Lower Patapsco River

Watershed Restoration Action Strategy

Howard County, Maryland
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Executive Summary

The Lower Patapsco River watershed, located in eastern Howard County, is approximately 37.9 square miles. The watershed contains portions of Woodstock, Daniels, Ellicott City and Elkridge. The majority of the watershed is located within the County's Planned Water and Sewer Service Area, which is also the County's Priority Funding Area under Maryland's Smart Growth Initiative. As a result, substantial urban / suburban development has occurred in the watershed. The watershed contains a variety of land uses, including residential, commercial, industrial, park, open space, institutional, and agriculture.

Development in the watershed, particularly development that occurred prior to County adoption of stormwater management and environmental protection regulations, has eliminated and degraded habitat for both land and aquatic species. Stream corridor assessment surveys conducted in 2001-2004, identified pipe outfalls, the majority of which were stormwater outfalls, inadequate stream buffers and stream bank erosion sites as the most common potential problems in the watershed. An assessment of water quality, based on the amount of impervious cover, indicates that the majority of the Lower Patapsco subwatersheds are expected to have degraded water quality and stream habitat. A stream biological assessment conducted in 2003 found that the watershed rated as poor for biological health and partially-supporting for physical habitat.

This Lower Patapsco Watershed Restoration Action Strategy (WRAS) includes a watershed restoration plan and implementation strategy that will serve as a work plan for protecting and restoring water quality and aquatic and terrestrial habitats, and for addressing the need for environmental outreach and education within the watershed. The WRAS defines goals and objectives for water quality, habitat and public outreach, and lists tools and actions that will help achieve these goals and objectives for the watershed. These tools and actions address land conservation, riparian buffers, better site design, erosion and sediment control, stormwater best management practices, other discharges, stream channel stabilization and restoration, habitat and wildlife management, watershed stewardship programs, and subwatershed studies. The actions are categorized into priority implementation categories to establish a work plan for the next fifteen years. Many of these actions will be expensive to implement and will require additional County funding and staff. Possible supplemental funding sources outside the County, including Federal, State and nongovernmental grants and loans, will be pursued to assist implementation efforts.

Implementing the Lower Patapsco Watershed Restoration Action Strategy will require a cooperative effort among the primary County agencies responsible for environmental activities - the Departments of Planning and Zoning, Public Works, and Recreation and Parks. The County's Environmental Steering Committee, which is comprised of representatives from these and other related agencies, such as the Howard Soil Conservation District, will provide the mechanism for coordinating and tracking these efforts.

Watershed Vision

The central theme of the Howard County General Plan 2000 is that we - individual citizens, businesses, community organizations and government agencies - are stewards of the County's social, economic and environmental systems. In support of this theme, the General Plan 2000 contains the following six visions:

1. Our actions will complement State and regional initiatives in resource and growth management.
2. Our rural lands will be productive and rural character will be conserved.
3. Our development will be concentrated within a growth boundary, will be served by adequate public facilities, and will encourage economic vitality.
4. Our communities will be livable, safe and distinctive.
5. Our environmental resources will be protected, used wisely and restored to health.
6. Our citizens will take part in the decisions and actions that affect them.

The General Plan visions most applicable to the Lower Patapsco Watershed Restoration Action Strategy were tailored to create this vision for the watershed:

> ***Environmental resources in the Lower Patapsco watershed will be protected, used wisely and restored to health. The actions we take will complement State and regional initiatives. Our citizens will take part in the decisions and actions that affect them, and environmental stewardship will be encouraged throughout the watershed.***

Introduction

Purpose of Study

In 2004, Howard County entered into a two-year cooperative Watershed Restoration Action Strategy Partnership agreement with the Maryland Department of Natural Resources (DNR). The agreement allowed the County to receive State grant monies to address watershed planning and assessment needs, develop a watershed restoration action strategy (WRAS), receive technical assistance from DNR, and have the opportunity to compete for future Federal and State watershed implementation project funding.

A WRAS combines the leadership of local jurisdictions, the input of citizens and landowners, and State and Federal technical assistance and funding to prioritize and implement watershed management actions. A WRAS can also serve as a marketing and management tool for public outreach and project funding applications.

The Lower Patapsco WRAS addresses the protection, conservation and restoration of streams, forests and other natural resources, for the purpose of improving water quality and habitat. This document describes the tools that were used to identify, prioritize and select sites for future management actions. The Lower Patapsco WRAS complements other State-wide watershed initiatives such as the Chesapeake Bay 2000 Agreement.

Public Participation

Input from watershed residents, businesses and organizations is an important component in successful development and implementation of a WRAS. To encourage public participation in development of the Lower Patapsco WRAS, a workgroup was formed that included representatives from community and environmental organizations in the watershed. The workgroup also included representatives from County, State and Federal agencies, and met regularly to review supporting studies for the WRAS and to plan workshops to encourage additional public participation. Three public workshops were held from 2004 to 2006. A report from each workshop is given in Appendix A. These workshops provided participants with information on the results of water quality and habitat assessments for the watershed, and provided a forum for participants to discuss their concerns and goals for watershed restoration. These concerns and goals helped guide the workgroup in their development of goals, objectives and implementation actions for the WRAS.

Watershed Characterization and Supporting Studies

The first step in developing a WRAS for the Lower Patapsco was to prepare a watershed characterization that compiled and analyzed existing water quality, land use and living resources data for the watershed. In February 2005, DNR produced the *Patapsco River Lower North Branch Watershed Characterization*. The Characterization provided good overall information on environmental conditions within the Lower Patapsco watershed. To provide more specific information on the location of environmental problems and restoration opportunities, a stream corridor assessment survey, impervious cover assessment, synoptic water quality monitoring,

and biological water quality monitoring were conducted for the watershed. In addition, detailed assessments were conducted in the Rockburn Branch and Sucker Branch subwatersheds to identify potential restoration projects. The following is a summary of the findings from the Characterization, the supporting studies and the detailed subwatershed assessments.

Watershed Characterization

The Watershed Characterization compiled existing information on land use, water quality and living resources for the Lower Patapsco River watershed. The Lower Patapsco River watershed in Howard County is contained within the larger Patapsco River Lower North Branch (LNB) watershed, as designated by the State. The Patapsco River LNB watershed contains a small portion of Baltimore City and Carroll County, and larger portions of Howard, Baltimore, and Anne Arundel County. Some of the available State information is for the larger Patapsco River LNB watershed, and is not tailored specifically for the Lower Patapsco River watershed in Howard County.

Under Maryland's Clean Water Action Plan, the Patapsco River LNB is classified as a Category 1 watershed, indicating that portions of the watershed do not meet clean water and other natural resource goals, and are in need of restoration. The watershed is also classified as a Category 3 watershed, indicating that portions of the watershed are pristine or sensitive, and in need of an extra level of protection.

Land Use

The Lower Patapsco River watershed, located in eastern Howard County, is approximately 37.9 square miles (Map 1). The watershed includes the Patapsco River North Branch to the south of the confluence with the Patapsco River South Branch and all its tributaries within Howard County. Mariottsville Road is near the western boundary for the watershed. The watershed contains portions of Woodstock, Daniels, Ellicott City and Elkridge (Map 2). The majority of the watershed is located within the County's Planned Water and Sewer Service Area, which is also the County's Priority Funding Area under Maryland's Smart Growth Initiative. The watershed contains a variety of land uses, including residential, commercial, industrial, park, open space, institutional, and agriculture (Map 3).

The Maryland Department of Planning 2002 land use data indicates that 49% of the watershed is developed, 41% is in brush and forest, and 10% is in agriculture. Development in the watershed tends to occur in the upland portions of tributary streams, while the lower portions are often forested as they enter the Patapsco Valley State Park. Approximately 22% of the watershed is protected from development as open space or parkland, or through an agricultural, environmental or historic easement (Map 4). The Patapsco River and Deep Run stream valley corridors are designated Regional and County Greenways, respectively.

Water Quality

Maryland classifies each waterbody in the State into one of seven designated use categories and has established water quality criteria to support these designated uses. The streams in the Lower Patapsco River watershed are classified as Use I, with designated uses of water contact recreation and protection of aquatic life. Numeric criteria are established for fecal coliform (a bacteria), dissolved oxygen, temperature, pH (a measure of acidity/alkalinity), turbidity and toxic substances. Narrative criteria are established for other water quality parameters such as odor.

Water bodies that do not meet the water quality criteria for their designated use are listed by the State as impaired waters. The State lists streams in the larger Patapsco River LNB watershed as impaired for metals, nutrients, and sediment from nonpoint and natural sources. The watershed is also listed as impaired for bacteria from point, nonpoint and natural sources. Point sources can include wastewater treatment plants and industrial plants. Nonpoint sources can include roads, parking lots, rooftops, lawns and agriculture.

Living Resources and Habitat

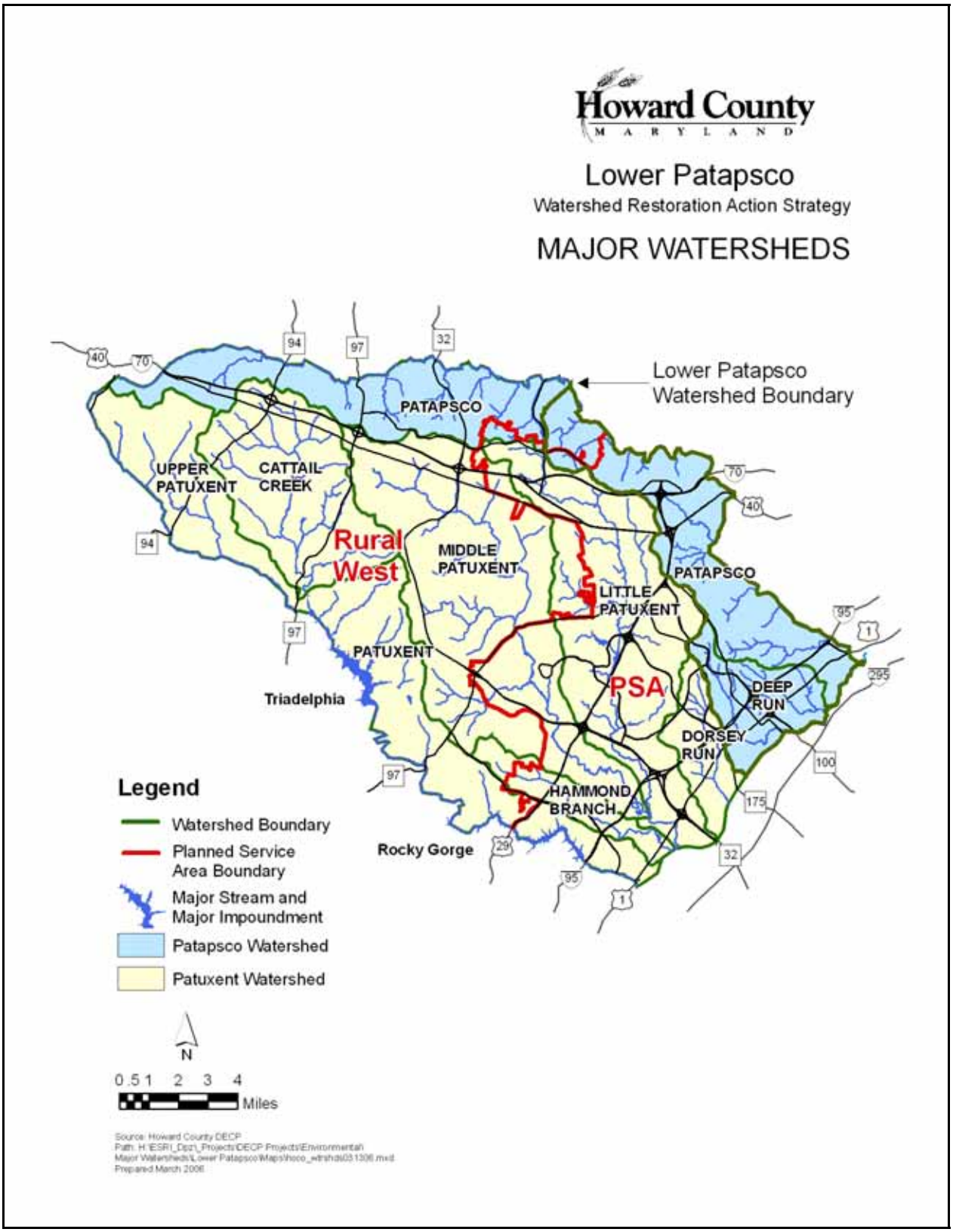
The majority of the Lower Patapsco River watershed lies within the Piedmont physiographic province, with a transition to the Coastal Plain province in the southern portion of the watershed. Major tributaries to the Lower Patapsco River include Sucker Branch, the Tiber-Hudson, Bonnie Branch, Rockburn Branch and Deep Run. Stream valleys are extensive and contain many important natural habitats, including the streams themselves, wetlands, floodplains, forests and adjacent steep slopes. The mainstem, in particular, has extensive areas of steep slopes adjacent to it.

Fish

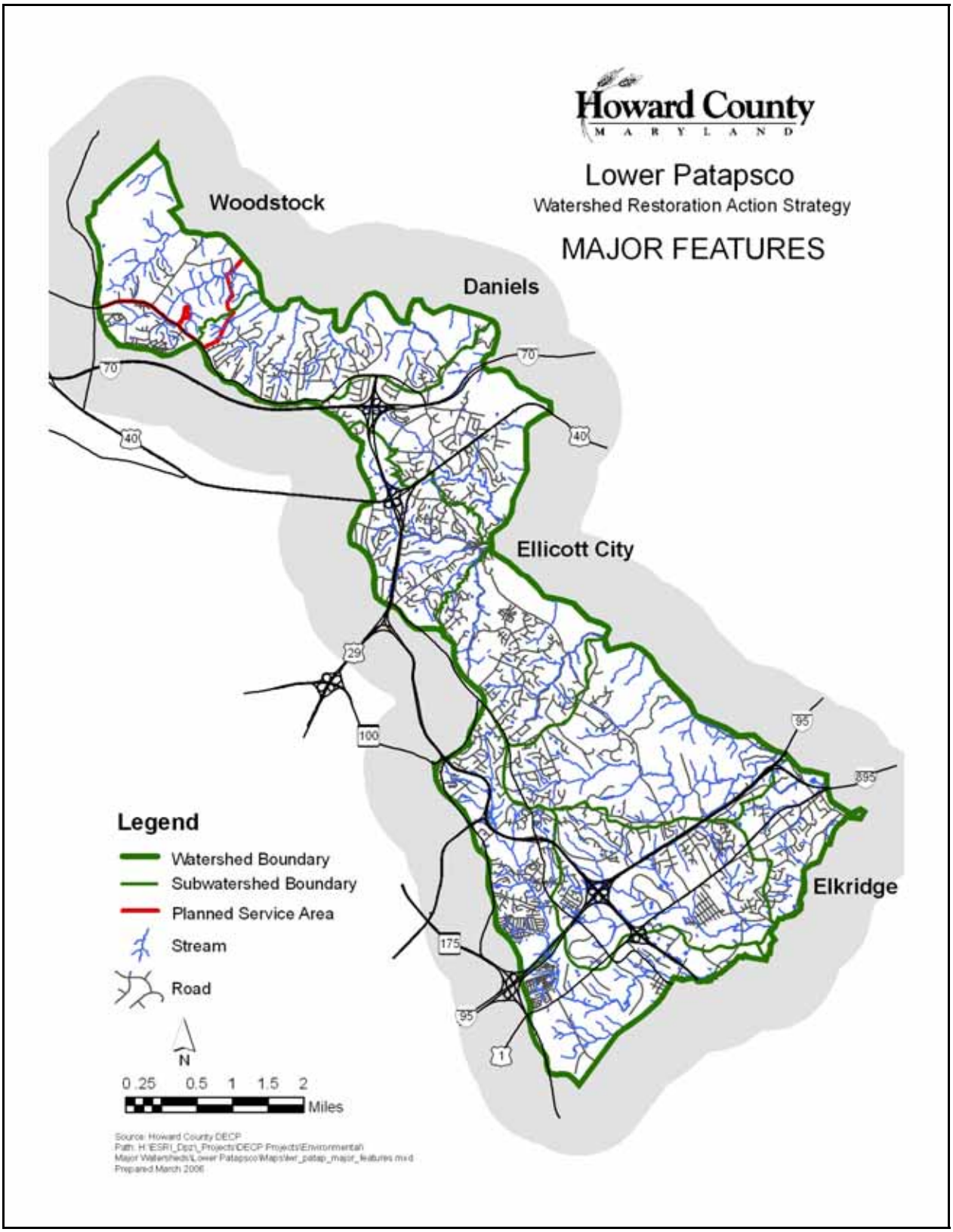
Anadromous fish, which live primarily in salt water but swim upstream to spawn in freshwater, have been documented in the Patapsco River as far upstream as Rockburn Branch, and in Deep Run about one mile upstream from the confluence with the Patapsco. Documented anadromous fish species include herring, white perch and yellow perch. Major dams that blocked fish movement along the Patapsco River, including Bloede Dam, Simkins Dam, Union Dam and Daniels Dam, have either been breached, removed or had fish ladders installed. Many tributaries to the Patapsco River contain fish blockages, and these are discussed in the Stream Corridor Assessment section.

Sensitive Species

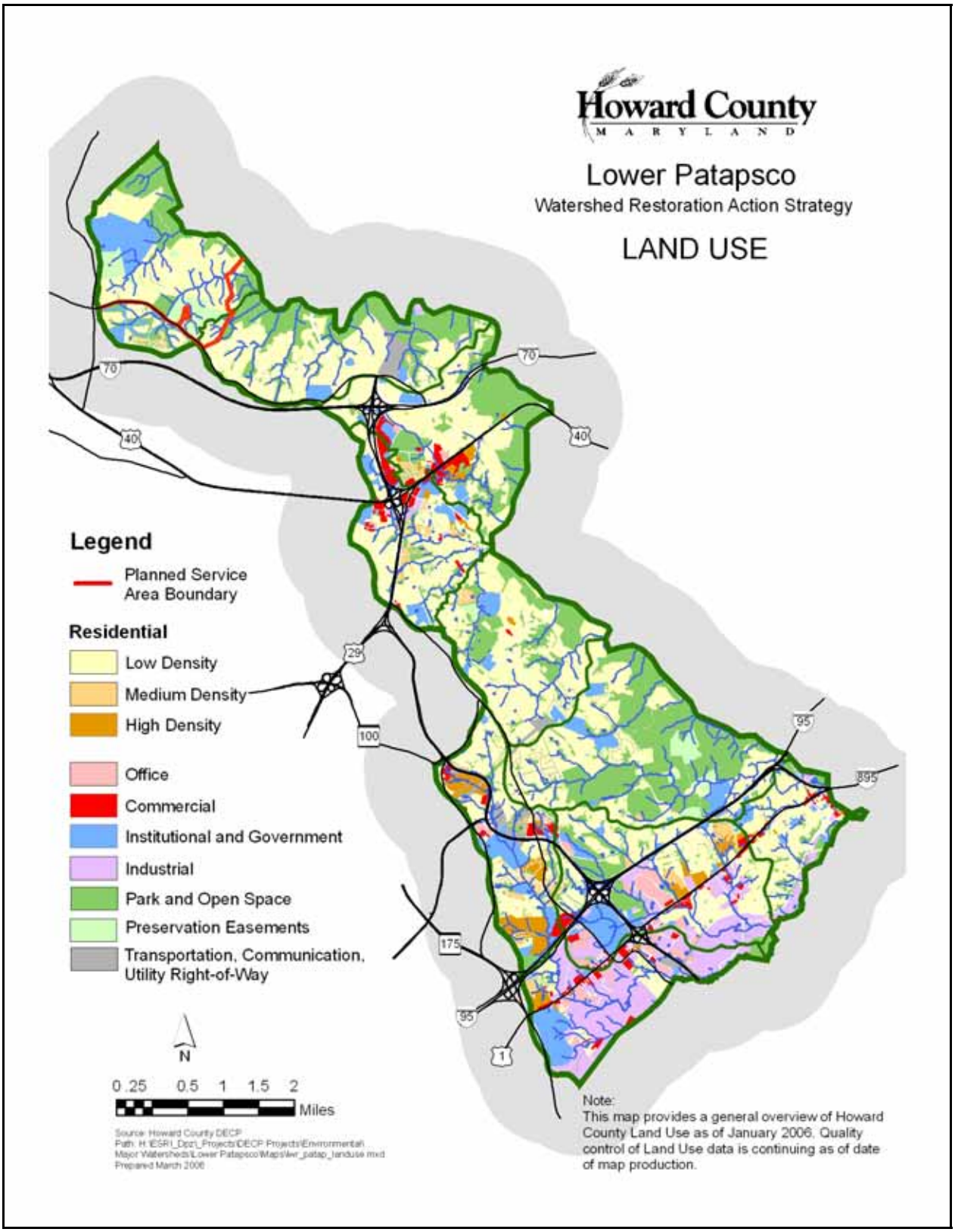
The Maryland Department of Natural Resources has identified eleven Ecologically Sensitive Areas in this watershed. These areas are primarily located along the mainstem of the Patapsco River, but there are also sites along the mainstem of Deep Run and near I-95 in the Deep Run watershed. Ecologically Sensitive Areas contain rare, threatened or endangered species, or other important natural resources such as rookeries or waterfowl staging areas. The mainstem of the Patapsco has several small Wetlands of Special State Concern contained within these Ecologically Sensitive Areas that are afforded greater regulatory protection.



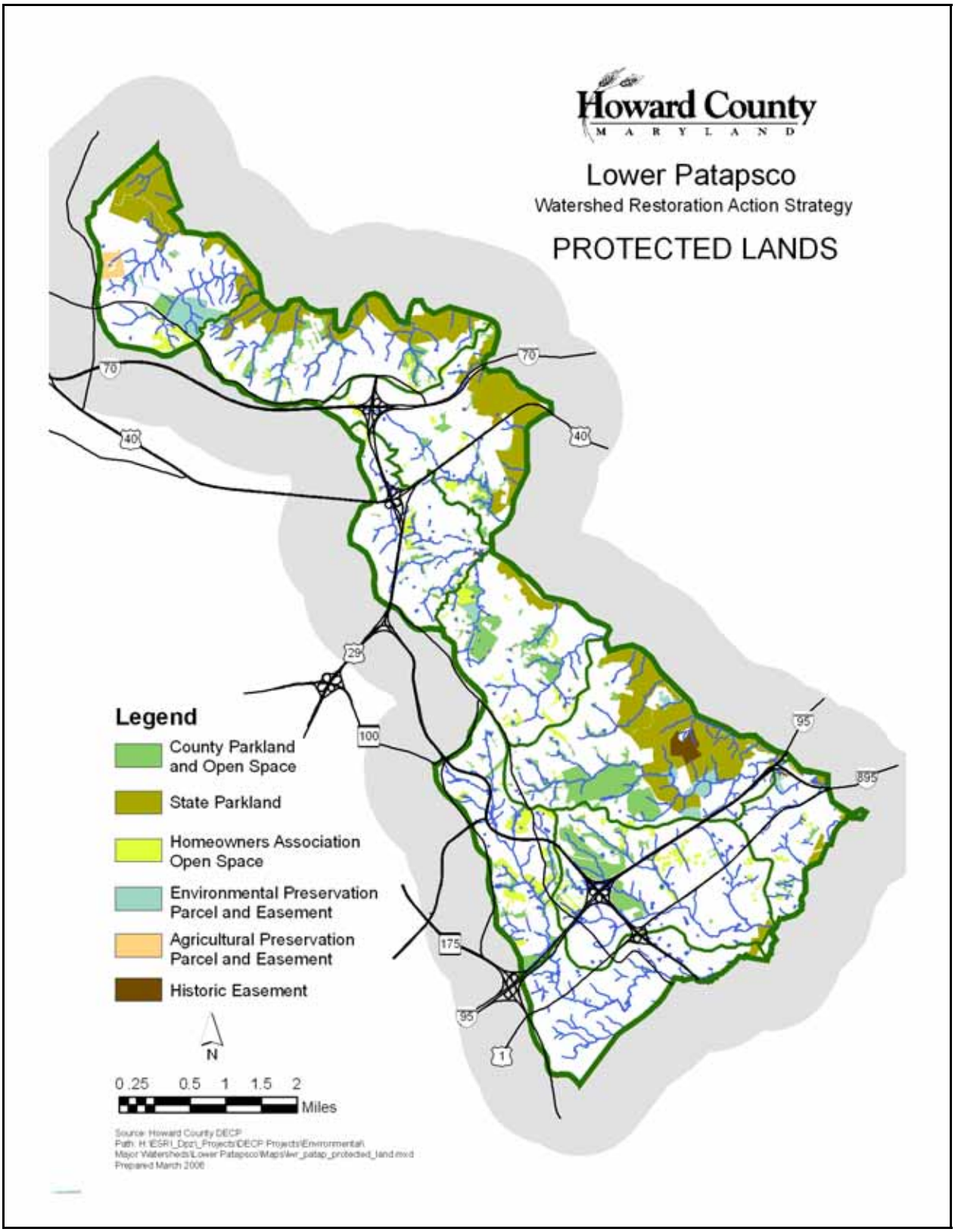
Map 1 – Major Watersheds. The Lower Patapsco watershed within Howard County, showing its relationship to the major Patuxent and Patapsco River watersheds. Source: Howard County DPZ, March 2006.



Map 2 – Major Features. The Lower Patapsco watershed, showing all streams, roads and major communities. Source: Howard County DPZ, March 2006.



Map 3 – Land Use. Generalized land use within the Lower Patapsco watershed. Source: Howard County DPZ and DRP, March 2006.



Map 4 – Protected Lands. Public and private open space and parkland in the Lower Patapsco watershed. Source: Howard County DPZ and DRP, March 2006.

Stream Corridor Assessment

Methods

In 2001-2002 and 2003-2004, DNR conducted a Stream Corridor Assessment (SCA) survey of the stream network in the Lower Patapsco River watershed. In 2001-2002, teams from the Maryland Conservation Corp walked the tributary streams in the Lower Patapsco River watershed, with the exception of the Deep Run subwatershed. In 2003-2004, the teams walked the streams in the Deep Run subwatershed, as well as the Patapsco main stem. In all, the teams surveyed about 178 stream miles. The surveys were intended to map and identify potential problem sites. Although the survey was not intended to be a detailed scientific evaluation of the watershed, it provided a rapid overview of the entire stream network to determine where potential environmental problems are located and to collect some basic information about the watershed.

At each site data was collected about each problem and its location, and photographs were taken to document existing conditions. To aid in prioritizing future restoration work, field crews rated all problem sites on a scale of one to five in three categories: severity, correctability, and accessibility. The narrative rating for problem severity was given as very severe, severe, moderate, low severity or minor.

Findings

The survey identified 878 potential problem sites, including 265 pipe outfalls, 186 sites with inadequately forested stream buffers, 151 sites with bank erosion, 115 fish migration blockages, 52 exposed pipes, 44 channelized stream sections, 23 unusual conditions, 23 trash dumping sites, and 19 sites with in or near stream construction (Table 1). The majority of the sites were found along the tributaries to the Patapsco, only 12 sites were found along the Patapsco mainstem. More detailed information on the data collected during the survey and the survey results is presented in the *Patapsco River Stream Corridor Assessment Survey in Howard County* (Patterson, Pellicano and Yetman, 2003) and the *Deep Run and Patapsco River Stream Corridor Survey* (Patterson, Pellicano and Yetman, 2005). The following presents a summary of the survey results by problem type.

Pipe Outfalls

Pipe outfalls include any pipes or small built channels that discharge into the stream through the stream corridor. Pipe outfalls are considered a potential environmental problem because they can carry uncontrolled runoff and pollutants such as oil, heavy metals, sediments and nutrients to a stream system. A total of 265 pipe outfalls were identified during the survey, making it the most frequently reported problem. Of the 265 outfall pipes observed, only 17 were reported to have a discharge that had some coloration or odor associated with it. The remaining discharges, when present, were recorded as clear with no odor. The majority of pipe outfalls were for stormwater discharges.

Inadequate Riparian Buffers
Riparian forest buffers are the combination of native trees, shrubs, herbaceous plants, animals and insects, and soils adjacent to water. They are a unique transition from water to land that help stabilize stream banks, protect water quality and provide valuable wildlife habitat. For this assessment, a riparian forest buffer was considered inadequate if it was less than 50 feet wide.

The SCA identified 186 sites where riparian forest buffers were inadequate, along approximately 30 miles of stream banks. Field teams found stretches of streams ranging in length from 50 feet to 1.6 miles with inadequate buffers. Most sites with inadequate riparian forest buffers received a moderate to low severity rating, indicating that the stream reaches were not long or that some vegetation was present at the sites.

Erosion
Erosion is a natural process of the wearing away of land surfaces by running water, wind, ice or other geological agents. In a stream habitat, too much erosion can destabilize stream banks, degrade in-stream habitat and cause sediment pollution problems downstream. Accelerated stream channel erosion primarily results from human activities that increase the frequency and volume of stream channel flows. Occasionally, animals may also cause increased erosion. Unstable eroding stream banks were reported at 151 sites. The majority of the erosion sites showed moderate to minor erosion that extended over moderate distances. The lengths of stream segments recorded as having unstable banks varied from 20 to 3300 feet. The survey reported 17 erosion sites as a threat to infrastructure. Overall, the results indicated that there were approximately 15.2 miles or 8.5% of the streams in the Lower Patapsco River watershed with unstable eroding banks.

Fish Migration Barriers
Fish migration barriers are anything in the stream that significantly interferes with the free movement of fish upstream. Fish barriers can be caused by built structures such as dams or road culverts, and by natural features such as waterfalls or beaver dams.

The survey identified 115 fish migration barriers. The barriers had a number of causes, including dams, natural falls, road crossings, channelized stream sections, debris dams, ponds and pipe crossings. Most of the sites were given moderate to minor severity ratings.

Exposed Pipes
Exposed pipes are any pipes that are in the stream or along the stream's immediate banks that could be damaged by a high flow event. It does not include pipe outfalls, where only the open end of the pipe is exposed. In urban areas, it is very common for sewer pipelines and other utilities to be located in the stream corridor. Damaged pipes have the potential to discharge fluids into the stream, causing water quality problems.

Exposed pipes were reported at 52 sites during the survey. This included exposed manhole stacks, and pipelines crossing above or along the bottom or side of the stream. All of the exposed pipe sites received a moderate to minor severity rating because there were no discharges observed and no signs that the stream would undermine or break the pipe in the near future.

Channel Alterations
Channel alterations are found in stream sections where the stream banks and channel have been significantly altered from a natural condition. This can include areas where the stream has been straightened and/or where the stream channel has been hardened using rock, gabion baskets or concrete over a significant length (usually 100 feet or more). It does not include road crossings unless a significant portion of the stream above or below the road has also been channelized. Results of this survey indicated that the stream system had been recognizably altered in 44 areas. The total length of stream affected by channelization was estimated to be about 1.9 miles or 1% of the stream miles in the watershed. Channelized sections ranged in length from 23 to 1600 feet. The longest section was the headwaters of Sucker Branch. There were no major stream systems reported in the survey as being extensively channelized and most of the sites were given a moderate to minor severity rating.

Unusual Conditions
The unusual conditions are sites with anything out of the ordinary seen during the survey. Twenty-three unusual condition sites were found during the survey, with most receiving a moderate to minor severity rating. A frequently recorded problem was red flock, an orange-red bacteria that grows in streams with high iron content. Other common problems included streams piped underground and structures in the stream causing erosion or blockages.

Trash Dumping
Trash dumping sites are places where large amounts of trash have been dumped or accumulated inside the stream corridor. The field survey crew found 23 sites where there was excessive trash, including residential waste/appliances, yard waste, construction waste, automobiles, industrial waste/tires, oil drums, and piping. Most sites were given severity ratings ranging from moderate to minor. The one severe site near Route 1 was estimated to have three dump-truck loads of industrial waste and tires.

In or Near Stream Construction
In or near stream construction occurring without proper sediment and erosion control measures can cause sediment pollution in a stream. Survey teams reported sites when there was evidence of inadequate sediment control measures and sediment pollution. The survey reported 19 sites with in or near stream construction. The majority of sites were in the moderate to minor severity ranking. Construction activity included residential, road crossing, golf course, trail, industrial, logging, and unknown activity.

Table 1 - Problem Type Summary

Problem Type	Number	Length (miles)	Very Severe	Severe	Moderate	Low Severity	Minor
Pipe Outfall	265		0	7	133	12	113
Inadequate Buffer	186	30.0	10	23	46	60	47
Erosion	151	15.2	4	7	48	57	35
Fish Migration Barrier	115		0	6	19	23	67
Exposed Pipe	52		0	0	13	22	17
Channel Alteration	44	1.9	1	2	8	14	19
Trash Dumping	23		0	1	7	9	6
Unusual Condition	23		1	1	8	7	6
Construction	19		1	2	5	4	7
Total	**878**		**17**	**49**	**287**	**208**	**317**
% of Total			**1.9**	**5.6**	**32.7**	**23.7**	**36.1**

Analysis and Recommendations

To prioritize sites for future remediation efforts, a problem site ranking system was developed using weighted criteria. Criteria were chosen to prioritize problem sites that posed the most severe and immediate threats to water quality, and to maximize benefits for water quality and habitat. The criteria were then given the following weighting:

Primary emphasis

- Pipe outfall, exposed pipe, unusual condition, construction, erosion or inadequate buffer – *to address problem types that pose the most immediate threats to water quality.*
- Problem severity ranking of moderate to very severe – *to address the most severe problems first.*
- Erosion sites that threaten structures or infrastructure – *to address problem types that threaten structures or infrastructure.*
- Proximity to other erosion sites – *to achieve greater benefits by addressing multiple problems.*

Secondary emphasis

- Location within a headwater stream – *to benefit sensitive habitat.*
- Location within a wetland – *to benefit sensitive habitat.*
- Location within habitat for threatened and endangered species – *to benefit sensitive habitat.*

Least emphasis

- Location within a greenway – *to benefit sensitive habitat.*

- Low percentage of existing impervious cover for the surrounding subwatershed – *to protect those subwatersheds with better quality from degrading further.*
- Low expected future increase in percentage of impervious cover for the surrounding subwatershed – *to direct efforts to more stable subwatersheds.*

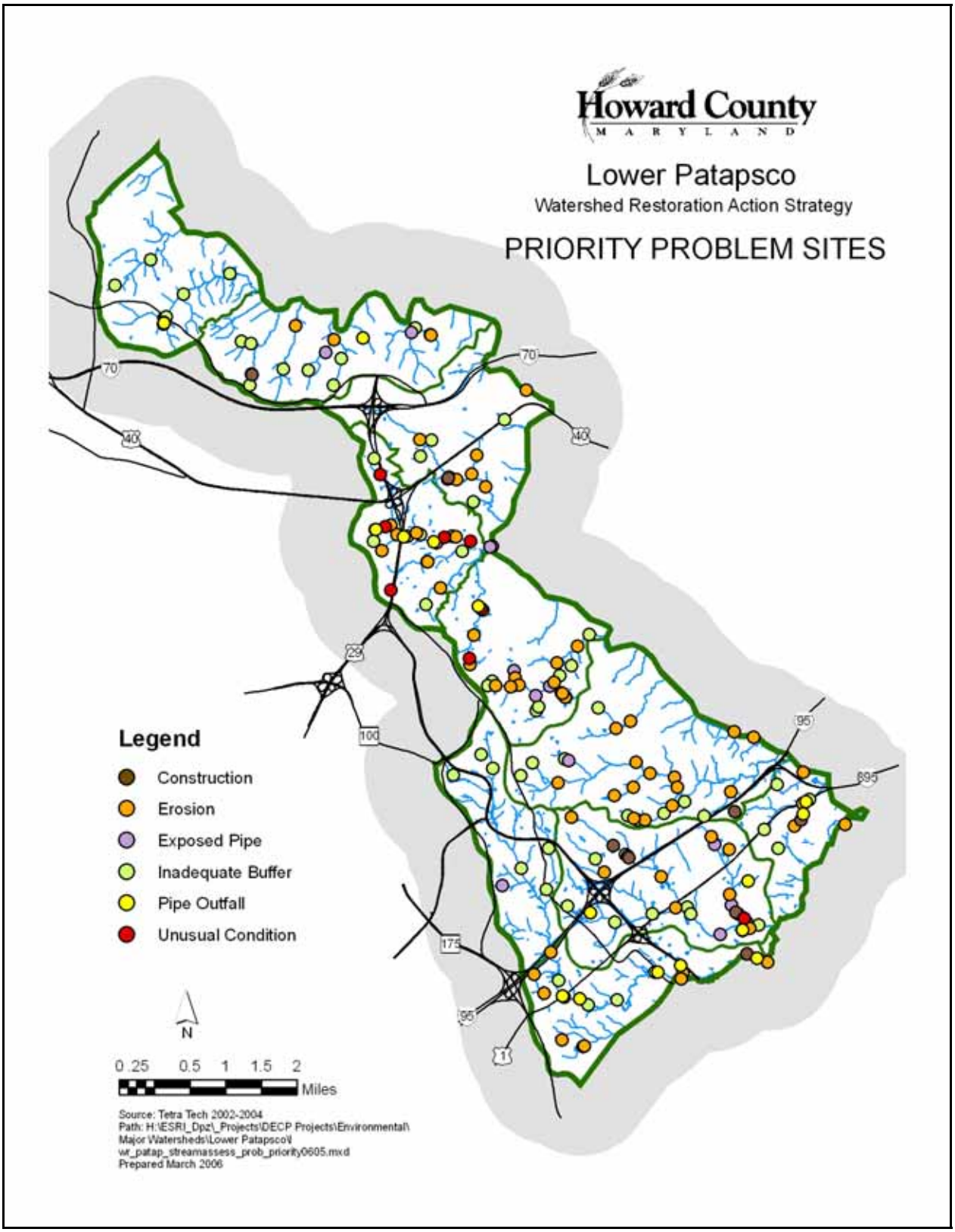
The criteria were further weighted to emphasize exposed pipe, pipe outfall and unusual condition problem sites. In addition, only those pipe outfalls with a discharge that had some coloration or odor associated with it were included in this prioritization. The ranking did not include problem sites with a low or minor severity rating, fish blockage, channel alteration and trash problem sites. Fish blockage and channel alteration sites were not included because of the high expense and lack of priority when compared to other, more immediate problems. In addition, the Maryland Department of Natural Resources has a program to address fish passage blockage. Trash problem sites were not included as these are problems that could be addressed by volunteer action. The prioritization exercise reduced the number of sites to be evaluated from 878 to 195, as shown in Table 2 and Map 5.

The priority problem sites were sorted by problem type and by subwatershed, because problem sites may be addressed by existing programs and by subwatershed restoration studies. For example, the pipe outfall sites were referred to the County Illicit Discharge Program, and the Rockburn Branch and Sucker Branch studies investigated the priority problem sites in each subwatershed.

Table 2 - Priority Problem Sites

Problem Type	Very Severe	Severe	Moderate	Total
Inadequate Buffer	10	23	46	79
Erosion	4	7	48	*68
Pipe Outfall	0	7	10	17
Exposed Pipe	0	0	13	13
Unusual Condition	1	1	8	10
Construction	1	2	5	8
Total				**195**

* Erosion sites total more than 59 because sites of lower severity that were threatening infrastructure were also included in the total.



Map 5 – Priority Problem Sites. Priority sites for future restoration efforts, based on a problem site ranking system. Source: Howard County DPZ, adapted from the DNR stream corridor assessment surveys of the Deep Run and Patapsco River, March 2006.

Impervious Cover Assessment

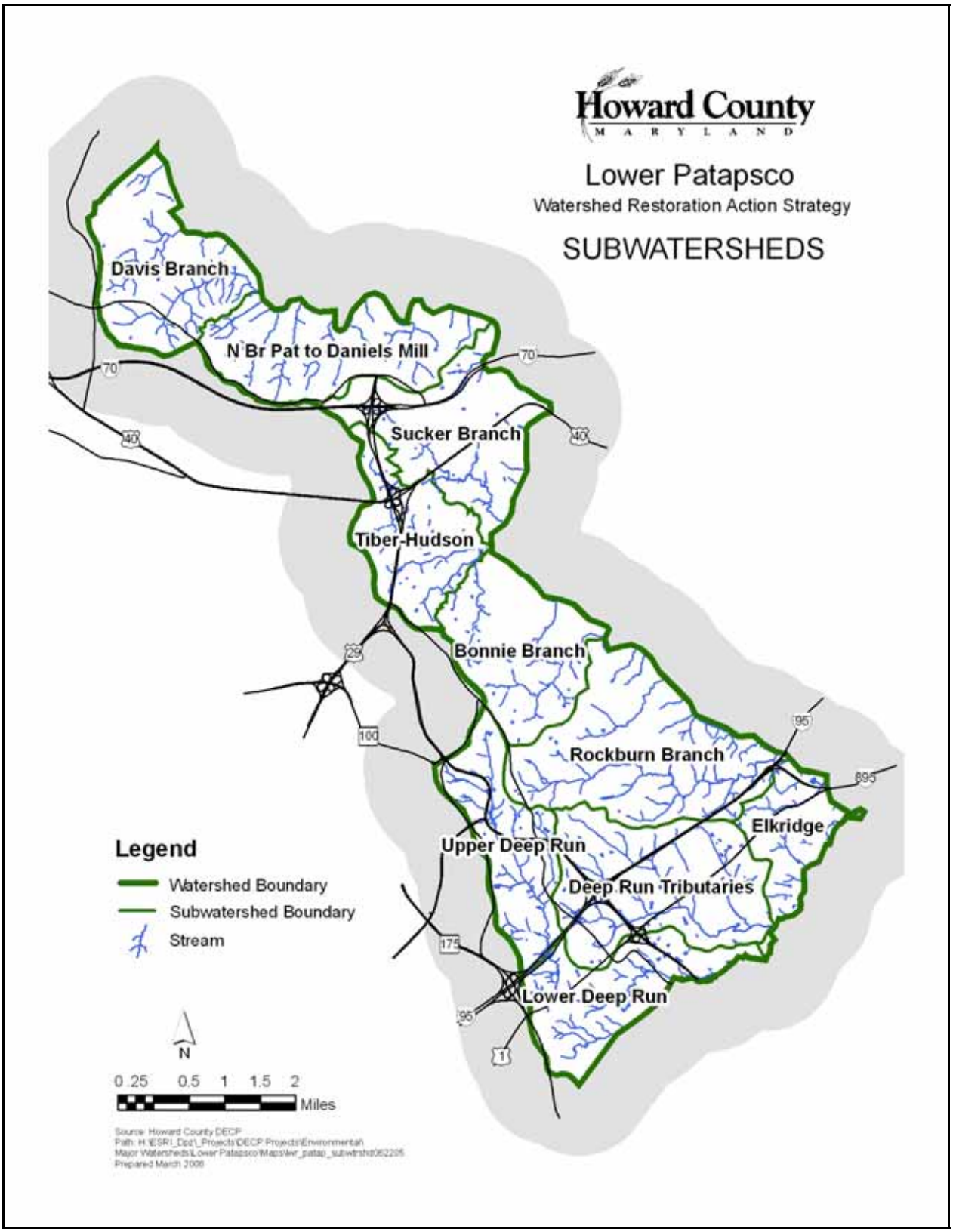
Methods

Impervious surfaces, which can include parking lots, roads, and buildings, have a significant impact on the hydrology of a watershed's streams. Impervious surfaces prevent water from soaking into the ground to recharge groundwater, and increase surface runoff into nearby streams during rainfall and snowfall events. Lower groundwater reduces base flow in streams during the drier months, and increased runoff means high water flows occur more frequently and have a larger volume, resulting in stream channel erosion. In addition, the runoff often washes pollutants such as oil and grease from these impervious surfaces and these pollutants further degrade water quality in the stream. For these reasons, the amount of impervious cover in a watershed can be a strong indicator of expected water quality and habitat conditions in a watershed's streams.

Under the Federal Clean Water Act, Howard County has a National Pollutant Discharge Elimination System (NPDES) permit for discharges from the County stormwater management system. The NPDES permit has significant requirements to produce measurable improvements to water quality in the County. To assess water quality and habitat conditions in the County, the NPDES program conducted an impervious cover assessment in 2001. This assessment divided the County into 64 subwatersheds ranging in size from 2 to 10 square miles. Based on the level of impervious cover, the subwatersheds were ranked as sensitive, impacted and non-supporting for existing and future conditions. Future conditions were estimated based on build-out at current zoning. Sensitive watersheds have low levels of impervious cover and are expected to have good to excellent stream conditions. Impacted watersheds have medium levels of impervious cover and are expected to have fair to good stream conditions but show clear signs of degradation. Non-supporting watersheds have high levels of impervious cover and are expected to have poor to fair stream conditions, with significant degradation in aquatic habitat and water quality.

Findings

The Lower Patapsco River watershed was subdivided into eleven subwatersheds (Map 6 and Table 3). Of these subwatersheds, three were ranked as sensitive, five were ranked as impacted and three were ranked as non-supporting for existing conditions. For future conditions, two subwatersheds were ranked as sensitive, five were ranked as impacted and four were ranked as non-supporting. Four of the subwatersheds are projected to have a significant (greater than 5%) increase in impervious cover – Davis Branch Woodstock, Bonnie Branch, Deep Run Tributaries and Lower Deep Run. However, only one of these subwatersheds – Deep Run Tributaries – is projected to change category. Rockburn Branch will also change category, but will have only a small increase in impervious cover.



Map 6 – Subwatersheds. The division of the Lower Patapsco watershed into subwatersheds. Source: Howard County DPZ, March 2006.

Table 3 - Subwatershed Impervious Cover and Category

Subwatershed (from north to south)	Area (sq. mi.)	% Existing Impervious	Existing Category	% Future Impervious	Future Category	Change % Imp.
Davis Branch Woodstock	4.0	2.5	Sensitive	8.9	Sensitive	6.4
N Br Patapsco to Daniels Mill	4.1	10.7	Impacted	12.9	Impacted	2.2
Sucker Branch	4.2	17.9	Impacted	21.8	Impacted	3.9
Tiber-Hudson	3.0	27.7	Non-Supporting	31.8	Non-Supporting	4.1
Bonnie Branch	3.7	11.7	Impacted	18.6	Impacted	6.9
Rockburn Branch	5.8	9.9	Sensitive	11.9	Impacted	2.1
Elkridge	1.8	19.2	Impacted	23.2	Impacted	4.1
Deep Run Tribs.	5.2	22.2	Impacted	31.2	Non-Supporting	9.0
Deep Run on County Line *	0.0	2.2	Sensitive	2.2	Sensitive	0.0
Upper Deep Run	3.0	26.4	Non-Supporting	28.4	Non-Supporting	2.0
Lower Deep Run	3.1	28.2	Non-Supporting	37.0	Non-Supporting	8.8
	37.9					

* Deep Run on County Line is 23 acres or 0.04 square miles and is predominantly within Patapsco Valley State Park.

Notes:
Sensitive watersheds have impervious cover less than or equal to 10%.
Impacted watersheds have impervious cover greater than 10% and less than or equal to 25%.
Non-supporting watersheds have impervious cover greater than 25%.

Analysis and Recommendations

The NPDES impervious area assessment also prioritized all County subwatersheds in 2001 for future restoration efforts to improve water quality. The priority ranking was based on a number of criteria, including: impervious cover; projected change in impervious cover at future build-out; projected change in subwatershed category; percentage of open space; and other planning activities in the subwatershed, such as the Route 1 and Route 40 Corridor Studies. The criteria were ranked to prioritize impacted subwatersheds with a low future increase in impervious cover, where restoration efforts would have the greatest measurable impact. Subwatersheds were also prioritized if there was a projected change in watershed category from sensitive to impacted. Subwatersheds with a high percentage of open space were priorities because this could provide more opportunities for restoration projects, and subwatersheds with other planning activities were prioritized because this showed ongoing County interest and the possibility of additional funding opportunities.

The Lower Patapsco River watershed contains three of the top ten priority subwatersheds – Rockburn Branch, Elkridge and the Deep Run Tributaries. As part of this WRAS, a more detailed assessment was conducted for the Rockburn Branch subwatershed to identify potential restoration projects.

Synoptic Water Quality Survey

Methods

A synoptic water quality survey was conducted in the Lower Patapsco watershed by DNR in March 2004. This survey sampled water quality at 36 sites around the watershed, measuring temperature, dissolved oxygen, pH, conductivity, and dissolved inorganic nitrogen and phosphorus. The *Report on Nutrient Synoptic Surveys in the Lower Patapsco River Watershed* (Primrose, 2005) presents detailed information on sampling methods and results.

Findings

Results of the sampling indicate that temperature, dissolved oxygen and pH were within normal ranges, but conductivity values were generally high at 26 sites. Conductivity is an indicator of dissolved salts such as road salt used for deicing roads. The highest concentrations for conductivity were in the Sucker Branch, Tiber-Hudson and Deep Run subwatersheds. These subwatersheds have a high density of local roads and highways.

Nitrogen concentrations were found to be excessive or high at two of the 36 sites. Nitrogen yields, which are based on concentration and stream flow, were found to be excessive or high at 9 sites. The Daniels subwatershed, in particular, had areas of excessive and high nitrogen concentrations and loads. Potential sources for nitrogen in urban / suburban watersheds include septic systems and failing or leaking sewer lines.

Sampling in late winter / early spring will overestimate concentrations for nitrogen since stream flows are predominantly groundwater fed and groundwater is high in dissolved nitrogen. Conversely, this sampling will underestimate phosphorus concentrations, since phosphorus is generally transported bound to sediment and sediment is more predominant in storm flows. Sampling was halted for a minimum of 24 hours after significant rainfall events.

Phosphorus concentrations were found to be excessive or high at four of the 36 sites. Most of these sites were on three adjacent tributaries in the Davis Branch and Daniels subwatersheds. There were no sites with excessive or high phosphorus yields. The areas with high phosphorus concentrations had construction activities and sediment control facilities that could have been contributing suspended sediments to the streams.

Analysis and Recommendations

The report concluded that nutrients do not currently appear to be a problem for the watershed, except in a few localized areas. There is currently a lack of research on the impacts to freshwater streams from chronic low level salt concentrations (conductivity).

Stream Biological Assessment

Methods

In 2001, Howard County initiated a County-wide, long-term biomonitoring program to provide an assessment of the ecological health of the County's stream systems. The biomonitoring program samples benthic macroinvertebrates (bottom-dwelling organisms) at randomly selected sites within a watershed, and also collects information on the physical habitat of the stream at each site. Benthic macroinvertebrates provide an indicator of stream health, because different species vary in their tolerance to water pollution and habitat degradation. The benthic and physical habitat information is used to provide an assessment of the condition of individual streams and overall watershed quality.

Biomonitoring was conducted in the Lower Patapsco River watershed in March 2003. The *Biological Assessment of the Patapsco River Tributary Watersheds, Howard County, Maryland* (Pavlik and Stribling, 2005) presents detailed information on sampling methods and results. The biomonitoring program divided the Lower Patapsco River watershed into two subwatersheds for sampling purposes – the Lower Patapsco main stem and Deep Run. Ten sampling sites were randomly selected within each subwatershed, as shown on Map 7. The random selection of ten sites allows for a statistical analysis of each subwatershed as a whole.

The benthic survey was conducted in accordance with DNR's Maryland Biological Stream Survey (MBSS) methods and MBSS methods were also used to develop a Benthic Index of Biological Integrity (B-IBI). MBSS methods and the US Environmental Protection Agency's Rapid Bioassessment Protocols were used to develop a physical habitat rating. The B-IBI and physical habitat rating were used to determine stream health.

Benthic Index of Biological Integrity (B-IBI).

The Benthic Index of Biological Integrity is calculated based on characteristics of the benthic macroinvertebrate community, such as the number of species present and the pollution-sensitivity of each species present. This B-IBI is then compared to the B-IBI of the healthiest streams within a similar region, and is given a narrative ranking of good, fair, poor or very poor.

Physical Habitat Rating.

The physical habitat rating measures the stream's ability to support a diverse aquatic community. The rating is calculated based on a variety of parameters, such as the velocity and depth of stream flow, the presence of sediment in the stream bed, bank stability and riparian buffer width. The overall physical habitat rating is translated into a narrative rating of comparable (to a healthy stream), supporting, partially supporting or non-supporting.

Findings

The following presents a summary of the benthic and physical habitat survey results for each subwatershed.

Lower Patapsco Main Stem

Ten sites were sampled in the Lower Patapsco main stem subwatershed (Table 4). One site in this subwatershed rated as very poor for biological condition, four sites rated as poor and the remaining five sites received fair ratings. The mean B-IBI rating for this subwatershed is poor. Physical habitat assessment results placed two of the sites in the non-supporting category, seven sites were in the partially supporting category and one site was in the supporting category. The mean physical habitat quality rated as partially supporting. Vegetative protection and bank stability were cited as areas that are generally problematic.

Table 4 – Lower Patapsco Main Stem Biological Monitoring

Site Number	Biological Rating	Habitat Rating	Subwatershed	Notes
221	Fair	Partially Supporting	Davis Branch	Mainstem; highest biological rating; only right bank sampled due to water depth.
222	Poor	Partially Supporting	Davis Branch	
223	Fair	Supporting	Davis Branch	
224	Poor	Partially Supporting	Daniels	Mainstem; only right bank sampled due to water depth.
225	Fair	Partially Supporting	Daniels	
226	Very Poor	Partially Supporting	Daniels	Not enough organisms in sample – automatic Very Poor rating.
227	Poor	Partially Supporting	Daniels	Just downstream of Site 226; sewer line nearby; this stream is adjacent to the stream with high nitrogen levels.
228	Fair	Non-Supporting	Sucker Branch	Sucker Branch under Rogers Ave – road culvert and rip-rap present.
229	Poor	Non-Supporting	Tiber-Hudson	Tiber Branch in Ellicott City – concrete banks, bridge, rip-rap and concrete present.
230	Fair	Partially Supporting	Bonnie Branch	Bonnie Branch close to Bonnie Branch Road.
Mean	**Poor**	**Partially Supporting**		

Deep Run

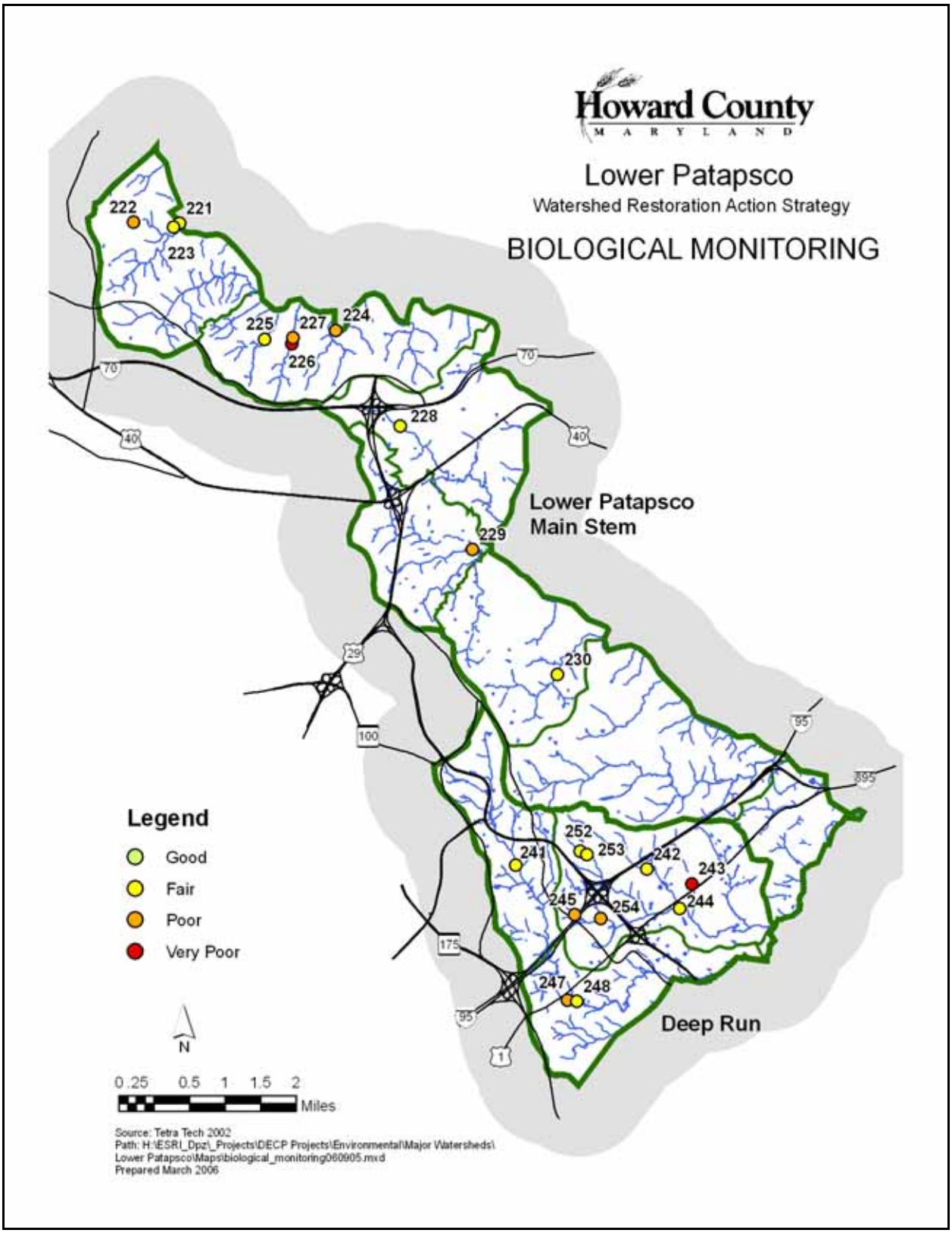
Ten sites were sampled in the Deep Run subwatershed (Table 5). One site was rated as very poor for biological condition, three rated as poor and six rated as fair. The mean B-IBI rating for this watershed is poor, but the score is very close to the fair condition. Physical habitat assessment results indicate that two of the sites are non-supporting and the remaining eight sites are partially supporting. The mean physical habitat quality rated as partially supporting.

Table 5 – Deep Run Biological Monitoring

Site Number	Biological Rating	Habitat Rating	Subwatershed	Notes
241	Fair	Partially Supporting	Upper Deep Run	Deep Run behind Old Hollow Court; water was discolored and algae present; recommend sampling for nutrients and metals. Nearby synoptic site had moderate nitrogen concentrations but high yields.
242	Fair	Partially Supporting	Deep Run Tribs	
243	Very Poor	Partially Supporting	Deep Run Tribs	Not enough organisms in sample – automatic Very Poor rating; recommend chemical sampling. Nearby synoptic site had baseline nitrogen and phosphorus levels.
244	Fair	Non-Supporting	Deep Run Tribs	State Highway Administration property; junkyard; recommend nutrient sampling. Nearby synoptic site had baseline nitrogen and phosphorus levels.
245	Poor	Non-Supporting	Deep Run Tribs	Near I-95; downstream of retention pond; straightened concrete and rip-rap channel.
247	Poor	Partially Supporting	Lower Deep Run	Deep Run; straightened channel.
248	Fair	Partially Supporting	Lower Deep Run	Deep Run; downstream of Site 247.
252	Fair	Partially Supporting	Deep Run Tribs	Timbers at Troy Golf Course; highest biological rating.
253	Fair	Partially Supporting	Deep Run Tribs	Timbers at Troy Golf Course downstream of Site 252; boulder sized rip-rap and open water line present.
254	Poor	Partially Supporting	Deep Run Tribs	
Mean	**Poor**	**Partially Supporting**		

Analysis and Recommendations

The benthic assessment provides general health and baseline information on the condition of the Lower Patapsco River watershed. The benthic survey found that the watershed has poor biological health and partially supporting physical habitat. This assessment also provides a baseline to measure the effectiveness of future watershed protection and rehabilitation strategies. The County biomonitoring program will conduct assessments of the watershed on a five-year cycle. As actions are implemented to improve water quality and physical habitat, future ratings for the watershed should improve.



Map 7 – Biological Monitoring. Biomonitoring was conducted at ten sites within the Lower Patapsco main stem and Deep Run subwatersheds. Source: Howard County DPZ and Tetra Tech, Inc., March 2006.

Rockburn Branch and Sucker Branch Assessments

The WRAS grant funds were used to conduct more detailed assessments on two subwatersheds. To select these subwatersheds a number of criteria were used, including existing impervious cover, expected future change in impervious cover, the number of severe problems and the variety of problem types identified in the stream corridor assessment survey, the percentage of publicly-owned land, and the degree of community activity in the watershed. The criteria were ranked to emphasize protecting sensitive subwatersheds as well as stabilizing impacted subwatersheds. There was a preference for selecting subwatersheds with a lower future increase in impervious cover. There was a preference for subwatersheds with the greatest number of very severe to moderate problems and the greatest diversity of problems, to allow a range of protection and restoration options to be explored. There was a preference for subwatersheds with the greatest amount of publicly-owned land, which can make project implementation easier. There was a preference for subwatersheds with more active community organizations. Based on these criteria, Rockburn Branch was chosen to examine issues in a less developed watershed. Sucker Branch was chosen to examine issues in a more urban / suburban watershed and to also provide geographic diversity to encourage public participation throughout the Lower Patapsco watershed.

The following presents a summary of the assessments for Rockburn and Sucker Branch. More detailed information on the assessments is available in *Assessing the Rockburn Branch Subwatershed of the Lower Patapsco River for Restoration Opportunities* (Lessard and Stribling, 2006) and *Assessing the Sucker Branch Subwatershed of the Lower Patapsco River for Restoration Opportunities* (Lessard and Stribling, 2006).

Rockburn Branch Assessment

Land Use

The Rockburn Branch watershed has an area of approximately 5.8 square miles, making it the largest subwatershed in the Lower Patapsco River watershed. The Rockburn Branch watershed is zoned entirely for low-density residential development and has approximately 55% of the watershed in parkland and open space (Map 8). A large part of this parkland is contained within Patapsco Valley State Park and Rockburn Branch Park. The watershed has 9.9% impervious cover, placing it at the top range of the sensitive watershed category. Sensitive watersheds are expected to have good to excellent stream conditions. Impervious cover is expected to increase to 11.9% at build-out, moving the watershed into the impacted category. Impacted watersheds are expected to have fair to good stream conditions, but show clear signs of degradation.

Biomonitoring

Biomonitoring was conducted at 10 sites in the Rockburn Branch watershed in March 2005. The Report on Supplemental Benthic Macroinvertebrate Surveys in the Lower Patapsco River Watershed Tributaries of Rockburn and Sucker Branches (Primrose 2006) presents detailed information on sampling methods and results. The monitoring locations are shown on Map 8. As

shown in Table 6, the biological scores ranged from poor to very poor and the physical habitat scores ranged from partially supporting to non-supporting. The average rating for the watershed was poor biological health and non-supporting physical habitat. These results indicate more degraded stream conditions than would be expected based on the impervious cover assessment.

Table 6 - Rockburn Branch Biomonitoring

Station	Biological Rating	Physical Habitat Rating
1	Poor	Partially supporting
4	Poor	Partially supporting
6	Poor	Non-supporting
7	Poor	Partially supporting
10	Poor	Partially supporting
12	Very Poor	Partially supporting
13	Poor	Non-supporting
15	Poor	Partially supporting
17	Very Poor	Non-supporting
20	Poor	Non-supporting
Mean	**Poor**	**Non-supporting**

Potential Project Sites

Twenty-seven priority problem sites were identified in the Rockburn Branch watershed, based on the results from the stream corridor assessment. These included 15 erosion sites, 10 inadequate buffers, 1 exposed pipe and 1 construction site. These sites were investigated for restoration potential, as were other opportunities in the watershed for stormwater management improvements. In addition, management practices were observed for residential and commercial areas to identify areas for public outreach to improve practices. This assessment identified 31 potential projects in the watershed. Potential projects included stormwater retrofits, stream and buffer restorations, and outreach and education. These projects were ranked based on cost, land ownership, physical constraints, and habitat and water quality benefits. This ranking produced 19 priority projects with an estimated $2 million in project costs. Rockburn Branch has a high percentage of publicly-owned land, and projects were ranked more highly if they were located on public land, so a majority of the priority projects are on public land. Table 7 lists all projects in the order of their ranking and indicates in bold which projects are considered priorities. Map 9 shows the location of all projects.

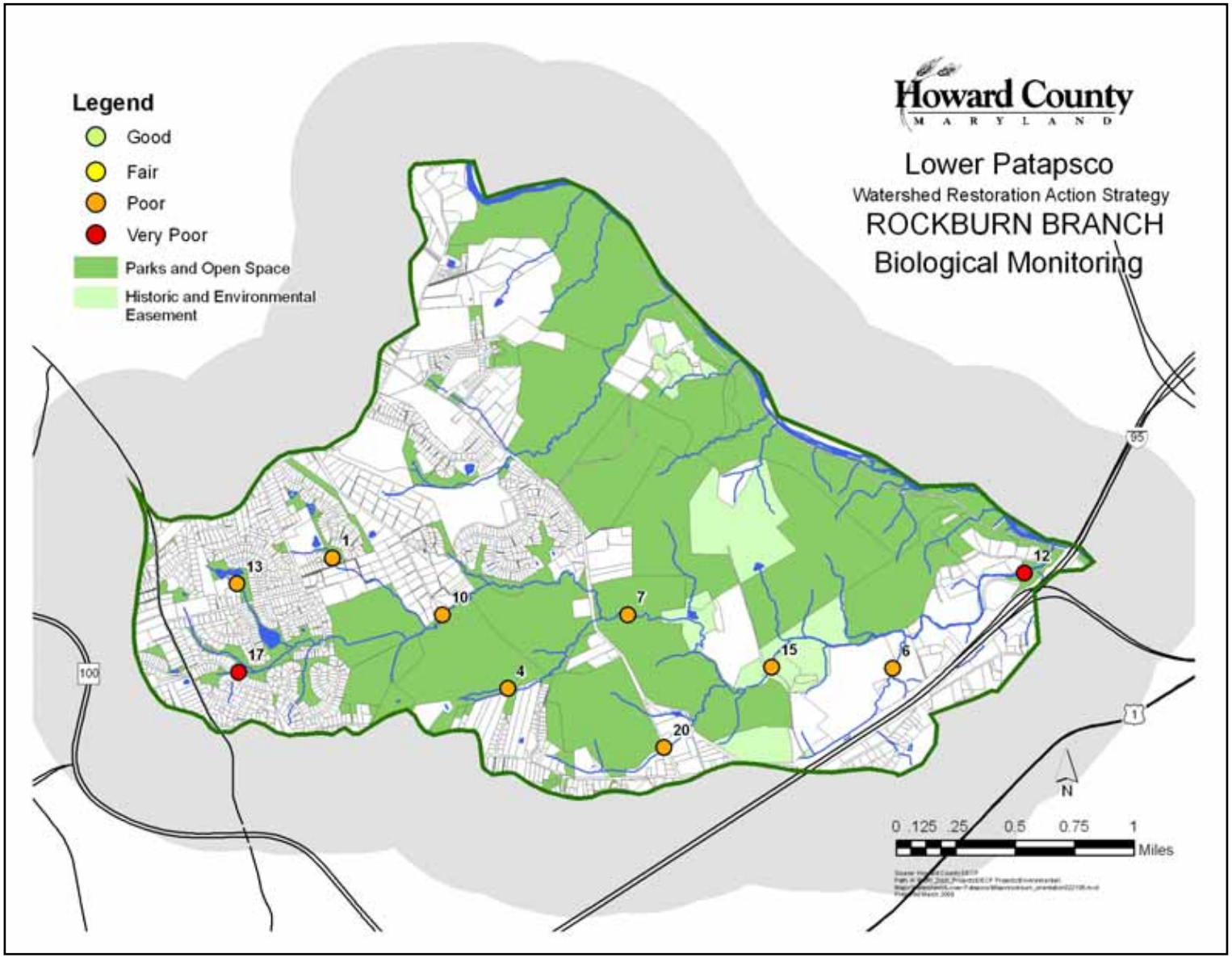
Potential pollutant load reductions that could be achieved by implementing all identified projects were analyzed using the Watershed Treatment Model (WTM). The Memorandum providing the results of this analysis is provided in Appendix B. The WTM was used to estimate existing sediment and phosphorus loads, based on current land use, and to estimate relative pollutant load reductions achieved by current management practices and by the proposed projects. Current management practices include practices such as erosion and sediment control for construction sites, street sweeping, and stormwater management. The WTM results indicate that the largest source of phosphorus and sediment in the watershed is urban land use and that current management practices reduce phosphorus loads by 27% and sediment loads by 46%. The

estimated pollutant load reductions from implementing all identified restoration projects is 4% for phosphorus and 11% for sediment.

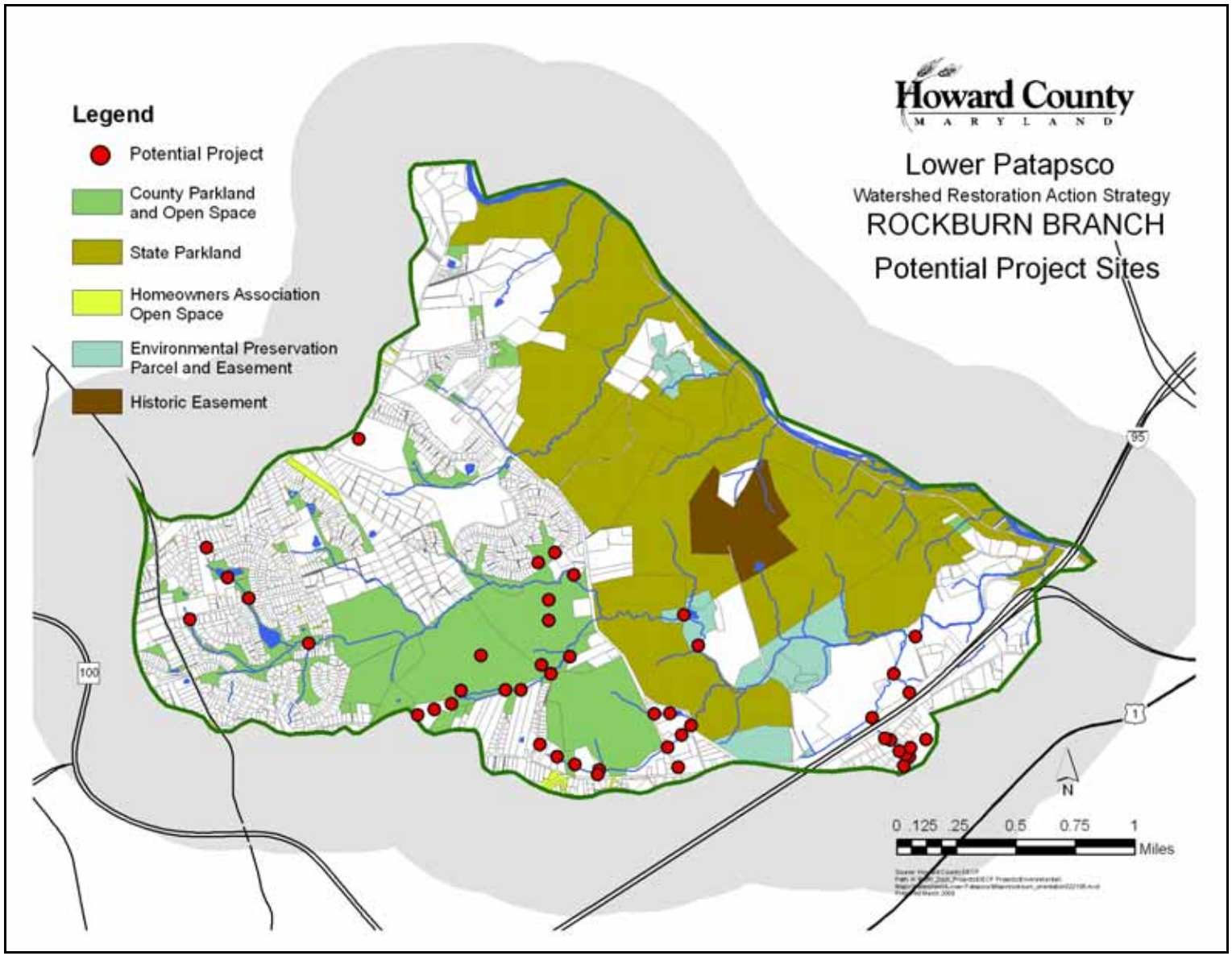
Table 7 – Rockburn Branch Projects

Project	Location	Description	Ownership	Estimated Cost ($)
RB - 18	Elkridge Elementary Pond	Stormwater Retrofit	Public	200,000
RB - 33	Radel Lane Pond	Stormwater Retrofit	Public	50,000
RB - 22	Rockburn Park West	Stormwater Retrofit	Public	150,000
RB - 20	Rockburn Elementary Pond	Stormwater Maintenance	Public	0
RB - 16	Elkridge Elementary Entrance Parking Lot	Stormwater Retrofit	Public	150,000
RB - 23	Rockburn Park Outfall	Stormwater Maintenance	Public	0
RB - 21	Rockburn Park East	Stormwater Retrofit	Public	150,000
RB - 5	Rockburn Branch Park Stream Crossing #1	Stream Restoration	Public	200,000
RB - 6	Rockburn Branch Park Stream Crossing #2	Stream Restoration	Public	200,000
RB - 8	Rockburn Branch Park Trail	Trail Erosion and Buffer Restoration	Public	50,000
RB - 1	Kerger Dry Pond	Stormwater Retrofit	Public	200,000
RB - 14	Old Montgomery Rd	Buffer Restoration	Public	50,000
RB - 19	Rockburn Elementary Parking Lot	Stormwater Retrofit	Public	150,000
RB - 28	Lawyers Hill Road	Stormwater Retrofit	Public	100,000
RB - 29	Green Valley Place	Stream Restoration	Private	200,000
RB - 24	Ilchester Elementary & Middle School Rain Garden	Education/Outreach	Public	40,000
RB - 31	Rockburn Manor Outfall	Education/Outreach	Private	10,000
RB - 26	Landing Road North	Buffer restoration	Private	50,000
RB - 3	Kerger Road Stream Buffer	Buffer Restoration	Private	50,000
RB - 7	Pumphouse Stream Buffer	Buffer Restoration	Both	50,000
RB - 27	Grace Episcopal Church	Stream Restoration	Private	200,000
RB - 11	Elibank Drive Stream Buffer	Buffer Restoration	Private	50,000
RB - 25	Landing Road South	Buffer Restoration	Private	50,000
RB - 30	Lawyers Hill Driveway	Buffer Restoration	Private	50,000
RB - 17	Elkridge Elementary Stream	Stream Restoration	Public	200,000
RB - 4	Western Rockburn Branch Park Stream	Stream Restoration	Public	200,000
RB - 2	Dunteachin Storm Drain	Stormwater Retrofit	Private	100,000
RB - 32	Grovemont Ponds	Stormwater Maintenance	Private	0
RB - 15	Old Montgomery Stream	Stream Restoration	Private	200,000
RB - 9	Sunnyfield Outfall	Native Species Planting	Private	20,000
RB - 10	Dunteachin Pond Outfall	Stormwater Maintenance	Private	0
		Total Cost Priority Projects		**2,100,000**
		Total Cost All Projects		**3,120,000**

Note: Projects are listed in order of priority ranking, and priority projects are indicated in bold.



Map 8 – Rockburn Branch Biological Monitoring. Biomonitoring was conducted at ten sites within the Rockburn Branch subwatershed. Source: Howard County DPZ and DRP, and MDE, March 2006.



Map 9 – Rockburn Branch Potential Project Sites. Thirty-one potential projects were identified in the Rockburn Branch watershed. Source: Howard County DPZ and DRP, and Tetra Tech, Inc. / Center for Watershed Protection, March 2006.

Sucker Branch Assessment

Land Use

The Sucker Branch watershed has an area of approximately 4.2 square miles. The Sucker Branch watershed has predominantly low-density residential development, with a cluster of medium and high density residential and office/commercial development along Route 40 and in the area southeast of the I-70/MD 29 interchange. Approximately 29% of the watershed is in parkland and open space, with a majority of the parkland being contained within Patapsco Valley State Park (Map 10). The watershed has 17.9% impervious cover, placing it in the impacted watershed category. Impervious cover is expected to increase to 21.8% at build-out, keeping the watershed within the impacted category. Impacted watersheds are expected to have fair to good stream conditions but show clear signs of degradation.

Biomonitoring

Biomonitoring was conducted at 12 sites in the Sucker Branch watershed in March 2005. The Report on Supplemental Benthic Macroinvertebrate Surveys in the Lower Patapsco River Watershed Tributaries of Rockburn and Sucker Branches (Primrose 2006) presents detailed information on sampling methods and results. The monitoring locations are shown on Map 10. As shown in Table 8, the biological scores ranged from poor to very poor and the physical habitat scores ranged from supporting to non-supporting. The average rating for the watershed was very poor biological health and non-supporting physical habitat. These results indicate more degraded stream conditions than would be expected based on the impervious cover assessment.

Table 8 - Sucker Branch Biomonitoring

Station	Biological Rating	Physical Habitat Rating
1	Very poor	Non-supporting
4	Very poor	Non-supporting
6	Very poor	Non-supporting
7	Very poor	Non-supporting
8a	Very poor	Non-supporting
10	Very poor	Partially supporting
11	Very poor	Partially supporting
13	Very poor	Supporting
15	Very poor	Non-supporting
16a	Very poor	Non-supporting
18a	Very Poor	Non-supporting
20	Poor	Partially supporting
Mean	**Very poor**	**Non-supporting**

Potential Project Sites

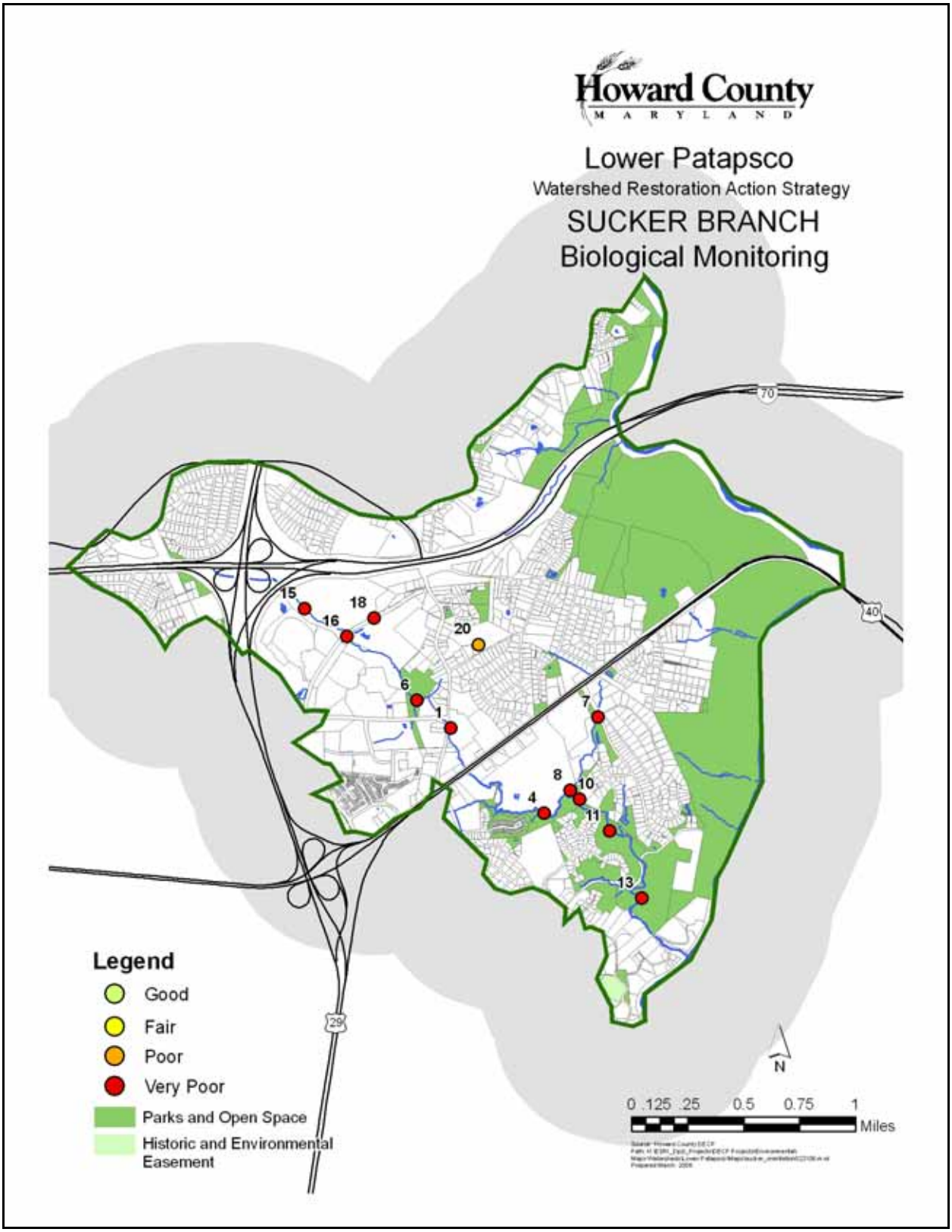
Fourteen priority problem sites were identified in the Sucker Branch watershed, based on the results from the stream corridor assessment. These included 7 erosion sites, 6 inadequate buffers, and 1 construction site. These sites were investigated for restoration potential, as were other opportunities in the watershed for stormwater management improvements. In addition, management practices were observed for residential and commercial areas to identify areas for public outreach to improve practices. This assessment identified 34 potential projects in the watershed. The majority of these projects were located in the more densely developed areas of the watershed. Potential projects included stormwater retrofits, stream and buffer restorations, trash removal, and outreach and education. The potential projects were ranked based on cost, land ownership, physical constraints, and habitat and water quality benefits. This ranking produced 26 priority projects with an estimated $4 million in project cost. Sucker Branch has a higher number of priority projects in part because the watershed has some large private landowners. For efficiency, if there were one or more priority projects on a particular property, then all projects on that property were designated as a priority so they could be discussed together with the owner. Only three of the priority projects are on public land, so moving forward with restoration projects in this watershed will require substantial landowner cooperation. Table 9 lists all projects in the order of their ranking and indicates the priority projects in bold. Map 11 shows the location of all projects.

Potential pollutant load reductions that could be achieved by implementing all identified projects were analyzed using the Watershed Treatment Model (WTM). The Memorandum providing the results of this analysis is provided in Appendix B. The WTM was used to estimate existing sediment and phosphorus loads, based on current land use, and to estimate relative pollutant load reductions achieved by current management practices and by the proposed projects. Current management practices include practices such as erosion and sediment control for construction sites, street sweeping, and stormwater management. The WTM results indicate that the largest source of phosphorus and sediment in the watershed is urban land use and that current management practices reduce phosphorus loads by 31% and sediment loads by 47%. The estimated pollutant load reductions from implementing all identified restoration projects is 4% for phosphorus and 6% for sediment.

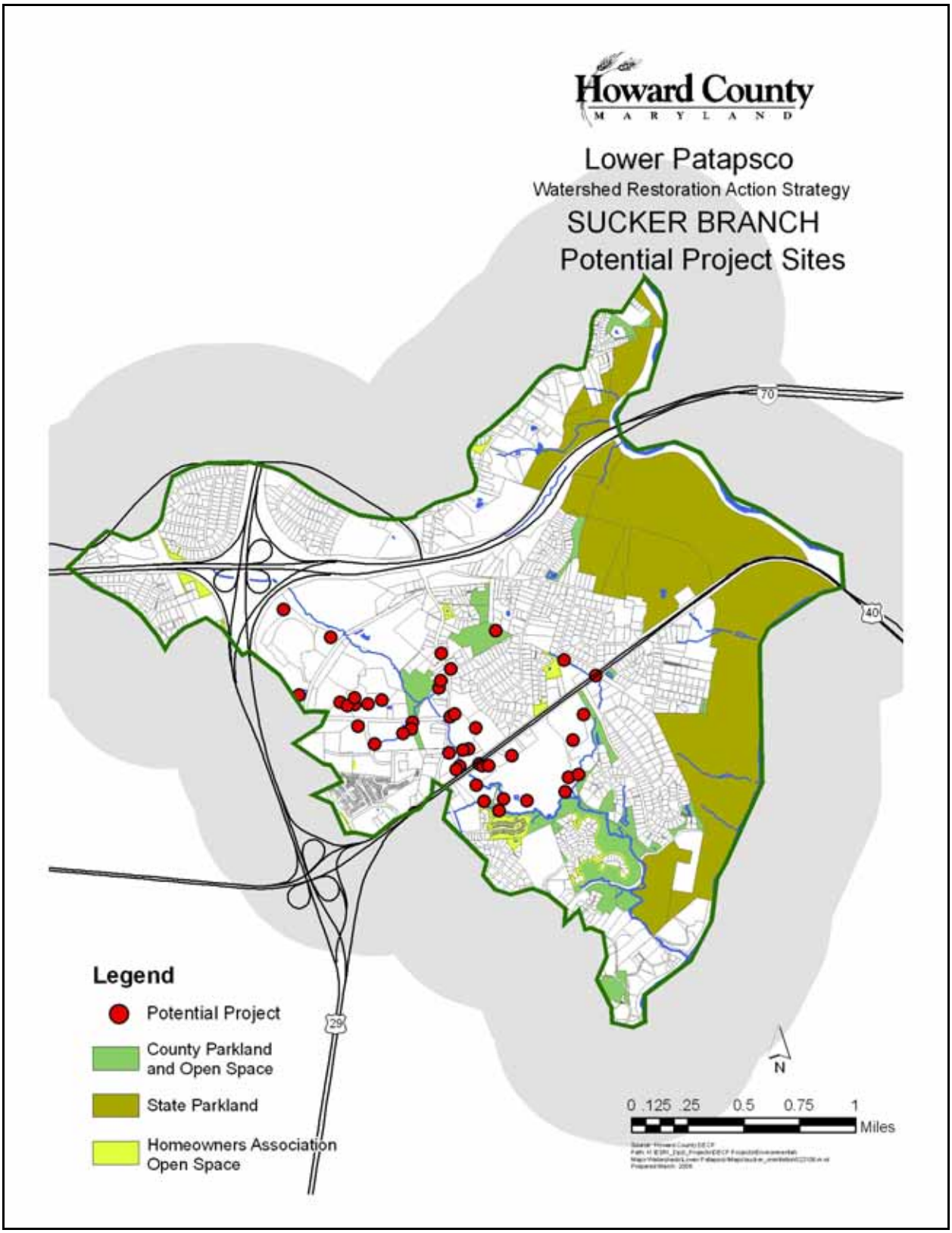
Table 9 – Sucker Branch Projects

Project	Location	Description	Ownership	Estimated Cost ($)
SB - 4	Apartments at Rogers Avenue	Stream Restoration & Stormwater Retrofit	Private	250,000
SB - 7B	Howard Crossing South	Buffer Restoration	Private	50,000
SB - 6A	Howard Crossing Channel	Stream Restoration	Private	200,000
SB- 27	North Ridge Professional Bldg Ponds	Stormwater Retrofit	Private	200,000
SB - 3	Rte 40 Plunge Pool	Stream Restoration & Stormwater Maintenance	Public	200,000
SB - 6D	Howard Crossing Channel	Stormwater Retrofit	Private	200,000
SB - 30	Rockland Art Center	Stormwater Retrofit	Public	250,000
SB - 7A	Howard Crossing South - Pool Area	Stream Restoration	Private	200,000
SB - 6B	Howard Crossing Buffer	Buffer Restoration	Private	50,000
SB - 14	Howard Crossing	Stream Restoration & Stormwater Maintenance	Private	200,000
SB - 2A & 2B	Charleston Manor & Dominion Great Oaks	Stream Restoration & Stormwater Retrofit	Private	250,000
SB - 10	Dominion Great Oaks #2	Stormwater Retrofit	Private	150,000
SB - 5	Rogers Avenue Buffer	Buffer Restoration	Private	50,000
SB - 1	Our Lady Center	Stream Restoration	Private	200,000
SB - 12	Residential Swimming Pool	Education/Outreach	Private	10,000
SB - 28	Heartlands Ponds	Stormwater Retrofit	Private	50,000
SB - 11	Route 40 Outfall	Stormwater Retrofit	Public	100,000
SB - 15	Chandler Lee - GMC Dealer	Stormwater Retrofit	Private	150,000
SB - 22	Normandy Shopping Center	Stormwater Retrofit	Private	250,000
SB - 6C	Howard Crossing Channel	Stormwater Maintenance	Private	50,000
SB - 18	Charleston Manor Tennis Court Parking	Stormwater Retrofit	Private	150,000
SB - 19	Charleston Manor Residential Parking	Stormwater Retrofit	Private	150,000
SB - 24	Infiniti Dealership	Stormwater Retrofit	Private	50,000
SB - 9	Dominion Great Oaks Pool Parking	Stormwater Maintenance & Retrofit	Private	100,000
SB - 26	Big Screen Store on Route 40	Trash Removal	Private	5,000
SB - 13	Rogers Avenue Stream	Buffer Restoration	Private	50,000
SB - 23	Miller Brothers Ford	Trash Removal	Private	5,000
SB - 29	Papa John's Dry Pond	Stormwater Retrofit	Private	100,000
SB - 20	Business Complex at 8569 Rte. 40	Stormwater Retrofit	Private	100,000
SB - 8	Charleston Manor Parking Lot	Stormwater Retrofit	Private	200,000
SB -16	Saturn Dealer on Route 40	Stormwater Retrofit	Private	150,000
SB -17	Shell Station on Rte 40	Stormwater Retrofit	Private	100,000
SB - 25	Big Screen Store on Route 40	Stormwater Retrofit	Private	50,000
SB - 21	Shell/High's Market on Normandy	Stormwater Retrofit	Private	100,000
		Total Cost Priority Projects		**3,865,000**
		Total Cost All Projects		**4,370,000**

Note: Projects are listed in order of priority ranking, and priority projects are indicated in bold.



Map 10 – Sucker Branch Biological Monitoring. Biomonitoring was conducted at twelve sites within the Sucker Branch subwatershed. Source: Howard County DPZ and DRP, and MDE, March 2006.



Map 11 – Sucker Branch Potential Project Sites. Thirty-four potential projects were identified in the Sucker Branch watershed. Source: Howard County DPZ and DRP, and Tetra Tech, Inc. / Center for Watershed Protection, March 2006.

Watershed Restoration Plan and Implementation Strategy

Summary of Watershed Conditions

As noted previously, the Lower Patapsco watershed is located predominantly within the County's Planned Water and Sewer Service Area, which is also the County's designated Priority Funding Area under Maryland's Smart Growth Initiative. As a result, substantial urban / suburban development has occurred in the watershed, particularly in the Tiber-Hudson and Deep Run subwatersheds, which contain historic Ellicott City and the I-95 / Route 1 corridor, respectively.

Development, particularly development that occurred prior to County adoption of stormwater management and environmental protection regulations, eliminates and degrades habitat for both land and aquatic species as forests are cleared, impervious surfaces increase, and streams receive polluted runoff at an increased volume and frequency. There are no significant point sources of pollution in the watershed, so nonpoint sources are the dominant source of pollution. The more recent pattern of development in the headwaters of tributary streams means that even protected downstream sections of a stream can have erosion and pollution problems generated by upstream development.

The stream corridor assessment survey found potential problem sites throughout the watershed, primarily along the tributaries to the Patapsco. The main stem of the Patapsco had relatively few problem sites. The mainstem may have fewer sites because it is protected from development by Patapsco Valley State Park and the negative impacts from development, such as an increase in impervious cover, are diluted as the size of a watershed increases. Almost 60% of the sites identified in the survey had a low to minor severity rating. The most common potential problem types were pipe outfalls, the majority of which were stormwater outfalls, inadequate stream buffers and stream bank erosion. Erosion along the tributaries was described as many sites with small bank heights extending over moderate distances. Erosion on the main stem was described as mostly moderate bank heights over short distances. Stream channel alterations were a minor problem in the watershed, indicating that a natural channel still remains in the majority of the watershed.

The impervious cover assessment reflects the urban / suburban nature of development in the watershed. The majority of subwatersheds are in the impacted or non-supporting category and are expected to have degraded stream habitat and water quality. This assessment is supported by the results of the biological monitoring, which ranked both the larger main stem and Deep Run subwatersheds as poor for biological health and partially-supporting for physical habitat. The synoptic water quality survey found high conductivity values, which is an indicator of dissolved salts such as road salt used for deicing roads, in those subwatersheds with a high density of local roads and highways.

The Rockburn Branch and Sucker Branch subwatersheds were chosen for additional study to examine restoration issues in a less developed watershed and a more urban / suburban watershed, respectively. Sucker Branch, with its higher level of impervious cover and its lower level of

publicly-owned land, has development conditions that are more typical of what would be found in most other subwatersheds in the Lower Patapsco. Restoration projects in both subwatersheds included stormwater retrofits, stream and buffer restorations, and public outreach and education. Sucker Branch, however, had almost twice as many stormwater retrofit sites and the estimated cost for project implementation was substantially higher than in Rockburn Branch. In addition, the majority of potential project sites in the Sucker Branch subwatershed were on private property and will not be implemented without landowner cooperation.

Despite the increasing urbanization of the watershed, almost one-third (32%) of the watershed is protected as County and State park land, open space or easement. This protected land often contains sensitive resources such as streams, wetlands, floodplains and forests. About 43% of the watershed is forested, and two-thirds (68%) of this forest is on publicly-owned land. Public ownership often affords greater protection for sensitive resources and provides greater access for restoration efforts. However, the majority (76%) of stream miles with inadequate buffers are located on private property. This ownership pattern points out the need for private landowner outreach and education to encourage cooperation for habitat and water quality improvements in the watershed.

Watershed Restoration Goals and Objectives

The Characterization and supporting studies provide evidence that the Lower Patapsco watershed has been substantially impacted by development. However, these studies also indicate that restoration efforts are feasible and can result in measurable improvements to water quality and habitat. To achieve the vision for the Lower Patapsco watershed, the following goals and objectives have been established for water quality, habitat and public outreach:

Water Quality

Goal: Achieve and maintain the water quality necessary to support the aquatic living resources of the Lower Patapsco River watershed and to protect human health.

Objectives:

- Improve biological and physical habitat ratings.
- Meet State water quality standards.
- Reduce sediment and nutrient loads.

Habitat

Goal: Protect, enhance and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Lower Patapsco River watershed.

Objectives:

- Retain, enhance, and restore forests, wetlands, meadows and other areas of natural cover.
- Increase the habitat value of ponds.
- Enhance and restore instream physical habitat, including streambeds and streambanks.
- Manage wildlife to support healthy and diverse populations of native species.

Public Outreach

Goal: Promote environmental stewardship and assist individuals, community-based organizations, businesses, schools and others to undertake watershed restoration initiatives.

Objectives:

- Increase awareness and personal involvement.

- Encourage participation in land preservation programs.
- Promote land management practices that conserve resources, reduce pollution and enhance habitat.
- Support the establishment of watershed protection organizations and partnerships.

Watershed Protection and Restoration Tools, Actions and Constraints

To achieve the goals and objectives for the Lower Patapsco watershed, the following watershed protection and restoration tools and related actions are needed:

Land Conservation – Protect sensitive land and water resources and habitats.

- Acquire key greenway and upland parcels through purchase, using State and County open space funds, or dedication.
- Acquire easements through the Agricultural Land Preservation Program, Howard County Conservancy, Rockburn Land Trust, Forest Conservation Program, dedicated preservation parcels and other appropriate easement programs.
- Assess existing easement monitoring programs for their effectiveness.
- Continue research and refinement of regulations for the protection of open space, sensitive resources and forest conservation. Ensure regulations are adequately enforced.
- Promote forest conservation banking for forest retention and reforestation.
- Improve land management practices and enforcement on protected lands.
- Encourage the development and implementation of soil conservation and water quality plans for agricultural lands.

Riparian Buffers – Establish, protect and enhance forested buffers for streams and wetlands.

- Prioritize locations where buffers are absent, as identified in the stream corridor assessment survey, and develop a planting strategy defining number of acres or linear feet per year to be planted.
- Continue planting buffers on County green space.
- Promote the Conservation Reserve Enhance Program and other habitat improvement programs to the rural and agricultural community.
- Develop and implement a strategy for control of invasive plants.
- Encourage private property owners to plant forested buffers, and to reduce mowing and use best management practices in existing buffers.
- Identify and develop funding sources for private buffer plantings.

Better Site Design – Minimize impervious surfaces and maximize open space.

- Develop an environmental regulations handbook for developers and citizens that explains the rationale for County environmental regulations, provides examples of effective design solutions and presents the benefits of going beyond minimum requirements.
- Continue to hold workshops for developers and consultants promoting the use of low impact development (LID) techniques, as permitted in the stormwater management regulations.
- Promote the use of LID techniques by creating demonstration projects at County facilities.
- Develop demonstration sites or case studies for successful stormwater management practices.
- Continue research and refinement of regulations that promote better site design.

Erosion and Sediment Control – Reduce sediment loss during construction and ensure sensitive areas are protected.

- Maintain State certification of the County sediment and erosion control program.

Stormwater Best Management Practices – Install practices to maintain groundwater recharge, reduce pollutant loads, protect stream channels and reduce flooding.

- Retrofit publicly maintained facilities identified as priorities in the County retrofit survey.
- Identify privately maintained facilities that are retrofit candidates and secure funding for retrofits of these facilities.
- Retrofit existing facilities and develop new facilities on County owned sites.
- Monitor the effectiveness of the stormwater management regulations and facilities.
- Encourage communities, agencies and nongovernmental organizations to increase the habitat value of existing facilities.
- Encourage private landowners to use low impact development techniques such as rain gardens and rain barrels.

Other Discharges – Manage septic systems, sanitary sewers and industrial discharges.

- Monitor pipe outfalls through the County illicit discharge program.
- Address priority pipe outfalls, exposed pipes and unusual conditions identified in the stream corridor assessment survey.
- Ensure that problem septic areas are addressed through the Health Department.

Stream Channel Stabilization and Restoration – Improve aquatic habitat and reduce sediment loads to streams.

- Address priority erosion sites identified in the stream corridor assessment survey using bioengineering techniques where feasible.
- Develop long-term strategies to address channelized stream sections and the removal of fish passage blockages identified in the stream corridor assessment survey.

Habitat and Wildlife Management – Establish, protect and enhance valuable habitat, and manage wildlife to support healthy and diverse populations of native species.

- Continue development and implementation of management plans for County and State parkland.
- Develop and implement a strategy for control of invasive plants.
- Protect and create areas of forest interior habitat, threatened and endangered species habitat, and other areas of diverse sensitive habitat.
- Develop a forest management plan to ensure forest diversity and resilience.
- Encourage private landowners of qualified properties to work with DNR to develop forest management plans.
- Plant forests in targeted areas to link, connect and extend forests.
- Promote native plant landscaping, and encourage non-turf alternatives and reduced mowing.
- Enhance existing wetlands and create new wetlands where feasible.
- Support continued implementation and County-wide expansion of the County deer management program. Coordinate efforts with DNR on adjacent parkland, and continue to assess and revise the program as necessary to improve effectiveness.
- Endorse development of urban wildlife management studies.

Watershed Stewardship Programs – Increase public understanding and promote better private land management.

- Conduct outreach to inform the public about County responsibilities and authority for enforcing environmental regulations. Include information on how to report infractions.
- Develop a generic public outreach strategy that can be tailored to promote specific messages for each identified target audience. Target audiences should include citizen boards, elected officials and other decision-makers.

Subwatershed Studies – Develop and implement restoration plans for subwatersheds.

- Develop more detailed restoration plans for all subwatersheds beginning with Elkridge and the Deep Run Tributaries, priority subwatersheds as defined through the County's National Pollutant Discharge Elimination System (NPDES) program.
- Conduct biological monitoring at a subwatershed scale, to provide more site-specific information for the subwatershed restoration plans.
- Implement subwatershed restoration plans through the County's NPDES stormwater discharge permit program and other applicable programs, beginning with the Rockburn Branch and Sucker Branch plans.

Implementation Monitoring

- Develop an implementation monitoring or tracking report. The report will be produced every 3 to 5 years.

Constraints on the implementation of these tools and actions can include the following:

Funding – Many of the actions listed previously are expensive to implement and County funding and staff are limited. As can be seen from the multi-million dollar cost estimates for Rockburn and Sucker Branch, restoration projects in particular are expensive. Increasing the current rate of implementing restoration projects will require additional capital funds and staff. Implementing actions that require new programs or new efforts under existing programs will also require additional funding and staff. Possible supplemental funding sources include Federal, State and nongovernmental grants and loans; however, competition for these can be strong.

Landowner Cooperation – In the Sucker Branch watershed, over 90% of the potential projects were on privately-owned land. Some proposed projects such as buffer plantings can be implemented on a voluntary basis by private landowners, but other projects such as stream channel restoration may need County assistance. There must be a clear public interest or benefit to justify County expenditure of public funds on private property, and a public easement must be acquired by the County. Lack of landowner cooperation for a proposed project on private property can slow a project, adding to the project cost, or even stop project implementation.

Site Access or Constraints – Some restoration sites may be relatively inaccessible. If restoration requires access by heavy equipment, and such access causes more harm than good, the project will not be pursued. Other sites may be constrained by the presence of utilities, which can limit the area available for restoration projects.

Next Steps and Implementation Priorities

Table 10 presents priorities for implementing the restoration actions listed previously. Actions have been grouped into one of five implementation priority categories:

- Ongoing actions - *Existing County programs address these actions.*
- Enhanced ongoing actions - *Existing County programs will have enhancements added that specifically address these actions.*
- Short-term actions - *New programs or new actions under existing programs will be implemented within the next two to five years.*
- Mid-term actions - *New programs or new actions under existing programs will be implemented within the next five to ten years.*
- Long-term actions - *New programs or new actions under existing programs will be implemented within the next ten to fifteen years.*

Programmatic Change

As part of the WRAS grant requirements, the final report should contain a recommended program change that complements or supports management objectives for the watershed. To support water quality and habitat goals for the watershed, the recommended program change is an update to the Howard County Forest Conservation Act and Manual. The Howard County Forest Conservation Program was instituted in 1993 and the Manual was last updated in 1999. The update is intended to include changes that will increase forest retention on developing sites, improve the success of forest mitigation planting, and encourage greater use of forest mitigation banking. Recommended revisions to the Act and Manual are currently being developed by a County workgroup with the assistance of a Steering Committee that includes members from the development and consultant community. The expected date for adoption of the update is early 2007.

Summary

Implementing the Lower Patapsco Watershed Restoration Action Strategy will require a cooperative effort among private landowners and County and State agencies. The primary County agencies responsible for environmental activities are the Departments of Planning and Zoning, Public Works, and Recreation & Parks. The County's Environmental Steering Committee, which is comprised of representatives from these and other related agencies, such as the Howard Soil Conservation District, will provide the mechanism for coordinating and tracking these efforts.

Table 10 - Implementation Priorities

Action	Responsible Agency
Ongoing (existing programs)	
Acquire key greenway and upland parcels through purchase or dedication.	DRP
Acquire conservation easements through purchase or dedication.	DPZ
Continue refinement of environmental regulations.	DPZ & DRP
Encourage the development and implementation of soil conservation and water quality plans.	HSCD
Continue planting buffers on County green space.	DPZ & DRP
Promote habitat improvement programs in the rural/agricultural community.	HSCD
Continue to hold workshops promoting the use of low impact development techniques.	DPZ
Continue refinement of better site design regulations.	DPZ
Maintain State certification of the County sediment and erosion control program.	DPW
Retrofit priority, publicly maintained stormwater management facilities.	DPW
Monitor the effectiveness of the stormwater management regulations and facilities.	DPW
Monitor pipe outfalls through the County illicit discharge program.	DPW
Ensure that problem septic areas are addressed.	HD
Enhanced Ongoing (existing programs)	
Assess easement monitoring programs for their effectiveness.	DPZ
Promote forest conservation banking for forest retention and reforestation.	DPZ
Improve land management practices and enforcement on protected lands.	DNR, DRP & DPZ
Develop demonstration sites or case studies for successful stormwater management practices.	DPZ & DPW
Continue development and implementation of management plans for County and State parkland.	DNR & DRP
Plant forests in targeted areas to link, connect and extend forests.	DRP & DPZ
Expand the County deer management program and coordinate efforts with DNR on adjacent parkland.	DNR & DRP
Endorse development of urban wildlife management studies.	DRP

Action	Responsible Agency
Short-Term (2 to 5 years)	
Prioritize locations where riparian buffers are absent and develop a planting strategy.	DPW & DRP
Develop and implement a strategy for control of invasive plants.	DRP
Encourage private property owners to plant forested riparian buffers and to use best management practices in existing buffers.	DPW & DRP
Identify and develop funding sources for private riparian buffer plantings.	DPW
Promote the use of low impact development techniques by creating demonstration projects at County facilities.	DPW
Encourage communities and other groups to increase the habitat value of existing stormwater management facilities.	DPW
Encourage private landowners to use low impact development techniques such as rain gardens and rain barrels.	DPZ & DPW
Address priority pipe outfalls, exposed pipes and unusual conditions.	DPW
Encourage qualified private landowners to work with DNR to develop forest management plans.	DNR
Promote native plant landscaping and encourage non-turf alternatives.	DPZ, DPW & DRP
Conduct public outreach on County responsibilities and authority for enforcing environmental regulations.	DPZ
Develop a generic public outreach strategy that can be tailored to target audiences.	DPZ, DPW & DRP
Conduct biological monitoring at a subwatershed scale.	DPW
Develop an implementation monitoring or tracking report.	DPZ, DPW & DRP
Mid-Term (5 to 10 years)	
Prepare outreach materials such as an environmental regulations handbook or case studies to promote better site design.	DPZ
Address priority stream channel erosion sites.	DPW
Develop more detailed restoration plans for all subwatersheds, beginning with priority subwatersheds.	DPZ, DPW & DRP
Implement subwatershed restoration plans, beginning with the Rockburn and Sucker Branch plans.	DPZ, DPW & DRP
Long-Term (10 to 15 years)	
Identify privately maintained stormwater management facilities that are retrofit candidates and secure funding for these retrofits.	DPW
Retrofit existing stormwater management facilities and develop new facilities on County owned sites.	DPW
Develop strategies to address channelized stream sections and the removal of fish passage blockages.	DPW
Protect and create areas of diverse sensitive habitat.	DPZ & DRP
Develop a forest management plan to ensure forest diversity and resilience.	DRP
Enhance existing wetlands and create new wetlands where feasible.	DPW

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Appendix A – Workshop Reports

October 23, 2004 Workshop Report

The Lower Patapsco Watershed Restoration Workshop was held on Saturday, October 23, 2004 in the Bureau of Utilities Conference Room, with 36 people in attendance. The purpose of the workshop was to inform the public about development of the Lower Patapsco Watershed Restoration Action Strategy (WRAS), a work plan to restore and protect water quality and habitat in the watershed, and to encourage public participation in this process.

Welcome and Introductions

The workshop began with Mina Hilsenrath (Howard County) welcoming the attendees and introducing the members of the WRAS Planning Team. Ursula Lemanski (National Park Service) then asked attendees what they valued about their watershed. The following was their response:

- Wildlife
- Forests
- Natural areas
- Fish
- Family and history
- Recreation
- Sanctuary for living things
- Kayaking
- Walking through historic Ellicott City & Patapsco Valley State Park
- Hiking & birding
- Accessibility to natural areas
- Cultural and natural together
- Ability to do environmental restoration

Patapsco Watershed: A River's Legacy

After viewing "Patapsco Watershed: A River's Legacy," a short video about the rich history of the Patapsco River valley, attendees were asked if they had comments or had learned anything new from the video. The following was their response:

- Seeing changes in Rockburn Branch - some algae and harder to see the bottom.
- Sucker Branch has mud flows from construction sites and flows over Park Drive.
- In Ilchester, when I was young, I could drink the water in the tributaries, but in the 1960s the color of the main stem was gray or pea green.
- On a canoe trip from Avalon to the Baltimore Harbor, the water clarity was pretty good. Water quality was degraded earlier in the 1900s from paper mill.

Why Watersheds?

Rebecca Winer of the Center for Watershed Protection gave a "Why Watersheds?" presentation. This presentation provided information about the definition of a watershed, why watershed health is important, the impacts of impervious cover on stream quality, and what communities and individuals can do to help improve their local streams. The presentation included information about the following eight tools of watershed protection:

1. Watershed Planning

2. Land Conservation
3. Aquatic Buffers
4. Better Site Design
5. Erosion & Sediment Control
6. Stormwater Management
7. Other Pollution Sources
8. Watershed Stewardship

Current Watershed Conditions

After a short break, Susan Overstreet (Howard County) gave a presentation on current conditions in the Lower Patapsco River watershed. This presentation included information about the WRAS planning process, current and projected impervious cover along with expected stream conditions, and the results from recent biological monitoring and a stream corridor assessment survey. A summary of this information can be found in the Lower Patapsco WRAS Fact Sheet, which is available on the DPZ web site.

Visioning Session

The attendees formed two workgroups to brainstorm about their ideas for what should be done to protect and restore the watershed. Specifically, the workgroups were asked: What do we need to do to restore and protect water quality and habitat for ourselves and for future generations? After generating ideas, workgroup members formed teams of two and prioritized their ideas. These priority ideas were written in short, five-word descriptions and then categorized. After the brainstorming session, the workgroups reported back on their categories for future action. A full list of all the ideas generated is given at the end of this report. The following is a summary of the key categories presented for future action:

- Public outreach, education and participation
- Land preservation
- Planning and regulation
- Enforcement of regulations
- Regulations for water quality improvement
- Stormwater management
- Point sources
- Water quality and habitat management
- Enhance riparian buffers
- Funding for restoration and management

Wrap Up and Next Steps

Mina Hilsenrath provided information on next steps. The WRAS Planning Team will refine the ideas generated at the workshop as it moves forward with the WRAS process. Anyone interested in participating on the planning team should contact Susan Overstreet. The Planning Team will hold a series of workshops in 2005 to look in more detail at various tributaries of the Lower Patapsco, and to identify specific priorities for protection and restoration. The Team hopes that all of the workshop attendees will be able to attend and continue their participation in the WRAS process. Attendees were encouraged to monitor the Department of Planning and Zoning web site at www.co.ho.md.us/DPZ/Environment/dpz_environmental_planning.htm for more information on these workshops.

Visioning Session Ideas

Group 1

Land Preservation / Management
- Land preservation
- More land preservation
- Additional acquisition/protection of open space

Funding
- Dedicated mitigation fund
- Restoration plan and program and projects
- Regional management and funding
- Action target – vendors that assist/profit remediation
- Market incentives to encourage behavior change

Water Quality / Habitat Management
- Deer control
- Dam and fish passage obstruction removal
- Plant more trees – expand canopy
- Restoration of streams
- Stream monitoring
  - Water quality
  - Stream stability
  - Habitat quality

Education /Action – Public Participation
- Educate kids and adults
- Citizen education and outreach – energize for action
- Raise awareness of lifestyle choice (house size, car, divorce, lawns or not)
- Involve schools
- Action target – citizens own stream

Regulations [for] water quality improvement
- No more loss of forest or wetlands within 100 feet
- Adopt LID [low impact development] regulations for County capital project and private development
- Limit development
- Alternatives to impervious surfaces

Enforcement of Regulations
- Better enforcement of existing development regulations
- County: model and enforce
- Assessment and ongoing monitoring of progress
- Prioritize Solutions
  - Practicality
  - Effectiveness

- Sustainability

Group 2

Education and Outreach
- Community project
  - Manage effectively
  - Communicate results
- Educate public
- Encourage public education and participation
- Citizen outreach and involvement
- Monitor
- Learn more
- Educate others
- Educate homeowners (to incite indignation)
- Coordinate efforts
- Train citizens to help enforce regulations

Managing Runoff
- Manage stormwater on-site
- Retrofit to reduce runoff
- Reduce impervious surfaces (existing and proposed)
- Stormwater management – implementing
- Repair erosion - help nature heal

Land Conservation
- Promote forest / habitat protection (habitat management)
- Conserve land
- Preservation – what can be saved
- Protect green space with land trust easements

Point Source and Industry
- Industry and utilities buy-in
- Leaking landfills
- Identify point sources
- WWTPs (wastewater treatment plants)

Enhance Buffer
- Promote stream buffers
- Plant natural buffers - remove invasives
- Increase buffers
- Restore and increase riparian buffers
- Reforestation / restoration buffer
- Remove invasive species

Planning and Regulation
- Good development planning, sensitive zoning

- Sustainable development
- Better site design (planning)
- Implement LIDs
- Better site design
- Commit more public resources to problems
- Enforcement of sediment control regulations
- Learn the regulations & enforce them

June 28, 2005 Workshop Report

The second Lower Patapsco Watershed Restoration Workshop was held on Tuesday, June 28, 2005 in the Bureau of Utilities Conference Room, with 15 people in attendance. The purpose of the workshop was to present results from recent water quality monitoring and stream corridor surveys, review priority restoration projects, discuss community priorities for the watershed, and provide information on practices homeowners can use to help improve water quality and habitat.

Welcome and Introductions

The workshop began with Mina Hilsenrath (Howard County) welcoming the attendees and introducing the members of the Lower Patapsco Watershed Restoration Planning Team.

Water Quality and Priority Restoration Sites

Susan Overstreet (Howard County) gave a presentation on the results from recent chemical and biological water quality monitoring. This monitoring and other data collection and analysis is being done to support development of a Lower Patapsco Watershed Restoration Action Strategy (WRAS). The WRAS will be a work plan to restore and protect water quality and habitat in the watershed. The presentation also reviewed the process used to prioritize problem sites identified in the stream corridor survey for additional investigation and potential restoration. Restoration activities could include stream channel stabilization, riparian buffer plantings, and/or stormwater management retrofits (installing new stormwater management facilities or modifying existing facilities to improve water quality treatment).

What You Can Do in Your Back Yard

Melissa DeSantis (Tetra Tech, Inc.) gave a presentation on homeowner practices that can help improve water quality and habitat. These practices can include proper disposal of pet waste, minimizing the use of lawn fertilizers, directing roof downspouts to vegetated areas, washing cars on the lawn or at a car wash, and replacing lawn areas with native plants.

Mapping Priorities

Attendees formed two groups to discuss the priority restoration sites and community priorities for restoration in the northern and southern portions of the watershed. Specifically, attendees were asked about water quality and habitat conditions in their local streams, and what they saw as major problem areas. Based on their combination of local knowledge and the planning team's priority sites, what did they think should be the high priority restoration and protection sites/projects? Their comments are presented below.

Northern Portion of the Watershed

- When people just see a pipe, not a stream, they don't realize the effect their actions may have. Storm drain stenciling might help educate them.
- Sucker Branch – in 1996 there was illegal dumping at the art center site.
- Church Road – good that we have green space; have erosion from upstream properties; in heavy storms, get washout at Park Drive; Governors Run contributes some even though it does have stormwater management.
- Sucker Branch – a sewer line runs down Sucker Branch; there was an overflow by the apartment complex (was reported and corrected).
- Sucker Branch – runs under Route 40; most people don't know it's there (also hard to access). Has had crayfish in part of the stream. Need to keep people upstream from causing problems.
- Priority pipe outfall site in Mount Hebron neighborhood – there is a sewage pumping station in this area; does it relate to anything happening in the area? Pipe outfall is probably a storm drain outfall.
- Hudson Branch – lots of problems; developed before stormwater management and environmental regulations; houses along road and stream; what is the priority unusual condition site?
- How does the old relate to the new? When have stormwater management on one site and unmanaged on another site?

Southern Portion of the Watershed

- Involve neighborhood/community associations as much as possible to gain the interest and participation of those that live near possible restoration sites.
- Consider conditions upstream of possible restoration when selecting projects. There was a concern that the success of a project could be jeopardized if, for example, a restoration project was completed but development continued to occur upstream, which could impact the restoration site.
- Near Worthington Way – has seen red flock; spring-fed stream runs along street, comes out at power lines.
- Railroad started a series of twelve fires along the track; were trying to clean off the rust on the tracks; grinding of tracks caused sparks and fires; Howard County Fire Department had to put out fires.
- Tiber-Hudson – look for ways to manage stormwater runoff. Highly visible location for restoration efforts; could be a "show-case" project.
- Rockburn Branch – look at stormwater retrofits on County/State land to control upstream development.
- Develop a cost estimate for all priority project sites to get a sense of the level of effort needed and to prioritize the project list by cost.
- Limit forest clearing – phase it in to limit clear-cut areas and the resulting sediment and erosion.
- Limit waivers for disturbance within stream buffers. To what degree is this occurring?

Wrap Up and Next Steps

Mina Hilsenrath provided information on next steps. The WRAS Planning Team will incorporate the information gathered at the workshop as it moves forward with developing the WRAS. The Planning Team will hold another workshop in November to present the draft WRAS. For more

information on the WRAS, attendees can monitor the Department of Planning and Zoning web site at www.co.ho.md.us/DPZ/Environment/dpz_environmental_planning.htm.

March 1, 2006 Restoration Workshop

The third Lower Patapsco Watershed Restoration Workshop was held on Wednesday, March 1, 2006 at the Ellicott City Senior Center, with 21 people in attendance. The purpose of the workshop was to present the draft Watershed Restoration Action Strategy Report for the Lower Patapsco and discuss the results from the Rockburn Branch and Sucker Branch subwatershed restoration assessments.

Welcome and Introductions

The workshop began with Mina Hilsenrath (Howard County) welcoming the attendees and asking each person to briefly describe why they were attending the workshop and what they hoped to learn at the workshop.

Draft Watershed Restoration Action Strategy Report
Rockburn and Sucker Branch Assessments

Susan Overstreet (Howard County) gave a presentation on the draft Lower Patapsco Watershed Restoration Action Strategy (WRAS) report and the results from the Rockburn Branch and Sucker Branch subwatershed restoration assessments. The Lower Patapsco WRAS will be a work plan to restore and protect water quality and habitat in the watershed. The report will contain: summaries of the water quality and habitat assessments conducted as part of the study; goals and objectives for water quality, habitat and public outreach; and watershed protection and restoration actions that are prioritized for immediate, short-term, mid-term and long-term implementation. The final report should be completed at the end of March 2006.

As part of the WRAS, the Rockburn and Sucker Branch subwatersheds were chosen for additional study to examine issues in a less developed and more urban/suburban subwatershed, respectively. Results from biological water quality monitoring in each subwatershed indicate poor biological health and non-supporting physical habitat in Rockburn Branch, and very poor biological health and non-supporting physical habitat in Sucker Branch. Field assessments identified 31 potential restoration project sites in Rockburn Branch and 19 of these sites were identified as priorities. The majority of these projects are on publicly-owned land. In Sucker Branch, 34 potential project sites were identified and 26 of these were classified as priorities. The majority of these projects are located on private property, so these projects will require landowner interest and cooperation for implementation. Potential restoration projects include stream channel stabilization, riparian buffer plantings, stormwater management retrofits (installing new stormwater management facilities or modifying existing facilities to improve water quality treatment), and public outreach and education. Priority project costs were estimated at $2 million for Rockburn Branch and at $4 million for Sucker Branch.

After the presentation, there was discussion about the subwatershed studies. Citizens were concerned about the impact on individual properties from potential projects. County staff explained that the projects are recommended, not required, and will not be implemented without landowner cooperation. Citizens suggested that greater water quality benefits could be achieved by reducing large parking lots rather than planting stream buffers. Citizens also questioned the timing of the projects and the availability of funding. The County staff responded that funding is

limited for project implementation and there are two other priority subwatersheds in the Little Patuxent watershed that also have identified projects.

Wrap Up and Next Steps

Next steps for the WRAS are to finalize the report and begin implementation. Implementation will depend on landowner cooperation, and County staff and funding resources. Information about the Lower Patapsco Watershed Restoration Action Strategy, including the assessment reports for Rockburn and Sucker Branch, can be found on the Howard County Department of Planning and Zoning Web page:
www.co.ho.md.us/DPZ/Environment/dpz_environmental_planning.htm

Appendix B – Watershed Treatment Model

Memorandum

Date: March 31, 2006

To: Susan Overstreet
Howard County, Maryland

From: Emily Corwin, Sally Hoyt and Paul Sturm
Center for Watershed Protection

Re: Task 2 – Summary of Pollutant Loads and Reduction Opportunities in the Lower Patapsco River

CENTER FOR WATERSHED PROTECTION

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This memorandum provides a summary of a model pollutant load assessment conducted by the Center for Watershed Protection (CWP) in association with Tetra Tech for the Lower Patapsco River Watershed Restoration Action Strategy (WRAS). The spreadsheet-based Watershed Treatment Model (WTM) was used to estimate existing sediment and phosphorus loads in the Sucker and Rockburn Branch subwatersheds. Potential load reductions were also evaluated based on the application of a suite of both structural and nonstructural treatment practices, as described in the project recommendations in the Rockburn and Sucker Branch subwatershed reports (Tetra Tech, 2006a and 2006b).

This memo includes the following sections:

More detailed information is tabularized in the Appendix. A digital copy of the WTM spreadsheet used in this modeling exercise is provided for each subwatershed.

1.0 Description of the WTM

The Watershed Treatment Model (WTM), version 3.1 (Caraco, 2002) is a simple spreadsheet model typically used to:

- Estimate pollutant loading under current watershed conditions
- Determine the effects of current management practices
- Estimate load reductions associated with implementation of structural and non-structural management practices

The model has two basic components: Pollutant Sources and Treatment Options. The *Pollutant Sources* component of the WTM estimates the load from primary land uses (i.e. residential, commercial, agriculture) and secondary sources (i.e. active construction, managed turf, channel

erosion, illicit connections) in a watershed without treatment measures in place. The *Treatment Options* component of the model estimates the potential reduction in this uncontrolled load if various treatment measures (both structural and nonstructural) are used. The WTM can examine a wide suite of treatment measures that are not typically tracked in models such as SLAMM and SWMM (see Table 1). The WTM allows the user to quantitatively examine how these practices can most effectively be combined to reduce pollutant loads.

Table 1. Menu of Treatment Options Evaluated in WTM

- Stormwater treatment practices (STP): STPs for new development, retrofits
- Stormwater management program practices: lawn care education, pet waste education, street sweeping, impervious cover disconnection, riparian buffers, catch basin cleanouts, CSO/SSO repair/abatement, illicit connection removal
- Erosion and sediment control
- Non-Stormwater—Septic system education, septic repair/inspection, septic system upgrade, marina pumpout, point source treatment

Pollutant source calculations are based on the Simple Method (Schueler, 1987) where impervious cover is used to estimate primary loads from various urban land uses. Specific concentration assumptions used for urban/suburban loading estimates in the WTM model are based on values for different land uses summarized in the National Stormwater Quality Database (NSQD), a summary of national stormwater data from over 200 communities nationwide (Pitt et. al., 2003). Estimated runoff volumes are multiplied by pollutant concentration data to compute stormwater loads. All loads are computed based on an annual time step.

Treatment options include the existing management practices and future management practices components of the WTM. The pollutant removal efficiencies associated with various structural and nonstructural urban stormwater management practices are based on existing research and studies in the National Pollutant Removal Performance Database for Stormwater Treatment Practices (Winer, 2000) and research compiled in the WTM (Caraco, 2002). Existing practice information is based on GIS data provided by Howard County and CWP field observations.

A unique feature of the WTM is the inclusion of *treatability* and *discount* factors. Treatability is the fraction of a source that can be treated by a practice. For structural practices, treatability is the drainage area; for education programs, it reflects the fraction of the population that can be reached. The model uses discount factors to account for maintenance and design criteria and to avoid double counting management practices that occur in series. For example, discount factors address imperfect practice application and maintenance, inability of educational programs to reach all citizens, and inadequate funding to implement all practices.

Caveats

There are many simplifying assumptions made by the WTM, and the model results are not calibrated to measured pollutant loads. Therefore, the results of the model simulations should be compared on a relative basis rather than used as absolute values.

The application of existing and future treatment practices is based on limited GIS data, best professional judgment, and default values associated with the WTM.

A series of modeling assumptions were made on loading rates, existing and current practice application, and stormwater program implementation that may or may not be valid. These assumptions will be highlighted throughout the memo so further model refinement can occur.

Modeling was only performed for phosphorus and sediment loads and does not look at nitrogen, bacteria, or other pollutants of concern.

2.0 INPUT DATA AND ASSUMPTIONS

This section provides a brief summary of the input data used in the WTM for both the Sucker and Rockburn Branch subwatersheds. It is organized by pollutant sources (primary and secondary sources) and treatment options (existing and future practices). Data assumptions for each section are also listed. The Rockburn and Sucker Branch subwatershed boundaries used for the WTM do not include the portions of the County delineated subwatershed boundaries that drain directly to the Lower Patapsco River.

2.1 Pollutant Sources

Primary Sources

Primary sources are based on 2005 land use data provided by Howard County. Table 2 summarizes existing land use areas and impervious cover estimates in the Sucker and Rockburn Branch subwatersheds, used as input data to the WTM. A summary of the land use areas provided by Howard County are presented in Table A1 of the Appendix.

Table 2. Summary of Rockburn and Sucker Branch Subwatersheds Primary Sources

Land Use	Description	Impervious Cover Coefficient by land use	Rockburn Area (acres)	Sucker Area (acres)
Residential	Low Density/Rural Residential (<1 du/acre)	11%	260.75	100.92
	Low Density (1-2 du/acre)	14%	134.53	260.42
	Medium Density (2-8 du/acre)	28%	313.12	187.03
	High Density (>8 du/acre)	41%	6.27	242.12
Urban Green	Cemetery	2%	59.12	0
	Park	2%	191.80	0
Commercial	Office	72%	0	82.39
Institutional		34%	87.05	96.11
Roadway		55%	56.16	205.09
Forest	Preserve	0%	857.21	298.37
Rural	Undeveloped Land	2%	208.98	186.56
Vacant Lots		0%	30.28	52.16
		Subwatershed Area	**2,205.27**	**1,711.17**
		Subwatershed Impervious Cover	**9%**	**24%**

Notes: (1) The land use data provides a general overview of Howard County land use as of July 2005. Quality control of this land use data is continuing as of the date of production of this report. (2) Medium and high density residential areas may be the result of clustered development permitted by R-20 and R-ED zoning.

Assumptions for primary sources include:

- An annual average precipitation of 40.76 inches (wunderground.com for Baltimore-Washington International Airport).
- Rockburn Branch has 10.8 stream miles; Sucker Branch has 3.40 stream miles.
- Planning horizon is 20 years.
- The land use analysis completed by Howard County estimated roadway area, where it was known. Additionally, the impervious cover estimates used in the WTM account for roadway within each land use category.

Secondary Sources

Secondary source loads are basically calculated as a product of flow and concentration. Refer to Caraco (2002) for detail on how loads are specifically calculated for each type of secondary source. Secondary sources that were present in the watershed and quantifiable based on existing data were considered. In most cases, this involved using GIS data provided to CWP by Howard County or based on default values of the WTM. Table 3 describes input data and assumptions for secondary sources in both subwatersheds.

Table 3. Secondary Sources Input Data and Assumptions

Input	Assumptions
Septic Systems	CWP estimated that approximately 50 of the 1,960 dwelling units in the Rockburn Branch subwatershed and none of the dwelling units in the Sucker Branch subwatershed are treated by septic systems. Dwelling units were calculated based on the residential land use (0.5 du/ac for low/rural, 1.5 du/ac for low, 5 du/ac for medium, and 10 du/ac for high density). The default values for effluent concentrations and failure rates were used.
SSOs and CSOs	Miles of sanitary sewer were calculated in GIS. The WTM uses the published value of 140 SSOs per 1000 miles of sewer per year. CWP assumed no CSOs are present in the Rockburn or Sucker Branch subwatersheds.
Active Construction	Area was calculated based on CWP field observations in 2005. In addition it was assumed 4/5 of the active construction in the Rockburn and Sucker Branch subwatersheds occurs in existing rural/low density residential land use areas and 1/5 in existing forested areas.
Illicit Discharges	Used default values of 0.1% of residents and 1% of businesses illicitly connected.
Lawns	Hydrologic soil group percentages were calculated based on information provided in the Howard County soil survey. This is used to calculate the runoff from lawns.
Road Sanding	Based on information from the Maryland State Highway Administration and presented in the 'Potomac River Source Water Assessments for Maryland Plants' report (Becker and O'Melia et.al, 2002), CWP assumed a road sand application rate of 1.66 tons/lane mile/year. Based on field observations, CWP estimated that 50% of all roads in the Rockburn Branch and 10% of the roads in Sucker Branch are open section.
Channel Erosion	CWP analyzed channel erosion using the 'ultimate channel enlargement ratio' as a predictive tool. CWP is currently assuming the average pre-development channel cross sectional area was 15 square feet and that 90% of the development in each subwatershed has occurred in the last 67 years. This indicates that the channel is still adjusted to the urbanized hydrologic regime and, therefore, channel erosion is occurring. Note: TP and TSS loads from channel erosion were considered separate from other upland sources of TP and TSS.
Livestock, Hobby Farms and Marinas	CWP is currently assuming no hobby farms, livestock operations, or marinas are present in the Rockburn or Sucker Branch subwatersheds.

2.2 Treatment Options

Existing Management Practices

The existing management practices included in the WTM were based on information provided by Howard County and CWP field observations. CWP used best professional judgment when applying discount factors to adjust the load reduction of existing practices. Table 4 summarizes the assumptions used for applying existing management practices.

Table 4. Existing Management Practices

Input	Assumptions
Education Programs	CWP assumed neither Pet Waste nor Lawn Care education programs currently exist in either of the subwatersheds.
Erosion and Sediment Control Program	CWP assumed the Howard County ESC program has an approximate 70% program efficiency. A program efficiency of 70% is based on a sediment control program that emphasizes erosion control measures, including practices that limit clearing and grading or use of phased construction methods, and requires advanced erosion and sediment control measures to reduce the concentration of sediment in runoff leaving the site (Caraco, 2002). CWP is also assuming 100% of all construction sites require ESC measures. Additionally, it is assumed contractors are educated about ESC techniques, poor performing ESC practices have been omitted from the design manual, and the program has certified inspectors and/or inspectors can visit sites weekly.
Street Sweeping	Based on information from Howard County, 70% of roadways in the County are swept four times annually, all with a mechanical sweeper. Additionally, CWP assumed no parking restrictions or operator training are required or in place.
Structural Stormwater Practices	Existing stormwater treatment practices (STP) (e.g., wet ponds, dry ponds, wetlands, bioretention facilities) were identified via the County storm drain GIS layers and observations made during the 2005 field survey. CWP estimated the impervious area draining to each STP by measuring the drainage area and applying impervious cover estimates provided in Impervious Cover and Land Use in the Chesapeake Bay Watershed (Cappiella and Brown, 2001). CWP is assuming the STPs were designed to capture 1" of runoff, equivalent to 90% of all rainfall events. In addition, CWP is assuming legally binding standards exist for STP design, and that regular maintenance of STPs is specified in design guidance, but the community has limited staff to ensure maintenance occurs. Pollutant removal efficiencies for STPs are based on the National Pollutant Removal Performance Database (Winer 2000).
Riparian Buffer	CWP is currently assuming enforceable design criteria exist to maintain and restore riparian buffers and an ordinance specific to riparian buffer impacts is in place, with inspection, education and enforcement efforts. CWP used the results of the DNR Stream Corridor Assessment (SCA) to estimate stream length with an adequate riparian buffer. Riparian buffer width was estimated by averaging the buffer width at 15 random locations within each subwatershed.
Impervious Cover Disconnection	CWP assumed 50% of residential parcels and 25% of commercial parcels have rooftop downspouts that are disconnected from impervious surfaces and storm drains.
Catch Basin Cleanouts	CWP assumed the acreage treated by catch basins in each subwatershed can be approximated by roadway imperviousness. CWP assumed the area treated by catch basins can be approximated by half of the roadway impervious area in each subwatershed. Based on information from Howard County, approximately 5% of all catch basins are cleaned annually and appropriate disposal practices are employed.

Future Management Practices

Future management practices included in the WTM were based on information provided in two reports summarizing the restoration opportunities within each subwatershed (Tetra Tech, 2006a and 2006b). The practices recommended in these reports were quantified to the extent possible and full implementation was assumed. Realistically, not all restoration projects will be

recommended for implementation, and not all recommendations will be implemented. Therefore the load reductions seen with the application of future management practices is considered a best case scenario.

CWP used best professional judgment when applying discount factors to adjust the load reduction of future practices. Table 5 summarizes the assumptions used for applying future management practices.

Table 5. Future Management Practices

Input	Assumptions
Education Programs	It is assumed, based on recommendations from the restoration opportunity reports (Tetra Tech 2006a and 2006b), that a lawn care education program will be implemented in both subwatersheds. CWP is currently assuming an outreach method such as a brochure would be used, which would reach approximately 8% of the outreach population.
Erosion and Sediment Control Program	It is assumed no changes will occur from the existing ESC program.
Street Sweeping	It is assumed no changes will occur from the existing street sweeping program.
Structural Stormwater Practices	Future stormwater treatment practices (STP) includes the existing STPs and proposed new and retrofitted STPs. Information such as the type of practice was taken from the restoration opportunity reports and the detailed field sheets (Tetra Tech, 2006a and 2006b). The impervious cover in the drainage area to the STP was estimated based on field observations and measurements in GIS. A summary of proposed Sucker Branch STPs is in Table A2 in the Appendix. A summary of proposed Rockburn Branch STPs is in Table A5 in the Appendix.
Riparian Buffer	Proposed increases to the riparian buffer in each subwatershed were estimated from length and width information for the specific projects recommended in the restoration opportunity reports prepared for both subwatersheds (Tetra Tech, 2006a and 2006b). A summary of proposed Sucker Branch riparian buffer projects is in Table A3 in the Appendix. A summary of proposed Rockburn Branch riparian buffer projects is in Table A5 in the Appendix.
Impervious Cover Disconnection	CWP is assuming impervious disconnection would apply to 50% of the residential land in Rockburn and 25% in the Sucker Branch subwatershed, and an outreach technique with 8% effectiveness would be employed. CWP is assuming no incentive will be provided for commercial businesses to employ disconnection and therefore 10% of commercial business would be willing to participate in both subwatersheds.
Catch Basin Cleanouts	It is assumed no changes will occur from the existing catch basin cleanout program.
Channel Protection	The percentage of unstable channel length in each subwatershed was calculated based on channel erosion locations observed during the Stream Corridor Assessment (SCA). The length of stabilized channel was calculated based on project recommendations included in the subwatershed restoration opportunity reports (Tetra Tech, 2006a and 2006b). The subwatershed area estimated to have flow control for small storms (<1-year events) was calculated based on the total impervious area proposed for treatment by stormwater practices, divided by the total subwatershed area. A summary of proposed Sucker Branch channel protection projects is in Table A3 in the Appendix. A summary of proposed Rockburn Branch channel protection projects is in Table A6 in the Appendix.
Stormwater Retrofits	The WTM contains a separate input field for planned retrofitting. This field was left blank in the spreadsheet because the detailed assessment of Rockburn and Sucker Branches allowed for details about the type of STP and size of the drainage area to be included in the **Structural Stormwater Practices** above.

Table 5. Future Management Practices	
Other Practices	The following are restoration practices that could be included in the WTM, but were not proposed in Sucker Branch and Rockburn Branch: Pet Waste Education, Septic System Education/Inspection/ Repair/Upgrade, Land Reclamation, Impervious Cover Reduction, Illicit Connection Removal, SSO Repair/Abatement.

3.0 Results

Results are presented for total phosphorus (TP) and total suspended sediment (TSS) loads from primary and secondary sources with existing management practices and with the recommended future management practices. While a numerical value in lbs/year is generated by the WTM, it is more appropriate to evaluate relative load changes via the percent of total load reduction, as provided in the following sections.

3.1 Pollution Sources

The following table presents the upland pollution sources analyzed by the WTM and their relative load contribution within the Rockburn and Sucker Branch subwatersheds for existing conditions. Only upland sources are included in Table 6 due to the relatively high load contribution from channel erosion. If included, channel erosion would account for approximately 90% of the combined upland and channel pollutant loads.

Table 6. Relative Pollution Sources as a Percentage of Total Loads for Existing Conditions

Upland Pollution Source	Rockburn Branch Subwatershed		Sucker Branch Subwatershed	
	TP	TSS	TP	TSS
Urban Land	50%	38%	71%	45%
Active Construction	1%	8%	0%	2%
SSOs	3%	0%	4%	1%
Illicit Connections	1%	0%	3%	0%
Road Sanding	0%	15%	0%	34%
Vacant Lots	1%	1%	1%	2%
Rural Land	20%	7%	14%	6%
Forest	22%	29%	6%	10%
Septic	2%	0%	0%	0%

3.2 Effects of Existing Management Practices

In the Rockburn Branch subwatershed the management practices currently in place can be assumed to reduce phosphorus loading by 26.9% and sediment loading by 46.5%. In the Sucker Branch subwatershed the management practices currently in place can be assumed to reduce phosphorus loading by 31.2% and sediment loading by 47.3%. The effects of the individual management practices considered in the WTM are summarized in Table 7.

Table 7. Load Reductions from Existing Practices				
Existing Management Practice	Rockburn Branch Subwatershed		Sucker Branch Subwatershed	
	TP	TSS	TP	TSS
Erosion and Sediment Control	1.4%	11.0%	0.3%	2.8%
Street Sweeping	1.1%	1.0%	1.3%	1.3%
Street Sweeping - Sanding	-	8.3%	-	18.2%
Impervious Cover Disconnection	18.2%	12.8%	26.1%	19.9%
Structural Stormwater Management Practices	3.6%	2.7%	3.0%	2.9%
Riparian Buffers	2.6%	10.6%	0.5%	2.2%
Catch Basin Cleanouts	0.0%	0.0%	0.0%	0.0%
Total Reduction	**26.9%**	**46.5%**	**31.2%**	**47.3%**

3.3 Effect of Future Management Practices

The application of future management practices results in a decrease in pollutant loads in each subwatershed, when compared to the pollutant loads with existing treatment practices applied. To effectively evaluate the proposed practices the analysis of future management conditions was separated into upland and channel sources.

Upland Sources

In the Rockburn Branch subwatershed the proposed management practices can be assumed to reduce phosphorus loading by 3.8% and sediment loading by 11.1%, above existing removal rates. In the Sucker Branch subwatershed the proposed management practices can be assumed to reduce phosphorus loading by 3.7% and sediment loading by 6.3%, above existing removal rates. The effects of the individual future management practices considered in the WTM on upland sources are summarized in Table 8.

Table 8. Upland Load Reductions from Future Practices				
Future Management Practice	Rockburn Branch Subwatershed		Sucker Branch Subwatershed	
	TP	TSS	TP	TSS
Lawn Care Education	1.2%	-	0.8%	-
Erosion and Sediment Control	-	-	-	-
Street Sweeping	-	-	-	-
Impervious Cover Disconnection	0.6%	0.5%	0.6%	0.6%
Structural Stormwater Management Practices	1.7%	2.7%	2.1%	2.8%
Riparian Buffers	0.3%	7.9%	0.2%	2.9%
Catch Basin Cleanouts	--	--	--	--
Total Reduction	**3.8%**	**11.1%**	**3.7%**	**6.3%**

Channel Sources

For channel sources, the proposed channel protection measures decreased loads originating from channel erosion. In Rockburn Branch, the TP load and TSS load were each reduced by 0.8%. In

Sucker Branch, TP and TSS were reduced by 1.5%. Channel protection includes structural stormwater practices and stream stabilization.

4.0 Conclusions

4.1. Existing Management Practices

The largest load reduction from existing practices is from impervious cover disconnection. The benefits of impervious disconnection observed in the WTM model emphasize the importance of disconnection and building with better site design techniques to minimize impervious cover, direct runoff to pervious areas, and conserve natural areas. Existing stormwater treatment practices and riparian buffers are also important contributors to reducing TP and TSS loads. Most of the subdivisions in Rockburn Branch have stormwater treatment practices, and many of these wet ponds, a high performing practice type. It is recommended that innovative and effective stormwater treatment practices continue to be implemented in each of the subwatersheds. Additionally, on-going efforts are needed to maintain the pollutant removal capacity of these practices. In addition, continuing to protect and replant riparian buffers will help reduce TP and TSS loads and provide numerous ancillary benefits in each subwatershed.

4.2 Future Management Practices

Of all the future practices proposed in each subwatershed, stormwater treatment practices will provide the largest relative load reduction for both TP and TSS. It is worth mentioning that the load reductions from future management practices are based on the best case scenario that all of the proposed projects will be implemented. In addition, each of the proposed stormwater practices will treat a relatively small drainage area, therefore only modest load reductions are predicted for individual practice implementation. The proposed riparian buffer improvements will reduce TSS loads, with smaller relative reductions in TP, in each of the subwatersheds. In Rockburn specifically, the proposed riparian buffer projects will have the greatest relative reduction in TSS loads. Implementing a lawn care education campaign can also be expected to reduce TP loads in each subwatershed. A summary of the proposed projects in each subwatershed is presented in the Appendix.

Additional load reductions would be expected in both the Rockburn and Sucker subwatersheds by improving erosion and sediment control measures, improving street sweeping practices, implementing a pet waste education program and increasing the frequency of catch basin cleanouts. None of these programs were recommended in the restoration opportunity reports and were therefore not included in the WTM.

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Tetra Tech. 2006b. *Assessing the Sucker Branch Subwatershed of the Lower Patapsco River for Restoration Opportunities.* Prepared for Howard County, Maryland.

APPENDIX

Table A1. Land Use Categories and Descriptions for Rockburn and Sucker Branch Subwatersheds (Provided by Howard County)					
		Rockburn HUC		Sucker HUC	
Land Use	Description	Acres		Acres (2)	
Residential	Low Density/Rural (<1 du/acre)	260.75	11.8%	100.92	5.9%
	Low Density (1-2 du/acre)	134.53	6.1%	260.42	15.2%
	Medium Density (2-8 du/acre)	313.12	14.2%	187.03	10.9%
	High Density (>8 du/acre)	6.27	0.3%	242.12	14.1%
Urban Green	Cemetery	59.12	2.7%	0	0.0%
	Golf	0	0.0%	0	0.0%
	Park	191.80	8.7%	0	0.0%
Commercial	Office	0	0.0%	82.39	4.8%
	Mixed Use	0	0.0%	0	0.0%
Institutional		87.05	3.9%	96.11	5.6%
Roadway (1)		56.16	2.5%	205.09	12.0%
Industrial	Manufacturing/Warehouse	0	0.0%	0	0.0%
Forest	Preserve	857.21	38.9%	298.37	17.4%
Rural	Pasture	0	0.0%		0.0%
	Undeveloped Land	208.98	9.5%	186.56	10.9%
Open Water		0	0.0%	0	0.0%
Active Construction		NA	0.0%	NA	0.0%
Vacant Lots		30.28	1.4%	52.16	3.0%
	Total	**2,205.27**	**100.0%**	**1,711.17**	**100.0%**

Notes:

(1) Roadway acres accounted for where known - may be undercounted

(2) 34.99 Acres of Railroad counted in Undeveloped Land

NA = Not Available

Summary of Proposed Sucker Branch Projects

Note: Three proposed projects were not included in the WTM analysis - SB-12 (Swimming Pool Outreach) & SB-23 and SB-26 (Trash Removal)

Table A2. Proposed Stormwater Treatment Practices in the Sucker Branch Subwatershed					
Project	**Project Type**	**Drainage Area (ft^2)**	**Drainage Area (acre)**	**Approximate Drainage Area Impervious Area (%)**	**Impervious Area (acre)**
Infiltration					
SB-9	Bioretention	27232.76	0.62	70%	0.43
SB-8	Parking Lot Bioretention or Wetland STP	15911.23	0.36	75%	0.27
SB-11	Bioretention	38221.84	0.87	80%	0.70
SB-10	Bioretention	74487.73	1.71	70%	1.20
SB-18	Permeable Paving/Bioretention	30652.05	0.7	85%	0.60
SB-19	Bioretention	68553.15	1.57	95%	1.49
SB-20	Stormwater Planters/Infiltration	41737.37	0.95	96%	0.91
SB-22	Permeable Paving/Bioretention	387504.04	8.89	95%	8.45
SB-25	Stormwater Planters/Infiltration	4845.48	0.11	100%	0.11
SB-2A	Bioretention	--	0.504	100%	0.50
SB-4	Bioretention for Rooftop and Parking Lot Runoff	--	0.37	80%	0.30
SB-14	Improve STP (Bioretention?) Function	--	--	--	0.35
SB-15	Bioretention	--	--	--	2.20
SB-30	Bioretention	--	--	--	0.50
Filters					
SB-16	Bioretention/Sand Filter	41201.52	0.94	100%	0.94
SB-17	Sand Filter	25176.32	0.57	100%	0.57
SB-21	Sand Filter	17198.13	0.39	100%	0.39
Dry Extended Detention Pond					
SB-27	Improve STP Dry Pond Function	173127.53	3.97	70%	2.78
SB-29	Improve STP Dry Pond Function	45803.21	1.05	100%	1.05
SB-24	Improve Dry Pond Function	--	2.26	--	1.63
Wetland					
SB-6D	Wetland Area	--	--	--	2.40
Wet Pond					
SB-28	Improve STP Wet Pond (#1) Function	--	23.7	--	10.52
	Improve STP Wet Pond (#2) Function	--	14.01	--	2.10

Table A3. Proposed Riparian Buffer Revegetation in the Sucker Branch Subwatershed			
Project	**Project Type**	**Length (ft)**	**Width (ft)**
SB-1	Buffer Revegetation	850	25
SB-5	Buffer Revegetation	200	30
SB-6B	Buffer Revegetation	300	15
SB-7A	Buffer Revegetation	150	30
SB-7A	Buffer Revegetation	150	100
SB-7B	Buffer Revegetation	260	20
SB-7B	Buffer Revegetation	680	10
SB-7B	Buffer Revegetation	380	20
SB-7B	Buffer Revegetation	380	30
SB-13	Buffer Revegetation	5300	30

Table A4. Proposed Channel Stabilization in the Sucker Branch Subwatershed		
Project	**Project Type**	**Length (ft)**
SB-1	Channel Stabilization	1000
SB-2B	Channel Stabilization	35
SB-3	Channel Stabilization	50
SB-6A	Channel Stabilization	300
SB-6C	Channel Stabilization	100

Summary of Proposed Rockburn Branch Projects

Note: Four proposed projects were not included in the WTM analysis - RB-17 (Removing Yard Waste from Channel with Upstream Volume Control) & RB-23 (Maintenance) & RB-9 (Non-native species removal) & RB-10 (Outfall repair and non-native species removal) & RB-13 (Vegetation regeneration)

Table A5. Proposed Stormwater Treatment Practices in the Rockburn Branch Subwatershed

Project	Project Type	Drainage Area (ft^2)	Drainage Area (acre)	Approximate Drainage Area Impervious Area (%)	Impervious Area (acre)
Infiltration					
RB-2	Bioretention	99441.23	2.28	50%	1.14
RB-16	Bioretention	41188.34	0.94	100%	0.94
RB-19	Bioretention	54173.61	1.24	85%	1.05
RB-21	Bioretention	--	0.32	95%	0.30
RB-22	Bioretention	--	1.85	96%	1.77
RB-24	Bioretention	--	0.84	25%	0.21
Filters					
RB-8	Trail Erosion	31444.87	0.72	10%	0.072
Dry Extended Detention Pond					
RB-32	Improve STP Function	--	35.65	21%	7.55
RB-33	Improve STP Function	--	11.61	28%	3.23
Wetland					
RB-1	Convert Existing Dry Pond to Stormwater Wetland	--	20	28%	5.56
RB-28	Wetland	--	22	25%	5.5
Wet Pond					
RB-18	Improve Existing Wet Pond	236274.55	5.42	70%	3.794
RB-20	Improve Existing Wet Pond Function	--	12.89	34%	4.43

Table A6. Proposed Riparian Buffer Revegetation in the Rockburn Branch Subwatershed			
Project	**Project Type**	**Length (ft)**	**Width (ft)**
RB-3	Buffer Revegetation	300	25
RB-7	Buffer Revegetation	400	20
RB-11	Buffer Revegetation	1700	30
RB-14	Buffer Revegetation	300	50
RB-25	Buffer Revegetation	1450	75
RB-26	Buffer Revegetation	675	12
RB-27	Buffer Revegetation	500	10
RB-29	Buffer Revegetation	150	100
RB-30	Buffer Revegetation	60	10
RB-31	Buffer Revegetation	50	10

Table A7. Proposed Channel Stabilization in the Rockburn Branch Subwatershed		
Project	**Project Type**	**Length (ft)**
RB-4	Channel Stabilization	800
RB-5	Channel Stabilization	50
RB-6	Channel Stabilization	50
RB-15	Channel Stabilization	30