mixed Forest	0.0										1%	<1%
Brush	0.0					5%	<1%	13%		<1%	1%	3%
Bare Ground	0.0					<1%					1%	<1%
Transportation	75.0	<1%	<1%		3%	3%	6%	1%	<1%	2%	8%	3%
Total Subwatershed Acres	---	640	839	935	1,174	1,754	598	1,294	866	1,245	1,718	11,063

1 - Two separate impervious factors were used for the low-density residential land use. Those low-density residential areas zoned by Howard County Department of Planning and Zoning as “RC” and “RR”, primarily in the western portions of the County, are less impervious than those in the eastern portions of the County and are therefore given a lower impervious percentage than is typical for low-density residential areas.

Figure 4: Land Use and Impervious



**Impervious percentage is based on planimetric data.*

2.3 Impervious Surface Analysis

Overall, the ULPR Watershed is approximately 16 percent impervious. This percentage was derived using the planimetric-based impervious GIS layers provided by the County intersected with the subwatershed layer. The planimetric layer is made up of polygons that depict the footprint of major impervious surfaces such as buildings, roads and sidewalks. The total footprint in each subwatershed was summed.

Under this analysis, the Red Hill Branch and Plum Tree Branch subwatersheds, the most downstream subwatersheds in the ULPR Watershed, are the areas with the highest percentages of imperviousness, as shown in Table 3 and on Figure 4. The Font Hill Tributary 2 subwatershed has the lowest percentage of impervious area at three percent. This subwatershed contains the Carroll Farm property with only a minor amount of residential development along the eastern edge of the subwatershed. Table 3 also includes the impervious areas currently being treated by stormwater management practices and those that are currently untreated.

The planimetric-based method of analysis differs from the land use-based analysis completed for the Watershed Prioritization Report (Howard County 2004). In a land use-based impervious analysis, an impervious percentage is applied to each individual land use polygon based on the type of land use. For example, four 1-acre residential lots were sampled for the watershed prioritization and found to be 13.2% impervious. This 13.2% is then applied to all 1-acre residential lots across the watershed. This method is useful for estimating imperviousness over large areas and for prioritizing watersheds for restoration or preservation; however any error in the sampling will be compounded across the study area.

The planimetric-based method effectively provides the impervious surfaces on the ground (disregarding changes in topography) at the time of the orthophotography and captures a more accurate depiction of the impervious area without the need for sampling or extrapolation. The County's planimetric layers were used for the imperviousness of the entire County, the ULPR watershed and subwatersheds, and also to derive the impervious acreage in the drainage areas of proposed sites to be treated or restored. In this manner the results will be directly comparable at the varying scales.

The relative ranking of the subwatersheds is similar between the two methods even though the impervious area and percentages for the individual subwatersheds may differ. In summary, the planimetric method resulted in 3,741 fewer impervious acres for the entire County; a subwatershed average of 60 fewer impervious acres; and a subwatershed average of 2.8 percent less for impervious percent.

Table 3: Percent Impervious (based on planimetric data)

Subshed	Impervious Acres	Subshed Acres	Percent Impervious	Total Impervious Area Treated (acres)	Total Untreated Impervious Area (acres)
Font Hill Trib 1	131	640	21%	62.8	68.7
Font Hill Trib 2	25	839	3%	4.8	20.6
Little Patuxent 1	168	935	18%	52.4	115.5
Little Patuxent 2	223	1,174	19%	115.0	108.2
Little Patuxent 3	220	1,754	13%	123.3	96.6
Little Patuxent 4	55	598	9%	9.1	46.0
Little Patuxent 5	88	1,294	7%	37.0	51.3
Plumtree Branch 1	171	866	20%	2.0	169.1
Plumtree Branch 2	295	1,245	24%	61.8	233.3
Red Hill Branch	433	1,718	25%	202.5	230.2
Grand Total	1,810	11,063	16%	670.6	1,139.4

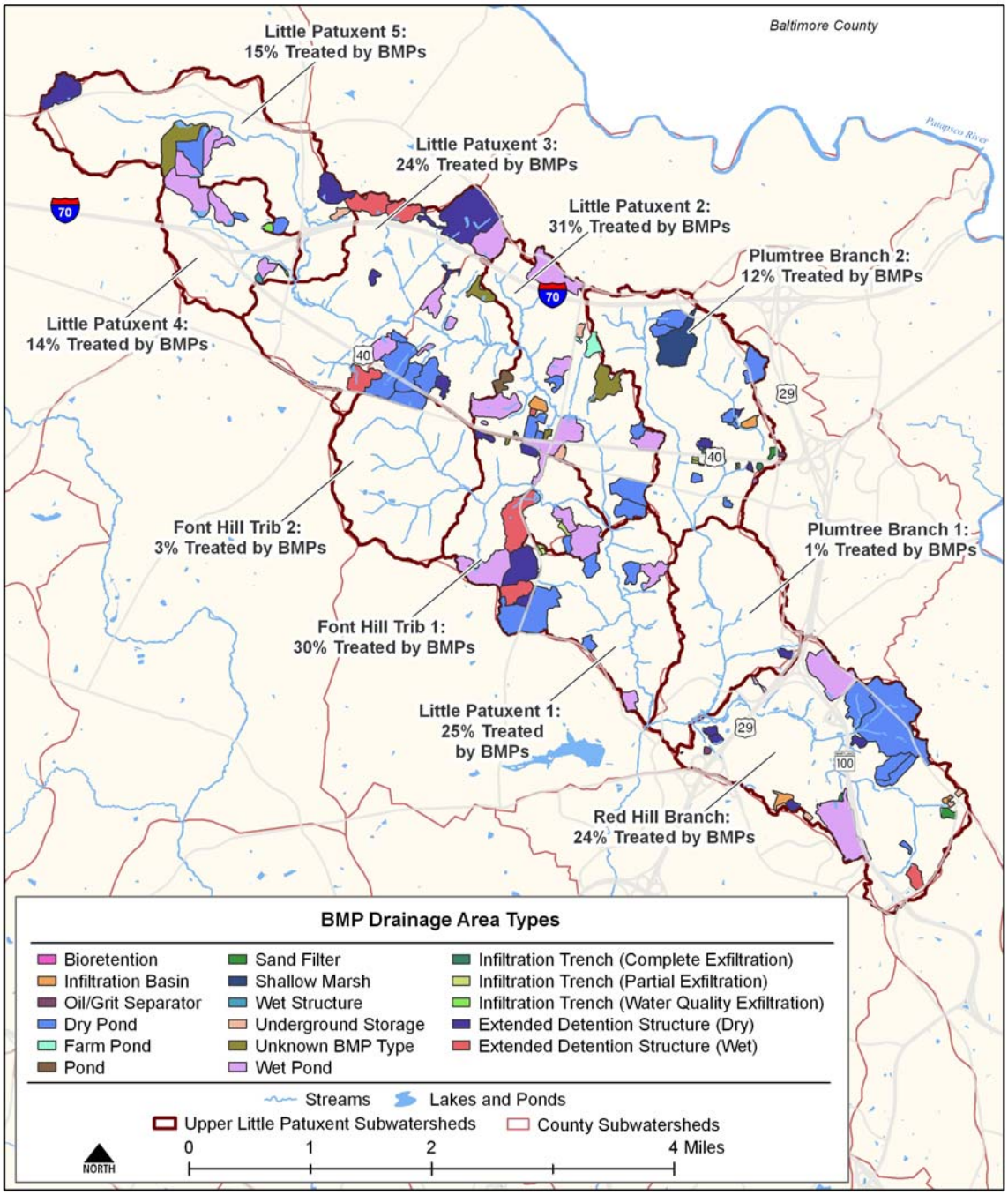
2.4 Pollutant Loading

Pollutants were modeled at the subwatershed scale to provide a means to identify areas of the County that may be experiencing high levels of pollutant inputs and further, to prioritize subwatersheds for additional study and treatment.

Pollutant loading is modeled yearly by the County as part of their NPDES permit requirements using a GIS-based analysis tool. The same model structure was used here, except instead of modeling to the 12 major County watersheds, the 10 ULPR subwatersheds were used.

A main component of the model are the stormwater BMPs. Locations, types of BMPs and drainage areas to the BMPs are maintained by the County and were used to estimate loading reductions. There are 176 BMPs providing retention and/or pollutant removal in the ULPR Watershed. The area treated per subwatershed ranges from one percent in the Plumtree Branch 1 subwatershed to 31 percent in the Little Patuxent 2 subwatershed. Figure 5 provides a map of the BMP drainage areas across the watershed with large shaded areas often reflecting multiple BMPs and their associated drainage areas. The percentage of area treated in each subwatershed is also shown on Figure 5. These percentages are also shown in Table 4.

Figure 5: BMP Drainage Areas and Percentage of Area Treated



The following summarizes the pollutant loading model approach:

Drainage Network – The focus is on identifying the overall drainage area for each subwatershed then accounting for the drainage areas for each BMP within the subwatershed. Since it is not practical to delineate drainage areas for certain single lot and pre-treatment BMPs, the County

has pre-defined a standard drainage area size to these facilities to account for their pollutant removal. The standard drainage area is used in the analysis tool spreadsheet.

Structural BMPs – The model accounts for pollutant load reductions by structural BMPs. The reductions for each pollutant are applied to the BMP drainage areas. It manages the sequence of load estimates and reductions within a drainage area and considers the sequence of BMPs in series to account for reduction of loads prior to treatment by the next downstream BMP.

Stormwater Pollutants – For each drainage area, pollutant loads are computed sequentially and nested in-line BMPs are accounted for. The County has identified a general list of Land Use (LU) codes, and for each LU has identified pollutant rates based on Event Mean Concentrations (EMCs). LU is taken primarily from the County's most recent land use update with supplements from Maryland Department of Planning data where necessary.

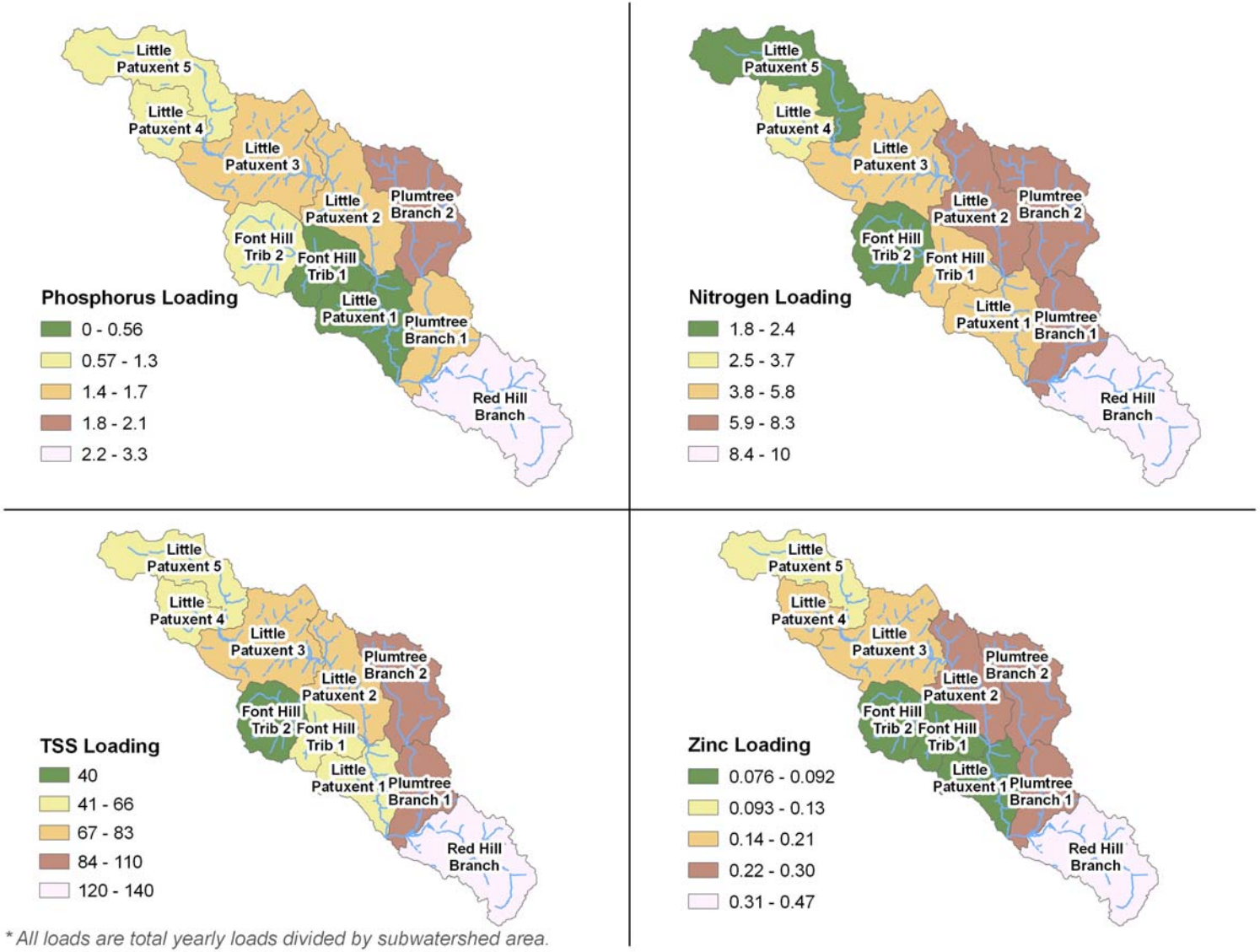
Table 4 details the loads for each of the parameters modeled. 'Total Loads' is the annual estimated pollutant load that would occur without the current BMPs. 'Reduced Loads' is the annual estimated load with the current BMPs factored in. This scenario best represents the current watershed condition.

Figure 6 shows the estimated pollutant loads for Nitrogen, Phosphorus and Zinc in lbs/acre/year for the ULPR Watershed. In general, the highest loads for the three pollutants are found in the more densely developed southeastern portions of the watershed. Red Hill Branch, in particular, had the highest estimated loads of all subwatersheds for the three pollutants. It is not surprising that Little Patuxent 2, Plumtree 1 and Plumtree 2 also have high loads. Those areas are densely populated, with high levels of impervious surface and most communities were built pre-stormwater management.

Table 4: Upper Little Patuxent River Pollutant Loads

Subshed	Percent Treated by BMP	Description	Cu (lbs/yr)	Pb (lbs/yr)	NO_2_NO_3 (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
Little Patuxent 5	15%	Total Loads	699	263	10,190	24,103	3,918	215,841	571
		Reduced loads	612	231	9,084	21,341	3,437	185,627	499
		% Reduction	**12%**	**12%**	**11%**	**11%**	**12%**	**14%**	**13%**
Red Hill Branch	24%	Total Loads	2,028	757	34,627	70,389	11,572	441,100	1,700
		Reduced loads	1,700	634	30,194	61,959	9,713	355,147	1,427
		% Reduction	**16%**	**16%**	**13%**	**12%**	**16%**	**19%**	**16%**
Plumtree Branch 1	1%	Total Loads	513	195	10,416	19,098	3,046	147,374	452
		Reduced loads	511	194	10,357	19,003	3,032	146,681	450
		% Reduction	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**
Little Patuxent 1	25%	Total Loads	403	158	9,877	16,358	2,482	136,307	378
		Reduced loads	314	124	8,135	13,627	1,949	106,803	297
		% Reduction	**22%**	**21%**	**18%**	**17%**	**21%**	**22%**	**22%**
Font Hill Trib 1	30%	Total Loads	389	148	7,878	14,355	2,286	108,634	340
		Reduced loads	293	112	6,129	11,342	1,726	80,604	255
		% Reduction	**25%**	**24%**	**22%**	**21%**	**24%**	**26%**	**25%**
Font Hill Trib 2	3%	Total Loads	1,254	475	19,276	41,333	6,939	257,350	998
		Reduced loads	1,246	472	19,170	41,155	6,897	254,509	991
		% Reduction	**1%**	**1%**	**1%**	**0%**	**1%**	**1%**	**1%**
Plumtree Branch 2	12%	Total Loads	983	367	17,594	34,382	5,652	244,956	828
		Reduced loads	901	336	16,112	31,844	5,189	221,149	757
		% Reduction	**8%**	**9%**	**8%**	**7%**	**8%**	**10%**	**9%**
Little Patuxent 2	31%	Total Loads	853	325	15,705	30,773	4,938	221,696	729
		Reduced loads	649	248	12,758	25,268	3,771	164,422	557
		% Reduction	**24%**	**24%**	**19%**	**18%**	**24%**	**26%**	**24%**
Little Patuxent 3	24%	Total Loads	1,057	402	18,133	37,721	6,067	300,033	887
		Reduced loads	826	314	14,176	30,257	4,714	235,261	687
		% Reduction	**22%**	**22%**	**22%**	**20%**	**22%**	**22%**	**23%**
Little Patuxent 4	14%	Total Loads	565	203	8,651	18,625	3,138	140,755	460
		Reduced loads	530	191	8,267	17,860	2,951	127,099	432
		% Reduction	**6%**	**6%**	**4%**	**4%**	**6%**	**10%**	**6%**

Figure 6: Select Pollutant Loading Results (lbs/acre/yr)



** All loads are total yearly loads divided by subwatershed area.*

2.5 Stream Corridor Assessment (2008)

A Stream Corridor Assessment (SCA) was first completed in 1999 by the Maryland Conservation Corps and used in the Little Patuxent WRAS to identify problem areas. Because the initial assessment was completed approximately 9 years prior to beginning this planning effort it was necessary to update the assessment using the same SCA methodology across the entire study area.

Howard County contracted with the U.S. Army Corps of Engineers to complete an SCA for the ULPR Watershed. The SCA was conducted between February 12 and March 20, 2008 to assess the general physical condition of stream corridors and identify environmental problems within the ULPR Watershed. The USACE followed protocol and methodologies developed by the Maryland Department of Natural Resources as written in Stream Corridor Assessment Survey: SCA Survey Protocols (MDNR, 2001).

Approximately 44 linear stream miles were assessed throughout the watershed. Each subwatershed was assessed for the following features: stream erosion sites, inadequate stream buffers, fish barriers, exposed or discharging pipes, channelized stream sections, trash dumping sites and unusual conditions. The assessment rated each feature for its severity, accessibility, and correctability where a score of 1 indicated a very severe problem that is very accessible and most easily correctable. Conversely, a score of 5 indicated a minor problem that is not easily accessible or correctable. The Trimble GEO-XH GPS handheld unit was used to spatially document field survey points. The USACE recorded 1180 points and identified 1271 environmental problems—with some field survey points representing more than one environmental problem.

Pipe outfalls and erosion sites were the most common environmental features respectively accounting for 53 and 22 percent, respectively, of the 1271 total environmental feature/problem sites identified. The majority of sites, 82 percent, were of minor to moderate severity. Erosion sites and inadequate buffers together made up 73 percent of the 174 sites rated as severe and 66 percent of the 58 sites rated as very severe. Tables 5 and 6 below summarize the results of the SCA. Table 5 provides a breakdown of the frequency of problem areas by severity for the entire watershed, while Table 6 demonstrates the frequency of the severity categories for each subwatershed.

Table 5: SCA Summary Results (USACE, 2008)

Potential Problems Identified	Number	Estimated Length	Very Severe (1)	Severe (2)	Moderate (3)	Low Severity (4)	Minor (5)
Pipe Outfalls	677		8	11	96	17	545
Erosion Sites	280	15,163 feet (2.87 miles)	26	93	132	18	11
Representative Site	95		0	2	19	1	73
Fish Barriers	89		6	24	39	17	3
Inadequate Buffers	78	27,413 feet (5.19 miles)	12	34	30	1	1
Unusual Condition	20		2	4	9	2	3
Trash Dumping	14		2	4	5	2	1
Exposed Pipes	10		1	1	3	2	3
Channel Alteration	8	484 feet	1	1	1	0	5
Total	1271		58	174	334	60	645

Table 6: Point Type and Severity per Subwatershed

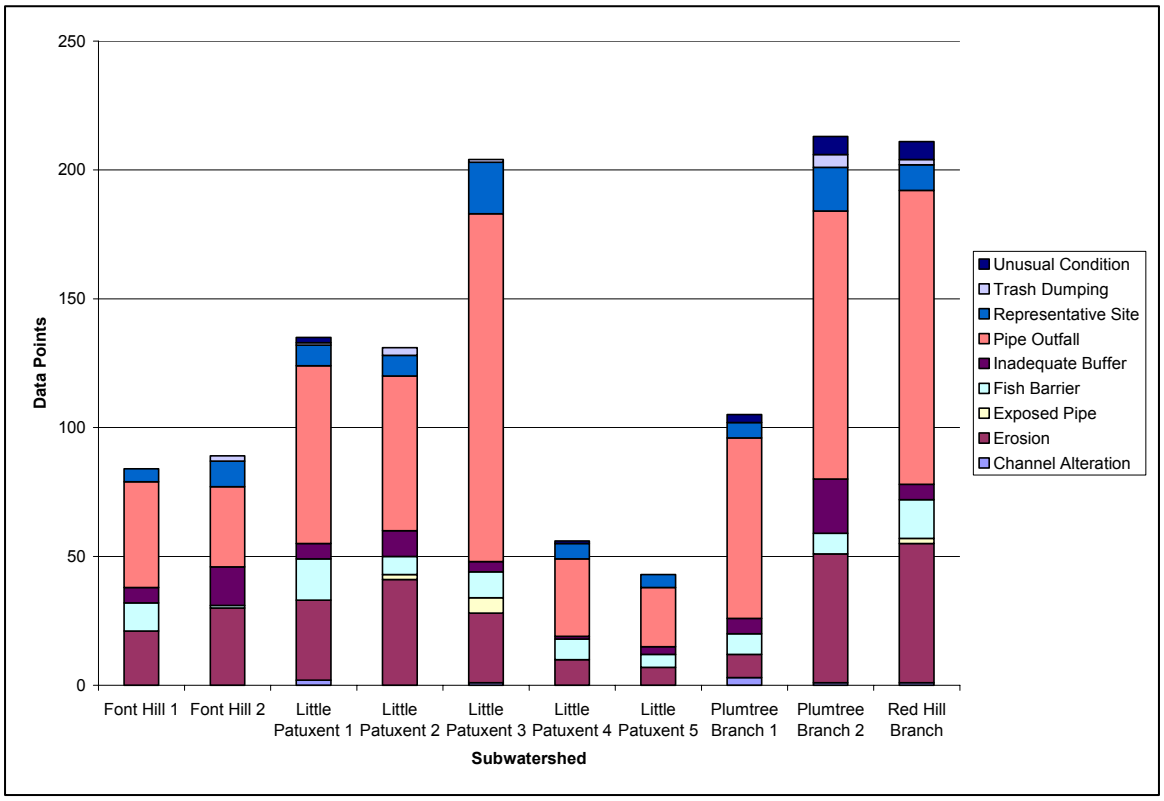
Subwatershed	Pipe Outfalls					Erosion Sites					Representative Site					Fish Barriers				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Font Hill 1				1	40	3	5	11	2						5	2	3	6		
Font Hill 2	1		13		17		6	21	2	1			4		6			1		
Little Patuxent 1	3	1	48		17	9	8	14					5		3	2	4	7	3	
Little Patuxent 2		3	6	2	49	3	21	15	2				1		7		1	4	2	
Little Patuxent 3		1	6	5	123		5	5	8	9			1	1	18		1	5	3	1
Little Patuxent 4				1	29		2	7	1						6		1	1	6	
Little Patuxent 5			1		22			7							5			3	2	
Plumtree Branch 1		3	10		57	1	4	2	2				4		2	1	4	2		1
Plumtree Branch 2	1	2	7	7	87	3	20	27				2	1		14		4	3		1
Red Hill Branch	3	1	5	1	104	7	22	23	1	1			3		7	1	6	7	1	

Gray	= <5 sites
Green	= 5-10 sites
Yellow	= 11-20 sites
Orange	= 21-50 sites
Red	= 51-100 sites
Purple	= >100 sites

Subwatershed	Inadequate Buffers					Unusual Condition					Trash Dumping					Exposed Pipes					Channel Alteration					Total Points
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Font Hill 1	2	1	3																							84
Font Hill 2		4	11										1	1												89
Little Patuxent 1	2	2	2					2					1									1			1	135
Little Patuxent 2	2	8										2	1					2								131
Little Patuxent 3		1	3											1			1		2	3					1	204
Little Patuxent 4		1							1																	56
Little Patuxent 5			3																							43
Plumtree Branch 1	3	3				1		1	1												1				2	105
Plumtree Branch 2	3	10	6	1	1			4		3		2	2		1								1			213
Red Hill Branch		4	2			1	4	2			2					1		1							1	211

For each subwatershed, the majority of environmental problems identified were pipe outfalls of minor severity (545 sites) and erosion sites of moderate severity (132 sites) (Table 6, Figures 7 and 9). With the exception of Little Patuxent 3, Little Patuxent 4 and Little Patuxent 5, all subwatersheds had at least one site classified as very severe. Little Patuxent 5 was the only subwatershed to have no sites with higher than moderate severity (Figure 8).

Figure 7: SCA Points per Subwatershed

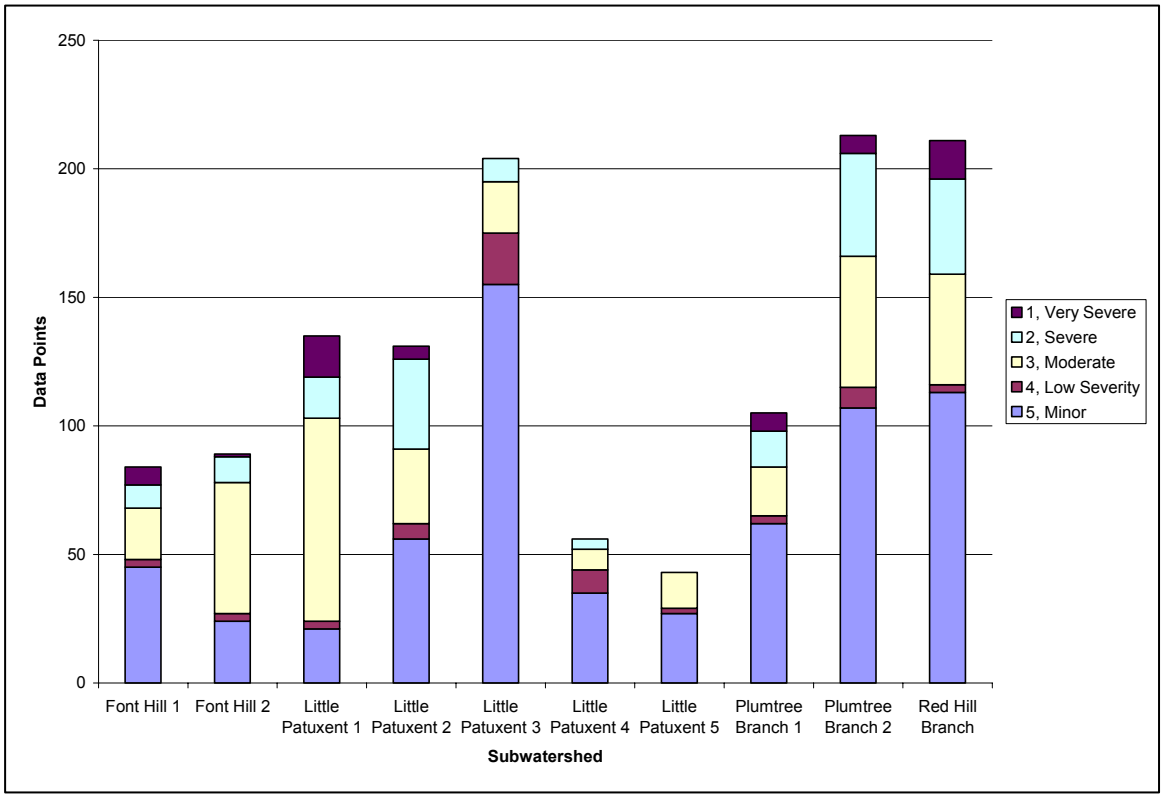


While it appears that Plumtree Branch 2, Red Hill Branch and Little Patuxent 3 had the highest quantity of data points collected (213, 211 and 204 respectively), this is mainly because they are the largest subwatersheds with the most stream length within the ULPR (Table 6 and Figure 7). Based on the number of data points per stream mile, Little Patuxent 1 had the highest concentration of sites (50 sites per stream mile), 15 sites more than the second highest concentration (35 sites per stream mile for both Little Patuxent 2 and Plumtree Branch 2). Little Patuxent 5 (11 sites) and Font Hill 2 (18 sites) had the fewest environmental problems identified per stream mile. The remaining subwatersheds had an average of 29 sites identified per stream mile (Table 7).

Table 7: Data Points per Stream Mile

Subwatershed	Stream Length (miles)	Data Points per Stream Mile
Font Hill 1	2.58	33
Font Hill 2	4.87	18
Little Patuxent 1	2.68	50
Little Patuxent 2	3.73	35
Little Patuxent 3	7.71	26
Little Patuxent 4	2.03	28
Little Patuxent 5	3.94	11
Plumtree Branch 1	3.46	30
Plumtree Branch 2	6.03	35
Red Hill Branch	7.18	29

Figure 8: Severity of Points per Subwatershed



Less than half of all environmental problem sites (45 percent) were recorded to have the best to moderate correctability with the remaining sites recorded as major restoration problems. Little

Patuxent 1 and Font Hill 2 had the highest percentage of sites with the best correctability (81 percent and 69 percent respectively) while Little Patuxent 3 and Little Patuxent 4 had the lowest percentage of correctable sites (14 percent and 21 percent respectively). Erosion sites had the highest percentage of correctable sites with 88 percent of erosion sites receiving best to moderate correctability scores. Eighty-three percent of pipe outfalls were recorded as having the worst correctability, the highest percentage of all point types. A total of 98 sites were recorded as very severe and severe with a high correctability score (Figures 9 and 10). Sites are distributed among six of the ten subwatersheds assessed as Font Hill 2, Little Patuxent 3, Little Patuxent 4 and Little Patuxent 5 did not have sites with severity scores of 1 or 2 with high correctability. The majority of high priority sites are erosion sites (46 percent) followed by inadequate buffers (19 percent). Thirty-seven percent of high priority sites are located within Red Hill Branch and 30 percent are located within Little Patuxent 1.

Figure 9: Very Severe and Severe Sites with High Correctability

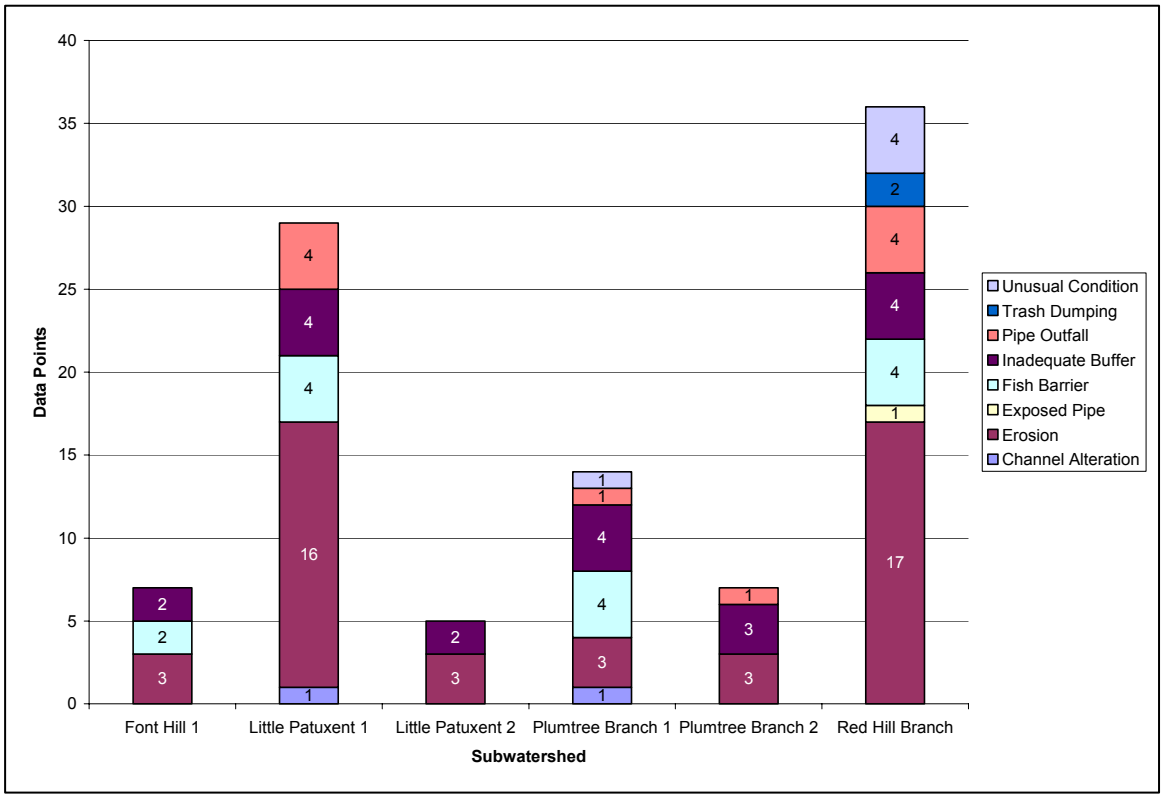
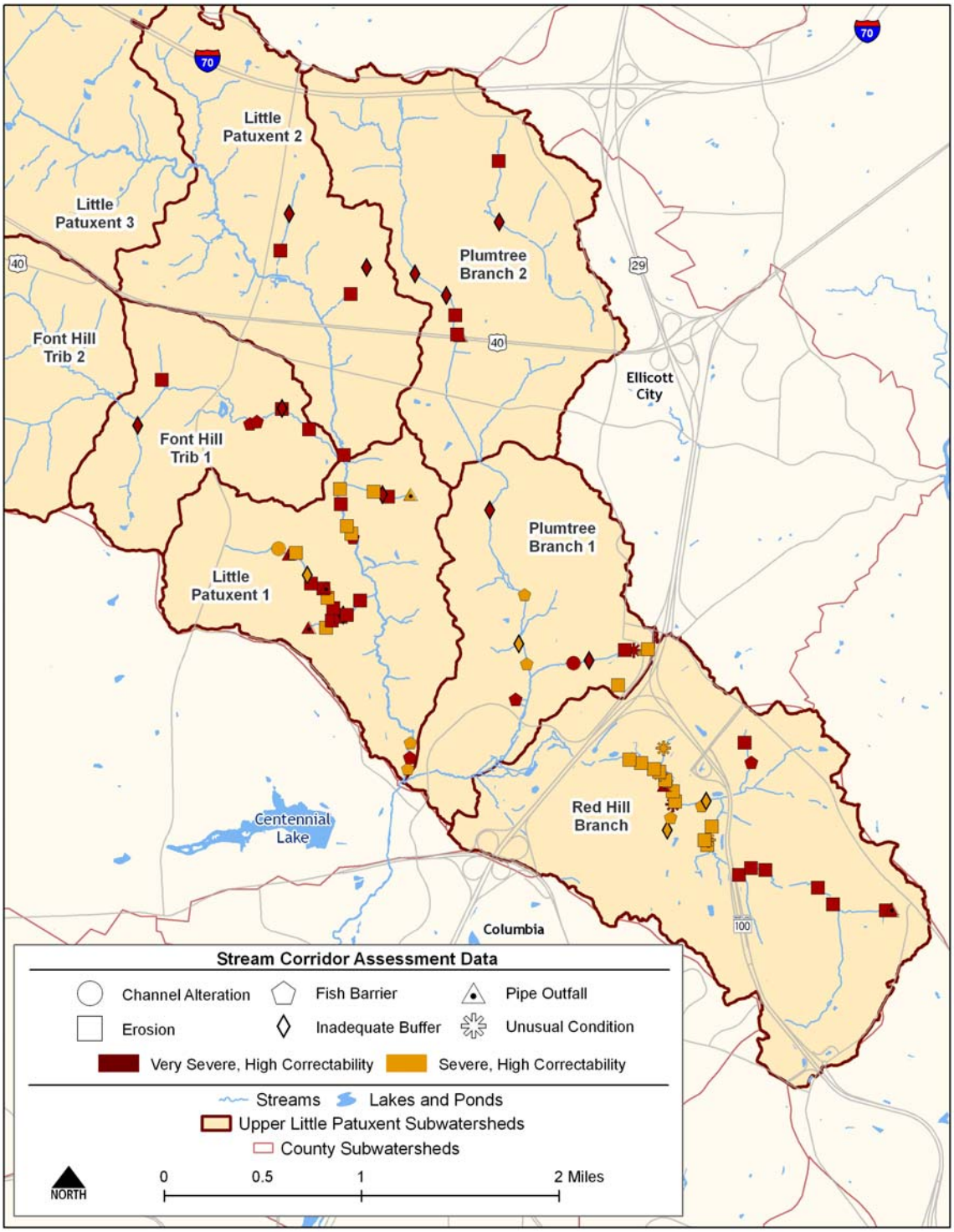


Figure 10: Map of Very Severe and Severe SCA Data with High Correctability



2.6 Subwatershed Prioritization

With limited time and resources to allocate to planning, design and implementation, any watershed planning effort has to be focused on areas of the watershed that are in the most need. A simple subwatershed prioritization scheme was used for the ULPR to identify areas where the identification of restoration and treatment sites would be focused.

The pollutant loads incorporate and effectively synthesize many watershed characteristics including degree of intensity of land use, the level of imperviousness and the amount of existing stormwater treatment. Therefore, loading results for several key pollutants (nitrogen, phosphorus, total suspended solids and zinc) were used as a primary factor in prioritizing the subwatersheds. The SCA points that were ranked severe or very severe in the 2008 assessment were also used as a means to prioritize the subwatersheds.

As shown in Table 8, the Red Hill Branch, Plumtree Branch 2 and Little Patuxent 3 subwatersheds were the highest priority subwatersheds based on the SCA data and nitrogen, phosphorus, total suspended solids and zinc loadings. Based on this ranking, field crews concentrated their efforts on these top priority subwatersheds when identifying candidate sites for restoration and retrofit as discussed in Section 3.

Table 8: Prioritization of Subwatersheds / Problem Areas

Subwatershed	Nitrogen Load Rank	Phosphorus Load Rank	Total Suspended Solids Rank	Zinc Rank	Severe SCA Points Rank	Final Score	Final Rank
Red Hill Branch	1	1	1	1	1	5	1
Plumtree Branch 2	2	2	3	2	4	13	2
Little Patuxent 3	3	3	2	3	7	18	3
Little Patuxent 2	4	4	4	4	6	22	4
Plumtree Branch 1	5	5	5	5	3	23	5
Little Patuxent 1	6	9	7	8	2	32	6
Little Patuxent 5	8	6	6	6	8	34	7
Font Hill Trib 1	7	10	8	10	5	40	8
Little Patuxent 4	9	8	9	7	9	42	9
Font Hill Trib 2	10	7	10	9	10	46	10

1 – 3 4 – 7 8 – 10

3 Candidate Project Site Identification

The types of management strategies that were investigated fell into three basic categories.

1. Stormwater – new ponds, pond retrofits, bioretention, and shallow marsh
2. Stream Restoration – streambank repair, full restoration, outfall stabilization
3. Reforestation – riparian buffer enhancement, reforestation

For each major category different approaches were necessary to identify the best possible candidate project sites.

3.1 Stormwater and Stream Restoration

To identify areas for improved stormwater treatment KCI completed Retrofit Reconnaissance Investigations (RRI) at sites throughout the ULPR Watershed and focused on areas identified in the subwatershed prioritization described previously. RRIs were also completed for potential stream restoration sites, however the RRI does not adequately provide for documentation of the restoration treatment proposed, therefore crews noted additional detail on the form for stream restoration sites.

Sites associated with the USACE SCA survey were generally assessed first followed by additional areas of interest, which were identified as a result of field investigation of stormwater systems. In addition the County maintains a database of citizen concerns. When possible those sites were visited and evaluated.

Field teams were equipped with detailed map sets. Three maps were developed for each subwatershed, an Overview Map, an Ownership Map, and a Detail Map. This allowed the crews to have virtually all of the data they would need on hand to make decisions about potential sites. Data included; streams, wetlands, parks, natural resource areas, mapped complaint database by type of issue, stormdrain system, BMP drainage areas by type, SCA data, property ownership, parcels by year built to determine general level of stormwater management and aerial photography.

Information regarding the current condition of the proposed retrofit location was recorded on each RRI and included an overall site description, existing level and type of storage, drainage area land use and existing stormwater management. A proposed retrofit summary was created including the purpose of retrofit, proposed treatment option(s), description of design elements and possible site constraints. A sketch of the potential retrofit location along with proposed treatment options was included in each RRI.

Potential retrofit sites were assigned a Unique Site ID. When available, the USACE SCA picture ID was used as a Unique Site ID (i.e. if a proposed retrofit site was located on or near a USACE point photographed and recorded for the SCA). If a site was not associated with a USACE record, an ID was created using a subwatershed acronym followed by a sequential number (i.e. RHB_01, for Red Hill Branch Site 1).

3.2 Reforestation

Reforestation and riparian stream buffer sites were identified through a desktop analysis using county and online aerial photography in combination with the Howard County GIS property layer and SCA deficient buffer sites. Attention was focused primarily on areas that would connect existing forest and provide a habitat corridor for woodland species and on areas where the stream riparian buffer was absent or deficient. Public lands (parks and open space) and institutional properties (land associated with schools, libraries and government buildings) meeting these criteria were identified first, as they were believed to provide the best opportunities for public involvement and have a higher chance of successful completion. Several private properties were also identified, primarily with deficient or absent riparian stream buffers. The entire ULPR subwatershed was viewed as a whole, with no priority given to any single subwatershed and sites were numbered sequentially as they were located (i.e. BF1).

3.3 Prioritization of Candidate Project Sites

Information gathered through the RRI field investigations and through the desktop identification of reforestation sites initially identified 184 candidate project sites. These sites are listed in Appendix A and summarized in Table 9. Within the scope of the WMP it was impossible to move forward with full concept design and cost estimation for all 184 sites. Nor would it be feasible to readily implement that number of projects in the near future. Therefore several steps were put in place to reduce the overall number of sites to get the full concept design. Initially, a project ranking was put in place.

Table 9: Initial Candidate Project Sites

Project Type	Number of Sites
Bioretention	31
New Pond / Shallow Marsh	7
Pond Retrofit	57
Stream Restoration / Outfall Stabilization	25
Reforestation	64
Total	184

Project Ranking – Project Benefits and Constraints

A project ranking was the first step used to reduce the numbers of sites. The potential projects were prioritized using a three step process. The first step was to determine a qualitative total benefit, the second step was to sum the potential project constraints and the third step was to apply a weighting factor for the amount of impervious area treated by the proposed project. The procedure is outlined further in the following sections.

Project Benefits Estimate

Qualitative project benefit estimates were derived based on how effectively each type of proposed project would perform at making improvements in multiple watershed/stream quality parameters. The fourteen parameters used are listed in Table 10.

Qualitative scores of 1, 2, and 3 were assigned to each benefit parameter; with 1 representing a beneficial impact and 3 representing no impact. The scores for each project were summed for a total benefit score. Possible total benefit scores ranged from 11 (most benefit) to 27 (least benefit).

Project Constraints and Constructability Estimate

An estimate of overall project constructability was developed using a matrix of each project rated against potential constraints. Property ownership was determined using Howard County parcel data supplied by Howard County, Maryland. The nine parameters are listed in Table 10.

Qualitative scores of 1, 2, and 3 were assigned to each constraint parameter; with 1 representing less of a constraint and 3 representing more of a constraint.

The scores for each project were summed for a total constraint score. Possible total constraint scores ranged from 8 (fewest constraints) to 19 (most constraints).

The total benefit score and the total constraint score were then summed for each project to determine the overall total project score. Total project scores ranged from 25 (most benefit/least constraint) to 41 (least benefit/most constraint).

Additional Weighting for Treated Impervious Area

A 10 percent weighting factor was applied to each project to account for the amount of impervious area treated. This was accomplished by multiplying the impervious area treated for each proposed project by 10 percent and then subtracting that from the total score. As a lower score indicates projects with the most benefits and fewest constraints, the scores for those projects with more impervious area treated were reduced more than those with less impervious area treated. Thus projects with higher amounts of impervious area treated were favored.

Overall, the 10 percent weight factor did not significantly change the results of the prioritization. All of the projects receiving the lowest scores (that is, most overall benefit) maintained low scores with very little movement up or down the prioritization project list. Only a few projects with large areas of proposed treated impervious area ended up receiving a much lower score, resulting in these projects being moved ahead of other projects with smaller proposed treated impervious areas.

Table 10: Proposed Project Benefits and Constraints

		Score		
		1	*2*	*3*
Benefit Parameters	*Quantity Control (water quality/water quantity treatment only)*	treat all or majority of the contributing drainage area	treat some of the contributing drainage area	no quantity treatment
	Quality Control (water quality/water quantity treatment only)	treat all or majority of the contributing drainage area	treat some of the contributing drainage area	no quality treatment
	Recharge	significant benefit	no significant benefit	N/A
	Water Temperature (stream restoration projects only)	restoration to incorporate significant shading, cool water temps, and mix of depth diversity	restoration to incorporate minor shading, cool water temps, and mix of depth diversity	restoration will not include shading, cool water temps, and mix of depth diversity
	Channel Erosion (water quality/water quantity treatment only)	proposed quantity control with existing downstream channel erosion	proposed quantity control without existing downstream channel erosion	no proposed quantity control
	Channel Erosion (stream restoration projects only)	significant benefit	minor benefit	no significant benefit
	Instream Habitat (water quality/water quantity treatment only)	proposed quality control at or very close to stream channel	proposed quality control not close to a stream channel	no significant benefit
	Instream Habitat (stream restoration projects only)	significant benefit	minor benefit	no significant benefit
	Riparian Habitat	significant benefit	minor benefit	no significant benefit
	Public Safety (stream restoration projects only)	restoration of property or infrastructure that has impending health or safety issues	partial restoration of property or infrastructure that has impending health or safety issues	restoration will not include property or infrastructure that has impending health or safety issues
	Public Outreach/Education	public place (park, school, library, etc.)	some public (parking lot, large neighborhood, church, etc.)	no significant benefit
	Addressing Citizen Complaint	proposed project is located at or near a complaint	no complaints at the proposed project	N/A
	Fish Passage (stream restoration projects only)	significant benefit	no significant benefit	N/A
	Combined	multiple proposed projects within close proximity	no significant benefit	N/A

		Score		
		1	*2*	*3*
Constraint Parameters	*Permitting*	no significant environmental impacts	significant removal or damage to existing forest/trees	instream or sensitive area (stream impounding, filling of wetlands, etc.)
	Adjacent Land Use	county/public	commercial/business	residential/HOA
	Property Ownership	county/public	commercial/business	residential/HOA
	Facility Access	no constraint	some constraint	significant constraint
	Design/Construction	no constraint	some constraint	significant constraint
	Public Safety (water quality/water quantity treatment only)	proposed dry treatment	proposed wet treatment (high traffic area, commercial/outreach area)	proposed wet treatment (residential area)
	Public Safety (stream restoration projects only)	restoration would not result in unsafe conditions for public	restoration may result in unsafe conditions for public	restoration would result in unsafe conditions for public
	Water Temperature (water quality/water quantity treatment only)	no standing water (dry)	standing water without direct input to a stream channel	standing water with direct input to a stream channel
	Existing Utility Conflicts	no constraint	some constraint	significant constraint

Prioritization Results

Based on the results, pond retrofits and bioretention projects appear to have the lowest scores (that is, most overall benefit). Due to the nature of stream restoration/stabilization projects, drainage area and therefore treated impervious areas for these types of stream projects were not calculated. Since no credit could be given to these types of projects for quantity/quality control or recharge they were assessed separately.

Of the pond retrofit and bioretention (filtration) projects listed, project PT1_01, a storage area in the median of MacAlpine Road, received the highest score due to its large amount of proposed treated impervious area and potential benefits. This particular project involves utilizing a long grass swale located between the northbound and southbound lanes of Macalpine Road for quality and quantity controls.

Of the proposed stream restoration projects listed, the top three projects ranked fairly high and are all located in the Red Hill Branch subwatershed. These appeared to have the most severe erosion over a fairly long stretch of natural channel.

In addition to the project ranking, two other factors reduced the number of sites that would move forward with full concept plan design and cost estimation. Howard County Department of Recreation and Parks conducted a full review of the proposed reforestation sites, including several site visits, to ensure that the projects proposed from the desktop analysis were feasible and would be beneficial. This was especially crucial as the available orthophotography reflects

conditions as of 2006 and did not always reflect the current condition of sites that may have been planted since that date.

The final reduction in the number of sites was a matter of engineering and constructability. Once the concept design phase was initiated several sites were identified as too small to adequately address the issue, had insufficient access, or simply did not have conditions favorable for a successful project. The final sites are identified in Appendix A and summarized below in Table 11.

Table 11: Final Candidate Project Sites for Concept Plan Development

Project Type	Initial Number of Sites	Final Number of Sites
Bioretention	31	7
New Pond / Shallow Marsh	7	7
Pond Retrofit	57	17
Stream Restoration / Outfall Stabilization	25	15
Reforestation	64	22
Total	184	68

3.4 Concept Plans and Cost Estimates

The following sections present the process for concept design and cost estimates for the 68 projects which have been proposed in the ULPR watershed. The estimates are largely based on planning-level unit costs with example projects designed and constructed for Howard County in recent years.

KCI developed a standard template for each general type of improvement, which includes direct construction costs, indirect costs, design and permitting, and maintenance costs to develop a life-cycle cost for each project.

Concept Plans and Cost Details for each project are located in Appendix B.

Stormwater Projects

Treatment Area

The drainage area to each project site was delineated using 2-foot contours, planimetric GIS data, stormdrain mapping (inlets, pipes) and existing BMPs. Once delineated, impervious surface calculations were completed for projects involving retention of stormwater such as ponds and bioretention. The County's planimetric impervious layer was used for the calculation of imperviousness.

Treatment Volume

The purpose of retrofitting existing stormwater management facilities is to 1) improve the

quality of the water, which improves habitat in receiving waters, and 2) enhance the quantity control of the facility, which reduces erosive flows downstream. These goals are met by designing the facility to store the water quality volume (WQv) and the channel protection volume (CPv) for 24 hours.

Pollutant load reduction is accomplished by storing the WQv, which is determined based on the amount of impervious surface within the facility's drainage area. The stored WQv allows sediment and some pollutants to settle out of the water. By controlling the release of the CPv from the facility, the volume of water is released over the course of 24 hours. This produces a constant discharge into the downstream channel, thus reducing or eliminating the peak discharges that can cause erosion.

For each facility, a drainage area was delineated and calculations provided in the 2000 Maryland Stormwater Design Manual were performed to determine the appropriate WQv and CPv for each retrofit site. For the range of conditions found for typical stormwater management retrofits, the ratio of storage to runoff volume (Vs/Vr) calculated in Appendix D.11 of the Maryland Stormwater Design Manual can be approximated by 0.6. The calculated volumes were then used to estimate the required excavation needed within the facility.

Stream Restoration Projects

Sites identified for stream restoration were field reviewed by stream restoration specialists to determine the feasibility of implementing a discrete project. The stream restoration specialists qualitatively assessed each restoration reach to understand the active channel processes influencing the channel stability. With this understanding the project limits were established and conceptual channel stabilization techniques were identified. Based on the project limits and proposed stabilization techniques, a cost per linear foot estimate was derived from a regression of total project costs for similar projects in the area. Concept plans were completed for 15 stream restoration projects extending over 7,500 feet of stream. Eight of the 15 projects are in the Red Hill Branch subwatershed.

Reforestation Projects

Concept plans and cost estimates were completed for 22 buffer restoration and reforestation projects. Tree and shrub size and species used to estimate costs were based on standard native planting lists used by the Howard County Department of Recreation and Parks. The cost of the planting material is based on a 2009 survey of local wholesale plant nurseries. The cost estimates assume a planting density of 681 plants per acre, or one tree or shrub planted at eight-foot intervals.

Many of the proposed projects lie on public property for which volunteer labor may be an option for planting and maintenance. Because of this volunteer option, separate total costs were estimated using volunteers and paid labor. Projects on private property may be eligible for free plant materials and/or funding through the Stream ReLeaf or Private Forest Conservation Establishment programs, detailed in Section 4.1.

3.5 Public Education and Outreach

Public education and citizen participation play a vital role in the implementation of any watershed management plan. Resident and homeowner education about steps that they can take in their daily life or in caring for their property is necessary. There are many things that residents can do to help the County accomplish improvements in water quality. Several are listed below.

Storm-drain stenciling: Stenciling storm drains with the words "Don't Dump – Chesapeake Bay Drainage" is an easy and quick reminder that anything that enters the stormdrain will eventually end up in the Chesapeake Bay. More information on storm-drain stenciling, including information on obtaining the stencils can be found on the Chesapeake Bay Foundations website at: http://www.cbf.org/Page.aspx?pid=406.

Pick up after your pet: If pet waste is not disposed of properly it can flow directly into streams or lakes untreated. Pet waste can carry bacteria and parasites that can affect human health and is one of the components contributing to poor water quality in streams and lakes. Pet owners should carry bags when walking dogs and dispose of waste properly by flushing or burying it. If waste is disposed of in the trash, it should be wrapped carefully to avoid spillage.

Fertilizers: Homeowners should use fertilizers sparingly. Excess fertilizers (or nutrients) in the form of phosphorus and nitrogen promote excessive algae growth in streams which contribute to a loss of oxygen available to other aquatic bugs and fish. Also remember that yard waste (leaves and grass clippings), if dumped directly into streams, can contribute to excess nutrients. Grass clippings can provide natural lawn fertilization and are free – clippings can be left on lawns or composted for later use (see: http://www.co.ho.md.us/DPW/Grasscycling.htm for more information on "GrassCycling" and http://www.co.ho.md.us/DPW/homecomposting.htm) for information on backyard composting. If fertilizers are necessary, try to use a slow-release, organic fertilizer.

Pesticides: Use pesticides only when necessary. It is better to prevent pests than to try to eliminate them once they're established. Pests can be prevented by creating a healthy soil environment, selecting the appropriate plants for your soil and climate, mulching and using biological controls. Remember that strong pesticides can eliminate beneficial insects as well as pests.

Rain gardens and rain barrels: Rain gardens are depressions planted with native plants that allow rainwater to be absorbed. Rain gardens are not only aesthetically pleasing but also provide benefits such as filtering runoff and providing control of excess flow. Rain barrels are used to catch and store rainwater from roofs for use in gardens and lawns. Useful information on a do-it-yourself rainbarrel and installing your own rain garden (using native plants) was put together in 2002 by the South River Federation and the Center for Watershed Protection. The document can be found online here:
http://www.cwp.org/Resource_Library/Center_Docs/Residential/rainbarrelgarden.pdf

Buffer/tree plantings: Where possible, plant trees and shrubs, especially near and along streambanks. Trees and shrubs will absorb more stormwater than mowed grass, prevent soil erosion and provide additional air quality benefits. A list of recommended native trees and sizes

compiled by the Howard County Department of Recreation and Parks can be found here: http://www.co.ho.md.us/DPW/native_plants.htm.

Use drought-tolerant plants: Plant drought-tolerant grasses and native plants. Native plants tend to be naturally drought-tolerant. Drought-tolerant grasses will reduce the need to water your lawn.

Disconnect downspouts: Make sure downspouts from your house are directed so that the flow does not fall directly onto pavement. Instead direct rain from downspouts to your lawn or to a rain garden planted with native plants which will filter rainwater and remove pollutants.

For a list of native plants and more ideas on ways you can improve your home landscape to support water quality check out the U.S. Fish and Wildlife Service BayScapes page: http://www.fws.gov/ChesapeakeBay/Bayscapes.htm

4 Implementation

The goals and objectives of the WMP are focused on reducing the negative impact of impervious surfaces, including reducing pollutants and streambank erosion, increasing forest area and public awareness, and protecting private property. To meet these goals, the approach taken in the WMP and the management strategies investigated and selected for the ULRP have focused primarily on structural on-the-ground improvements. These types of improvements provide measureable reductions in pollutants to mitigate stormwater impacts. Secondarily the plan's implementation will have a focus on involving public participation, providing outreach and education opportunities and encouraging behavioral changes.

This implementation plan provides a basic approach to ensuring that proposed projects move forward and positive change is realized in the ULPR watershed. The plan includes the following:

- Implementation Responsibilities – A summary of the major County entities and programs that will be primarily responsible for the implementation of the plan's recommendations.
- Tier Ranking of Projects – A ranking of projects to identify the highest priority initiatives.
- Funding Requirement and Sources – A summation of project costs by type and tier ranking and a sampling of potential funding sources that the County can utilize to fund various projects.
- Community Involvement – A summary of community involvement completed to date and strategies moving forward in the implementation phase.
- Monitoring Strategy – A summary of the strategy that will be used to track the progress of implementation and the success of projects.

4.1 Implementation Responsibilities

The Howard County Department of Public Works, Bureau of Environmental Services, Stormwater Management Division (SWMD) will be the primary entity responsible for implementing the WMP for the ULPR. The primary duties of the SWMD include:

- NPDES MS4 permit compliance,
- Stormwater Management Facility maintenance and inspection,
- Watershed Management and Monitoring,
- Community Involvement

The SWMD will undertake, with cooperation from other State, and County agencies and local groups, the proposed projects involving design and construction of new and retrofit stormwater management systems including bioretention facilities, ponds and shallow marshes. The SWMD will also be responsible for the proposed stream restoration and outfall stabilization projects.

The SWMD currently manages open-end design and construction contracts that will be the primary vehicle for accomplishing these types of projects.

Howard County Department of Recreation and Parks Natural Resources Operations will be the primary entity responsible for implementing the reforestation projects. The Natural Resources Operations section is responsible for conservation and natural resource management activities. More specifically the Forest Mitigation / Reforestation unit will take a lead role, with community and volunteer support, in the planting and maintenance of the proposed reforestation areas. The following sections highlight specific programs that will be used to implement the reforestation activities.

Stream ReLeaf

The Stream ReLeaf Program was initiated by the SWMD in 2003 as part of the implementation of the Little Patuxent River WRAS. The Program has grown and expanded in scope significantly over the years, and is now managed by the Natural Resources Division of the Department of Recreation and Parks.

Stream ReLeaf is a program designed to enhance riparian (stream) buffers by providing free native trees and shrubs to homeowners. The homeowner commits to planting the trees and shrubs on their property and the County delivers the requested plants free of charge. Requirements for the program are as follows: the area that the homeowner is willing to plant must be within 75 feet of a stream (rights-of-way are not eligible); and the homeowner must commit to planting at least 12 trees.

Since the program began in 2003, 120 homeowners have participated resulting in the planting of almost 4,000 trees. Past performance is presented in Table 12.

Table 12: Stream Re-Leaf Program

Year	Number of Participants	Number of Trees Planted
2003	8	103
2004	15	468
2005[1]	1	100
2006	37	1374
2007	31	1208
2008[2]	28	716
Total	120	3969

[1]Program not staffed.

[2]Some 2008 plantings rescheduled for Spring 2009.

In 2009, this program will extend its range of services to incorporate plantings on HOA properties, and the utilization of a contractor to install plants on resident's property when the resident commits to a minimum of 100 plants.

The Private Forest Conservation Establishment (PFCE) Program

Howard County, through the Department of Planning and Zoning and the Department of

Recreation and Parks, recently created the new Private Forest Conservation Establishment (PFCE) program. The PFCE program is designed to create forest conservation easements on private properties on a maximum of 50 acres in one or more easements. Funding for the program is provided by Howard County's Forest Conservation Act established in 1993. The Act was established to reduce the number of forested acres cleared when land is developed for residential, commercial or industrial use.

The Department of Recreation and Parks is responsible for site selection, development of forest conservation plans, preparation and recordation of forest conservation easement plats and agreements, site preparation, installation of forest plantings and management of plantings for a two year period. Forest conservation plans conform to the Howard County Forest Conservation Manual and easements created will remain in perpetuity.

To be considered for the PFCE program, properties must be ten acres or larger and forest conservation planting sites on these properties must be one acre or larger. Areas under federal or state programs that provide funds for similar tasks are not eligible. Planting on properties that are encumbered by another preservation easement must comply with the policy for forest planting on such easements.

Sites will be chosen to maximize water quality and habitat benefits, based on the following criteria:

- Meet or exceed minimum stream or wetland buffer requirements
- Located in stream headwater areas
- Located in the Patuxent Reservoirs water supply watershed
- Expand existing forest areas to increase forest interior habitat
- Connect adjacent forest areas to create wildlife corridors

Two sites in the County have already been planted totaling just over nine acres and buffering over 4,000 feet of stream and over 400 feet of wetland boundary. Two additional sites have been approved for planting in fall 2009, adding another 10 acres of forest and buffering just over 6,000 feet of stream. Additional participants are awaiting approval. If approval for these participants is gained, the program will have garnered over 30 of the 50 acres of forest conservation the program is funded for. Due to the success of the PFCE Program in its first year the Department of Recreation and Parks hopes that it may become a permanent fixture as part of the County's environmental initiative.

Implementation Support

While the SWMD and Natural Resource Operations section will be primarily responsible for the implementation of the proposed projects. They may seek support from other state and county agencies and local organizations to aid them in meeting the goals of the plan. Some of these groups are listed here, in no particular order.

- Maryland Department of the Environment
- Maryland Department of Natural Resources
- Maryland Department of Planning
- Howard County Office of Environmental Sustainability
- Howard County Department of Planning and Zoning
- Howard County Soil Conservation District
- Howard County Master Gardeners
- Howard County Forestry Board
- Columbia Association
- Patuxent Tributary Strategy Team – Patuxent River Commission
- Alliance for the Chesapeake Bay

4.2 Tier Ranking of Projects

Because of limited resources all of the 68 identified projects cannot be implemented immediately and County managers need to know which projects should be implemented with higher priority and what their cost will be. A qualitative benefit analysis was completed to aid in prioritizing the projects. The process used to rank the projects is very similar to that used to first determine the candidate sites that would have completed concept plans developed.

Each project was rated based on how effectively it met each of the benefit and constraint criteria outlined in Table 10. Total scores for each project, with the exception of the buffer restoration and reforestation projects were tallied and each was placed in a Tier category based on a percentile-based (using natural breaks) tier rank for both benefits and constraints according to the following breakout in Table 13.

Table 13: Percentile Ranking of Benefits and Constraints

Benefits		Constraints	
0 – 24%	Tier 1	0 – 19%	Tier 1
25 – 74%	Tier 2	20 – 39%	Tier 2
75 – 85%	Tier 3	40 – 59%	Tier 3
85 – 100%	Tier 4	60 – 79%	Tier 4
		80 – 100%	Tier 5

Those projects with the greatest benefit (Tier 1) and least constraint (Tier 1) would receive a higher priority and should be scheduled for full design and construction ahead of lower priority projects. All projects are listed with their tier ranking in Appendix A.

Implementation of the structural projects (i.e., new ponds, pond retrofits and other BMPs) will directly treat 163 acres of the estimated 966 acres required to be treated under the current NPDES permit.

Completion of non-structural projects (i.e., stream and buffer restoration) adds water quality benefits, but the effect is not easily quantified. Baltimore City, in their annual NPDES report, estimated that one acre of impervious area generates the equivalent phosphorus load as 16.25 feet of stream (City of Baltimore, 2007.) This value is based on preliminary research completed on Baltimore City streams. Because the data is preliminary, the City reduced their estimated treatment area by 50 percent such that restoring 16.25 feet of stream is equivalent to treating ½ acre of impervious area. In the ULPR watershed, approximately 7,585 linear feet of stream restoration is recommended. Using estimates similar to those used by Baltimore City, this will treat the equivalent of 233 acres of impervious.

The combined total impervious area treated between structural and stream restoration projects is approximately 396 acres, or 41 percent of the 966 acres of impervious required to be treated under the current permit. Other non-structural steps such as street-sweeping, disconnecting impervious and education are also methods that are already or can be employed for treating impervious area. However, the success of these methods is not easily measured and therefore not used in accounting for treated impervious area.

Red Hill Branch

The County has selected the Red Hill Branch subwatershed as the first area to focus restoration efforts. The subwatershed was the number 1 priority subwatershed (see Table 8). The County currently has several projects in the subwatershed underway (Autumn Harvest stream repair, Brampton Hills Pond Retrofit, and Bramhope Stream restoration) and will focus restoration and monitoring in this area in an effort to demonstrate project scale and watershed scale reductions as a result of the implemented treatments. Proposed Red Hill Branch projects in this ULPR study include:

- Three stormwater projects treating 8.44 impervious acres costing $414,000
- Eight stream restoration projects treating 1660 linear feet totaling $2.25 million
- Four reforestation projects replanting 6.9 acres totaling $92,000

A description of the monitoring plan for the Red Hill Branch restoration is located in section 4.5.

4.3 Funding Requirements and Sources

A summary of the planning level cost estimates are provided below in Table 14. Costs associated with individual projects can be found in summary sheets provided in Appendix A and with each concept plan in Appendix B.

Table 14: Project Type and Cost

		Number of Projects	Capital	Life Cycle
Streams	Public	14	$ 7,586,553	$ 7,927,300
	Private	1	$ 396,825	$ 435,800
	Total	15	$ 7,983,378	$ 8,363,100
Stormwater	Public	25	$ 5,940,120	$ 8,064,200
	Private	6	$ 1,012,646	$ 1,367,200
	Total	31	$ 6,952,766	$ 9,431,000
Reforestation	Public	14	$ 304,856	$ 356,200
	Private	9	$ 218,576	$ 255,400
	Total	23	$ 523,432	$ 611,600
	Grand Total	71	$ 15,402,470	$ 18,339,400

The typical capital budget for the SWMD ranges from approximately $1 to $2 million per year. There is no guarantee, however, if and how much capital will be funded in any given year. While some of the project's monitoring costs that are included in the cost summary above might be funded from the Division's operating budget, most of the $15.4 million total for streams and stormwater would need to be funded by the capital budget.

These recommended projects are also competing against an existing backlog of projects, and projects requiring emergency repair to ensure public safety. SWMD project managers will utilize this WMP when selecting projects and phasing them into their annual capital budgets.

There is obviously a budget shortfall which could make implementation of these projects through County funding alone a very slow process. A list of additional funding sources is provided below. Those listed are by no means complete and additional sources can be investigated. If any particular project is limited enough in its scope and monetary/staffing requirement, existing staff and program resources may be adequate.

Many of the individual projects are costly, will require additional staff time and are presently beyond the existing capacity of the primary responsible party. To meet the goals of the WMP, the County will need to seek additional program funds and/or additional staff. To supplement current resources, Federal, State and private grant, cost share and loans programs are available.

The implementation of the WMP should include regular review of programs and funding sources that ULPR projects would qualify for. Several funding sources are listed below.

- Buffer Incentive Program, MDNR, Forest Service
- Chesapeake Bay Small Watersheds Grants Program, National Fish and Wildlife Foundation
- Chesapeake Bay Trust
- Clean Water Action Plan Nonpoint Source Program (319 Grant)
- Conservation Reserve Enhancement Program (CREP) – for farmlands
- Environmental Quality Incentives Program (EQIP), NRCS – for farmlands
- FishAmerica Foundation (American Sportfishing Association) and NOAA Fisheries Community Based Restoration Program
- National Fish Habitat Action Plan Grant
- Five Star Restoration Grant Program, EPA
- Maryland Agricultural Water Quality Cost Share Program (MACS) – for farmlands
- Maryland Environmental Trust
- Maryland Heritage Area Authority
- Maryland Nontidal Wetlands Mitigation Program
- Maryland State Highways Administration, Transportation Enhancement Program (TEP)
- National Scenic Byways Program
- North American Wetlands Conservation Act, Standard and Small Grants Programs, USFWS
- Partners for Fish and Wildlife, USFWS
- Reforestation Income Tax Modification Program
- Rural Legacy
- Small Creeks and Estuary Water Quality Restoration Program
- State Water Quality Revolving Loan Fund
- Stormwater Pollution Control Cost Share Program
- Stream ReLeaf
- Tree-Mendous Maryland
- Watershed Assistance Grants
- Wetlands Reserve Program (WRP)
- Wildlife Habitat Incentive Program (WHIP)
- Woodland Incentive Program (WIP)

Funding opportunities are continually changing and new programs are being developed. The American Recovery and Reinvestment Act of 2009 (ARRA) was recently passed and is moving funding into federal grant programs and into state and local programs. Two projects in the County, discussed below, have already been approved for funding through this program. Funding has been allocated for infrastructure improvements and initiatives for clean waterways. Funding to Agency's such as the Environmental Protection Agency, the US Army Corps of Engineers, and the Department of the Interior should be watched closely by County managers for funding sources. In addition the federal government's 2010 budget includes $35.1 million for the EPA's Chesapeake Bay initiative.

Currently grant funds are available through the Department of the Interior funded by the Recovery Act's National Fish Habitat Action Plan and the National fish Passage Program totaling $15.8 million. These types of sources should be aggressively sought by the County.

Recent Funding Progress

Howard County has recently been successful in securing funding through several avenues and partnerships. The County partnered with the US Army Corps of Engineers for the completion of the SCA for this project.

Two projects in the Red Hill Branch subwatershed will receive funding from outside sources. The County is currently designing the Brampton Hills Stream Restoration Project in the Red Hill Branch subwatershed, which is scheduled for construction in the Summer of 2010. The project is currently slated to receive a Transportation Enhancement Project (TEP) grant, which is administered by Maryland State Highway Administration, as well as a $500,000 grant from the State's Fiscal Year 2010 capital budget, which is administered by MDE.

The County has also received funding from the Chesapeake and Atlantic Coastal Bays 2010 Trust Fund for a Local Implementation Grant. The County partnered with the Columbia Association and General Growth Properties for implementing projects in the Little Patuxent watershed. To date the County has received notice of $1.47 million to be evenly divided between the County and the Columbia Association. This funding is for Fiscal Years 2009 and 2010 and will be used towards implementation and monitoring aimed at reducing priority pollutants, nitrogen, phosphorus and total suspended solids. The County will use much of this money to focus on restoration and monitoring of the Red Hill Branch Subwatershed.

The grant amounts noted above for the State Fiscal Year 2010 and Chesapeake Bay 2010 Trust Fund are current as of the time that this ULPR WMP document was finalized. Future State budget cuts, due to the bad economy, may cause the final grant amounts to decrease.

The ARRA is currently providing construction funding through the EPA and MDE for two projects in the County. The Baltimore Washington Industrial Park Stormwater Retrofit Project in the Dorsey Run subwatershed (a tributary to the Little Patuxent River) will receive $182,500 toward construction costs. The Tall Maple Court Stream Restoration Project, which involves restoration of approximately 250 feet of stream along a tributary to Bonnie Branch (in the Patapsco River watershed), will receive $120,074 toward construction costs.

4.4 Community Involvement

Community input and active participation are an important part of the WMP development process and a key element of successfully implementing the watershed management plan. Outreach and educational activities conducted in the development of the WMP are considered to be an active part of the implementation of the plan. During the development of the WMP, public meetings, websites and site visits to individual homeowners were the primary means of distributing information to the public and receiving their comments and suggestions.

The first of two public meetings to discuss the ULPR Watershed plan was held on June 3, 2008 at the Ellicott City Senior Center. This meeting was well-attended with approximately 55 residents and other interested individuals. Several topics were covered in this first public meeting including an overview of the current conditions in the ULPR watershed, management goals and strategies to attain these goals. The overview included discussion of the existing land use and impervious cover in the watershed, current stormwater management, results of the 2007 stream corridor assessment and outlined the priority areas for management. General management strategies for water quality were also presented. Follow-up meetings with several residents concerning stream related problems on their property resulted from the June 3 meeting.

The second public meeting was held at Burleigh Manor Middle School on March 24, 2009. Approximately 35 attendees were present for this meeting. The primary goal of the second meeting was to present the results of the field search for candidate sites for restoration. Sixty-five of the 68 proposed projects were presented.

At both meetings the citizens were provided with information about watersheds, how they function, what causes impairment, and what the County is doing to protect and restore their natural areas and waterways. More importantly, education on ways the public can be involved and be good stewards was presented to encourage active participation.

To monitor the effectiveness of the public meetings a questionnaire was used for the June 3, 2008 meeting. Of the 55 attendees there were 31 respondents. The following basic information was gleaned from the results.

- 87 percent felt that they learned something new about the ULPR watershed
- 87 percent were satisfied with the level of material provided
- 68 percent said they would be involved in future activities
- 23 of the respondents gave details on specific issues and concerns

The County followed up immediately with 20 specific requests for information (copy of presentation, SCA data specific to their property) and site visits. The County also made five site visits based on these requests. This type of engagement is very positive for building relationships and promoting the goals of the WMP.

The presentations for both meetings can be found at the County's Upper Little Patuxent Watershed Management Plan website located at: http://www.co.ho.md.us/DPW/wras.htm. This website also includes a map with links to the proposed projects discussed in the management plan and other completed watershed studies.

Homeowners and residents are encouraged to continue to take an active role in the implementation of the WMP through activities such as those listed in Section 3.5. Additionally, interested residents are encouraged to educate others in their neighborhood who may be unaware of their impact on overall watershed health.

4.5 Monitoring Program, Success Tracking

While each management strategy type will be tracked for completion and monitored for implementation success individually, broader scientifically based monitoring and analysis is required to demonstrate a quantifiable effect. To draw conclusions with confidence the monitoring needs to be long term, regular, and be wide enough in its coverage that conclusions can be drawn at the project, subwatershed and even watershed level. The following general monitoring strategies should be used to track effectiveness at the site level and for the overall condition of the ULPR and its subwatersheds. It is cost prohibitive however for every County project to be monitored in a very detailed manner. Detailed monitoring and analysis results from one project can be extrapolated to other projects of similar type and size.

Stream Restoration

- Stream restoration sites should be monitored to ensure the goals of the project have been met and that the design and construction are stable. Monitoring includes physical channel measurements and assessment of the design features and bank stabilization techniques. Additionally the site should be monitored to detect habitat enhancement and pollutant loading reductions.

Stormwater

- Stormwater BMPs should be monitored for effectiveness and to quantify rates of pollutant removal. Data from a well-monitored project site could be extrapolated to other similar sites, thus saving County resources. Flows and pollutants into the system and out of the system should be monitored before the project is in place to determine a baseline condition and after the project is complete. Differences in pollutant loadings before and after and upstream and downstream will determine the effectiveness of the BMP.

Reforestation Monitoring

- Riparian buffer plantings at the project site level should be monitored for survivability rates and to ensure that sites are properly protected and maintained. Assessment of invasive species should be included.
- Riparian buffer planting and reforestation efforts should be tracked at the subwatershed and watershed levels. Data from various programs buffer planting programs such as Stream Releaf and the Forest Conservation Program should be compiled to track the full extent of buffer plantings and areal and percent forest cover.

On-going Monitoring

Data from several regular monitoring programs can be integrated into the monitoring program for the ULPR.

- Howard County Biological Monitoring Program. The County conducts biological, physical habitat, water quality, and geomorphological monitoring in three watershed sampling units per year such that all watersheds are sampling on a five year rotating basis. This program should be continued to detect long-term trends.
- Howard County NPDES Discharge Characterization Monitoring. The County conducts regular baseflow and stormflow water quality monitoring in addition to collecting physical biological data to characterize runoff. The County can potentially coordinate its NPDES site to supplement the monitoring program.
- Maryland Biological Stream Survey (MBSS) data from both random and sentinel sites should be used to supplement County efforts. The data includes indicators of stream health such as water quality, macroinvertebrates, fish and physical habitat.
- Continued monitoring and data share with volunteer efforts such as the MDNR's Stream Waders program and Howard County's Stream Team.

Red Hill Branch

- As mentioned above in the near term the County is focusing restoration and monitoring efforts in the Red Hill Branch and has been awarded 2010 Trust Fund monies to assist in the implementation.
- Monitoring will be targeted on Nitrogen, Phosphorus and Sediment.
- After consultation with the Maryland Department of Natural Resources (DNR) the County is going to undertake a two pronged approach. The primary monitoring strategy is project specific monitoring in addition to a more secondary watershed scale approach.
- The Project Specific approach uses a 'Before, After, Upstream (Control), Downstream (Impact)' design at specific project sites. This approach will be targeted to get more immediate results than a watershed based approach would allow. Additionally by positioning the monitoring sites immediately upstream and downstream of projects, most uncontrolled watershed variables will be eliminated therefore differences in water quality and quantity from upstream to downstream will be more attributable to the project. In general uncertainty in the data will be reduced. Because stormwater BMP retrofits and stream restoration projects are the most prevalent types of projects proposed in Red Hill they have been selected as the types of projects to monitor. One representative project from the two types will be selected.

- The watershed scale approach will be limited to biological and physical habitat monitoring at three locations and one off-site watershed control to detect a biological response to the management efforts.
- Baseflow and stormflow water quality monitoring at the watershed scale will also take place. An automated sampler at Meadowbrook Park is at the bottom of the watershed downstream of 90% of the Red Hill Branch proposed projects. It will serve to detect changes in the primary pollutants at the watershed scale (sediment sampling will include measures of bedload, washload and suspended load). No control site is proposed and the data will rely on detection of trends in pollutant loads over time.

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APPENDIX A

All maps for Appendix A and linked project write-ups for Appendix B can be found on the Watershed Study Results Map on the Howard County watershed studies website:
http://www.co.ho.md.us/DPW/wras.htm

The Watershed Study Results Map displays information on both candidate sites and potential project sites. Candidate sites are those sites that were field-visited but for which no project was proposed. Potential project sites are those sites for which a project is proposed. Write-ups for these projects can be viewed by selecting the live link for the project on the map.

Structural Projects

Project No.	Project Type Based on Initial Field Survey	Subwatershed	Total Drainage Area (acres)/Total Area (Reforestation)	Impervious Area Treated (acres)	Concept Plan Completed	Concept Plan Name
PT1_01	Pond New (above roadway culverts - Storage/WQ swale/bioret.)	Plumtree Branch 1	164.3	34.2	No	
1923	Bioretention -Filtration at park - Quantity retrofit	Little Patuxent 2	29.7	6.4	No	
1561_1562_1565_1566	Pond Retrofit (Dry to Wetland/Storage)	Plumtree Branch 2	4.2	1.8	No	
1629_1630A	Pond New (storage above roadway culvert)	Font Hill 1	54.1	14.9	Yes	1629_1630B_Stream
1714_1715_1713	Pond New (wetland/storage)	Red Hill Branch	11.8	3.7	No	
FH1_01	Pond Retrofit (More Storage)	Font Hill 1	27.2	6.2	Yes	FH1_01_Pond_Retrofit
FH1_02	Pond Retrofit (Dry to Wetland)	Font Hill 1	5.3	1.1	No	
FH1_03	Pond Retrofit (Bioretention/Infiltration - filtration)	Font Hill 1	1.0	0.8	No	
FH1_04A	Pond Retrofit (Dry to Wetland)	Font Hill 1	4.8	2.8	Yes	FH1_04A_Pond_Retrofit
FH1_04B	Bioretention/Sand Filter - Filtration	Font Hill 1	0.5	0.3	Yes	FH1_04B_Bioretention
FH1_04C	Bioretention/Sand Filter - Filtration	Font Hill 1	2.5	1.3	Yes	FH1_04C_Bioretention
FH1_04D	Pond New (Quantity - Storage)	Font Hill 1	10.3	5.5	No	
FH1_05	Pond Retrofit (Dry - more storage)	Font Hill 1	7.4	1.3	No	
FH2_01	Bioretention/Sand Filter - filtration (above roadway culvert)	Font Hill 2	1.0	0.3	Yes	FH2_01_Storage_area
FH2_02	Bioretention/Sand filter - Filtration	Font Hill 2	3.8	1.2	No	
FH2_03	Pond Retrofit (Dry to Wetland)	Font Hill 2	21.7	4.5	No	
LPX1_01	Pond Retrofit (More Storage)	Little Patuxent 1	6.5	1.6	No	
LPX1_02	Pond Retrofit (Dry to Wetland/Storage - Channel Protection)	Little Patuxent 1	78.1	18.2	Yes	LPX1_02_Pond_Retrofit
LPX1_03	Pond Retrofit (More Storage)	Little Patuxent 1	12.1	2.4	No	
LPX1_04A	Pond Retrofit (Dry to Wetland/Storage - Channel Protection)	Little Patuxent 1	21.6	3.6	Yes	LPX1_04A_Pond_Retrofit
LPX1_04B	Pond Retrofit **(Will be part of 4A)**	Little Patuxent 1	7.7	3.0	No	
LPX1_05A	Pond Retrofit (Dry to Wetland/Storage - Channel Protection)	Little Patuxent 1	41.8	9.6	Yes	LPX1_05A_Pond_Retrofit
LPX1_05B	Pond Retrofit **(Will be part of 5A)**	Little Patuxent 1	0.7	0.3	Yes	LPX1_05B_depression
LPX1_06	WQ Swale	Little Patuxent 1	3.4	1.7	Yes	LPX1_06_WQ swale
LPX1_07	Biroretention/Filtration (above roadway culvert)	Little Patuxent 1	8.4	1.5	No	
LPX1_08	Biroretention/Filtration	Little Patuxent 1	7.6	2.1	No	
LPX1_10	Pond Retrofit (Wetland/Wet Pond)	Little Patuxent 1	12.4	3.2	No	
LPX1_12	Bioretention	Little Patuxent 1	0.5	0.3	No	
LPX2_01	Pond Retrofit (Dry to Storage/Channel Protection)	Little Patuxent 2	7.7	2.2	Yes	LPX2_01_Pond_Retrofit
LPX2_02	Pond New (storage above roadway culvert)	Little Patuxent 2	19.7	5.2	No	
LPX2_03	Pond Retrofit (Dry to Wetland/Storage)	Little Patuxent 2	30.2	5.6	Yes	LPX2_03_Pond_Retrofit
LPX2_04	Pond Retrofit (Dry to Wetland/Storage)	Little Patuxent 2	19.3	3.3	Yes	LPX2_04_Pond_Retrofit
LPX2_05	Pond Retrofit/Repair (Fix Storage)	Little Patuxent 2	2.6	1.3	No	
LPX2_06	Bioretention/Grass Swale	Little Patuxent 2	1.1	0.5	No	
LPX2_07	Pond Retrofit (Dry to Wetland)	Little Patuxent 2	14.1	9.7	No	
LPX2_08	Pond Retrofit (Dry to Wet) - No conversion	Little Patuxent 2	1.6	0.7	No	
LPX2_09	Pond Retrofit (Dry to Wetland/Storage)	Little Patuxent 2	10.8	2.9	No	
LPX2_10	Bioretention	Little Patuxent 2	1.0	0.6	No	
LPX2_11A	Pond New (wetland/some quantity)	Little Patuxent 2	28.2	6.7	No	
LPX2_11B	New WQSwale	Little Patuxent 2	2.1	0.6	No	
LPX3_01	Pond New (storage/wetland-above roadway culvert)	Little Patuxent 3	18.7	3.4	No	
LPX3_02	Pond Retrofit (Dry to Wetland)	Little Patuxent 3	9.4	3.1	No	
LPX3_03	Pond New (wet/storage)	Little Patuxent 3	36.7	8.9	No	
LPX3_04	Pond Retrofit (Dry to Wetland)	Little Patuxent 3	23.8	6.4	No	
LPX3_05	Pond Retrofit (Dry to Wet Pond)	Little Patuxent 3	23.3	4.2	Yes	LPX3_05_Pond_Retrofit
LPX3_06	Pond Retrofit (Quantity/Storage - Instream)	Little Patuxent 3	56.9	12.2	No	

Structural Projects

Project No.	Project Type Based on Initial Field Survey	Subwatershed	Total Drainage Area (acres)/Total Area (Reforestation)	Impervious Area Treated (acres)	Concept Plan Completed	Concept Plan Name
LPX3_07	Pond Retrofit (Dry to Wetland)	Little Patuxent 3	7.3	2.2	No	
LPX3_08	Pond Retrofit (Dry to Wetland)	Little Patuxent 3	5.2	1.2	No	
LPX3_09	Pond New bio/inf. - filtration	Little Patuxent 3	9.0	4.6	Yes	LPX3_09_Bioretention_Infiltration
LPX3_10	Pond Retrofit (Dry to Wet pond)	Little Patuxent 3	5.0	0.9	No	
LPX3_11	Pond Retrofit (Dry to Wetland)	Little Patuxent 3	8.5	2.4	No	
LPX3_12	Bioretention/Sand Filter - Filtration	Little Patuxent 3	1.8	1.1	No	
LPX3_13	Pond New (wet/storage)	Little Patuxent 3	24.0	6.4	Yes	LPX3_13_New_Pond
LPX4_01	Pond Retrofit (Dry to Bioret./Sand Filter - Filtration)	Little Patuxent 4	1.2	0.8	No	
LPX5_01	Pond Retrofit (Dry/Micropool to wetland)	Little Patuxent 5	25.8	2.1	No	
LPX5_02	Pond Retrofit (Dry/Micropool to Wet pond)	Little Patuxent 5	8.9	1.3	Yes	LPX5_02_Pond_Retrofit
LPX5_03	Wet Pond Retrofit - Frog Pond	Little Patuxent 5	5.9	0.7	No	
LPX5_04	Rain Garden Creation	Little Patuxent 5	0.7	0.2	No	
PT1_01	Storage Area	Plumtree Branch 1	164.0	34.0	Yes	PT1_01_storage area
PT1_02A	Bioretention	Plumtree Branch 1	0.7	0.2	Yes	PT1_02A_Bioretention
PT1_02B	Bioretention	Plumtree Branch 1	4.3	2.3	Yes	PT1_02B_shallowmarsh
PT1_03	Pond Retrofit (Dry to Wetland/Wetpond)	Plumtree Branch 1	9.1	3.3	Yes	PT1_03_Pond_Retrofit
PT1_04	Bioretention - Remove imp. Driveway	Plumtree Branch 1	1.8	1.2	Yes	PT1_04_Bioretention
PT1_05	Bioretention	Plumtree Branch 1	0.3	0.2	No	
PT1_06A	Bioretention	Plumtree Branch 1	3.5	2.9	No	
PT1_06B	Pond New (storage/wetland)	Plumtree Branch 1	9.3	5.6	No	
PT1_07	Pond New (wetland/wet pond/storage)	Plumtree Branch 1	43.5	13.5	Yes	PT1_07_New_Pond
PT1_08	Bioretention	Plumtree Branch 1	6.9	3.8	No	
PT2_01	Bioretention	Plumtree Branch 2	2.2	1.5	Yes	PT2_01_Bioretention
PT2_02	Pond Retrofit (Dry to Wetpond/Storage)	Plumtree Branch 2	27.0	6.5	Yes	PT2_02_Pond_Retrofit
PT2_03	Pond Retrofit (Dry to Wetpond/Storage)	Plumtree Branch 2	12.5	3.3	Yes	PT2_03_Pond_Retrofit
PT2_04	Pond Retrofit (Dry to Wetpond)	Plumtree Branch 2	18.1	4.2	No	
PT2_05	Pond Retrofit (Dry to Wetland)	Plumtree Branch 2	8.8	2.4	No	
PT2_06	Pond Retrofit (Dry to Wetland/Storage)	Plumtree Branch 2	2.8	2.0	No	
PT2_07	Pond Retrofit (Dry to Wetland/Storage)	Plumtree Branch 2	25.2	5.2	Yes	PT2_07_Pond_Retrofit
PT2_08	Pond Retrofit (Dry to Wetland)	Plumtree Branch 2	3.7	1.2	No	
PT2_09A	Bioretention	Plumtree Branch 2	0.6	0.3	No	
PT2_09B	Bioretention	Plumtree Branch 2	2.4	0.7	No	
PT2_09C	Bioretention/Inlet Treatment	Plumtree Branch 2	1.4	0.5	No	
PT2_10C	Pond Retrofit (Dry to Wetland)	Plumtree Branch 2	2.0	0.2	No	
PT2_11	Pond Retrofit (Wetland/Storage)	Plumtree Branch 2	4.7	1.1	No	
RHB_02	Pond Retrofit (Storage)	Red Hill Branch	3.0	0.8	No	
RHB_03A	Pond Retrofit (Dry to Wetland/Storage)	Red Hill Branch	19.9	3.3	Yes	RHB_03A_Pond_Retrofit
RHB_03B	Pond Retrofit (Dry to Wetland/Storage)	Red Hill Branch	15.8	4.4	Yes	RHB_03B_Pond_Retrofit
RHB_04	Pond New (wetland/storage)	Red Hill Branch	27.0	7.0	No	
RHB_06	Pond Retrofit (Storage)	Red Hill Branch	63.5	14.8	No	
RHB_07	Pond Retrofit (Storage)	Red Hill Branch	148.3	36.0	No	
RHB_08	Bioretention, pavement removal	Red Hill Branch	1.6	0.7	Yes	RHB_08_Bioretention
RHB_09	Pond Retrofit (Dry to Wetland)	Red Hill Branch	36.6	12.7	No	
RHB_10A	Bioretention	Red Hill Branch	0.5	0.5	No	
RHB_10B	Bioretention	Red Hill Branch	0.9	0.7	No	
RHB_13	Pond Retrofit (Dry to Wetland)	Red Hill Branch	5.6	1.3	No	
RHB_14B	Pond New (storage)	Red Hill Branch	3.3	1.5	No	

Stream Restoration Projects

Project No.	Project Type Based on Initial Field Survey	Subwatershed	Total Drainage Area (acres)/Total Area (Reforestation)	Impervious Area Treated (acres)	Concept Plan Completed	Concept Plan Name
1223	Stream Restoration	Red Hill Branch	na	na	Yes	1223_Stream
1216	Stream/Ditch Stabilization - Bioret./Pavement Removal	Red Hill Branch	na	na	Yes	1216_Stream
1668	Stream Restoration/Utility	Red Hill Branch	na	na	Yes	1668_Stream
1435_1436_1438_1440	Stream Restoration	Little Patuxent 1	na	na	Yes	1435_1436_1438_1440_1442_1441_Stream
1446_1448_1453_1443	Stream Restoration	Little Patuxent 1	na	na	No	
1461_1462_1463_1464	Stream Restoration/Outfall Stabilization	Little Patuxent 1	na	na	Yes	1461_1462_1463_1464_Stream
1524_1529_1532_1534	Stream Restoration	Font Hill 1	na	na	No	
1570_1615	Stream Restoration/Buffer	Plumtree Branch 1	na	na	No	
1601_1603_1592_1599	Stream Restoration	Plumtree Branch 2	na	na	No	
1629_1630B	Stream Restoration/Utility	Font Hill 1	na	na	Yes	1629_1630B_Stream
1650_1651	Stream Restoration	Red Hill Branch	na	na	No	
1689_1690	Stream, Bank, Outfall Stabilization	Red Hill Branch	na	na	Yes	1689_1690_Stream
1704_1710_1711	Stream Restoration	Red Hill Branch	na	na	Yes	1704_1708_1710_1711_1712_Stream
1714_1715_1713	Stream Restoration - Avoca Ave.	Red Hill Branch	na	na	Yes	1714_1715_1713_Stream
1727_1726_1722_1721	Stream Restoration, Buffer	Red Hill Branch	na	na	Yes	1727-1726-1722-1727_Stream
1752A	Remove Concrete from Stream/Buffer	Red Hill Branch	na	na	Yes	1752_JopendaDrive_Stream
1827_1828_1829	Stream Restoration/Buffer	Plumtree Branch 2	na	na	Yes	1827_1828_Stream
1836_1839_1840_1842	Stream Restoration/Buffer	Plumtree Branch 2	na	na	Yes	1836__1839_1840_1842_Stream
1914_1915_1912	Stream Restoration/Outfall Stabilization	Little Patuxent 2	na	na	Yes	1914_1915_Stream
1971_1967_1956_1955	Stream Restoration/Stabilization	Little Patuxent 2	na	na	No	
640 - HART	Mr. Hart's Riverside Circle Mainstem Erosion	Little Patuxent 1	na	na	No	
LPX1_09	Stream Restoration/Stabilization	Little Patuxent 1	na	na	No	
LPX1_11	Outfall Stabilization	Little Patuxent 1	na	na	No	
PT1_09	Stream Restoration	Plumtree Branch 1	na	na	No	
PT2_12	Outfall Stabilization/Restoration	Plumtree Branch 2	na	na	Yes	PT2_12_Stream
RHB_17	Stream Restoration	Red Hill Branch	na	na	No	

Buffer/Reforestation Projects

Project No.	Project Type Based on Initial Field Survey	Subwatershed	Total Drainage Area (acres)/Total Area (Reforestation)	Impervious Area Treated (acres)	Concept Plan Completed	Concept Plan Name
BF1	Buffer Restoration	Little Patuxent 3	1.42	na	No	
BF2	Buffer Restoration	Little Patuxent 3	4.42	na	Yes	BF2 Reforestation
BF3	Reforestation	Little Patuxent 3	5.80	na	No	
BF4	Buffer Restoration/Reforestation	Little Patuxent 3	1.94	na	No	
BF5	Reforestation	Little Patuxent 3	4.31	na	No	
BF6	Buffer Restoration	Font Hill 1	0.17	na	Yes	BF6 Buffer Replacement
BF7	Buffer Restoration	Font Hill 1	1.03	na	Yes	BF7 Buffer Replacement_Reforestation
BF8	Buffer Restoration	Little Patuxent 5	3.34	na	Yes	BF8 Buffer Replacement_Reforestation
BF9	Reforestation	Little Patuxent 2	0.06	na	Yes	BF9 Reforestation
BF10	Buffer Restoration	Plumtree Branch 2	0.16	na	Yes	BF10 Buffer Replacement
BF11	Buffer Restoration	Plumtree Branch 2	0.26	na	Yes	BF11 Buffer Replacement;
BF12	Buffer Restoration	Plumtree Branch 2	0.13	na	Yes	BF12 Buffer Replacement;
BF13	Buffer Restoration	Plumtree Branch 2	0.71	na	Yes	BF13 Buffer Replacement;
BF14	Buffer Restoration	Plumtree Branch 2	0.65	na	Yes	BF14 Buffer Replacement;
BF15	Buffer Restoration	Plumtree Branch 2	0.12	na	Yes	BF15 Buffer Replacement;
BF16	Reforestation	Plumtree Branch 1	0.27	na	No	
BF17	Buffer Restoration	Plumtree Branch 1	0.47	na	No	
BF18	Buffer Restoration	Plumtree Branch 1	0.94	na	Yes	BF18 Buffer Replacement
BF19	Buffer Restoration	Red Hill Branch	0.49	na	Yes	BF19 Buffer Replacement_Reforestation
BF20	Buffer	Red Hill Branch	16.05	na	No	
BF21	Buffer Restoration	Plumtree Branch 1	1.56	na	Yes	BF21 Buffer Replacement
BF22	Buffer Restoration	Plumtree Branch 2	1.68	na	No	
BF23	Buffer Restoration	Plumtree Branch 2	0.49	na	No	
BF24	Buffer Restoration	Plumtree Branch 2	0.08	na	No	
BF25	Buffer Restoration	Little Patuxent 1	0.07	na	No	
BF26	Reforestation	Little Patuxent 1	2.04	na	No	
BF27	Reforestation/Buffer Restoration	Red Hill Branch	0.66	na	Yes	BF27 Reforestation
BF28	Reforestation	Red Hill Branch	4.53	na	Yes	BF28 Reforestation
BF29	Buffer Restoration	Red Hill Branch	1.19	na	Yes	BF29 Buffer Replacement_Reforestation
BF30	Buffer Restoration	Plumtree Branch 1	2.19	na	Yes	BF30 Buffer Replacement
BF31	Buffer Restoration/Reforestation	Red Hill Branch	3.59	na	No	
BF32	Buffer Restoration	Red Hill Branch	1.07	na	No	
BF33	Buffer Restoration/Reforestation	Red Hill Branch	0.26	na	No	
BF34	Buffer Restoration	Red Hill Branch	0.97	na	No	
BF35	Buffer Restoration/Reforestation	Red Hill Branch	3.12	na	No	

Buffer/Reforestation Projects

Project No.	Project Type Based on Initial Field Survey	Subwatershed	Total Drainage Area (acres)/Total Area (Reforestation)	Impervious Area Treated (acres)	Concept Plan Completed	Concept Plan Name
BF36	Buffer Restoration	Red Hill Branch	2.53	na	No	
BF37	Buffer Restoration	Plumtree Branch 2	1.46	na	Yes	BF37 Buffer Replacement
BF38	Buffer Restoration	Little Patuxent 2	0.34	na	No	
BF39	Buffer Restoration	Font Hill Trib 1	1.64	na	No	
BF40	Reforestation	Font Hill Trib 1	1.62	na	No	
BF41	Reforestation	Little Patuxent 1	0.52	na	No	
BF42	Buffer Restoration	Little Patuxent 1	0.22	na	No	
BF43	Buffer Restoration	Font Hill Trib 2	8.04	na	No	
BF44	Buffer Restoration	Font Hill Trib 2	15.36	na	No	
BF45	Buffer Restoration	Font Hill Trib 2	5.26	na	No	
BF46	Buffer Restoration	Font Hill Trib 2	7.93	na	No	
BF47	Buffer Restoration	Font Hill Trib 2	4.20	na	No	
BF48	Buffer Restoration	Font Hill Trib 2	9.29	na	No	
BF49	Buffer Restoration	Font Hill Trib 1	0.14	na	No	
BF50	Buffer Restoration	Font Hill Trib 1	1.05	na	No	
BF51	Buffer Restoration	Font Hill Trib 1	0.79	na	No	
BF52	Buffer Restoration	Little Patuxent 2	0.39	na	No	
BF53	Buffer Restoration	Little Patuxent 2	1.20	na	No	
BF54	Buffer Restoration	Little Patuxent 5	1.23	na	Yes	BF54 Buffer Replacement
BF55	Buffer Restoration	Little Patuxent 5	0.38	na	No	
BF56	Buffer Restoration	Little Patuxent 3	1.79	na	No	
BF57	Buffer Restoration	Font Hill Trib 2	1.65	na	No	
BF58	Buffer Restoration	Little Patuxent 2	0.22	na	No	
BF59	Buffer Restoration	Plumtree Branch 2	0.42	na	No	
BF60	Buffer Restoration	Plumtree Branch 2	1.49	na	Yes	BF60 Buffer Replacement
BF61	Buffer Restoration	Plumtree Branch 2	4.09	na	No	
BF62	Buffer Restoration	Little Patuxent 1	1.05	na	No	
BF63	Buffer Restoration	Plumtree Branch 1	1.85	na	Yes	BF63 Buffer Replacement
BF64	Reforestation	Red Hill Branch	3.03	na	No	

Stormwater Projects Tier Ranking

									BENEFITS												CONSTRAINTS									
Project ID	Project Type	Ownership	Subwatershed	Total Drainage Area (acres)	Impervious Area Treated (acres)	Project Cost (Capital Only)	Cost per Impervious Acre Treated	Project Cost (Full Life Cycle)	Quantity Control	Quality Control	Recharge (1 or 2)	Channel Erosion	Instream Habitat	Riparian Habitat	Public Education/Outreach	Addressing Citizen Complaint	Fish Passage	Combined	Total	Benefit Rank		Permitting (forest, wetland, instream)	Adjacent Landuse	Property Ownership	Facility Access	Design/Construction	Public Safety	Water Temperature	Existing Utility Conflicts	Total	Constraint Rank
PT1_01	Storage	Public	Plumtree Branch 1	164.32	34.23	$108,350	$3,165	$133,000	1	1	1	1	1	1	2	2	2	1	13	Tier 1		1	2	3	1	2	2	2	1	14	Tier 4
1629_1630A	New Pond	Public	Font Hill 1	54.06	14.91	$247,017	$16,567	$328,300	1	3	2	1	3	3	2	2	2	2	21	Tier 4		2	1	1	1	2	1	1	1	10	Tier 2
LPX1_02	Pond Retrofit	Public	Little Patuxent 1	78.05	18.2	$403,592	$22,175	$550,900	1	1	1	1	1	1	3	2	2	2	15	Tier 1		2	1	1	2	1	3	3	1	14	Tier 4
LPX1_05A	Pond Retrofit	Public	Little Patuxent 1	41.83	9.64	$248,157	$25,742	$330,900	1	1	1	1	1	1	2	2	2	1	13	Tier 1		2	1	1	1	3	2	3	1	14	Tier 4
FH1_01	Pond Retrofit	Public	Font Hill 1	27.22	6.23	$190,731	$30,615	$252,600	1	3	2	1	3	3	3	2	2	2	22	Tier 4		1	1	1	1	1	1	1	1	8	Tier 1
RHB_03B	Pond Retrofit	Public	Red Hill Branch	15.79	4.4	$151,328	$34,393	$196,600	2	1	1	1	1	1	3	2	2	1	15	Tier 1		1	1	1	1	2	2	3	1	12	Tier 3
PT2_02	Pond Retrofit	Public	Plumtree Branch 2	26.98	6.45	$241,852	$37,496	$322,500	1	1	1	1	3	1	3	2	2	1	16	Tier 2		2	1	1	1	2	2	2	1	12	Tier 3
PT1_03	Pond Retrofit	Private	Plumtree Branch 1	9.09	3.32	$140,025	$42,176	$180,400	3	1	1	3	2	1	2	1	2	2	18	Tier 2		1	1	2	1	2	2	2	2	13	Tier 4
RHB_03A	Pond Retrofit	Public	Red Hill Branch	19.88	3.31	$140,177	$42,350	$180,600	2	1	1	1	1	1	3	2	2	1	15	Tier 1		2	1	1	1	2	2	3	1	13	Tier 4
LPX1_04A	Pond Retrofit	Public	Little Patuxent 1	21.59	3.57	$153,750	$43,067	$200,000	1	1	1	1	1	1	2	2	2	1	13	Tier 1		2	1	1	1	3	2	3	1	14	Tier 4
LPX2_03	Pond Retrofit	Public	Little Patuxent 2	30.22	5.56	$248,981	$44,781	$332,000	1	1	1	1	1	1	3	2	2	2	15	Tier 1		3	1	1	1	3	2	3	1	15	Tier 5
PT1_07	New Pond	Public	Plumtree Branch 1	43.46	13.52	$663,323	$49,062	$925,800	1	1	1	2	1	1	2	2	2	2	15	Tier 1		3	2	1	1	3	3	3	1	17	Tier 5
LPX1_06	WQ Swale	Public	Little Patuxent 1	3.44	1.7	$84,652	$49,795	$107,700	3	1	1	3	2	3	1	1	2	2	19	Tier 2		1	1	1	1	2	1	1	1	9	Tier 1
PT2_07	Pond Retrofit	Public	Plumtree Branch 2	25.16	5.17	$266,387	$51,526	$355,900	2	1	1	2	2	1	3	2	2	2	18	Tier 2		2	1	1	2	2	2	2	1	13	Tier 4
PT2_03	Pond Retrofit	Public	Plumtree Branch 2	12.52	3.34	$180,288	$53,978	$237,700	1	1	1	1	3	1	3	2	2	1	16	Tier 2		2	1	1	1	2	2	2	1	12	Tier 3
FH1_04A	Pond Retrofit	Private	Font Hill 1	4.75	2.83	$155,196	$54,840	$202,100	3	1	1	3	3	1	3	1	2	1	19	Tier 2		1	1	2	1	1	2	2	1	11	Tier 3
LPX2_04	Pond Retrofit	Public	Little Patuxent 2	19.26	3.3	$184,627	$55,947	$243,900	1	1	1	1	1	1	3	2	2	2	15	Tier 1		2	1	1	1	3	2	3	1	14	Tier 4
LPX3_09	Bioretention	Private	Little Patuxent 3	8.98	4.55	$282,074	$61,994	$395,800	1	3	1	3	1	3	2	2	2	2	20	Tier 3		1	2	2	1	1	1	1	2	11	Tier 3
LPX2_01	Pond Retrofit	Public	Little Patuxent 2	7.67	2.15	$149,003	$69,304	$193,300	1	3	2	1	2	3	2	2	2	2	20	Tier 3		1	1	1	1	1	1	1	1	8	Tier 1
LPX5_02	Pond Retrofit	Public	Little Patuxent 5	8.93	1.25	$103,399	$82,719	$125,100	3	1	1	3	2	1	2	2	2	2	19	Tier 2		1	1	1	1	2	2	1	1	10	Tier 2
PT2_01	Bioretention	Public	Plumtree Branch 2	2.16	1.52	$166,953	$109,837	$229,800	3	1	1	3	2	3	1	2	2	1	19	Tier 2		1	1	1	1	2	1	1	2	10	Tier 2
FH1_04C	Bioretention	Private	Font Hill 1	2.46	1.29	$161,122	$124,901	$221,700	3	1	1	3	3	3	3	1	2	1	21	Tier 4		1	1	2	1	1	1	1	1	9	Tier 1
LPX3_13	New Pond	Public	Little Patuxent 3	24.02	6.44	$993,724	$154,305	$1,428,900	1	1	1	1	1	1	3	2	2	2	15	Tier 1		2	3	1	2	3	3	3	1	18	Tier 5
PT1_04	Bioretention	Private	Plumtree Branch 1	1.76	1.24	$207,059	$166,983	$285,900	3	1	1	3	2	3	2	2	2	1	20	Tier 3		1	1	2	1	1	1	1	1	9	Tier 1
RHB_08	Bioretention	Public	Red Hill Branch	1.6	0.73	$122,788	$168,202	$166,100	3	1	1	3	1	3	3	2	2	2	21	Tier 4		1	1	1	1	1	1	1	1	8	Tier 1
FH2_01	Storage	Public	Font Hill 2	1.02	0.3	$52,338	$174,460	$137,300	3	1	1	3	2	3	1	2	2	2	20	Tier 3		1	1	3	1	1	1	1	1	10	Tier 2
PT1_02B	Shallow Marsh	Public	Plumtree Branch 1	4.28	2.31	$548,577	$237,479	$729,800	3	1	1	3	1	3	1	2	2	1	18	Tier 2		1	1	1	1	3	1	1	1	10	Tier 2
PT1_02A	Bioretention	Public	Plumtree Branch 1	0.69	0.2	$48,668	$243,340	$55,700	3	1	1	3	2	3	1	2	2	1	19	Tier 2		1	1	1	1	1	1	1	1	8	Tier 1
FH1_04B	Bioretention	Private	Font Hill 1	0.47	0.27	$67,170	$248,777	$81,300	3	1	1	3	3	3	3	1	2	1	21	Tier 4		1	1	2	1	1	1	1	1	9	Tier 1
LPX1_05B	Depression	Public	Little Patuxent 1	0.65	0.27	$74,250	$275,000	$80,700	1	1	1	1	1	1	2	2	2	1	13	Tier 1		2	1	1	1	3	2	3	1	14	Tier 4
LPX3_05	Pond Retrofit	Public	Little Patuxent 3	0.67	0.2	$167,210	$836,049	$219,100	3	1	1	3	1	1	2	2	2	2	18	Tier 2		2	3	1	1	2	3	3	1	16	Tier 5

Stream Restoration Projects Tier Ranking

								BENEFITS															CONSTRAINTS								
Project ID	Project Type	Ownership	Subwatershed	Linear Feet	Project Cost (Capital Only)	Cost Per Linear Foot	Project Cost (Full Life Cycle)	Quantity Control (Channel Protection, Flood Control)	Quality Control	Recharge (1 or 2)	Water Temperature	Channel Erosion	Instream Habitat	Riparian Habitat	Public Safety	Addressing Citizen Complaint	Public Education / Outreach	Fish Passage (1 or 2)	Combined	Total	Benefit Rank		Permitting (forest, wetland, instream)	Adjacent Landuse	Property Ownership	Facility Access	Design/Construction	Public Safety	Existing Utility Conflicts	Total	Constraint Rank
1216	Outfall Stabilization	Public	Red Hill Branch	250	$154,650	$619	$160,100	3	2	1	2	1	1	2	2	2	2	2	1	21	Tier 1		1	3	3	1	2	1	2	13	Tier 4
1827_1828_1829	Stream Restoration	Public	Plumtree Branch 2	2,000	$1,371,218	$686	$1,523,200	3	3	2	1	1	1	1	2	1	3	2	1	21	Tier 1		2	3	3	3	1	1	1	14	Tier 5
1461_1462_1463_1464	Utility/Outfall Repair	Public	Little Patuxent 1	325	$237,600	$731	$251,200	3	3	2	3	1	1	2	2	1	3	2	1	24	Tier 4		2	1	1	3	1	1	1	10	Tier 1
1836_1839_1840_1842	Stream Restoration	Public	Plumtree Branch 2	1,000	$967,756	$968	$1,075,000	3	3	2	1	1	1	1	2	2	3	1	1	21	Tier 1		2	3	1	1	2	1	1	11	Tier 3
1435_1436_1438_1440	Stream Restoration	Public	Little Patuxent 1	1,100	$1,081,020	$983	$1,203,000	3	3	2	1	1	1	1	1	2	3	1	2	21	Tier 1		2	3	1	2	2	1	2	13	Tier 4
1914_1915_1912	Stream Restoration	Public	Little Patuxent 2	1,000	$986,515	$987	$1,095,700	3	3	2	3	1	1	1	2	2	3	2	2	25	Tier 4		2	1	1	2	2	1	1	10	Tier 1
1689_1690	Stream Restoration	Public	Red Hill Branch	600	$713,675	$1,189	$791,300	3	3	2	3	1	1	2	2	1	3	1	1	23	Tier 2		2	3	1	1	1	1	1	10	Tier 1
PT2_12	Stream Restoration	Private	Plumtree Branch 2	300	$396,825	$1,323	$435,800	3	3	2	1	1	1	3	1	2	3	2	1	23	Tier 2		2	2	3	1	2	1	1	12	Tier 4
1629_1630B	Stream Restoration	Public	Font Hill 1	200	$290,125	$1,451	$316,700	3	3	2	3	1	1	2	1	2	3	2	2	25	Tier 4		1	3	1	1	1	1	2	10	Tier 1
1704_1710_1711	Stream Restoration	Public	Red Hill Branch	200	$302,951	$1,515	$330,600	3	2	1	2	1	1	2	1	1	3	2	1	20	Tier 1		2	3	1	1	2	1	1	11	Tier 3
1223	Stream Restoration	Public	Red Hill Branch	150	$250,110	$1,667	$272,600	3	3	1	2	1	1	2	2	2	1	2	1	21	Tier 1		2	1	1	1	1	1	1	8	Tier 1
1668	Stream Restoration	Public	Red Hill Branch	100	$168,176	$1,682	$180,900	3	3	2	2	1	1	1	2	1	3	2	2	23	Tier 2		2	3	1	1	1	1	2	11	Tier 3
1727_1726_1722_1721	Stream Stabilization	Public	Red Hill Branch	125	$210,803	$1,686	$228,600	3	3	2	2	1	1	1	1	2	3	2	2	23	Tier 2		2	3	1	2	1	1	2	12	Tier 4
1714_1715_1713	Stream Restoration	Public	Red Hill Branch	235	$411,448	$1,751	$448,200	3	3	2	2	1	1	1	2	2	2	2	1	22	Tier 2		2	1	1	1	2	1	1	9	Tier 1
1752A	Buffer Enhancement	Public	Red Hill Branch	na	$43,680	na	$50,200	3	3	2	1	2	1	2	2	1	3	2	1	23	Tier 2		2	3	3	2	1	1	1	13	Tier 4

APPENDIX B

All maps for Appendix A and linked project write-ups for Appendix B can be found on the Watershed Study Results Map on the Howard County watershed studies website:
http://www.co.ho.md.us/DPW/wras.htm

The Watershed Study Results Map displays information on both candidate sites and potential project sites. Candidate sites are those sites that were field-visited but for which no project was proposed. Potential project sites are those sites for which a project is proposed. Write-ups for these projects can be viewed by selecting the live link for the project on the map.