Bush River Watershed

MANAGEMENT PLAN

April 2003

Prepared For:
Harford County Department of Public Works
212 South Bond Street
Bel Air, Maryland 21014

Prepared By:
Center for Watershed Protection
8391 Main Street
Ellicott City, Maryland 21043

BUSH RIVER WATERSHED MANAGEMENT PLAN

Prepared For:
Harford County Department of Public Works
212 South Bond Street
Bel Air, Maryland 21014
410.638.3545 phone
410.893.3849 fax

Prepared By:
The Center for Watershed Protection
8391 Main Street
Ellicott City, Maryland 21043
410.461.8323 phone
410.461.8324 fax

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CWP Project Team
Ted Brown – Quality Control and Project Engineer
Paul Sturm – Aquatic Biologist
Rebecca Winer – Project Manager

GIS DATA NOTE
Many of the GIS layers used in maps and analyses produced as a result of this report, were provided from three major sources: Maryland Department of Natural Resources, Harford County and the Maryland Department of Planning. Additional data analysis layers were created by the Center for Watershed Protection.

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EXECUTIVE SUMMARY

Located in Harford County, the Bush River watershed is approximately 117 square miles in size and is a tidal estuary to the Chesapeake Bay. It contains more than 520 miles of streams that flow through a wide variety of land uses that vary between urban, agriculture, forest and wetlands. A large portion of the watershed is located within the County's residential and industrial development envelope. Two major tributaries, Winters Run and Bynum Run currently deliver large amounts of sediment, nutrients and bacteria to the Bush River and with the recent development pressures, increased impacts from urbanization are anticipated within the watershed.

Over the last several years, there has been a significant effort put forth to attempt to assess and improve the overall health of both the tidal and non-tidal portions of the Bush River watershed. The Bush River Watershed Restoration Strategy (WRAS) has provided a framework for the consolidation of these efforts. The WRAS aims to identify pollutant sources, implement environmentally sensitive development techniques, increase community involvement and implement restoration and protection opportunities. This document details a major planning piece of this initiative, the Bush River Watershed Management Plan (WAMP). The goal of this WAMP is to concisely define a strategy for Harford County to pursue with respect to improving the overall conditions in the Bush River watershed. Specifically, the WAMP identifies and details:

- General management practices that can be applied across similar subwatershed types to improve watershed conditions and reduce pollutant loads
- Specific high quality subwatersheds that should be evaluated for future protection against development and enhancement with respect to riparian buffers and upland preservation efforts.
- Specific impacted subwatersheds within the development envelope that present opportunities for stormwater retrofits.
- Management approaches in both rural and urban subwatersheds that promote and encourage public awareness and involvement.

This report utilized an extensive amount of information provided by DNR and Harford County including data from the Bush River Watershed Characterization, Maryland Biological Stream Survey (MBSS), and Stream Corridor Assessment Methodology (SCAM). This data, supported with some additional calculations (current IC, future IC, etc) and field verifications (stream habitat, contiguous forest, and wetland evaluations), was to identify ten priority subwatersheds: Grays Run, Little East Bynum, West Branch, Middle Bynum, Lower Bynum, Plumtree Run, Otter Point DD, Church Creek DD, Bush Creek DD, and Haha Branch.

Recommendations and prioritizations were provided on a subwatershed basis as well as on an individual project or management measure basis (e.g., contiguous forest protection, riparian corridor reforestation, stormwater retrofits, and stream stabilization). A summary of recommendations are provided in Table E1.

Table E1. Summary of Bush River Watershed Management Recommendations	
Subwatershed Management Category	**Recommendation**
Sensitive	Preserve Contiguous Forests in all Sensitive Subwatersheds
Sensitive	Enhance Existing Riparian Buffer in all Sensitive Subwatersheds
Sensitive	Grays Run Contiguous Forest Preservation
Sensitive	Grays Run Stream Buffer Enhancement
Sensitive	Maintain Grays Run Sensitive Status
Sensitive	Field Verify and Prioritize Contiguous Forest Areas for Preservation
Rurally Impacted	Preserve Farmlands in Rurally Impacted Subwatersheds
Rurally Impacted	Restore Riparian Buffer in Rurally Impacted Subwatersheds
Rurally Impacted	Reduce Livestock Access in Little East Bynum
Rurally Impacted	Agricultural Practices Assessment in Rurally Impacted Subwatersheds
Rurally Impacted	Septic System Education in Rurally Impacted Subwatersheds
Impacted	Educate Residents on Watershed Stewardship in Impacted Subwatersheds
Impacted	Implement Stormwater Retrofits in Impacted Subwatersheds
Impacted	Conduct Stream Clean-ups in Lower and Middle Bynum
Impacted	Preserve Contiguous Forest in Lower Winters DD and Cranberry Run
Impacted	Investigate Other Stormwater Retrofit Opportunities in Impacted Subwatersheds
Impacted Special Resource	Preserve Large Wetland Tracts in Impacted Special Resource Subwatersheds
Impacted Special Resource	Implement Stormwater Retrofits in Impacted Special Resource Subwatersheds
Impacted Special Resource	Streambank Stabilization in Haha and Otter Point Subwatersheds
Impacted Special Resource	Develop a Heightened Plan Review in Impacted Special Resource Subwatersheds
Watershed-Wide	Establish an Implementation Committee
Watershed-Wide	Foster the Development of Bush River Watershed Association
Watershed-Wide	Create Watershed Stewardship Website
Watershed-Wide	Implement Recommendations of Harford County Site Planning Roundtable
Watershed-Wide	Establish an Adopt-a-Pond Program
Watershed-Wide	Improve ESC Implementation, Inspection and Enforcement

SECTION 1.0 WATERSHED PROFILE AND PROJECT BACKGROUND

SECTION 1.1 WATERSHED PROFILE

The Bush River Watershed is located in the south central portion of Harford County between Edgewood and the City of Aberdeen. The watershed is approximately 117 square miles and over 25% of the land in the County resides within the watershed (See Map 1)[1]. Approximately half of the City of Aberdeen and the entire incorporated limits of the Town of Bel Air are located within the watershed. The Bush River is a tidal estuary to the Chesapeake Bay and the major tributaries in the basin are Winters Run, Otter Point Creek, Bynum Run, James Run, Bush Creek and Church Creek (Map 2). The majority of the watershed is located in the Piedmont Plateau, while a small portion, southeast of Route 40, is located in the Coastal Plain. The watershed contains more than 520 miles of streams that flow through a wide variety of land uses that vary between urban, agriculture, forest and wetlands.

A large portion of the watershed is located within the County's residential and industrial development envelope, which follows the Route 40/I-95 corridor and extends northward to include the Route 24/Bel Air corridor. Winters Run and Bynum Run currently deliver large amounts of sediment, nutrients and bacteria to the Bush River, and with the recent development pressures, increased impacts from urbanization are anticipated within the watershed.

The Maryland Department of the Environment cites four impaired waterbodies in the Bush River Watershed on its 303(d) list: Bush River, Bynum Run, Atkisson Reservoir (located in the portion of Winters Run), and Aberdeen Proving Ground[2] (MDE, 2003). Causes of impairment include nutrients and suspended sediments. Aberdeen Proving Ground was also listed for toxic substances. Additionally, under Maryland's Clean Water Action Plan, both the Bynum Run and the Bush River watersheds have been listed as a Priority Category I Watershed (watersheds that are in most need of restoration).

SECTION 1.2 WATERSHED HISTORY

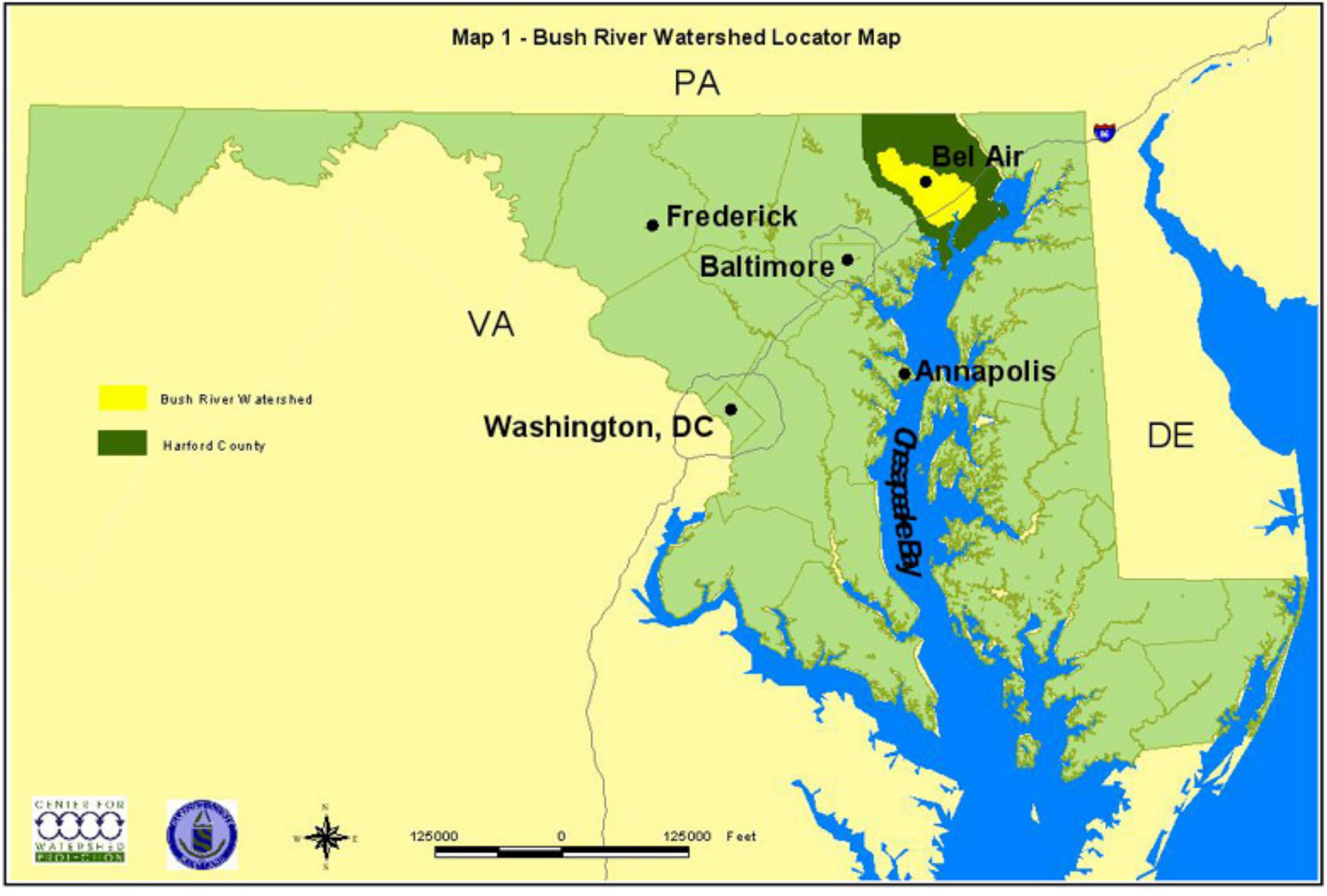
According to the 2000 Census, the population for Harford County was 226,565. The population has increased over 50% since 1980 and projections for 2020 estimate another 15% increase. Over the past 30 years, the greatest amount of development within Harford County has occurred in the Bush River watershed. Approximately 50% of the Harford County population resides within the Winters Run and Bynum Run drainage areas.

The placement of development within this geographic area has not been by chance. A "development envelope" was established in 1977 to direct development towards areas served, or planned for service, by public water and sewer[3]. By concentrating the majority of development within the development envelope, outlying areas may be preserved in a rural state to preserve the viability of agriculture in the County, as well as conserve other natural resources (See Map 2).

[1] Numbers specific to CWP analyses.

[2] Drainage from APG lands are not being considered in this analysis.

[3] Areas served by public sewer and water can accommodate a large portion of the County's population in medium and high density residential development. Services, such as police and fire, libraries, schools, can also be concentrated and serve the greatest number of people in the most efficient and cost-effective manner.


Map 1 - Bush River Watershed Locator Map
PA
Bel Air
Frederick
Baltimore
VA
Annapolis
Bush River Watershed
Harford County
Washington, DC
DE
Chesapeake Bay
CENTER FOR WATERSHED PROTECTION
125000
0
125000 Feet

Map 2 - Major Tributaries and Development Envelope in the Bush River Watershed

Many of the County's residents depend on the tributaries of the Bush River for their source of drinking water. The Town of Bel Air and surrounding areas use water withdrawn from Winters Run for their source of drinking water. Areas farther outside the Town of Bel Air on public water and sewer are supplied their drinking water from Harford County. The County drinking water is a mixture of water from several sources including water withdrawn from wells located in the Church Creek and Deep Spring Branch subwatersheds. Remaining residents within the Bush River watershed depend on groundwater for their source of drinking water through private wells.

As Harford County continues to grow, County planners, public works officials, and elected officials are increasingly aware of the delicate balance between a vibrant sustainable local economy and community and the fragility of important natural resources. Protection of environmental quality within the development envelope as well as beyond its boundary is important to the County, as it is clear that the quality of life of the citizens and visitors to the County goes hand in hand with the quality of the environment that surrounds them.

SECTION 1.3 PROJECT BACKGROUND

Over the last several years, there has been a significant effort put forth to attempt to assess and improve the overall health of both the tidal and non-tidal portions of the Bush River watershed. Various state, local and federal agencies and non-profit environmental groups have tried to accomplish this common goal, often working independently of each other, but more recently working cooperatively in a partnership fashion. The overall goal of the partnership is to develop a strategy to improve impacted watershed conditions in order to meet Class I water quality standards in the Bush River watershed through implementation of environmentally sensitive development techniques and promotion and encouragement of community awareness in the watershed.

In September 2002, the Maryland Department of Natural Resources (DNR) completed a Bush River Watershed Characterization Report[4] in support of Harford County's Watershed Restoration Action Strategy (WRAS), which went a long way towards consolidating and summarizing existing information and data collection efforts. As a supplement to the standard data compiled and presented in the Characterization Report, the County also arranged for DNR to collect and compile more detailed nutrient, benthic macroinvertebrate and fish synoptic data.

In addition, a County-wide initiative focusing on environmentally sensitive development is currently underway. In cooperation with the Harford County Department of Planning and Zoning and the Home Builders Association of Maryland, the Center for Watershed Protection and the Alliance for the Chesapeake Bay kicked off a yearlong roundtable process starting in September 2002 as part of the *Builders for the Bay* agreement. During the roundtable, representatives from the development and environmental communities, county and municipal governments, civic and nonprofit organizations, and business groups will review existing codes and ordinances and determine which should be revised to better protect the area's water resources and aquatic communities while allowing for economic growth. Through a consensus process, recommendations by the roundtable will be made to the County, which will then work

[4] This document does not attempt to reiterate the wealth of information presented in the Characterization Report. Rather, the reader is encouraged to refer to the report for many of the "big picture" findings presented in the document.

to incorporate those principles into County subdivision and commercial development practices. A final consensus document is expected to be completed by June 2003.

The third major planning piece of the Bush River initiative is the development of a Bush River Watershed Management Plan (WAMP), which this document details. The purpose of the WAMP is to utilize the WRAS data, aerial photos, and other related GIS data layers to develop stream and habitat restoration guidance in the watershed and to identify subwatershed areas where priority restoration and rehabilitation is warranted.

The primary vehicle used to develop the Bush River WAMP is a watershed vulnerability analysis, which enables larger watersheds like the Bush River to be rapidly assessed so that subwatersheds most vulnerable to current and future land development and management problems can be identified for prioritization of management efforts. The vulnerability analysis is also a useful tool to heighten public awareness in the watershed as it can distill key issues and pressures facing the watershed and allow general management approaches to be applied to subwatersheds with similar conditions.

SECTION 1.4 WAMP GOALS

The Bush River watershed is a unique and complex watershed in the Chesapeake Bay region because it contains large tracts of both urban and rural land uses. Consequently, management measures will need to be aligned with these different parameters and will take on vastly different approaches. For example, rural/agricultural subwatershed management practices typically emphasize land conservation, riparian enhancement, and nutrient management techniques, while urban subwatershed management practices generally emphasize stormwater retrofitting, pollution prevention, public education, and streambank stabilization techniques.

The goal of this WAMP is to concisely define a strategy for Harford County to pursue with respect to improving the overall conditions in the Bush River watershed. Overall watershed impairments have previously been identified in Maryland Biological Stream Survey (MBSS, 2001) and Characterization reports on the Bush River and typically involve excess nutrient loads, poor habitat quality, and channel instability. Therefore, the focus of the WAMP is to:

1. Identify general management practices that can be applied across similar subwatershed types to improve watershed conditions and reduce pollutant loads
2. Identify specific high quality subwatersheds that should be evaluated for future protection against development and enhancement with respect to riparian buffers and upland preservation efforts.
3. Identify specific impacted subwatersheds within the development envelope that may lend themselves to stormwater retrofits.
4. Identify management approaches in both rural and urban subwatersheds that promote and encourage public awareness and involvement.

SECTION 1.5 IMPERVIOUS COVER AS A SCREENING TOOL

Perhaps the most useful screening parameter in watershed assessment is impervious cover. Impervious cover is defined as the sum of all surfaces within the watershed that do not allow

water to infiltrate through the ground. Examples include roadways, driveways, houses, sidewalks, and parking lots that are covered by concrete, asphalt or other impermeable surface. In recent years, impervious cover has emerged as a key indicator to explain and sometimes predict how severely streams change in response to different levels of watershed development (CWP, 2003). The Center has integrated these research findings into a general watershed planning model, known as the impervious cover model (ICM) (Figure 1). The ICM predicts that most stream quality indicators decline when watershed impervious cover exceeds 10%, with severe degradation expected beyond 25% impervious cover. The model classifies subwatersheds into one of three categories: sensitive, impacted, and non-supporting.

Sensitive subwatersheds have an impervious cover of 0 to 10 percent. Consequently, streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects (CWP, 1998). The main goal for these types of subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

Impacted subwatersheds have an impervious cover ranging from 11 to 25 percent and show clear signs of degradation due to watershed urbanization. Greater storm flows have begun to alter the stream geometry. Both erosion and channel widening are evident. Stream banks become unstable, and physical habitat in the stream declines noticeably. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream (CWP, 1998). The main goals for these types of subwatersheds are to limit the degradation of stream habitat quality and maintain a good biological community.

Non-supporting subwatersheds have an impervious cover greater than 25 percent. Streams in this category essentially become a conduit for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, down-cutting and streambank erosion. The water and biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish. The goals for these subwatersheds are to minimize downstream pollutants, alleviate downstream flooding, and improve aesthetic appeal.

The ICM has proven to be an extremely important tool for watershed planning, since it can rapidly project how streams will change in response to future land use. The Center routinely estimates existing and future impervious cover in our watershed planning approach, and find that it is an excellent indicator of change for subwatersheds from 0 to 30%, which is the range where the Bush River subwatersheds fall.

The ICM often forces watershed plans to directly confront land use planning and land conservation issues early in the planning process; however, impervious cover is not a perfect indicator of existing stream quality. A number of additional stream and subwatershed criteria should be evaluated in the field before a final classification decision is made, particularly when the stream is on the borderline between two classifications. Some of the additional criteria might include: reported presence of rare, threatened or endangered species; fair to good, good, or good to excellent macroinvertebrate scores; stream channels with little evidence of ditching, enclosure, tile drainage or channelization; fair-to-good stream habitat scores; significant conservation areas; large contiguous forest tracts; farming, ranching and livestock operations using best management practices; and prior development with stormwater best management practices.

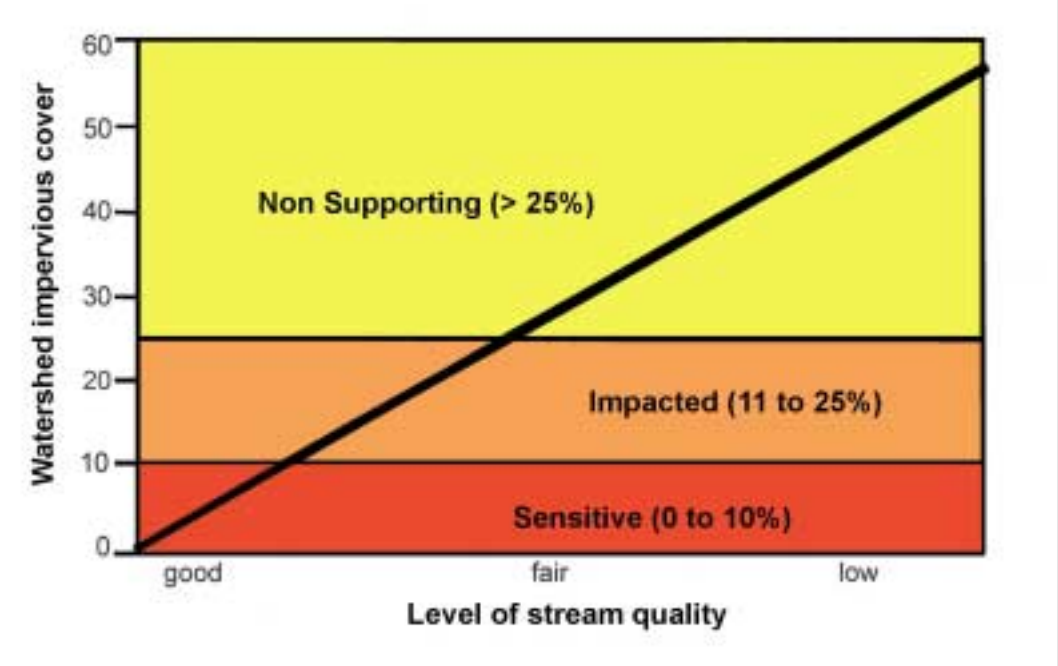


Figure 1. The Impervious Cover Model

The ICM is based on the following assumptions and caveats. The ICM:

1. Applies only to 1st, 2nd and 3rd order streams;

2. Requires accurate estimates of percent impervious area, which is defined as the total amount of impervious area over a subwatershed area;

3. Predicts potential rather than actual stream quality. It can and should be expected that some streams will depart from the predictions of the model. While impervious cover (IC) can be used to initially diagnose stream quality, supplemental field monitoring is recommended to actually confirm it;

4. Does not predict the precise score of an individual stream quality indicator, but rather predicts the average behavior of a group of indicators over a range of IC. Extreme care should be exercised if the ICM is used to predict the fate of individual species (e.g., trout, salmon, mussels);

5. Athresholds@ defined as 10 and 25% IC, are not sharp Abreakpoints,@ but reflect instead the expected transition of a composite of individual indicators in that range of IC. Thus, it is virtually impossible to distinguish real differences in stream indicators within a few percentage points of watershed IC (e.g., 9.9 vs. 10.1%);

6. Should only be applied within the ecoregions where it has been tested, including the mid-Atlantic, Northeast, Southeast, Upper Midwest, and Pacific Northwest;

7. Has not yet been validated for non-stream conditions (e.g., lakes, reservoirs, aquifers and estuaries). Additional locally-based research is needed to adapt the ICM model for these conditions; and

8. Is conservative in that it does not predict the potential mitigating impact of watershed treatment practices. At this time, researchers are not sure that they can detect the impact of watershed treatment, and none has gone so far as to assert that it dramatically shifts the basic ICM.

SECTION 1.6 THE SCALE OF WATERSHED PLANNING AND THE SUBWATERSHED APPROACH

An effective watershed plan for the Bush River requires an understanding of the dynamics of the entire watershed, including its environmental status, growth in residential and commercial sectors, and agricultural land management practices. However, it is important to understand that developing watershed management plans at the scale of the Bush River watershed (i.e., over 100 square miles) is a particularly challenging task and limited by available resources for assessment and analysis. Furthermore, it is generally difficult to develop specific management recommendations that can easily proceed towards implementation without first analyzing at the subwatershed level. Consequently, the preferred and recommended assessment approach involves working with a smaller management unit, on the order of 10 square miles (CWP, 1998). From a naming convention standpoint, this management unit will be referred to as a subwatershed in this document (refer to Figure 2 and Table 1).

Subwatersheds are the preferred unit for developing watershed plans because they are sensitive to the influence of impervious cover, generally enable the distinction between pollutant sources to be made, generally are contained within a single jurisdictional boundary, and allow for a rapid approach to mapping, monitoring, and other subwatershed assessment steps. The Center, in coordination with County staff delineated the Bush River watershed into 19 subwatersheds for this project. Map 3 shows the delineations and Section 2.1 provides a detailed description of the factors that were considered when developing the delineation.

In an effort to balance the common management and planning challenges that arise from assessing large watersheds, the Center applies an assessment tool called the watershed vulnerability analysis to serve as a preliminary screening tool that identifies subwatersheds that are most vulnerable to current and future land development and management problems (thus the term "vulnerability analysis"). This process is described in more detail below.

Table 1. Description of the Various Watershed Management Units

Unit	Typical Area (square miles)	Influence of Impervious Cover
Catchment	0.05 to 0.50	very strong
Subwatershed	1 to 10	strong
Watershed	10 to 100	moderate
Subbasin	100 to 1,000	weak
Basin	1,000 to 10,000	very weak

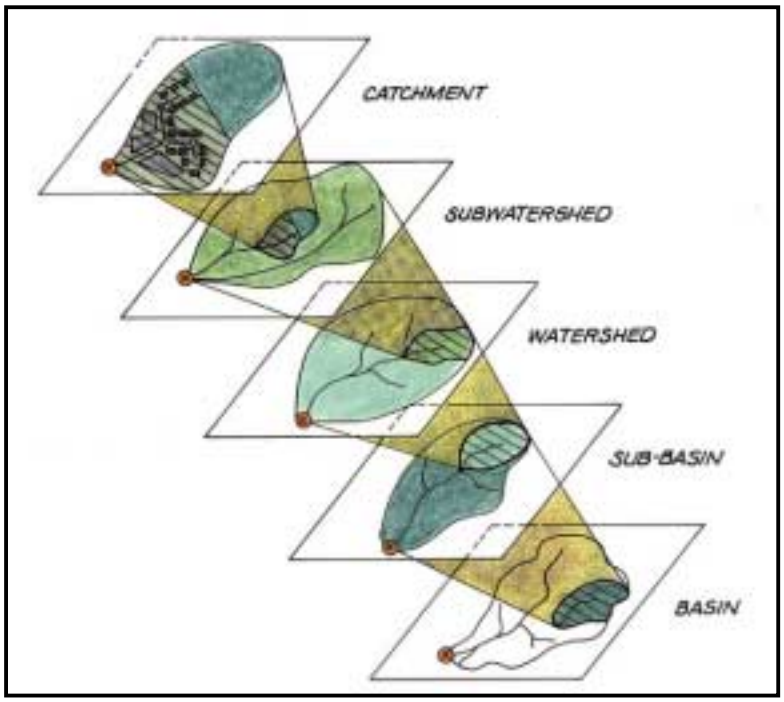


Figure 2. Units for Watershed Assessment and Management

SECTION 1.7 VULNERABILITY ANALYSIS APPROACH IN THE BUSH RIVER WATERSHED

A vulnerability analysis determines key watershed management issues, compiles, and combines detailed information in order to prepare plans to protect and restore vulnerable subwatersheds within the Bush River watershed. While specific management recommendations are generated for targeted subwatersheds, more detailed follow-up studies are generally warranted prior to implementation.

Within the context of the Bush River watershed, vulnerability can have several definitions, depending on the characteristics of a particular subwatershed. For example, high quality subwatersheds are vulnerable to even small land use changes. Some subwatersheds within Bush River are termed vulnerable because of the impact of current and planned future development. Lastly, others are deemed vulnerable due to the impacts of rural land management practices, unrelated to development pressure.

The foundation of a watershed vulnerability analysis is existing watershed information and GIS data. Land use and impervious cover estimates serve as the starting point of the analysis. Biological, physical, and chemical data are then used to refine the analysis. Therefore, the more good quality data that are available, the more reliable the assessment and recommendations will be. In the case of the Bush River, excellent watershed-wide data exists from a variety of sources, including: DNR's WRAS data, Harford County Stream Corridor Assessment Method (SCAM) data, MBSS data, and 2000 aerial and planimetric data. Table 2 illustrates the variety of data that are available for the watershed.

Table 2. Current Conditions in Bush River Watershed	
Watershed Factor	**Current Conditions**
Total Area	117 square miles (74,880 acres)
Number of Subwatersheds	19
Mapped Perennial Stream Miles	521 miles
Current Impervious Cover	11%
Future (buildout) Impervious Cover	18%
Estimated Forest Area (based on 2000 MDP[1])	23,579 acres (31% of watershed)
Forested Streamside (100 feet on either side of stream)	6310 acres (8% of watershed)
Protected Land (includes ag easements, private easements, MET, parks, and DNR land)	3,841 acres (5% of watershed)
Forested Protected Land	1,630 acres (2% of watershed)
Potentially Developable Area within the watershed	32,947 acres (44% of watershed)
Development Envelope within the watershed	36,691 acres (49% of watershed)
Agricultural Characteristics (based on 2000 MDP)	4% Pasture (2,631 acres) 27% Cropland (19,988 acres)
MDP: Maryland Department of Planning Land Use/Land Cover MET: Maryland Environmental Trust	

The vulnerability analysis is organized into the following five primary steps:

1) Delineation of subwatersheds.
2) Calculating current impervious cover.
3) Determining future impervious cover.
4) Scaling and utilizing other screening factors for further characterization.
5) Prioritizing subwatersheds.

Once subwatershed delineations are made, the amount of current and future impervious cover is calculated using current GIS data layers and projections from zoning ordinances and comprehensive plans. Subwatersheds are initially classified solely on impervious cover, using the ICM.

Next, other watershed information is evaluated to further refine the initial classifications. This step is particularly important in watersheds with significant areas of rural or agricultural land use. For example, research on streams in the Georgia Piedmont indicated that other watershed factors such as forest and agricultural cover are useful indicators of stream quality (Divivo, 1997) (see Figure 3). Agricultural reference streams had lower Index of Biotic Integrity (IBI) scores than similar forested reference streams. Therefore, even when a subwatershed has low impervious cover levels that initially classify it as a "sensitive" subwatershed, there may be other influences that cause the biological community to show signs of degradation and stress. Under the vulnerability analysis approach, these subwatersheds might be shifted to the "impacted" designation for planning and management purposes.

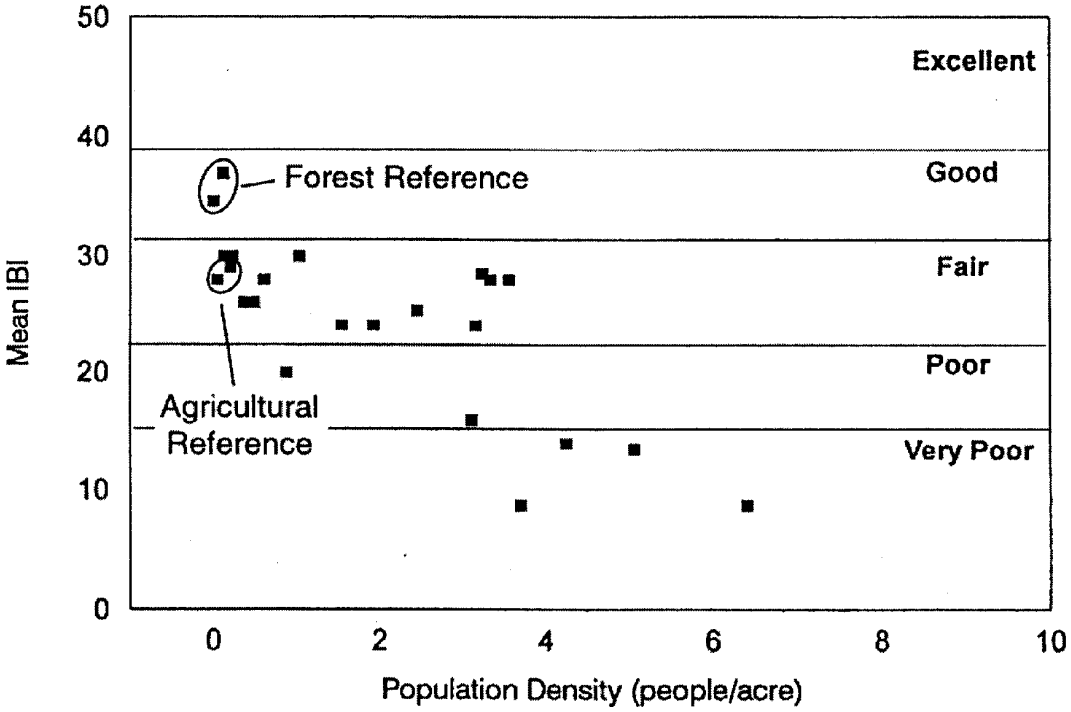


Figure 3. Impacts of Urbanization and Agriculture on IBI Scores (Divivo *et al.*, 1997)

Existing data and field verification revealed that there are really four different subwatershed types within the Bush River watershed: Sensitive, Rurally Impacted, Impacted, and Impacted Special Resource. To initially classify these subwatersheds, a uniform and quantitative approach was developed for further evaluation of the health the subwatersheds. The method incorporated utilized a variety of in-stream and subwatershed factors and required assigning points based on the presence of a given factor. Specific factors included: forested streamside, protected lands, and agricultural land uses. Details on these scoring methods and a summary table for each of the subwatersheds are provided in Section 2.4.

Based on this analysis, the current and future status of many of the subwatersheds were revised and resulted in the reclassification into one of the four management categories. The quantitative approach for the other analysis factors enabled a preliminary prioritization to be made, where 10 subwatersheds were identified and considered the most vulnerable. Management recommendations are detailed for these priority subwatersheds in Section 3.0.

SECTION 1.8 DOCUMENT ORGANIZATION

The remainder of this Bush River Watershed Management Plan document is organized as follows:

Section 2 – This section details and summarizes all of the key watershed and subwatershed data that were analyzed and considered in the development of the management plan. General

findings are also presented from the assessments conducted. Field verifications and retrofit inventories were conducted and detailed in this section in support of the initial findings.

Section 3 – Management recommendations on a subwatershed and land use basis are presented in this section.

Section 4 –Implementation of specific management recommendations are presented in this section.

Section 5 – The last section provides guidance on what types of approaches can be employed to serve as measures of success as recommended management measures are implemented in the watershed.

Section 6 – Conclusion

Section 7 – References

SECTION 2.0 METHODS AND FINDINGS

SECTION 2.1 SUBWATERSHED DELINEATIONS

The Bush River watershed was delineated into subwatershed management units that range in area from between 2 and 13 square miles. Where feasible, the delineations were developed to align with distinct land uses (i.e., rural/agricultural vs. urban/suburban) and geologic provinces (i.e., Piedmont vs. Coastal Plain) so that unique conditions and management approaches could be more easily separated and distinguished across subwatersheds.

Several factors were evaluated during the delineation process, including:

- Existing Harford County DPW delineations
- Land use (goal to delineate based on largely homogeneous land uses)
- Break between Piedmont and Coastal Plain geology
- Area (goal to have a minimum drainage area of 2 square miles and a largest to smallest drainage area to ratio of about 5:1)
- Known field assessment data points (Conservation Corps and MBSS)
- Scope and budget (goal to keep total number between 20 and 30 based on resources allocated to mapping and analysis tasks)

These guidelines generally worked well when applied across the Bush River watershed. The one exception is Winters Run, where the shape of the watershed and its tributaries along with the distribution of land use presented some challenges. Detail on the delineations and key decision points are provided below. Table 3 presents the delineations based on major watershed, unique identifier, and drainage area. Map 3 is a map of the delineation.

Watershed by Watershed Delineation

A subwatershed numbering and naming convention was developed for this management plan to ensure consistent and unique naming and referencing. While some subwatersheds have identifying names (e.g., Bear Cabin), there are others that do not or may be associated with a different drainage area by local residents. Therefore, alphanumeric identifiers were assigned to ensure consistent definition of the subwatershed areas. The naming and numbering convention for the subwatersheds is based on the major watershed initials and a number assigned in a general clockwise manner. For example, Otter Point Creek Direct Drainage would be assigned the ID of OP-1.

It is of note that there are several subwatersheds that are direct drainages to the mainstem of a larger watershed. This is largely a function of the delineation guidelines that were applied and the unique characteristics of the watersheds. These direct drainage areas, however, are assessed in the same manner as the other subwatersheds.

Otter Point Creek

As previously mentioned, Winters Run (the major tributary of Otter Point Creek) presented the most challenge in terms of delineation decisions. Specifically, due to the long and narrow shape of the watershed, there are several small (i.e., < 2 square miles) subwatersheds that drain to the mainstem of Winters Run. As a result, it was decided to consolidate many of these

subwatersheds into direct drainage delineations. In all cases, these subwatersheds were less than 2 square miles and in most cases they exhibited similar land use as the direct drainage. Lastly, some of these smaller subwatersheds had few if any field data points associated with them, making assessments more uncertain.

Another area that required discussion involved three small, unnamed tributaries on the northeast side of the lower Winters Run mainstem that are much more urbanized than those on the southwest. These subwatersheds were consolidated in to direct drainage delineations, however, their potential to contribute urban influences has been noted in the assessment.

Bush Creek
The Bush Creek watershed is comprised of four Bynum Run subwatersheds, a James Run subwatershed (James Run and Broad Run are combined due to similar land use), and Bush River direct drainage (for analysis simplification purposes, a small drainage area of Bush Creek was lumped with direct drainage to the Bush River on the north side of Bush River as well as Deep Spring Branch drainage on the south side of Bush River). The middle and lower Bynum Run delineations are essentially direct drainages to the mainstem; however, since they contain largely urban land use, this was viewed to be more straightforward than the Winters Run scenario.

Church Creek
The Church Creek delineation is comprised of Grays Run, Cranberry Run, and Church Creek direct drainage. Grays Run is predominantly outside of the development envelope and is largely rural in nature; however, Cranberry Run contains portions of Aberdeen and the Church Creek direct drainage is traversed by major transportation corridors. So there are various urban influences to be aware of in these latter two subwatersheds.

Aberdeen Proving Grounds (APG)
Drainage from APG lands generally are not being considered in this analysis, as the assumption is that these federal lands are not subject to management plan development and implementation.

Table 3. Bush River Subwatersheds

Watershed	Subwatershed Name	Subwatershed ID	Subwatershed Area (sq mi)
Otter Point	Otter Point DD	OP-1	5.09
Otter Point	Lower Winters DD	OP-2	8.04
Otter Point	Mountain Branch	OP-3	2.36
Otter Point	Middle Winters DD	OP-4	6.19
Otter Point	Upper Winters DD	OP-5	12.95
Otter Point	West Branch	OP-6	9.55
Otter Point	East Branch	OP-7	10.21
Otter Point	Bear Cabin	OP-8	3.45
Otter Point	Plumtree Run	OP-9	2.92
Otter Point	Haha Branch	OP-10	2.50
Otter Point		**Subtotal**	63.27
Bush Creek	Bush Creek DD	BC-1	3.98
Bush Creek	Lower Bynum	BC-2	2.48
Bush Creek	Middle Bynum	BC-3	8.44
Bush Creek	Upper Bynum	BC-4	8.64
Bush Creek	James Run	BC-5	11.33
Bush Creek	Little East Bynum	BC-6	3.54
Bush Creek		**Subtotal**	38.40
Church Creek	Church DD	CC-1	3.09
Church Creek	Grays Run	CC-2	6.06
Church Creek	Cranberry Run	CC-3	6.08
Church Creek		**Subtotal**	15.22
		Total	**116.89**

Notes:

DD - direct drainage

See Map 3for locations

Map 3 - Bush River Subwatershed Delineations

SECTION 2.2 CURRENT IMPERVIOUS COVER ANALYSIS

Current impervious cover was estimated from 2000 Maryland Department of Planning land use. Impervious cover was calculated using the land use method. The land use method involves calculating the total area of each current land use then multiplying it by an impervious cover coefficient (ICC). The ICC requires that the built area of each land use be multiplied by a unique ICC to yield a provisional estimate of impervious cover for each land use. The land use classifications and their associated ICC are outlined in Table 4.

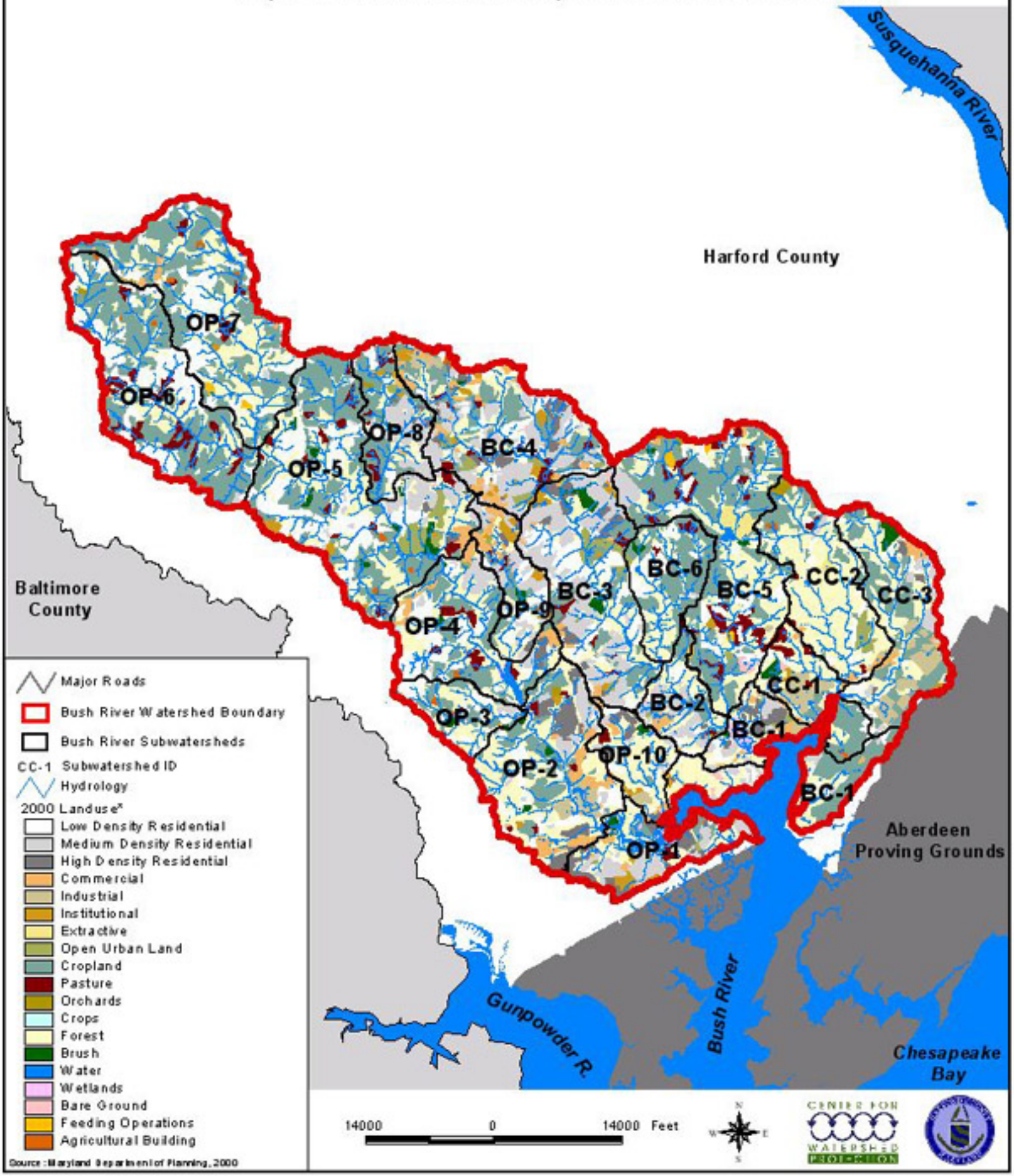
Table 4. Harford County Land Use and Assigned Impervious Cover % (modified from Brown and Cappiella, 2001)

Land Use Code*	Land Use Description	% Impervious
11	Low Density Residential	14.3
12	Medium Density Residential	27.8
13	High Density Residential	40.9
14	Commercial	72.2
15	Industrial	53.4
16	Institutional	34.4
17	Extractive	1.9
18	Open Urban Land	8.6
191	Rural Residential	3.5
192	Rural Residential	3.5
21	Cropland	1.9
22	Pasture	1.9
23	Orchards	1.9
24	Feeding Op	1.9
242	Ag Building	1.9
25	Crops	1.9
41	Forest/Brush	0
42	Forest/Brush	0
43	Forest/Brush	0
44	Forest/Brush	0
50	Water	1.9
60	Wetlands	0
71	Beaches	0
72	Bare Rock	8.6
73	Bare Ground	8.6

*Land Use/Land Cover Data Source: MDP, 2000
For additional details on the Land Use/Land Cover Codes, see Appendix A

A graphical representation of the current impervious cover in Bush River watershed is presented in Map 4. For current impervious cover, subwatersheds were designated as sensitive (<10% impervious cover), impacted (10-25% impervious cover), or non-supporting. Based on impervious cover, seven subwatersheds are classified as Sensitive and 12 fall into the Impacted classification. All of the Impacted subwatersheds have a significant portion, if not all, of their area within the development envelope. Two subwatersheds, Grays Run (CC-2) and Upper Winter DD (OP-5) are projected to shift from Sensitive to Impacted. The remaining ten subwatersheds maintain the same management classification. The results of the calculations are presented in Table 6 and Map 5.

Map 4 - Bush River Current Impervious Cover Baseline Data



Map 5 - Bush River Current Impervious Cover Results

SECTION 2.3 FUTURE IMPERVIOUS COVER

Future impervious cover estimates were projected based on developable land and current zoning. Impervious cover coefficients were developed for each major zoning category outlined in Harford County's Zoning Ordinance (Harford County, 2002). For the purposes of this analysis, full build-out of current zoning was assumed for future conditions. Consequently, the future impervious cover estimates represent the maximum level of development that can be expected in the subwatershed, since not all land that are zoned for a particular land use will ultimately be built (i.e., economic conditions, access, lack of infrastructure, etc.).

To project future impervious cover, undeveloped lands were identified within each subwatershed, based on the current land use. Next, unbuildable land was subtracted from the undeveloped land. Unbuildable lands include conservation easements, parks, DNR owned land, 100-year floodplain buffer (defined in County code as 75ft beyond 100-year delineation), stream buffers (depending on the stream, the County Zoning Ordinance may require either a 150ft or 75ft buffer on both sides of the stream), wetland buffers (County Zoning Ordinance requires that wetlands exceeding 40,000ft^2 have a 75 foot buffer), and slopes greater than 25%. The remaining area was then multiplied by an estimated impervious cover coefficient (See Table 5.)

Table 5. Harford County Zoning Categories and Assigned Impervious Cover %

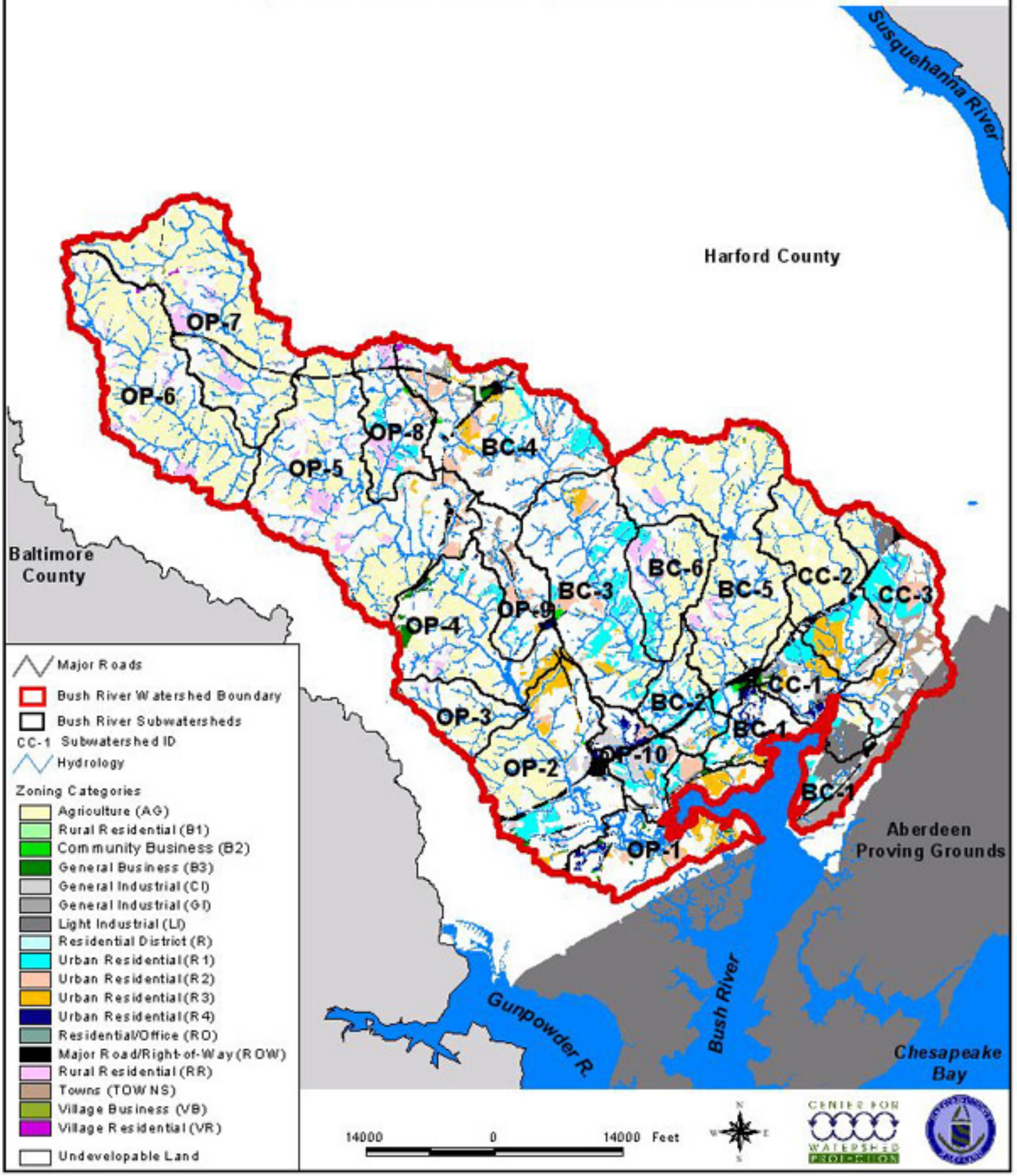
Zoning Category	Description	% Impervious
AG	Agriculture	1.9
RR	Rural Residential	10.6
R	Residential District	14.3
R1	Urban Residential	21.2
R2	Urban Residential	27.8
R3	Urban Residential	30.0
R4	Urban Residential	32.6
RO	Residential/Office	44.4
VR	Village Residential	40.9
VB	Village Business	65.6
B1	Neighborhood Business	72.2
B2	Community Business	72.2
B3	General Business	72.2
C1	General Industrial	53.4
L1	Light Industrial	53.4
G1	General Industrial	53.4
TOWNS	Towns	53.4
ROW	Major Highways and assoc. ROWs	70.0

A graphical presentation of future impervious cover for the Bush River watershed is provided in Map 6. There were seven subwatersheds which went from Impacted in the Current IC scenario to Non-Supporting. All of these subwatershed fall within the development envelope. The results of the calculations are presented in Table 6 and Map 7.

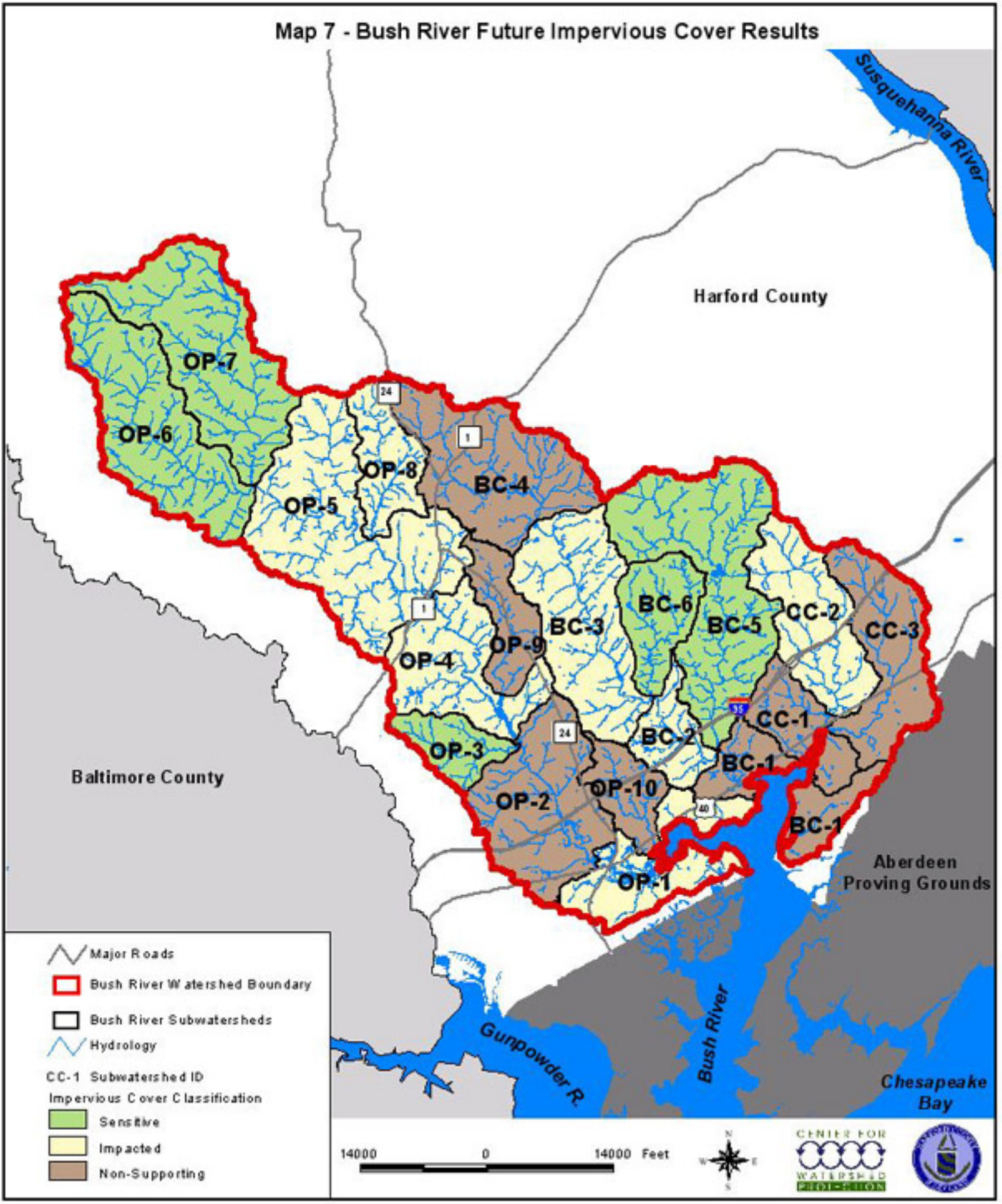
Table 6. Current and Future Impervious Cover Estimates for Bush River Subwatersheds

Subwatershed Name	Subwatershed ID	Current IC %	Current IC Management Classification	Future IC %	Future IC Management Classification
Otter Point DD	OP-1	15.4	Impacted	24.8	Impacted
Lower Winters DD	OP-2	17.1	Impacted	26.0	Non-Supporting
Mountain Branch	OP-3	5.8	Sensitive	6.9	Sensitive
Middle Winters DD	OP-4	11.1	Impacted	16.5	Impacted
Upper Winters DD	OP-5	7.6	Sensitive	11.0	Impacted
West Branch	OP-6	5.3	Sensitive	7.1	Sensitive
East Branch	OP-7	5.3	Sensitive	8.2	Sensitive
Bear Cabin	OP-8	11.5	Impacted	17.6	Impacted
Plumtree Run	OP-9	20.1	Impacted	28.2	Non-Supporting
Haha Branch	OP-10	14.8	Impacted	36.0	Non-Supporting
Bush Creek DD	BC-1	14.4	Impacted	34.5	Non-Supporting
Lower Bynum	BC-2	13.4	Impacted	20.0	Impacted
Middle Bynum	BC-3	16.8	Impacted	22.4	Impacted
Upper Bynum	BC-4	19.8	Impacted	29.3	Non-Supporting
James Run	BC-5	4.7	Sensitive	8.2	Sensitive
Little East Bynum	BC-6	3.3	Sensitive	6.8	Sensitive
Church Creek DD	CC-1	13.2	Impacted	33.5	Non-Supporting
Grays Run	CC-2	3.9	Sensitive	12.5	Impacted
Cranberry Run	CC-3	13.6	Impacted	30.6	Non-Supporting
Bush River Watershed		**10.7**	**Impacted**	**17.9**	**Impacted**

Map 6 - Bush River Future Impervious Cover Baseline Data



Map 7 - Bush River Future Impervious Cover Results



SECTION 2.4 OTHER SCREENING FACTORS

Given the great amount of existing monitoring and mapping data available in Harford County and recognizing that impervious cover alone is not always a perfect indicator of stream health, CWP developed two additional subwatershed classifications – Rurally Impacted and Impacted Special Resource. These additional subwatershed classifications also help to further refine the subwatershed classification system and derive priority (a.k.a. most vulnerable) subwatersheds. This section outlines the data sources utilized to refine subwatershed classifications and provides additional details on the new subwatershed classifications.

Data Sources

Data used to refine the initial subwatershed classifications came from a variety of sources, but most heavily relied on data provided by DNR and Harford County. DNR provided data in a number of formats, most notably, through the Bush River Watershed Characterization, monitoring data (MBSS and synoptic), and Stream Corridor Assessment Methodology (SCAM). The purpose of the report was to characterize the Bush River watershed using immediately available information. Data utilized from this report include fish blockages, forests suitable for interior dwelling species, wetlands of special concern, and hydric soils. Monitoring data is available through the Maryland Biological Stream Survey (MBSS). In the Bush River watershed MBSS data was available for water quality (e.g. nitrate concentrations), physical in-stream habitat, benthic macroinvertebrates diversity, and fish diversity. The Stream Corridor Methodology (SCAM), developed by DNR, consists of visual observations of specific problems such as bank erosion, livestock access, trash dumping, and fish blockages. Harford County has partnered with both DNR and Maryland Conservation Corp to collect much of the SCAM field data. Additional data from Harford County that proved to be useful in this portion of the vulnerability analysis included critical habitat areas, erodible soils, and digital orthophotographs. These data taken all together is reflective of current stream conditions and its corresponding land uses.

Rurally Impacted Subwatersheds

The Bush River watershed contains a mix of land uses including agriculture. This classification was developed to identify those subwatersheds that have strong agricultural influences. Although these subwatersheds are under 10% impervious cover, they may be degraded due to livestock access, and grazing and cropping practices that may have severely altered the riparian zone and created isolated stream bank erosion. Due to these factors, Rurally Impacted subwatersheds should be managed differently than other Sensitive subwatersheds.

An in-office analysis was conducted, utilizing available data, to identify Rurally Impacted subwatersheds. This analysis was done by creating a rurally impacted point system. In this system, data such as poor fish diversity and high amounts of cropland are assigned a point in favor of rural impacted-ness. Point assignments were largely based on a quartile approach. In most cases, a point was assigned to a parameter if it exceeded the 75^{th} Percentile. For example, the average nitrate concentration was taken for all sensitive subwatersheds. The 75^{th} Percentile of nitrate concentrations was 3.02 mg N/L. Therefore, all sensitive subwatersheds with nitrate concentrations greater than 3.02 mg N/L were assigned a point. Rurally impacted points were assigned for:

- High percentage of cropland
- High percentage of pasture
- High percentage of unforested streamside
- Livestock access per stream mile
- Eroded banks per stream mile
- High nitrate concentrations
- Presence of poor fish diversity
- Presence of poor benthic macroinvertebrate diversity
- Presence of poor physical in-stream habitat

Points were then added up and normalized to obtain a score. Subwatersheds with scores in the highest quartile were then designated as rurally impacted (for more details on the rurally impacted point system, see Appendix B).

As a result of this analysis, two subwatersheds, Little East Bynum (BC-6) and West Branch (OP-6) (see Figures 4 and 5, respectively) were reclassified as Rurally Impacted. Maps 15 and 16 illustrate the parameters utilized in this analysis. Field verification which consisted of stream habitat assessments and visual confirmation also reinforced the status of these subwatersheds as Rurally Impacted (see Section 2.5).

Figure 4. Little East Bynum

Figure 5. West Branch

Impacted Special Resource

The Bush River watershed contains large expanses of tidally influenced wetlands. The Impacted Special Resource classification was developed to identify those subwatersheds with an impervious cover between 10 and 25% and that also contain these valuable and unique natural resources. Due to the water quality and habitat value of these special resources, Impacted Special Resource subwatersheds should be managed differently than other Impacted subwatersheds.

An in-office analysis was also utilized to identify Impacted Special Resource subwatersheds. This analysis was done by creating a special resource point system. In this system, data such as good fish diversity and high amounts of wetlands are assigned a point in favor of special resource-ness. Point assignments and rankings were applied using the same methodology that

determined Rurally Impacted subwatersheds. While the methodology was relatively the same, the parameters that determined Impacted Special Resource subwatersheds were different:

- Presence of tidal influence
- High percentage of forest suitable for interior dwelling species
- High percentage of wetlands (NWI)
- High percentage of wetlands of special concern
- High percentage of forested streamside
- High percentage of habitat of local significance
- Presence of good fish diversity
- Presence of good benthic macroinvertebrate diversity
- Presence good physical in-stream habitat
- High expected increase in IC (change from Current to Future IC)

A more detailed presentation of this analysis can be found in Appendix B.

As a result of this analysis, three subwatersheds, Otter Point DD (OP-1), Church Creek DD (CC-1), and Bush Creek DD (BC-1) (see Figures 6, 7, and 8 respectively) were reclassified as Impacted Special Resource. Field verification that consisted of wetland assessments (to evaluate water quality and habitat value), stream habitat assessments and visual confirmation, verified fully established that these subwatersheds should be classified as Impacted Special Resource.

Although it did not quite score high enough in the impacted special resource point system, Haha Branch (OP-10) subwatershed was also reclassified as Impacted Special Resource due to field findings, tidal influence, and direct drainage to Otter Point (see Figure 9). GIS mapping also indicates that Haha Branch subwatershed may contain a significant tract of contiguous forest.

Maps 17, 18, 19, and 20 illustrate the parameters utilized in the impacted special resource classification.

Figure 6. Otter Point Creek DD

Figure 7. Church Creek DD

Figure 8. Bush Creek DD

Figure 9. Haha Branch

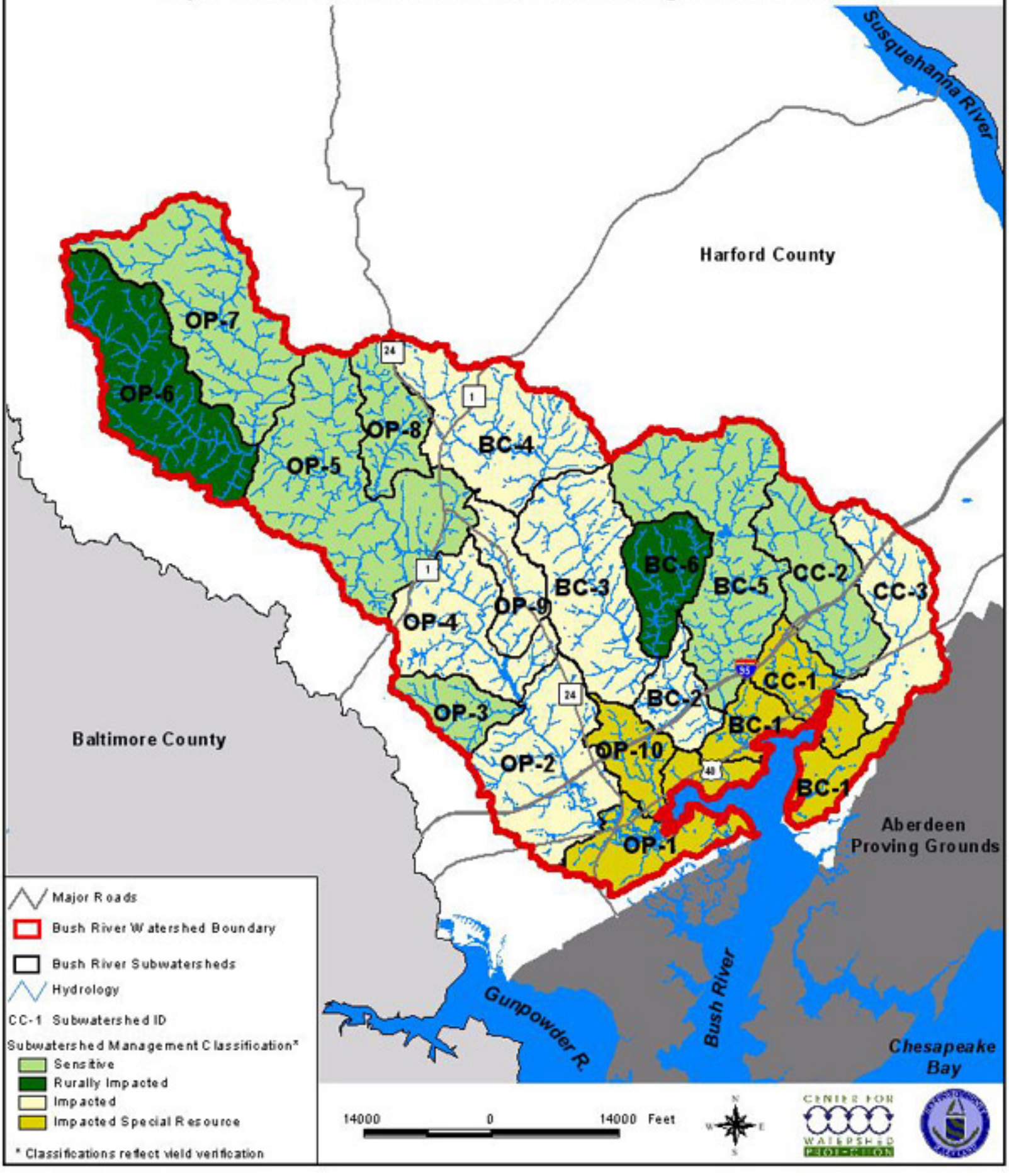
A summary of the classification changes as a result of rurally impacted and impacted special resource point systems is provided in Table 7. Map 8 illustrates these revised management classifications.

Table 7. Revised Subwatershed Management Classifications

Subwatershed Name	Subwatershed ID	% Current IC	Current IC Classification	Revised Management Classification
Otter Point DD	OP-1	15.35	Impacted	Impacted Special Resource
Lower Winters DD	OP-2	17.05	Impacted	Impacted
Mountain Branch	OP-3	5.79	Sensitive	Sensitive
Middle Winters DD	OP-4	11.07	Impacted	Impacted
Upper Winters DD	OP-5	7.56	Sensitive	Sensitive
West Branch	OP-6	5.33	Sensitive	Rurally Impacted
East Branch	OP-7	5.31	Sensitive	Sensitive
Bear Cabin*	OP-8	11.49	Impacted	Impacted
Plumtree Run	OP-9	20.99	Impacted	Impacted
Haha Branch	OP-10	14.82	Impacted	Impacted Special Resource
Bush Creek DD	BC-1	14.39	Impacted	Impacted Special Resource
Lower Bynum	BC-2	13.4	Impacted	Impacted
Middle Bynum	BC-3	16.75	Impacted	Impacted
Upper Bynum	BC-4	19.76	Impacted	Impacted
James Run	BC-5	4.7	Sensitive	Sensitive
Little East Bynum	BC-6	3.32	Sensitive	Rurally Impacted
Church Creek DD	CC-1	13.24	Impacted	Impacted Special Resource
Grays Run	CC-2	3.87	Sensitive	Sensitive
Cranberry Run	CC-3	13.6	Impacted	Impacted

Notes:
* Subwatershed classification later changes from Impacted to Sensitive as a result of field verification (see Section 2.5)

Map 8 - Bush River Revised Subwatershed Management Classification



SECTION 2.5 FIELD METHODS

In January, 2003, CWP spent a week field verifying the assumptions of the vulnerability analysis by visiting targeted subwatersheds and conducting special studies. In particular, CWP utilized the time spent in the field to answer the following questions:

- Do subwatersheds with a current impervious cover between 10-12% belong in the Sensitive or Impacted subwatershed management classification?
- In Impacted Special Resource subwatersheds, are the wetlands capable of water quality treatment and providing valuable habitat?
- Do Rurally Impacted subwatersheds reflect their revised management classification (i.e., lack stream buffers, cattle access, row crops, etc)?
- Which of the sensitive subwatersheds deserve prioritization?
- Are there opportunities for streambank stabilization?

CWP employed three special studies to help answer these questions: the Rapid Bioassessment Protocol (RBP), contiguous forest assessment, and wetland evaluation. Descriptions of these field methods are provided below.

Rapid Bioassessment Protocol (RBP)

The purpose of the EPA's RBP Habitat Assessment is to provide a measure of the overall habitat condition of the study reaches based on assessments at discrete intervals. The RBP is a semi-quantitative method that asks an investigator to assign a score to various stream habitats or channel parameters by comparing what is seen at points along the stream to a series of descriptions. Examples of the parameters that are evaluated include bank stability, riparian buffer (stream buffer) width and disruption, sediment deposition and the quality of in-stream habitat features such as pools and riffles. After the parameters are assessed, a total score is determined. The RBP method determines the degree of impairment by comparing the total assessment scores found at study reaches to those found at the least impaired reference reaches to determine the overall condition and the degree of impairment. These reference streams represent a surrogate for the best attainable condition for the region. A sample field sheet is provided in Appendix C. The entire RBP method documentation can be viewed and downloaded from EPA's website at www.epa.gov/owow/monitoring/bioassess.htm

To evaluate the results of the sampling effort, scoring criteria were established. The scoring criteria are based upon the concept of a reference condition. The reference condition is considered to be the least impaired, best attainable condition for a stream in a given region. The highest rated sample stations in the study area were considered to be equivalent to reference conditions. The best two sample station scores in the study area were 180 and 184 for an average of 182. A score of at least 90% or greater of this number (>164) is considered comparable to the reference condition and represents excellent stream conditions. A score of 65% or less (<118) is considered non-supporting or poor stream conditions. Scores between these two extremes are considered good or fair. The final scoring criteria are shown in Table 8.

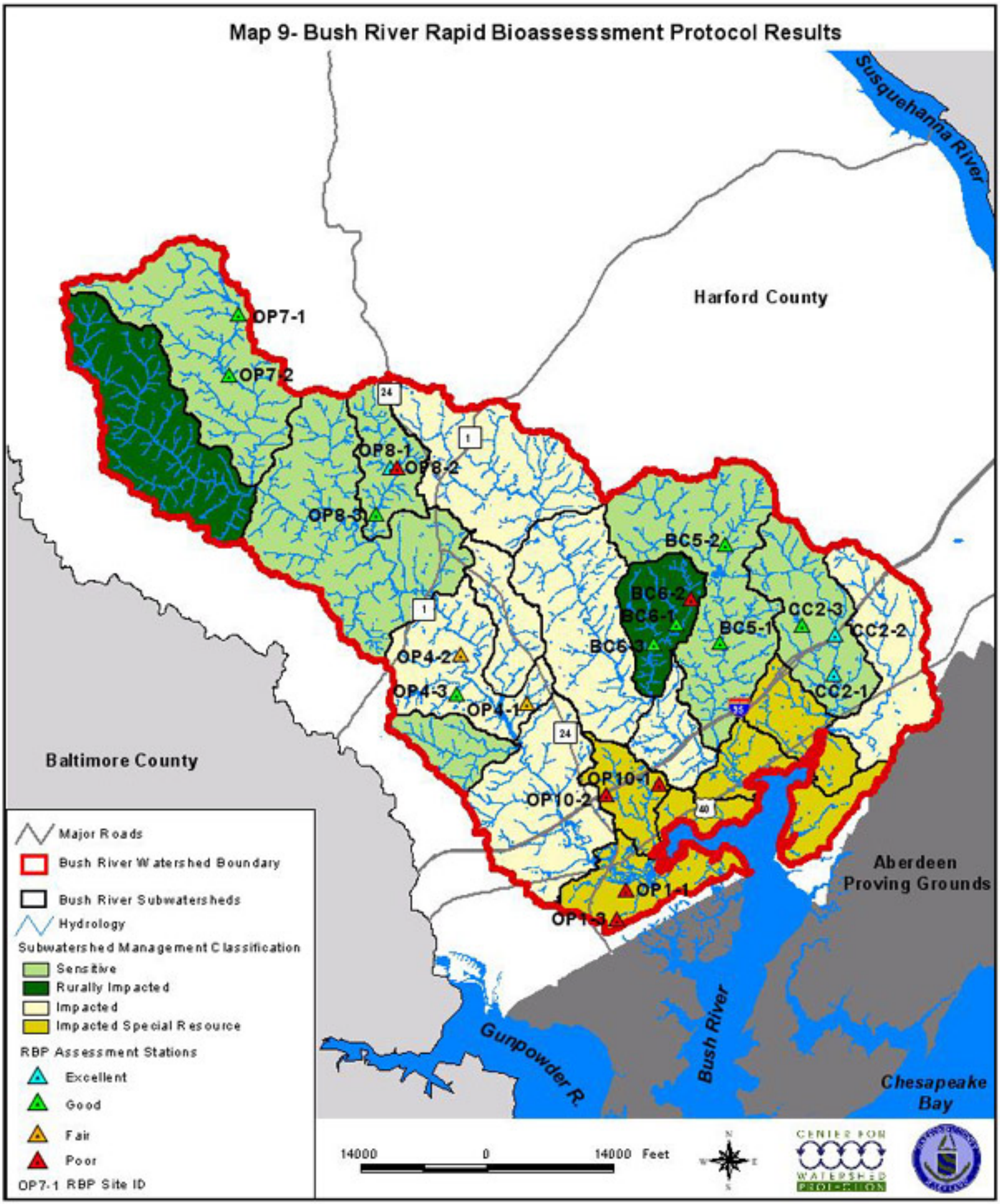
Table 8 Stream Assessment Scoring Criteria	
Habitat Category	**Habitat Score**
Excellent	>=164
Good	163-142
Fair	142-118
Poor	<118

A total of 20 RBP points were taken in the Bush River watershed. The distribution of these points are illustrated in Table 9 and Map 9. As mentioned previously, the RBP was mainly utilized to verify field assumptions and answer the questions presented above. Table 9 provides a summary of the RBP habitat conditions found at each site and presents a justification for why an RBP assessment was conducted within a given subwatershed. These results were used in the final determination of management classifications and recommendations (See Section 3.0).

Table 9. In-stream Habitat Conditions in Bush River Subwatersheds

Subwatershed Name	RBP ID	Total RBP Score	RBP Habitat Category	Field Notes	Purpose of RBP Assessment
James Run	BC5-1	156	Good	Streams with good habitat quality; large contiguous agricultural parcels	Assess for prioritization. Scoring indicates borderline status (see Section 2.7)
James Run	BC5-2	144	Good		
Little East Bynum	BC6-1	144	Good	Streams with generally good habitat quality; evidence of agricultural impacts	No existing monitoring data (Fish IBI, etc); wanted to verify Rurally Impacted classification
Little East Bynum	BC6-2	114	Poor		
Little East Bynum	BC6-3	152	Good		
Grays Run	CC2-1	180	Excellent	Highest rated streams in assessed subwatersheds	Assess for prioritization. Establish reference stream condition
Grays Run	CC2-2	184	Excellent		
Grays Run	CC2-3	150	Good		
Otter Point DD	OP1-1	59	Poor	Unstable channels associated with developed areas	Special Resource Impacted classification plus SCAM revealed several eroded streambanks; assess potential for streambank stabilization.
Otter Point DD	OP1-3	80	Poor		
Middle Winters	OP4-1	126	Fair	Somewhat degraded conditions	Current IC at 11.1 – should subwatershed be managed as Sensitive or Impacted
Middle Winters	OP4-1	141	Fair		
Middle Winters	OP4-3	160	Good		
East Branch	OP7-1	150	Good	Some obvious impacts of agriculture including lack of buffer and cattle access to streams	Assess for prioritization. Scoring indicates borderline status (see Section 2.7)
East Branch	OP7-2	145	Good		
Bear Cabin	OP8-1	169	Excellent	Mainstem had good to excellent habitat. One 1st order tributary was very degraded due to uncontrolled stormwater runoff	Current IC at 11.5 – should subwatershed be managed as Sensitive or Impacted
Bear Cabin	OP8-2	107	Poor		
Bear Cabin	OP8-3	156	Good		
Haha Branch	OP10-1	79	Poor	Unstable channels associated with developed areas	Special Resource Impacted classification plus SCAM revealed several eroded streambanks; assess potential for streambank stabilization.
Haha Branch	OP10-2	89	Poor		

Map 9- Bush River Rapid Bioassesssment Protocol Results



Contiguous Forest Tract Identification and Assessment

Contiguous forest is defined as a forest that is continuous and without significant breaks from roads, power lines or other clearings. The larger and more round a tract of contiguous forest, the greater the amount of interior forest is created. Contiguous forest is important for species diversity and the protection of forest interior dwelling species including breeding songbirds and small mammals. Identification of contiguous forest in the Bush River watershed involved two steps. In the first step, land cover digital orthophotographs provided by Harford County were analyzed to identify potential contiguous tracts of forest. In the second step, candidate sites were evaluated in the field by assessing forest community, structure and canopy. In this step, site visits were performed to evaluate the contiguous forest stands and determine if they were affected by roads, clearing or development. In the assessment, forest plots were selected and factors were measured including the dominant tree species using a wedge prism and canopy cover using a concave densiometer. Forest structure, understory conditions, invasive species and diseases were also noted.

Contiguous forest tracts were assessed in the Church Creek Direct Drainage (CC-1), Grays Run (CC-2) and Otter Point Creek Direct Drainage (OP-1) subwatersheds (see Map 10). Contiguous forest assessments were conducted in Grays Run for several reasons. In addition to preliminarily being identified as a priority Sensitive subwatershed (See Section 2.7), GIS data for Grays Run indicated significant tracts of contiguous forest. While GIS mapping did not show large expanses of forest in Church Creek Direct Drainage, field verification indicated otherwise (See Figure 10). A contiguous forest assessment was conducted in Otter Point Direct Drainage because of its Impacted Special Resource classification (see Section 2.4) and GIS mapping that indicated the presence of contiguous forest.

Figure 10. Contiguous Forest Tract in Church Creek DD

Field verification found that one of the largest tracts of contiguous forest in Grays Run had recently undergone selective timber harvesting and contained clearing that may be a precursor to development. Six contiguous forest tracts greater than 200 acres were identified in the first step, and two of these tracts were assessed during the fieldwork. A seventh tract (CA-OP-1) was identified in the field. Findings from the contiguous forest assessments are summarized in Table 10. The form and methodology used for the Contiguous Forest Assessment is located in Appendix C.

Table 10. Contiguous Forest Assessment

Subwatershed Name	Contiguous Forest ID	Condition
Church Creek DD	CA-CC2-1	Remains contiguous – some cattle grazing reduces the extent
Grays Run	CA-CC2-2	Selective timber harvesting
	CA-CC2-3	Selective timber harvesting
	CA-CC2-4	Mature forest along a tributary to Grays Run
	CA-CC2-5	Contiguous
Otter Point Creek DD	CA-OP1-1	Contiguous (mature tract associated with the Izaak Walton League property)

CA: conservation area

Wetland Identification and Evaluation

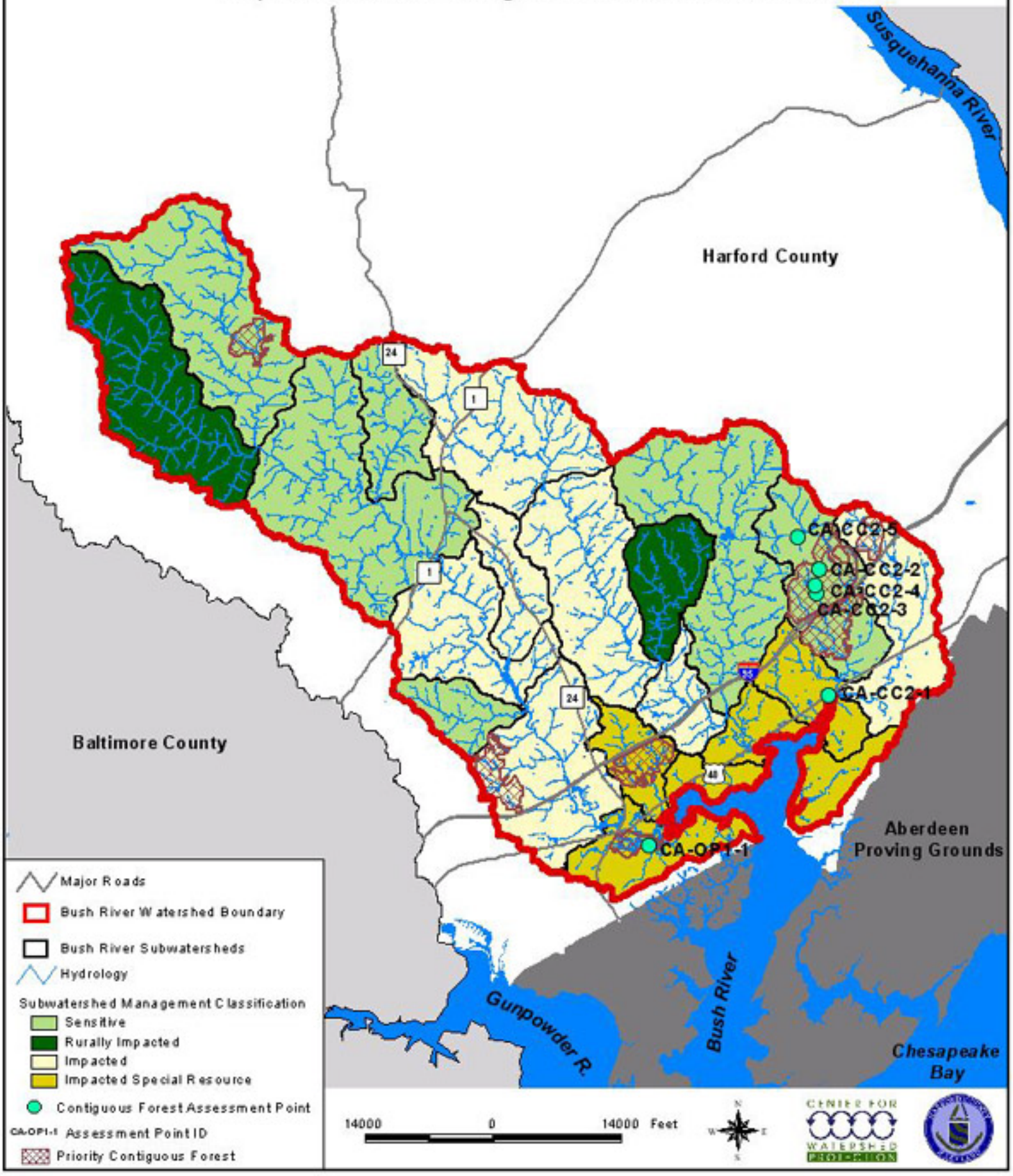
The goal of the wetland identification and evaluation assessment was to determine the significance of large wetland complexes, identified by reviewing the National Wetlands Inventory data layer, for both habitat and water quality. These wetland sites were then located in the field and assessed for wetland habitat and water quality function. The methodology and the scoring guidelines are located in Appendix C. The functional assessment for wildlife was focused on determining both habitat complexity and features that negatively affect habitat value. The functional assessment for water quality was based on vegetation, detention time, water contact and substrate-slope characteristics. The two wetland sites that were surveyed scored highly for water quality and habitat. Consequently, they were determined to provide diverse wildlife habitat and provide significant water quality treatment and protection.

The two wetland areas surveyed included are located in the Impacted Special Resource subwatersheds, Church Creek Direct Drainage (CC-1) and Bush Creek Direct Drainage (BC-1) (see Map 11). Both wetlands surveyed allow flood flows to have close contact with vegetation and provide large areas for flood flows to dissipate and be filtered by wetland vegetation.

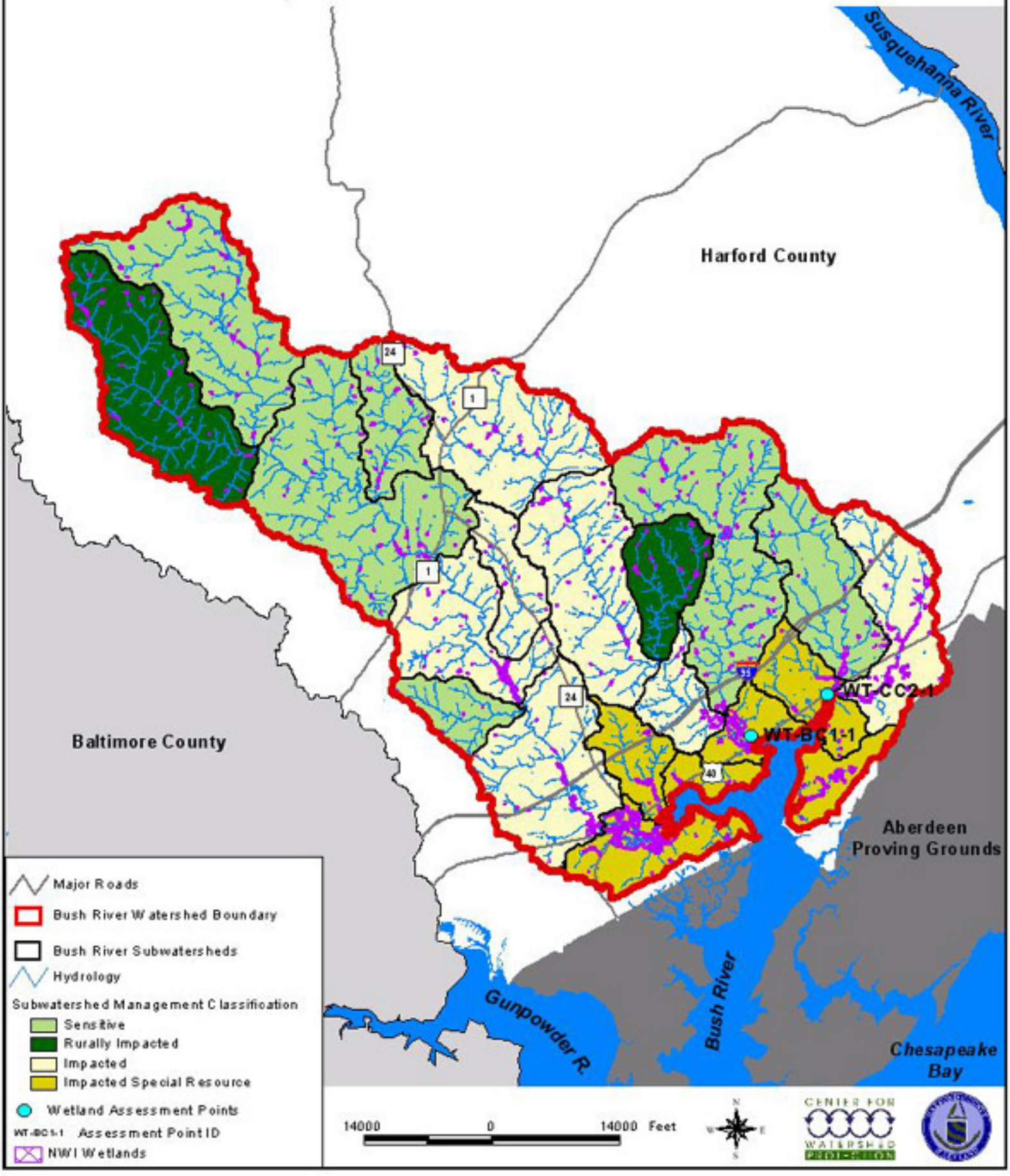
Additional Field Verification

The utilization of the field findings are mostly discussed within Section 2.7, Subwatershed Prioritization and Section 3.0, Recommendations. However, it is appropriate to note here that because of RBP scores, the Bear Cabin subwatershed, with 11.5% impervious cover, was found to be in the Sensitive management classification, while Middle Winters Direct Drainage (11.1% IC) remains in the Impacted management classification. Map 8 (management revisions) reflects these changes.

Map 10 - Bush River Contiguous Forest Assessment Results



Map 11 - Bush River Wetlands Assessment Points



SECTION 2.6 RETROFIT INVENTORY

A stormwater retrofit inventory and prioritization assessment was conducted as part of the Bush River Watershed Study in February 2003. Stormwater retrofits are being pursued as one of the tools of the Bush River Watershed Management Plan to provide channel protection storage to limit downstream channel erosion and to provide water quality treatment to reduce pollutant loading to receiving streams and the Chesapeake Bay during stormwater runoff events.

Center staff conducted the inventory in portions of four subwatersheds of the Bush River watershed, including Haha Branch (OP-10), Otter Point Creek Direct Drainage (OP-1), Lower Winters Run (OP-2) (primarily targeting the Route 24 corridor), and Plumtree Run (OP-9). These areas were focused on for the following reasons:

- A preliminary retrofit inventory already exists in the Bynum Run subwatershed (KCI, 1999).
- Tidal water areas such as lower Haha Branch and Otter Point Creek Direct Drainage exhibit relatively high quality conditions and protecting the current conditions is a priority identified in the management plan. These areas are also planned for significant increases in future development.
- Lower Winters Run tributaries off of the Route 24 corridor are impacted by the rapid development that has occurred over the last 10 to 15 years. Stormwater management associated with the new development does not typically provide channel protection storage. Retrofitting existing facilities should reduce the rate at which the downstream channels are enlarging and reduce the amount of sediment and associated nutrients transported downstream.
- Plumtree Run presented an opportunity to fully investigate a smaller subwatershed planning unit, where much development exists with no stormwater management. The watershed ranking factors (described in Section 2.7) identified Plumtree Run as the highest ranking subwatershed outside of Bynum Run in terms of potential for restoration. The biological and physical habitat data in the watershed are poor, and approaches to improve these conditions were explored.

The retrofit candidate sites are depicted in Map 12. Key aspects of the assessment are presented in this section. Appendices D and E contain a general discussion on the retrofitting process and the retrofit inventory sheets, which contain descriptions of each retrofit and a conceptual sketch of the most likely retrofit option.

It is important to note that project scope limited the extent of the retrofit inventory and therefore does not reflect the extent of opportunities for retrofitting that may be available throughout the Bush River watershed. The County should look for opportunities to conduct further retrofit inventory efforts to achieve wider watershed coverage. A more complete picture of watershed retrofit opportunities will likely result in more cost effective application of resources and yield higher pollutant reduction and channel protection benefits throughout the watershed.

Bush River Watershed Retrofit Inventory and Assumptions

A preliminary office investigation (using aerial photography, topographic and other base mapping, and preliminary stream assessment and SCAM results) identified approximately 22 candidate stormwater retrofit sites. Screening criteria were employed to target sufficiently large drainage areas associated with outfall locations and existing ponds so that the number of candidate sites to investigate would be reasonable and the total watershed area potentially addressed was maximized. Other screening criteria targeted sites upstream of locations where

the downstream physical assessment indicated unstable banks and significant channel erosion. The ideal target for each site was to provide 100% of the water quality volume (1 inch per impervious acre) and 100% of the channel protection storage (extended detention for the 1-year, 24-hour event, which is approximately 2.6 inches).

In addition to the original 22 candidate stormwater retrofit sites identified in the office, at least seven additional candidate sites were identified during the field investigation portion of the analysis, yielding a total of 29 candidate sites. Of the 29 sites, 18 are located at or near storm drain outfalls and 11 are at existing stormwater management facilities, generally stormwater detention facilities (i.e., dry ponds). In general, candidate stormwater sites have drainage areas of at least ten acres. Exceptions to this occur when isolated hotspot areas are targeted or where retrofit concepts involve practices that perform best when serving smaller drainage areas (e.g., bioretention, infiltration trenches).

Of the 29 original candidate sites, six were deemed infeasible or impractical based on the field reconnaissance and/or further office analysis. These six candidate sites were dropped from further consideration. The reasons for dropping a site from further consideration generally were because of too little available area, poor or impractical construction and/or maintenance access, or the presence of existing natural features such as mature forest and wetlands. Table 11 provides a summary of the final 23 retrofit sites that are considered feasible after the field verification and subsequent office confirmation. Map 12 shows the locations of the 23 final candidate retrofit sites.

Most of the retrofit concepts involve use of stormwater treatment practices that are identified in the Maryland Stormwater Design Manual (2000) as capable of removing 80% of the total suspended sediment (TSS) load, and 40% of the total phosphorus (TP) load in the treated runoff. Retrofits where practices, such as dry ponds, previously exist will have a net load reduction something less than these percentages (roughly half is reasonable to expect) since limited treatment is already being provided by the existing practice.

Table 11. Summary of Final Candidate Retrofit Sites

Site ID	Subwatershed	Retrofit Concept	Area (ac)	Est. Impervious Cover	New or Existing Facility	Land Ownership	Notes
HH-1	Haha Branch	shallow marsh ED	40	85	existing	private	industrial park/green roof opportunity
HH-2	Haha Branch	plunge pool	15	75	new	private	apartment complex
HH-2A	Haha Branch	plunge pool	10	75	new	private	senior housing townhouses
HH-4	Haha Branch	shallow marsh ED	27	30	new	public	mixed residential
HH-5	Haha Branch	Shallow marsh ED	10	25	existing	private	SF residential
HH-5A	Haha Branch	infiltration trench/ level spreader	0.5	100	new	public	road runoff
OP-1	Otter Point DD	shallow marsh ED	15	30	existing	private	SF residential
OP-1A	Otter Point DD	shallow marsh ED	15	30	new	unknown	open space area
OP-2	Otter Point DD	shallow marsh ED	15	40	new	public	apartment complex
OP-2A	Otter Point DD	cut-off wall/ trench	NA	NA	new	public	head cut mitigation
OP-3	Otter Point DD	bioretention	22	40	new	public	APG abandoned housing
OP-4	Otter Point DD	shallow marsh ED	7.5	90	existing	private	Food Lion shopping center
OP-6	Lower Winters DD	shallow marsh ED	50	70	existing	private	BJ's assuming buildout
OP-7	Lower Winters DD	micropool ED	120	50	existing	public	Walmart
OP-8	Lower Winters DD	shallow marsh ED/ bioretention	17	35	existing	private	mixed residential
OP-9	Lower Winters DD	micropool ED	120	30	existing	public	SHA site/ Weiss market plaza
OP-9A	Lower Winters DD	bioretention	3	100	new	private	Weiss market parking lot
OP-10	Lower Winters DD	micropool ED	19	25	new	public	SF residential
OP-11	Lower Winters DD	micropool ED	35	40	existing	public	Abingdon ES
OP-12	Lower Winters DD	shallow marsh ED	19	50	existing	private	mixed residential
OP-13	Middle Winters DD	shallow marsh ED	29	90	existing	private	Festival at Bel Air shopping center
OP-13A	Middle Winters DD	bioretention	2	100	new	private	Festival at Bel Air shopping center
OP-14	Plumtree Run	shallow marsh WL	25	25	new	unknown	SF residential

Priority of Sites Based on Assessment

Weighing the individual merits of the candidate retrofits in terms of water quality, channel protection, cost, implementation issues, and other benefits/liabilities can provide an indication of the most effective (i.e., biggest bang for the buck) practices; however, it does not always provide a rationale for selecting retrofits to pursue in terms of overall subwatershed or catchment benefit. There may be a greater benefit in terms of overall subwatershed or catchment quality if several less effective retrofits, located within the same subwatershed are pursued together. Looking at the retrofits according to subwatershed and catchment location also allows information from other watershed-wide assessments to be integrated into the retrofitting analysis.

Initiating a stormwater retrofit program requires a certain level of expertise and experience on the part of the local agencies involved. It may be best to pursue one or more of the initial projects as demonstration projects. Good opportunities often exist on publicly owned land (e.g., OP-9) where there are few potential infrastructure conflicts and the retrofit designs are not highly complicated or where there are good opportunities for interagency partnerships (e.g., State Highway Administration). Additionally, many of the existing dry pond modification sites offer similar low risk efforts. By selecting a few projects that can be implemented relatively easily, both the public and agency personnel can become familiar with retrofit project requirements and be better able to implement more complicated projects down the road.

Taking the above into consideration, the candidate retrofits were broken into three prioritization tiers (Table 12) with the first tier representing the top retrofit recommendations. Tier 2 and 3 retrofits still may have merit in pursuing, particularly if funding is available, a willing partner is identified, or it is deemed to be a good demonstration project due to its visibility. However, Tier 2 and 3 retrofits are not viewed as having as large a benefit either because they provide limited treatment, are associated with significant forest or wetland impacts, or may have lower public acceptance. Table 13 provides more specific description and justification for the Tier 1 retrofits.

Table 12. Prioritized Candidate Retrofit Sites

Tier Rank	Site ID	Subwatershed	Retrofit Concept	Area (ac)	Est. Impervious Cover	New or Existing Facility	Land Ownership	Notes
1	HH-1	Haha Branch	shallow marsh ED	40	85	existing	private	industrial park/green roof opportunity
1	HH-4	Haha Branch	shallow marsh ED	27	30	new	public	mixed residential
1	OP-4	Otter Point DD	shallow marsh ED	7.5	90	existing	private	Food Lion shopping center
1	OP-6	Lower Winters DD	shallow marsh ED	50	70	existing	private	BJ's assuming buildout
1	OP-9	Lower Winters DD	micropool ED	120	30	existing	public	SHA site/ Weiss market plaza
1	OP-14	Plumtree Run	shallow marsh WL	25	25	new	unknown	SF residential
2	HH-2	Haha Branch	plunge pool	15	75	new	private	apartment complex
2	HH-2A	Haha Branch	plunge pool	10	75	new	private	senior housing townhouses
2	HH-5	Haha Branch	Shallow marsh ED	10	25	existing	private	SF residential
2	HH-5A	Haha Branch	infiltration trench/ level spreader	0.5	100	new	public	road runoff
2	OP-1	Otter Point DD	shallow marsh ED	15	30	existing	private	SF residential
2	OP-2	Otter Point DD	shallow marsh ED	15	40	new	public	apartment complex
2	OP-2A	Otter Point DD	cut-off wall/ trench	NA	NA	new	public	head cut mitigation
2	OP-7	Lower Winters DD	micropool ED	120	50	existing	public	Walmart
2	OP-11	Lower Winters DD	micropool ED	35	40	existing	public	Abingdon ES
2	OP-13	Middle Winters DD	shallow marsh ED	29	90	existing	private	Festival at Bel Air shopping center
3	OP-1A	Otter Point DD	shallow marsh ED	15	30	new	unknown	open space area
3	OP-3	Otter Point DD	bioretention	22	40	new	public	APG abandoned housing
3	OP-8	Lower Winters DD	shallow marsh ED/ bioretention	17	35	existing	private	mixed residential
3	OP-9A	Lower Winters DD	bioretention	3	100	new	private	Weiss market parking lot
3	OP-10	Lower Winters DD	micropool ED	19	25	new	public	SF residential
3	OP-12	Lower Winters DD	shallow marsh ED	19	50	existing	private	mixed residential
3	OP-13A	Middle Winters DD	bioretention	2	100	new	private	Festival at Bel Air shopping center

It is important to emphasize again that the inventory that was conducted as part of this study was not watershed-wide due to available resources. Therefore the recommendations should ultimately be considered in the context of existing retrofit concepts that have been previously developed in the Bynum Run subwatersheds (see KCI, 1999) as well as planned future inventory assessments.

Table 13. Recommended "Tier 1" Retrofit Projects

Recommended Projects for Implementation	Description and Justification
Stormwater retrofit: HH-1 Shallow Marsh Wetland with Forebay	***Description:*** The concept involves converting an existing dry detention pond to a shallow marsh wetland facility. ***Justification:*** This existing site serves a large industrial park and can be easily modified to provide enhanced water quality treatment as well as channel protection storage. The site is located in Haha Branch, where several erosional reaches were identified during the SCAM. Several additional opportunities for source control (volume reduction and groundwater recharge enhancement) also exist within the industrial park. These include exploring porous pavement for a limited number of parking areas, green rooftops (as roofs approach replacement age), rain gardens/bioretention, and shallow onsite infiltration galleries.
Stormwater retrofit: HH-4 Shallow Marsh Wetland with Forebay	***Description:*** The concept involves constructing a new shallow marsh wetland facility at a pipe outfall located in existing open space of a residential area. ***Justification:*** This large residential drainage area currently has no stormwater management and the uncontrolled runoff is causing major channel degradation downstream of the outfall. The retrofit concept provides both water quality and channel protection storage. The concept consumes some existing open space and would likely have some fringe forest impacts associated with it; however, the space is not currently utilized in an active manner and the forest is not mature. In conjunction with HH-1, this site will provide channel protection in Haha Branch to help reduce the sediment load being transported to Bush River.

Table 13. Recommended "Tier 1" Retrofit Projects	
Recommended Projects for Implementation	**Description and Justification**
Stormwater retrofit: OP-4 Shallow Marsh Wetland with Forebay	***Description:*** The concept involves converting an existing dry detention pond to a shallow marsh wetland facility. ***Justification***: This site is at the location of the Food Lion and Post Office off of Hanson Rd in the Otter Point Creek subwatershed. Severe channel erosion is present downstream of the practice that contributes significant sediment loads to the Bush River. The concept is to expand the current facility using the available unused turf area adjacent to the parking lot and convert it to a shallow marsh wetland to provide water quality and channel protection storage. Additional adjacent measures would increase the effectiveness of this retrofit such as incorporating bioretention islands into the Food Lion parking lot, installing porous pavers at the Post Office and providing downspout disconnections using rain barrels or rain gardens at the apartment complexes that parallel the receiving stream.
Stormwater retrofit: OP-6 Wet Extended Detention (ED) Pond	***Description:*** This retrofit consists of converting an existing dry detention pond to a wet extended detention pond along with adding a forebay at each major inflow point. ***Justification:*** This site is located adjacent to BJ's and is presumed to be the facility sized for the ultimate buildout scenario in this retail/commercial complex. The concept is to make modifications to the existing facility as the parcels are built out to provide enhanced water quality treatment and to provide channel protection storage downstream. This latter design modification would bring the facility up to current State of MD criteria for channel protection and would reduce the downstream erosion. In the absence of this modification, it is anticipated that the downstream conditions will significantly degrade in response to the full buildout of the area. Finally, as buildout of this area continues, it should be a priority of the County to encourage the implementation of better site design and low impact development techniques that reduce runoff volumes and promote shallow groundwater recharge such as porous pavement for overflow parking areas, green rooftops, bioretention and stormwater trees for parking lot landscaping, and filter strips and vegetated swales to break up and lengthen flow paths and enhance pollutant removal.

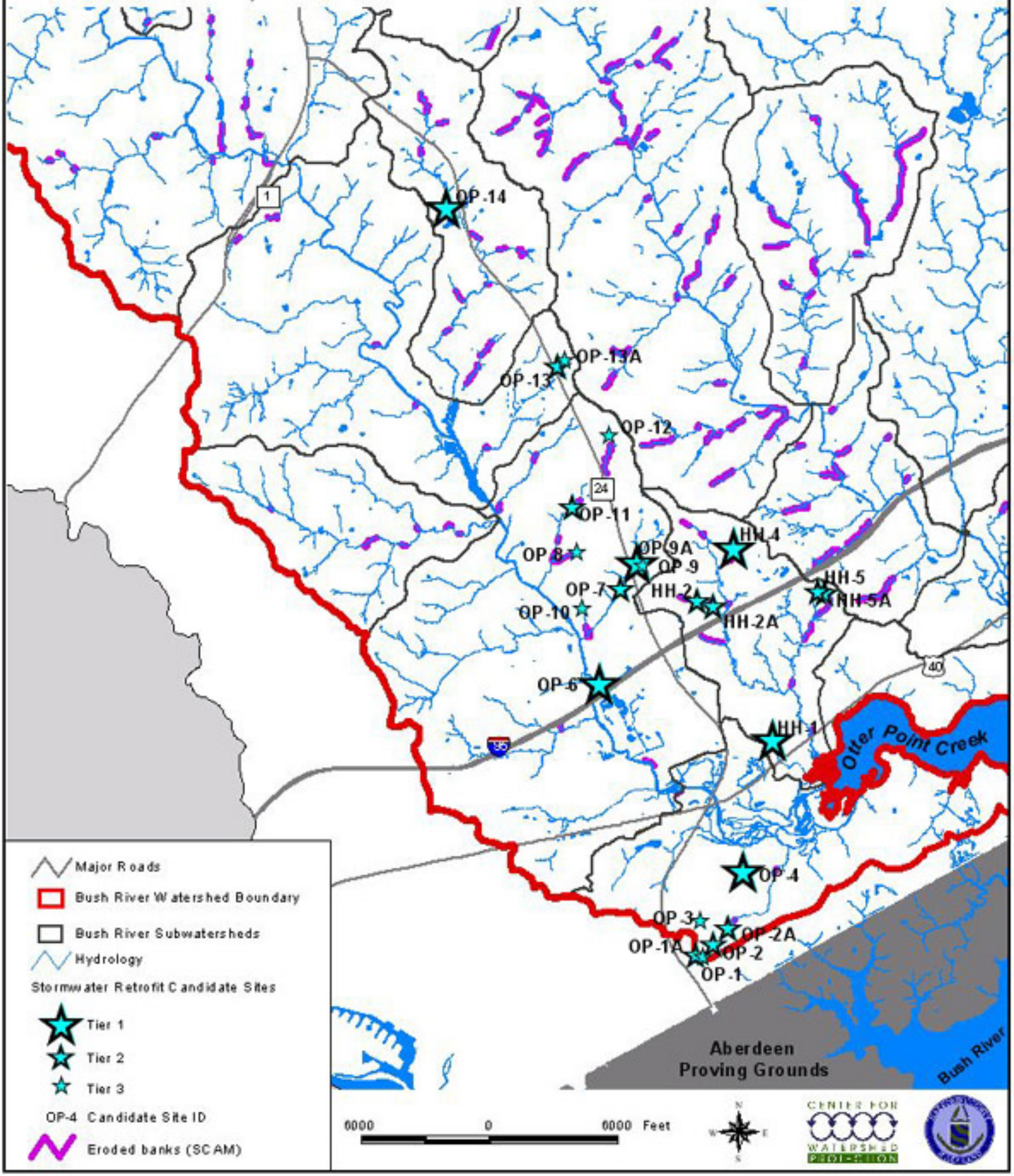
Table 13. Recommended "Tier 1" Retrofit Projects	
Recommended Projects for Implementation	**Description and Justification**
Stormwater retrofit: OP-9 Shallow Marsh Wetland with Forebay and Micropool	***Description:*** The concept involves converting an existing on line control structure to provide more attenuation and convert the expansive upstream area into a shallow marsh wetland facility. ***Justification:*** This site is an online structure that currently provides flood control only. It is likely a SHA facility that was constructed in association with Rte 24 improvements. The site is well below road grades in the area and provides an excellent opportunity to provide water quality and channel protection control on a major tributary to Lower Winters Run. The modification would involve some temporary impacts to existing habitat, but in the long-term would provide more diverse habitat for plant and animal communities. This site is also provides a good opportunity to work cooperatively and potentially cost share with SHA.
Stormwater retrofit: OP-14 Shallow Marsh Wetland with Forebay	***Description:*** The concept involves creating a new shallow marsh wetland facility that receives diverted in-stream water as well as runoff from residential subdivision. ***Justification:*** This Plumtree Run concept is one of the most promising opportunities for retrofitting that was found in the watershed (outside of the City of Bel Air limits). The concept involves creating a shallow marsh wetland behind an existing single family residential subdivision that currently has no controls. The facility would provide water quality and channel protection controls for the subdivision and would likely have additional storage capacity to enable a diversion from the adjacent stream during runoff events that would provide attenuation and limited water quality treatment. The facility would have significant habitat benefits as well. This facility, in conjunction with potential retrofit sites identified but not fully investigated in Bel Air, could provide significant channel protection storage that would help alleviate some of the downstream erosion currently occurring on Plumtree Run.

In addition to the structural retrofits targeted in Table 12, there are a handful of residential areas where nonstructural practices such as downspout disconnection (using filter strips, rain barrels, or rain gardens) could have a meaningful effect on volume reduction and water quality treatment. At least two areas were identified during the retrofit inventory, including:

- Lower Winters Run subdivision in the vicinity of Crissfield Drive and Goodwill Court
- Otter Point apartment facilities along Hanson Road near the Food Lion and Post Office

Potential partnerships with large retailers in the watersheds such as Walmart and BJ's should be explored to initiate and implement a community program where the retailers provide partial or full funding of rain barrels, supplies, etc. to interested residents.

Map 12 - Bush River Stormwater Retrofit Candidate Sites



SECTION 2.7 SUBWATERSHED PRIORITIZATION

This section outlines the methodology for determining the "most vulnerable" or "priority" subwatersheds in Bush River and presents the final prioritization. Prioritization is necessary where more than 15 or more subwatersheds exist in a watershed (Bush River watershed has 19) to group and prioritize subwatersheds so that the County can focus its resources on the subwatersheds that merit prompt restoration and/or preservation actions. Prioritization was determined utilizing all of the previously gathered data: Current IC, Future IC, Other Screening Factors, and field findings. Table 14. summarizes the strategy for subwatershed prioritization.

Table 14. Bush River Subwatershed Prioritization Strategy

Current IC Management Classification	Revised Management Classification	Prioritization Strategy
Sensitive	Sensitive	Those subwatersheds with valuable natural resources, good to excellent stream habitat, development pressures and stand up to field verification.
	Rurally Impacted	All subwatersheds identified as Rurally Impacted
Impacted	Impacted	Those subwatersheds with restoration potential
	Impacted Special Resource	All subwatersheds identified as Impacted Special Resource

Sensitive

There are seven sensitive subwatersheds in the Bush River watershed. To determine which of the Sensitive subwatersheds should be prioritized, CWP devised a point system to act as a first screening for subwatersheds that contain a lot of valuable natural resources, have excellent stream conditions, and may be subject to development pressures in the future.

This analysis, almost identical in nature to the one used for revising management classifications, was based on a quartile approach. More details on this analysis are provided in Section 2.4. Parameters that were assessed to prioritize Sensitive subwatersheds included:

- High percentage of forest suitable for interior dwelling species
- High percentage of wetlands of special concern
- High percentage of forested streamside
- High percentage of habitat of local significance
- Good fish diversity
- Good benthic macroinvertebrate diversity
- Good physical in-stream habitat
- High expected increase in IC (change from Current IC to Future IC)

Details specific to this analysis can be found in Appendix F.

As a result of this analysis, Grays Run (CC-2) (see Figure 11 and Map 14) was identified as priority Sensitive subwatersheds. Because both East Branch (OP-7) and James Run (BC-5) subwatersheds came very close to meeting the scoring requirements, CWP did conduct in-stream habitat assessments and found that both subwatersheds have good in-stream habitat (see Section 2.5). However, field verification also revealed some agriculturally influenced impacts such as cattle access and poor buffer. The field verifications and stream assessments solidify East

Branch and James Run subwatersheds' classification as Sensitive subwatersheds but do not warrant their prioritization.

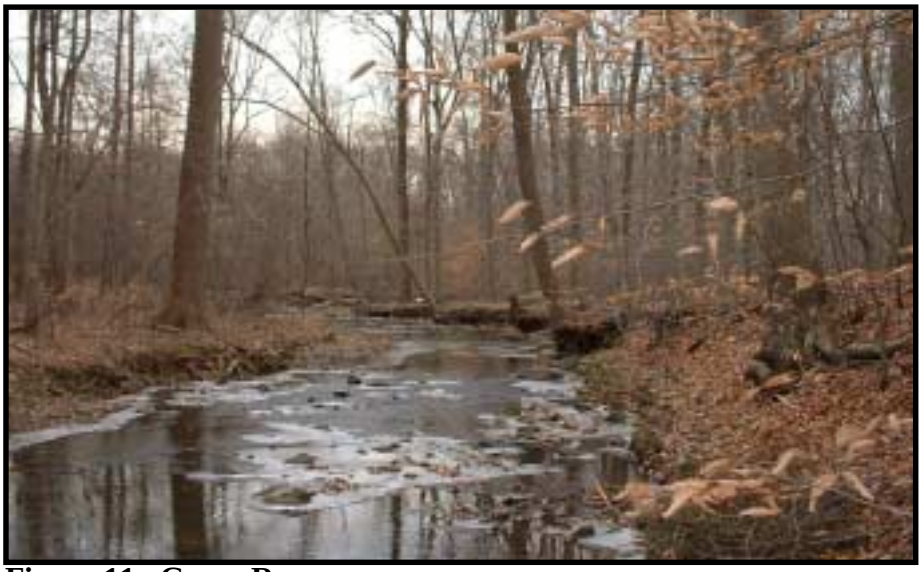


Figure 11. Grays Run

Rurally Impacted

Rurally Impacted subwatersheds were previously identified using a rurally impacted point system in Section 2.4. As a result of this point system, two subwatersheds were identified as Rurally Impacted – Little East Bynum (BC-6) and West Branch (OP-6) (see Maps 15 and 16, respectively). Little East Bynum fell out as Rurally Impacted most notably for its combination of livestock access and large amounts of cropland. West Branch's rurally impacted indicators included high levels of nitrate and large amounts of cropland. As noted in Table 14, all subwatersheds identified as Rural Impacted receive automatic prioritization.

Impacted

Over half of the subwatersheds in Bush River are have an impervious cover over 10%, classifying them as Impacted. A point system was devised to determine which of the Impacted subwatersheds should receive prioritization. Under this point system, Impacted subwatersheds were evaluated on their potential for restoration.

This analysis, is also almost identical in nature to the one used for revising management classifications, was based on a quartile approach. More details on this analysis are provided in Section 2.7. Parameters that were assessed to prioritize Impacted subwatersheds included:

- High number of stormwater facilities (potential for improvement of old facilities)
- High percentage of industrial land (pollution prevention opportunities)
- High percentage of detached residential lots (backyard retrofit opportunities)
- High number of fish blockages (removal for fish passage)
- High number of eroded banks (potential for streambank stabilization)
- High number of trash dumping sites (stream clean-up; community involvement)
- High percentage of public land (no private ownership issues)
- High percentage of parks, forest, and wetlands (pervious area management)
- High percentage of unforested streamside (tree plantings; community involvement)

- High percentage within the development envelope (subject to development pressures)
- One indicator of good stream health (i.e., good fish diversity, bug diversity, or habitat)

Additional details on this analysis can be found in Appendix F.

As a result of this analysis, Middle Bynum (BC-3), Lower Bynum (BC-2) and Plumtree Run (OP-9) subwatersheds (see Maps 22, 23, and 24, respectively) were identified as priority Impacted subwatersheds.

Impacted Special Resource

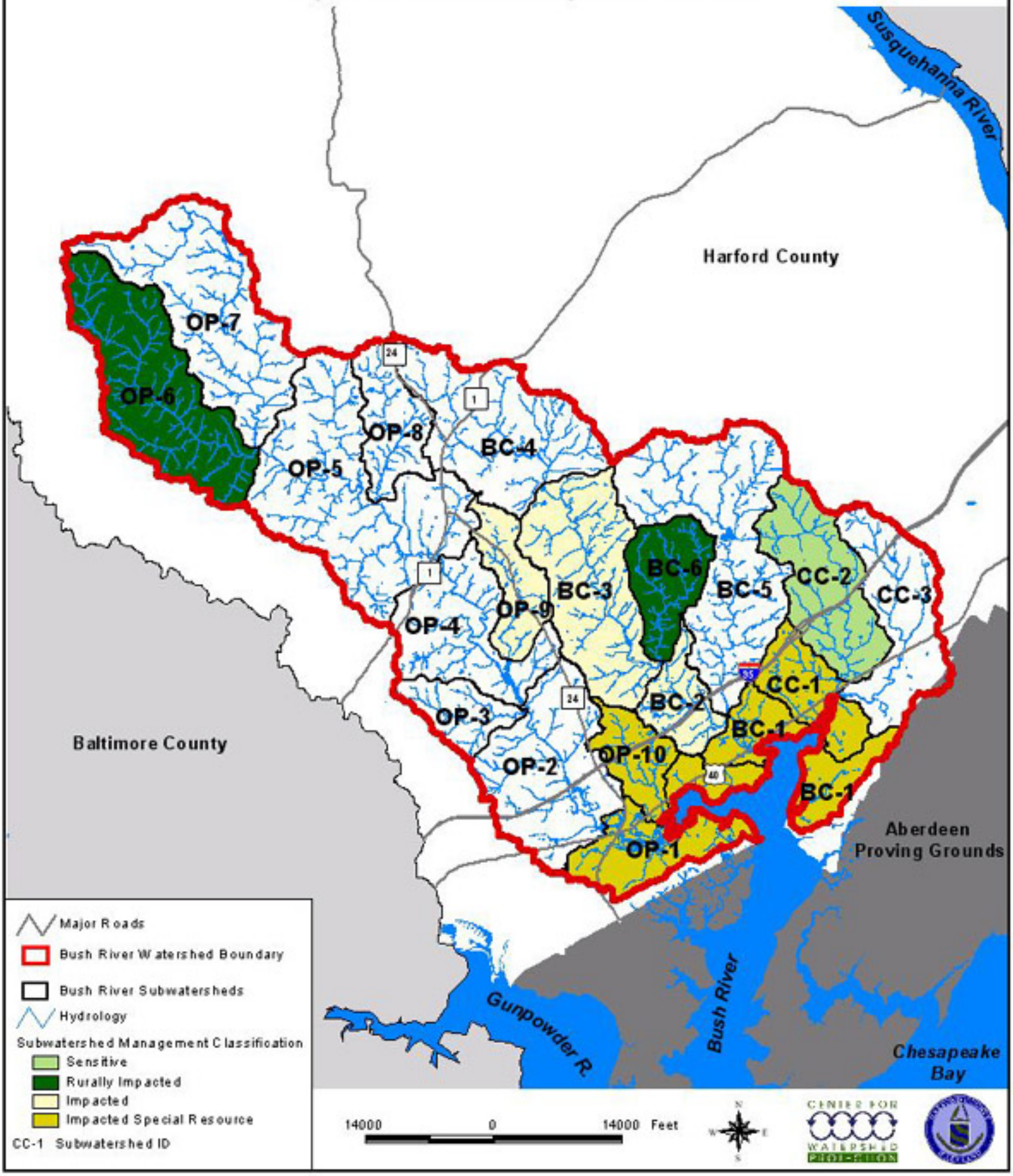
Impacted Special Resource subwatersheds were previously identified using an impacted special resource point system in Section 2.4. As a result of this point system and field verification, Otter Point DD (OP-1), Bush Creek DD (BC-1), Church Creek DD (CC-1), and Haha Branch (OP-10) were identified as Impacted Special Resource (see Maps 17,18, 19, and 20, respectively). All of these subwatersheds exhibit tidal influences and large expanses of wetlands.

A summary of the Bush River priority subwatersheds is provided in Table 13. Map 13 illustrates this prioritization.

Table 15. Bush River Priority Subwatersheds

Category	Subwatershed Name	Subwatershed ID
Sensitive	Grays Run	CC-2
Rurally Impacted	West Branch	OP-6
	Little East Bynum	BC-6
Impacted	Middle Bynum	BC-3
	Lower Bynum	BC-2
	Plumtree	OP-9
Impacted Special Resource	Otter Point DD	OP-1
	Bush Creek DD	BC-1
	Church Creek DD	CC-1
	Haha Branch	OP-10

Map 13 - Bush River Priority Subwatersheds



SECTION 2.8 STAKEHOLDER INVOLVEMENT

Watershed residents and other stakeholders including representatives from local businesses, developers and agencies play a vital role in the creation of a watershed management plan. Stakeholder involvement is a key ingredient in a watershed plan as stakeholders must live with the decisions that are made. They also bring issues to the table that are important to them and participation gives them a stake in the outcome and helps to ensure plan implementation.

The stakeholder involvement process in the Bush River Vulnerability Analysis consists of two public meetings. The first public meeting occurred in February 2003 and covered the eight tools of watershed protection and the initial findings of the vulnerability analysis and was attended by more than 20 stakeholders. Stakeholders were asked a series of questions to identify their concerns and opinions on the issues facing the watershed. Stakeholders also expressed opinions on the tools that are most important to implement and views on public expenditure on restoration and land conservation. The stakeholder views are summarized in Table 16.

The three questions that were asked of the breakout group participants and a summary of subsequent answers are as follows:

What do you value most about the Bush River Watershed and the place that you live?
Stakeholders valued the quality of life they experience in Harford County and the Bush River watershed including the natural beauty from both a rural picturesque sense and the natural surroundings including the forests, wetlands, meadows as well as the scenery and quality of the tidal Bush River. Benefits of clean air and relative proximity to shops, services and natural areas were also significantly valued.

In your opinion, what are the top issues facing the Bush River watershed?
The top issues that stakeholders reported included managing growth and the type of development (making sure impervious cover and impacts to water quality are minimized), streambank erosion (especially from urbanized areas), the need for more rigorous erosion and sediment control applications and enforcement, and runoff from agricultural and urban areas causing sedimentation and eutrophication in the estuary. Two other related issues were the lack of forested buffers on streams and rivers and the loss of forestland which has accompanied growth in Harford County. The other top issue that several of the groups reported was the lack of stewardship of watershed residents and the need for even greater watershed awareness and education for residents and school children.

Which of the eight tools do you feel restoration and protection efforts should be focused on?

Six of the eight tools of watershed protection were discussed specifically by the stakeholders as being important to focus management efforts including Better Site Design (reducing the impact of development when development does occur), Land Conservation (the use of land conservation tools to protect sensitive and resource lands), Buffers (the use of stream buffers to protect streams and rivers), Stormwater Management (the use and retrofit of stormwater practices to improve water quality and channel protection), Stewardship/education (watershed education and stewardship efforts) and Erosion and Sediment Control (reducing sediment loss from new construction). The eight tools of watershed protection are tools discussed in the Center for Watershed Protection's Rapid Watershed Planning Handbook (CWP, 1998).

A summary of the results of the questionnaire on stakeholder interest in citizen participation as well as their views on public expenditure for restoration and land conservation is provided in Table 16. Additional comments we received on the questions are included in Appendix G. Although only a small cross-section of County residents were present, the results reflect a strong interest in citizen participation in watershed protection activities, and strong support for land conservation and restoration activities as well as the expenditure of public resources to accomplish those goals. There is also fairly strong support for denser development in some areas in order to protect others.

Table 16. Summary of Stakeholder Questionnaire Results

***1**. What activities would you as a citizen, be interested in participating?*[1]		
11 Tree planting **11** Stream clean-ups **9** Reducing fertilizer use **7** Reducing pesticide use **6** Picking up after your pet		**6** Being a member of a local watershed group **5** Adopt-a-pond or stream programs **3** Hazardous waste drop offs **3** Putting land in a conservation easement
***2.** Do you support land conservation, transfer of development rights, and open space acquisition initiatives in high quality subwatersheds?*		
Yes	**No**	**No Answer/Other**[2]
7	0	9
a. The use of public funds for these policies?		
Yes	**No**	**No Answer/Other**
10	1	5
b. Denser development in other areas as a result of these programs?		
Yes	**No**	**No Answer/Other**
10	2	4
2. Do you support expenditures of public money on watershed restoration and protection?		
Yes	**No**	**No Answer/Other**
15	**0**	**1**

1: Numbers indicate responses in favor of activity
2: There were a high number of "no answers" for this question because people were not sure if they were supposed to answer this question or just skip to 2a.

SECTION 3.0 RECOMMENDATIONS

This section describes the management recommendations, for meeting the Bush River watershed goals. This section is organized by the four different subwatershed management types: Sensitive, Rurally Impacted, Impacted, and Impacted Special Resource (see Map 8). Under each management category, broad recommendations, guidance on focusing resources and/or implementation of specific projects or initiatives, and recommendations for future assessments and program development are explained. All the recommendations are based on the assumption of a 10-year planning window. This window should be continually revisited and revised as progress is made. A summary of the recommendations and responsible parties are presented in Table 18.

SECTION 3.1 SENSITIVE

Sensitive subwatersheds have an impervious cover of 0 to 10 percent. Consequently, streams in these subwatersheds are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects (CWP, 1998). The main goal for these types of subwatersheds is to maintain predevelopment stream biodiversity and channel stability.

Broad Recommendations

Preserve 75% of contiguous forest

Cumulatively, more than 1800 acres of contiguous forest in the Sensitive subwatersheds have been identified (see Map 10). The Department of Planning and Zoning (DPZ) should work with Harford Land Trust to preserve land through land acquisition, purchase of development rights and easements and continued landowner stewardship in contiguous forest areas. In areas where land acquisition, conservation easements or other land conservation techniques may not be feasible, encourage the use of conventional development with open space (COS) in the urban residential districts and conservation development standards (CDS) in the agricultural and rural districts to preserve valuable forest and stream resources.

Enhance Existing Riparian Buffers by 40%

Enhancing the current riparian buffers will improve riparian habitat, protect stream banks, and remove nonpoint source pollutants. Over 80 stream miles in sensitive subwatersheds exhibit impacted riparian buffers. Inadequately buffered areas that are not covered by existing programs should be targeted by the county with a supplemental program that would help to establish buffers on residential lands. Forest Conservation Act fee-in-lieu funds could be targeted solely for stream buffer areas, rather than upland areas, in order to increase water quality benefits on areas that do not qualify for the Conservation Reserve Enhancement Program[1] (CREP). Additional funds based on the level of interest from the small farm community (below CREP thresholds) and the non-agricultural community could be allocated to increase implementation of buffers in the Bush River watershed. Lower residential densities usually indicate single large landowners, making this recommendation fairly easy to implement in these areas.

[1] CREP is intended to help farmers restore riparian buffers through rental and cost share payments.

Focusing Resources/Specific Projects

Focus Resources on Priority Sensitive Subwatershed: Grays Run

Grays Run (subwatershed CC-2) was ranked as having some of the most environmentally sensitive and valuable features within the Bush River Watershed (See Appendix F and Map 14). In addition to existing sources of data, CWP's field work rated Grays Run physical in-stream habitat as "excellent" to "good." With the exception of some areas of selective logging, Grays Run also has large expanses of contiguous forest. Grays Run is currently 4% impervious and is likely to become Impacted in the future (projected future IC of 12.5%). Focusing stream enhancement and contiguous forest preservation resources in Grays Run should be a priority for the County. The DPZ should also utilize programs such as the purchase of development rights (PDRs) and transfer of development rights (TDRs) to keep Grays Run under 10% impervious cover.

Areas for Future Assessment and Program Development

Field Verify and Prioritize Contiguous Forest Areas for Preservation

With the exception of the contiguous forest areas in Grays Run, CWP did not have the opportunity to field verify the value and contiguousness of the other contiguous forest tracts highlighted in Map 10. The forest tracts highlighted in Map 10 were selected based on GIS mapping, size (greater than 100 acres) and roundness. DPZ should field verify the contiguousness of the forests and assign each a value utilizing the form and methodology found in Appendix C. This value should be used to prioritize the areas for preservation. Depending on field verification, consider assigning the tract in East Branch a higher priority due to its Sensitive classification; the contiguous forest tract will also provide protection for good quality streams.

SECTION 3.2 RURALLY IMPACTED

Rurally Impacted subwatersheds have an impervious cover of 0 to 10 percent but may be degraded due to livestock access, and grazing and cropping practices that may have severely altered the riparian zone and created isolated stream bank erosion. Once the riparian management improves, however, these streams are often expected to recover (CWP, 1998).

Broad Recommendations

Preserve 50% of farmland

In Little East Bynum (BC-6) and West Branch (OP-6) alone, there are more than 4000 acres of cropland and pasture (See Map 15 and 16). The DPZ should use existing agricultural preservation programs such as TDRs and the Agricultural Land Preservation program to target large land owners and encourage them to preserve and maintain the rural nature of Little East Bynum and West Branch subwatersheds. Where development may be inevitable in Rurally Impacted subwatersheds, encourage and work with developers to utilize cluster development options (CDR and COS) to preserve agricultural tracts of land. DPZ should work with the Maryland Department of Natural Resources (DNR) to establish these areas as Rural Legacy and obtain funding.

Restore Impacted Riparian Buffer by 40%

In Little East Bynum and West Branch, there are more than 30 miles of impacted riparian buffer. Existing federal and state programs such as the CREP make planting buffers in agricultural land relatively inexpensive for the County and could be taken advantage of by hiring or seeking funding to hire a person to work directly with the MD Department of Natural Resources Forestry

Division and work directly with property owners adjacent to streams in the watershed. DNR forestry already maintains a database of all the landowners with unbuffered stream segments in the Bush River watershed, so startup time would be minimal.

Focusing Resources/Specific Projects

Reduce Livestock Access in Little East Bynum

The Maryland DNR Stream Corridor Assessment Method (SCAM) revealed long stretches of stream bank erosion combined with livestock access in Little East Bynum (see Map 15). The Harford Soil Conservation District (SCD) should work with these land owners to reduce unmanaged cattle access to streams by installing exclusionary fencing, off-stream water supplies, and stabilized cattle crossing to minimize stream bank erosion and nonpoint sources pollution to streams.

Areas for Future Assessment and/or Program Development

Conduct an Operations Assessment of Farming Practices

In order to effectively reduce the nutrient contribution from Rurally Impacted subwatersheds, Harford SCD should first conduct an assessment of types of practices commonly used in farming practices. This assessment would look at practices such as nutrient management, livestock fencing, and manure storage and handling. Of particular concern is nitrate, a pollutant commonly found in groundwater and associated with agriculture. According to water quality monitoring conducted by DNR, the majority of the West Branch subwatershed has elevated concentrations of nitrate. An assessment may also help to identify the cause of the elevated pollutant concentrations in West Branch (See Map 16). The results of the assessment should be then utilized to target specific landowners and education programs to improve the current state of farming practices within the rurally impacted subwatersheds.

Septic System Education

The Harford County Health Department is currently identifying the locations of septic systems in Harford County. Once this inventory is complete, the Health Department should identify areas that have both high septic system densities and high nitrate concentrations (as identified via DNR's water quality monitoring). This may indicate a high rate of failing septic systems. The Health Department should consider implementing an inspection program for these areas or targeting them with a septic system maintenance campaign. The Septic Education Kit available from the Padilla Bay National Estuarine Research Reserve, Washington State Department of Ecology and Department of Commerce is provides excellent guidance for this types of initiative: www.ocrm.nos.noaa.gov/nerr/septickit/welcome.html.

SECTION 3.3 IMPACTED

Impacted subwatersheds have an impervious cover ranging from 11 to 25% and show clear signs of degradation due to watershed urbanization. Greater storm flows have begun to alter the stream geometry. Both erosion and channel widening are clearly evident. Stream banks become unstable, and physical habitat in the stream declines noticeably. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream (CWP, 1998).

Broad Recommendations

Educate 40% of the Residents on the Importance of Watershed Stewardship

The DPW should continue and expand upon existing Bush River educational programs by targeting residents in the Urban Residential Districts. Educational programs should include rooftop disconnection, preventing buffer encroachment, and lawn care. A nutrient behavior survey of the target audience should be conducted before and after the education effort to monitor success (See Appendix H for a sample nutrient behavior survey). Specific suggestions include:

- The future integrity of the riparian buffer system requires a strong education program. The goal of such a program is to make the buffer "visible" to the community. To prevent homeowner encroachment, the DPW should educate buffer owners/adjacent land owners about the benefits and uses of the buffer with pamphlets and meetings with homeowners associations.
- The DPW should build and expand on the existing rain barrel program by targeting residents living in Urban Residential Districts. Educational brochures should be created and sent to these residents. Developers should be encouraged to utilize the rooftop disconnection credit presented in the Maryland Stormwater Manual (2000).
- Lawn care education is another critical element of a watershed plan in an urban and suburban watershed because of the high proportion of lawns and the tendency of suburban landowners to overfertilize their lawns. A rough estimate of lawn acres (80% of pervious residential land use) in the Bush River watershed based on land use is over 13,000 acres or over 20 square miles (Caraco, 2001). As a result lawns represent a significant portion of the nitrogen load in the watershed and therefore the reduction in fertilizer use in the watershed via lawn care education would be a large single source of nitrogen reduction. A lawn care education program that focuses on reducing the use of fertilizers and pesticides as well as picking up after pets would be well justified and provide a considerable water quality benefit to the Bush River watershed. Mediums that should be used in the campaign include radio (via public service announcements), the newspaper, cable TV and schools. The county is already working on a video to be shown on cable TV and in the schools. See the Maryland Tributary Strategies' Non-Point Source Pollution Education Campaign for ideas: http://www.dnr.state.md.us/bay/tribstrat/nps_pollution.html.

Implement Three Stormwater Retrofits

The majority of the Bush River watershed includes stormwater practices designed under previous County stormwater criteria that did not require water quality or channel protection treatment. DPW should construct up to three stormwater retrofits within Impacted subwatersheds as a start to improve existing management of runoff from urban areas. Three of CWP's top six candidate retrofit sites are located in Impacted subwatersheds (See Map 12 and Table 12). In 1999, KCI conducted a study that also identified good retrofit opportunities in Bynum Run. For a more in-depth discussion on the CWP's retrofit inventory, see Section 2.6. To obtain buy-in from adjacent landowners, consider holding educational meetings before the retrofit design.

Focusing Resources/Specific Projects

Conduct Stream Clean-ups in Middle and Lower Bynum

According to the SCAM data, there are a high number of trash dumping sites per stream mile in Middle Bynum (BC-3) and Lower Bynum (BC-2) (See Map 22 and 23). DPW should coordinate stream clean-up activities to target these sites. Once the Bush River Watershed Association has

been established (see Watershed-wide recommendations), they should take over this function. Trash dumping is an on-going issue and stream clean-ups should go beyond the site identified by the SCAM. The County should track reported dumpings and address them as needed.

Preserve the Contiguous Forest Areas in Lower Winters Direct Drainage and Cranberry Run
After DPZ has had the opportunity to field verify the remaining contiguous forest tracts in the Sensitive subwatersheds, DPZ should field verify the contiguous forest areas identified in Lower Winters (OP-2) and Cranberry Run (CC-3) (see Map 10). These contiguous forest areas are estimated to be more than 460 and 200 acres, respectively. If the DPZ's field verification is promising, the County should work to preserve these areas.

Areas for Future Assessment and/or Program Development

Continue to Investigate and Implement Stormwater Retrofit Opportunities
The retrofit inventory conducted by CWP surveyed a small area relative to the overall drainage area of the Bush River watershed. DPW should explore other opportunities for stormwater retrofitting including:

- the Bel Air portion of the Plumtree subwatershed (OP-9) (See Map 24). Field reconnaissance and survey of aerial photographs indicated that there are several more opportunities for stormwater retrofits in this area including Bel Air High School and the Upper Chesapeake Health Center. There may be some merit in pursuing a cooperative approach to retrofitting with the Town of Bel Air.
- implementation of the feasible and visible CWP Tier 2 and Tier 3 retrofit candidate sites (See Table 12).
- partnerships with SHA and the Town of Aberdeen to look for cost share projects.

SECTION 3.4 IMPACTED SPECIAL RESOURCE

Impacted Special Resource subwatersheds have an impervious cover ranging from 11 to 25% but also have notable natural resource areas (i.e., tidal waters, contiguous forest, high quality wetlands, etc.). The objective in these subwatersheds is to maintain present status of special resource area through conservation, restoration, and stormwater retrofit opportunities. The three impacted special resource subwatersheds in Bush River are Otter Point Creek Direct Drainage (OP-1), Bush Creek Direct Drainage (BC-1), Church Creek Direct Drainage (CC-1), and Haha Branch (OP-10). Maps 17, 18, 19, and 20, respectively depict some of the valuable resources and monitoring results of these three subwatersheds.

Broad Recommendations

Preserve 75% of large wetland tracts
The Impacted Special Resource subwatersheds are unique in that they contain large expanses of tidally-influenced wetlands. Field verification revealed that these wetlands have significant habitat and water quality value. Unfortunately all of the wetlands are within the development envelope and may be subject to future development impacts. The DPZ and Harford Land Trust should work together to protect these valuable natural resources and maintain their current status. Several avenues can be pursued to ensure their protection. To preserve the wetlands, conservation easements and land acquisition can be pursued. The County should also work to ensure that development does not occur within 75 feet of these wetlands.

Implement Three Stormwater Retrofits

The majority of the Bush River watershed includes stormwater practices designed under previous County stormwater criteria that did not require water quality or channel protection treatment. DPW should construct up to three stormwater retrofits within Impacted Special Resource subwatersheds to improve existing management of runoff from urban areas. Three of CWP's top six candidate retrofit sites are located in Impacted Special Resource subwatersheds (See Map 12 and Table 12). To obtain buy-in from adjacent landowners, consider holding educational meetings before the retrofit design. For a more in-depth discussion on the CWP's retrofit inventory, see Section 2.6.

Focusing Resources/Specific Projects

Conduct Streambank Stabilization in Haha Branch and Otter Point Creek DD

During in-office analyses, Haha Branch did not appear to be a subwatershed to warrant special attention. However, based on the CWP field verification, Haha Branch has a high environmental significance to due to its contiguous forest stand (based on GIS mapping) and because it serves as a transitional area to between upland forest and tidal wetland areas.

Given its importance, CWP has identified several areas that would warrant streambank stabilization in combination with upstream stormwater retrofit sites (see Map 21). The primary goal of the retrofits would be to reduce flashy flows associated with uncontrolled stormwater runoff. The streams in the two subwatersheds are characterized by highly erosive bed and bank materials, consisting largely of sand and gravel. These materials have eroded easily when impacted by changed hydrology due to urbanization. During fieldwork in the watershed, the streams in Haha and Otter Point exhibited the most instability and sediment transport of the subwatersheds evaluated. To obtain buy-in from adjacent landowners, consider holding educational meetings before the stabilization design. Table 17 lists the stabilization priorities in order of severity as well as the length of stream reach and associated retrofits.

Table 17. Stream Stabilization Priorities in Haha Branch and Otter Point Creek DD

ID	Description	Approx. Stream Length[1]	Associated Tier 1 or 2 Stormwater Retrofit
SS-1	This site is located on an unidentified stream drainage[2] downstream of the Edgewood Food Lion and Post Office. The reach runs parallel to Hanson Rd. The SS1 reach is characterized by steep eroding banks and evidence of considerable sediment transport and highly mobile (sand and gravel) substrate materials.	1200 ft including side channels	OP-4
SS-2	Site SS2 is located in the Otter Point Creek subwatershed parallel to Cedar Drive South near Edgewood Elementary school. The reach is characterized by headcut migration, steep eroding banks and highly mobile substrate materials.	1200 ft	OP-1 OP-2 OP-2a
SS-3	Site SS3 is located in Haha Branch downstream of a portion of Philadelphia Station, a 10-15 year old neighborhood in Abingdon. The particular stream reach receives untreated runoff from Abingdon Rd and runoff from a dry pond that is a priority retrofit location in Philadelphia Station. The reach is characterized by headcut migration, steep eroding banks and highly mobile substrate materials.	1000 ft	HH-5 HH-5A
SS-4	Site SS4 is located in a residential development called Box Hill South downstream of Windy Laurel Way and parallel to Deer Creek Drive. The reach exhibited evidence of steep eroding banks and considerable sediment transport due to uncontrolled stormwater runoff. Stream bed and stream bank substrates are highly erodible and mobile.	500 ft	HH-4
SS-5	Site SS5 is located adjacent to an apartment community called Woodsdale off 924. The stream reach is characterized by eroding banks, sediment transport and	1600 ft	HH-2A

Table 17. Stream Stabilization Priorities in Haha Branch and Otter Point Creek DD			
ID	**Description**	**Approx. Stream Length[1]**	**Associated Tier 1 or 2 Stormwater Retrofit**
	instability. Outfalls from the development have destabilized and eroded the associated channels.		
SS-6	Site SS6 is located in an area where new development is currently occurring near Lou-Mar Drive and Sedberry Lane off of Abingdon Rd. The stream shows signs of instability, erosion and sediment transport that is likely to become more severe as increased stormwater from new development enters this stream reach.	330 ft	None - New development will likely contain stormwater practices
1: Determined from field verification and GIS mapping 2: Stream does not show on GIS hydrology layer			

Preserve the Contiguous Forest Area in Haha Branch
After DPZ has had the opportunity to field verify the remaining contiguous forest tracts in the Sensitive subwatersheds, DPZ should field verify the contiguous forest area identified in Haha Branch (see Map 10). This contiguous forest area is estimated to be more than 430 acres. If the DPZ's field verification is promising, the County should work to preserve this area.

Areas for Future Assessment and/or Program Development
Develop a Heightened Plan Review in Impacted Special Resource Subwatersheds
CWP's field verification combined with the SCAM data has indicated a high number of severely eroded streambanks in these subwatersheds. DPZ should consider implementing a heightened plan review of these subwatersheds due to a potentially high rate of substrate erodibility. Place an emphasis on environmentally sensitive development either through better site design or low impact development techniques because they strive to replicate pre-disturbance hydrology.

SECTION 3.5 WATERSHED-WIDE

Establish a Bush River WAMP Implementation Committee
To ensure the implementation of the Bush River WAMP, DPW should establish an Implementation Committee. The purpose of the committee would be to coordinate implementation efforts between agencies and organizations, secure funding for implementation efforts, and track the success of the implementation (See Section 5.0). The Implementation should include representatives from DPZ, DPW, County Health Department, Forest Service, Harford SCD, Harford Land Trust, DNR and other key watershed stakeholders. DPW should take the lead to organizing the committee as the first order of business in implementing the plan.

Foster the development of a watershed group for the Bush River
The DPW, with strong landowners/stakeholders support should foster the development of a Bush River watershed organization. Stakeholders have expressed interest in the participating in a watershed group, organized stream clean-ups and tree plantings (see Section 2.8 on Stakeholder Involvement). This organization can facilitate community-based stewardship of the Bush River watershed. Eventually, this group could organize tree plantings, stream cleanups, environmental education programs, and recreational activities.

Create a website to encourage watershed stewardship
DPW should provide a central location for citizens to access information about their watersheds and streams. The website should provide information on watershed basics (i.e., what is a

watershed), locator watershed maps (i.e., what watershed do you live in?), promote practices that citizens can do on an everyday basis to become better watershed stewards, and provide information on how to volunteer or become involved. For an example of such a website, visit James City County's PRIDE website: www.protectedwithpride.org See Appendix I for CWP's "Top Ten Things You Can Do to Protect Your Watershed."

Implement Recommendations of the Harford County Site Planning Roundtable

As of March, 2003, the Harford County Site Planning Roundtable is still underway. Once recommendations are complete, in May, 2003, the DPW and DPZ should work to incorporate these recommendations into their codes. The final product of the Roundtable will include specific recommendations for code and ordinance revisions that would allow flexibility in site design by encouraging minimization of impervious cover, protecting natural areas, integrating stormwater management, and maintaining product marketability. Some highlights of the draft recommendations include:

- Removal of Natural Resource District from private lots with some flexibility in lot geometry
- Creation of a Traditional Neighborhood District option
- Require a conceptual design meeting with plan reviewers/DPW/and designers early in process
- Require landscaped islands for large cul-de-sacs
- Establish maximum parking ratio with provisions for pervious materials
- Reduce parking requirements for areas of mass transit and shared or joint parking
- Increase landscape requirements for parking lots
- Encourage development of a landscaping ordinance
- Adopt a native plants list for the County

Establish an Adopt-A-Pond Program

All stormwater ponds should have a maintenance plan in place. By engaging Homeowner Associations and other volunteers in the beautification and maintenance of their stormwater ponds, they are also helping to keep the embankments stable and improve or maintain the current pollutant removal capability. Other amenities that a properly designed and maintained pond may have are increased wildlife habitat, recreation areas, and aesthetic vistas. The County should develop an Adopt-a-Pond program that would work with Homeowner Associations and other interested individuals and volunteers to conduct basic maintenance for their stormwater ponds. This would include basic inspections (i.e., are trees on the embankment or is there significant damage to the riser), trash pick up, mowing, and aquatic vegetation plantings. Hillsborough County, FL is a great example of a successful Adopt-a-Pond program. Materials and information on their program can be obtained by visiting the website: http://www.hillsboroughcounty.org/publicworks/engineering/stormwtr.html

Improve ESC Implementation, Inspection and Enforcement

Keeping soil on the land with erosion and sediment control (ESC) is an extremely important best management practice in the Bush River watershed because of the current and expected growth within the watershed. Currently over 550 construction permits are active in Harford County for an estimated 2250 acres of development based on fiscal year 2001 and 2002 data (MDE, 2003). As the Bush River watershed makes up a significant portion of the development envelope in Harford County, development is expected to continue at a rapid rate. An effective sediment and erosion control program is a vital part of protection and sediment reduction in the Bush River watershed. Data received from the Maryland Department of the Environment (MDE) indicates

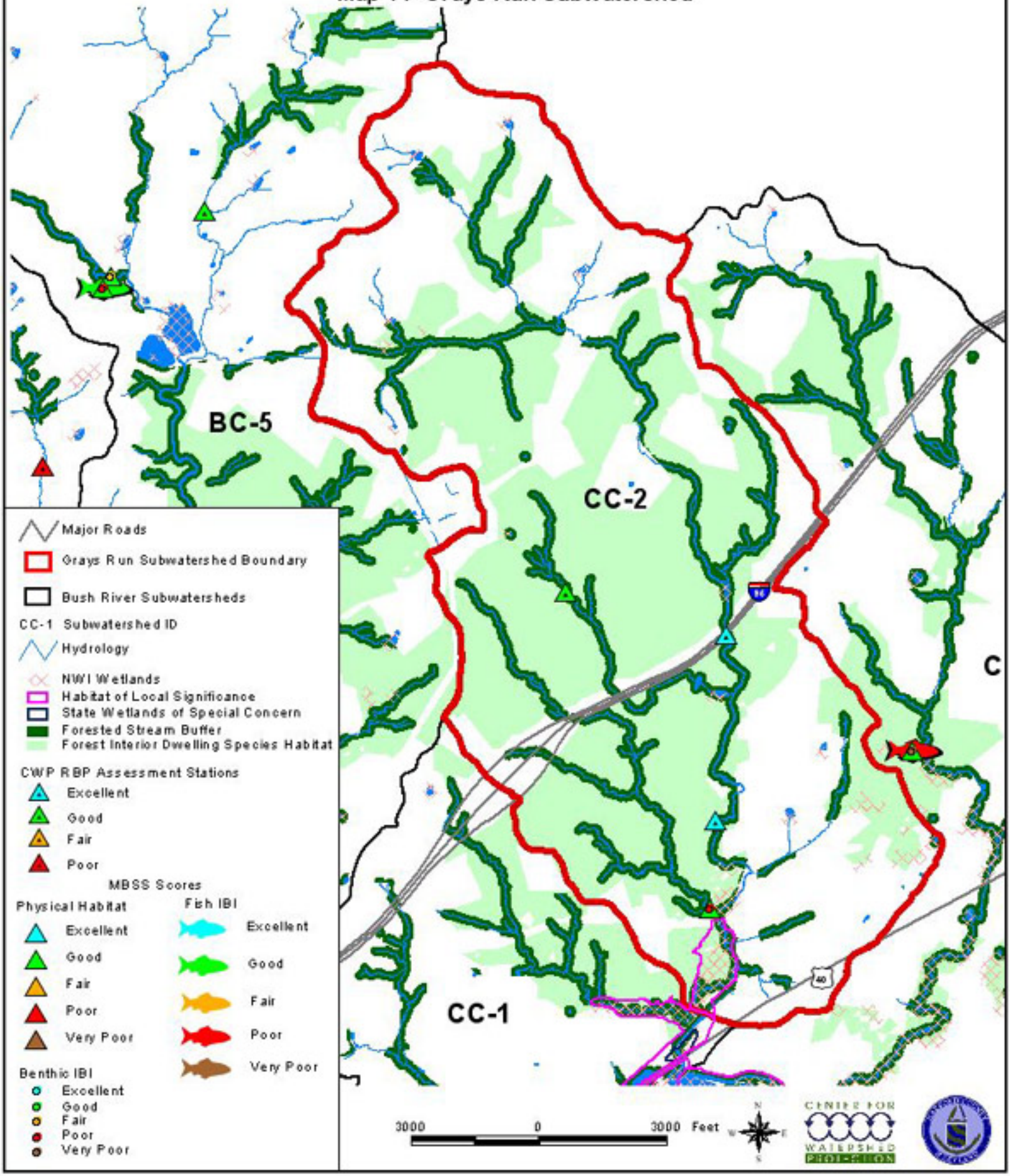
that implementation and maintenance of erosion and sediment controls could be improved in the Bush River watershed. In the 2002 ESC Program review completed by MDE, 18 of 33 sites had inadequate implementation on at least one occasion and 9 of 33 sites were said to have unsuccessful enforcement overall. Also of concern is the fact that for 565 sites inspected by the county, 2943 violations were written (an average over 5 per site) suggesting that sites are routinely out of compliance and yet no fines were levied and stop work orders were only issued 56 times. The review did conclude that Harford County demonstrated an ability to enforce ESC requirements and that for the most part during the review when sites were re-inspected that compliance improved. Further improvement in implementation and enforcement has the potential to reduce sediment transport considerably in the watershed. A benchmark should be set that fewer than 10% of sites should be out of compliance during MDE's program review and that proper installation and maintenance of ESC practices becomes routine in Harford County.

Table 18. Summary of Bush River Watershed Management Recommendations

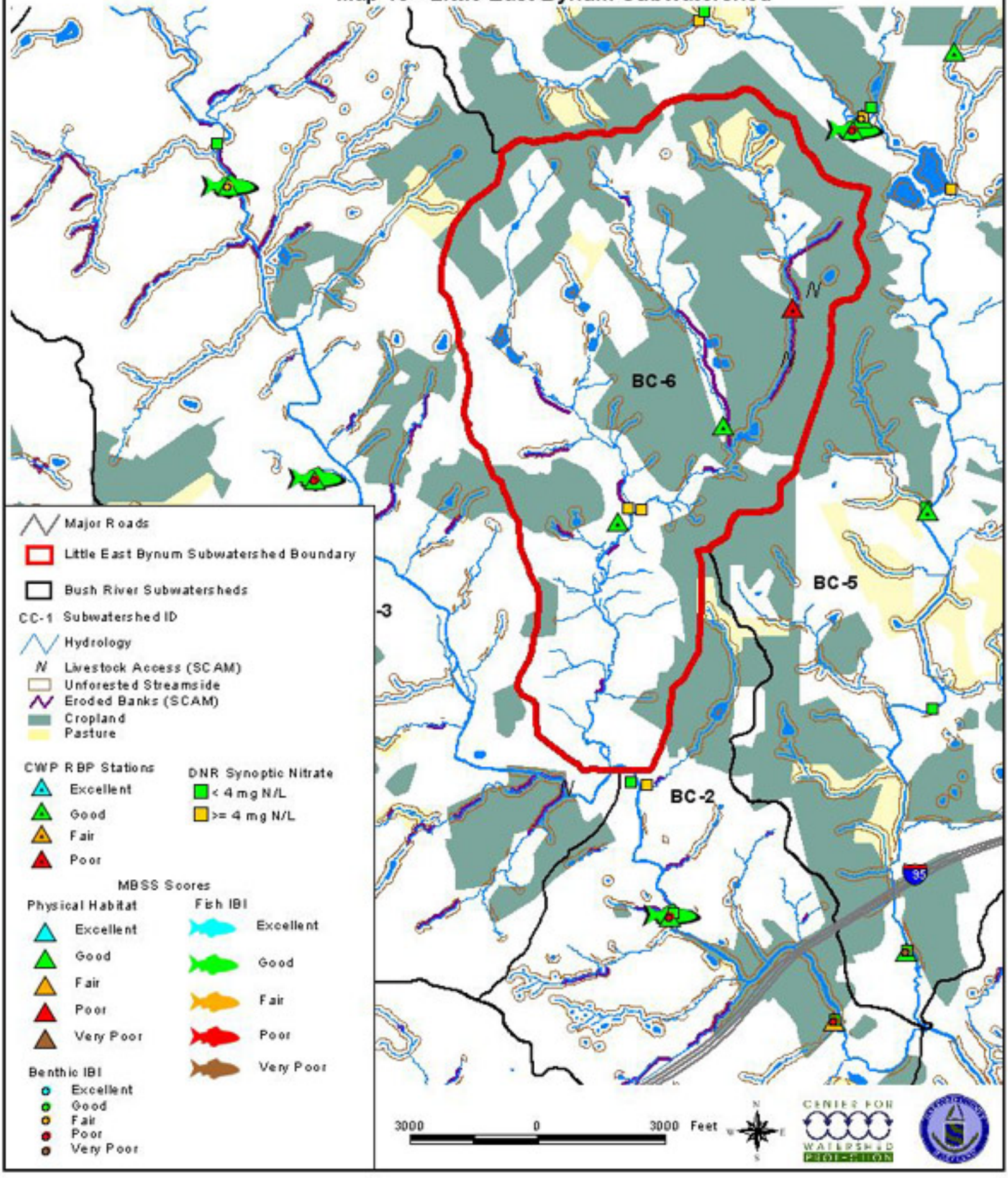
Subwatershed Management Category	Recommendation	Responsible Party
Sensitive	Preserve Contiguous Forests in all Sensitive Subwatersheds	DPZ & Harford Land Trust
Sensitive	Enhance Existing Riparian Buffer in all Sensitive Subwatersheds	DPW, Forest Service, Harford SCD
Sensitive	Grays Run Contiguous Forest Preservation	DPZ & Harford Land Trust
Sensitive	Grays Run Stream Buffer Enhancement	DPW, Forest Service, Harford SCD
Sensitive	Maintain Grays Run Sensitive Status	DPZ
Sensitive	Field Verify and Prioritize Contiguous Forest Areas for Preservation	DPZ
Rurally Impacted	Preserve Farmlands in Rurally Impacted Subwatersheds	DPZ & DNR
Rurally Impacted	Restore Riparian Buffer in Rurally Impacted Subwatersheds	DPW, Forest Service, Harford SCD
Rurally Impacted	Reduce Livestock Access in Little East Bynum	Harford SCD
Rurally Impacted	Agricultural Practices Assessment in Rurally Impacted Subwatersheds	Harford SCD & DPW
Rurally Impacted	Septic System Education in Rurally Impacted Subwatersheds	Health Department
Impacted	Educate Residents on Watershed Stewardship in Impacted Subwatersheds	DPW
Impacted	Implement Stormwater Retrofits in Impacted Subwatersheds	DPW
Impacted	Conduct Stream Clean-ups in Lower and Middle Bynum	DPW
Impacted	Preserve Contiguous Forest in Lower Winters DD and Cranberry Run	DPZ & Harford Land Trust
Impacted	Investigate Other Stormwater Retrofit Opportunities in Impacted Subwatersheds	DPW
Impacted Special Resource	Preserve Large Wetland Tracts in Impacted Special Resource Subwatersheds	DPZ & Harford Land Trust
Impacted Special Resource	Implement Stormwater Retrofits in Impacted Special Resource Subwatersheds	DPW
Impacted Special Resource	Streambank Stabilization in Haha and Otter Point Subwatersheds	DPW
Impacted Special Resource	Develop a Heightened Plan Review in Impacted Special Resource Subwatersheds	DPZ

Table 18. Summary of Bush River Watershed Management Recommendations		
Subwatershed Management Category	**Recommendation**	**Responsible Party**
Watershed-Wide	Establish an Implementation Committee	All Responsible Parties plus key stakeholders
Watershed-Wide	Foster the Development of Bush River Watershed Association	DPW/Stakeholders
Watershed-Wide	Create Watershed Stewardship Website	DPW
Watershed-Wide	Implement Recommendations of Harford County Site Planning Roundtable	DPZ & DPW
Watershed-Wide	Establish an Adopt-a-Pond Program	DPW
Watershed-Wide	Improve ESC Implementation, Inspection and Enforcement	DPW

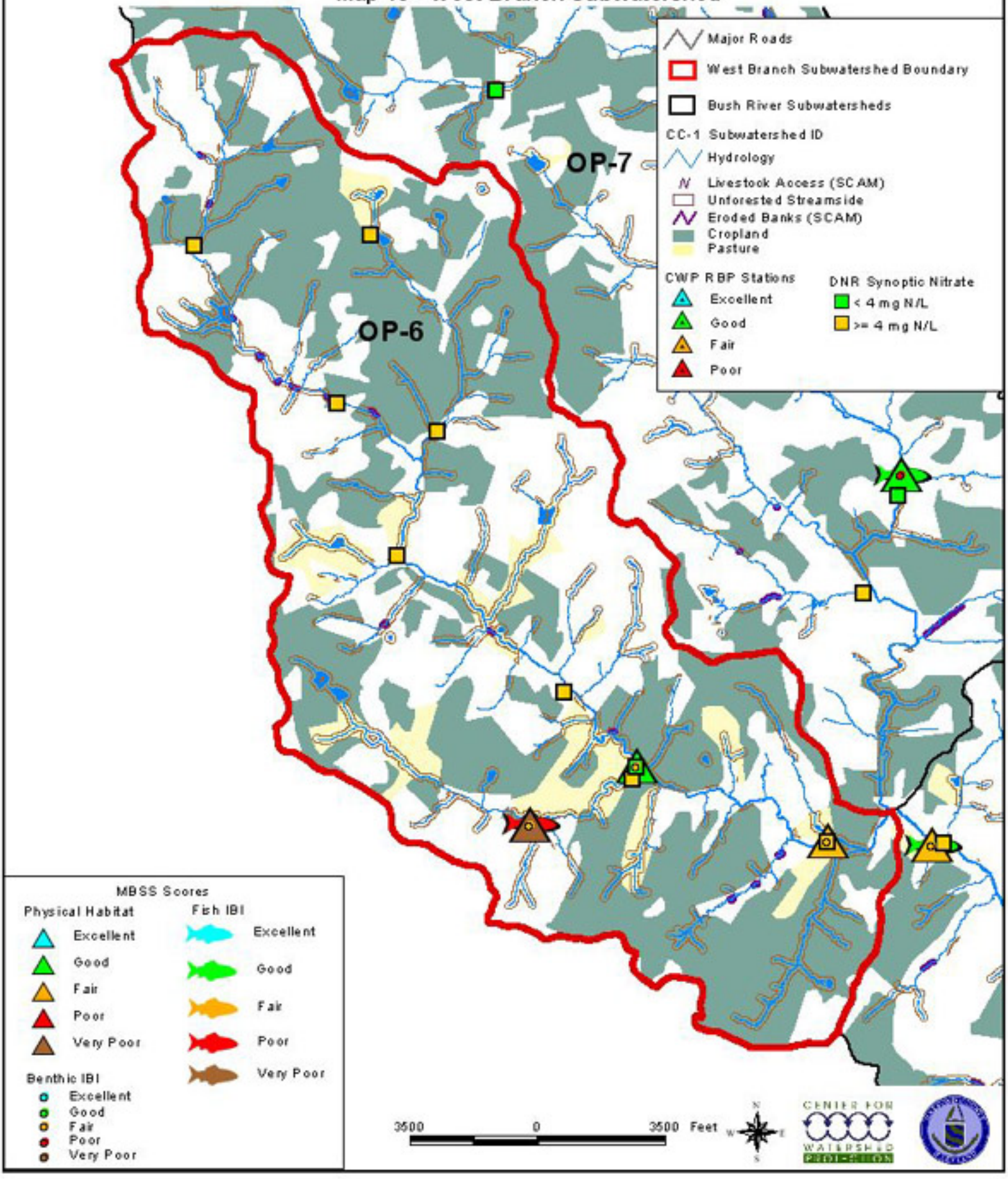
Map 14- Grays Run Subwatershed



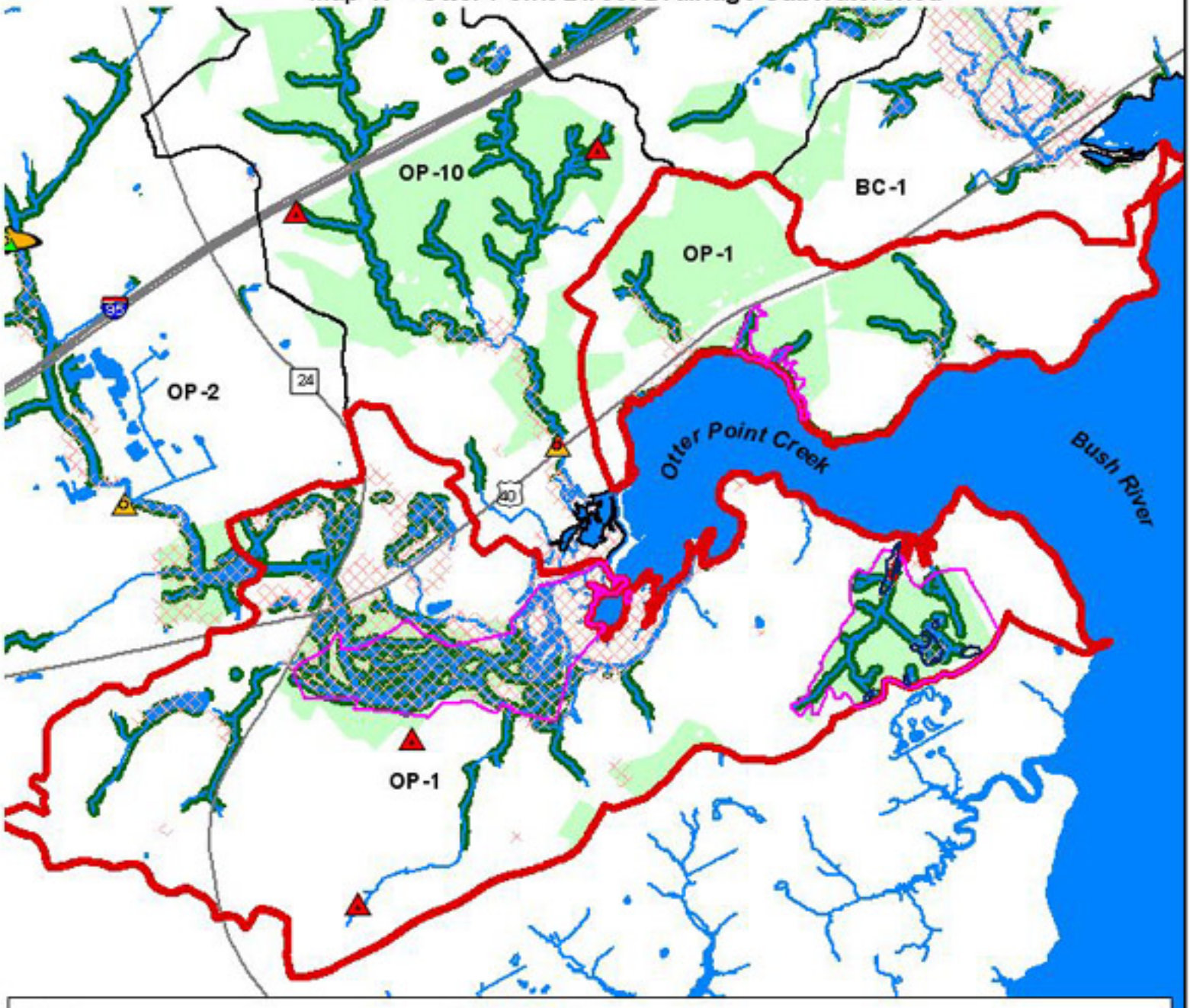
Map 15 - Little East Bynum Subwatershed



Map 16 - West Branch Subwatershed



Map 17 - Otter Point Direct Drainage Subwatershed



Major Roads
Otter Point Subwatershed Boundary
Bush River Subwatersheds
CC-1 Subwatershed ID
Hydrology
NWI Wetlands
Habitat of Local Significance
State Wetlands of Special Concern
Forested Stream Buffer
Forest Interior Dwelling Species Habitat

CWP RBP Stations
Excellent
Good
Fair
Poor

MBSS Benthic IBI Scores
Excellent
Good
Fair
Poor
Very Poor

MBSS Physical Habitat Scores
Excellent
Good
Fair
Poor
Very Poor

MBSS Fish IBI Scores
Excellent
Good
Fair
Poor
Very Poor

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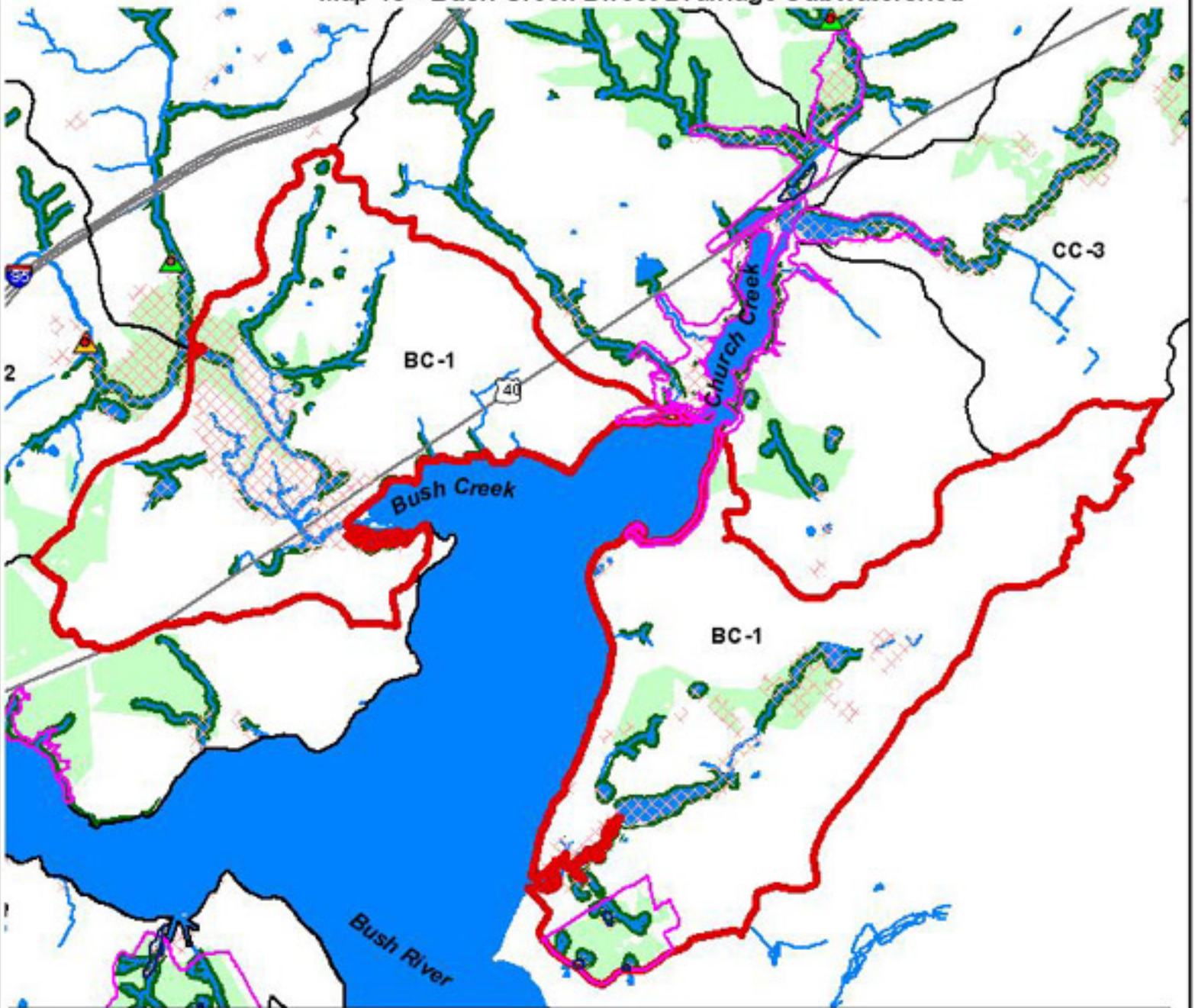
Map 18 - Bush Creek Direct Drainage Subwatershed



Major Roads
Bush Creek Subwatershed Boundary
Bush River Subwatersheds
CC-1 Subwatershed ID
Hydrology
NWI Wetlands
Habitat of Local Significance
State Wetlands of Special Concern
Forested Stream Buffer
Forest Interior Dwelling Species Habitat

CWP RBP Stations
Excellent
Good
Fair
Poor

MBSS Benthic IBI Scores
Excellent
Good
Fair
Poor
Very Poor

MBSS Physical Habitat Scores
Excellent
Good
Fair
Poor
Very Poor

MBSS Fish IBI Scores
Excellent
Good
Fair
Poor
Very Poor

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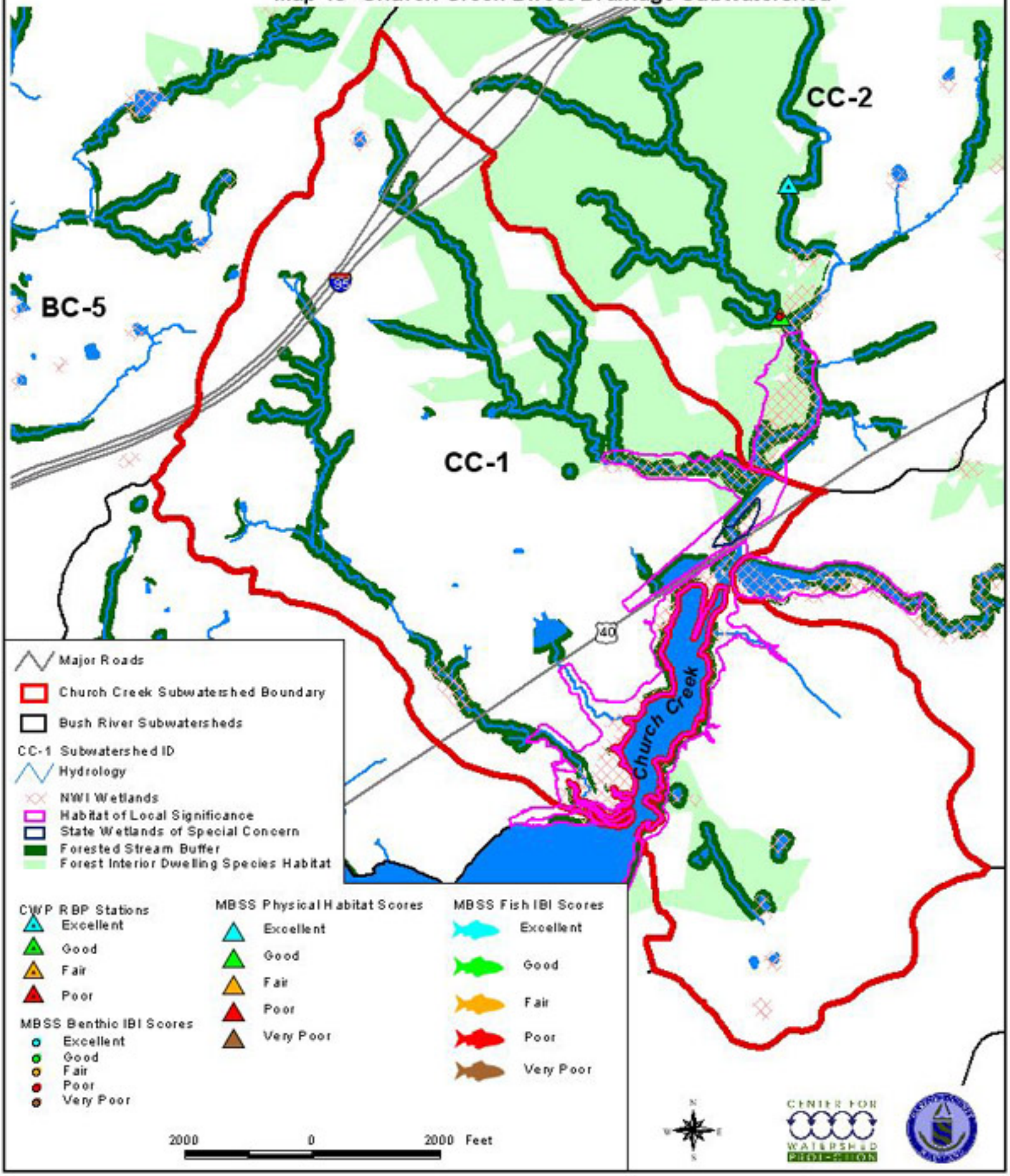
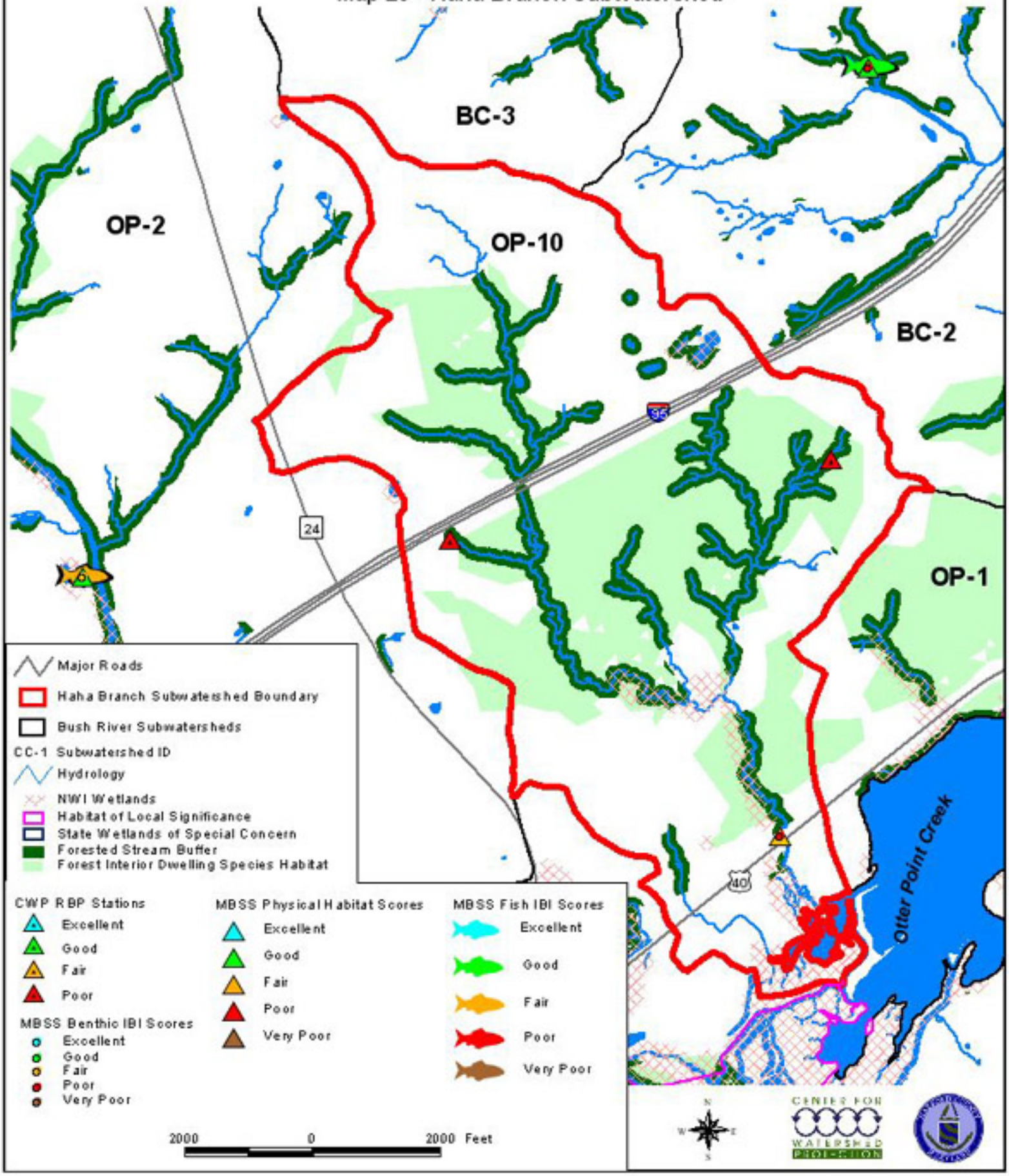
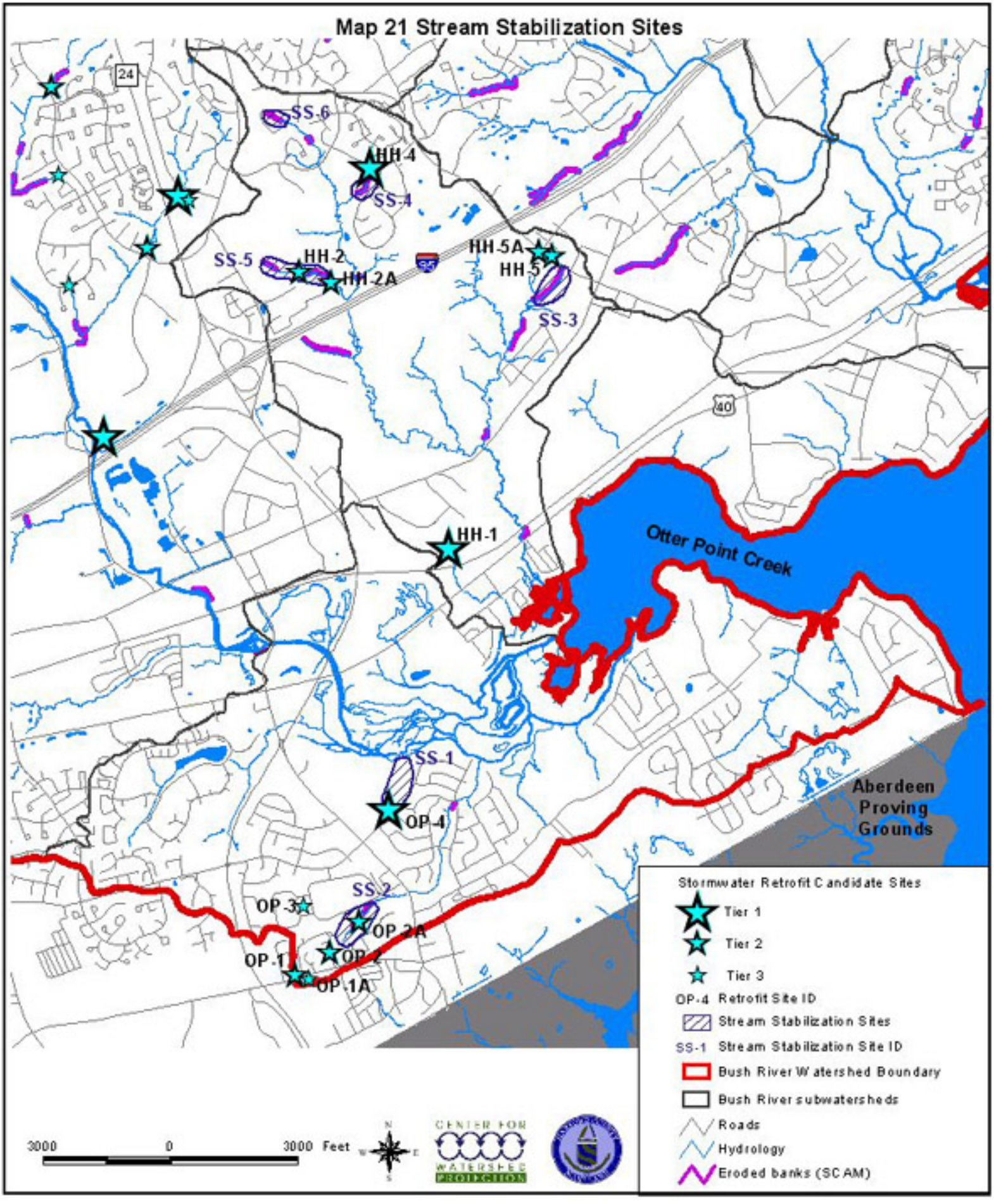
CENTER FOR WATERSHED PROTECTION

Map 19- Church Creek Direct Drainage Subwatershed



Map 20 - Haha Branch Subwatershed




Map 21 Stream Stabilization Sites
24
40
SS-6
HH-4
SS-4
SS-5
HH-2
HH-2A
HH-5A
HH-5
SS-3
HH-1
Otter Point Creek
SS-1
OP-4
Aberdeen Proving Grounds
SS-2
OP-3
OP-2A
OP-1
OP-2
OP-1A
Stormwater Retrofit Candidate Sites
Tier 1
Tier 2
Tier 3
OP-4 Retrofit Site ID
Stream Stabilization Sites
SS-1 Stream Stabilization Site ID
Bush River Watershed Boundary
Bush River subwatersheds
Roads
Hydrology
Eroded banks (SCAM)
3000 0 3000 Feet
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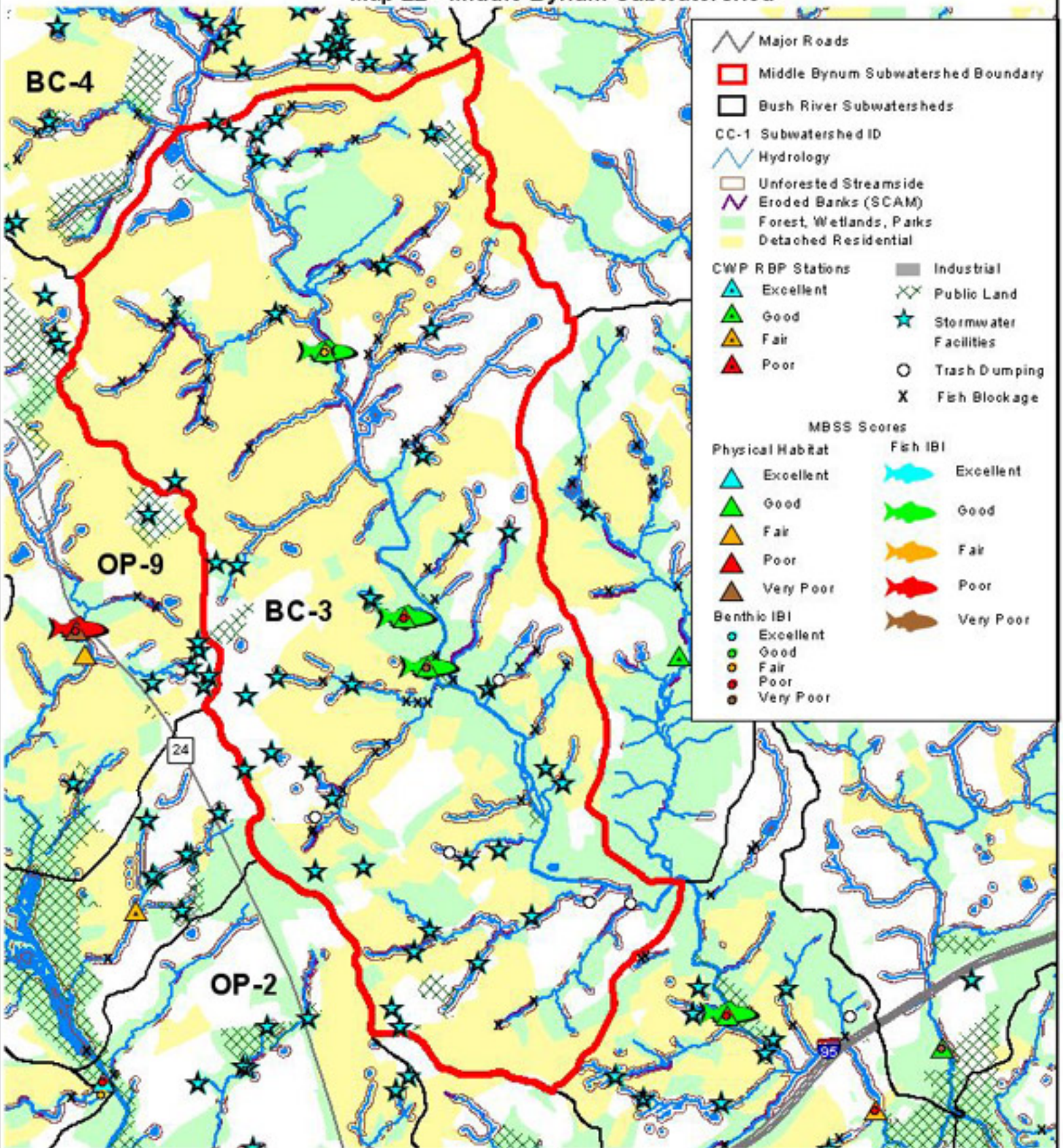
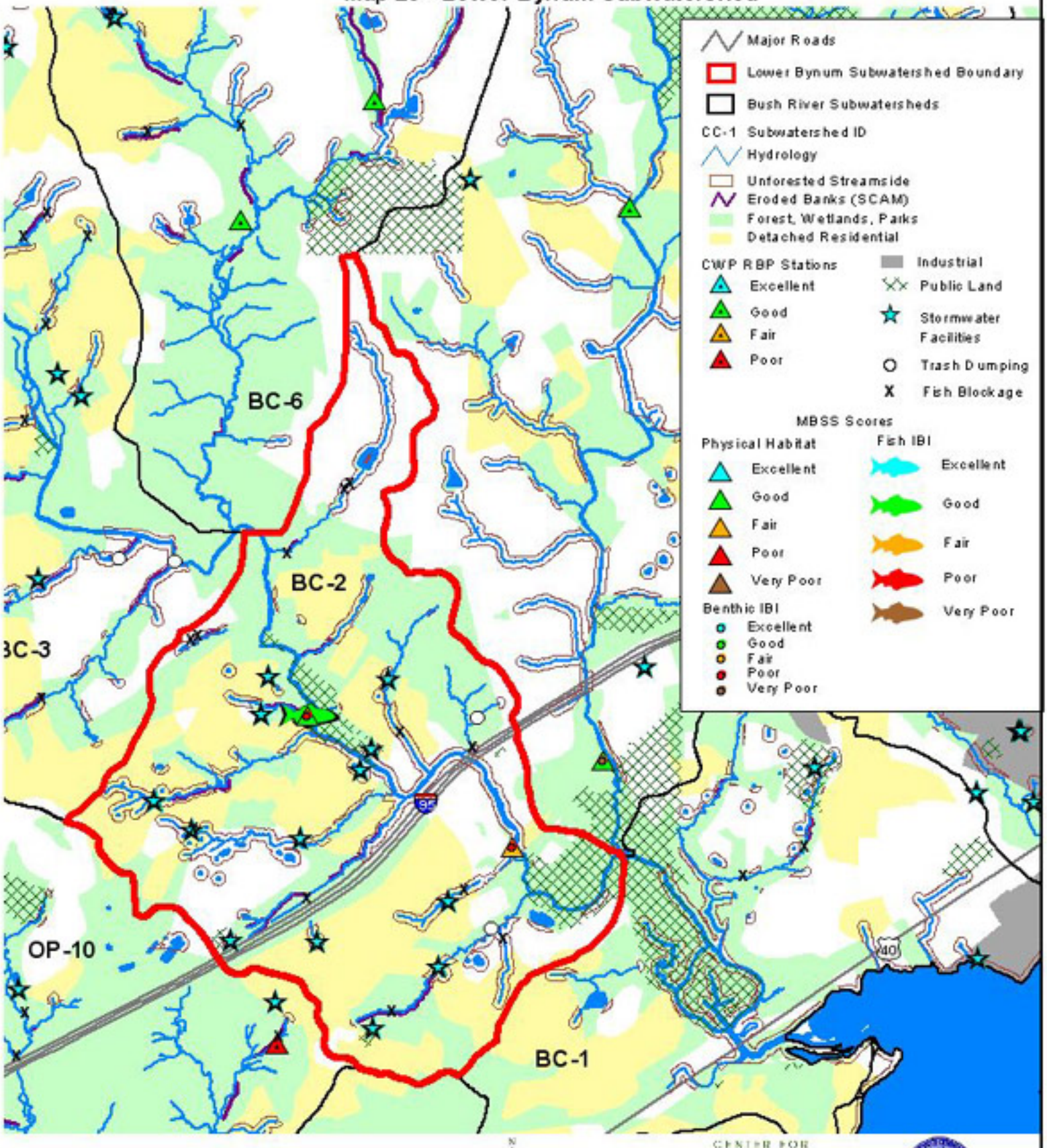
CENTER FOR WATERSHED PROTECTION

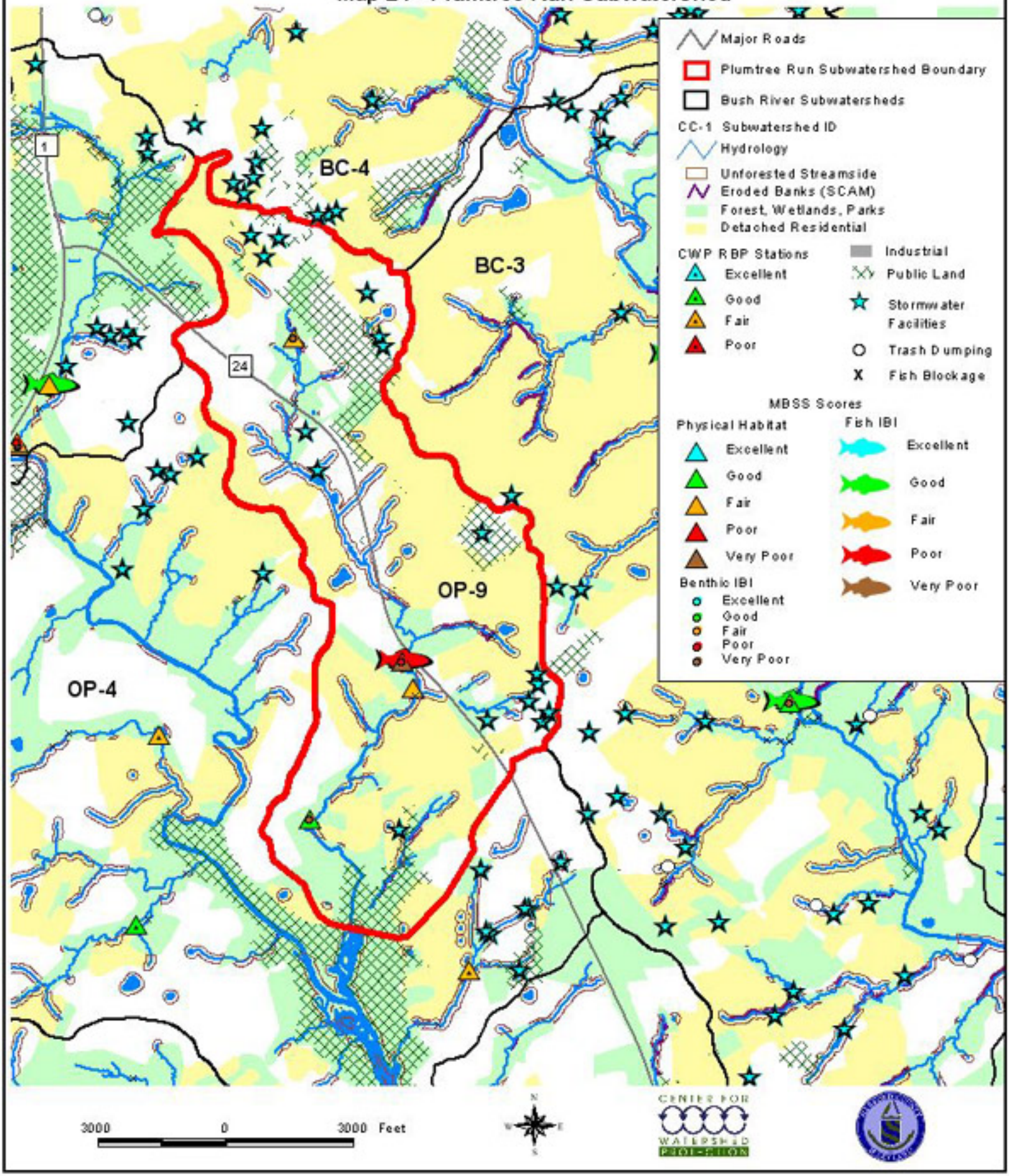
Map 22 - Middle Bynum Subwatershed



Map 23 - Lower Bynum Subwatershed



Map 24 - Plumtree Run Subwatershed



SECTION 4.0 IMPLEMENTATION

In this section, the recommendations have been broken into three prioritization tiers (Table 19) with the first tier representing the top watershed recommendations. Tier 2 and 3 recommendations should still be pursued, but monetary and staff resources should initially be directed towards Tier 1 recommendations. The prioritization is based on the following factors:

- Does the recommendation affect a priority subwatershed?
- What is the overall benefit to the Bush River watershed health?
- Does the recommendation directly meet WAMP goals?
- Does the recommendation require more assessment or program development?

Given a 10 year planning horizon, Tier 1 recommendations should be implemented within the first five years. The time frame for Tier 2 should roughly be within five to seven and Tier 3 within seven to ten. When certain opportunities such as funding or County and/or State initiatives present themselves, Tier 2 and Tier 3 recommendations should be given priority.

Where possible, planning level cost assumptions for recommendations are summarized. An over-riding assumption is that all recommendations will require some level of staff time, although this cost has not been included in cost per unit.

Table 19. Bush River Subwatershed Implementation Strategy

Tier Rank	Recommendation	Subwatershed Management Classification	Estimated Cost per Unit
1	Grays Run Contiguous Forest Preservation	Sensitive	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]
1	Grays Run Buffer Enhancement	Sensitive	$1200/ac[5]
1	Maintain Grays Run Sensitive Status	Sensitive	PDR: $5600/ac[2] TDR: staff time
1	Reduce Livestock Access in Little East Bynum[6]	Rurally Impacted	Exclusionary fencing: $4/ft fencing[3,5] Off-stream water source: $2500[3]
1	Coordinate Stream clean-ups within Middle and Lower Bynum	Impacted	Staff time
1	Educate Residents on Watershed Stewardship in Impacted Subwatersheds	Impacted	$20,000[4]
1	Implement Stormwater Retrofits in Impacted Subwatersheds	Impacted	$4-15K per acre treated
1	Implement Stormwater Retrofits in Impacted Special Resource Subwatersheds	Impacted Special Resource	$4-15K per acre treated
1	Establish an Implementation Committee	Watershed-wide	Staff time
1	Implement Recommendations of Harford County Site Planning Roundtable	Watershed-wide	Staff time
2	Field Verify and Prioritize Contiguous Forest Areas for Preservation in Sensitive Subwatersheds	Sensitive	Staff time
2	Preserve Priority Contiguous Forests in Sensitive Subwatersheds	Sensitive	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]
2	Enhance Existing Riparian Buffers in Rurally Impacted Subwatersheds	Rurally Impacted	$1200/ac[5]
2	Preserve Contiguous Forests in Lower Winters DD and Cranberry Run	Impacted	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]

Table 19. Bush River Subwatershed Implementation Strategy

Tier Rank	Recommendation	Subwatershed Management Classification	Estimated Cost per Unit
2	Preserve Contiguous Forest in Haha Branch	Impacted Special Resource	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]
2	Preserve Large Wetland Tracts in Impacted Special Resource Subwatersheds[7]	Impacted Special Resource	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]
2	Develop a Heightened Plan Review in Impacted Special Resource Subwatersheds	Impacted Special Resource	Staff time
2	Streambank Stabilization in Haha Branch and Otter Point Subwatersheds	Impacted Special Resource	$50-100/liner foot[4]
2	Foster the Development of a Bush River Watershed Association	Watershed-wide	Staff time
2	Improve ESC Inspection and Enforcement	Watershed-wide	Staff time
3	Preserve Farmland in Rurally Impacted Subwatersheds	Rurally Impacted	Land Acquisition: $20,000/ac[1] PDR: $5600/ac[2]
3	Agricultural Practices Assessment in Rurally Impacted Subwatersheds	Rurally Impacted	Staff time
3	Septic System Education in Rurally Impacted Subwatersheds	Rurally Impacted	Staff time
3	Investigate Other Stormwater Retrofit Opportunities in Impacted Subwatersheds	Impacted	Staff time
3	Create a Watershed Stewardship Website	Watershed-wide	Staff time
3	Establish an Adopt-a-Pond Program	Watershed-wide	Staff time

1: Source: Harford County Land Trust 2002 purchase of the woodland surrounding the Anita C. Leight Estuary Center.
2: Source: Loudoun County 2002 PDRs www.loudoun.gov/news/pdrnews.htm
3: Includes cost of post every 10 feet
4: Source: modified from Rapid Watershed Planning Handbook
5: Source: Marshall County, TN NRCS
6: Cost may be covered under CREP
7: Cost of wetland preservation may be lower due to development restrictions already in place by State and County regulations.

SECTION 5.0 TRACKING SUCCESS AND NUTRIENT AND SEDIMENT LOAD REDUCTION ESTIMATES

This section is broken into two parts, a strategy for tracking the success of the Bush River WAMP and the potential pollutant load reductions as a result of the implementation of the WAMP. Both components should be continually revisited and updated as progress has been made.

SECTION 5.1 TRACKING SUCCESS

This section outlines the strategy the County should take to track the success of the implementation of the Bush River WAMP. The proposed tracking entails four main components, a quantifiable objective, monitoring component, public involvement, and programmatic change. Table 20. provides details on how tracking for these components apply to the WAMP recommendations (See Section 3.0). Where possible, the objective places a quantifiable target for each recommendation. All watershed plans should contain a monitoring component to measure and evaluate the response of the watershed over the course of implementation. Public involvement is an important part of the watershed implementation process for two reasons. Public involvement is necessary for the successful implementation and acceptance of projects (stormwater retrofits, buffer enhancement, etc.) that may be on or adjacent to privately owned land. Secondly, it is also necessary to change the collective behaviors of residents that affect water quality. In table 20, the public involvement component explains how the public can be involved with each recommendation. Programmatic change indicates what modifications may be necessary to Harford County's codes or programs in order to implement a recommendation. Programmatic change may not be relevant in all cases. Table 20 is based on the assumption of a 10-year planning window.

Tracking projects undertaken in the watershed is an effective tool to measure success. The system assists in interpreting changes in subwatershed quality and assessing program performance. A database should be developed that records information such as:

- Project ID
- Project Type
- Cost Share?
- Total Cost
- Sponsoring Agency
- Subwatershed
- Property Owner
- Property Owner Phone#
- Property Owner Address
- Location on Property
- Maintenance Responsibility
- Date Installed
- Description
- Installer/Contractor name
- Installer/Contractor phone #
- Inspection Schedule
- Initial Inspection Date
- Initial Inspection Comments
- Follow-up Inspection
- Follow-up Inspection Comments
- Next Inspection Date

The tracking data should be summarized and reviewed on an annual basis. This will allow for adjustments in program implementation and incremental assessments of program effectiveness.

Table 20. Tracking Success of the Bush River WAMP

Recommendation	Objective	Monitoring Component	Public Involvement	Programmatic Change
Contiguous Forest Preservation	75% of contiguous forest preserved	Track # of acres preserved	Work with large landowners to put in easement	NR; make use of existing programs such as PDR and TDR
Buffer Enhancement/Restoration	Increase buffers by 40%; 75 miles of buffer created	Track # of miles of buffer planted and # landowners contacted	Awareness education in urban residential areas; volunteer opportunities	New staff to make direct contact with landowners of unbuffered stream segments
Reduce Livestock Access	Reduce known access by 40%[3]	Track # of acres of pasture fenced out of steams and linear stream fencing	Work with large landowners to implement	NR
Coordinate Stream Clean-ups	Reduce known sites by 50%	Track # of sites cleaned-up	Work with stakeholders and volunteer groups to implement	NR
Educate Residents on Watershed Stewardship	Educate 40% of homeowners	Nutrient behavior survey before and after education effort[1]	Public is target audience	NR
Implement Stormwater Retrofits	Six stormwater retrofits implemented at a minimum	Track # of retrofits implemented; conduct water quality monitoring before and after	Stakeholder meeting with neighborhood or business before retrofit design	NR
Establish a Bush River Implementation Committee	Establishment of Committee	Track overall progress of WAMP implementation	NR	NR
Implement Recommendations of Site Planning Roundtable	Incorporate recommendations into existing codes and ordinance; Improved COW Score[2]	Less impervious cover in new development assessed in GIS	Current stakeholder process has included environmentalists and developers	Changed codes and ordinances
Preserve Wetland Tracts	75% of wetland tracts preserved	Track # of acres of wetlands preserved	Work with large landowners	NR
Develop Heightened Plan Review	Development of Heightened Review	Use SCAM to monitor severity of existing eroded banks and identify any new ones	Possible developer education	Modified plan review for designated areas within the County
Streambank Stabilization	2 miles of stream stabilization	Cross sections taken over time to monitor stability; would include at least one before and after stabilization	Stakeholder meeting with neighborhood or business before stabilization design; could possibly involve stakeholders in implementation	NR
Erosion and Sediment Control Improvements	Less than 10% of sites with repeated installation or maintenance problems	Track reported installation and maintenance problems	Hotline for ESC violations and complaints	Implementation of fines and stop work orders for repeated non-compliance

Table 20. Tracking Success of the Bush River WAMP

Recommendation	Objective	Monitoring Component	Public Involvement	Programmatic Change
Bush River Watershed Association	Establishment of Association	Track # of members	Direct community involvement; creates opportunities to volunteer and educate	NR
Farmland Preservation	50% of farmland preserved	Track # of acres preserved	Work with large landowners to implement	Establish areas as Rural Legacy
Agricultural Practices Assessment	Completion of assessment	Track % of in-place practices	Work with local farmers	NR
Septic System Education	Established Education Effort	Continued Synoptic Surveys	Education of target audience	Inspections at point of sale; pumpouts on at least a 5 yr cycle
Watershed Stewardship Website	Completion of website	Track # of hits	Possible role through writing of content pieces or message board	NR
Adopt-a-Pond Program	Establishment of Program	Track # ponds adopted	Provides volunteer and education opportunities	Program would be addition to DPW's current stormwater management program

Notes:
Some recommendations are specific to certain subwatershed classifications and do not necessarily infer watershed-wide implementation. See Section 3.0 for more details.
NR: Not relevant.
1: See Appendix H for a sample nutrient behavior survey.
2: Codes and Ordinance Worksheet (COW); a quantifiable assessment of a community's ability to implement Better Site Design (see Appendix J for Harford County's COW).
3: Unidentified access should be addressed as part of the Agricultural Practices Assessment

SECTION 5.2 TRACKING NUTRIENT AND SEDIMENT LOAD REDUCTION ESTIMATES

Measurable nutrient and sediment reductions based on full implementation of the Section 3 Recommendations of the Bush River WAMP are presented in Table 21. Percent estimations of expected load reductions are based on the planning level use of the Watershed Treatment Model (WTM) Version 3.0 (Caraco, 2000) written for EPA Region 5 and the Technical Reference for Maryland's Tributary Strategies (DNR, 2003). For a number of management measures we were not able to assign a load reduction because of insufficient data or because the measure would result in future benefits that we are not able to quantify in terms of pollutant loads.

The WTM load reductions are presented to estimate the relative benefit of management measures and not an absolute load reduction. Improved load reduction estimates would require reconciling the assumptions of the Technical Reference for Maryland's Tributary Strategies with the Watershed Treatment Model. This is beyond the scope of this project. Nevertheless, the WTM serves as a useful planning level tool that Harford County and/or DNR could use to estimate and track the effectiveness of the implementation of the watershed management plan. The management measures that we can quantify are presented in Table 21. Based on the WTM, lawn care education and increased riparian buffers are critical measures to reduce nutrient loads. Improved erosion and sediment control (ESC), increased riparian buffers, and the combination of stormwater retrofits with stream restoration are critical to reducing sediment loads. It is noteworthy that two of the most effective management measures, watershed education and improved ESC cannot be estimated with the Technical Reference.

Additional management measures that could lead to load reduction estimates or watershed benefits are summarized in Table 22. One example of additional information that would be needed to compute a load reduction associated with nutrient management is the number of acres currently under nutrient management as well as a future estimate of the acres where nutrient would be implemented for both nitrogen and phosphorus. Additional measures that would lead to long-term benefits for the watershed include the preservation of contiguous forest and farmland and an Adopt-a-Pond program.

Table 21. Percent Nutrient and Sediment Reductions based on Full Implementation (Planning Level Estimates)

Management Recommendations	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	TSS (lbs/yr)	Comments
Educate Residents on Watershed Stewardship specifically -Lawn Care Education	7%	1.1%	--	Based on research of the effectiveness of different media campaign types (newspaper, cable TV) and the percentage of individuals willing to change behavior (reduced fertilizer application)
Erosion and Sediment Control (ESC) Improvements	--	--	3.4%	Based on improved ESC practice implementation and enforcement -- potential for improvement is based on their MDE program evaluation (MDE, 2002)
Buffer Enhancement/ Restoration	3.7%	1.7%	4.4%	Based on the implementation of 75 miles of stream buffers
Implement Stormwater retrofits	Less than 0.5 %	Less than 0.5 %	Less than 0.5 %	Based on the implementation of 2 retrofits a year for 10 years
Streambank stabilization / retrofits	*Less than 0.5 %	*Less than 0.5%	2.5%	Based on 2 miles of stream stabilization with 80% o the stabilization associated with channel protection retrofits
Total	12%	3%	10.5%	Planning Level Estimates

These planning level estimates are based on the WTM Model Version 3.0 (Caraco, 2000)
* Estimates based on the Technical Resource Document (DNR, 2003) (estimate does not account for retrofits with channel protection criteria)

Table 22. Additional Management Recommendations Where Loads or Future Benefits Could not be Quantified	
Management Recommendations	**Justification**
Implement Recommendations of the Site Planning Roundtable	Based on the reduction in IC and a decrease in runoff benefit of Better Site Design can be estimated with the Watershed Treatment Model (WTM)
Reduce livestock access to streams	Based on the number of acres where livestock access is removed -- loads can be generated using Technical Resource Assumptions TN – (.75 eff)*(7.2lbs/acre/yr) - (2.8 lbs/acre/yr) TP – (.75 eff)*(0.2lbs/acre/yr) - (0 lbs/acre/yr) (Assumed to reduce the load of TN and TP by 75% of the pasture load minus the background forest load)
Septic system education	The assumption is that with better education, septic system maintenance would be more frequent and there would be a reduction in failing systems. With information on number of homes on septic, the benefit of an education program can be estimated by the WTM.
Agricultural Practices Assessment -- Nutrient management	In the Technical Reference - nutrient management is expected to reduce loads in the Upper Western Shore by: N - 4.6lbs/acre/yr P - 0.3 lbs/acre/yr Mandatory nutrient management for both N & P is expected to be phased in over the next few years
Adopt-a-Pond Program	Though difficult to measure improved maintenance factor and pond performance can be estimated using the WTM.
Farmland Preservation	Reduces the potential increase in loads that can be associated with conversion of farmland to developed land
Preserve Contiguous Forest	Reduces the potential increase in loads that can be associated with conversion of forest to developed land. Contiguous forest is also important for breeding songbirds and wildlife.
Investigate additional stormwater retrofit opportunities	This step is necessary in order to perform additional retrofits
Watershed Stewardship Website	The benefit is not easy to estimate but provides users and public with quick access to good information
Preserve Wetland Tracts	Important to the overall protection of the watershed especially the large tidally influenced wetlands at the mouths of the creeks

SECTION 6.0 CONCLUSION

The large size and rapid rate of development within the Bush River watershed presents a challenge for its effective management. Working closely with DNR and other key partners and stakeholders, Harford County DPW identified the following three major Watershed Restoration Action Strategy (WRAS) objectives:

1. Implement smart growth and low impact development
2. Promote stewardship and community engagement
3. Improve impacted watershed conditions to enhance water quality, aquatic habitats, and the aesthetic quality of the watershed

The Bush River WAMP represents a major component of the comprehensive WRAS, as outlined by Harford County. Specifically, the WAMP identifies and details:

- General management practices that can be applied across similar subwatershed types to improve watershed conditions and reduce pollutant loads
- Specific high quality subwatersheds that should be evaluated for future protection against development and enhancement with respect to riparian buffers and upland preservation efforts.
- Specific impacted subwatersheds within the development envelope that present opportunities for stormwater retrofits.
- Management approaches in both rural and urban subwatersheds that promote and encourage public awareness and involvement.

Utilizing existing data, supported with some additional calculations (current IC, future IC, etc) and field verifications, ten priority subwatersheds were identified within the watershed: Grays Run, Little East Bynum, West Branch, Middle Bynum, Lower Bynum, Plumtree Run, Otter Point DD, Church Creek DD, Bush Creek DD, and Haha Branch.

Recommendations and prioritizations are provided on a subwatershed basis as well as on an individual project or management measure basis (e.g., contiguous forest protection, riparian corridor reforestation, stormwater retrofits, and stream stabilization). Where applicable, the recommendations and prioritization reflect opinions and sentiments of stakeholders that have participated in the discussion and planning process. A basis for implementation with associated cost estimates (in terms of capital dollars and staff needs) is provided for the recommendations. In addition, planning level estimates of potential pollutant load reductions (specifically nutrients and sediment) associated with recommended management measures are provided. As more detailed information and data are generated and compiled, load reduction estimates can be refined to more accurately reflect watershed response. Lastly, the WAMP presents a tracking system that measures progress as recommendations are implemented.

The establishment of an Implementation Committee is recommended to assist the County in following through and tracking the WAMP. The County and Implementation Committee will need to identify sustainable and new funding sources to pursue target projects within the watershed. Partnerships with DNR, SHA, EPA, MDE and others should be thoroughly explored and developed.

Due to the limited scope of this project, detailed field verification and specific restoration project identification and prioritization was not possible. However, future assessment needs are identified in the WAMP (see Section 3.0). Furthermore, as implementation proceeds and additional data are collected, compiled, and assessed, the County and Implementation Committee should regularly revisit and update the WAMP to reflect the most current knowledge of restoration opportunities and watershed conditions. The Bush River WAMP, in conjunction with other WRAS components identified by the County (e.g., revision of development codes, public outreach and education initiatives, etc.), provides a concise and rapid approach to improve existing watershed conditions and protect existing high quality natural resource areas.

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APPENDIX A

MARYLAND DEPARTMENT OF PLANNING LAND USE/LAND COVER DESCRIPTIONS

1990 & 1994 MdOP Land Use/Land Cover
(Use and document more recent codes if available)

Organization: by County
Source: Maryland Office of Planning
Projection: Stateplane NAD 83
Units: Meters
Spatial Data Type: Polygon

10 Urban Built-up

- **11 Low Density Residential** – Detached single family/duplex dwelling units, yards, and associated areas. Areas of more than 90 percent single family/duplex dwelling units, with lot sizes less than five acres but at least one-half acres (.2 dwelling units/acre to 2 dwelling units/acre).

- **12 Medium Density Residential** – Detached single family/duplex, attached single unit row housing, yards, and associated areas. Areas of more than 90 percent single family/duplex units and attached single unit row housing, with lot sizes of less than one-half acre but at least one-eighth acre (2 dwelling units/acre to 8 dwelling units/acre).

- **13 High Density Residential** – Attached single unit row housing, garden apartments, high rise apartments/condominiums, mobile home and trailer parks. Areas of more than 90 percent high density residential units, with more than 8 dwelling units/acre.

- **14 Commercial** – Retail and wholesale services. Areas used primarily for the sale of products and services, including associated yards and parking areas.

- **15 Industrial** – Manufacturing and industrial parks, including associated warehouses, storage yards, research laboratories, and parking areas.

- **16 Institutional** – Elementary and secondary schools, middle schools, junior and senior high schools, public and private colleges and universities, military installations (built-up areas only, including buildings and storage, training, and similar areas) churches and health facilities, correctional facilities, and government offices and facilities that are clearly separable from the surrounding land cover.

- **17 Extractive** – Surface mining operations, including sand and gravel pits, quarries, coal surface mines, and deep coal mines. Status of activity (active vs. abandoned) is not distinguished.

- **18 Open Urban Land** – Urban areas whose use does not require structures, or urban areas where non-conforming uses characterized by open land have become isolated. Included are golf courses, parks, recreation areas (except associated with schools or other institutions), cemeteries, and entrapped agricultural and undeveloped land within urban areas.

- **191 Large Lot Subdivision (Agriculture)** – Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of open fields or pasture.

- **192 Large Lot Subdivision (Forest)** - Residential subdivisions with lot sizes less than 20 acres but at least 5 acres, with a dominant land cover of deciduous, evergreen or mixed forest.

20 Agriculture

- **21 Cropland** – Field and forage crops.

- **22 Pasture** – Land used for pasture, both permanent and rotated: grass.

- **23 Orchards/Vineyards/Horticulture** – Areas of intensively managed commercial bush and tree crops, including areas used for fruit production, vineyards, sod and seed farms, nurseries, and green houses.

- **24 Feeding Operations** – Cattle or hog feeding lots, poultry houses, and holding lots for animals, and commercial fishing areas (including oyster beds).

- **241 Feeding Operations** – Cattle or hog feeding lots, poultry houses, and holding lots for animals.

- **242 Agricultural Building** – Breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds, and commercial fishing areas.

- **25 Row and Garden Crops** – Intensively managed track and vegetable farms and associated areas.

40 Forest

- **41 Deciduous Forest** – Forested areas in which the trees characteristically lose their leaves at the end of the growing season. Included are such species as oak, hickory, aspen, sycamore, birch, yellow poplar, elm, maple, and cypress.

- **42 Evergreen Forest** - Forested areas in which the trees are characterized by persistent foliage throughout the year. Included are such species as white pine, pond pine, hemlock, southern white cedar, and red pine.

- **43 Mixed Forest** – Forested areas in which neither deciduous or evergreen species dominate, but in which there is a combination of both types.

- **44 Brush** – Areas that do not produce timber or other wood products but may have cut-over timber stands, abandoned agriculture fields, or pasture. These areas are characterized by vegetation types such as sumac, vines, rose, brambles, and tree seedlings.

50 Water – Rivers, waterways, reservoirs, ponds, bays, estuaries, and ocean.

60 Wetlands – Forested and non-forested wetlands, including tidal flats, tidal and non-tidal marshes, and upland swamps and wet areas.

70 Barren Land

- **71 Beaches** – Extensive shoreline areas of sand and gravel accumulation, with no vegetative cover or other land use.

- **72 Bare Exposed Rock** – Areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.

- **73 Bare Ground** – Areas of exposed ground caused naturally, by construction, or other cultural processes.

APPENDIX B

REVISING SUBWATERSHED MANAGEMENT CLASSIFICATION POINT SYSTEM

Table A1. Rurally Impacted Subwatersheds Point System[1]

Subwatershed Name	Subwatershed ID	Cropland	Pasture	Unforested Streamside	Livestock Access	Eroded Banks	Nitrate	Fish IBI	Benthic IBI	Physical Habitat Index	Total Points	Total Possible Points	Score
Little East Bynum	BC-6	1			1	1	1	NA	NA	NA	4	6	67
Grays Run	CC-2				NA	NA		NA	1		1	6	14
James Run	BC-5		1	1	NA	NA			1		3	7	43
East Branch	OP-7								1		1	9	22
West Branch	OP-6	1	1	1			1	1			5	9	56
Mountain Branch	OP-3					1		NA		NA	1	7	14
Upper Winters DD	OP-5								1		1	9	11

Notes:
All subwatersheds have impervious cover under 10%
IBI: Index of Biological Integrity
NA: data not available
1: For additional information on the point system, see Section 2.4

Table A2. Impacted Special Resource Subwatersheds Point System[1]

Subwatershed Name	Subwatershed ID	Tidal	FIDS Habitat	NWI	WSC	Forested Stream-side	Critical Area	Fish IBI	Benthic IBI	Physical Habitat Index	Change in IC%[2]	Total Points	Total Possible Points	Score
Middle Winters DD	OP-4							NA	NA	NA		0	7	0
Bear Cabin	OP-8							NA		1		1	9	11
Church Creek DD	CC-1	1			1	1	1	NA	NA	NA	1	5	7	71
Lower Bynum	BC-2							1		1		2	10	20
Cranberry Run	CC-3		1	1		1	1			1		5	10	50
Bush Creek DD	BC-1	1		1	1		1	NA	NA	NA	1	5	7	71
Haha Branch	OP-10	1	1	1		1		NA			1	5	9	56
Otter Point DD	OP-1	1	1	1	1		1	NA	NA	NA		5	7	71
Middle Bynum	BC-3							1		1		2	10	20
Lower Winters DD	OP-2		1					1		1		3	10	30
Upper Bynum	BC-4											0	10	0
Plumtree Run	OP-9											0	10	0

Notes:
All subwatersheds have current impervious cover between 10 and 25%
FIDS: Forest Interior Dwelling Species habitat
NWI: National Wetlands Inventory
WSC: Wetlands of Special Concern
IBI: Index of Biological Integrity
NA: data not available
1: For additional information on the point system, see Section 2.4
2:Difference between %Current IC and %Future IC

APPENDIX C

SUMMARY DATA AND FIELD FORMS: RBP, CONTIGUOUS FOREST ASSESSMENT, AND WETLAND EVALUATION

RBP HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #_____ RIVER MILE	STREAM CLASS	
LAT _____ LONG	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE _____ TIME _____ AM PM	REASON FOR SURVEY

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

RBP HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	**Channelization or dredging absent or minimal; stream with normal pattern.**	**Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.**	**Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.**	**Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.**
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvio us bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plan growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minim ally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

RBP Habitat Assessment Data Summary																	
Subwatershed Name	**Subwater-shed ID**	**RBP Station #**	**Epifaunal Substrate**	**Embed-dedness**	**Velocity/ Depth Regime**	**Sediment Deposition**	**Channel Flow Status**	**Channel Alteration**	**Channel Sinuosity**	**Bank Stability Left**	**Bank Stability Right**	**Veg. Protect Left**	**Veg. Protect Right**	**Riparian Zone Left**	**Riparian Zone Right**	**Total Score**	**Habitat Category**
James Run	BC5	1	16	16	16	16	15	16	17	8	8	8	8	6	6	156	Good
James Run	BC5	2	15	14	15	16	15	16	17	5	8	5	8	1	9	144	Good
Little East Bynum	BC6	1	15	12	14	13	16	16	17	6	8	7	7	4	9	144	Good
Little East Bynum	BC6	2	13	12	14	11	15	6	13	7	7	7	7	1	1	114	Poor
Little East Bynum	BC6	3	15	13	14	13	16	16	17	8	8	8	8	9	7	152	Good
Grays Run	CC2	1	17	19	18	19	18	18	17	9	9	9	9	9	9	180	Excellent
Grays Run	CC2	2	18	19	17	19	18	19	19	9	9	9	9	9	10	184	Excellent
Grays Run	CC2	3	17	14	13	15	19	17	12	7	6	7	7	8	8	150	Good
Otter Point DD	OP1	1	2	2	6	2	2	16	16	0	0	1	1	6	5	59	Poor
Otter Point DD	OP1	3	4	3	5	4	8	16	16	2	2	2	2	8	8	80	Poor
Middle Winters	OP4	1	13	11	14	13	13	16	16	5	4	7	6	4	4	126	Fair
Middle Winters	OP4	2	15	13	17	14	15	16	17	5	5	5	5	6	8	141	Fair
Middle Winters	OP4	3	17	17	15	18	18	17	18	8	8	7	7	5	5	160	Good
East Branch	OP7	1	16	17	17	17	17	16	16	7	7	6	6	6	2	150	Good
East Branch	OP7	2	14	14	16	10	16	16	16	7	6	7	6	9	8	145	Good
Bear Cabin	OP8	1	18	15	18	17	17	17	18	9	9	9	9	5	8	169	Excellent
Bear Cabin	OP8	2	6	13	13	4	8	17	16	4	4	5	5	6	6	107	Poor
Bear Cabin	OP8	3	14	11	16	16	18	18	18	7	8	8	8	7	7	156	Good
Ha Ha	OP10	1	3	6	6	5	8	16	5	3	3	3	3	9	9	79	Poor
Ha Ha	OP10	2	5	6	6	5	8	16	15	3	3	3	3	8	8	89	Poor

CONSERVATION AREA PLANNING
UPLAND CONTIGUOUS FOREST
FIELD DATA SHEET

PROJECT:	**LOCATION**
STATION #_____	**STORET #**
LAT _____ LONG	**INVESTIGATORS**
FORM COMPLETED BY	**Picture #**
DATE _____ **TIME_____ AM PM**	**Weather**

FOREST ASSOCIATION	Loblolly Pine, Willow Oak -- Loblolly Pine, Bald Cypress, Basket Oak – Loblolly Pine , Chestnut- Post - Black Jack Oak., Other - describe		
# OF TREES IN PRISM and DBH			
DOMINANT TREE SPECIES			
SPECIMEN OR RARE SPECIES	Rank (1-5) 5 being highest Describe		
DENSIOMETER READING # of spaces >3/4 filled	/24		
WETLAND?	Soils	Hydrology	Plants
UNDERSTORY CHARACTERIZATION	Dense, Medium, Sp arse Dominant species		
HABITAT COMPLEXITY	Canopy, Mid Canopy, Understory 3 present 2 present 1 present		
FORBES	Dense, Medium, Sparse		
EVIDENCE OF DISRUPTION AND EXTENT (%)	Natural (ie. storm)	Anthropogenic (ie. clearing, dirt road, timber harvesting)	Disease
INVASIVES			
WATERSHED FEATURES	**Predominant Surrounding Landuse** ‘ Forest ‘ Commercial ‘ Field/Pasture ‘ Industrial ‘ Agricultural ‘ Residential ‘ Other _____	**Local Watershed NPS Pollution** ‘ No evidence ‘ Some potential sources ‘ Obvious sources	

Notes or Sketch on Back

CONSERVATION AREA PLANNING
UPLAND CONTIGUOUS FOREST
FIELD DATA SHEET (CONT.)

Contiguous Forest Evaluation Data Summary												
Station ID	**Subwater-shed**	**# of trees in prism**	**Median DBH**	**Dominant Tree Species**	**Avg Densiometer Reading**	**Understory/ species**	**Habitat Complexity**	**Forbes**	**Disruption**	**Invasives**	**Predominant surrounding land use**	**Local NPS Pollution**
CA-OP1-1	Otter Point DD	12	14.5	green ash	22.5	medium	3	med	beaver	N	forest, res.	no evidence
CA-CC2-1	Grays Run	10	16	beech	21.8	medium; beech	3	sparse	farm; cattle; ATV	N	forest, field, ag, res.	some (ATV, cattle)
CA-CC2-2	Grays Run	12	9	tulip poplar, red maple	15.8	sparse; beech, poplar,	2	sparse	limited clearing, dirt road	N	forest	none
CA-CC2-3	Grays Run	9	7.5	beech, tulip	19.0	dense; sassafras, beech, poplar, multi-flora	3 (thin; older, selective cutting)	sparse	timber harvesting (a couple years ago 5-10)	N	forest	no evidence
CA-CC2-4	Grays Run	14	14.5	beech, tulip	22.3	medium; beech	3	sparse	minor selective cutting	N	forest	no evidence
CA-CC2-5	Grays Run	13	15		21.3	medium; beech	3	n/a	no evidnence	N	forest	some potential sources

Wildlife Wetland Assessment Data Summmary

Station ID#	Subwatershed	Element														FCI
		4	16	20	11a	11b	11c	12a	12b	12c	12d	13a	13b	21a	22a	23	
WT-BC1-1	Bush Creek DD	1.00	1.00	1.00	1.00	0.30	1.00	0.26	0.10	0.10	1.00	0.10	0.10	0.10	0.00	0.10	0.66
WT-CC2-1	Church Creek DD	1.00	1.00	1.00	0.50	0.30		0.19	0.10	0.10	1.00	1.00	0.50	0.10	0.00	0.10	0.68

Element #s align with Wildlife Data Sheet
FC: Functional Condition Index (0-1)

Water Quality Wetland Assessment Data Summary

Station ID#	Subwatershed	Element																			FCI
		15	4b	7a	16	1	5	14	10	10h	10l	9	17	18	19	LF	SS	V	WC	W	C	
WT-BC1-1	Bush Creek DD	1.00	1.00	1.00	1.00	0.70	1.00	1.00	1.00	1.00	1.00	1.00		0.50	1.00	1.00	0.90	1.00	0.70	0.95	0.98	0.92
WT-CC2-1	Church Creek DD	1.00	1.00	1.00	1.00	0.70	1.00	1.00	1.00	1.00	1.00	1.00		0.70	1.00	1.00	0.90	1.00	0.74	0.95	0.98	0.93

Element #s align with Water Quality Data Sheet
LF: Limiting Factors
SS: Substrate Slope
V: Vegetation Characteristics
WC: Water Contact
W: Wetland Characteristics
C: Wetland Condition
FC: Functional Condition Index (0-1)

APPENDIX D

THE WATERSHED RETROFITTING PROCESS

Ideally, stormwater treatment practices, designed to maintain water quality, control flooding, protect stream channels, or meet other watershed goals, are put in place as development occurs. When sites are designed in this way, with stormwater management in mind, the necessary contours, space, and other features to accommodate these practices are provided. The State of Maryland stormwater regulations require new development and redevelopment to carefully consider stormwater management and develop appropriate and effective designs to manage stormwater runoff from sites. Unfortunately, there are substantial portions of the Bush River watershed developed prior to these requirements. In these areas, there are generally either no stormwater treatment practices or practices that only provide peak discharge controls for larger storm events (e.g., the 2 or 10 year return frequency storms). Peak discharge facilities have little capability to control channel erosion or enhance water quality.

Watershed retrofitting should be viewed as a long-term process involving a myriad of disciplines from natural resources management, to engineering design, to public policy and education. Since every watershed is different, it is a challenge to break such a complicated process into a step-wise, objective approach. However, there are eight basic elements that are key to a successful retrofitting effort. Over the past several years, CWP staff has developed a step-by-step approach to stormwater retrofitting (CWP, 2000). Table 1 presents this approach. This Bush River study is limited to the first three steps of the process presented in Table 1.

Table 1 Basic Elements of a Stormwater Retrofitting Implementation Strategy

Step	Element	Purpose
1.	Preliminary Watershed Retrofit Inventory	Identify potential retrofit sites
2.	Field Assessment of Potential Retrofit Sites	Verify that sites are feasible and appropriate, produce concept designs.
3.	Prioritize Sites for Implementation	Set up a priority for implementing future sites
4.	Public Involvement Process	Solicit comments and input from the public and adjacent residents on potential sites
5.	Retrofit Design	Prepare construction drawings for specific facilities
6.	Permitting	Obtain the necessary approvals and permits for specific facilities
7.	Construction Inspections	Ensure that facilities are constructed properly in accordance with the design plans
8.	Maintenance Plan	Ensure that facilities are adequately maintained

Retrofits come in many shapes and sizes, from large regional retention ponds that provide a variety of controls, to small on-site facilities providing only water quality treatment for smaller storms. Usually, at least some kind of practice can be installed in almost any situation. However, fiscal constraints, pollutant removal capability, practical physical limitations and watershed capture area must all be carefully weighed in any retrofit selection criteria. These factors will often result in eliminating a potential site from further consideration.

The first step in retrofit implementation strategy is the process of identifying feasible and appropriate retrofit site locations. This involves a process of identifying as many potential sites as possible. The best retrofit sites fit easily into the existing landscape, are located at or near major drainage outlets or existing stormwater control facilities, and are easily accessible. In other areas, there are large stormwater outfalls where suitable retrofit opportunities exist. Table 2 lists some of the most likely spots for locating facilities and some common applications.

Table 2 Best locations for Stormwater Retrofits

Location	Type of Retrofit
Existing stormwater detention facilities.	Usually retrofitted as a wet pond or stormwater wetland capable of multiple storm frequency management
Immediately upstream of existing road culverts	Often a wet pond, wetland, or extended detention facility capable of multiple storm frequency management
Immediately below or adjacent to existing storm drain outfalls	Usually water quality only practices, such as sand filters, vegetative filters or other small storm treatment facilities
Directly within urban drainage and flood control channels	Usually small scale weirs or other flow attenuation devices to facilitate settling of solids within open channels
Highway rights-of-way and cloverleaves	Can be a variety of practices, but usually ponds or wetlands
Within large open spaces, such as golf courses and parks.	Can be a variety of practices, but usually ponds or wetlands capable of multiple storm frequency management
Within or adjacent to large parking lots	Usually water quality only facilities such as sand filters or other organic media filters (e.g., bioretention)

Step 1 of the retrofit process is completed in the office using topographic mapping, low altitude aerial photographs, and land use, zoning, and property maps. Storm drain master plans are also useful during the inventory process. Scouting for potential candidate sites follows the guidance discussed above in Table 2.

Two important tasks need to be undertaken before venturing into the field. First, the drainage area to each retrofit is delineated and second, the potential surface area of the facility is measured. The drainage area is used along with an estimate of impervious cover within the drainage area to calculate the target water quality and channel protection volumes. The potential surface area is used to compute a preliminary storage volume for the facility. A preliminary storage volume (V) for a pond can be computed by multiplying two-thirds of the facility surface area (SA) times an estimated maximum depth (d) ($V = 0.67 \times SA \times d$). These two pieces of information are used as a quick screening tool.

For this study, the water quality target storage volume for each retrofit is equal to approximately 1 inch per impervious acre[1]. Providing channel protection storage was also a priority of the retrofit inventory and concept development, because the stream corridor assessment method (SCAM) survey data indicated the presence of significant channel erosion areas throughout the subwatersheds.

[1] The justification for targeting 1 inch per impervious acre is based on the new State of Maryland water quality design rainfall, which was derived from a rainfall frequency analysis approach that attempts to capture and treat approximately 90% of the annual events. This sizing criteria: (1) captures 90% of the annual runoff load, providing water quality treatment for all but the larger storms; even the larger storms will receive some degree of treatment; (2) captures and treats more than just the so called, "first flush"; and (3) ensures fairly high level of treatment at highly impervious sites that are often hotspot areas such as parking lots, gas stations, and convenience stores.

Channel protection target storage volume was determined by providing 24-hour extended detention for the 1-year return frequency storm, which for Harford County is approximately 2.6 inches[2].

In the next step, Step 2, the candidate retrofit sites are investigated in the field to verify that they are feasible. Without detailed infrastructure mapping, the field investigation is more complicated and requires some investigation at each candidate site to determine the location of outfalls and the general storm drain network configuration. The storm drain network is particularly important for refining tributary drainage areas. The field investigation also involves a careful assessment of site-specific information such as identifying the presence of sensitive environmental features, the location of existing utilities, the type of adjacent land uses, the condition of receiving waters, construction and maintenance access opportunities, and most importantly, whether or not the contemplated retrofit will actually work in the specified location. A conceptual sketch is prepared, photographs are taken, and the retrofit inventory form is completed for each site (see Appendix E).

References

Allen and Narramore., 1985. Allen, P.M. and Narramore, R. (1985) "Bedrock Controls on Stream Channel Enlargement With Urbanization, North Central Texas," Water Resources Bulletin, 21:6, pp. 1037-1048.

Center for Watershed Protection. 2000. The Practice of Watershed Protection. pp. 742.

Morisawa, M. and LaFlure, 1979. Hydraulic Geometry, Stream Equilibrium and Urbanization, In Adjustments of the Fluvial System, D.D. Rhodes and G.P. Williams (eds.), Proc. 10th Annual Geomorphology Symposium. Series, Binghampton, N.Y. (Sept. 21-22), pp.333-350.

[2] Channel protection in stormwater management attempts to minimize the downstream channel expansion and erosion, which normally occurs with urbanization of a watershed. As pervious surfaces such as fields and forests are converted to impervious surfaces, the volume and frequency of runoff is increased significantly. Researchers have demonstrated that urbanization causes channels to expand two to five times their original size to adjust to the increased volume and frequency of runoff from impervious surfaces and the increased routing efficiency of curbs, gutters and storm drains (Moriwasa and LaFlure, 1979, and Allen and Narramore, 1985). Typically, the "channel forming" events have a recurrence interval of between 1 and 2 years, with approximately 1.5 years as the most prevalent. The premise of the 1-yr, 24-hr extended detention design criteria is that runoff is stored and released in such a gradual manner that critical erosive velocities are seldom exceeded in downstream channels.

APPENDIX E

RETROFIT INVENTORY FIELD SHEETS AND PHOTOGRAPHS

Stormwater retrofit: HH-1

Stormwater retrofit: HH-2

Stormwater retrofit: HH-4

Stormwater retrofit: HH-5

Stormwater retrofit: OP-1

Stormwater retrofit:OP-2

Stormwater retrofit: OP-3

Stormwater retrofit: OP-4

Stormwater retrofit: OP-6

Stormwater retrofit: OP-8

Stormwater retrofit: OP-9

Stormwater retrofit: OP-10

Stormwater retrofit: OP-11

Stormwater retrofit: OP-12

Stormwater retrofit: OP-13

Stormwater retrofit: OP-14

APPENDIX F

PRIORITY SUBWATERSHED POINT SYSTEM

Table D1. Priority Sensitive Subwatersheds Point System[1]

Subwatershed Name	Subwatershed ID	FIDS Habitat	WSC	Forested Streamside	Critical Area	Fish IBI	Benthic IBI	Physical Habitat Index	Change in IC%*	Total Points	Total Possible Points	Score
Grays Run	CC-2	1		1	1	NA		1	1	5	7	71
James Run	BC-5					1		1	1	3	8	38
East Branch	OP-7	1				1		1		3	8	38
Mountain Branch	OP-3					NA		NA		0	6	0
Upper Winters DD	OP-5					1				1	8	13

Notes:
All subwatersheds have impervious cover under 10%
Difference between %Current IC and %Future IC
FIDS: Forest Interior Dwelling Species habitat
IBI: Index of Biological Integrity
NA: data not available
1: For additional details on the point system, see Section 2.7

Table D2. Priority Impacted Subwatersheds Point System

Subwatershed Name	Subwatershed ID	Storm-water Facilities	Industrial Land	Detached Res Lots	Fish Blockages	Eroded Banks	Trash Dumping	Public Land	Parks, Forest, & Wetlands	Unforested Streamside	Develop-ment Envelope	Good Stream Health Indicator	Total Points	Total Possible Points	Score
Middle Winters DD	OP-4				1							NA	1	10	10
Bear Cabin	OP-8		1							1		1	2	11	18
Lower Bynum	BC-2	1	1		1	1	1					1	5	11	45
Cranberry Run	CC-3				NA	NA	NA					1	2	8	25
Middle Bynum	BC-3			1	1	1	1			1	1	1	7	11	64
Lower Winters DD	OP-2		1				1					1	2	11	18
Upper Bynum	BC-4	1		1	1	1				1			4	11	36
Plumtree Run	OP-9	1		1	NA			1			1		4	10	40

All subwatersheds have an impervious cover between 10 and 25%
NA: data not available
1: For additional information on the point system, see Section 2.7

APPENDIX G

BUSH RIVER STAKEHOLDER MEETING INPUT

BREAK OUT GROUPS:

1. **What do you value most about the Bush River Watershed and the place you live?**

- Rural atmosphere
- Quality of life factor
- Green rolling hills
- Natural aspect/wildlife
- Diversity of plants and animals
- Wetlands, forests, meadows,
- Quality of Air
- Benefits of Rural/City Combination
- Breeze
- Natural areas
- Picturesque nature of the area
- Head of the Chesapeake Bay
- Boating
- Scenery
- Waterfowl/hunting
- Recreation opportunities
- Overall livability

2. **In your opinion, what are the top issues facing the Bush River watershed?**

- Critical area protection
- Streambank erosion
- Agricultural pollution
- Education/watershed awareness
- Erosion and sediment control
- Impervious surfaces
- Growth management
- Lack of enforcement in development community
- Lack of buffers
- Sediment
- Water depth
- Population growth
- Loss of forest
- Type of development (perception of what is desirable)
- Lack of Stewardship
- Stormwater runoff
- State Budget or lack thereof

3. **Which of the eight tools do you feel restoration and protection efforts should be focused on?**

- Land Conservation
- Stream Buffers
- Better Site Design

- Erosion and Sediment Control (ESC)
- Stormwater management
- Stewardship/education

QUESTIONNAIRE:

 # Returned: 16

1. What activities would you as a citizen, be interested in participating:

11 Tree planting	**3** Hazardous waste drop offs
9 Reducing fertilizer use	**11** Stream clean-ups
7 Reducing pesticide use	**5** Adopt-a-pond or stream programs
6 Picking up after your pet	**3** Putting land in a conservation easement
6 Being a member of a local watershed group	

Other/Additional Comments:

- Streambank Stabilization & WQ/Benthic Monitoring Training
- Encouraging County Gov't to enact legislation that will protect our watershed and promote resource conservation

2. Do you support land conservation, transfer of development rights, and open space acquisition initiatives in high quality subwatersheds?

Yes	No	No Answer/Other
7	0	9*

*I believe there were a high number of "no answers" for this questions b/c people were not sure if they were supposed to answer this question or just skip to 2a.

Other/Additional Comments:

- Transfer of development rights, if managed properly; do we have the money?
- I would support land conservation but not transfer of development rights

a. The use of public funds for these policies?

Yes	No	No Answer/Other
10	1	5

Other/Additional Comments:

- Only for Acquisitions

- Promote County regulations for developers to stop sediment, etc
- In good times (strong economy)

b. Denser development in other areas as a result of these programs?

Yes	No	No Answer/Other
10	2	4

Other/Additional Comments:

- Yes, but only if new SW Regs are institutued to reduce impervious surface
- I cannot see destroying one area to protect another. I feel development should be able to support what's going on

3. Do you support expenditures of public money on watershed restoration and protection?

Yes	No	No Answer/Other
15	0	1

Other/Additional Comments:

- Yes, we need to locate more federal/state monies to assist Counties and local watershed groups in protecting and improving watersheds.
- Within reason
- YES!!!

APPENDIX H

A SURVEY OF RESIDENTIAL NUTRIENT BEHAVIOR

Background:
Hello, I am calling on behalf of the Center for Watershed Protection. We are conducting a brief 5 minute survey of local citizens to assess whether certain programs designed to protect the water quality of the Chesapeake Bay are accomplishing their goal. We are also trying to establish which media or outreach techniques are most effective at reaching citizens within the Chesapeake Bay region. Would you be willing to spare a few minutes to help us determine how your tax dollars may be spent more effectively to improve the water quality of your local streams and the Bay?

Personal Profile Info
Some question to guard against bias based on who answers the phone. Probably the adult whose birthday falls next. Some questions regarding age, location, possibly income.

Section I: Lawn Care Maintenance and fertilizer use:

Question 1: Do you have a lawn or yard? (Yes __or no__). If yes, answer the following questions. If no, skip to the next section.

Question 2: Who maintains your lawn and/or yard?
Homeowner_____
Lawn Care Company_____
Other_____

Question 3: If you hire a lawn care company, how did you pick them ? (check all that apply)
Contacted directly by company (by phone or mail) ___Cheapest rates___ First in the phone book___ Recommendation of a friend___Reputation for high quality lawns_____ Being "environmentally friendly"____

If respondent uses lawn care service, skip to question 12

Question 4: Have you ever obtained advice or information on how to manage your lawn (e.g., watering, fertilizing, composting, establishing turf)?
Yes___ No___ Don't Know___

If respondent answers No or Don't Know, skip to question 7

Question 5: Did this advice include information or techniques on managing your lawn to better protect the environment? ?
Yes___ No___ Don't Know___

Question 6: Did you apply this information to make changes to the way you care for your lawn?
Not at all___ some changes___ significant changes___

Question 7: Do you fertilize your yard? Yes___ No___ Don't Know___

Question 8: How many times a year do you fertilize? ___ Times ___ Don't Know___

Question 9: When do you fertilize your yard?
Fall__ Spring__ Summer__ Winter____ Don't fertilize___

Question 10: What information do you use to decide how much fertilizer to apply ? (check all that apply)
Consult label on the bag ___
Use recommendations of a local agency or extension agent ___
Fertilize to green up lawn ___
Consult garden or lawn care center ___
Other (source of information) ___
Don't use any information___

Question 11: Have you had a soil nutrient test on your lawn in the last three years?
Yes__ No__ Don't Know ___

Question 12: Do you compost or recycle your leaves? Yes__ No__ Don't Know___

Question 13: Have you applied pesticides to your yard or garden in the last year?
Yes__ No__ Don't Know___

Question 14: How do you decide how much pesticide to apply? Past experience ___ Advice from cooperative extension/local agency__ Product labels__ Friends/Neighbors Lawn Care Company__ Garden Center__ Apply "just in case"___ Don't use ___

Section II: Septic System Questions

Question 1: Is your home served by a septic system? Yes __or no __. If yes, answer the following questions. If no, skip to the pet waste section.

Question 2: How old is your house? _____ Years ___ Don't Know___

Question 3: Do you know approximately where your septic system is located in your yard?
Yes__ No___

Question 4: Have your had your septic system tank inspected in the last three years?
Yes__ No__ Don't Know___

Question 5: Have you had your septic system tank cleaned out in the last five years?
Yes__ No__ Don't Know___

Question 7: Do you dispose of any of the following materials down your drains/toilets:
Grease Yes__ No___
Baby wipes Yes__ No___
Coffee grounds Yes__ No___
Bleach Yes__ No___
Cigarette Butts Yes__ No___
Facial Tissues Yes__ No___

Question 8: Have you ever obtained advice on how to maintain your septic system
Yes___ No___ Don't Know___

Question 9: If yes, where do you go for your advice?
Local health department or other agency ___ Friends/Neighbors__Cooperative extension office ___ Pumping service ___ Books/magazine __ Internet___

Question 10 Do you agree or disagree with this statement:
Inspection and routine clean out of septic tanks is necessary to protect the water quality of the Bay.
Agree___ Don't know/no opinion___ Disagree___

Section III: Pet Waste Disposal Questions

Question 1: Do you own a dog? Yes __or no __. If yes, answer the following questions. If no, skip to the attitudes section.

Question 2: Do you walk your dog? Yes___ No___

Question 3: How frequently do you clean up after your dog on walks?
Not at all___ Occasionally ___ Most of the time ___All the time___

Question 4: For those people which do not answer all the time on Question 3
Which of the following factors would encourage you to clean up after your dog?
Convenient disposal locations at parks or along trails___
A fine___
A simple, sanitary collection method (aka, Pooper-scooper, etc)___
Complaints of neighbors___

Question 5 Do you agree or disagree with the following statement:
Pet waste can be a source of nutrients and bacteria for nearby streams and water bodies.
Agree___ Don't know/no opinion___ Disagree____

Section IV: Outreach Questions

Which of the following sources of information do you feel are most effective at attracting your attention about protecting water quality. Please rate on a scale of 1-10, with 1 being the least effective and 10 being the most effective:

_____Brochures mailed to my home

_____Supplement in your local newspaper

_____Community newsletter article

_____Free educational video

_____ Demonstration project in your neighborhood

_____ Free home consultation from local expert

_____ Public service announcements on television

_____Internet website

_____Weekend training workshop

_____ Public access cable shows

_____Radio call in show

_____Public television shows on topics such as gardening or home repair/maintenance

_____Regular newspaper column

_____Phone consultation with extension agent

APPENDIX I

TOP TEN THINGS YOU CAN DO TO PROTECT YOUR WATERSHED

The top ten things you can do to protect your watershed are:

1) Water your lawn only where and when needed.

2) Limit the use of pesticides and fertilizers used on your lawn. Consider using an alternative to the use of chemical pesticides, such as Integrated Pest Management (IPM), which is the use of natural methods to deter pests.

3) Plant native vegetation. By planting vegetation that is adapted to your region you will reduce the amount of pesticides, fertilizers and watering that will be required. This means less work for you!

4) Redirect rooftop runoff using a rain barrel or at the very least a spreader.

5) Dispose of pet waste properly. Because pet waste can be high in bacteria and nutrients, it should be disposed of in a toilet or trash can.

6) Carefully choose where you wash your car. Washing your car on you lawn will reduce the amount of water that is converted to runoff and allow the detergents to be filtered by your lawn before it enters the stream system. Another alternative is choosing an automatic carwash that is connected to the sewer system or recycles wash water.

7) Properly maintain your car. Regular maintenance will ensure a smooth running machine and reduce the amount of oil and other fluid leaks as well as reducing other pollutants that result from driving cars.

8) Dispose of or recycle chemicals properly. All paints, oils, grease, antifreeze and cleaning products should be disposed of properly. Many of these items need to special processing which dumping down the stormdrain or even a household drain can not do. Many communities have a household hazardous waste disposal station or annual collection day.

9) Properly maintain septic system. For most people, out of site out of mind. Unfortunately though, septic systems are one of the top polluters because of their limited lifetime and up to 35% failure rate. Septic system discharge has high levels of bacteria and nutrients that can contaminate the groundwater, as well as streams. It is critical to have your septic system regularly inspected and maintained. Inspections should be done at least once every three years.

10) The best thing you can do to protect your watershed is to join a watershed organization. Doing so will help you learn more about your own watershed and its unique qualities. It will keep you informed as to what is going on in your watershed and what future plans there are for development. Watershed organizations can also provide a unified plan of action that can really make a difference in the future of your watershed.

APPENDIX J

HARFORD COUNTY CODES AND ORDINANCES WORKSHEET