Final Report

Tidal Back River Small Watershed Action Plan

Volume II

Prepared for

BALTIMORE COUNTY MARYLAND

Department of Environmental Protection and Resource Management

Prepared by

PB 100 YEARS PARSONS BRINCKERHOFF

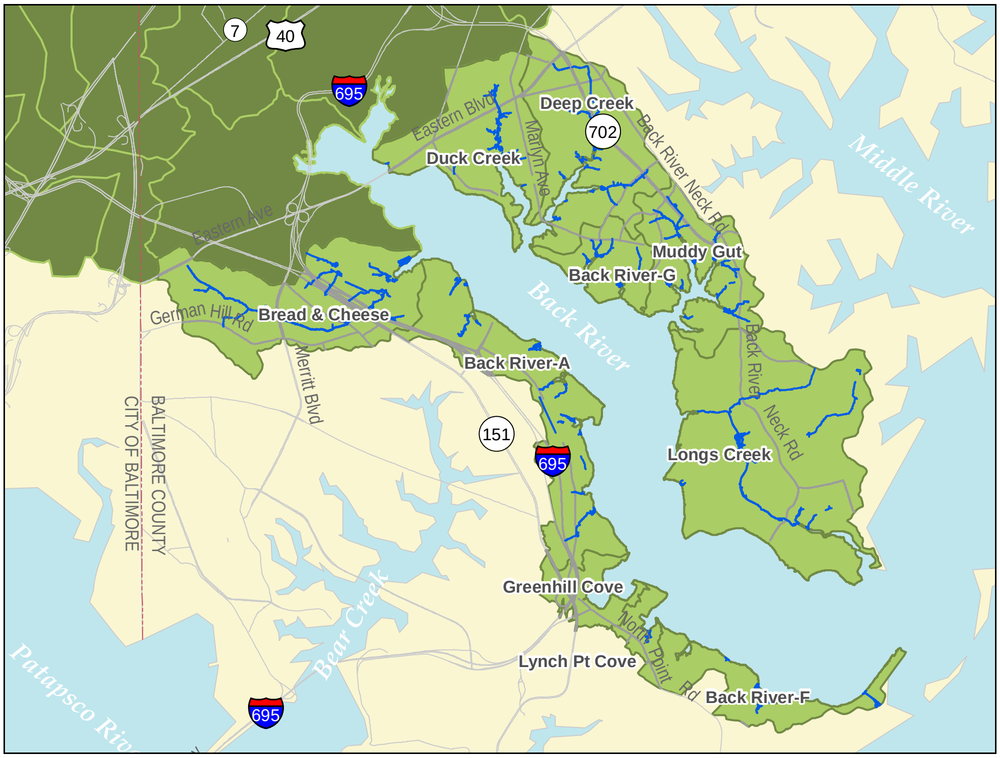
February 2010

APPENDIX D:

Tidal Back River Watershed Characterization Report

Final Report

Tidal Back River
Watershed Characterization



Prepared for:

BALTIMORE COUNTY
MARYLAND

Department of Environmental Protection
and Resource Management

Prepared by:

PARSONS BRINCKERHOFF

October 2009

Table of Contents

List of Figures

List of Tables

CHAPTER 1: INTRODUCTION

1.1 Purpose

The purpose of the Tidal Back River Watershed Characterization Report is to:

1. Summarize the factors that may affect the water quality of Tidal Back River such as landscape, geomorphology, hydrology, and biological characteristics; and
2. Explain the current conditions of the watershed and its natural resources.

This report also describes human impacts on the watershed and identifies restoration and preservation strategies appropriate for accomplishing watershed goals. A Small Watershed Action Plan (SWAP) for Tidal Back River will be developed based on the information provided in this watershed characterization report.

1.2 Watershed Location and Scale

The Tidal Back River watershed is within the Coastal Plain region of Maryland, located just east of the City of Baltimore boundary in Baltimore County (see Figure 1-1). It is one of two planning areas that represent the Back River watershed. The Tidal Back River planning area comprises the lower portion and is approximately 7,720 acres (12 square miles) or 22 percent of the Back River watershed. The remaining 78 percent is occupied by the Upper Back River planning area (27,717 acres, 43 square miles) as shown in Figure 1-2. A SWAP for the Upper Back River was developed previously in November 2008 (DEPRM 2008).

The Tidal Back River watershed was subdivided into smaller drainage areas called subwatersheds. In addition to characterizing the entire watershed, analyses were conducted on a subwatershed scale to provide detailed information for smaller areas and to focus restoration and preservation efforts. Also, success of restoration efforts can be more easily monitored and measured on this smaller scale. As shown in Figure 1-3, the Tidal Back River watershed consists of 10 separate subwatersheds. Subwatersheds and corresponding acreages are listed below in Table 1-1. Watershed and subwatershed delineation is explained further in Chapter 2.

Table 1-1: Tidal Back River Subwatershed Acreages

Subwatershed	Area (Acres)	Area (Sq Miles)
Back River-A	973.1	1.52
Back River-F	420.4	0.66
Back River-G	313.4	0.49
Bread & Cheese	1,183.0	1.85
Deep Creek	989.5	1.55
Duck Creek	825.0	1.29
Greenhill Cove	221.6	0.35
Longs Creek	2,028.0	3.17
Lynch Point Cove	113.2	0.18
Muddy Gut	653.0	1.02
Total	***7,720.2***	***12.06***

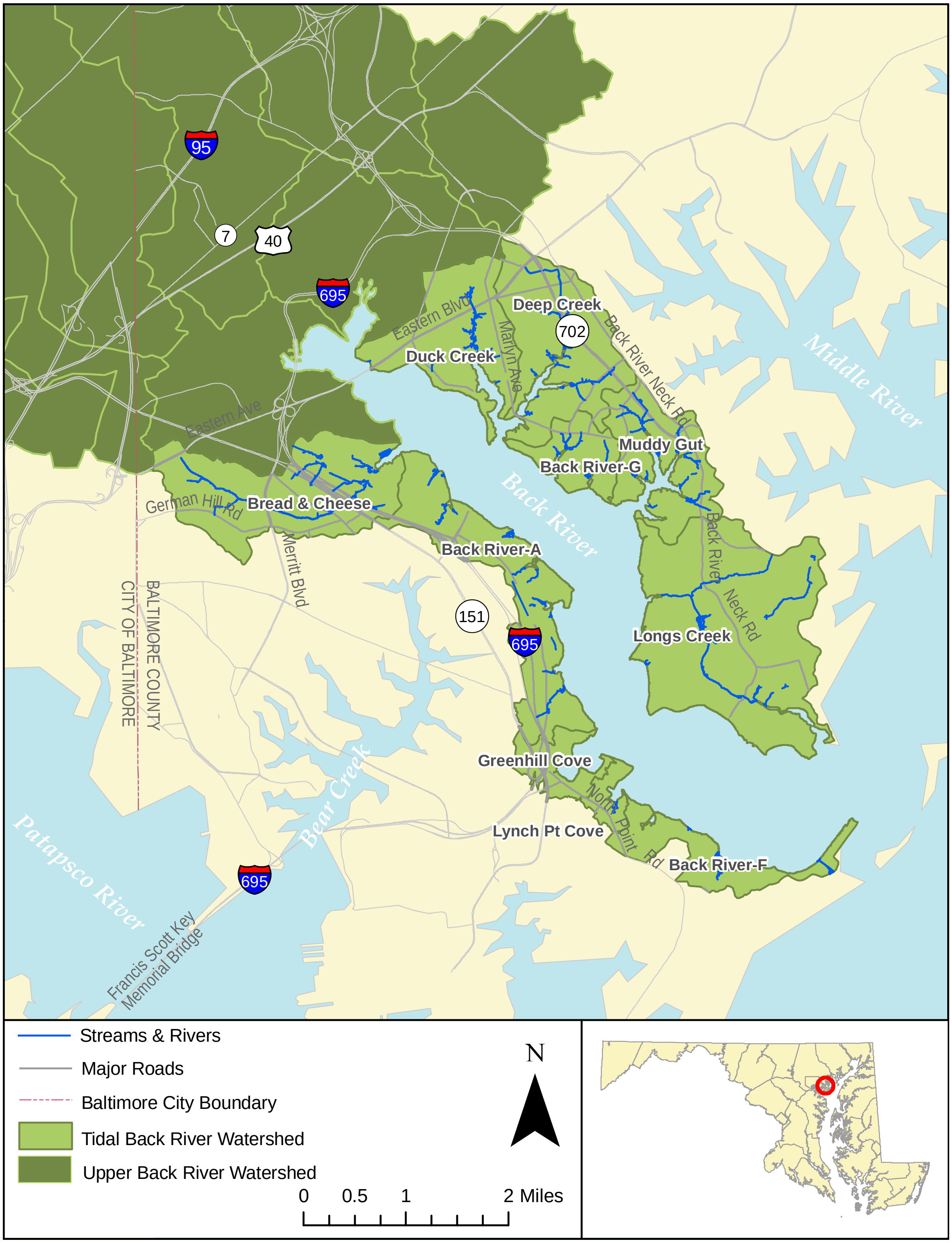


Figure 1-1: Tidal Back River Watershed Location

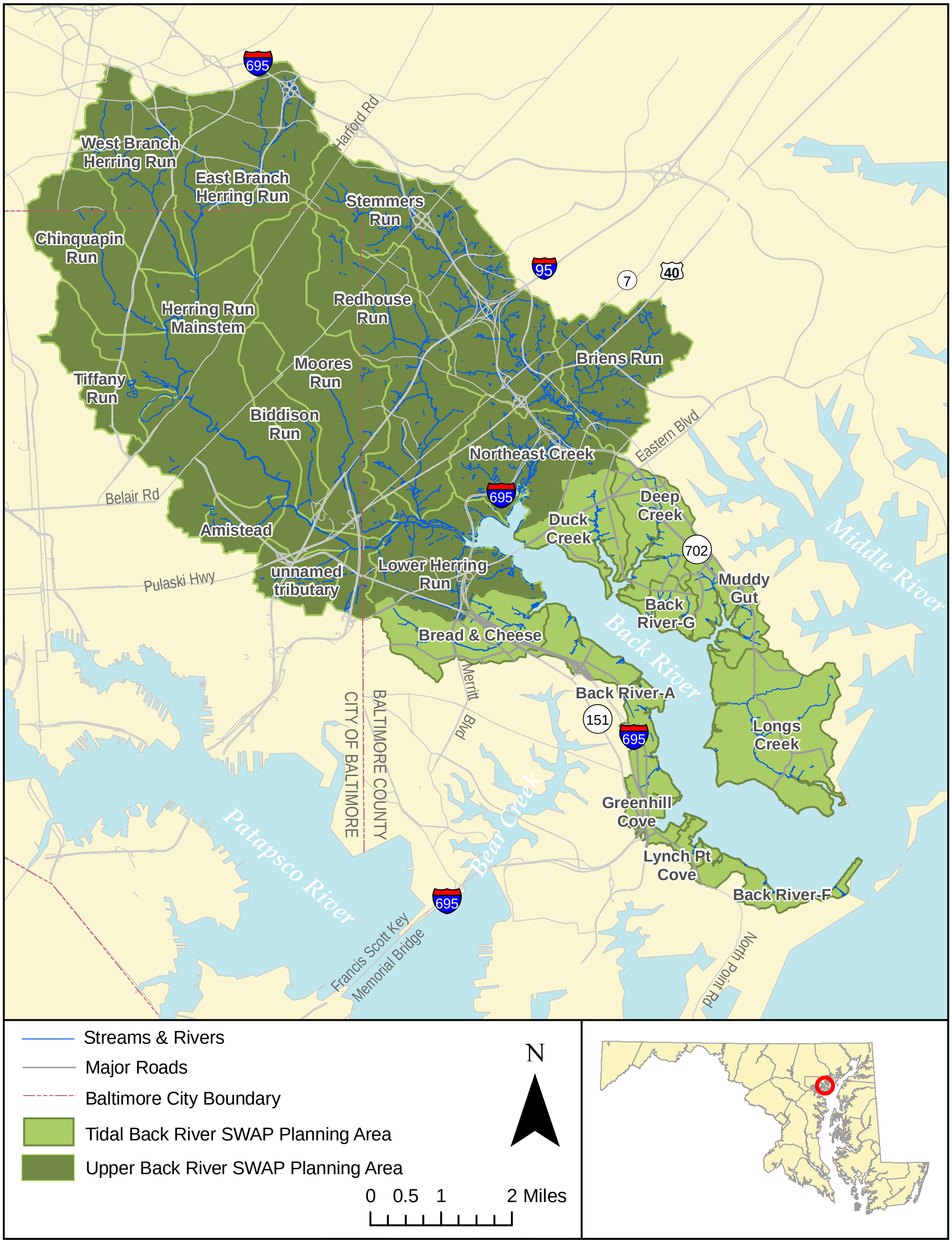


Figure 1-2: Back River SWAP Planning Areas

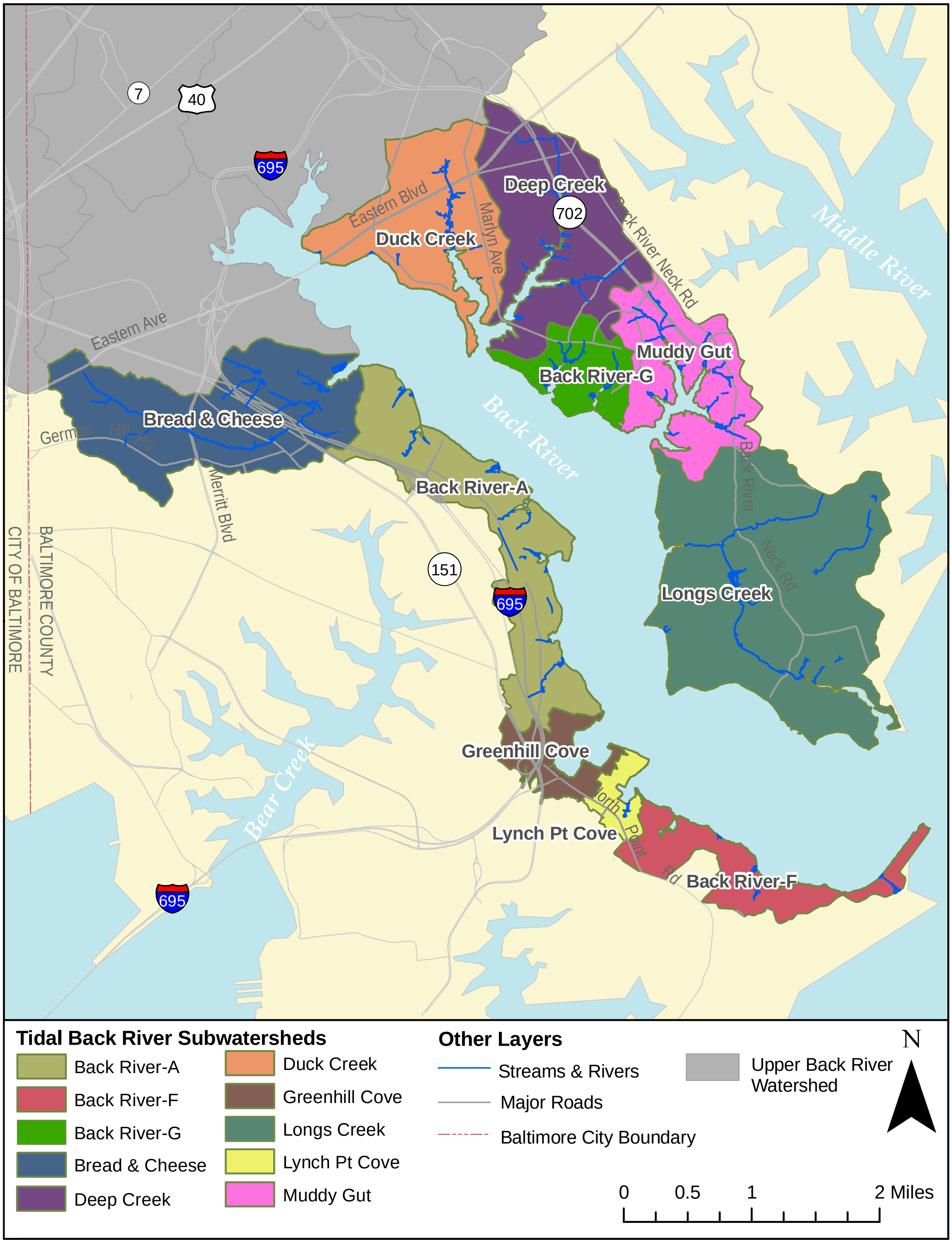


Figure 1-3: Tidal Back River Subwatersheds

1.3 Report Organization

This report is organized into the following six major chapters:

Chapter 1 explains the purpose of this report and the location and scope of the watershed characterization.

Chapter 2 summarizes watershed characteristics related to landscape and land use that may affect natural resources and water quality. This chapter contains landscape information related to natural features such as geology, soils, forest cover, and streams and pertaining to human influence such as land use, population, impervious cover, water distribution and storm water infrastructure.

Chapter 3 discusses water quality and quantity conditions based on available monitoring and stream assessment data.

Chapter 4 describes the uplands assessment conducted to identify pollutant sources and restoration opportunities for neighborhoods, institutions, pervious areas, and hotspots.

Chapter 5 presents restoration and preservation strategies appropriate for accomplishing watershed goals developed by the community and Back River Steering Committee.

Chapter 6 contains a list of references consulted during the development of this report.

CHAPTER 2: LANDSCAPE AND LAND USE

2.1 Introduction

This chapter describes land cover and land use in the Tidal Back River including natural land surface characteristics and development activities. Land-use related parameters such as soil type and impervious cover strongly influence the quantity and quality of watershed runoff. For example, the amount and rate at which precipitation will be absorbed by the ground surface depends on the infiltration capacity of a soil for pervious areas; impervious (e.g., paved) surfaces impede rainfall infiltration which can result in flooding, erosion, and a decrease in groundwater supply. In addition, the type and extent of pollutants carried by stormwater is affected by land use characteristics. For example, residential or agricultural areas may contribute fertilizers and pesticides to stormwater runoff. Developed areas may transmit various types of pollutants directly to receiving water bodies such as trash, bacteria (livestock and pet waste), and chemicals depending on land use activities since there is often inadequate buffer or vegetation to filter pollutants. The information presented in this chapter provides the physical setting and background necessary to evaluate other watershed components including water quality, natural resources, restoration, and management.

2.2 Natural Landscape

Natural climate and land surface characteristics relevant to watershed properties and processes are described in the following sections.

2.2.1 Climate

Climate is an important consideration since it can influence soil and erosion processes, stream flow patterns, and topography. In addition, climate affects vegetative growth and determines the species composition of terrestrial and aquatic life of a region.

This region can be described as a humid continental climate with four distinct seasons (DEPRM 2008). It has a relatively temperate climate due to the combined effects of the Appalachian Mountains to the west and the Chesapeake Bay and Atlantic Ocean to the east. According to the National Climatic Data Center (NCDC), it is also in the path of low pressure systems that move across the country which results in frequent changes in wind direction and weather (NCDC 2009). Average annual rainfall in Baltimore, Maryland is 40.76 inches based on 30 years of data (1961-1990) (NRCC 2009). Monthly average rainfall is approximately 3.40 inches based on the same data set. Rainfall is uniformly distributed throughout the year, with monthly averages ranging from 2.98 inches for October to 3.92 inches for August. Most snowfall occurs in December, January, February, and March; an average annual snowfall is 21.1 inches based on 48 years of data (1961-1998).

2.2.2 Watershed Delineation

A watershed-based approach for evaluating water quality conditions and improvement potential involves determining the drainage area that contributes runoff and groundwater to a specific water body. Drainage areas vary greatly in size depending on the scale of the stream system of interest. Drainage areas for large river, estuary, and lake systems are typically on the order of several thousand square miles and are often referred to as basins. For example, the Chesapeake Bay basin covers over 64,000 square miles, including over 100,000 tributaries (i.e., rivers and streams) and portions of six different states (CBP 2009). Basins consist of sub-basins which refer to drainage areas on the order of several hundred square miles and may consist of one or more major stream networks. Maryland has 13 sub-basins including the Patapsco/Back River sub-basin. Sub-basins are further subdivided into watersheds and subwatersheds which are the most commonly used and practical hydrologic units for management and restoration purposes. There are 138 state-defined watersheds (called 8-digit watersheds) in Maryland, ranging in size from 20 to 100 square miles. Over 1,100 subwatersheds (called 12-digit watersheds) have been identified by Maryland Department of Natural Resources (DNR); subwatersheds refer to the drainage areas of a specific stream and typically cover 10 square miles or less. (DNR 2005)

There are 14 state-defined, 8-digit watersheds and 51 DNR-defined, 12-digit subwatersheds in Baltimore County. The Back River watershed is approximately 55 square miles (35,437 acres) and consists of five 12-digit subwatersheds. For planning and management purposes, the Back River watershed has been further subdivided into 24 subwatersheds by Baltimore County. As discussed previously, the Back River watershed was divided into two planning areas: the Upper Back River and the Tidal Back River (see Figure 1-2). As the name indicates, the Upper Back River planning area includes the higher portion of the Back River watershed and the mouth of Back River. It covers approximately 43 square miles (27,717 acres) and consists of 14 subwatersheds. The Tidal Back River planning area comprises the lower portion of the Back River watershed which ultimately discharges to the Chesapeake Bay. It includes 10 subwatersheds (see Figure 1-3) and encompasses approximately 12 square miles (7,720 acres) or nearly a quarter of the Back River watershed. Baltimore County's Office of Information Technology (OIT) provided Geographic Information System (GIS) data including watershed and subwatershed delineations based on Maryland's state-defined 8- and 12-digit watersheds, respectively and Baltimore County's 1954 topographic maps (OIT 2008).

2.2.3 Topography

Topography of a region describes the relative positions and elevations of surface features such as ridges and valleys. Land surface shape, including degree of slope and concavity, is important as it affects the flow of surface water, soil erosion patterns, and suitability for development. For example, steep slopes are more prone to overland flow and soil erosion than flatter slopes which also means a greater potential for generating pollutants. Slopes were determined based on Baltimore County's GIS soils data and divided into the following five categories, derived from slope class definitions provided in the USDA *Soil Survey Manual* (USDA 1993):

- Nearly level (0 to 5% slopes)
- Gently sloping, undulating (2 to 10% slopes)
- Strongly sloping, rolling (4 to 16% slopes)
- Moderately steep, hilly (10 to 30%)
- Steep (15 to 65%)

Table 2-1 summarizes the percent breakdown of each soil slope category by subwatershed. The distribution of these slope categories within the Tidal Back River watershed is depicted in Figure 2-1.

Table 2-1: Tidal Back River Subwatershed Slope Categorization

	SLOPE CATEGORY				
SUBWATERSHED	Nearly Level* (0-3%)	Gently sloping, undulating (2-10%)	Strongly sloping, rolling (4-16%)	Moderately steep, hilly (10-30%)	Steep (15-65%)
Back River-A	45.6	52.6	1.9	0.0	0.0
Back River-F	62.5	36.7	0.8	0.0	0.0
Back River-G	30.3	69.7	0.0	0.0	0.0
Bread & Cheese	33.2	50.8	3.0	11.9	1.1
Deep Creek	29.6	67.4	0.9	2.1	0.0
Duck Creek	18.9	75.5	2.8	2.8	0.0
Greenhill Cove	40.4	59.6	0.0	0.0	0.0
Longs Creek	71.4	26.3	1.6	0.3	0.3
Lynch Pt Cove	71.4	28.6	0.0	0.0	0.0
Muddy Gut	26.9	73.1	0.0	0.0	0.0
Total	***44.5***	***51.2***	***1.5***	***2.5***	***0.2***

* Includes 'Water/Pavement' features shown in Figure 2-1.

Since the Tidal Back River watershed is located within the Coastal Plain region, the area is relatively flat. As shown in Figure 2-1 and Table 2-1, the majority of the watershed is gently sloping (~51%) or nearly level (~45%). Therefore, this area is generally less prone to erosion; note, however, that erosion also depends on soil type and land use/land cover. Less than three percent of the watershed has moderately steep or steep slopes. Steeper slopes are mostly located in the northeastern portion of the watershed near the mouth of Back River. Bread and Cheese is the subwatershed with the greatest proportion of moderately steep and steep slopes (13% of its area) making it more prone to erosion (again depending on soil type and land use). Duck Creek and Deep Creek have the second and third highest fractions of moderately steep and steep slopes, respectively, although not as significant (~3% and ~2%, respectively).

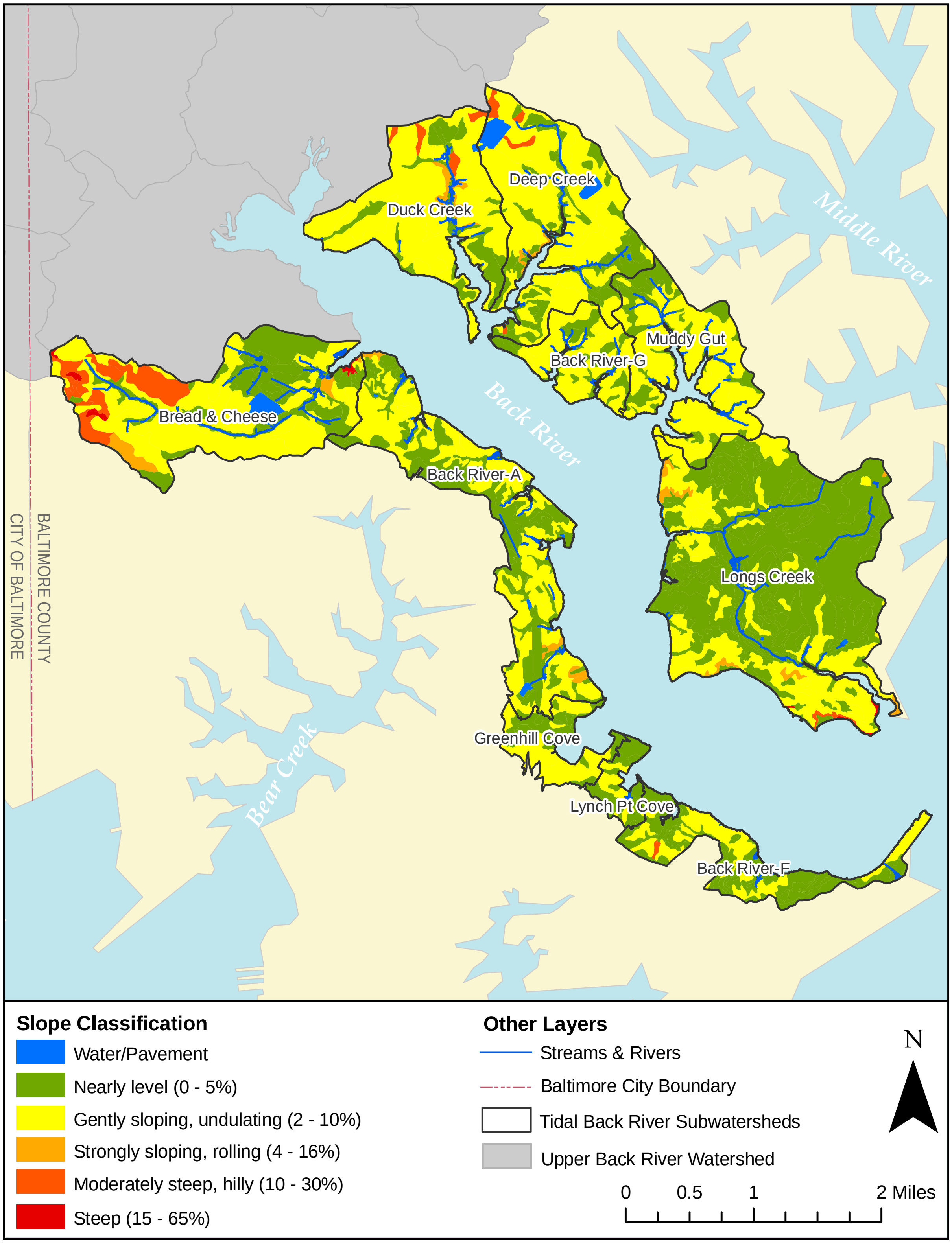


Figure 2-1: Tidal Back River Topography based on Soil Slopes

2.2.4 Geology

The Tidal Back River watershed is within the Coastal Plain Province which is underlain by unconsolidated rocks including gravel, sand, silt, and clay (MGS 2009). This overlaps the metamorphic rock that underlies the northern portion of the Back River watershed within the Piedmont region. The dominant geological formation of all subwatersheds (100% of total area) within Tidal Back River watershed is Patapsco Formation.

Geology has an effect on the chemical composition of surface and groundwater and groundwater/well recharge rate. It is also relevant to soil formation and influences the buffering of pollution to water bodies in developed areas. Consequently, geology is closely related to water quality.

2.2.5 Soils

Soil conditions are important when evaluating water quantity and quality in streams and rivers. Soil type and moisture conditions, for example, impact how land may be used and its potential for vegetation and habitat. Soils are an important consideration for projects aimed at improving water quality and/or habitat. Baltimore County's GIS soils layer was used for the soils data analysis and is a representation of the Baltimore County Soil Survey published by USDA/NRCS in 1976.

2.2.5.1 Hydrologic Soil Groups

The Natural Resources Conservation Service (NRCS) classifies soils into four hydrologic soil groups (HSG) based on runoff potential. Runoff potential is the opposite of infiltration capacity (ability for the soil to absorb precipitation). Soils with high infiltration capacity will have low runoff potential, and vice versa. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile (e.g., land development activities). For example, urbanization in watersheds with high infiltration rates (e.g., sands and gravels) will impact runoff more than in watersheds consisting mostly of silts and clays which have low infiltration rates. The four hydrologic soil groups are A, B, C, and D where Group A soils generally have the lowest runoff potential and Group D soils have the greatest.

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

- **Group A** soils include sand, loamy sand, or sandy loam types. These soils have a high infiltration rate and low runoff potential even when thoroughly wet. These consist mainly of deep, well to excessively drained sands or gravel. These soils have a high rate of water transmission.

- **Group B** soils include silt loam or loam types. They have a moderate infiltration rate when thoroughly wet. These soils mainly consist of somewhat deep to deep, moderately well to well drained soils with moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- **Group C** soils are sandy clay loam. These soils have a low infiltration rate when thoroughly wet. These types of soils typically have a layer that hinders downward movement of water and soils with moderately fine texture or fine texture. These soils have a low rate of water transmission.

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

Table 2-2: Tidal Back River Subwatershed Hydrologic Soil Categorization

	Hydrologic Soil Group %			
SUBWATERSHED	**A**	**B**	**C**	**D**
Back River-A	3.3	16.0	51.7	29.0
Back River-F	0.0	20.5	47.2	32.3
Back River-G	0.0	11.0	40.6	48.4
Bread & Cheese	2.1	49.3	18.1	30.5
Deep Creek	1.5	47.4	33.5	17.6
Duck Creek	0.0	73.3	18.9	7.8
Greenhill Cove	2.5	63.6	26.0	7.9
Longs Creek	2.0	17.1	53.2	27.7
Lynch Pt Cove	0.0	59.3	34.0	6.7
Muddy Gut	0.0	0.7	67.7	31.7
Total	***1.5***	***32.3***	***40.8***	***25.4***

As shown in Table 2-2 and Figure 2-2, most soils in the Tidal Back River Watershed are classified as Group C and B soils which correspond to a low and medium infiltration rates, respectively or relatively high runoff potential. Additionally, about a quarter of the soils fall within the Group D category representing high runoff potential.

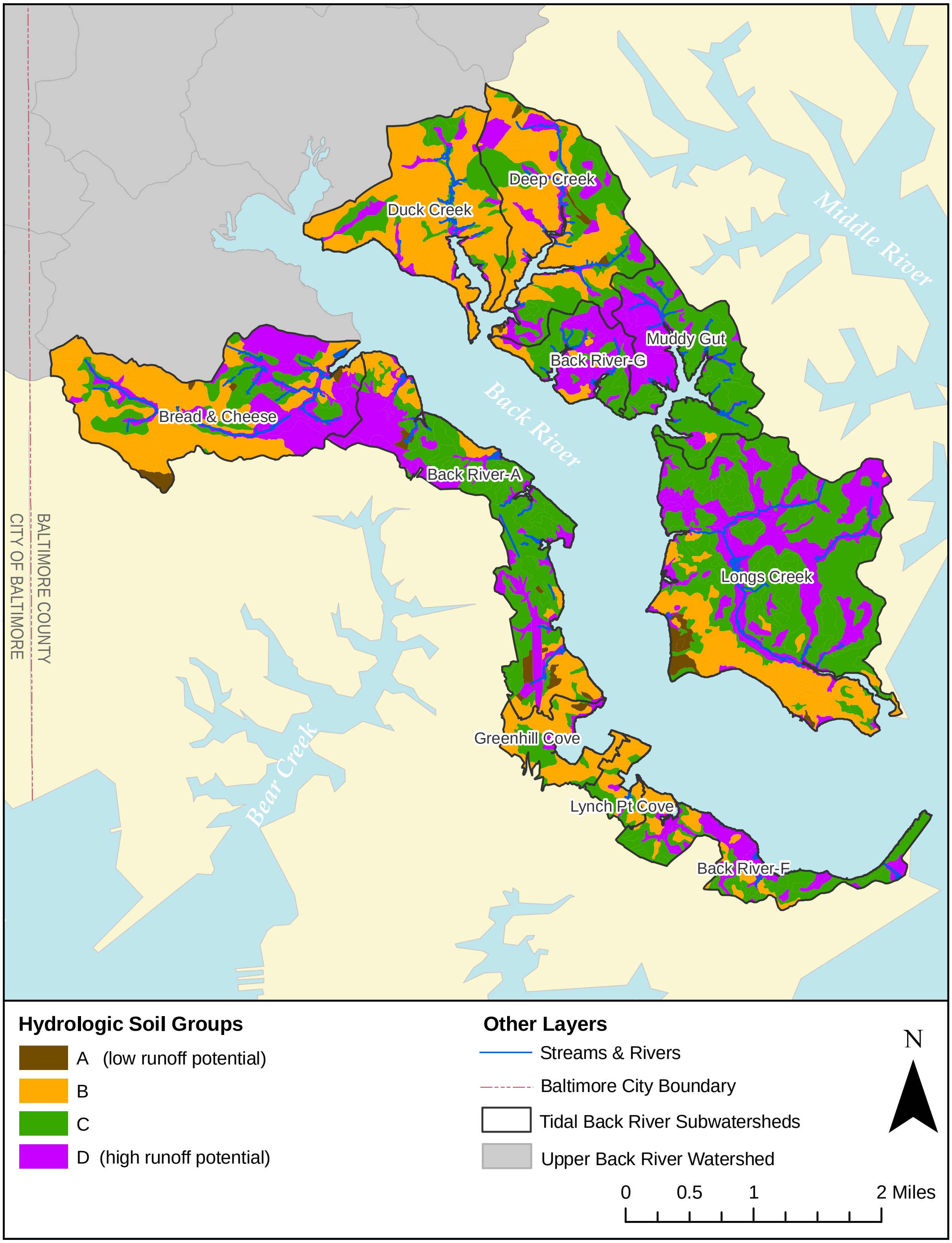


Figure 2-2: Tidal Back River Hydrologic Soil Groups

2.2.5.2 Erodibility

Erodibility is the susceptibility of soil to erosion. It is quantified by the K factor, which is part of the Universal Soil Loss Equation (USLE) developed by USDA's Agricultural Research Service to estimate rate of erosion and soil loss for a particular site. Low K factor values indicate low erodibility or high resistance to detachment and high K factors represent high erodibility potential. Erodibility is based on the physical and chemical properties of the soil, which determine how strongly soil particles cohere with one another. For example, clay soils are cohesive or resistant to detachment and have low K values on the order of 0.05 to 0.15 (Ouyang 2002).

Soil erodibility was divided into the following three categories based on the grouping of soils data obtained from Baltimore County's OIT for Tidal Back River:

- Low Erodibility (K factor < 0.24);
- Medium Erodibility (0.24 ≤ K factor ≤ 0.32); and
- High Erodibility (K factor > 0.32).

Figure 2-3 illustrates the distribution of soil erodibility in the Tidal Back River watershed based on these categories and a summary by subwatershed is shown in Table 2-3.

Subwatersheds with the largest fractions of highly erodible soils present the greatest potential for addressing soil conservation issues via best management practices (BMPs) such as minimizing bare soil and keeping topsoil in place. Soil erodibility data are also useful in combination with other information such as location of cropland, slope steepness, and distance to streams to determine where retirement of highly erodible land, another BMP, is appropriate. High K factor values can also serve as a warning for urban activities planned near streams such as road construction or utility placements.

Table 2-3: Tidal Back River Subwatershed Soil Erodibility Categorization

	SOIL ERODIBILITY CATEGORY %		
SUBWATERSHED	**Low***	**Medium**	**High**
Back River-A	12.7	21.6	65.7
Back River-F	12.3	49.1	38.7
Back River-G	4.1	15.2	80.7
Bread & Cheese	17.4	51.2	31.4
Deep Creek	34.7	24.4	40.9
Duck Creek	13.0	74.7	12.3
Greenhill Cove	10.8	65.9	23.4
Longs Creek	4.4	25.8	69.9
Lynch Pt Cove	1.0	72.0	26.9
Muddy Gut	3.4	0.1	96.5
Total	***12.5***	***34.9***	***52.6***

* Includes 'Water/Pavement' features shown in Figure 2-3.

As shown in Table 2-3 and Figure 2-3, medium and high erodibility categories represent over 85 percent of the soil erodibility distribution in the Tidal Back River watershed; more than 50 percent of the soils are classified as higly erodible. This indicates that most of the watershed's soils are prone to moderate or high erosion. Significant portions of subwatersheds Back River-A, Back River-G, Longs Creek, and Muddy Gut consist of highly erodible soils. Note that these areas also correspond to the soils classified as hydrologic Groups C and D representing high runoff potential (see Figure 2-2). The same observation can be made for portions of Bread and Cheese, Deep Creek and Duck Creek with highly erodible soils and soils with medium to high runoff potential. Back River-G and Muddy Gut are almost entirely represented by highly erodible soils. Nearly 70 percent of soils in Longs Creek are classified as highly erodible; however soils in this subwatershed were classified mostly as nearly level in terms of slope. These areas would rank as a priority for maintaining protective land cover such as forested area. Since significant portions of these subwatersheds are relatively undeveloped compared to the rest of the watershed (see section 2.3.1 for land use discussion), preserving forested area would protect those areas prone to erosion from becoming a potential sediment source.

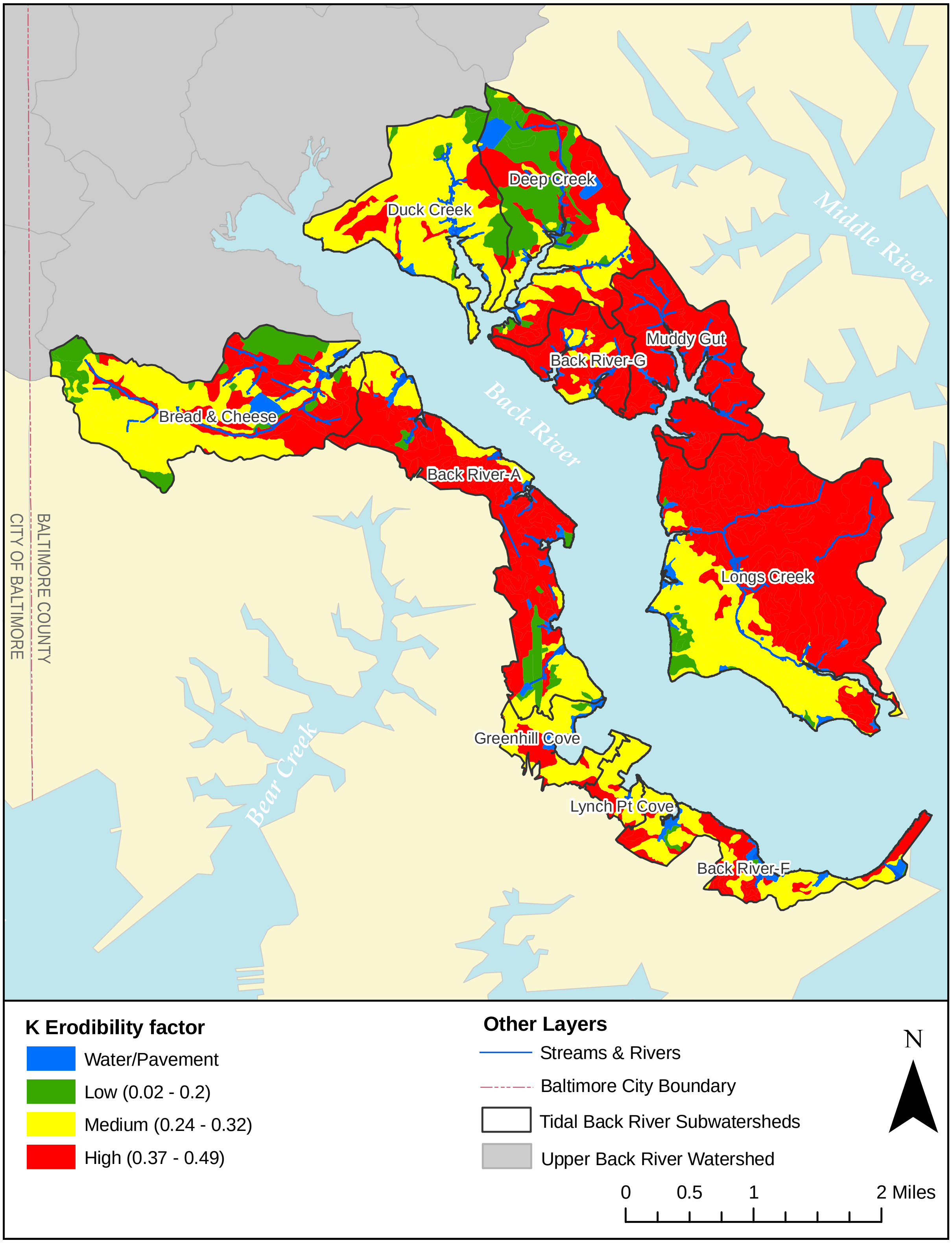


Figure 2-3: Tidal Back River Soil Erodibility (based on the K factor)

2.2.6 Forest Cover

Forest provides the greatest protection among land cover types for water and soil quality. In pristine systems, forest and soils co-evolve, shaping the hydrologic cycle; these systems operate within a natural range of variability, assuring healthy habitat and water quality. The entire Chesapeake Bay basin, including the Tidal Back River watershed, consisted overwhelmingly of old-growth forest at the time of European settlement. In human-impacted systems, forest cover can still provide many benefits and protect water quality if judiciously planned and conserved.

While the forested area has been greatly reduced in the Tidal Back River watershed since European settlement, it remains relatively high compared to more urbanized watersheds in the region such as the adjacent Upper Back River planning area. Table 2-4 summarizes forested acres and percent forested area by subwatershed and Figure 2-4 shows the distribution of forest cover within the Tidal Back River watershed based on Baltimore County's wooded GIS layer. To create this layer, wooded areas were delineated at the outer boundary of tree trunks (not tree canopies) using aerial photographs from 1995, 1996, and 1997.

Table 2-4: Tidal Back River Subwatershed Forested Area

Subwatershed	Total Acres	Forested Acres	% Forested
Back River-A	973.1	223.2	22.9
Back River-F	420.4	139.3	33.1
Back River-G	313.4	64.9	20.7
Bread & Cheese	1,183.0	134.5	11.4
Deep Creek	989.5	92.5	9.3
Duck Creek	825.0	64.1	7.8
Greenhill Cove	221.6	15.8	7.1
Longs Creek	2,028.0	1,321.6	65.2
Lynch Pt Cove	113.2	3.7	3.3
Muddy Gut	653.0	258.1	39.5
Total	***7,720.2***	***2,317.6***	***30.0***

Table 2-4 shows that the Tidal Back River watershed contains approximately 2,318 acres of forested area or slightly less than one-third of the total watershed area. This is generally consistent with Maryland Department of Planning's (MDP) 2007 land use/land cover classification scheme, which estimates that 32 percent of forest cover remains in the Tidal Back River watershed. (Slight variations between the County wooded layer and MDP land use/land cover scheme result from different scales and photo sources used.) Longs Creek is the subwatershed with the most forested acres and the highest percentage forested. Significant portions of Back River-F and Muddy Gut also remain forested. These areas represent a potential priority for forest preservation. The remaining subwatersheds contain less than 25 percent forest cover, where Lynch Pt Cove has the least forest cover (3.3 percent). All of these areas offer an opportunity for forest restoration.

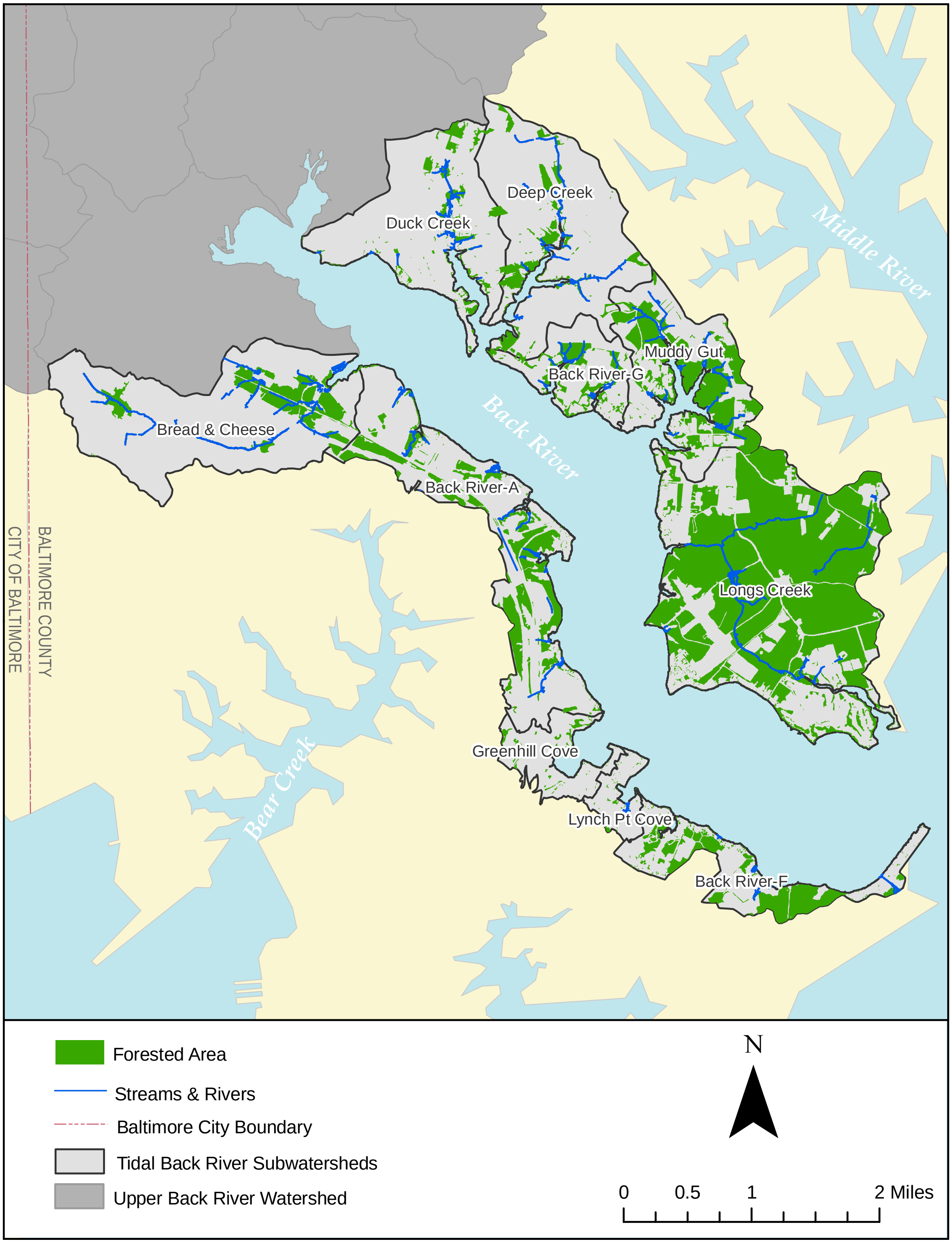


Figure 2-4: Tidal Back River Forest Cover

2.2.7 Stream Systems

Stream systems are a watershed's circulatory system, and the most visible part of the hydrologic cycle. Streams are the flowing surface waters; and while they are distinct from ground water and standing surface water such as lakes, they are closely connected to both. The stream system is an intrinsic part of the landscape and closely reflects conditions on the land. Streams are a fundamental natural resource with numerous benefits for plants, animals, and humans. Maintaining a healthy stream system is a priority for many individuals and organizations, and requires insuring that stream flows and water quality closely mimic the conditions found in un-impacted watersheds.

2.2.7.1 Stream System Characteristics

As discussed in Chapter 2.2.2, the entire Back River watershed is a state-defined 8-digit watershed and part of the Chesapeake Bay basin. The Tidal Back River watershed is a subset of the Back River watershed and is subdivided into 10 subwatersheds. The Tidal Back River watershed contains approximately 33 miles of streams, all of which drain to the Back River and ultimately to the Chesapeake Bay. A summary of stream mileage and density by subwatershed is included in Table 2-5. Figure 2-5 shows the streams and the 10 subwatersheds comprising the Tidal Back River watershed.

Table 2-5: Tidal Back River Stream Mileage and Density

Subwatershed	Area (sq. mi.)	Stream Miles	Stream Density (mi./sq. mi.)
Back River-A	1.52	3.94	2.59
Back River-F	0.66	1.26	1.92
Back River-G	0.49	1.75	3.58
Bread & Cheese	1.85	8.45	4.57
Deep Creek	1.55	3.86	2.50
Duck Creek	1.29	3.11	2.41
Greenhill Cove	0.35	0.00	0.00
Longs Creek	3.17	6.39	2.02
Lynch Pt Cove	0.18	0.36	2.03
Muddy Gut	1.02	3.98	3.90
Total	***12.06***	***33.10***	***2.74***

Bread & Cheese and Longs Creek have the greatest lengths of streams. These areas may represent a priority for stream restoration opportunities.

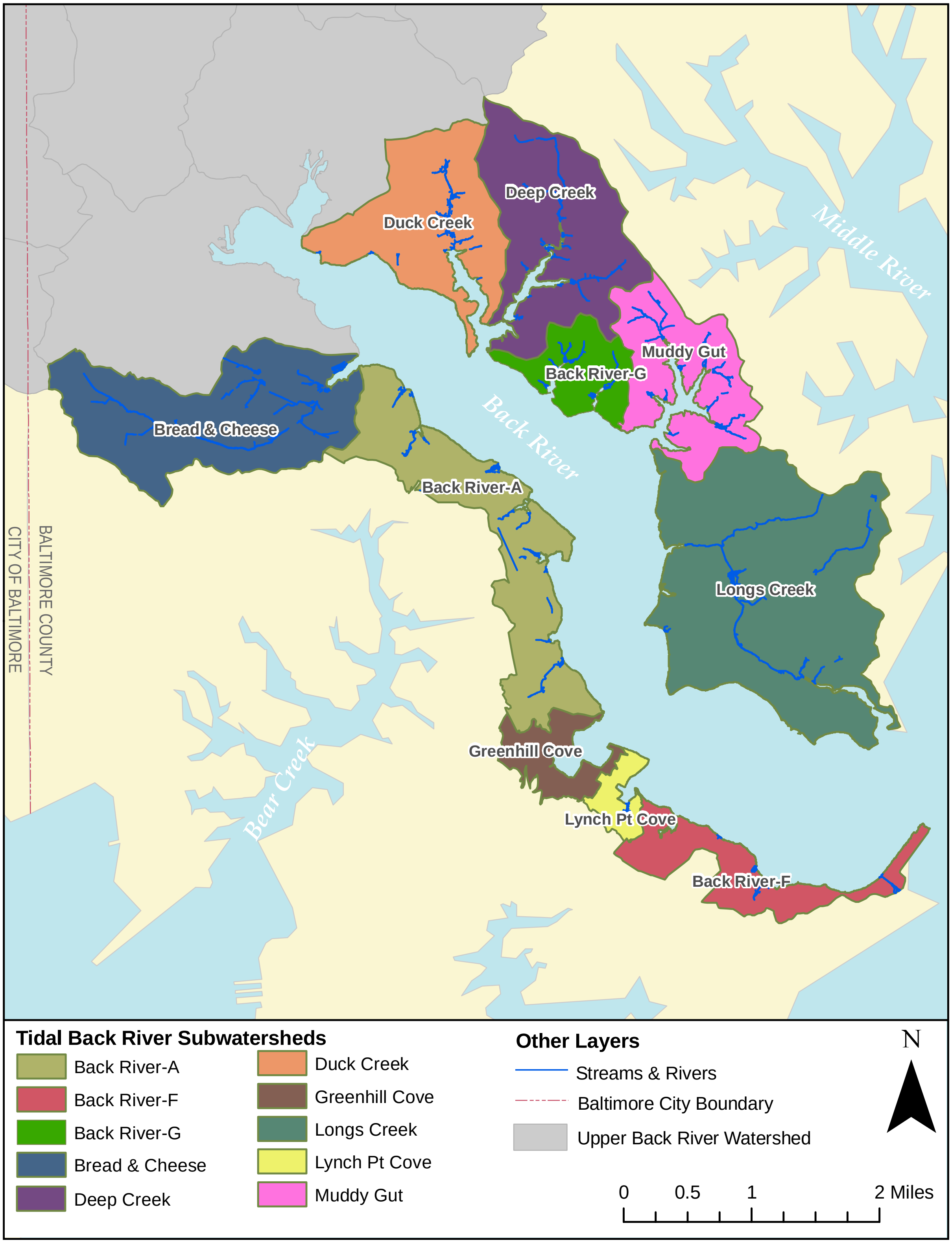


Figure 2-5: Tidal Back River Stream System and Subwatersheds

2.2.7.2 Stream Riparian Buffers

Riparian buffers refer to the vegetated areas adjacent to streams that protect water bodies from pollutant loads while also providing bank stabilization and habitat. Forested buffer areas along streams play a crucial role in improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life including fish. Tree roots, for example, capture and remove pollutants including excess nutrients (e.g., nitrogen) from shallow flowing water; the tree root structure also impedes erosion and water flow which in turn reduces sediment load and the risk of flooding. Tree canopy provides shading and results in cooler water temperatures required for much stream life, particularly cold-water species like trout. In smaller streams such as the ones surveyed, terrestrial plant material falling into the stream is the primary source of food for stream life. Trees provide seasonal food in the form of leaves and plant parts for stream life at the base of the food chain, while fallen tree branches and trunks provide a more consistent, slow-release food source throughout the year. Tree roots and snags also offer habitat for fish and other aquatic species. Maintaining healthy streams and forest buffers are important for reducing nutrient and sediment loadings to the Back River and to the Chesapeake Bay. When stream riparian buffers are converted from forest to agriculture or development (e.g., residential), many of these benefits are lost and stream health declines. Riparian buffer zones can be re-established or preserved as a BMP to reduce land use impacts by intercepting and controlling pollutants entering a water body.

The vegetative condition of the riparian buffer was analyzed based on a 100-foot buffer on either side of the stream system. Three conditions were used to classify stream buffer conditions: impervious, open pervious, or forested. Impervious areas were determined by overlaying the roads and buildings data layers over the 100-foot stream buffer layer. Similarly, the forested areas were determined using the wooded GIS layer and removing any impervious area footprint. Remaining areas were classified as open pervious areas. Stream buffer conditions are summarized by subwatershed in terms of acres and percentages in Table 2-6. The distribution of the 100-ft stream buffer classification scheme is shown in Figure 2-6.

Table 2-6: Tidal Back River Land Use in the 100 ft. Stream Buffer

	FORESTED		IMPERVIOUS		OPEN PERVIOUS		TOTAL	
SUBWATERSHED	Acres	%	Acres	%	Acres	%	Acres	%
Back River-A	14.9	24.9	4.9	8.1	40.3	67.0	60.1	11.4
Back River-F	1.2	9.6	1.1	8.6	10.3	81.8	12.6	2.4
Back River-G	17.4	63.7	1.0	3.8	8.9	32.5	27.3	5.2
Bread & Cheese	38.2	30.4	13.6	10.8	73.8	58.7	125.6	23.9
Deep Creek	14.9	21.1	12.0	17.0	43.5	61.8	70.3	13.4
Duck Creek	14.1	33.7	3.7	8.9	24.0	57.4	41.9	8.0
Greenhill Cove	0.0	--	0.0	--	0.0	--	0.0	--
Longs Creek	105.5	89.3	1.1	0.9	11.5	9.8	118.2	22.5
Lynch Pt Cove	0.1	3.6	0.1	5.0	2.5	91.3	2.8	0.5
Muddy Gut	35.6	53.0	6.8	10.1	24.9	37.0	67.2	12.8
Total	***242.0***	***46.0***	***44.3***	***8.4***	***239.6***	***45.6***	***525.9***	***100.0***

Lynch Pt Cove has the smallest percentage of forested buffer, however, the acreage of buffer area is very small. In addition, Greenhill Cove has zero stream buffer areas. Excluding these two subwatersheds, percentage of stream buffer that is forested ranges from as low as ~10 percent in Back River-F to as high as ~90 percent in Longs Creek with 46 percent of forested buffer area overall. Open pervious areas represent approximately 46 percent of the 100-foot stream buffer in the Tidal Back River watershed, meaning nearly half of the area offers potential opportunities for reforestation of the riparian buffer. While riparian buffer covered by impervious areas have less potential for remediation and make up less than 10 percent of the total area, there may be an opportunity for impervious cover removal and buffer reforestation.

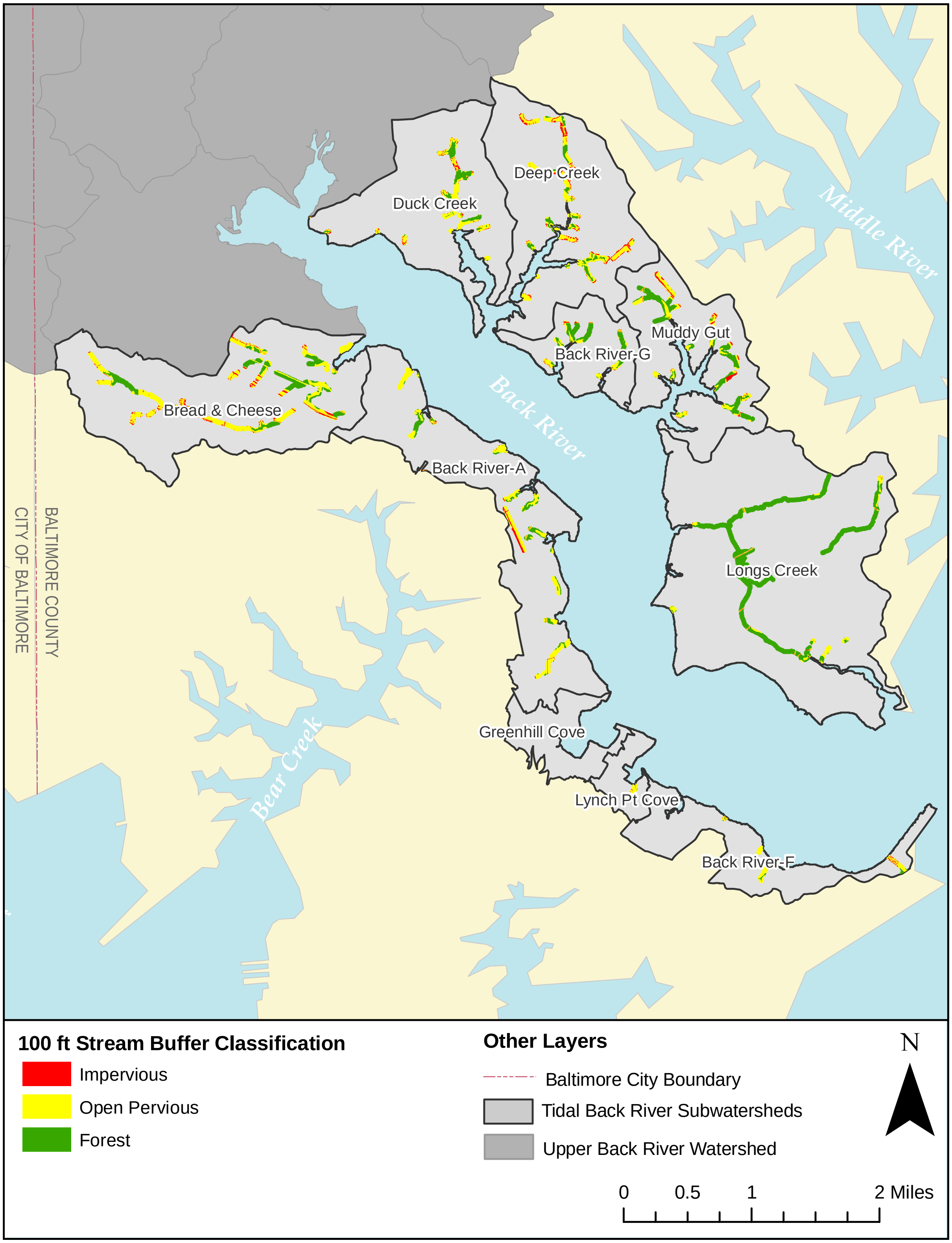


Figure 2-6: Tidal Back River 100 ft. Stream Buffer Condition

2.2.8 Tidal Waters

The tidal waters of Back River encompass approximately 3,947 acres. Embayments (e.g., coves, bays) represent about 10 percent of this area and the remaining 90 percent is open tidal water. The tidal waters of Back River are oligohaline which denotes low salinity/brackish waters (0.5 to 5 parts per thousand [ppt]). Water quality impairments related to nutrients, sediment, chlordane, and polychlorinated biphenyls (PCBs) have been identified for the tidal waters of Back River. The impairment listings reflect the inability to meet water quality standards for the designated uses of Back River which is Use I – water contact recreation, fishing, and protection of aquatic life and wildlife according to the Maryland Water Quality Standards Surface Water Use Designation [Code of Maryland Regulations (COMAR) 26.08.02.07]. Pollutant load limits are either under development or being implemented for the various pollutants of concern. In addition, targets have been established for submerged aquatic vegetation (SAV) and water clarity since these are both indicators of good water quality and habitat. SAV coverage of 340 acres and water clarity to 0.5 meters (1.64 feet) are proposed for Tidal Back River. Water quality issues and current conditions are discussed further in Chapter 3.

The Tidal Back River watershed contains approximately 34 miles of coastline. A summary of coastline mileage and density by subwatershed is included in Table 2-7.

Table 2-7: Tidal Back River Coastline Mileage and Density

Subwatershed	Area (sq. mi.)	Coastline Miles	Coastline Density (mi./sq. mi.)
Back River-A	1.52	5.72	3.76
Back River-F	0.66	3.70	5.64
Back River-G	0.49	1.85	3.78
Bread & Cheese	1.85	0.72	0.39
Deep Creek	1.55	3.17	2.05
Duck Creek	1.29	4.41	3.42
Greenhill Cove	0.35	1.61	4.66
Longs Creek	3.17	6.94	2.19
Lynch Pt Cove	0.18	1.01	5.69
Muddy Gut	1.02	4.67	4.58
Total	***12.06***	***33.81***	***2.80***

Longs Creek, Back River-A, and Muddy Gut are the subwatersheds with the greatest lengths of coastline. These areas represent a priority for shoreline restoration opportunities; however, restoration potential is often influenced by property ownership.

Similar to the stream riparian buffer analysis, the vegetative condition of the riparian buffer along the shoreline was analyzed based on a 100-foot buffer from the tidal waters. Three conditions were used to classify shoreline buffer conditions: impervious, open pervious, or forested. Impervious areas were determined by overlaying the roads and buildings data layers over the 100-foot shoreline buffer layer. Similarly, the forested areas were determined using the wooded GIS layer and removing any impervious area footprint. Remaining areas were classified as open pervious areas. Shoreline buffer conditions are summarized by subwatershed in terms of acres and percentages in Table 2-8. The distribution of the 100-ft shoreline buffer classification scheme is shown in Figure 2-7.

Table 2-8: Tidal Back River Land Use in the 100 ft. Shoreline Buffer

	FORESTED		IMPERVIOUS		OPEN PERVIOUS		TOTAL	
SUBWATERSHED	Acres	%	Acres	%	Acres	%	Acres	%
Back River-A	12.5	18.5	5.4	8.0	49.8	73.5	67.8	15.7
Back River-F	7.3	15.5	6.2	13.0	33.7	71.5	47.1	10.9
Back River-G	6.6	20.4	1.6	5.0	24.0	74.6	32.2	7.5
Bread & Cheese	2.3	24.1	0.2	2.2	7.1	73.6	9.6	2.2
Deep Creek	10.8	23.2	1.8	3.9	33.8	72.9	46.4	10.7
Duck Creek	7.3	13.9	8.2	15.6	37.1	70.5	52.6	12.2
Greenhill Cove	1.2	6.1	2.8	13.7	16.4	80.2	20.4	4.7
Longs Creek	24.7	28.7	4.6	5.4	56.6	65.9	85.9	19.9
Lynch Pt Cove	0.5	3.7	2.7	22.2	9.1	74.1	12.3	2.9
Muddy Gut	21.9	38.1	2.3	3.9	33.2	57.9	57.4	13.3
Total	***95.0***	***22.0***	***35.9***	***8.3***	***300.9***	***69.7***	***431.8***	***100.0***

Similar to the stream buffer analysis, Lynch Pt Cove has the smallest percentage of forested buffer. The percentage of shoreline buffer that is forested ranges from as low as ~4 percent in Lynch Pt Cove to ~38 percent in Muddy Gut with only 22 percent of forested shoreline buffer area overall. Open pervious areas represent nearly 70 percent of the 100-foot shoreline buffer in the Tidal Back River watershed, meaning over half of the area offers potential opportunities for reforestation of the shoreline riparian buffer. While riparian buffer covered by impervious areas have less potential for remediation and make up less than 10 percent of the total area, there may be an opportunity for impervious cover removal and buffer reforestation.

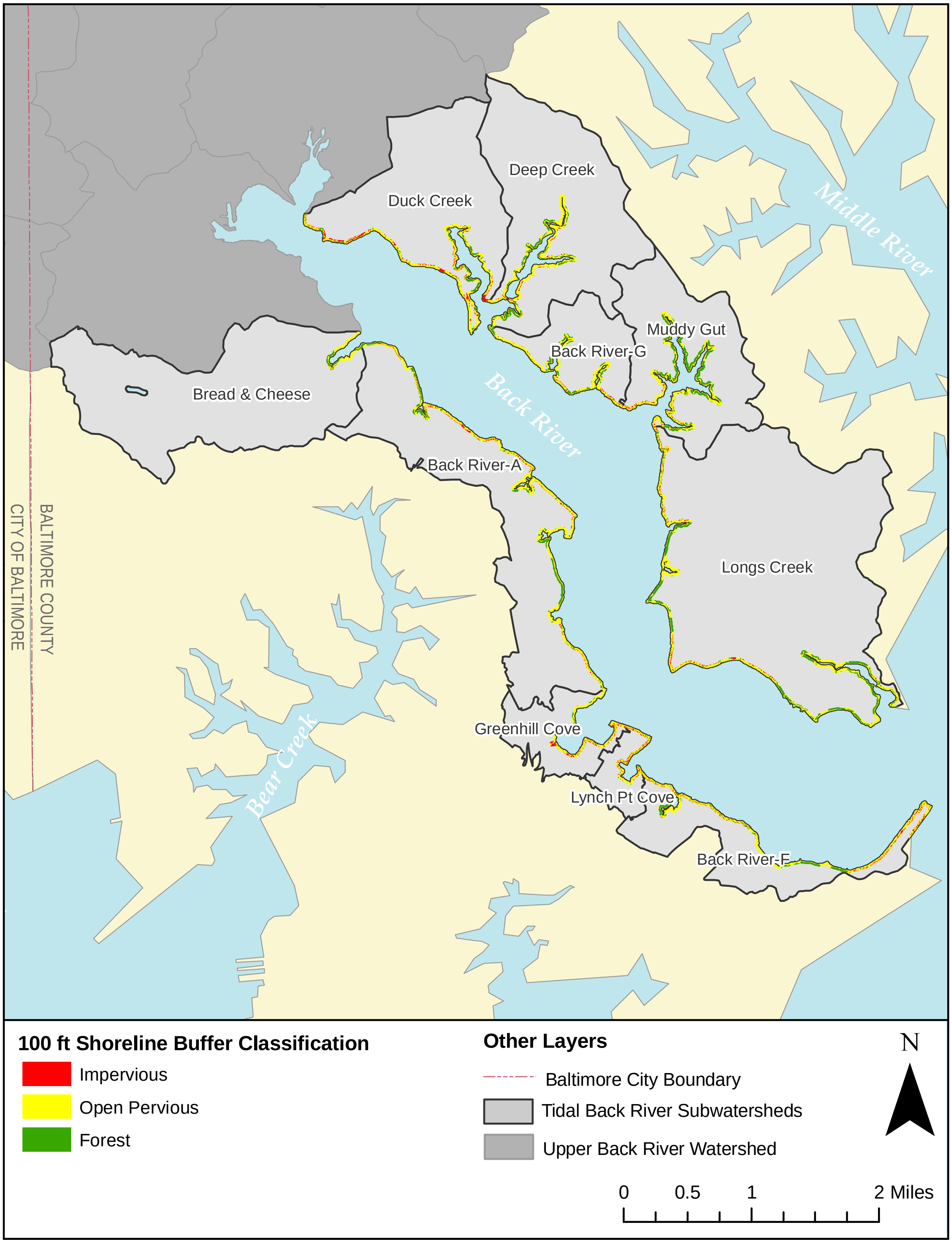


Figure 2-7: Tidal Back River 100 ft. Shoreline Buffer Condition

Baltimore County encompasses approximately 219 miles of tidal shoreline on several tributaries to the Chesapeake Bay. The County monitors and manages the conditions of its shorelines for the overall benefit of the public. Baltimore County Department of Environmental Protection and Resource Management (DEPRM), in particular, has a well established program for waterway improvement and coastal management to protect these resources and meet public demands for access and recreation. Approximately 8.5 miles of shoreline in the Tidal Back River watershed were identified as having enhancement potential in DEPRM's Shoreline Enhancement Feasibility Study (DEPRM 1998). This includes areas adjacent to previously improved shorelines, state lands, and large tracts of private lands where the County could cooperate with the property owner. The purpose of the feasibility study was to establish baseline shoreline conditions and identify shoreline enhancement potential. A summary of existing conditions results for the shoreline reaches surveyed in the Tidal Back River watershed are presented in Table 2-8 by subwatershed. This includes property ownership, reach lengths, adjacent land cover and land use, shoreline change rates, and presence of SAV.

As shown in Table 2-9, a total of 8 shoreline reaches were investigated in the Tidal Back River watershed, including 5 publicly-owned properties and 3 private lands that the County could approach. The locations of these 8 properties are approximately shown in Figure 2-8. There is at least one shoreline reach located in 7 out of the 10 subwatersheds. There are two reaches located within Longs Creek which is the subwatershed with the greatest length of coastline. The shoreline areas investigated are primarily forested which presents a good opportunity for preservation. A significant portion is also open pervious area (grass, open field) which may be an opportunity for reforestation. All areas represent an opportunity for resource conservation since there are no impervious surfaces along these shoreline reaches. SAV was either absent or unobserved at the time of this study in most areas except a small segment of the Rocky Point Park reach, along Longs Creek shoreline. Manmade structures including those for coastal protection and public access were identified at some of the shoreline reaches investigated in the watershed. This includes prior shoreline projects completed at Cox's Point Park and Rocky Point Park. Manmade structures present at Cox's Point Park include revetments, groins, sills, breakwaters, and marsh creation. Rocky Point Park includes revetments, groins, bulkheads, a boat ramp, and marsh creation. Derelict bulkheads were identified at Norris Farm Landfill and the Back River WWTP.

Shorelines change and erode naturally over time. Erosion patterns and rates vary depending on the degree of wave action and boat wakes to which a shoreline is subjected. The rates of erosion or accretion presented in feet per year in the table above were based on scaled measurements and comparisons of Maryland Geological Survey's oldest and more recent shoreline maps. Table 2-9 shows the greatest rates of changes for shoreline reaches surveyed in Back River-A, Back River-F, Bread and Cheese, and Longs Creek.

Table 2-9: Shoreline Study Results for Tidal Back River

				Land Cover (%)					
Subwatershed	**Reach Name**	**Owner-ship**	**Reach Length (ft)**	Open Pervious	Forest	Impervious	**Land Use**	**Erosion/ Accretion Rate (ft/yr)**	**SAV**
Back River-A	Norris Farm Landfill	Private	5,000	50	50		Other	+0.6 to -0.9	Absent
Back River-F	North Point State Park	State	3,700		100		Park	-1.9	Absent
Back River-G	-	-	-	-	-	-	-	-	-
Bread & Cheese	Back River WWTP	City	6,700	50	50		Industrial	+1.2 to -0.8	Absent
Deep Creek	Fox Ridge Park	County	100		100		Park	No data	Unobserved
Duck Creek	Cox Point Park	County	5,500	70	30		Park	Null	Absent
Greenhill Cove	-	-	-	-	-	-	-	-	-
Longs Creek	Essex Sky Park	Private	5,600	1	99		Industrial	-0.8 to -3.5	Absent
	Rocky Point Park	County	17,400	60	40		Park	+0.8 to -3.3	Present
Lynch Pt Cove	-	-	-	-	-	-	-	-	-
Muddy Gut	Somogyi Farm	Private	1,000		100		Park	Null	Absent

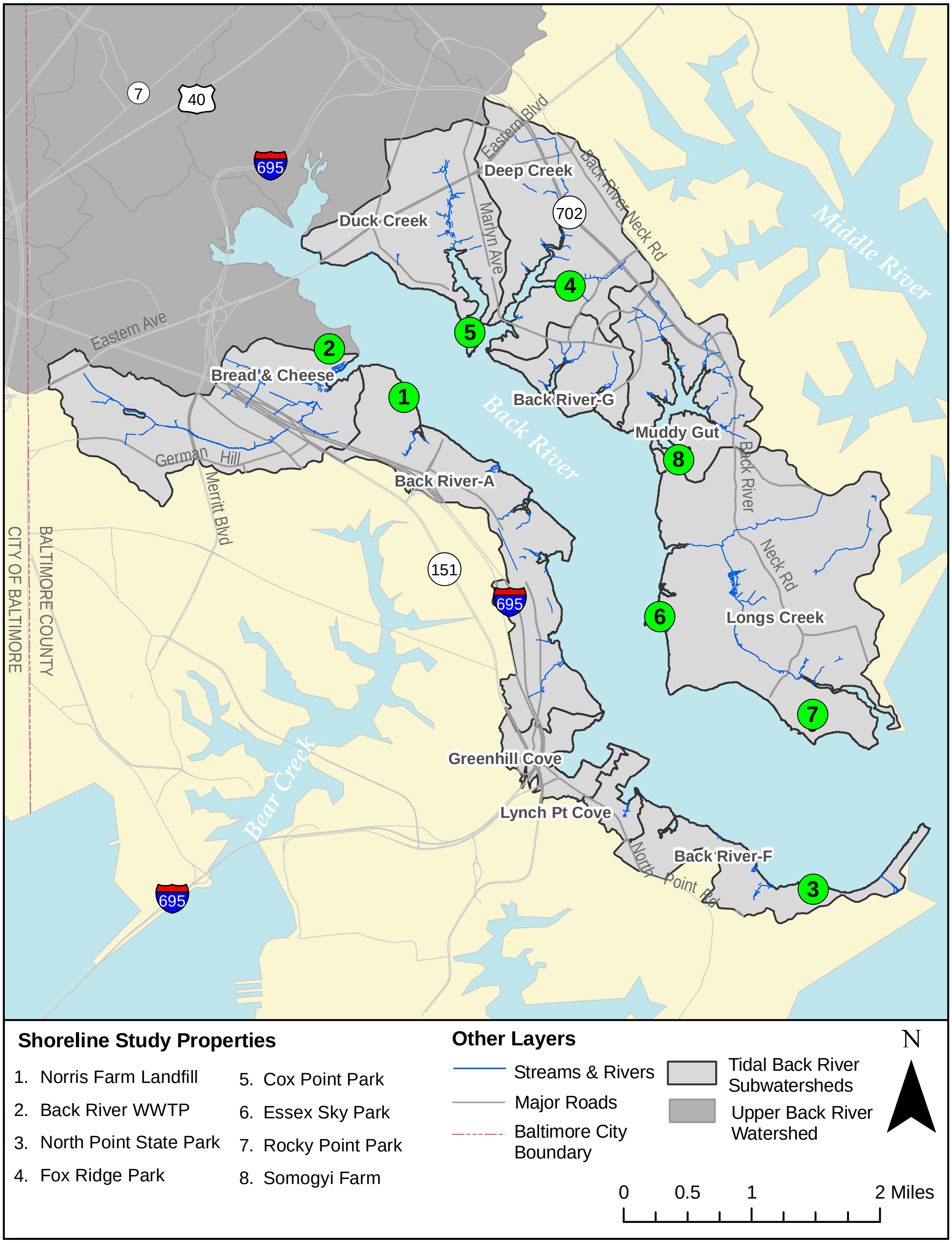


Figure 2-8: Potential Shoreline Enhancement Properties in Tidal Back River

After baseline conditions were established and reviewed, DEPRM rated enhancement potential for the reaches studied. For each reach, a rating was assigned to describe the feasibility of implementing the following five categories of enhancement projects:

- Erosion Control
- Habitat Enhancement
- Existing Project – Expansion/Protection/Enhancement
- Existing Project – Enhancement/Retrofit
- Beneficial Use

Enhancement potential and feasibility for each category was rated as high, medium or low based on accepted practice and professional judgment/experience of the study team. In general, reaches with serious erosion or degraded habitat were designated as high enhancement potential. A low enhancement potential rating was assigned where a low probability of success was anticipated such as reaches that were relatively stable with a balanced habitat or where development would have measurable impacts. Reaches where the shorelines were stable or where previous enhancement projects were successful were classified as complete/stable and not prioritized for shoreline enhancement. Feasibility ratings for potential shoreline enhancement projects are summarized in Table 2-10.

Table 2-10: Shoreline Enhancement Feasibility Ratings

Subwatershed	Reach Name	Erosion Control	Habitat Enhance	Expand Ex. Project	Retrofit Ex. Project	Beneficial Use
Back River-A	Norris Farm Landfill	M	H			M
Back River-F	North Point State Park	H				M
Back River-G	-	-	-	-	-	-
Bread & Cheese	Back River WWTP	M	M			L
Deep Creek	Fox Ridge Park	Complete/Stable				
Duck Creek	Cox Point Park		L		L	
Greenhill Cove	-	-	-	-	-	-
Longs Creek	Essex Sky Park	H				M
	Rocky Point Park	M	H	L		
Lynch Pt Cove	-	-	-	-	-	-
Muddy Gut	Somogyi Farm	L	L			

Potential shoreline enhancement sites were narrowed down based on the feasibility ratings. During the screening process, three sites were not carried forward including Fox Ridge Park since it was designated as currently stable and Cox's Point Park and Somogyi Farm since they received two low potential ratings. Shoreline areas identified as warranting erosion protection and/or ecological improvement included reaches in Back River-A, Back River-F, Bread and Cheese, and Longs Creek.

2.2.9 Waterway Dredging

Dredging of tidal waterways to restore or enhance use and navigability for both recreational and commercial boat traffic is an integral component in the management of the County's 219 miles of shoreline. Recreational and commercial boating and the industries it supports have developed into a significant component of the County's economy.

Baltimore County DEPRM initiated a comprehensive dredging program in 1987 to address the demand for dredging and to identify and control the sources of sedimentation. The funding for the dredging program is typically cost shared between Maryland DNR and Baltimore County Funds. The State DNR funding is from the State Excise Tax, which is generated from the tax on the sale of boats; thus, the state funds are used to benefit boaters. In order to systematically address issues and establish a County-wide program, a study was completed in 1988 to develop priorities for all the tidal waterways in the County. The report prioritized 63 segments of 26 creeks. The study evaluated the volume of material to be dredged and the number of boaters benefiting from each dredging project. This report has been used as a tool for implementation of the County's program.

Baltimore County DEPRM administers the dredging program which includes: collecting the necessary data to determine the need for dredging; identifying environmental constraints; evaluating dredged material placement opportunities; applying for State and Federal Permits; assisting spur applicants with permit applications; and the design and construction management for the project. Baltimore County also identifies problems and implements necessary corrections to improve water quality for each creek through water quality improvement projects.

Baltimore County DEPRM has planned, designed, permitted and overseen the construction of dredging projects on several tributaries in Back River. Lynch Point Cove main stem and spurs were dredged in 1991. Muddy Gut and Greenhill Cove main stem and spurs were dredged in 1996, and Duck and Deep Creeks were dredged in 2008. Maintenance dredging of the main channels and twenty associated spurs for Muddy Gut, Greenhill Cove and Lynch Point Cove was completed in February 2006. Baltimore County DEPRM also maintains the aids to navigation on the aforementioned waterways and conducts annual spring and summer submerged aquatic vegetation surveys. Bathymetry surveys in the next several years will help to determine the need and frequency of future maintenance dredging.

2.3 The Human Modified Landscape

The natural landscape has been modified for human use over time. The intensity of development activities has increased, starting with the colonization of Maryland in the 1600s. This modification has resulted in environmental impacts to both terrestrial and aquatic ecosystems. This section describes the characteristics of the human modified landscape and how it is associated with impacts to the natural ecosystem. This includes a general description of land use and land cover and more specific issues such as population, impervious cover, drinking water and wastewater, storm water systems, discharge permits, zoning, and build-out analysis.

2.3.1 Land Use and Land Cover

Land use has pronounced impacts on water quality and habitat. Different land uses generate different types and amounts of pollutants. As discussed in the previous section, a forested watershed has the capacity to absorb pollutants such as sediment and nutrients and reduce the flow rate of water into streams. Developed areas with impervious surfaces block the natural seepage of precipitation into the ground. Impervious surfaces include roads, parking lots, roofs and other human constructions. Unlike most natural surfaces, impervious surfaces tend to concentrate stormwater runoff, accelerate flow rates, and direct stormwater to the nearest stream. This can cause bank erosion and destruction of in-stream and riparian habitat. Undeveloped watersheds and those with small amounts of impervious surfaces tend to have better water quality in local streams than developed watersheds with larger amounts of impervious surfaces. In addition, agricultural land can contribute to increases in nutrients and coliform bacteria in streams if not properly managed.

MDP develops a statewide land use/land cover GIS layer every five years to provide a general overview of predominant land cover/usage (interpreted from aerial photography and satellite imagery) and to monitor development activities throughout the state. The most recent update available and used for this characterization report is a draft version of the 2007 MDP land use/land cover scheme. This was based on the 2002 land use/land cover GIS layer and updated using 2005 aerial imagery in conjunction with 2006 parcel information. The main focus of the 2007 update is to assess the state's conversion of land to development and to characterize the type of development. Two new land use/land cover categories were introduced in this draft version including very low density residential (large lot subdivision, 5 to 20 acres) and transportation (major highways and miscellaneous transportation features not classified elsewhere). MDP does not anticipate major changes to the 2007 land use/land cover layer used for this report. A summary of land use/land cover percentages by subwatershed is included in Table 2-11. A map of land use/land cover according to MDP's 2007 scheme is shown in Figure 2-9.

Table 2-11: Tidal Back River Land Use/Land Cover Classification (%)

Land Use Type	Back River-A	Back River-F	Back River-G	Bread & Cheese	Deep Creek	Duck Creek	Greenhill Cove	Longs Creek	Lynch Pt Cove	Muddy Gut	Totals
Very Low Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	6.9	**0.8**
Low Density Residential	2.1	0.0	2.0	0.0	0.0	0.0	0.0	1.7	0.0	10.1	**1.6**
Medium Density Residential	18.7	19.4	51.8	20.2	20.1	63.2	33.1	5.2	61.5	21.7	**23.0**
High Density Residential	0.0	2.5	10.8	10.2	42.3	5.6	3.2	0.0	0.0	3.6	**8.6**
Commercial	5.3	2.8	0.0	14.0	13.0	15.7	3.7	1.6	12.3	2.3	**7.2**
Industrial	21.0	0.0	0.0	1.9	0.0	0.0	16.4	0.0	0.0	0.5	**3.5**
Institutional	0.0	5.5	8.2	11.5	6.4	5.5	3.3	0.2	21.0	1.7	**4.4**
Open Urban	20.3	0.0	0.0	19.2	3.4	2.2	17.7	11.1	0.0	1.0	**9.7**
Cropland	0.0	18.5	0.0	0.0	0.0	0.0	0.0	10.3	0.0	7.5	**4.3**
Pasture	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
Deciduous Forest	22.8	32.6	17.6	15.3	8.1	5.0	0.0	65.0	2.8	38.7	**29.7**
Mixed Forest	0.0	4.8	0.0	1.5	1.0	0.0	0.0	0.0	0.0	1.6	**0.7**
Brush	0.7	2.7	4.0	0.6	1.6	0.0	14.8	2.2	0.0	0.3	**1.7**
Water	1.0	3.5	0.5	0.4	0.5	0.9	1.7	0.4	2.4	1.1	**0.9**
Wetlands	1.9	6.0	5.0	1.8	1.4	1.9	0.0	1.5	0.0	3.0	**2.1**
Bare Ground	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Transportation	6.1	0.0	0.0	3.3	2.3	0.0	6.0	0.0	0.0	0.0	**1.7**

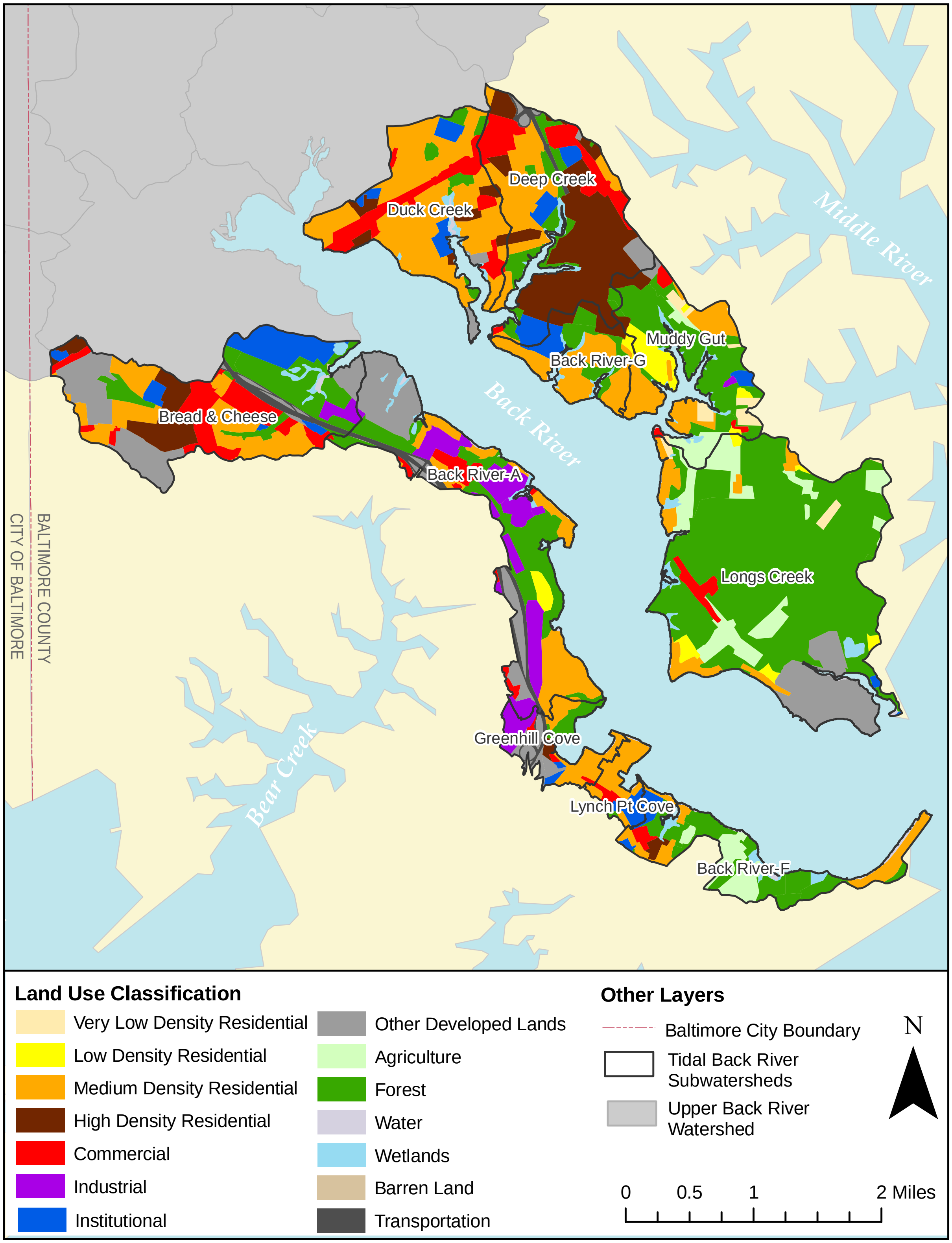


Figure 2-9: Tidal Back River Land Use/Land Cover

The Tidal Back River watershed encompasses 7,720 acres (12 square miles) of land. The dominant land uses are residential (2,624 acres, 34.0% of total area), forest (2,481 acres, 32.1% of total area), and urban including commercial, industrial, open urban and transportation land use types (1,706 acres, 22.1% of total area). The remaining area consists of institutional uses (4.4%), agricultural lands (4.4%), and water/wetlands with very little barren ground (3.0%). Residential development represents one-third of the land use in the Tidal Back River watershed, with the majority (23%) classified as medium density residential (< 1/2 acre per dwelling unit). High density residential development (< 1/8 acre per dwelling unit) represents another 9 percent of the watershed. Residential development is a significant land use in most subwatersheds with the exception of Longs Creek which is mostly undeveloped. Residential areas represent an opportunity for community involvement in restoration efforts, neighborhood source control, and environmental stewardship. Longs Creek represents over half of the forested area in the watershed; considerable portions of Muddy Gut and Back River-F (~40%) also remain forested. These areas represent an opportunity for forest preservation. Institutional land use covers about 4 percent of the watershed and includes community-based facilities such as schools, churches, medical facilities, and government offices. Many of these institutions represent an opportunity to initiate environmentally sensitive management of the grounds and for educating the community about environmental stewardship.

2.3.2 Population

Population data provides another way to evaluate the intensity of land use. For example, a higher population density (persons per acre) represents a more intense use of the land and potential for environmental degradation. As previously mentioned, much of the degradation from urban/suburban land uses (where population is mainly concentrated) is related to the extent of impervious cover and also conversion of land uses that protect water resources such as forest. Smart growth principles are aimed at directing future growth to areas of existing services and where development has already occurred. This will result in less land conversion to residential and supporting urban development such as commercial areas and therefore, conservation of land uses with less environmental impacts such as forest and agriculture.

Population density in the Tidal Back River watershed was estimated based on the 2000 U.S. Census. Table 2-12 summarizes population density by subwatershed with respect total area and impervious area. Population density distribution for the Tidal Back River watershed is shown in Figure 2-10. In general, higher population densities correspond to the areas designated as medium and high density residential land use discussed in the last section. Population is most dense in the northwest portion of the watershed in Bread and Cheese, Duck Creek, and Deep Creek. There is also a high concentration of people located in the vicinity of Edgemere which includes portions of subwatersheds Greenhill Cove and Lynch Pt Cove.

Table 2-12: Tidal Back River Population Data

Subwatershed	Total Population (2000 census)	Total Area (acres)	Population Density (per acre)	Impervious Area (acres)	Population Density (per impervious acre)
Back River-A	1,469	973.1	1.51	156.5	9.39
Back River-F	1,300	420.4	3.09	46.1	28.21
Back River-G	1,716	313.4	5.48	53.8	31.89
Bread & Cheese	9,038	1,183.0	7.64	326.9	27.65
Deep Creek	16,126	989.5	16.30	324.1	49.76
Duck Creek	9,080	825.0	11.01	274.1	33.12
Greenhill Cove	1,066	221.6	4.81	59.3	17.99
Longs Creek	803	2,028.0	0.40	60.1	13.36
Lynch Pt Cove	971	113.2	8.57	37.3	26.07
Muddy Gut	2,455	653.0	3.76	86.1	28.50
Total	***44,024***	***7,720.2***	***5.70***	***1,424.3***	***30.91***

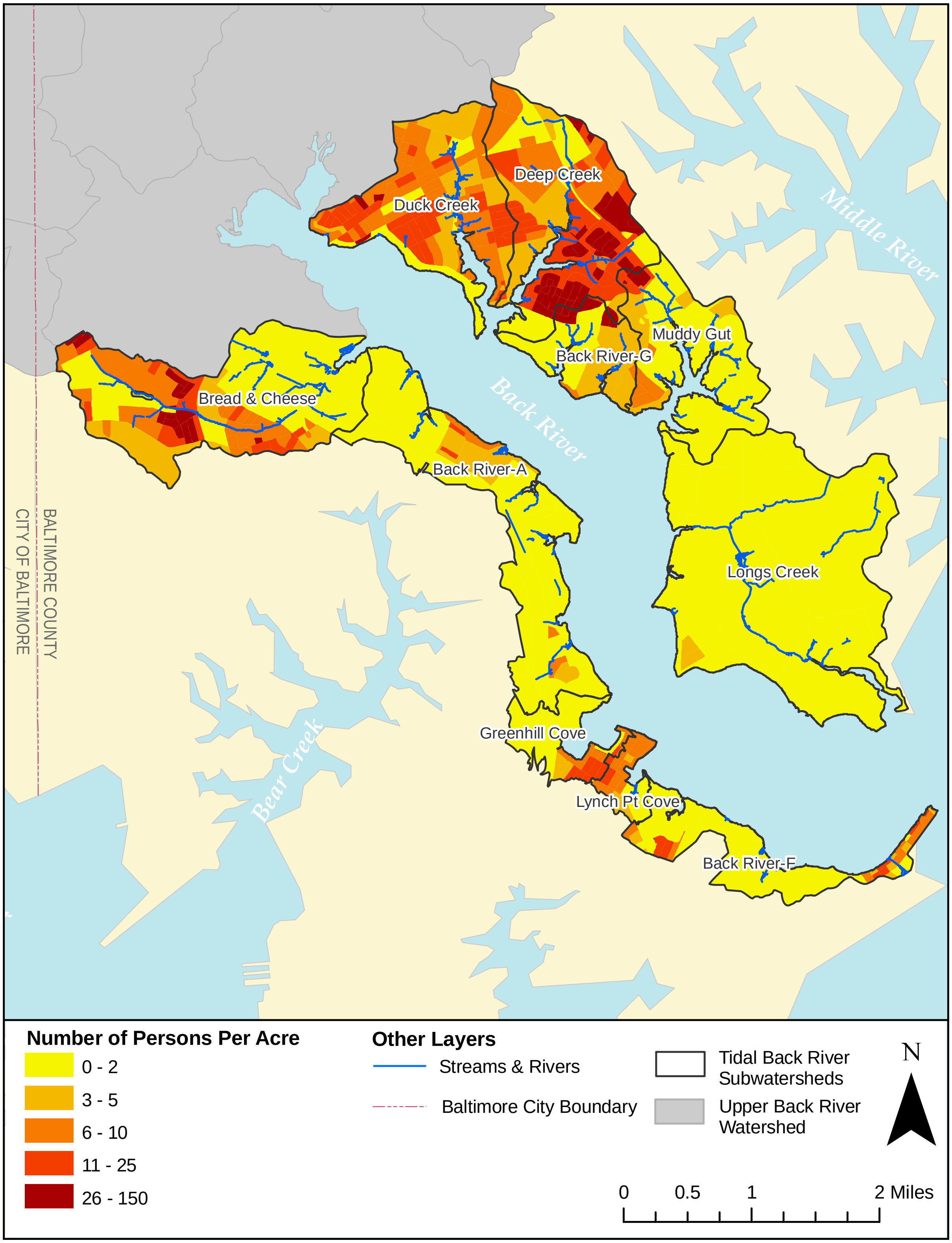


Figure 2-10: Tidal Back River Population Distribution

2.3.3 Impervious Surfaces

Impervious surfaces prevent precipitation from naturally infiltrating into the ground; these include roads, parking areas, roofs, and other paved surfaces. Because runoff from impervious surfaces can not infiltrate into the ground, it is typically concentrated, accelerated and conveyed directly to the nearest stream. Consequently, stormwater runoff from impervious surfaces can cause stream erosion and habitat destruction from the high energy flow and is likely more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover.

Impervious cover is a primary factor when determining pollutant characteristics and amounts in stormwater runoff. Research has been conducted to link the degree of urbanization (typically measured by amount of impervious cover) with various watershed-based indicators of water quality such as the diversity and abundance of aquatic and terrestrial life. The Center for Watershed Protection (CWP) compiled stream research conducted in various parts of the country and developed a simple model that relates stream quality to percentage of impervious cover in a watershed. Studies used to develop the impervious cover model measured stream quality based on a variety of indicators such as number of aquatic insect species, stream temperature, channel stability, aquatic habitat, wetland plant density, and fish communities. CWP's impervious cover model is illustrated in Figure 2-11.

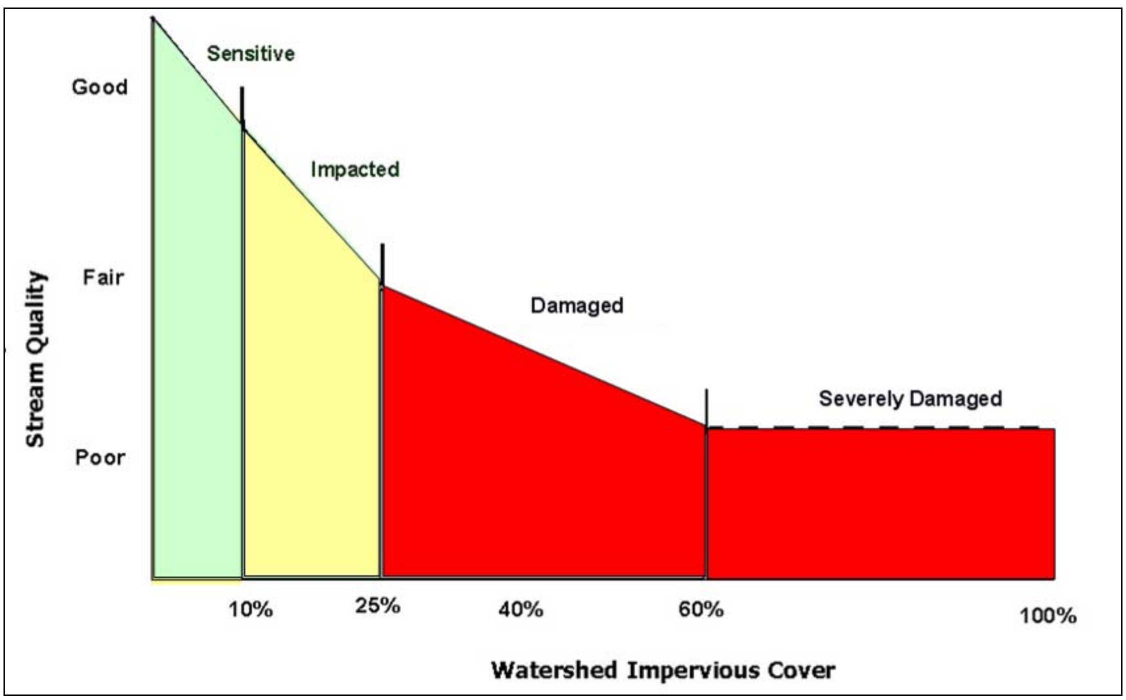


Figure 2-11: Impervious Cover Model (adapted from CWP 2003)

Based on the research compiled, CWP determined three general categories to classify and predict stream quality in terms of impervious cover. Watersheds with less than 10 percent impervious cover are referred to as sensitive and typically have high quality streams with stable channels, good habitat conditions, and good to high water quality; sensitive watersheds are susceptible to environmental degradation with urbanization and increases in impervious cover.

The model predicts that between 10 and 25 percent impervious cover, watersheds become impacted and would show clear signs of degradation such as erosion, channel widening, and a decline in stream habitat. There is a possibility to restore streams to a somewhat natural functioning system within this category. When a watershed has more than 25 percent impervious cover, streams are classified as damaged which are characterized by fair to poor water quality, unstable channels, severe erosion, and inability to support aquatic life and provide habitat; many streams in this category are typically piped or channelized. Figure 2-10 shows that when impervious cover exceeds 60 percent, a watershed is classified as severely damaged and means that most of the natural stream system is gone. Management of damaged and severely damaged streams may focus on decreasing pollutant loads to downstream receiving waters (e.g., installing BMPs) but the ability to restore natural functions, such as habitat, is unlikely. Restoration efforts may also focus on making the remaining stream systems stable, aesthetically pleasing and an amenity to the community. It should be noted that the impervious cover model is a simplified approach for classifying the quality of urban streams. Although it is based on research, there are inherent model assumptions and limitations that should be considered such as regional variations and scale effects. In addition, while impervious cover is a relevant and significant indicator for watershed health, it is only one of many different factors affecting stream health and contributing to the cumulative impacts of development on water quality. For example, agricultural land uses contribute sediment and nutrient loads to receiving waters depending on management practices. Also, the ability of BMPs to offset adverse impacts from urbanized areas is not specifically accounted for in this model.

The roads and buildings GIS data layers from Baltimore County were used to derive impervious surface areas within the Tidal Back River watershed (see Figure 2-12). The area for each layer was determined and then combined to obtain estimates of impervious cover areas on a subwatershed scale. Table 2-13 summarizes the area of roads and buildings, total impervious area, and percent impervious area for each subwatershed. Impervious cover represents about 18 percent of the watershed or 1,424 acres. Subwatershed ratings according to the CWP impervious cover model and these impervious area estimates are shown in Figure 2-13.

Table 2-13: Tidal Back River Impervious Area Estimates

Subwatershed	Total Area (acres)	Roads (acres)	Buildings (acres)	Impervious Area (acres)	% Impervious (%)
Back River-A	973.1	114.8	41.7	156.5	16.1
Back River-F	420.4	28.3	17.8	46.1	11.0
Back River-G	313.4	32.3	21.5	53.8	17.2
Bread & Cheese	1,183.0	216.2	110.8	326.9	27.6
Deep Creek	989.5	212.0	112.0	324.1	32.8
Duck Creek	825.0	162.6	111.5	274.1	33.2
Greenhill Cove	221.6	40.9	18.4	59.3	26.7
Longs Creek	2,028.0	45.0	15.1	60.1	3.0
Lynch Pt Cove	113.2	20.4	16.9	37.3	32.9
Muddy Gut	653.0	62.4	23.7	86.1	13.2
Total	***7,720.2***	***934.9***	***489.4***	***1,424.3***	***18.4***

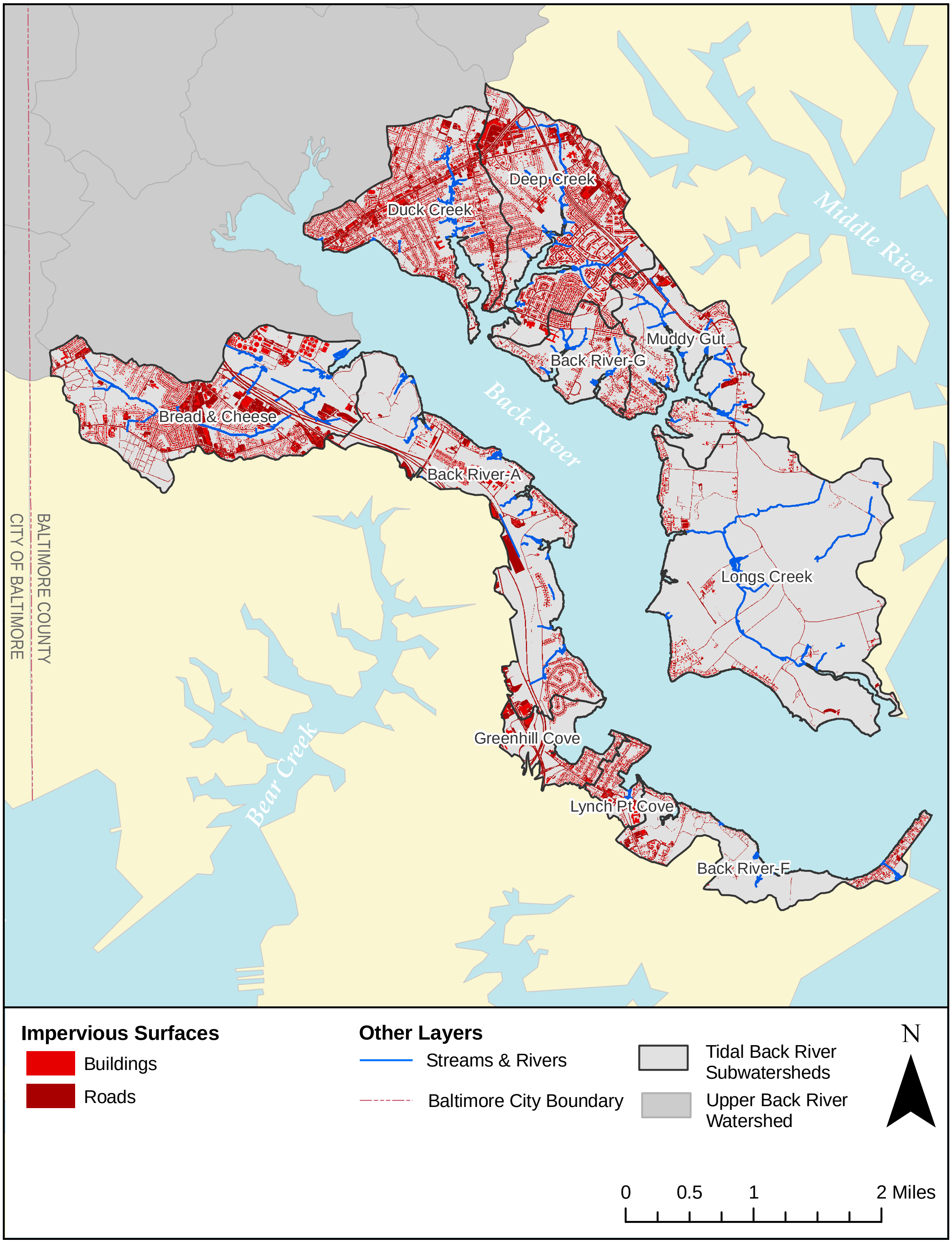


Figure 2-12: Tidal Back River Impervious Surfaces

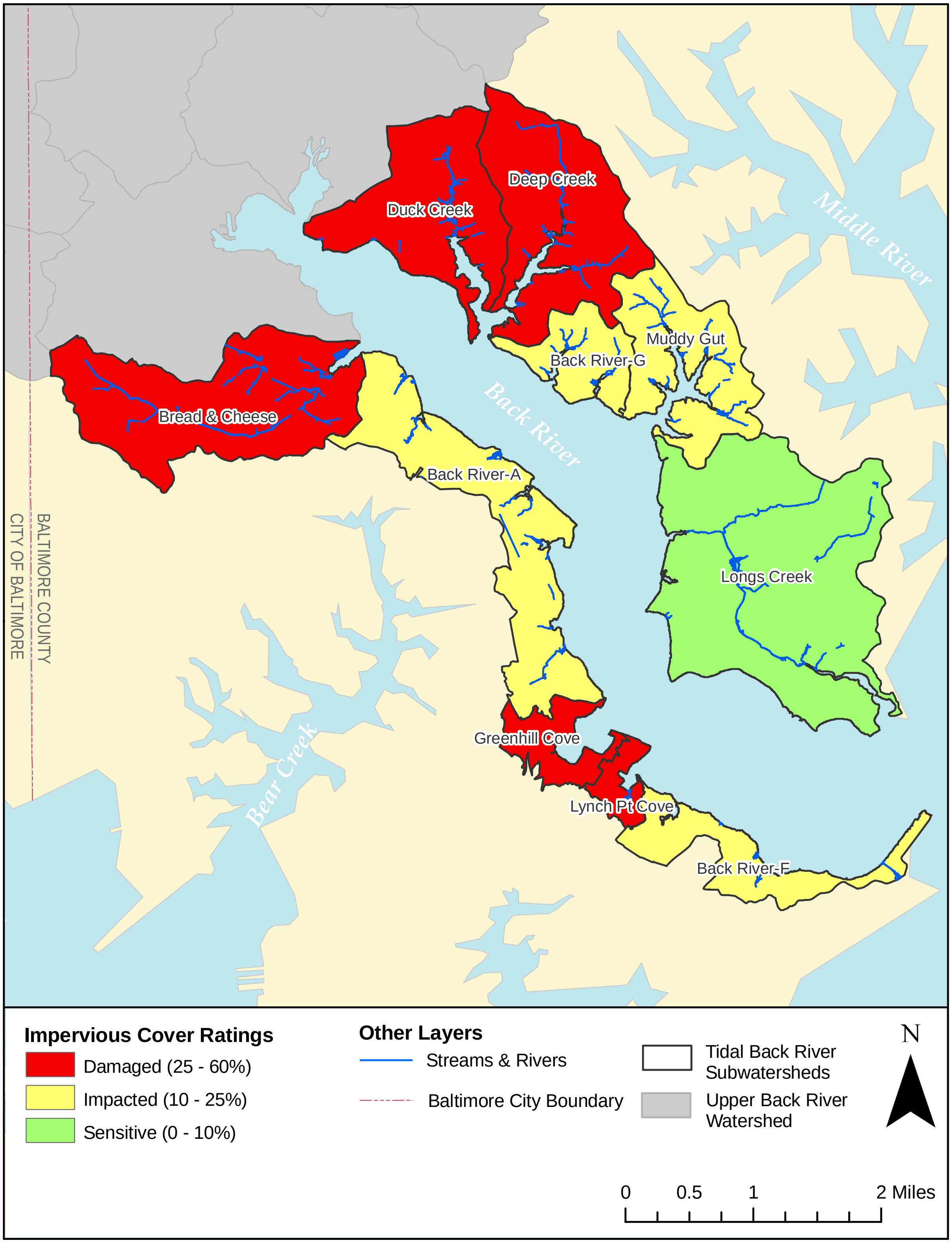


Figure 2-13: Tidal Back River Impervious Cover Ratings

2.3.4 Drinking Water

Drinking water is a fundamental need for human development. It can be supplied either by public distribution systems or by wells associated with individual developed properties. Having an adequate supply of drinking water is essential to maintaining the human population in a region.

2.3.4.1 Public Water Supply

Environmental impacts associated with public supply of water include the potential for increased residential development with associated impervious cover effects discussed in the previous section and the potential for leaks from the system. Leaks from public water supply systems introduce chlorine into the aquatic system which can result in the death of aquatic organisms. In addition, major leaks can cause erosion which contributes to the sediment load in stream channels; this can bury aquatic benthic communities and degrade habitat.

2.3.5 Wastewater

Wastewater created through human use must be treated and disposed. This is accomplished either through public conveyance to a treatment facility or through individual wastewater treatment systems (septic systems). Residential wastewater consists of all water typically used by residents including wash water, bathing water, human waste disposal water, and any other rinse water (paint brush, floor washing, etc.). Industrial wastewater depends on the operation and could contain various contaminants such as metals, organic compounds, detergents, or synthetic compounds. All of these types of wastewater have the potential to adversely impact the natural environment.

2.3.5.1 Septic Systems

Properly functioning septic systems provide treatment for nearly all of the phosphorus present in wastewater, but can leak nitrogen in the form of nitrates. Depending on the location of the system, nitrates may be reduced or eliminated through de-nitrification as the treated water passes through riparian buffers, particularly forested riparian buffers. Failing systems can release nitrogen, phosphorus, and other chemicals and in turn, contaminate the aquatic environment. They can also result in increased bacterial contamination of nearby streams and therefore, potential for human health concerns. The table below summarizes the approximate number of septic systems by subwatershed.

Table 2-14: Tidal Back River Septic Systems by Subwatershed

Subwatershed	No. of Septic Systems
Back River-A	21
Back River-F	10
Back River-G	5
Bread & Cheese	8
Deep Creek	13
Duck Creek	23
Greenhill Cove	12
Longs Creek	8
Lynch Pt Cove	2
Muddy Gut	14
Total	***116***

2.3.5.2 Public Sewer

A public sewer system conveys wastewater from individual households or business to a facility that treats the wastewater prior to discharge. It consists of the piping system within the public right-of-way and cleanouts on individual properties. Property owners are responsible for the maintenance of the latter part of the system, their individual cleanouts. The portion of the system within the public right-of-way is owned and maintained by the local government. This includes gravity piping system, access manholes, pumping stations, and force mains. Table 2-15 summarizes the types and lengths of public sewer piping by subwatershed in the Tidal Back River watershed. This includes force (pressure) and gravity main lines and portions of the gravity main that have been abandoned or removed. Table 2-16 includes sewer piping density or length per square mile for each subwatershed.

Table 2-15: Public Sewer Piping Length in Tidal Back River

Subwatershed	Pressurized Main (ft)	Gravity Main (ft)	Gravity Main Abandoned (ft)	*Total* (ft)
Back River - A	20,104	29,445	0	***49,548***
Back River - F	2,199	12,033	0	***14,232***
Back River - G	14,624	15,763	0	***30,387***
Bread & Cheese	6,318	76,804	1,201	***84,324***
Deep Creek	2,938	72,920	1,175	***77,033***
Duck Creek	10,393	96,055	251	***106,699***
Greenhill Cove	1,794	12,394	0	***14,188***
Longs Creek	50,723	94	0	***50,817***
Lynch Pt Cove	1,626	10,366	0	***11,992***
Muddy Gut	14,215	19,213	0	***33,427***
Total	***124,933***	***345,086***	***2,628***	***472,647***

Table 2-16: Public Sewer Piping Density in Tidal Back River

Subwatershed	Area (sq mile)	Pressurized Main (ft/sq mi)	Gravity Main (ft/sq mi)
Back River - A	1.52	13,222	19,366
Back River - F	0.66	3,348	18,319
Back River - G	0.49	29,868	32,193
Bread & Cheese	1.85	3,418	41,550
Deep Creek	1.55	1,900	47,164
Duck Creek	1.29	8,062	74,515
Greenhill Cove	0.35	5,181	35,792
Longs Creek	3.17	16,007	30
Lynch Pt Cove	0.18	9,189	58,586
Muddy Gut	1.02	13,932	18,830
Total	***12.06***	***10,357***	***28,608***

Environmental impacts associated with public sewer are usually the result of sewage overflows. Overflows typically result from blockages within the sewage system, pumping station failure, or rainwater inflows exceeding pipe capacity. Dry weather flows can also have potential impacts due to leaks in the sewer system. Environmental concerns related to sewer overflows and leaks include high bacteria concentrations, release of nutrients, elevated turbidity (cloudiness), and low dissolved oxygen.

2.3.5.3 Wastewater Treatment Plant

The Back River Wastewater Treatment Plant (WWTP) is located in Baltimore County in Dundalk, Maryland on the northwestern shore of the Tidal Back River and immediately west of the Eastern Boulevard Bridge to Essex, Maryland. The physical plant is accessed by Eastern Avenue and encompasses approximately 466 acres including a portion of the Bread and Cheese subwatershed. Plant construction began in 1907 and treatment around 1911 or 1912. Today, the Back River WWTP serves a population of approximately 994,000 and an area of 140 square miles. It has the capacity to treat 180 million gallons per day (MGD) and still meet target effluent concentrations; currently, the Back River WWTP treats approximately 150 MGD.

The Back River WWTP currently employs Biological Nitrogen Removal (BNR) technology which removes nitrogen to approximately 8 mg/L on an annual average basis. Baltimore City is in the design phase of an Enhanced Nutrient Removal (ENR) upgrade for the plant. This upgrade will include a large denitrification filter as well as a pumping station and chemical addition facilities required for proper operation. This may also require additional capacity in the form of aeration tanks and clarifiers in the secondary treatment process to meet stringent discharge limitations. Construction is expected to start in 2010 and changes are expected to be implemented by 2015; however, actual completion date will depend on funding availability. When the ENR upgrade is complete and operating as designed, the WWTP will be capable of achieving an effluent with total nitrogen concentration of approximately 3 mg/L (annual average) rather than the 8 mg/L currently discharged. It should also be noted that part of the effluent from the plant goes to the steel mill at Sparrows Point for re-use as industrial water. Currently, approximately 40 MGD (~27%) is directed to the steel mill and the remaining 100 to 110 MGD of treated effluent is discharged to the Back River. (Plant description based MDE 2009 and personal communication with John Martin, Operations Engineer, on July 29 and August 6, 2009)

2.3.6 Stormwater

Stormwater is water generated during and immediately after storm events. Stormwater that does not seep into the ground becomes stormwater runoff and goes directly to receiving water bodies. The amount and characteristics of stormwater runoff is affected by rainfall amount and intensity, soil properties, slope, and land use/land cover. Concerns associated with stormwater include rate and volume of runoff and water pollution. For example, more runoff is generated from impervious cover and agricultural land than in undeveloped land. As previously mentioned, impervious surfaces do not allow any water to infiltrate into the ground and runoff is conveyed directly to the stream system. The increase in runoff rate and volume can cause flooding and stream erosion which in turn, results in the destruction of habitat and natural stream functions such as nutrient reduction. In addition, there is less potential for groundwater recharge when there is little or no infiltration of stormwater.

Stormwater runoff can also carry various contaminants depending on land use characteristics and human activities. Pollutants deposited on impervious surfaces and other developed lands from daily human activities are often carried by stormwater to stream systems. For example, common constituents in impervious surface runoff (e.g., highways, parking lots) include sediment, metals, bacteria, nutrients, and petroleum; pollutants such as these build-up over time from various sources such as maintenance activities (de-icing, roadside fertilizer use), vehicles (exhaust, leaks), and accidents/spills and are washed off during storm events. While the runoff from other developed areas, agriculture operations and residential areas for example, may be moderate compared to highly impervious areas, it can still carry pollutants such as nutrients, bacteria, and chemicals to receiving water bodies.

2.3.6.1 Storm Drainage System

The storm drainage system consists of either drainage swales (roadside ditches) or a curb and gutter system including inlets, piping, and outfalls. Both methods are intended to prevent flooding and potentially hazardous situations by removing water quickly from roadways. However, the efficiency and environmental impacts associated with each method are different. The curb and gutter system removes stormwater from impervious surfaces quickly and typically conveys water directly to the stream system. While the curb and gutter system removes stormwater quickly from roadways, it delivers increased runoff volumes and untreated pollutants to receiving water bodies. Drainage swales do not convey water as quickly as the curb and gutter system but the stormwater flow is somewhat reduced before entering the stream system. Drainage swales also allow some infiltration into the ground unlike the curb and gutter system; this reduces the amount of water delivered and provides some filtering of pollutants.

Curb and gutter system components in the Tidal Back River watershed are summarized in Table 2-17 by subwatershed. This includes an estimate of the number of major (> 3 feet) and minor (< 3 feet) storm drain outfalls and corresponding number of inlets and length of storm drain pipe. Storm drain system databases used to compile this table were created in 1992 with periodic updates according to County storm drain plans. This data provides a reasonable approximation of storm drain pipe data for this analysis and the numbers presented in Table 2-17 where pipe lengths were rounded to the nearest tens of feet. Table 2-18 provides a summary of the proportion of subwatershed area covered by the storm drain system (stormwater drainage area within subwatershed divided by total subwatershed area) and the number of inlets per square mile for each subwatershed. Figure 2-14 shows the location of major (> 3 feet) and minor (< 3 feet) outfalls within the watershed.

Table 2-17: Storm Drain System Components in Tidal Back River

	MAJOR (> 3 ft)			MINOR (< 3 ft)			ALL OUTFALLS		
Subwatershed	***Outfalls (#)***	***Inlets (#)***	***Pipe (ft)***	***Outfalls (#)***	***Inlets (#)***	***Pipe (ft)***	**Total Outfalls (#)**	**Total Inlets (#)**	**Total Piping (ft)**
Back River - A	2	6	1,130	2	4	1,320	4	10	2,450
Back River - F	1	10	670	1	5	630	2	15	1,300
Back River - G	2	5	890	2	9	1,080	4	14	1,970
Bread & Cheese	8	76	7,800	8	40	4,960	16	116	12,760
Deep Creek	10	59	7,180	17	58	6,740	27	117	13,920
Duck Creek	9	41	6,530	16	47	5,640	25	88	12,170
Greenhill Cove	2	9	1,230	0	0	0	2	9	1,230
Longs Creek	0	0	0	0	0	0	0	0	0
Lynch Pt Cove	0	0	0	3	12	1,070	3	12	1,070
Muddy Gut	1	5	400	1	2	130	2	7	530
Total	***35***	***211***	***25,830***	***50***	***177***	***21,570***	***85***	***388***	***47,400***

Table 2-18: Stormwater System Coverage in Tidal Back River

Subwatershed	**Stormwater System Drainage Area *(acre)***	**Area Covered by Stormwater System *(%)***	**No. of Inlets *(#)***	**Inlet Density *(#/sq mi)***
Back River - A	55	6%	10	6.6
Back River - F	37	9%	15	22.8
Back River - G	70	22%	14	28.6
Bread & Cheese	404	34%	116	62.8
Deep Creek	489	49%	117	75.7
Duck Creek	198	24%	88	68.3
Greenhill Cove	11	5%	9	26.0
Longs Creek	0	0%	0	0.0
Lynch Pt Cove	12	10%	12	67.8
Muddy Gut	13	2%	7	6.9
Total	***1,289***	***17%***	***388***	***32.2***

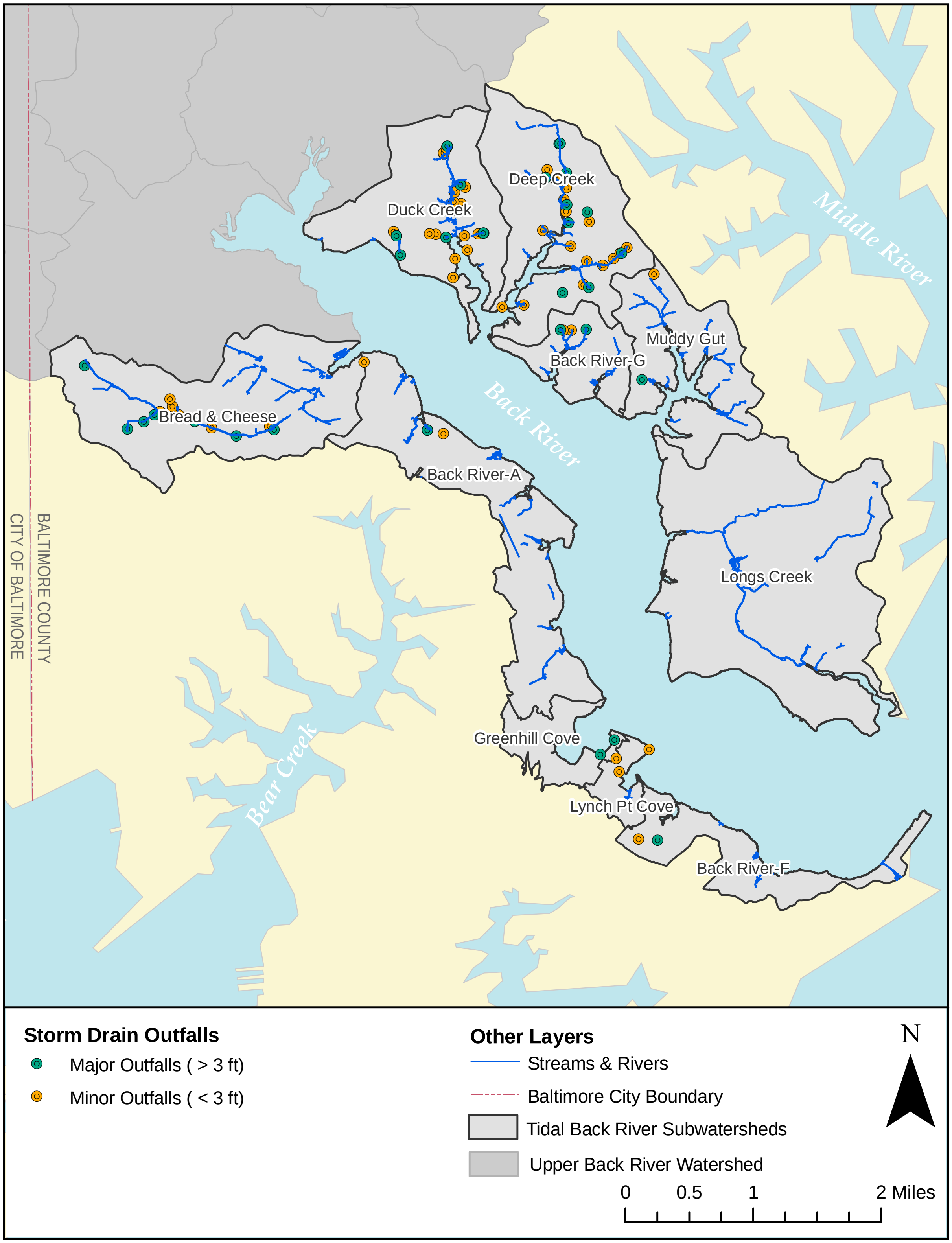


Figure 2-14: Tidal Back River Storm Drain Outfalls

From Tables 2-17 and 2-18 and Figure 2-14, the subwatersheds with the most storm drain system coverage are Bread and Cheese, Duck Creek and Deep Creek. This coincides with the high concentration of residential development that is present in these areas.

2.3.6.2 Stormwater Management Facilities

Maryland was the first state to adopt stormwater quality regulations more than 20 years ago. Stormwater management (SWM) practices evolve as technology and research grows. It continues to be a significant consideration for new and redevelopment within the state. Management of stormwater runoff is required to reduce erosion, sedimentation, pollution, and flooding per Title 4, Subtitle 2 of the Environment Article of Annotated Code of Maryland (MDE 2000). Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual to provide BMP design standards and environmental incentives (MDE 2000) and a general shift toward adopting practices that mimic natural hydrologic processes, are low impact, and achieve pre-development conditions. The latter is evident by the Maryland Stormwater Management Act of 2007 which requires that environmental site design (ESD) be implemented to the maximum extent practicable via nonstructural BMPs and/or other better site design techniques.

There are many types of BMPs available for managing stormwater runoff and providing stormwater quality treatment. SWM can target specific objectives depending on the BMP type such as stormwater quality, soil stabilization, stormwater flow control, and stream restoration. In addition, different SWM facilities have different pollutant removal capabilities. For example, initial dry pond designs for SWM have low pollutant removal efficiency compared to practices that filter the stormwater or allow it to infiltrate into the ground or through plant roots. Several considerations are taken into account when selecting appropriate stormwater treatment measures such as space requirement, maintenance, cost, and community acceptance.

Table 2-19 provides a summary of the different SWM facilities located within the Tidal Back River watershed by subwatershed including dry and wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs and other types of SWM facilities. The distribution of SWM facilities throughout the watershed is illustrated in Figure 2-15.

Table 2-19: Stormwater Management Facilities in Tidal Back River

SWM Facility Type	Back River-A	Back River-F	Back River-G	Bread & Cheese	Deep Creek	Duck Creek	Greenhill Cove	Longs Creek	Lynch Pt Cove	Muddy Gut	*Totals*
Dry Pond (#)	1	0	0	0	1	1	0	0	0	1	***4***
Drainage Area (acres)	3.18	0.00	0.00	0.00	2.53	4.44	0.00	0.00	0.00	8.07	***18.22***
Wet Pond (#)	2	0	0	0	0	0	0	0	1	0	***3***
Drainage Area (acres)	25.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.87	0.00	***52.25***
Wetland (#)	0	2	0	0	0	0	1	0	0	0	***3***
Drainage Area (acres)	0.00	3.40	0.00	0.00	0.00	0.00	6.06	0.00	0.00	0.00	***9.46***
Infiltration/Filtration (#)	0	0	12	0	1	2	2	0	1	0	***18***
Drainage Area (acres)	0.00	0.00	51.21	0.00	1.32	4.21	11.14	0.00	0.05	0.00	***67.93***
Extended Detention (#)	5	0	0	3	2	2	1	0	0	1	***14***
Drainage Area (acres)	42.15	0.00	0.00	17.32	3.66	8.24	22.30	0.00	0.00	7.33	***101.00***
Proprietary BMP (#)	0	0	0	0	0	0	1	0	1	0	***2***
Drainage Area (acres)	0.00	0.00	0.00	0.00	0.00	0.00	12.21	0.00	1.08	0.00	***13.29***
Other (#)	3	0	0	0	1	1	0	0	0	0	***5***
Drainage Area (acres)	4.67	0.00	0.00	0.00	0.93	0.67	0.00	0.00	0.00	0.00	***6.27***

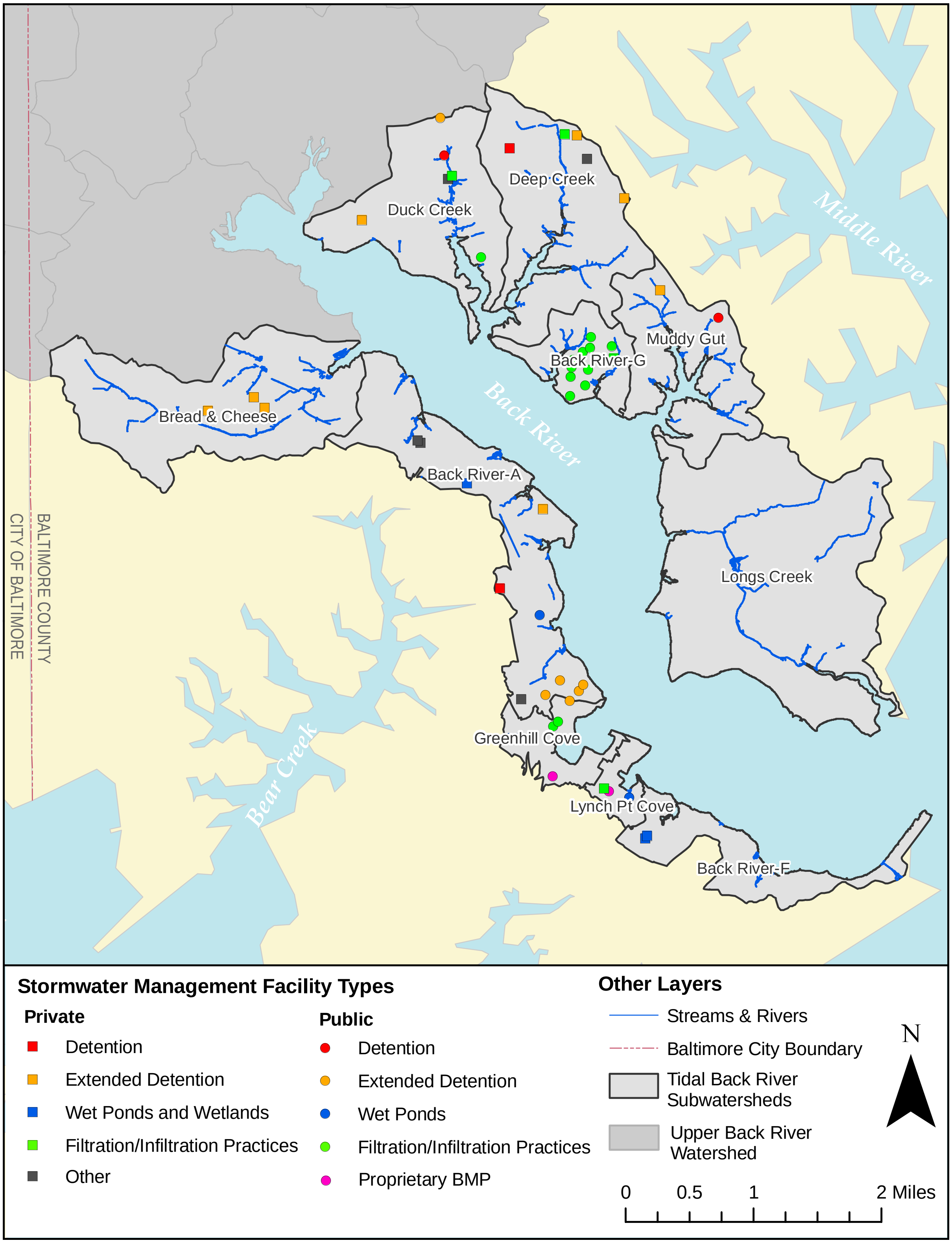


Figure 2-15: Distribution of Stormwater Management Facilities in Tidal Back River

Table 2-19 and Figure 2-15 show that the most common types of SWM within the watershed are filtration/infiltration practices and extended detention facilities. Most subwatersheds have some form of SWM with the exception of Longs Creek which is reasonable since this is the least developed subwatershed. The dry pond facilities represent the best opportunity for conversion to BMPs with higher pollutant removal capabilities. The two proprietary BMPs in the watershed are Stormceptor devices which remove sediment, oil and grease through hydrodynamic separation. Sediment particles and oil and grease settle out as flow circulates in a swirling path; floatable and settled debris collected in the treatment chamber are typically removed by a vacuum truck at regular intervals. SWM facilities classified as other in the watershed include grassed channels, a stilling basin, and underground stone detention.

The total area treated by SWM and the proportion of urban area treated by SWM is summarized in Table 2-20 by subwatershed.

Table 2-20: Stormwater Management Facilities in Tidal Back River

Subwatershed	Area *(acres)*	Urban Land Use *(acres)*	Area Treated by SWM *(acres)*	Urban Land Use Treated by SWM *(%)*
Back River-A	973	715	75	11%
Back River-F	420	127	3	3%
Back River-G	313	228	51	22%
Bread & Cheese	1,183	950	17	2%
Deep Creek	989	866	8	1%
Duck Creek	825	760	18	2%
Greenhill Cove	222	185	52	28%
Longs Creek	2,028	418	0	0%
Lynch Pt Cove	113	107	28	26%
Muddy Gut	653	313	15	5%
Total	***7,720***	***4,670***	***268***	***6%***

Note that for this analysis urban land use includes the following MDP land use categories: low, medium and high residential, commercial, industrial, institutional, open urban, and transportation. Table 2-20 shows that urban land use encompasses about 60 percent of the Tidal Back River watershed but only 6 percent of that is treated by SWM practices. This indicates an opportunity to implement SWM (BMPs or treatment devices) in existing developed areas where no practices are currently in place or retrofitting facilities that are not providing adequate treatment before stormwater reaches the stream system. Refer to Section 3.7 for more details on assessed SWM facilities within the watershed.

2.3.7 NPDES Discharge Permits

Facilities that discharge municipal or industrial wastewater or conduct activities that can contribute pollutants to a waterway are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The number and type of NPDES-permitted facilities within each subwatershed is summarized in Table 2-21.

Table 2-21: NPDES-Permitted Facilities in Tidal Back River

Subwatershed	# General Industrial Stormwater Permits	# Surface Industrial Discharge Permits	# General Permits	Total # of Permits
Back River-A	5	-	-	5
Back River-F	-	-	-	-
Back River-G	-	-	-	-
Bread & Cheese	4	-	-	4
Deep Creek	-	-	2	2
Duck Creek	-	-	2	2
Greenhill Cove	-	1	-	1
Longs Creek	-	-	-	-
Lynch Pt Cove	-	-	-	-
Muddy Gut	-	-	1	1
Total	***9***	***1***	***5***	***15***

As of 2008, there are currently 15 NPDES-permitted facilities within the Tidal Back River watershed (see Figure 2-16). Most (9 out of 15) are general industrial stormwater permits which corresponds to stormwater discharges from various industrial areas in the watershed such as the Back River WWTP, American Yeast and truck terminal/freight facilities. Industrial surface water discharge permits are issued for industrial facilities that discharge process water to State surface waters which must meet applicable federal effluent guidelines and/or State water quality standards. This includes the Greenhill Cove WWTP. The Back River WWTP also has an industrial surface discharge permit for its treated effluent; however, this permit falls within the Upper Back River watershed. General permits correspond to discharges from marinas and a community pool in the watershed. Marina discharge permits may refer to either process water or stormwater discharges.

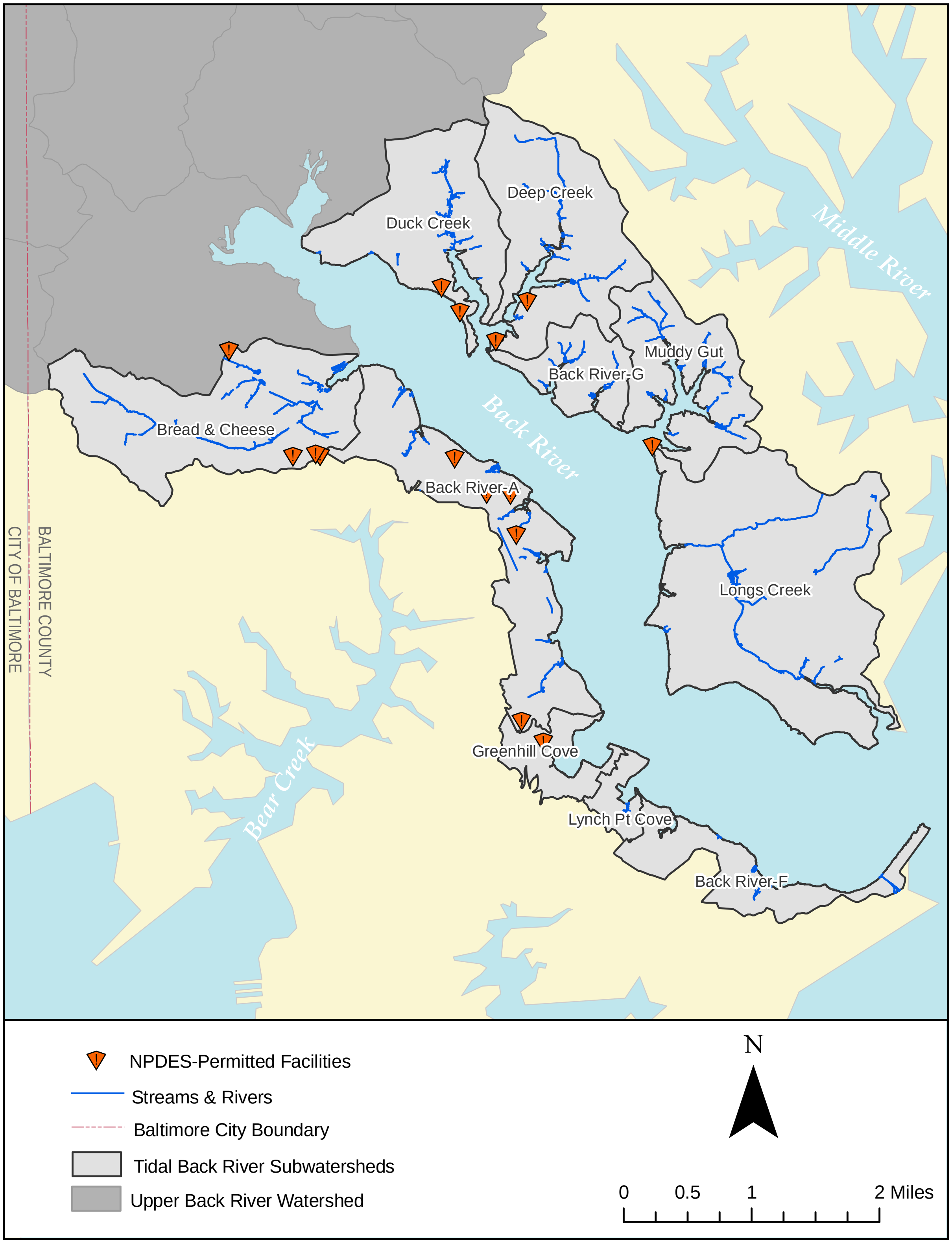


Figure 2-16: Location of NPDES-Permitted Facilities in Tidal Back River

2.3.8 Zoning

According to the Baltimore County Office of Planning (2007), zoning is defined "a system of land use regulation that controls the physical development of land and a legal mechanism by which local government is able to regulate an owner's right to use privately owned land for the sake of protecting the public health, safety, and/or general welfare." In other words, zoning manages development patterns over time throughout the county. The current zoning for the Tidal Back River watershed is shown in Figure 2-17. Various zoning categories are shown in this figure; however, the major zoning categories within the watershed are residential ('DR' categories), commercial, industrial, and resource conservation ('RC' categories).

As shown in Figure 2-17, commercial and residential areas are grouped together as they are considered compatible land uses since population is typically concentrated in these areas. The most undeveloped subwatershed, Longs Creek, is mainly zoned as resource conservation areas and specifically include RC 20 and RC 5 categories, meaning resource conservation critical area and rural residential, respectively. Undeveloped portions of Back River-F (including North Point State Park) and Muddy Gut are also zoned as resource conservation critical area. These areas represent potential for forest preservation and restoration opportunities. As previously noted, areas zoned for industrial use are located mostly within portions of Bread and Cheese and Back River-A. A summary of zoning category acreages and proportions within the Tidal Back River watershed is included in Table 2-22.

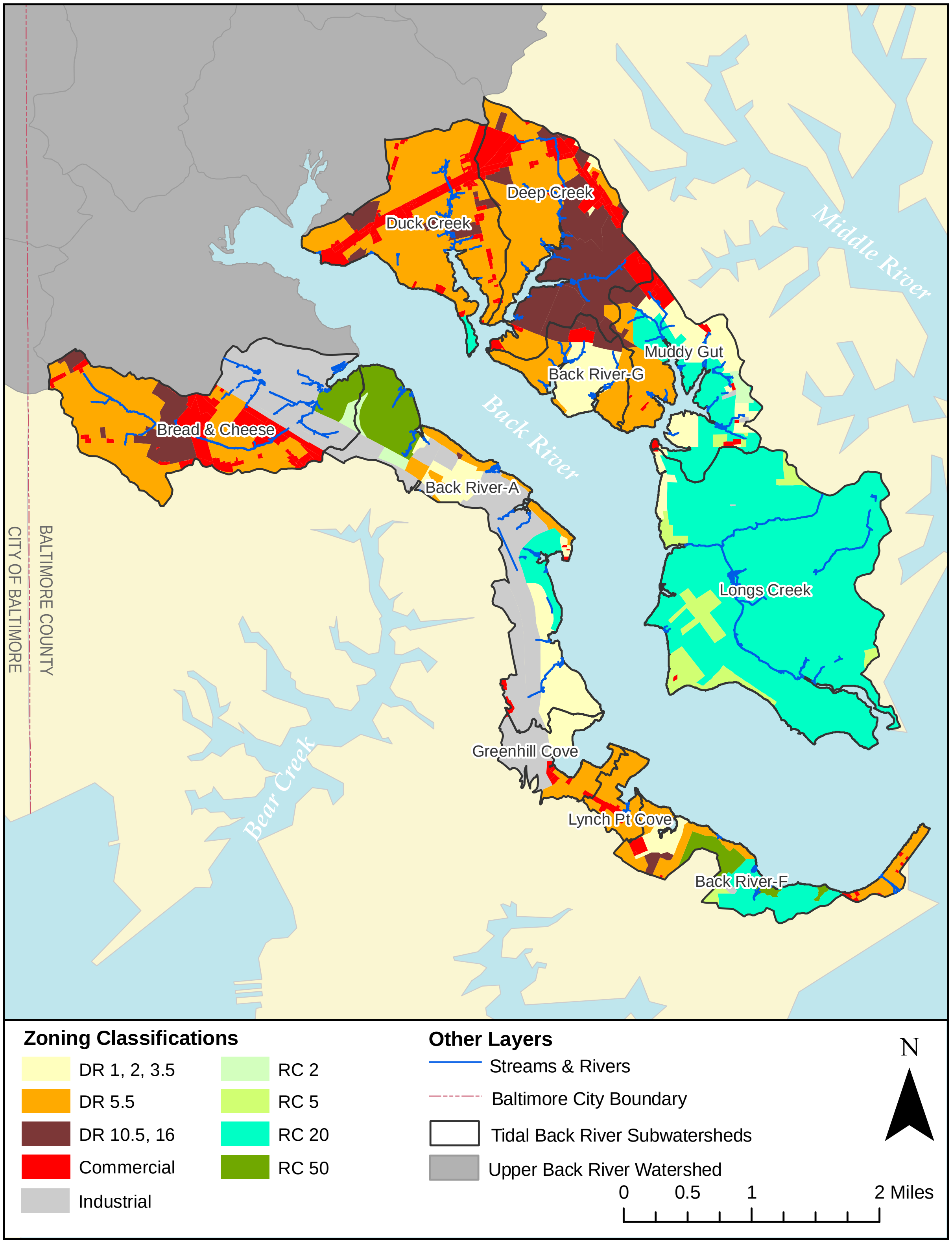


Figure 2-17: Tidal Back River Zoning

Table 2-22: County Zoning in Tidal Back River

Zoning Code	Zoning Description	Allowed Units/Acre	Total Acres	% of Watershed Area
DR 1	Density Residential	1	71	0.9
DR 2	Density Residential	2	126	1.6
DR 3.5	Density Residential	3.5	456	5.9
DR 5.5	Density Residential	5.5	2,175	28.2
DR 10.5	Density Residential	10.5	319	4.1
DR 16	Density Residential	16	346	4.5
Commercial	Office/Business	-	558	7.2
Manufacturing	Industrial	-	860	11.1
RC 2	Agricultural	-	50	0.6
RC 5	Rural Residential	-	179	2.3
RC 20, 50	Resource Conservation Critical Area	-	2,578	33.4
Total			***7,718***	***100.0***

Nearly half (45%) of the Tidal Back River watershed is residentially zoned area, with the majority classified as ‘DR 5.5’; this generally corresponds to MDP’s medium density residential (< ½ acre per dwelling unit) land use category. One-third of the watershed is zoned as Resource Conservation Critical Area, particularly in the undeveloped portions of the watershed as previously noted above. A noticeable portion of the watershed is also zoned for manufacturing/industrial purposes.

CHAPTER 3: WATER QUALITY AND LIVING RESOURCES

3.1 Introduction

This chapter describes the water quality, living resources, and habitat for the Tidal Back River based on existing conditions. In addition to water quality maintenance and improvement, the SWAP aims to provide for plants, animals, and their habitat. Natural communities require many habitat characteristics for survival. This includes land, water, and biological conditions that provide their needs for food, water, shelter, and reproduction.

Water is an integral part of the habitat of all species. Living resources, including all animals and plants, require water to survive. Living resources and their habitat are intimately connected to water quality and availability. They respond to changes in water quality and habitat conditions in ways that indicate the status of water bodies and the effects of watershed characteristics and activities. In some cases, water quality is measured in terms of its ability to support living resources such as trout or shellfish. Information on living resources is presented in this chapter to indicate water quality status and to evaluate habitat conditions in the watershed. This information can help to determine if current watershed management practices are adequately providing for the needs of natural communities.

The following sections include descriptions of the following with respect to the Tidal Back River watershed: impairments per Maryland's 303(d) listing, water quality monitoring data available to date, pollutant loadings analysis for total nitrogen and total phosphorus, sewer overflow occurrences and impacts, stream corridor assessments, and stormwater management facility assessments.

3.2 303(d) Listings and Total Maximum Daily Loads (TMDLs)

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

The Back River is listed as impaired in the Maryland 303(d) list of impaired waters for various pollutants of concern including nutrients (1996 listing), suspended sediments (1996 listing), chlordane (1996 listing), polychlorinated biphenyls (PCBs, 1998 listing), zinc (1998 listing), fecal coliform (2002 listing), and impacts to biological communities (2002 listing). There are two water quality segments for Back River: 1) segment 02130901 for the land and streams in the watershed and 2) MD-BACOH applicable to the tidal receiving waters. All impairments were listed for the tidal waters with the exception of impacts to biological communities, which are listed for the non-tidal region. Back River is designated as Use II – support of estuarine and marine aquatic life and shellfish harvesting – subcategories 1, 2, and 3 according to the Maryland water quality standards:

1. Migratory Fish Spawning and Nursery	Migratory fish including striped bass, perch, shad, herring and sturgeon during the late winter/spring spawning and nursery season.	In tidal freshwater to low-salinity habitats. This habitat zone is primarily found in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay.
2. Shallow Water – Submerged Aquatic Vegetation	Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.	Shallow waters provided by grass beds near the shoreline.
3.Open-Water Fish and Shellfish	Water quality in the surface water habitats to protect diverse populations of sportfish, including striped bass, bluefish, mackerel and seatrout, bait fish such as menhaden and silversides, as well as the shortnose sturgeon, and endangered species.	Species within tidal creeks, rivers, embayments and the mainstem Chesapeake Bay year-round.

Impairment listings reflect the inability to meet water quality standards for these designated uses. Impairment in the tidal receiving waters is related to pollutants coming from the entire watershed; therefore, TMDLs developed for this segment will require watershed pollutant load reductions. Water Quality Assessments (WQAs) are performed to determine if the pollutant of concern is actually impairing the waters. If it is determined that the pollutant of concern is not contributing to water impairment, a report documenting the findings is submitted to USEPA for concurrence. Table 3-1 summarizes the status of the various impairment listings for Back River.

Table 3-1: Back River Water Quality Impairment Listings and Status

Impairment	Applicable Segment	Status	Approval Date
Stream biological community	02130901	Impaired	
PCBs in fish tissue	MD-BACOH	TMDL under development	
Tidal aquatic life – PCBs	MD-BACOH	TMDL under development	
Tidal aquatic life – TSS	MD-BACOH	Impaired	
Chlordane	MD-BACOH	TMDL complete	December 1999
Nutrients	MD-BACOH	TMDL complete	June 2005
Fecal Coliform	02130901	TMDL complete	December 2007
Zinc	MD-BACOH	Water Quality Assessment	December 2004

PCBs – Polychlorinated Biphenyls (toxic organic compounds that were widely used for applications such as transformers, capacitors, and coolants); TSS – Total Suspended Solids

As shown in the table above, the Back River watershed has eight impairment listings. Note that the listing for nutrients includes both nitrogen and phosphorus. Three TMDLs and one WQA have been completed. TMDLs are currently being developed for PCBs which will address two of the listings. TMDLs will be developed at some point in the future for the remaining listings for TSS and stream biological community. A WQA was completed and submitted to USEPA for zinc, showing that the aquatic life criteria and designated uses associated with zinc are being met in the Back River and that a TMDL for zinc is not necessary to achieve water quality standards (MDE 2004). The USEPA agreed with MDE's findings that a zinc TMDL is not necessary for Back River in a letter to MDE dated December 23, 2004. This report will be used to support the removal of Back River from Maryland's 303(d) list in the future.

The three TMDLs that have been approved by USEPA are briefly discussed in the following sections.

3.2.1 Nutrients

TMDLs for nitrogen and phosphorus in the tidal segment of Back River were approved by USEPA in June 2005 (MDE 2005). The tidal portion of Back River was first listed as having a nutrient impairment in 1996 due to signs of eutrophication (denoted by high chlorophyll-a levels). Eutrophication is over-enrichment of water bodies by excessive nutrient input which causes excessive growth of aquatic plants (algal blooms) and bacterial consumption of dissolved oxygen when the plants decompose. Therefore, the water quality goal for the nutrients TMDLs is to reduce high chlorophyll-a concentrations (maximum of 100 µg/L, target of less than 50 µg/L) and maintain dissolved oxygen levels (minimum of 5 mg/L) to meet designated uses of Back River (COMAR 28.02.03).

Total nitrogen and total phosphorus loads were assigned to contributing nonpoint and point sources in the Back River watershed. Average annual allocations of total nitrogen and phosphorus developed based on existing relative contributions and reductions necessary to meet TMDLs for Back River are summarized in Table 3-2.

Table 3-2: Average Annual Nutrient Allocations (lbs/year)

Source	Total Nitrogen	Total Phosphorus
Nonpoint Source	26,323	1,239
Point Source	1,737,626	96,896
Margin of Safety	9,151	1,036
Total	***1,773,100***	***99,171***

The TMDL analysis showed that non-urban, nonpoint source loads including agricultural, forest, and atmospheric sources represent the least significant contributor to nutrients in Tidal Back River. Nonetheless, Maryland's Water Quality Improvement Act of 1998 requiring the implementation of nutrient management plans for all agricultural lands in the state will help achieve nonpoint source load reductions. This act required that comprehensive and enforceable nutrient management plans for nitrogen be implemented by 2002 and for phosphorus by 2005. Point source loads include urban stormwater discharges and nutrient inputs from the Back River WWTP. The TMDL analysis showed that the Back River WWTP was the most significant contributor to nutrient inputs to the Back River. The bulk of the nitrogen and phosphorus reductions required to meet the TMDLs and water quality standards for Tidal Back River will come from the Enhanced Nutrient Removal (ENR) improvements scheduled for completion in 2015. As discussed in Chapter 2.3.5.3, the Back River WWTP will be able to achieve effluent concentrations of 3 mg/L total nitrogen and 0.2 mg/L total phosphorus upon completion of the upgrade. Urban stormwater loads of nitrogen and phosphorus make up the balance of allowable nutrient loads and represent a 15 percent reduction from baseline urban stormwater loads estimated for the average annual TMDL scenario. The Upper Back River SWAP and Tidal Back River SWAP are intended to address the actions needed to achieve this reduction in nitrogen and phosphorus and help meet water quality standards.

3.2.2 Bacteria

According to Maryland's 303(d) listing, the fecal bacteria impairment for the Back River watershed is limited to Herring Run in the Upper Back River SWAP planning area. Fecal coliform data collected by Baltimore County Department of Public Works (DPW) for four years at three representative sites in the Herring Run watershed was translated to E. coli, the indicator used by the state, and used to develop the bacteria TMDL. The fecal bacteria long-term annual average TMDL for the Herring Run watershed is 652,460 billion MPN E. coli/year (1,788 MPN/day) with a maximum daily load of 42,266 MPN/day (MDE 2007). The units of MPN/day were used to represent a long-term allowable load for various hydrological conditions. The State water quality standard for E. coli is 126 MPN/100 mL (COMAR 26.08.02.03-3). The loading capacity of Herring Run was based on a more stringent water quality endpoint concentration of 119.7 MPN/100 mL (5% margin of safety). MDE determined that most of the bacteria could be attributed to human sources (71%, annual average) with some also coming from domestic pets (19%, annual average) and wildlife (10%, annual average). The reductions needed to meet water quality standards are on the order of 93 percent and would require nearly a total elimination of human and domestic pet waste as well as a significant portion of the wildlife source. Much of the human source reduction will be achieved through implementation of the requirements documented in Baltimore City and Baltimore County consent decrees (see Chapter 3.4).

3.2.3 Chlordane

Chlordane was used as a pesticide to control termites in building foundations. It was detected in certain Back River fish tissues, prompting a fish consumption advisory in 1986 and an impairment listing in 1996 for chlordane. The use of chlordane was restricted in 1975 and ultimately, its sale was banned in 1988. There are no known existing sources of chlordane other than what exists in the sediment and data suggests that chlordane concentrations are decreasing (MDE 2009). For these reasons, the TMDL for chlordane identified a strategy of natural recovery and periodic monitoring of fish and sediment contaminant levels to meet water quality standards.

3.3 Pollutant Loading Analysis

Pollutant loading analyses are underway for each of the Maryland designated 8-digit watersheds located entirely or in part within Baltimore County. Analyses are intended to assess the impacts of current and future development on water quality. To support these analyses, Baltimore County has derived watershed-specific pollutant loading rates for nitrogen and phosphorus based on two sources: technical guidance provided by MDE's *User's Guide for Nutrient Load Analysis Spreadsheet in Support of the Water Resources Element (WRE)* and the Chesapeake Bay Program – Watershed Model Phase 4.3 and Phase 5.2 (CBP 1998). MDE's guidance document was used to develop nutrient loadings rates for all non-urban land uses and CPB's model was used to develop loadings rates for urban land uses. Pollutant loading rates developed by Baltimore County for different land cover types in Back River and used to estimate pollutant loadings from the Tidal Back River watershed are summarized in the table below. More details regarding pollutant loading rates and analysis methods will be presented in Baltimore County's, Baltimore *WRE Technical Memo – B, Pollutant Loading Analysis*.

Table 3-3: Annual Pollutant Loadings Rates for Back River (lbs/acre/year)

WRE Land Use	Nitrogen per acre	Phosphorus per acre
Impervious Urban	14.1	2.26
Pervious Urban	7.255	0.429
Cropland	13.54	0.69
Pasture	5.64	0.66
Livestock	19.68	0.99
Forest and Wetlands	1.29	0.02
Water	10	0.57
Bare soil	5.64	0.66

As discussed in Chapter 2.3.1, land use information for the Tidal Back River watershed was obtained from MDP's 2007 LU/LC GIS layer. For the purposes of watershed-scale pollutant loading analyses, Baltimore County uses a consolidated version of MDP's 2002 land use classifications since loading rates do not differ significantly between certain land use classes (e.g., various forest types). The MDP LU/LC categories present in the Tidal Back River and the corresponding WRE land cover classes used for the pollutant loading analyses are summarized in the table below.

Table 3-4: Reclassification of MDP LU/LC to WRE Land Cover for Tidal Back River

MDP LU/LC Classification	WRE Land Cover
192 Very Low Density Residential	Urban*
11 Low Density Residential	Urban*
12 Medium Density Residential	Urban*
13 High Density Residential	Urban*
14 Commercial	Urban*
15 Industrial	Urban*
16 Institutional	Urban*
18 Open Urban	Urban*
21 Cropland	Cropland
22 Pasture	Pasture
41 Deciduous Forest	Forest and Wetlands
43 Mixed Forest	Forest and Wetlands
44 Brush	Forest and Wetlands
50 Water	Water
60 Wetlands	Forest and Wetlands
73 Bare Ground	Bare Ground
80 Transportation	Urban*

* These categories were split into pervious urban and impervious urban areas using Baltimore County's roads and buildings GIS layers.

Consolidated land uses were used to determine the total acreage for each WRE land cover category. These were multiplied by the corresponding loading rates presented in Table 3-3. Resulting annual pollutant loads for total nitrogen and total phosphorus from the Tidal Back River watershed are summarized in the table below.

Table 3-5: Total Annual Nutrient Loads from Tidal Back River Watershed

		NITROGEN		PHOSPHORUS	
WRE Land Use	**Area (acres)**	**Rate (lb/ac)**	**Load (lbs)**	**Rate (lb/ac)**	**Load (lbs)**
Impervious Urban	1,379	14.1	19,444	2.26	3,117
Pervious Urban	3,291	7.255	23,873	0.429	1,412
Cropland	335	13.54	4,532	0.69	231
Pasture	7	5.64	41	0.66	5
Forest	2,642	1.29	3,408	0.02	53
Water	66	10	656	0.57	37
Bare soil	1	5.64	4	0.66	0
Total	***7,720***		***51,959***		***4,855***

Total annual nutrient loads were previously calculated for the purposes of the Upper Back River SWAP. Annual loads estimated for total nitrogen and total phosphorus for both planning areas and the results for the entire Back River watershed are summarized in the table below.

Table 3-6: Estimated Nutrient Loads from Back River SWAP Planning Areas (lbs/year)

	Total Nitrogen	**Total Phosphorus**
Upper Back River	239,941	26,174
Tidal Back River	51,959	4,855
Total	***291,300***	***31,029***

Loads attributed to Baltimore County and Baltimore City (urban stormwater loads) for average annual flow TMDLs totaled 155,571 lbs/year for total nitrogen and 17,619 lbs/year for total phosphorus (MDE 2004). Based on the planning level estimates of existing watershed loads, this represents a 47 percent reduction required for total nitrogen loads and a 43 percent reduction for total phosphorus loads.

The loads calculated for Tidal Back River watershed represent approximately 18 percent of the annual nitrogen load and 16 percent of the annual phosphorus load from the entire Back River watershed. This is reasonable considering that the Tidal Back River planning area comprises approximately 22 percent of the Back River watershed. Nutrient loadings were also calculated on a subwatershed basis using the same loading rates and land cover designations. These estimates will provide baseline nutrient loads before implementation of restoration projects and will allow a better assessment of both progress made to date and further progress needed to meet TMDL goals for urban nonpoint source reduction. Table 3-7 summarizes acreages of WRE land cover categories by subwatershed.

Table 3-7: Tidal Back River WRE Land Cover Classification (acres)

WRE Land Cover	Back River-A	Back River-F	Back River-G	Bread & Cheese	Deep Creek	Duck Creek	Greenhill Cove	Longs Creek	Lynch Pt Cove	Muddy Gut	*Totals*
Total Urban	715	127	228	950	866	760	185	418	107	313	***4,670***
Impervious Urban	148	36	49	322	318	271	59	37	37	103	***1,379***
Pervious Urban	568	91	179	628	547	490	126	381	71	210	***3,291***
Cropland	0	78	0	0	0	0	0	208	0	49	***335***
Pasture	0	7	0	0	0	0	0	0	0	0	***7***
Livestock	0	0	0	0	0	0	0	0	0	0	***0***
Forest	248	193	84	228	119	57	33	1,394	3	285	***2,642***
Water	10	15	2	5	5	8	4	8	3	7	***66***
Bare soil	0	0	0	1	0	0	0	0	0	0	***1***
Totals	***973***	***420***	***313***	***1,183***	***989***	***825***	***222***	***2,028***	***113***	***653***	***7,720***

The resulting nutrient loads for the 10 subwatersheds in Tidal Back River are summarized in the tables below. These tables also include nitrogen and phosphorus loading rates (lbs/ac/yr) for each subwatershed. Tables 3-8 and 3-9 show that the subwatersheds generating the greatest annual pollutant loads are Bread and Cheese, Deep Creek, Longs Creek, Back River-A, and Duck Creek. Note, however, that these subwatersheds also have larger surface areas in comparison to the remaining subwatersheds. Duck Creek and Lynch Pt Cove are the subwatersheds that generate the highest amount of nutrients per acre. Deep Creek, Greenhill Cove, Bread and Cheese, Back River-A, and Back River-G also have high nutrient loadings rates (lbs/acre/yr). Subwatershed pollutant loadings and rates will be used to prioritize restoration efforts. The total planning level pollutant load estimate will be used to determine necessary reductions to meet TMDL and Tributary Strategy reductions.

Table 3-8: Annual Nitrogen Loads by Subwatershed

SUBWATERSHED	Total Area (acres)	ANNUAL NITROGEN LOADS BY WRE LAND COVER (lbs/yr) Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water	Bare soil	Total Nitrogen Load (lbs/yr)	Nitrogen Loading Rate (lbs/acre/yr)
Back River-A	973.1	1,192	8,950	0	0	319	101	0	10,563	10.9
Back River-F	420.4	287	1,441	1,053	41	249	149	0	3,221	7.7
Back River-G	313.4	396	2,823	0	0	108	17	0	3,343	10.7
Bread & Cheese	1,183.0	2,597	9,901	0	0	294	48	4	12,843	10.9
Deep Creek	989.5	2,567	8,630	0	0	153	50	0	11,400	11.5
Duck Creek	825.0	2,181	7,722	0	0	74	77	0	10,054	12.2
Greenhill Cove	221.6	475	1,987	0	0	42	38	0	2,543	11.5
Longs Creek	2,028.0	299	6,007	2,819	0	1,798	78	0	11,002	5.4
Lynch Pt Cove	113.2	295	1,117	0	0	4	27	0	1,443	12.7
Muddy Gut	653.0	827	3,313	659	0	367	72	0	5,237	8.0
Totals	***7,720.2***	***11,115***	***51,893***	***4,532***	***41***	***3,408***	***656***	***4***	***71,649***	***9.3***

Table 3-9: Annual Phosphorus Loads by Subwatershed

SUBWATERSHED	Total Area (acres)	ANNUAL PHOSPHORUS LOADS BY WRE LAND COVER (lbs/yr) Impervious Urban	Pervious Urban	Cropland	Pasture	Forest	Water	Bare soil	Total Phosphorus Load (lbs/yr)	Phosphorus Loading Rate (lbs/acre/yr)
Back River-A	973.1	75	1,294	0	0	5	6	0	1,380	1.4
Back River-F	420.4	18	208	54	5	4	9	0	297	0.7
Back River-G	313.4	25	408	0	0	2	1	0	436	1.4
Bread & Cheese	1,183.0	164	1,432	0	0	5	3	0	1,604	1.4
Deep Creek	989.5	162	1,248	0	0	2	3	0	1,415	1.4
Duck Creek	825.0	138	1,117	0	0	1	4	0	1,260	1.5
Greenhill Cove	221.6	30	287	0	0	1	2	0	320	1.4
Longs Creek	2,028.0	19	868	144	0	28	4	0	1,063	0.5
Lynch Pt Cove	113.2	19	161	0	0	0	2	0	182	1.6
Muddy Gut	653.0	52	479	34	0	6	4	0	575	0.9
Totals	***7,720.2***	***703***	***7,503***	***231***	***5***	***53***	***37***	***0***	***8,532***	***1.1***

3.4 Water Quality Monitoring Data

Baltimore County conducts chemical, biological, and illicit connection monitoring within the Tidal Back River watershed. Section 3.2.1 summarizes the chemical data available for Tidal Back River and Section 3.2.2 summarizes the biological monitoring program. Section 3.2.3 discusses the illicit connection program.

3.4.1 Chemical Data

Various chemical monitoring data are available for the Tidal Back River including two programs administered by Baltimore County and one by Maryland DNR for the Patapsco/Back River Basin. Chemical water quality data available to date in the watershed and tidal portion of the Back River are summarized in the following sections.

3.4.1.1 County Recreational Water Sampling Program

Baltimore County has nearly 200 miles of tidal coastline including public and privately owned tidal and fresh water recreational beaches. These resources support various recreational uses such as fishing, camping, and boating. Baltimore County regularly conducts bacteriological sampling of many of these areas to provide water quality information to the public and encourage safe use of these resources. The sampling program uses the indicator organism, enterococci, which are found in the intestines of all warm-blooded animals; if enterococci are found in high concentrations in association with a known or suspected source of sewage contamination, it indicates the probable presence of pathogenic (disease causing) organisms in the water samples. Sampling for tidal waters is generally performed April through November as weather permits. Additional sampling may be conducted in response to unusual conditions that could adversely impact water quality.

There are currently 7 sampling locations in the tidal portion of Back River as shown in Figure 3-1. The most recent sampling data results for these sampling locations (2008-2009) are summarized in Table 3-9. The USEPA/MDE bacteriological standard for consideration of beach closure at tidal beaches is a geometric mean of 35 MPN enterococci. MPN stands for most probable number. Measurements are typically denoted as MPN/100 mL which stands for the most probably number of bacteria colonies expected to be found in a 100-mL sample of water. (DEPRM 2009, see also Code of Maryland Regulations (COMAR) 26.08.02.03)

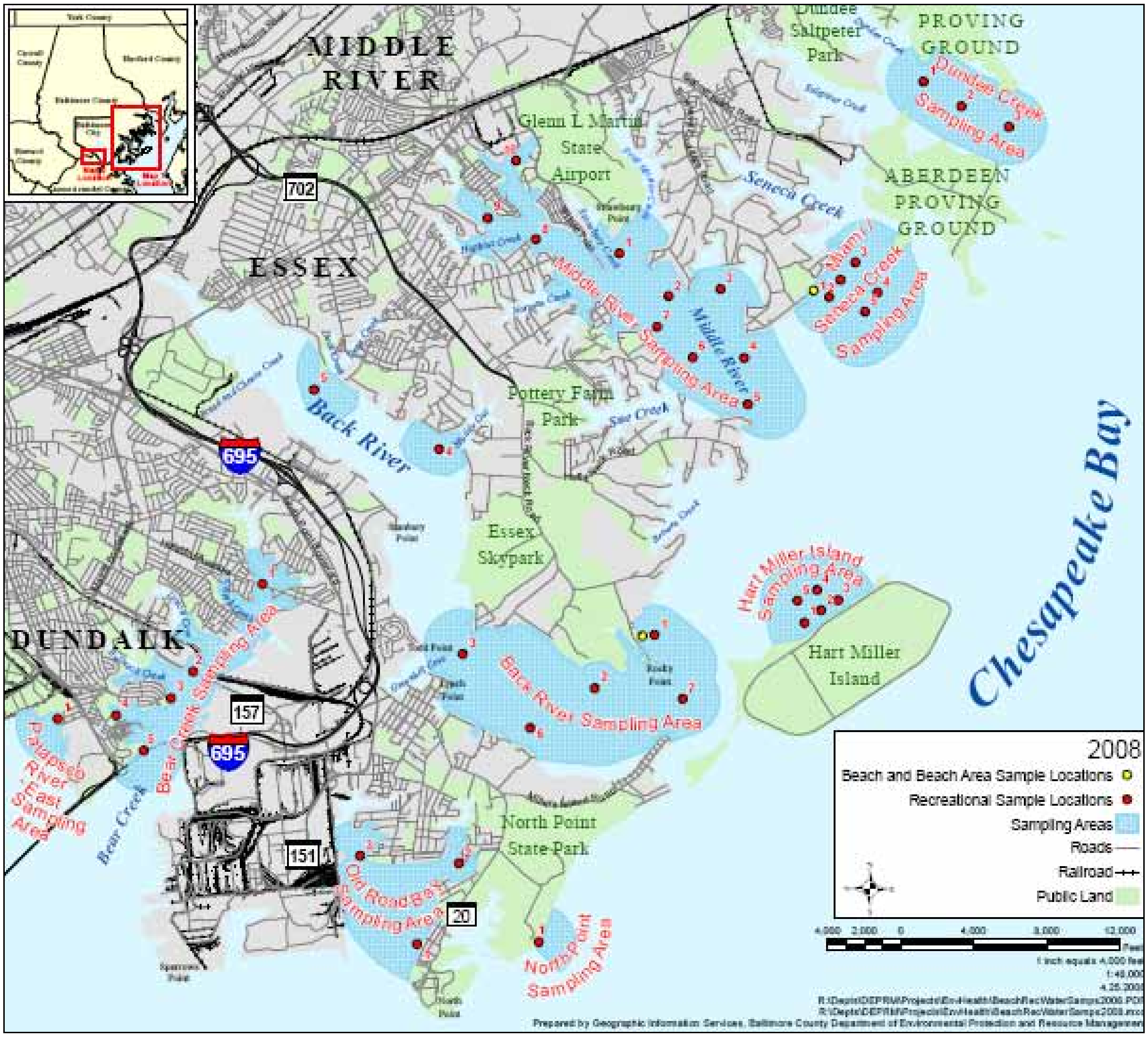


Figure 3-1: Baltimore County Recreational Water Sample Locations in Tidal Back River
(Excerpt from DEPRM 2009)

Table 3-10: Back River Recreation Waters Sampling Results (MPN Enterococci)

Sample Date	SAMPLE ID 1	2	3	4	5	6	7	Geometric Mean
07/20/09	<10	10	<10	10	<10	<10	10	1.93
07/13/09	<10	<10	<10	<10	<10	<10	<10	1.00
06/24/09	<10	<10	<10	<10	<10	10	<10	1.38
06/08/09	<10	<10	10	<10	<10	<10	<10	1.00
05/28/09	<10	<10	10	<10	20	<10	<10	2.96
05/11/09	<10	<10	<10	<10	<10	10	<10	1.93
04/27/09	<10	<10	<10	<10	<10	<10	<10	1.00
04/13/09	<10	<10	<10	<10	10	<10	10	1.93
11/06/08	<10	<10	<10	<10	<10	<10	<10	1.00
10/07/08	<10	<10	<10	20	<10	10	<10	1.53
09/23/08	<10	<10	20	10	<10	<10	10	2.96
09/08/08	<10	<10	<10	<10	<10	<10	<10	1.00
08/27/08	<10	<10	10	20	10	<10	<10	2.96
08/12/08	<10	<10	<10	10	<10	<10	<10	1.38
07/29/08	<10	<10	<10	<10	10	<10	<10	1.38
07/15/08	<10	10	<10	80	40	<10	<10	4.40
07/02/08	<10	<10	<10	10	-	<10	<10	1.46
06/24/08	<10	<10	10	50	<10	10	<10	3.37
06/10/08	<10	10	10	<10	<10	<10	<10	1.93
05/29/08	<10	10	<10	<10	<10	10	<10	1.93
05/14/08	<10	<10	<10	<10	180	<10	<10	2.09
05/05/08	<10	<10	<10	<10	<10	<10	<10	1.00
04/08/08	<10	<10	<10	<10	<10	<10	<10	1.00

Table 3-9 shows that the geometric means for recent sampling events are well below the USEPA/MDE limit of concern of 35 MPN enterococci.

Sampling results are also available for the period between 2002 and 2007 in Tidal Back River. Baltimore County maintains an archive for water sampling results here:
http://www.baltimorecountymd.gov/Agencies/environment/watersampling/samplingresults/

Historical sampling locations corresponding with the link above are shown approximately in Figure 3-2. The geometric means for the 2002-2007 sampling period in Tidal Back River are generally similar throughout the 6-year time period, ranging from 9.9 to 16.2 MPN enterococci which is also below the USEPA/MDE standard. Note, however, geometric means for the 2008-2009 sampling period are much lower ranging from 1.0 to 4.4 MPN enterococci, indicating a decrease in bacteria population and water quality improvement in the Tidal Back River.

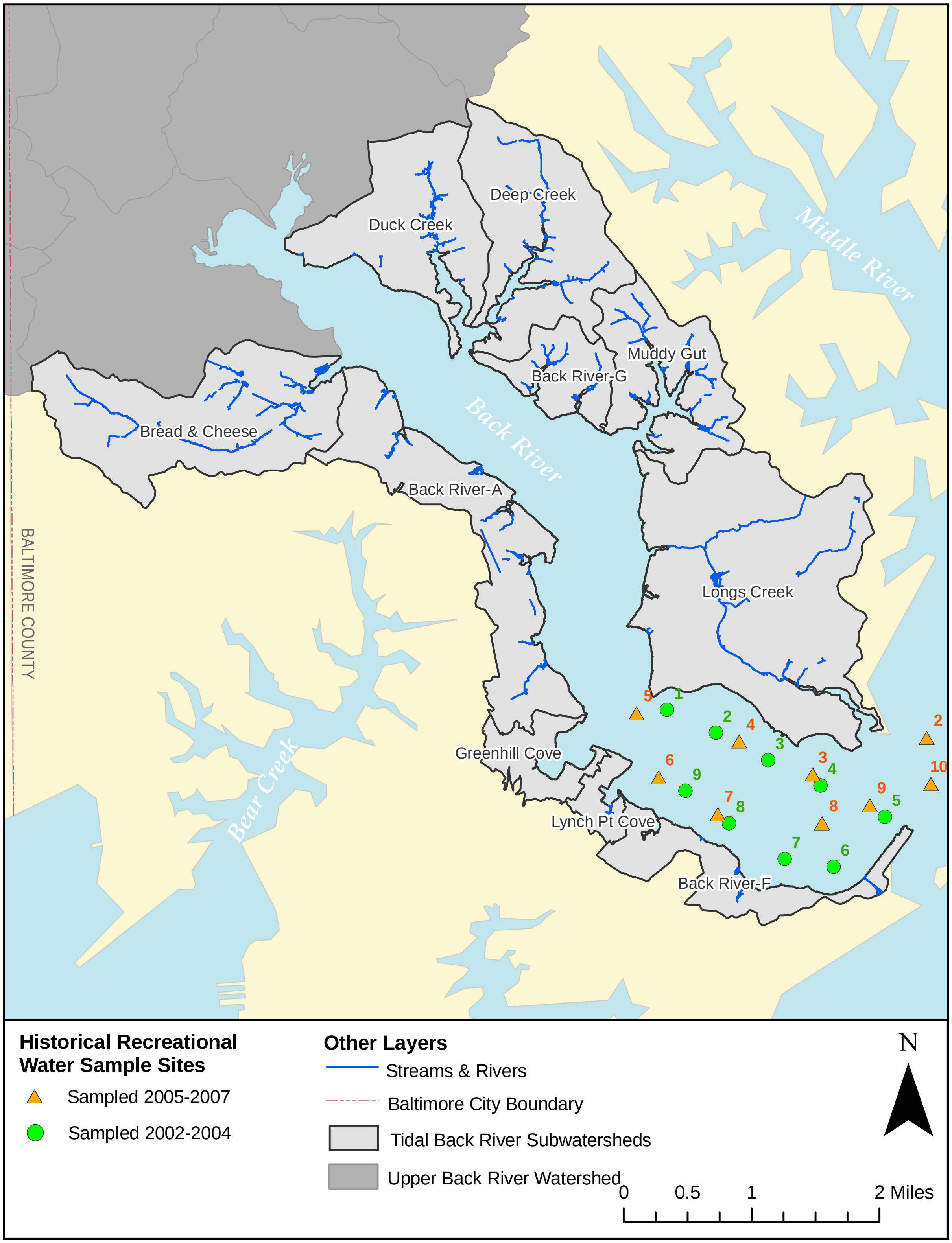


Figure 3-2: Baltimore County Historical Recreational Water Sample Locations in Tidal Back River

Other water quality parameters are also measured in Tidal Back River as part of the tidal recreational waters monitoring program including total suspended solids (TSS), nutrients, metals, and chloride. The importance of each of these parameters is briefly described below.

- Suspended Solids: Excessive suspended solids in water bodies can adversely impact aquatic life as it affects the light available for photosynthesis by plants and visual capacity of aquatic life. Decreased light can lead to increase algae communities and resulting decrease in abundance and diversity of invertebrate and fish communities. Excessive sediment can also negatively affect habitat structure.

- Nutrients: As discussed previously, over-enrichment of water bodies by excessive nutrient input can cause excessive growth of aquatic plants (algal blooms) and bacterial consumption of dissolved oxygen when the plants decompose. This can lead to significant reductions in water quality as well as abundance and diversity of aquatic life communities.

- Metals: Metals are a concern because they dissolve in water and are easily absorbed by aquatic organisms such as fish. Small concentrations of metals in water bodies can be toxic to aquatic life and human health. While metals may not directly kill organisms, many adverse health effects are associated with metals such as growth and reproductive impacts.

- Chloride: Chlorides come from various sources such as agricultural runoff, waste water, and road salting. High levels of chlorides can be toxic to aquatic communities including fish.

Since the Tidal Back River is defined as a fresh water body and designated for water contact recreation, fishing, and protection of aquatic life and wildlife per COMAR, it is subject to toxic substance criteria established for ambient surface waters, pertaining to aquatic life in fresh water. USEPA National Recommended Water Quality Criteria (USEPA 2009) and reporting limits for measured water quality parameters in Tidal Back River are summarized in the table below.

Table 3-11: Numeric Water Quality Criteria and Report Limits (mg/L)

Parameter	CMC (acute)	CCC (chronic)	Reporting Limit
Suspended Solids	N/A	N/A	1
Total Phosphorus	N/A	N/A	0.02
Total Nitrogen	N/A	N/A	0.2
Cadmium	0.002	0.0025	0.001
Copper	0.013	0.009	0.001
Lead	0.065	0.0025	0.001
Zinc	0.12	0.12	0.001
Chloride	860	230	-

CMC: Criteria Maximum Concentration is an estimate of the highest concentration to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.

CCC: Criterion Continuous Concentration is an estimate of the highest concentration to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

Water criteria for suspended solids and nutrients are currently not available. As discussed in the previous TMDL section, the effect of nutrients in Tidal Back River is measured by chlorophyll-a and dissolved oxygen. For tidal waters, suspended solids is expressed as a water clarity requirement which is 0.5 meters (1.6 feet) for Back River. The geometric means of these water quality parameters measured for the years 2002 to 2009 in Tidal Back River are presented in the table below.

Table 3-12: Back River Recreation Waters Sampling Results (Annual Geometric Means, mg/L)

YEAR	TSS	TN	TP	CD	CU	PB	ZN	CL
2002	29.6	1.6	0.09	0.001	0.025	0.001	0.008	1,238
2003	21.3	1.5	0.14	0.001	0.007	0.002	0.006	664
2004	11.1	1.7	0.11	0.001	0.006	0.001	0.005	803
2005	26.1	1.6	0.12	0.001	0.004	0.001	0.006	2,390
2006	24.2	1.4	0.15	0.001	0.012	0.001	0.012	1,629
2007	18.8	1.8	0.20	0.001	0.003	0.001	0.004	1,849
2008	17.5	2.0	0.17	0.001	0.003	0.001	0.008	623
2009	18.3	N/A	0.06	0.001	0.002	0.001	0.004	580

TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus; CD = Total Cadmium; CU = Total Copper; PB = Total Lead; ZN = Total Zinc; CL = Chloride

The table above shows that heavy metal and nutrient concentrations have remained fairly consistent during the time period from 2002 to 2009, with slight decreases in copper, zinc and suspended solids. Lead and zinc levels are well below applicable water quality criteria. Cadmium levels are well below acute criteria. Because most lead and cadmium concentrations were recorded as the reporting limit, levels could be even lower. Copper concentrations are well below acute criteria with the exception of 2002. Most copper concentrations are below the chronic levels except 2002 and 2006. Chloride concentrations consistently exceed chronic criteria; however, a significant decrease has occurred since 2007. Current levels of chloride are below acute criteria.

3.4.1.2 County Baseflow Monitoring Program

Baltimore County initiated a baseflow monitoring program in 1999 for the Lower Gunpowder, Little Gunpowder, Middle River, and Baltimore Harbor watersheds. These sites were initially selected for monitoring because Water Quality Management plans were under development at that time. In the fall of 2000, baseflow monitoring began in the Back River, Jones Falls, and Gwynns Falls watersheds. Baseflow monitoring for the Back River has been conducted in odd years since 2003 (DEPRM 2008).

Baseflows are monitored in the Patapsco/Back River Basin in odd-numbered years and in the Gunpowder/Deer Creek Basin in even-numbered years. A total of 53 sites are monitored in the Patapsco/Back River Basin with only one site in the Tidal Back River watershed. This site, BR-01, is located on Bread and Cheese Creek, upstream of Merritt Boulevard, adjacent to Rabon Avenue. Baseflow monitoring results collected for site BR-01 are summarized in Table 3-12.

Table 3-13: Tidal Back River Baseflow Monitoring Results at Site BR-01 (mg/L)

DATE	TSS	TN	TP	CD	CU	PB	ZN	CL
04/03/03	0.5	2.64	0.05	0.0005	0.006	0.0005	0.005	135.72
04/23/03	0.5	3.02	0.05	0.0005	0.0005	0.001	0.007	113.79
09/10/03	52	4.49	0.27	0.0005	0.004	0.009	0.008	772.74
09/10/03	0.5	4.27	0.05	0.0005	0.003	0.0005	0.006	111.91
10/02/03	0.5	2.93	0.05	0.0005	0.002	0.001	0.0005	109.27
01/03/05	0.5	2.28	0.03	0.0005	0.003	0.0005	0.0005	111.28
01/03/05	0.5	2.28	0.03	0.0005	0.003	0.0005	0.0005	111.28
08/02/05	0.5	-	0.03	0.0005	0.004	0.0005	0.0005	118.96
08/23/05	0.5	4.04	0.03	0.0005	0.0005	0.0005	0.0005	107.62
07/16/07	10	-	0.09	0.0005	0.0005	0.001	0.02	108.78
Min	***0.5***	***2.28***	***0.03***	***0.0005***	***0.0005***	***0.0005***	***0.0005***	***107.62***
Max	***52***	***4.49***	***0.27***	***0.0005***	***0.006***	***0.009***	***0.02***	***772.74***
Median	***0.5***	***2.98***	***0.05***	***0.0005***	***0.003***	***0.0005***	***0.003***	***111.60***

TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus; CD = Total Cadmium; CU = Total Copper; PB = Total Lead; ZN = Total Zinc; CL = Chloride

The table above shows that measured concentrations of copper, lead, and zinc are well below water quality criteria established by USEPA. Cadmium concentrations are consistently below acute criteria but exceed chronic thresholds. Chloride concentrations are below established criteria with the exception of September 2003 which exceed chronic criterion. Suspended sediments concentrations are fairly consistent; however, a considerable increase occurred between 2005 and 2007. Nutrient levels are fairly consistent.

3.4.1.3 Patapsco/Back River Tributary Strategy Data

To help achieve Maryland's portion of the reductions in nitrogen, phosphorus and sediment to the Chesapeake Bay, a Tributary Strategy Team has been selected for each of the 10 basins comprising the Chesapeake Bay including the Patapsco/Back River Basin. Maryland's Tributary Teams consist of local citizens, farmers, business leaders, and state and local government officials appointed by the Governor to help implement pollution prevention measures and to address local water quality programs including water quality monitoring. To assist the Tributary Team, Maryland DNR documented Patapsco/Back River basin characteristics including available water quality monitoring results in their report, *Maryland Tributary Strategy Patapsco/Back Rivers Basin Summary Report for 1985-2005 Data* (DNR 2007).

Water quality parameters including nitrogen, phosphorus, chlorophyll-a (algal abundance), total suspended solids, water clarity and dissolved oxygen are measured at two long-term tidal monitoring stations in the Patapsco/Back River Basin, one of which is located in the Back River (see Figure 3-3). Results are assigned a current status of good, fair or poor relative to baseline data or scientifically based benchmarks (e.g., applicable state thresholds) depending on the parameter. For example, concentrations of dissolved oxygen (DO) are compared to ecologically meaningful thresholds available: good (DO > 5 mg/L); fair (DO = 2-5 mg/L); and poor (DO < 2 mg/L). Since scientific benchmarks are not available for the remaining parameters, a Chesapeake Bay-wide scale was developed for each parameter based on salinity zone. All data available for the Chesapeake Bay between 1985 and 1990 were used to establish a baseline for rating water quality at each station. Three cutoff points were derived to define good, fair, and poor ratings from a cumulative logistic function for the monthly medians of the baseline data. Monthly medians from the most recent data set (2003-2005) at a given station are compared to these cutoff points to establish water quality status ratings. Water quality ratings are indicators relative to similar stations in the Chesapeake Bay during the baseline time period (1985-1990); therefore, a good rating does not necessarily reflect levels needed to sustain healthy living resource populations. Refer to the following link for more details regarding water quality analysis methods:

http://www.dnr.state.md.us/Bay/tribstrat/status_trends_methods.html

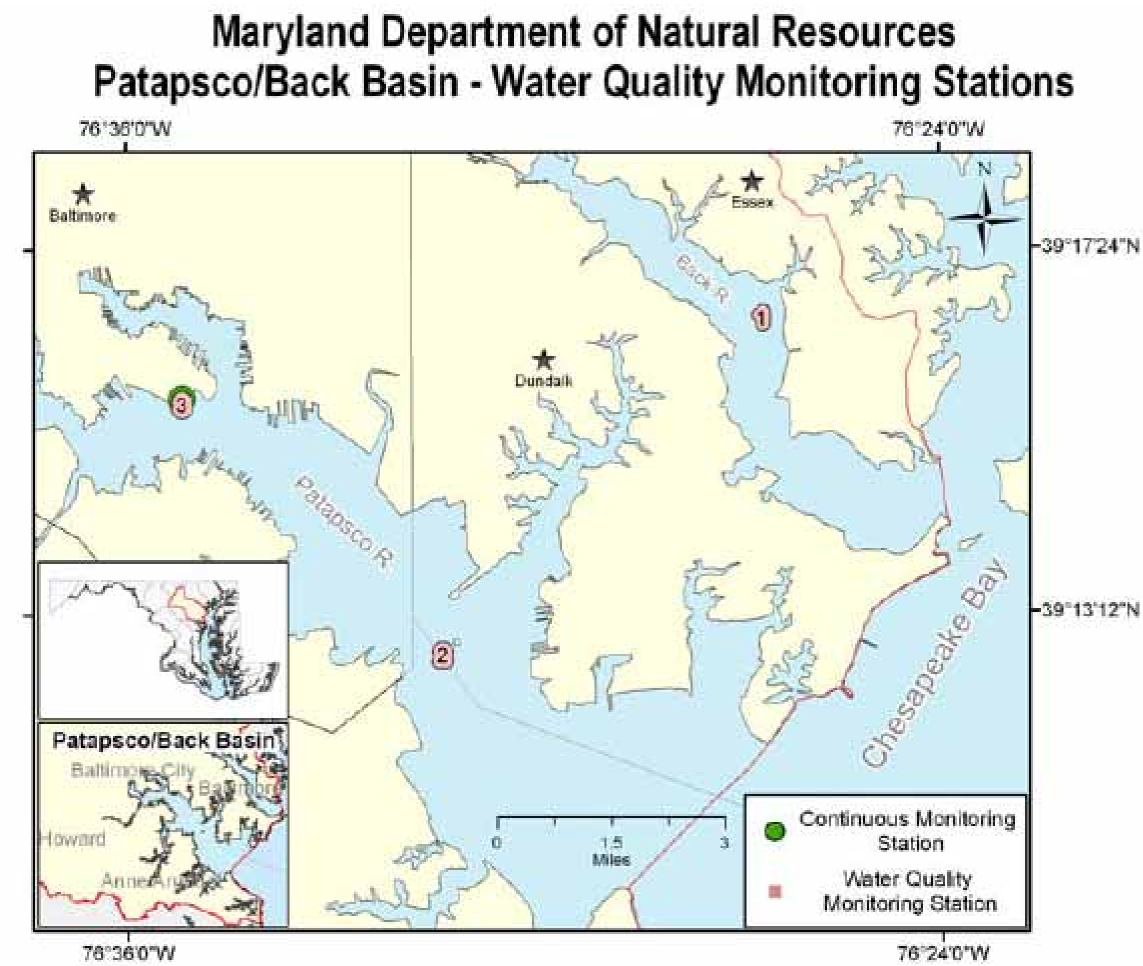
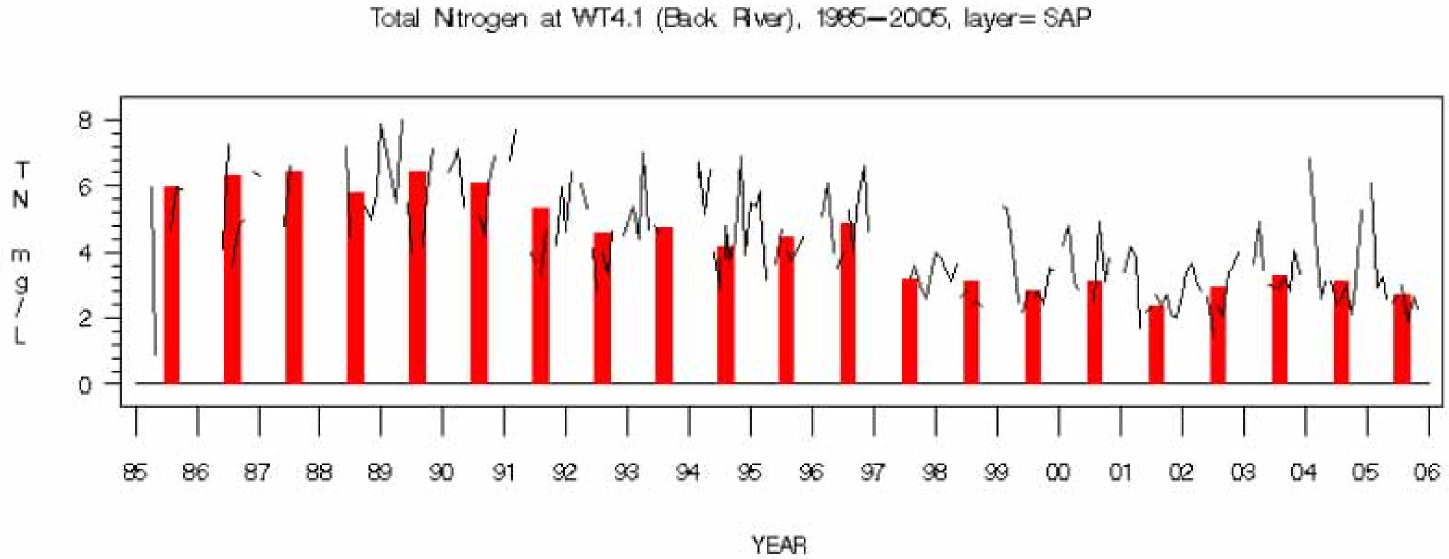


Figure 3-3: Location of Maryland DNR's Tidal Monitoring Station in Back River
(obtained from DNR 2007)

Figures 3-4 to 3-6 show the water quality monitoring results reported by Maryland DNR for Back River (Station WT4.1) during the period 1985-2005. Note that the black lines in Figures 3-4 to 3-6 denote concentrations for each sampling date and annual medians of these values are shown as red bars. Figure 3-4 shows total nitrogen concentrations ranging from as high as 6 mg/L in 1985 to as low as 2 or 3 mg/L in more recent years. Total phosphorus concentrations range from approximately 0.3 mg/L to 0.15 mg/L with a general decreasing trend in more recent years also. Chlorophyll concentrations were as high as 100 µg/L and appear to have decreased to 60 or 70 µg/L in 2005-2006. This still exceeds the level associated with excess eutrophication (nutrient enrichment) or 50 µg/L. Total suspended solids concentrations are generally less than 40 mg/L during the sample period with concentrations around 25-30 mg/L in more recent years. Water clarity is measured in terms of Secchi depth or the depth of water transparency. Figure 3-6 shows that water clarity is generally consistent from 1985 to 2005, where the Secchi depth is less than 0.5 m (1.6 feet) throughout the time period. Dissolved oxygen levels appear to be above the desired 5 mg/L level throughout the monitoring period.



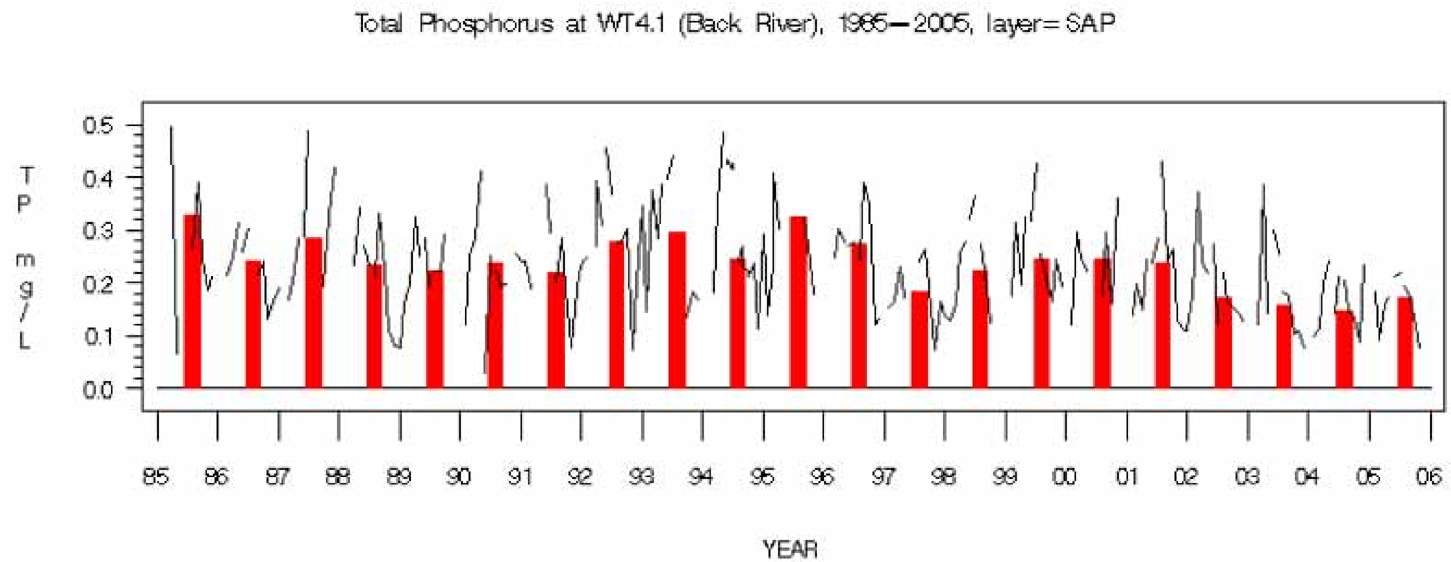


Figure 3-4: Total Nitrogen and Phosphorus Tidal Monitoring Results in Back River

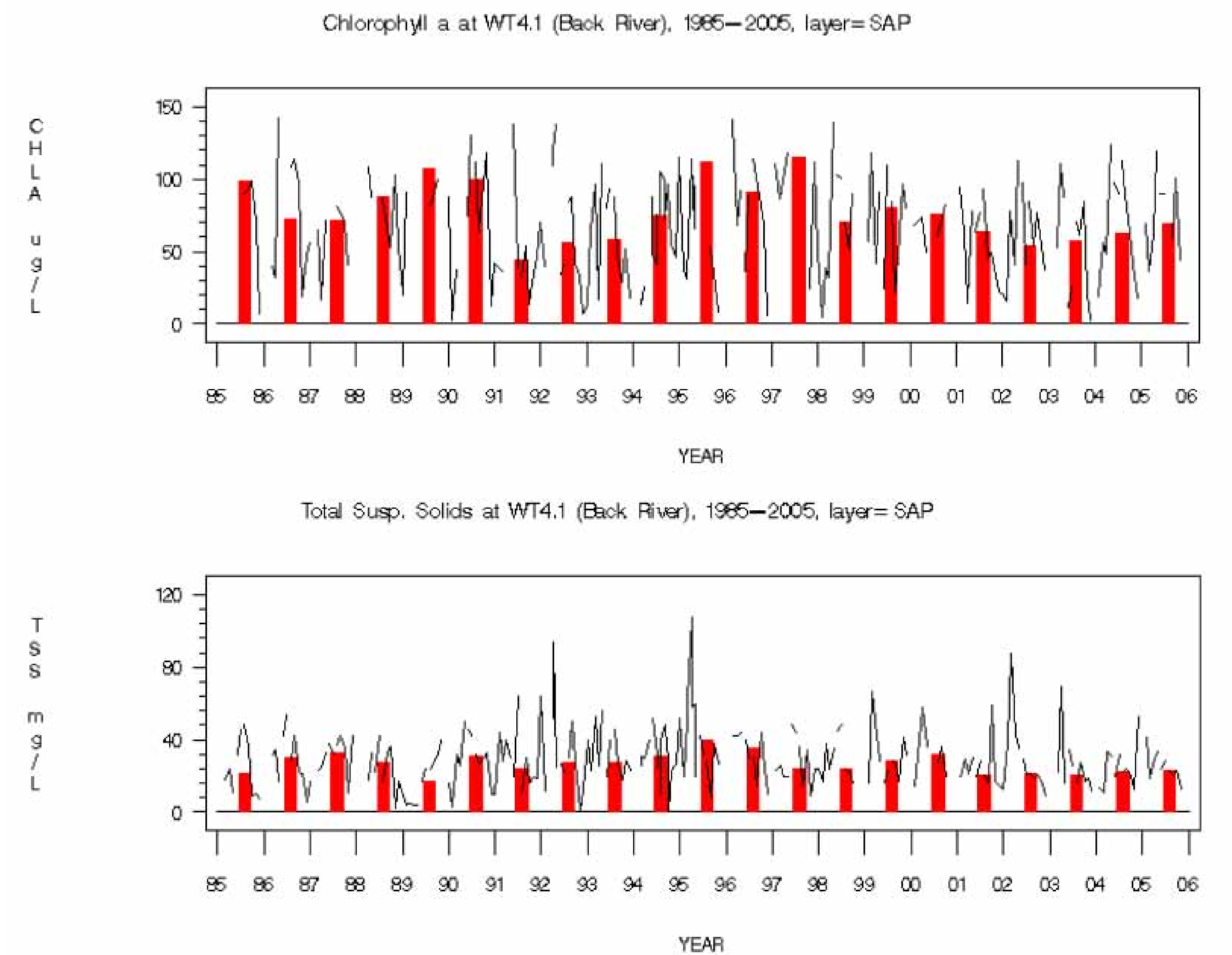


Figure 3-5: Chlorophyll-a and Total Suspended Solids Tidal Monitoring Results in Back River

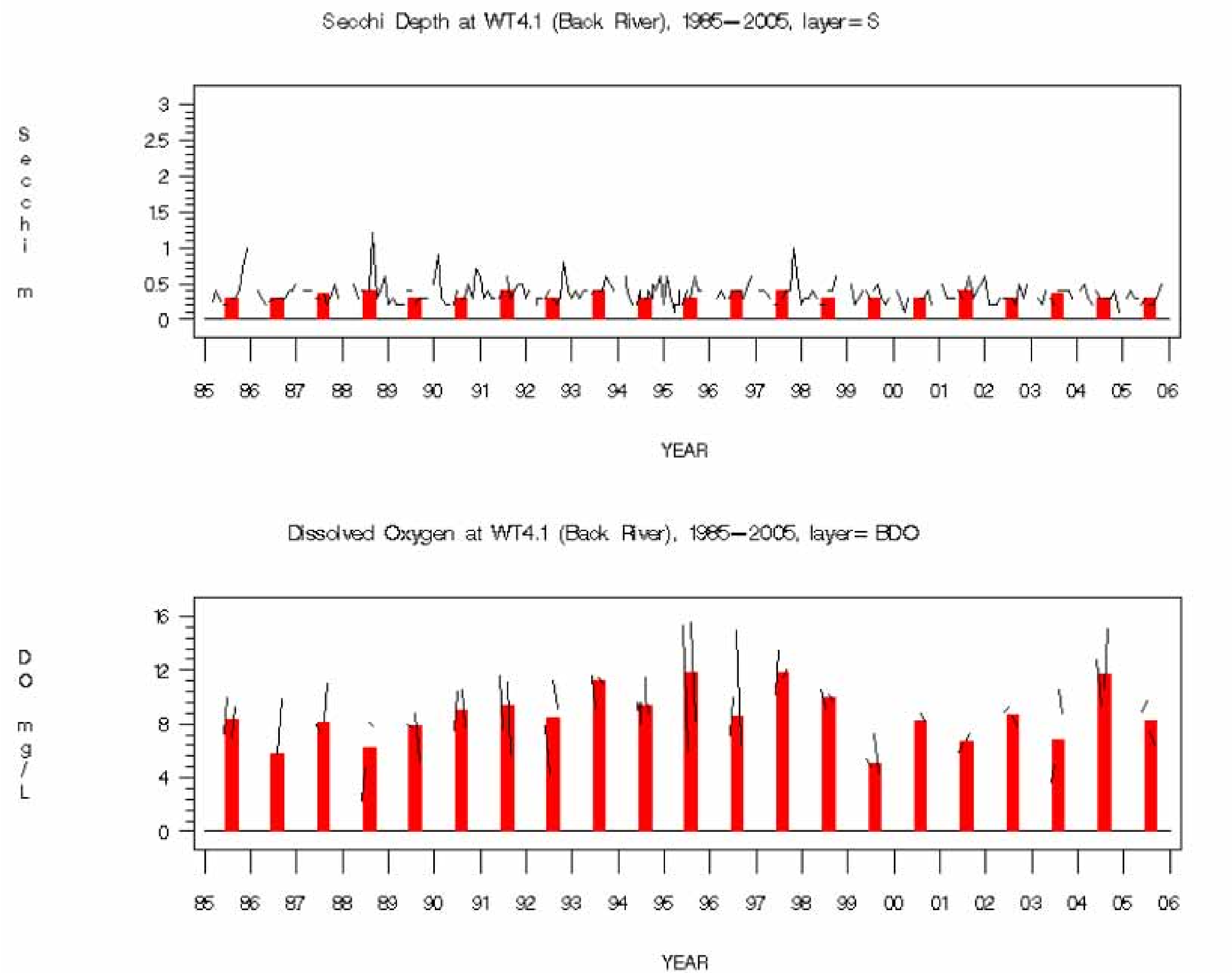


Figure 3-6: Water Clarity and Dissolved Oxygen Tidal Monitoring Results in Back River

Based on these monitoring results, Back River tidal water quality for the period 2003-2005 was considered as poor for four of the six parameters measured including total nitrogen, total phosphorus, chlorophyll-a, and water clarity. Total suspended solids concentration in Back River was designated as fair and dissolved oxygen concentrations were good (up to ~6.5 feet deep). The Tributary Team, however, reports improving trends for total nitrogen, total phosphorus, total suspended solids, and cholorphyll-a. In contrast, water clarity has been degrading from 1995 to 2005. The Tributary Team also noted that wet weather conditions (high rainfall and flow) increase nutrient and suspended solids concentrations. For more information, please refer to the *Maryland Tributary Strategy Patapsco/Back Rivers Basin Summary Report for 1985-2005 Data* (DNR 2007).

Submerged aquatic vegetation (SAV) is also monitored because it is a good indicator of water quality and habitat. SAV conditions are determined through aerial photography by the Virginia Institute of Marine Science (VIMS). 2004 is the first year that VIMS ever recorded SAV in Back River. At this time, 30 acres of wild celery were identified. The largest beds of SAV were observed near Cuckold and Cedar Points. In addition, the Tributary Team reported that wild celery transplants done during the period 1999-2003 in Longs Creek near the launch ramp at Rocky Point Park were successful. This observation was based on approximately 2.5 acres of SAV identified in the fall of 2005 with evidence of flowering and seed production. It is anticipated to result in more SAV recovery in the future. The target SAV coverage for Back River is 340 acres.

3.4.2 Biological Data

Baltimore County conducts biological monitoring of benthic macroinvertebrates on an annual basis using the Maryland Biological Stream Survey (MBSS) protocols (Kazyak 2001). The MBSS is a random design stream sampling program that was initiated by the Maryland DNR in 1993. It is intended to provide unbiased, statewide estimates of the biological resources in streams and rivers. Benthic macroinvertebrates are organisms without a backbone that live on the bottom of streams and can be seen with the naked eye. They are an important part of stream ecosystems as they are a source of food for other aquatic life such as fish. The presence, condition, numbers, and types of benthic macroinvertebrates also convey information about a water body’s quality. Results of the MBSS protocol include a benthic Index of Biological Integrity (IBI) score based on the benthic community characteristics at a sampling site. Qualitative ratings of stream biological integrity are based on IBI scores and range from good (4.0 – 5.0) denoting minimally impacted conditions to very poor (1.0 – 1.9) indicating severe degradation.

Sample sites for the Baltimore County biological sampling program are randomly selected focusing on the Patapsco/Back River Basin in odd years and the Gunpowder/Deer Creek Basin in even years. Between 2003 and 2007, three sites have been randomly sampled in the Tidal Back River watershed. Table 3-13 summarizes the benthic IBI scores and ratings based on the MBSS protocol and the location of the sampling sites are shown in Figure 3-7.

Table 3-14: Biological Monitoring Results in Tidal Back River

Site ID	Subwatershed	Longitude	Latitude	Sample Year	Benthic IBI Score	Benthic IBI Rating
138632	Bread & Cheese	-76.4916	39.2840	2005	1.67	Very Poor
1387550	Bread & Cheese	-76.5188	39.2877	2005	2.00	Poor
1478623	Deep Creek	-76.4518	39.3089	2007	1.57	Very Poor

As shown in Figure 3-7, two sites were sampled in Bread and Cheese and one site was sampled in Deep Creek. Both of these subwatersheds are significantly developed with mostly residential and commercial areas. The benthic IBI scores indicate poor to very poor stream conditions in these areas.

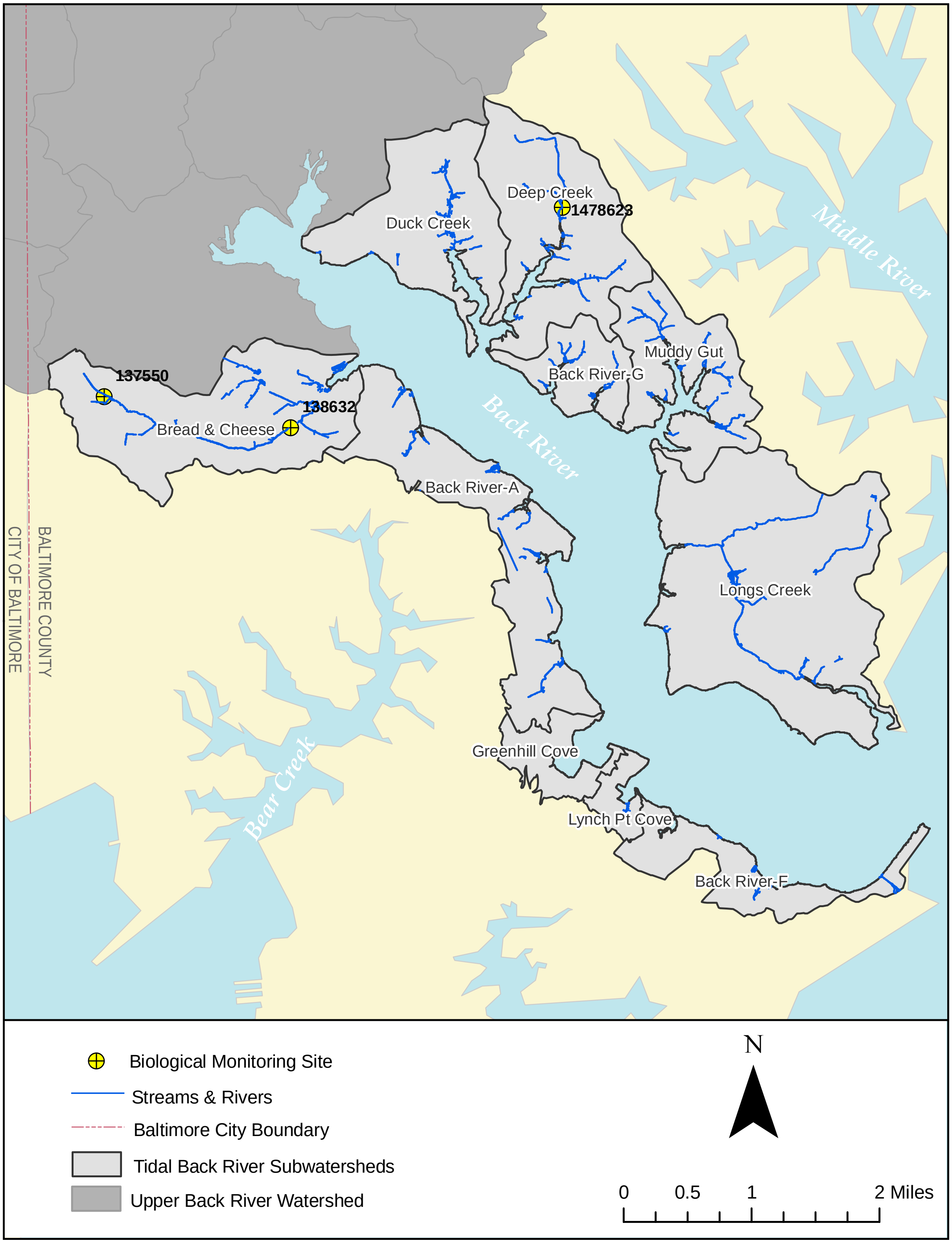


Figure 3-7: Biological Sampling Sites in Tidal Back River

3.4.3 Illicit Discharge and Elimination Data

Baltimore County tracks illicit discharges through a program of routine outfall screening. The program consists of three parts:

1. A quantitative analysis of the effluent that includes measuring the effluent flow rate, temperature and pH, and field testing for parts per million (ppm) of chlorine, phenols, and copper using a specially configured LaMotte NPDES test kit;

2. A qualitative assessment of the effluent, outfall structure, and receiving channel noting conditions such as water color, odor, vegetative condition, sedimentation, erosion, damage, etc.; and

3. A visual inspection of each outfall that identifies any structural damage.

The County has an outfall prioritization system based on data from the outfall screening. There are approximately 3,509 outfalls. About 80 percent of these (2,800) are minor outfalls (less than 3 feet in diameter) which are not prioritized. Of the remaining 709 major outfalls (greater than 3 feet in diameter), 473 have a prioritization rating (DEPRM 2008). The prioritization system allows for a more streamlined approach in selecting outfalls to screen and provides a more efficient use of manpower. Also under this system, outfalls screened only once or not at all can be screened sufficiently and properly prioritized. The list of outfalls to be screened is generated by a Microsoft Access query based on the prioritization screen.

Under that outfall prioritization system, outfalls that have not been screened at least twice are not prioritized. Prioritized outfalls, those screened two or more times, are assigned one of the following priority ratings:

- ***Priority 0 (Not Prioritized)*****:** Outfalls with insufficient data to determine a priority rating. This may be due to inaccessibility or if there has been only a single screening.

- ***Priority 1 (Critical):*** Outfalls with major problems that require immediate correction and/or close monitoring, or outfalls with recurring problems. These outfalls are sampled four times each year.

- ***Priority 2 (High):*** Outfalls with moderate to minor problems that have the potential to become severe. These outfalls are sampled once a year.

- ***Priority 3 (Low):*** Outfalls with minor or no problems that do not require close monitoring. These outfalls are sampled on a 10-year cycle.

A second screening is conducted if nearly a decade has passed since the previous screening. If no pollution problems were indicated, then the outfall is considered a low priority. This allows more focus on outfalls with more potential of an illicit connection. A second screening is also performed at an outfall when prior screening indicates that one or more of the water quality criteria were exceeded. The second screening helps determine whether the pollutant is a persistent constituent of the effluent or simply an anomaly. No remedial action is taken if the second screening indicates that the pollutant is within acceptable levels; however, the outfall is considered to have a potential illicit connection and is automatically queued for re-screening within one year. If the problem is severe enough to warrant immediate correction, an investigation begins immediately. Some sites are determined to have problems severe enough to warrant immediate investigation and/or corrective action only after one screening.

There are 35 major outfalls in the Tidal Back River watershed (see Figure 2-12). Table 3-14 summarizes the priority ratings for these outfalls by subwatershed.

Table 3-15: Baltimore County Storm Drain Outfall Prioritization Results

Outfall Priority Rating	Back River-A	Back River-F	Back River-G	Bread & Cheese	Deep Creek	Duck Creek	Greenhill Cove	Longs Creek	Lynch Pt Cove	Muddy Gut	Totals
Priority 0	2	0	0	0	3	0	0	0	0	0	***5***
Priority 1	0	0	1	1	1	0	0	0	0	0	***3***
Priority 2	0	1	1	3	5	5	0	0	0	0	***15***
Priority 3	0	0	0	4	1	4	2	0	0	1	***12***
Total	***2***	***1***	***2***	***8***	***10***	***9***	***2***	***0***	***0***	***1***	***35***

3.5 Sewer Overflow Impacts

At present, sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) are inevitable byproducts of our expanding population and aging sewer systems. Sewer overflows can be caused by various factors such as severe weather, insufficient maintenance, pumping station equipment malfunction, electrical outage, sewer line breaks, improper disposal of fats and grease, and vandalism. Raw sewage can enter nearby streams when a sanitary sewer system is overwhelmed by volume or if the infrastructure fails. USEPA reports that there are at least 40,000 of these incidents per year. Environmental and human health consequences of these overflows can be serious. E. Coli bacteria and other pathogens are typically present in raw sewage and can pose health risks to individuals who may come into contact with contaminated water. Sewer overflows can also contain high levels of nutrients (nitrogen and phosphorus) which are toxic to aquatic life and feed organisms that deplete oxygen in waterways. High levels of sediment are also present in sewer overflows which can clog streams and block sunlight from reaching essential aquatic plants.

In September 2005, USEPA and MDE issued a consent decree to Baltimore County with deadlines to reduce and eliminate sanitary sewer overflows. Implementation of work (capital, equipment, operations improvements) in compliance with the consent decree will result in a reduction of nutrients and bacteria entering streams in the Back River watershed. However, this may not address all impacts associated with the sanitary sewer system since the consent decree is targeted at overflows. For example, the sanitary sewer system may leak without resulting in an overflow. Depending on the locations of the leaks, which are typically at joints, there may still be adverse impacts to the stream system from the sanitary sewer system.

The number of SSO events documented and approximate volume discharged between 2000 and 2008 is summarized in Table 3-15 based on Baltimore County's SSO GIS layer. Table 3-16 summarizes the estimated volume and pollutant loads associated during this 9-year period by subwatershed.

Table 3-16: Sanitary Sewer Overflow Volumes in Tidal Back River (2000-2008)

Year	# of SSO Events	Volume (gallons)
2000	2	9,000
2001	3	45,750
2002	3	740
2003	7	152,400
2004	2	5,300
2005	4	6,300
2006	1	1,400
2007	1	0
2008	2	2,500
Total	***25***	***223,390***

Table 3-17: Sanitary Sewer Overflow Volumes and Pollutant Loads by Subwatershed

Subwatershed	# of SSO Events	Volume (gallons)	TP (lbs)	TN (lbs)	FC (MPN)
Back River-A	1	45,000	3.7	11.3	1.1E+13
Back River-F	0	0	0.0	0.0	0.0E+00
Back River-G	3	1,340	0.1	0.3	3.2E+11
Bread & Cheese	3	2,550	0.2	0.6	6.1E+11
Deep Creek	6	10,500	0.9	2.6	2.5E+12
Duck Creek	5	153,700	12.8	38.4	3.7E+13
Greenhill Cove	2	2,900	0.2	0.7	7.0E+11
Longs Creek	0	0	0.0	0.0	0.0E+00
Lynch Point Cove	5	7,400	0.6	1.9	1.8E+12
Muddy Gut	0	0	0.0	0.0	0.0E+00
Total	***25***	***223,390***	***19***	***56***	***5.4E+13***

Pollutant load estimates were calculated based on the following assumptions:

- ***Total Phosphorus (TP):*** A conversion factor of 8.3×10^{-5} was used to convert gallons of overflow to pounds of pollutant. This is based on a 10 mg/L TP concentration for raw sewage and a multiplier of 8.3×10^{-6} lb·L/mg·gal.

- ***Total Nitrogen (TN):*** A conversion factor of 2.5×10^{-4} was used to convert gallons of overflow to pounds of pollutant. This is based on a 30 mg/L TN concentration for raw sewage and a multiplier of 8.3×10^{-6} lb·L/mg·gal.

- ***Fecal Coliform (FC):*** A conversion factor of 2.4×10^{8} was used to convert gallons of overflow to MPN fecal coliform. This is based on a multiplier of 6.4×10^{6} MPN/100 mL.

Figure 3-8 shows the location of SSOs in the Tidal Back River watershed. Back River-F, Longs Creek, and Muddy Gut are the only subwatersheds without reports of sanitary sewer overflows between 2000 and 2008. The most SSO events have been documented in Deep Creek and Duck Creek. The greatest volumes of overflow were observed in Duck Creek and Back River-A. SSOs in Bread and Cheese, Duck Creek, and Lynch Pt Cove appear to be focused within a similar area. All of these areas have the potential for follow-up inspection and addressing SSO problems.

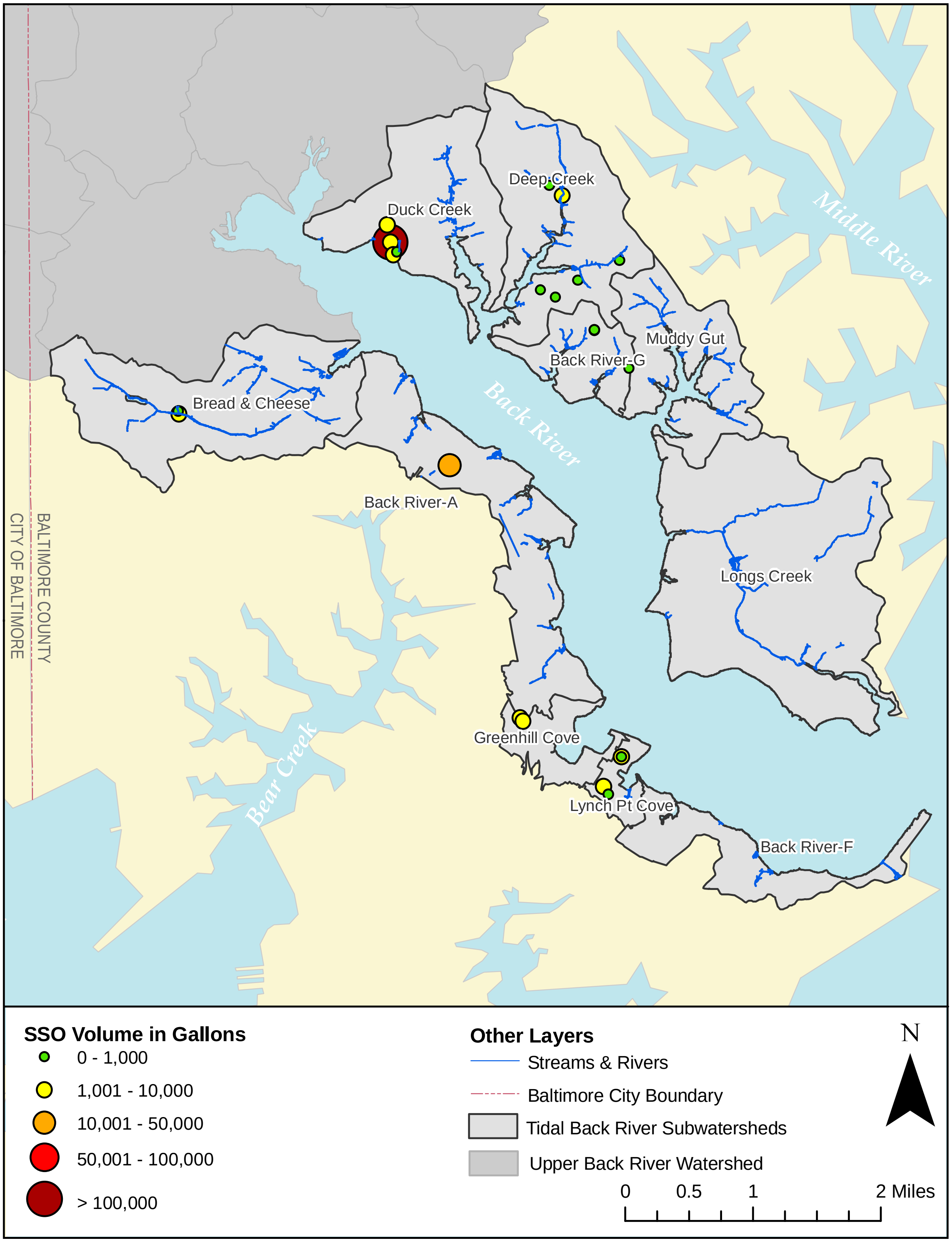


Figure 3-8: Sanitary Sewer Overflow Locations in Tidal Back River (2000-2008)

3.6 Stream Corridor Assessments

Stream corridor assessments (SCAs) were conducted for a subset of streams in the Tidal Back River Watershed. The subwatersheds selected for SCAs included Bread and Cheese Creek, Deep Creek, Duck Creek and Muddy Gut. These were conducted based on Maryland DNR's SCA Survey Protocols which were developed as a tool for environmental managers to quickly identify environmental problems within a watershed's stream network (Yetman 2001). It is a rapid field survey rather than a detailed scientific assessment to better target monitoring, management, and conservation efforts on the watershed and subwatershed scale. The SCA protocol employed, stream corridors investigated and results for the Tidal Back River watershed are described in the following sections.

3.6.1 Assessment Protocol

The SCA method is used to quickly assess physical conditions and identify common environmental problems in a stream corridor. Representative sites were selected along each of the assessed streams to provide general characteristics of the habitat and buffer conditions for a stream reach. Three person field crews walked all of the wadeable streams within each of the selected subwatersheds and identified the following environmental problems:

- Erosion Sites
- Inadequate Stream Buffers
- Fish Migration Barriers
- Exposed or Discharging Pipes
- Channelized or Altered Stream Sections
- Trash Dumping Sites
- In or Near Stream Construction
- Unusual Conditions

The field survey team walked along the selected subset of stream corridors noting the location of problem and representative sites on field maps and filling out appropriate data sheets for each site based on guidance provided in DNR's SCA manual. Each site was assigned a unique identification (ID) number according to map ID number and then numbered sequentially in the order it was encountered (see Section 3.3.2). At least one photograph was taken at each site to document the conditions observed.

All problem sites were scored by the field survey team on a scale of one to five for the following three factors: severity, correctability, and access. The scores are intended to help prioritize potential restoration opportunities where a score of 5 denotes a minor problem or one that is easy to fix and a score of 1 would be the worst observed in a particular problem category. The criteria for scoring problem severity, correctability, and access depend on the problem type. Guidelines for rating each factor are generally described below; however, specific criteria depend on problem type. Problem-specific criteria used to assign ratings in the field are described briefly in the following subsections.

- ***Severity:*** Measure of how bad a problem site is compared to other problems in the same category. The most severe problems (rating =1) are those with a direct and wide impact on stream resources such as discolored or smelly discharge from a pipe outfall.
- ***Correctability:*** Measure of how easy a problem would be to correct. Minor problems (rating = 1) would be quick and easy to correct, requiring minimal planning and resources (e.g., volunteers, hand labor). Major restoration problems (rating = 5) would require heavy equipment and significant funding to fix.
- ***Accessibility:*** Measure of how difficult it is to reach a site. An easily accessible site (rating = 1) can be accessed by car or on foot. A difficult site to access (rating = 5) is one where there are no nearby roads or trails.

In addition to these ratings, site descriptions and measurements were also recorded depending on the problem category.

Representative sites were selected in the field and were used to characterize the in-stream habitat and adjacent stream corridor conditions. DNR's SCA protocol evaluates habitat conditions based on parameters and conditions typical of non-tidal, rocky bottom streams. Because the stream system in this watershed consists of mostly low gradient, tidal streams that do not have gravel bottoms, habitat parameters evaluated were modified to obtain ratings that are more representative of the type of streams found in the Tidal Back River watershed. The habitat assessment procedure developed by the New Jersey Department of Environmental Protection (NJDEP), Bureau of Freshwater and Biological Monitoring, as part of their biological monitoring program for low gradient streams was chosen as the most appropriate method based on a literature search (NJDEP 2007). Consistent with DNR's SCA protocol, 10 habitat parameters are rated as optimal, suboptimal, marginal or poor based on observed conditions relative to a reference (healthy) stream. The 10 habitat parameters evaluated at each representative site based on the low gradient stream methodology were:

- Epifaunal Substrate/Available Cover
- Pool Substrate Characterization
- Pool Variability
- Sediment Deposition
- Channel Flow Status
- Channel Alteration
- Channel Sinuosity
- Bank Stability
- Bank Vegetative Protection

- Riparian Vegetative Zone Width

In addition to the habitat ratings, data was collected on stream wetted width, bottom type (silt, sand, gravel, etc.) and pool depths according to the DNR SCA protocol.

3.6.2 Summary of Sites Investigated

SCAs were focused in four subwatersheds: Bread and Cheese, Duck Creek, Deep Creek, and Muddy Gut. With the exception of Longs Creek, these subwatersheds have the greatest length of streams appropriate for the SCA survey (i.e., wadeable, non-tidal/non-marsh area). Longs Creek was not included in the SCA since a previous study has been conducted. Table 3-17 summarizes the miles of stream surveyed and the percentage of total stream miles surveyed by subwatershed. Figure 3-9 illustrates the location of streams surveyed as part of the SCAs with respect to the overall stream system in the Tidal Back River watershed.

Table 3-18: Tidal Back River Miles of Stream Assessed

Subwatershed	Total Stream Miles	Surveyed Wadeable Stream Miles	% of Total Stream Miles Surveyed
Back River-A	3.94	-	-
Back River-F	1.26	-	-
Back River-G	1.75	-	-
Bread & Cheese	8.45	3.73	44
Deep Creek	3.86	2.43	63
Duck Creek	3.11	1.62	52
Greenhill Cove	0.00	-	-
Longs Creek	6.39	-	-
Lynch Pt Cove	0.36	-	-
Muddy Gut	3.98	2.91	73
Total	***33.10***	***10.69***	***32***

As shown in Table 3-17, nearly one-third of the total stream miles were surveyed as part of the SCA survey. With the exception of Longs Creek, the remaining streams were not appropriate for a walking field survey. For example, all wadeable and accessible portions of the stream network in Bread and Cheese were surveyed; there was no access to the area between the railroad tracks and the Back River WWTP. The portions of streams not surveyed in Duck Creek, Deep Creek, and Muddy Gut were mostly deep, tidal, marshy areas not suitable for the SCA.

As noted above, each site was assigned a unique ID number according to map ID number and then numbered sequentially in the order it was encountered. Map ID numbers were obtained from the grid used by Baltimore County for generating field maps (tabloid size) and assigning unique IDs to data collected in the field. The grid and map ID numbers used for the Tidal Back River SCA survey is shown in Figure 3-10. The field team walked stream segments by map number. For example, the first survey site encountered along Bread and Cheese Creek within map number ‘096B3’ was numbered 096B3-01 and sites were numbered consecutively as encountered until the stream segment in this map was completed (e.g., 096B3-02, 096B3-03, etc.). The same site ID scheme was applied to the remaining maps and stream segments within the survey grid. Field maps used for the Tidal Back River SCAs are included in Appendix A.

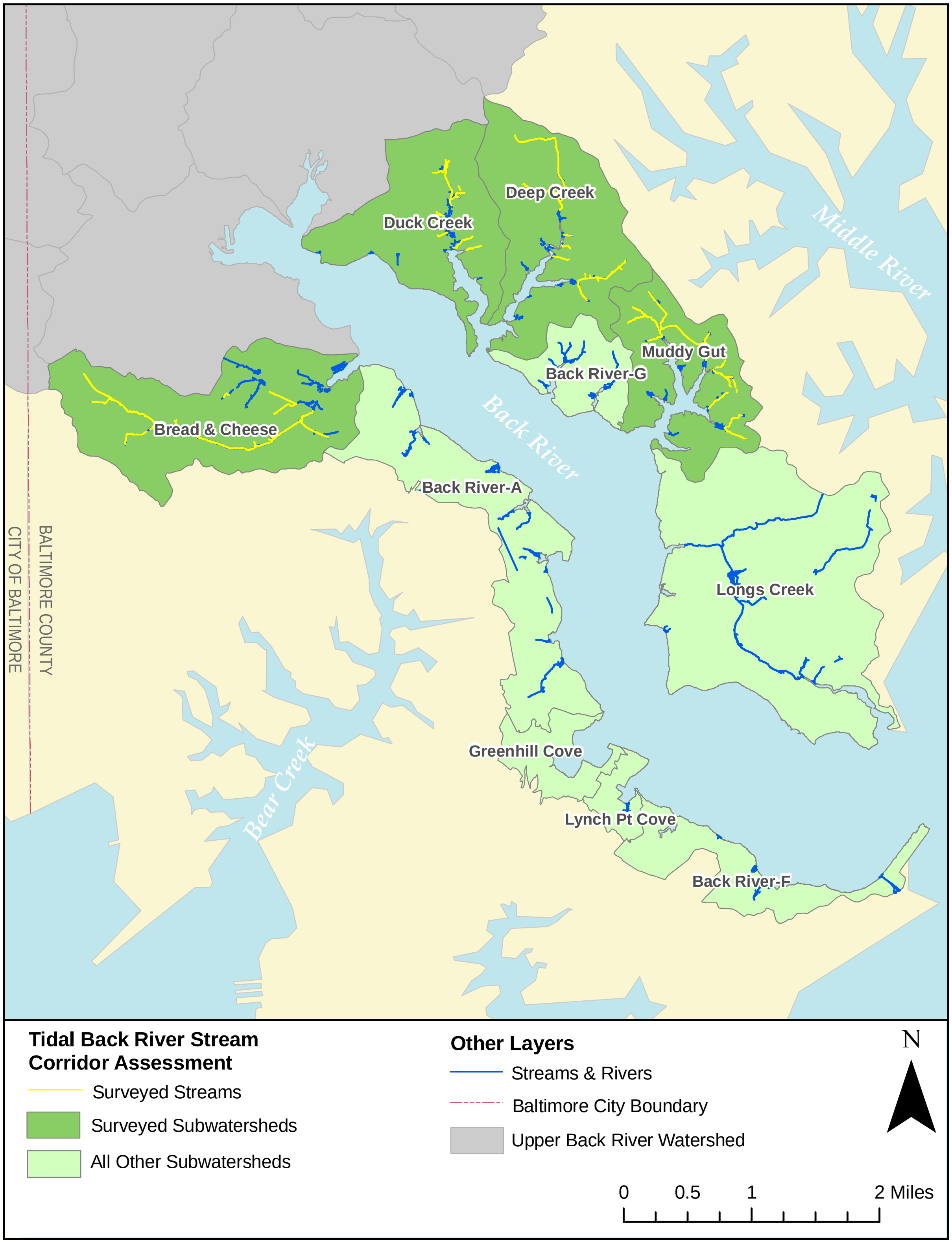


Figure 3-9: Surveyed Streams in Tidal Back River

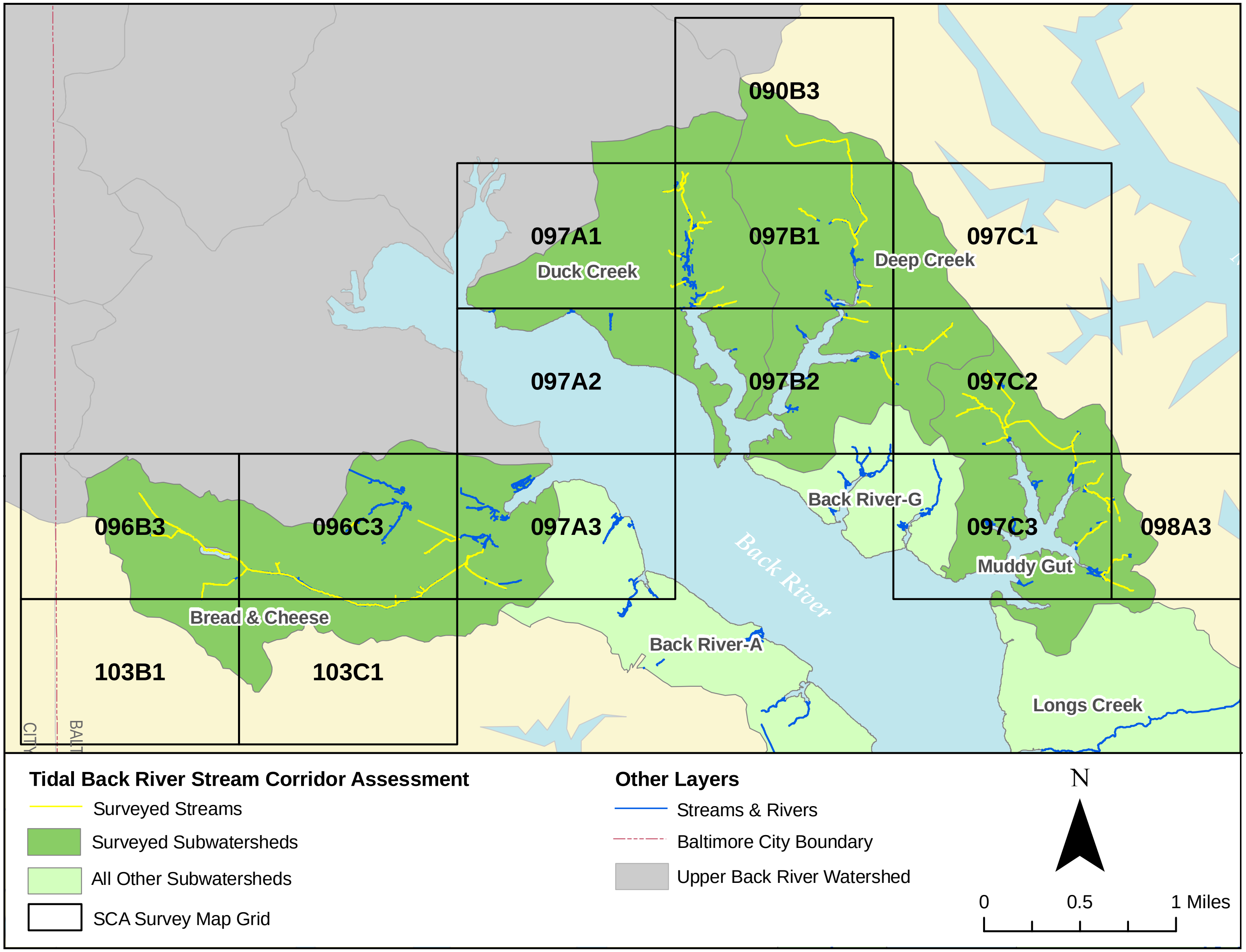


Figure 3-10: SCA Survey Grid and Map Numbers for Tidal Back River

3.6.3 General Findings

Along the 10.7 miles of stream walked in the Tidal Back River watershed, 304 potential problems were observed. Table 3-18 summarizes the number of potential problems observed within each category and for each stream walked.

Table 3-19: Tidal Back River SCA Survey Results – Number of Environmental Problems

SUBWATERSHED	Inadequate Buffer	Trash Dumping	Channel Alteration	Erosion	Pipe Outfalls	Exposed Pipe	Fish Barrier	In/Near Stream Construction	Unusual Conditions	Totals
Bread & Cheese	16	16	10	10	29	4	5	2	13	***105***
Deep Creek	15	14	9	8	37	2	4	1	7	***97***
Duck Creek	13	11	4	2	14	1	2	0	5	***52***
Muddy Gut	11	2	5	6	7	0	3	1	15	***50***
Totals	***55***	***43***	***28***	***26***	***87***	***7***	***14***	***4***	***40***	***304***

Excluding pipe outfalls, the most frequently observed potential problems were inadequate stream buffers and trash dumping. Channel alteration and erosion were also observed in several locations throughout the stream network surveyed. A summary of the lengths of inadequate stream buffer, channel alteration, and erosion observed (includes both sides of stream corridor) and the number of pick-up truck loads estimated to clean up trash dumping sites are summarized in Table 3-19 by stream.

Table 3-20: Tidal Back River SCA Survey Results – Number of Environmental Problems

SUBWATERSHED	Length of Inadequate Buffer (ft)	Length of Channel Alteration (ft)	Length of Erosion (ft)	# of Truckloads for Trash Dumping Sites
Bread & Cheese	16,905	830	755	63
Deep Creek	12,565	3,814	440	27
Duck Creek	4,995	315	66	59
Muddy Gut	7,465	295	785	26
Totals	***41,930***	***5,254***	***2,046***	***175***

The field team also recorded habitat condition data at 24 representative sites. Representative sites and each environmental problem category are briefly described the following sections. Data collected in the field for environmental problem and representative sites are compiled in tables included in Appendix B. For each problem category table, sites are sorted first by severity rating where most severe problems with a rating of 1 are listed first and then by stream name for each rating.

3.6.3.1 Inadequate Stream Buffers

As previously mentioned, forested buffer areas along streams are important for improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks (root systems), shade streams, remove pollutants such as nutrients and sediment from runoff and provide habitat for various types of terrestrial and aquatic life including fish. For the SCA, a stream buffer was considered inadequate if it was less than 50 feet wide from the edge of the stream. Inadequate stream buffers were the most commonly observed environmental problem within the Tidal Back River SCA survey area. The field team identified 55 inadequate buffer sites in the study area with a total length of 41,930 feet. This means that nearly 75 percent of the total stream miles surveyed (7.9 out of 10.7 miles) were considered as having inadequate stream buffers.

The severity of inadequate stream buffers was rated according to length and width. The most severe sites received a severity rating of 1 if they had a significant length of stream (> 1,000 feet) that was completely open with no trees on either side. Figure 3-11 shows photos of two sites that were considered as very severe inadequate buffers and assigned a severity rating of 1. The photo on the left is a portion of Bread and Cheese Creek in the Oak Lawn Cemetery where both sides of the stream are completely open pervious area. The photo on the right is in Duck Creek where both sides of the stream are residential lawn areas. These two sites represent a potential opportunity for stream buffer reforestation.

Figure 3-11: Examples of Very Severe Inadequate Buffer Sites (severity rating = 1)

Table 3-20 summarizes the number of inadequate buffer sites associated with each severity rating (1, 2, 3, 4 or 5) and the length of inadequate buffer observed by stream. This table also presents the proportion of the total stream miles surveyed considered to have inadequate stream buffer.

Table 3-21: Tidal Back River SCA Survey Results – Inadequate Stream Buffers

	SEVERITY RATING INVENTORY								% of Total
	Severe				Minor		LENGTH		Length
STREAM	1	2	3	4	5	All	(ft)	(mi)	Surveyed
Bread & Cheese	3	2	9	2	0	16	16,905	3.2	86%
Deep Creek	0	5	4	4	2	15	12,565	2.4	98%
Duck Creek	1	1	5	4	2	13	4,995	0.9	58%
Muddy Gut	0	3	6	2	0	11	7,465	1.4	49%
Totals	***4***	***11***	***24***	***12***	***4***	***55***	***41,930***	***7.9***	***74%***

The number of inadequate buffer sites was nearly evenly distributed among the four streams surveyed. However, Bread and Cheese and Deep Creek had the greatest total lengths of inadequate stream buffer. Nearly all of the stream miles surveyed in these two subwatersheds were considered as having inadequate stream buffer. Most inadequate buffer sites observed (44%) were rated as moderate severity (rating =3). About 28 percent of the sites were considered as very severe or severe inadequate buffers (rating = 1 or 2) which would be a priority for stream buffer restoration. The distribution of inadequate stream buffer and severity ratings in the surveyed subwatersheds are shown in Figure 3-12. Location of inadequate buffer sites are shown on the field maps included in Appendix A. Tables summarizing data collected for inadequate buffer sites are included in Appendix B and sites are ranked in order of severity by stream.

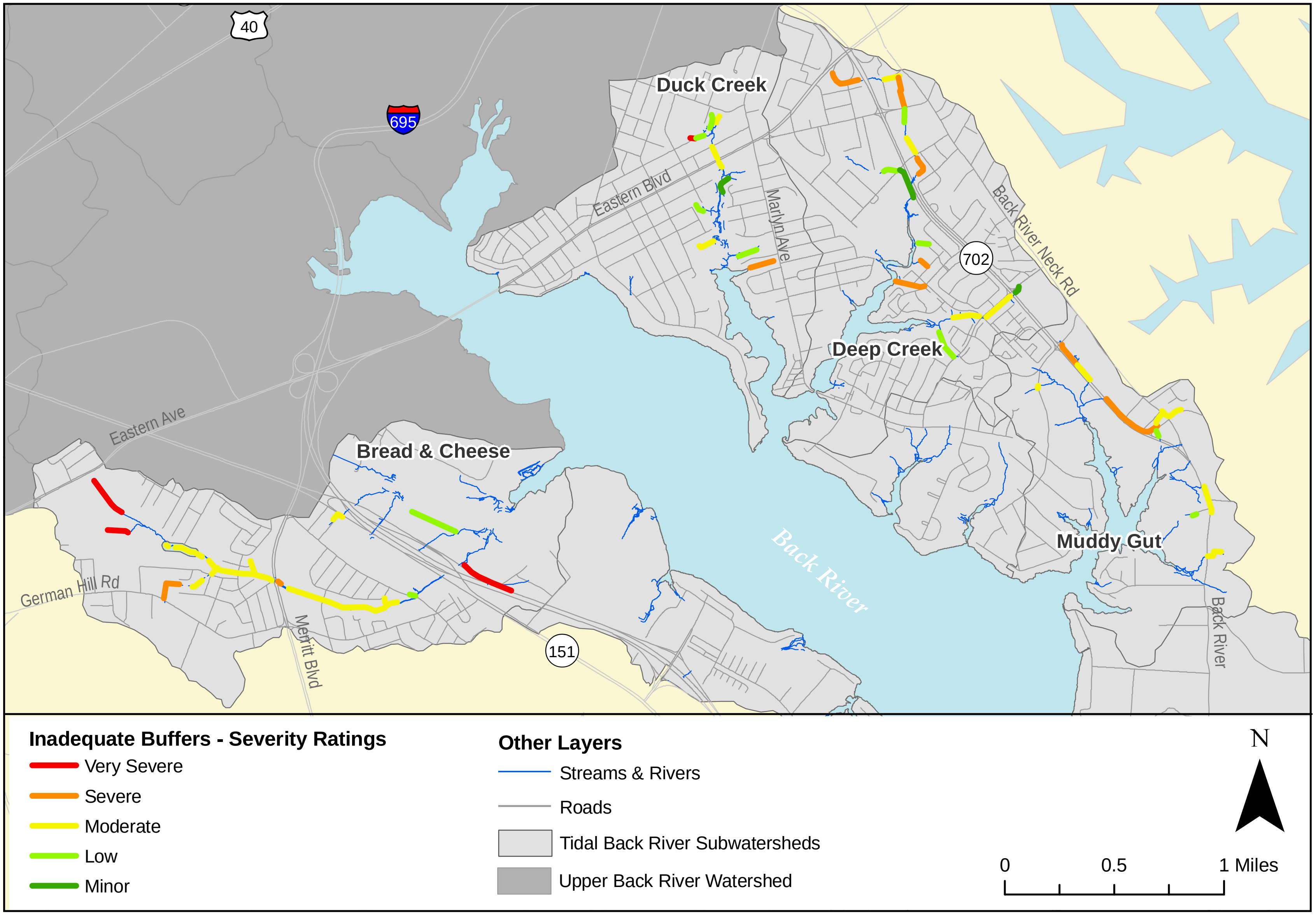


Figure 3-12: Map of Inadequate Stream Buffers in Tidal Back River Watershed

3.6.3.2 Trash Dumping

Trash dumping sites are places where large amounts of trash have been dumped or have accumulated inside the stream corridor. Identifying trash dumping sites serves two main purposes. One is to limit access to the areas of the stream corridor, as feasible, where trash dumping and accumulation is a problem. The second is to identify locations suitable for and to encourage volunteer stream clean-ups. This is a chance to encourage the community to take action and see the condition of their local streams.

Trash dumping sites were a prevalent environmental problem in the streams surveyed. A total of 43 trash dumping sites were documented as part of the Tidal Back River SCA survey. The severity of trash dumping sites was rated according to the amount and type of trash present, its location, and whether cleaning up the trash would present problems (access and safety). The amount of trash was estimated in terms of number of pick-up truck loads. Type of trash was classified as one of the following: residential, industrial, yard waste, floatables, tires, construction, or other. A very severe rating (severity rating = 1) was assigned to sites where large amounts of trash were scattered over a large area, where access is very difficult. Sites with indications of any hazardous materials such as chemical drums were assigned a very severe rating regardless of the amount. Moderately severe trash dumping sites (rating = 3) are those with a fairly large amount of trash in a small area with easy access that could be cleaned up in a few days. Most of these sites represent volunteer opportunities; however, volunteer cleanup potential can be limited by various factors such as site access, safety, or the need for small backhoes. Low severity and minor trash dumping sites (rating = 4 or 5) are those with easy access and typically where there is potential for a volunteer cleanup. Figure 3-13 shows an example of a trash dumping site in Muddy Gut considered as very severe (rating = 1) since potentially hazardous materials were stored adjacent to the stream corridor including construction equipment, machinery, and drums. Figure 3-14 shows examples of moderately severe (rating = 3, left photo) and low severity trash dumping sites (rating = 4, right photo). The left photo is in Bread and Cheese Creek where a relatively large amount (~ 4 truck loads) of residential trash (e.g., bottles) was observed in a large area. The right photo is a site in Deep Creek where approximately two truck loads of residential trash (tires) was observed. Both of these sites were considered as possible volunteer projects.

Figure 3-13: Photos of a Very Severe Trash Dumping Site (severity rating = 1)

Figure 3-14: Examples of Moderately Severe & Low Severity Trash Dumping Sites

Table 3-21 summarizes the number of trash dumping sites associated with each severity rating (1, 2, 3, 4 or 5) and the estimated total number of pick-up truck loads by stream.

Table 3-22: Tidal Back River SCA Survey Results – Trash Dumping

	SEVERITY RATING INVENTORY						
	Severe				Minor		# TRUCK
STREAM	1	2	3	4	5	All	LOADS
Bread & Cheese	0	4	7	4	1	16	63
Deep Creek	0	2	3	8	1	14	27
Duck Creek	1	1	5	4	0	11	59
Muddy Gut	1	0	0	1	0	2	26
Totals	***2***	***7***	***15***	***17***	***2***	***43***	***175***

Most trash dumping sites were identified along Bread and Cheese Creek with several also observed in Deep Creek and Duck Creek. The greatest amount of trash in terms of number of pick-up truck loads was observed in Bread and Cheese and Duck Creek. Observed trash dumping sites were mostly rated as moderately severe or low severity with the majority considered as having potential for a volunteer/community cleanup project. The distribution of trash dumping sites and severity ratings in the surveyed subwatersheds are shown in Figures 3-15 through 3-18. This figure also shows trash dumping sites considered having potential for volunteer projects. Multiple dumping sites were assigned one unique site ID if they were observed within a distinct stream section separated by small distances and if severity, access, and correctability characteristics were similar. These sites, however, are shown individually in Figures 3-15 through 3-18. Locations of trash dumping sites are also shown on the field maps included in Appendix A. Tables summarizing data collected for trash dumping sites are included in Appendix B and sites are ranked in order of severity by stream.

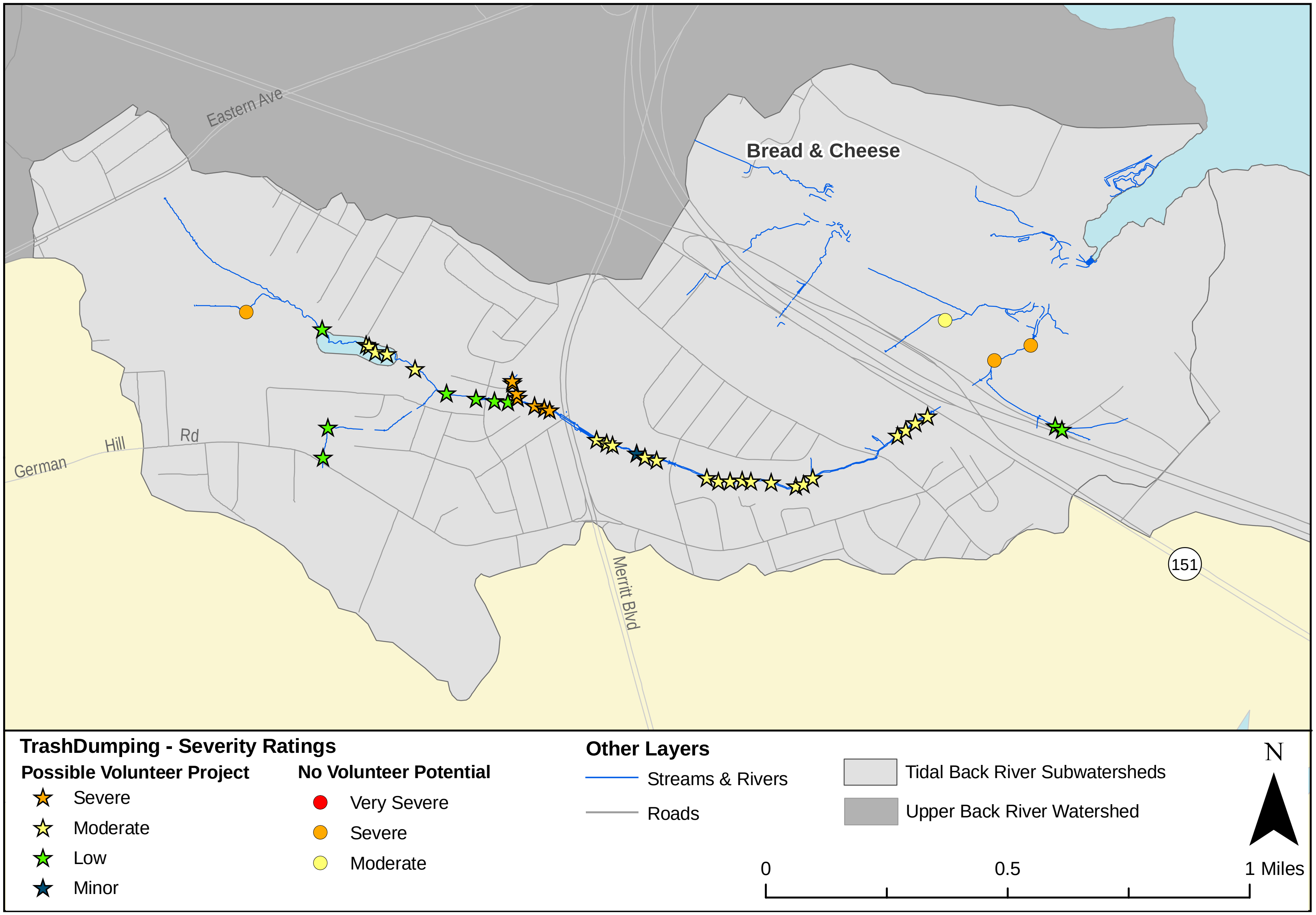


Figure 3-15: Map of Trash Dumping Sites in Bread & Cheese

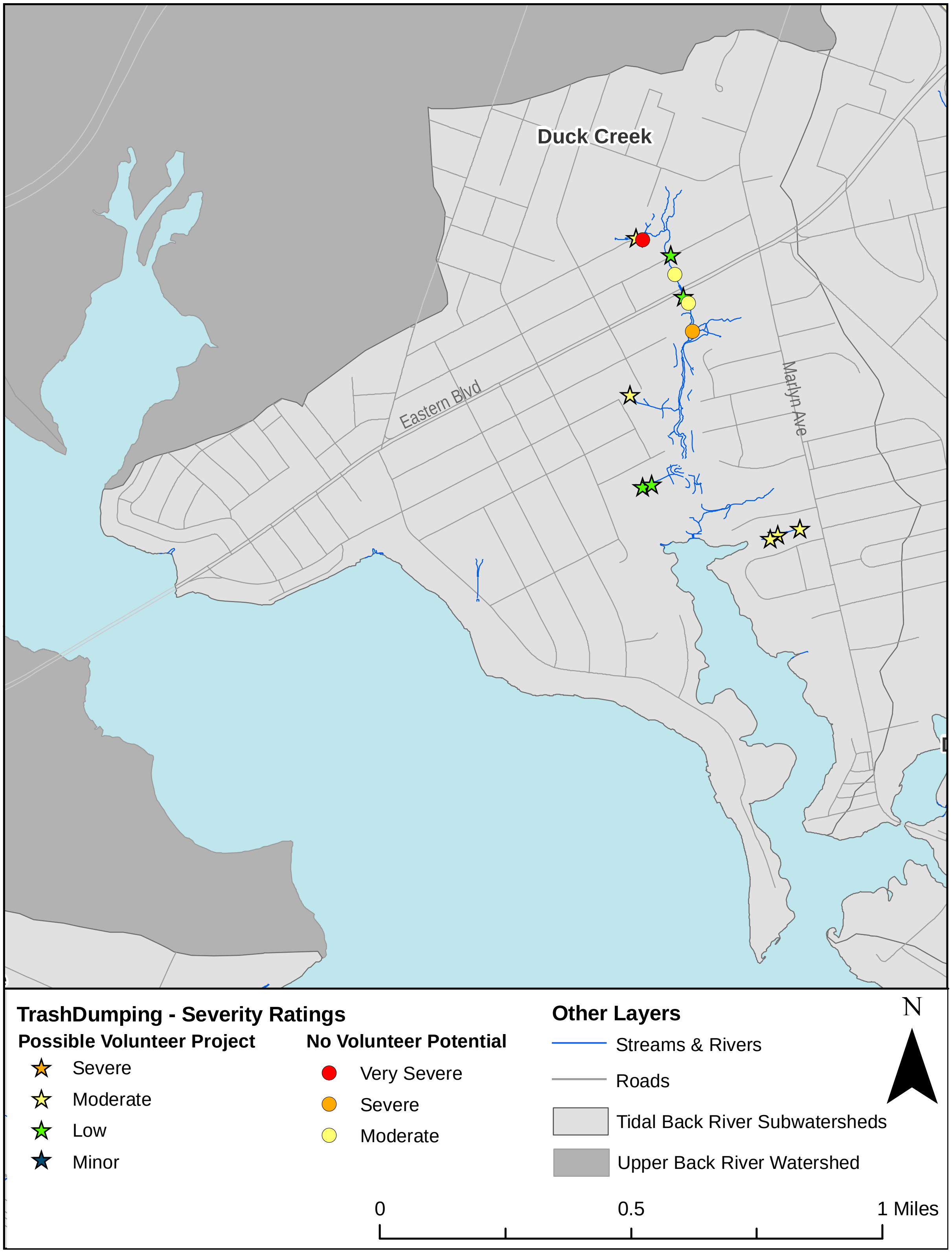


Figure 3-16: Map of Trash Dumping Sites in Duck Creek

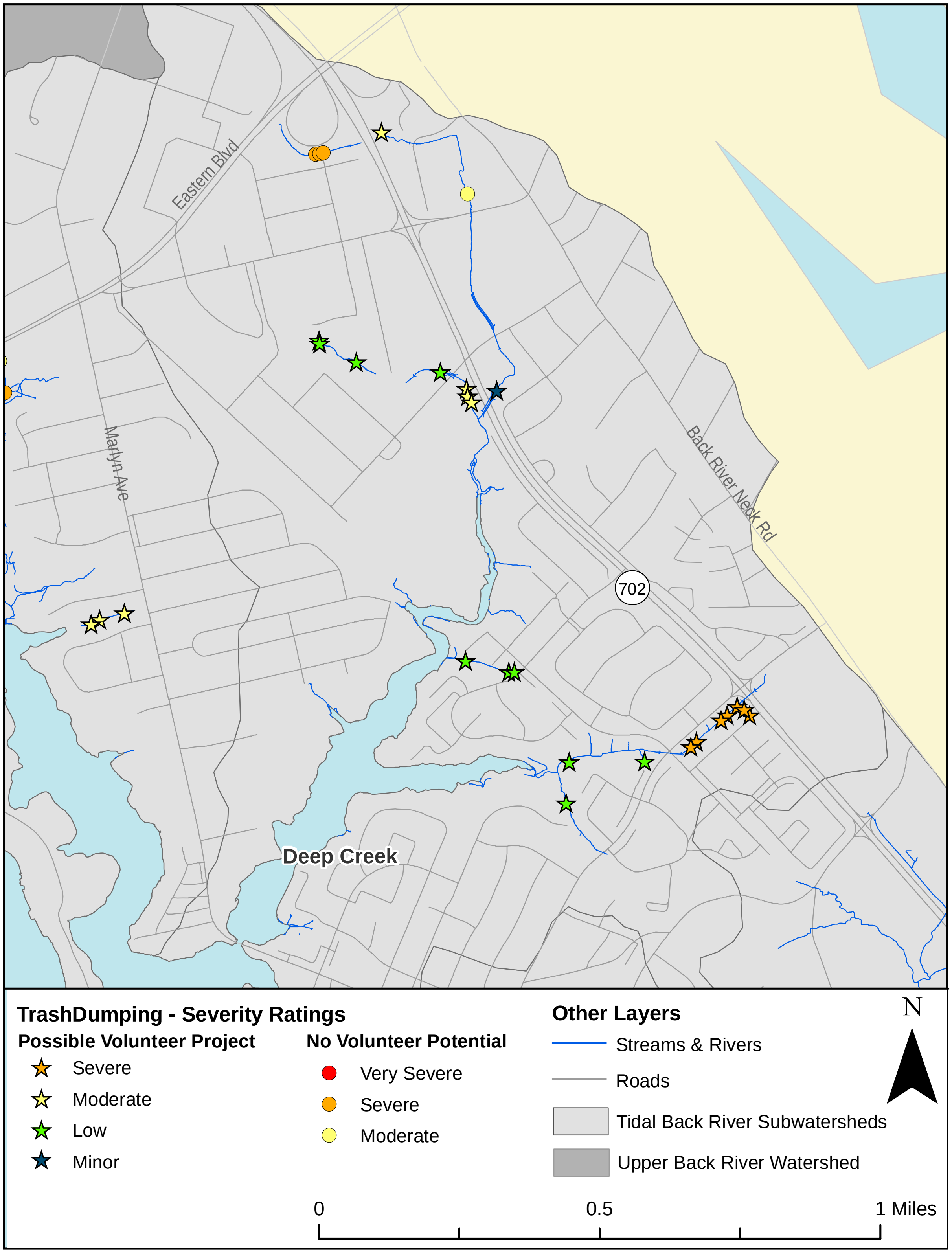


Figure 3-17: Map of Trash Dumping Sites in Deep Creek

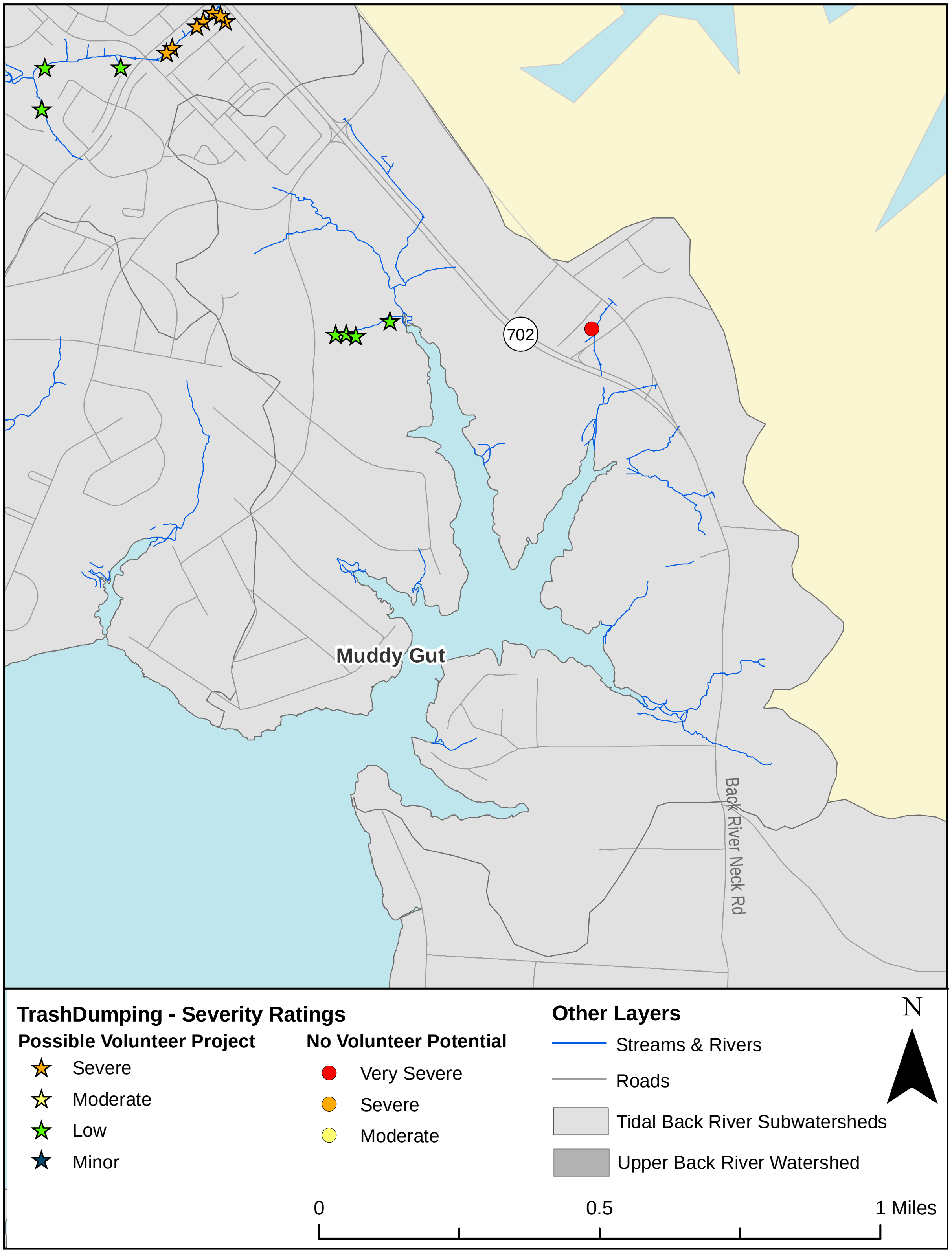


Figure 3-18: Map of Trash Dumping Sites in Muddy Gut

3.6.3.3 Channel Alteration

Channel alteration refers to stream sections where the banks or channel have been significantly modified from their naturally occurring structure or condition. This includes channelized stream sections where a stream channel has been dredged, widened, straightened, and/or covered with concrete. Channelized streams are typically intended to convey more water and to prevent flooding but often create adverse environmental impacts such as impairing habitat and increasing water temperature.

A total of 28 channel alteration sites were documented during the Tidal Back River SCA survey with a total length of 5,254 feet. Less than 10 percent of the total stream miles surveyed (1.0 out of 10.7 miles) were considered to have channel alterations. Severity rating was mainly based on channel alteration length, channel type, and stream functions. The most severe rating of 1 was assigned to concrete channels where water depth was less than ¼ inch with little or no natural sediments present. These channels were generally open to full sunlight over long stretches (> 1,000 feet). Channel alterations were considered moderately severe (rating = 3) if a significant length had been channelized (> 500 ft) but show signs of stabilization and natural stream functions such as sediment bars and vegetation. Minor ratings (rating = 5) were assigned to earthen channels less than 100 feet in length with good water depth, a natural sediment bottom, and with a size and shape similar to unchannelized reaches upstream and downstream of the site. Figure 3-19 shows examples of severe channel alteration sites (severity rating = 2) encountered in the Tidal Back River watershed. The photo on the left is a site along Bread and Cheese Creek where timber retaining walls had been installed and were slightly undermined and rotting with some erosion around the walls. The photo on the right is a site along Deep Creek where a long portion of the stream channel (300 feet) is concrete with no shading and very little water depth.

Figure 3-19: Examples of Severe Channel Alteration Sites (rating = 2)

Table 3-22 summarizes the number of channel alteration sites associated with each severity rating (1, 2, 3, 4 or 5) and the length of channelization observed by stream. This table also presents the proportion of the total stream miles surveyed considered to have channel alterations.

Table 3-23: Tidal Back River SCA Survey Results – Channel Alterations

	SEVERITY RATING INVENTORY						LENGTH		% of Total
	Severe				Minor				Length
STREAM	1	2	3	4	5	All	(ft)	(mi)	Surveyed
Bread & Cheese	0	1	5	2	2	10	830	0.2	4%
Deep Creek	1	1	4	2	1	9	3,814	0.7	30%
Duck Creek	0	0	1	1	2	4	315	0.1	4%
Muddy Gut	0	0	2	3	0	5	295	0.1	2%
Totals	***1***	***2***	***12***	***8***	***5***	***28***	***5,254***	***1.0***	***9%***

Channelized sections of stream represent approximately 1 mile or 9 percent of the total stream miles surveyed. The most sites were observed in Bread and Cheese and Deep Creek. The greatest length of channelized stream sections was identified in Deep Creek, where 30 percent of the streams surveyed in this subwatershed were considered to be altered. Most of the 28 sites identified were rated as moderately severe or low severity.

Correcting channelized stream sections can be challenging and expensive; however, concrete and riprap channels can be removed and a more natural channel can be established. Location of channel alteration sites are shown on the field maps included in Appendix A. Tables summarizing data collected for channel alteration sites are included in Appendix B and sites are ranked in order of severity by stream.

3.6.3.4 Erosion

Erosion can destabilize stream banks, destroy habitat, and cause sediment pollution problems downstream. Significant erosion problems are a result of changes to stream hydrology or sediment supply which is often attributed to land use changes in a watershed (e.g, urbanization, increased impervious cover). Since erosion is also a natural process, it was not the purpose of the SCA survey to identify every occurrence of erosion. Erosion was documented for unstable stream reaches with significant amounts of erosion along the stream's banks such as vertical stream banks and where vegetative roots along a reach were unable to hold soil onto the banks. The type of erosion, possible cause, adjacent land use, and whether there was a threat to infrastructure was noted at each erosion site.

A total of 26 erosion sites were documented during the Tidal Back River SCA survey with a total length of 2,046 feet. Less than 5 percent of the total stream miles surveyed was considered to have erosion problems (0.4 out of 10.7 miles). The severity of erosion was rated based on length and height of the eroding stream bank. The most severe rating (rating = 1) was assigned to sites with long sections of incision (> 1,000 feet), with unstable banks on both sides, and that were eroding at a fast rate. Erosion was considered minor (rating = 5) if it was a short stream section (< 300 feet) where the affected area was fairly limited. Figure 3-20 shows examples of moderately severe (rating = 3) and low severity (rating = 4) erosion sites identified during the SCA survey. The photo on the left is an erosion site along Muddy Gut which was approximately 400 feet long with banks approximately 2.5 feet high. The photo on the right is erosion occurring along a 50-foot stretch in Bread and Cheese and appears to be a result of land use change upstream (construction activity).

Figure 3-20: Examples of Moderately Severe and Low Severity Erosion Sites

Table 3-23 summarizes the number of erosion sites associated with each severity rating (1, 2, 3, 4 or 5) and the length of erosion observed by stream. This table also presents the proportion of the total stream miles surveyed considered to have erosion issues.

Table 3-24: Tidal Back River SCA Survey Results – Erosion

	SEVERITY RATING INVENTORY								% of Total
	Severe				Minor		LENGTH		Length
STREAM	**1**	**2**	**3**	**4**	**5**	**All**	**(ft)**	**(mi)**	**Surveyed**
Bread & Cheese	0	0	1	7	2	10	755	0.14	4%
Deep Creek	1	0	0	4	3	8	440	0.08	3%
Duck Creek	0	0	0	0	2	2	66	0.01	1%
Muddy Gut	0	0	2	3	1	6	785	0.15	5%
Totals	***1***	***0***	***3***	***14***	***8***	***26***	***2,046***	***0.39***	***4%***

Erosion sites observed add up to 2,046 feet (0.4 miles) and represent 4 percent of the total miles of stream surveyed. The greatest lengths of erosion were observed in Muddy Gut and Bread and Cheese Creek. Most of the erosion sites documented were rated as low severity or minor problems. Minor erosion problems, particularly those in open areas, can usually be corrected using simple stream restoration/bioengineering techniques and in some cases there may potential for community-based stream restoration projects.

Location of erosion sites are shown on the field maps included in Appendix A. Tables summarizing data collected for erosion sites are included in Appendix B and sites are ranked in order of severity by stream.

3.6.3.5 Pipe Outfalls/Exposed Pipe

Pipe outfalls include pipes or small manmade channels that discharge into the stream. These are considered a potential environmental problem since they can carry untreated runoff and pollutants such as oil, heavy metals, and nutrients to a stream system. Of particular interest were outfalls that were discharging at the time of the survey for which color and odor of discharge were noted. The pipe material type and size were also recorded. Exposed pipes were also assessed and include any pipes that were either in the stream or along the immediate banks that could be damaged by a high flow event. Exposed pipes are susceptible to being punctured by debris which is a concern since fluids being carried by the pipeline can leak into the stream causing water quality problems depending on the fluid type. Exposed pipes include manhole stacks, pipes exposed along the stream banks, pipes exposed that run under the stream bed, and pipes built over a stream but that are low enough to be affecting during high storm flows.

A total of 87 outfalls were identified during the Tidal Back River SCA survey. The severity rating for a pipe outfall was primarily based on the discharge including whether discharge was present, color, odor, amount, and downstream impacts. A pipe outfall that had a strong discharge relative to the normal stream flow, a distinct color and/or odor, and where discharge was causing significant impacts downstream would receive the most severe rating of 1. Minor severity ratings (rating = 5) were assigned to outfalls intended to carry storm water that did not have dry weather discharge and did not cause erosion problems. Table 3-24 summarizes the number of pipe outfalls associated with each severity rating (1, 2, 3, 4 or 5).

Table 3-25: Tidal Back River SCA Survey Results – Pipe Outfalls

	SEVERITY RATING INVENTORY					
	Severe				Minor	
STREAM	**1**	**2**	**3**	**4**	**5**	**All**
Bread & Cheese	0	3	12	12	2	29
Deep Creek	0	1	7	15	14	37
Duck Creek	0	2	4	5	3	14
Muddy Gut	0	1	1	3	2	7
Totals	***0***	***7***	***24***	***35***	***21***	***87***

None of the pipe outfalls identified were rated as very severe environmental problems. Of the 87 documented during the SCA survey, 7 were considered as potentially severe problems (severity rating = 2) and 24 were considered moderately severe due to the nature of the discharge (i.e., discolored and/or odor). The remaining 56 outfalls (64% of those surveyed) were considered low severity or minor issues.

A total of 7 exposed pipes were identified during the Tidal Back River SCA survey. The severity rating for exposed pipes was based on the amount of pipe exposed, location with respect to the stream, whether structural stability of pipe is affected by erosion, and whether the pipe is leaking. A very severe rating (rating = 1) represents any pipe that is leaking or immediate threat of failure such as one likely to collapse, a pipe that runs under the stream bed where part is suspended, a long section along the stream edge that is mostly exposed, or a manhole stack in the center of the stream with evidence of cracks. Moderate ratings were assigned to relatively long sections of exposed pipes with no immediate threat of failure. Minor exposed pipe problems (rating = 5) are small sections of exposed pipe and stable stream banks. Table 3-25 summarizes the number of exposed pipes associated with each severity rating (1, 2, 3, 4 or 5).

Table 3-26: Tidal Back River SCA Survey Results – Exposed Pipes

	SEVERITY RATING INVENTORY					
	Severe				Minor	
STREAM	1	2	3	4	5	All
Bread & Cheese	0	1	0	3	0	4
Deep Creek	0	0	1	0	1	2
Duck Creek	0	0	1	0	0	1
Muddy Gut	0	0	0	0	0	0
Totals	***0***	***1***	***2***	***3***	***1***	***7***

Similar to pipe outfalls, none of the exposed pipes identified were rated as a very severe environmental problem. Of the 7 documented during the SCA survey, 1 was considered as a potentially severe problem (severity rating = 2) and 2 were considered moderately severe. The remaining 4 exposed pipes were considered low severity or minor issues. Figure 3-21 shows a photo of the exposed pipe considered as a potentially severe problem. This was an exposed manhole in Bread and Cheese Creek and was rated as severe because of the large exposed section, its proximity to the stream, and since it carries sewage.

Figure 3-21: Examples of a Potentially Severe Exposed Pipe Problem (rating = 2)

Figure 3-22 shows the location of the outfalls and exposed pipes considered as potentially severe or moderately severe problems. These sites represent a potential threat to water quality in the Tidal Back River and public health. Consequently, they are recommended for follow-up inspection and/or consideration of these pipe outfalls for inclusion in the County's outfall screening program discussed in Chapter 3.2.3 if appropriate. For example, five of the 31 outfalls appear to correspond with Baltimore County's minor outfall GIS layer and therefore, would not be prioritized for the screening program. These and other minor outfalls (< 3 feet) would be recommended for follow-up site inspection. Of the 31 outfalls rated as potentially severe or moderately severe problems during the SCA, 7 appear to correspond to major outfalls that are already part of the County screening program. These include: Bread and Cheese outfalls 41 (Priority 1), 328 (Priority 3), and 593 (Priority 3); Deep Creek outfalls 340 (Priority 1) and 342 (Priority 3); and Duck Creek outfalls 431 (Priority 2) and 351 (Priority 3). Screening is conducted 4 times per year for Priority 1 outfalls, once per year for Priority 2 outfalls, and once per decade for Priority 3 outfalls.

Location of all outfalls and exposed pipes surveyed are shown on the field maps included in Appendix A. Tables summarizing data collected for these sites are included in Appendix B and sites are ranked in order of severity by stream.

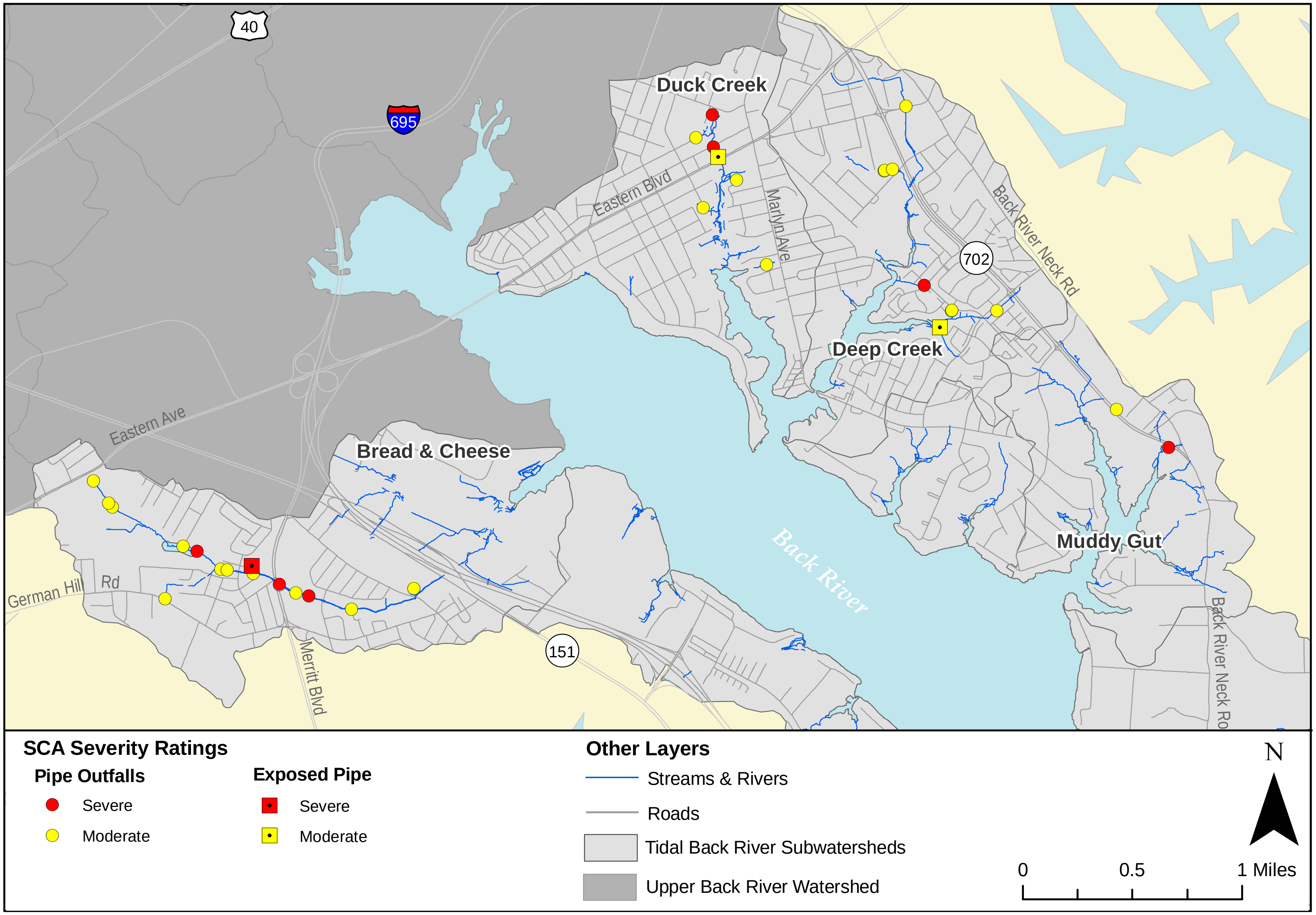


Figure 3-22: Potentially Severe and Moderately Severe Outfall Locations in Tidal Back River

3.6.3.6 Fish Migration Barriers

A fish barrier denotes anything in the stream that significantly interferes with the upstream movement of fish. Unimpeded upstream movement is important for various species that move up and downstream during different parts of their life cycle such as spawning. Fish barriers can reduce the fish population and diversity in stream sections. Fish barriers include manmade structures such as dams or road culverts and natural features such as waterfalls. Three main factors were considered when identifying blockages: 1) vertical drop too high for fish to swim over (vertical drop greater than 6 inches); 2) water depth was too shallow (e.g., water spread over a large area at channelized sections or road crossings); and 3) water was moving too fast (e.g., steep culvert pipe discharging high velocity flow). Severity was rated based on location of the barrier in the stream network and whether the blockage was total, partial, or temporary. A fish barrier was considered very severe (rating = 1) when a structure completely blocked a large stream or river. A minor rating (rating = 5) was assigned to temporary and/or natural fish barriers that blocks little in-stream habitat.

A total of 14 fish barriers were identified during the Tidal Back River SCA survey. Table 3-26 summarizes the number of fish barriers associated with each severity rating (1, 2, 3, 4 or 5).

Table 3-27: Tidal Back River SCA Survey Results – Fish Migration Barriers

	SEVERITY RATING INVENTORY					
	Severe				Minor	
STREAM	1	2	3	4	5	All
Bread & Cheese	0	0	4	1	0	5
Deep Creek	1	1	0	2	0	4
Duck Creek	0	1	1	0	0	2
Muddy Gut	0	0	2	1	0	3
Totals	***1***	***2***	***7***	***4***	***0***	***14***

Fish barriers observed were nearly evenly distributed among the four subwatersheds surveyed. Most of the fish barriers were rated as moderately severe or low severity blockages with one considered as very severe (see Figure 3-23). This blockage was the result of a road/pipe crossing in Deep Creek that was very high and completely blocked fish migration. Most of the fish barrier sites identified (11 out of 14) were a result of road crossings where the blockage was either too high or the depth was too shallow for fish passage. Two of the low severity sites were a result of debris dams and one of the severe-rated sites was a result of failed rip-rap.

Figure 3-23: Very Severe Exposed Fish Migration Barrier (rating = 1)

3.6.3.7 In or Near Stream Construction

Sites where construction was observed in or near the stream were documented as in or near stream construction sites. At these sites, the field team quickly noted lack of sediment control measures and any sign of construction-related pollution, particularly sediment. Severity of these sites were rated based on size of the construction site, proximity of construction activities to the stream, adequate sediment controls, and evidence of sediment from construction downstream. A very severe rating was assigned to large construction sites with large amount of disturbance to the stream channel with no or poorly maintained sediment controls. Minor ratings were assigned to construction sites well outside the riparian buffer with no evidence of sediment input to the stream from construction activities.

A total of 4 in or near stream construction sites were identified during the Tidal Back River SCA survey. Table 3-27 summarizes the number of these sites associated with each severity rating (1, 2, 3, 4 or 5) and the length of construction activity observed by stream. This table also presents the proportion of the total stream miles surveyed considered to have nearby construction activities.

Table 3-28: Tidal Back River SCA Survey Results – In or Near Stream Construction

	SEVERITY RATING INVENTORY								% of Total
	Severe				Minor		LENGTH		Length
STREAM	1	2	3	4	5	All	(ft)	(mi)	Surveyed
Bread & Cheese	0	1	0	1	0	2	1,000	0.2	5%
Deep Creek	0	1	0	0	0	1	450	0.1	4%
Duck Creek	0	0	0	0	0	0	0	0.0	0%
Muddy Gut	0	0	0	0	1	1	30	0.0	0%
Totals	***0***	***2***	***0***	***1***	***1***	***4***	***1,480***	***0.3***	***3%***

A total of 1,480 feet (0.3 miles) of construction activity was observed during the SCA survey in Tidal Back River. As shown in the table above, construction activity was observed in portions of all streams except Duck Creek. Two sites were rated as a potentially severe environmental problem. One site was located at the end of Edsworth Road along Bread and Cheese Creek and was the development of a recreation area (this site was also shown in the photo on the right of Figure 3-20 as an erosion concern). This site appeared to have adequate sediment controls and no excess sediment entering the stream as a result of the activity; however, the stream buffer appeared to have been completely cleared as a result of this construction. The second site was at the end of Mansfield Road where road resurfacing activities were taking place (see Figure 3-25). Excess sediment input into Deep Creek was observed as a result of this activity and inadequate sediment control measures were noted by the field time (no inlet protection).

Figure 3-24: Severe Near Stream Construction at the End of Mansfield Road

3.6.3.8 Unusual Conditions

Unusual conditions were used to document the location of anything out of the ordinary or to provide additional comments on a specific problem. An unusual condition was ranked as very severe if the potential problem was considered to have a direct and wide-reaching impact on the stream's aquatic resources. A site was rated as minor if the site was considered to have no significant impact on aquatic resources. Table 3-28 summarizes the number of unusual conditions sites associated with each severity rating (1, 2, 3, 4 or 5).

Table 3-29: Tidal Back River SCA Survey Results – In or Near Stream Construction

	SEVERITY RATING INVENTORY					
	Severe				Minor	
STREAM	1	2	3	4	5	All
Bread & Cheese	0	4	9	0	0	13
Deep Creek	0	1	4	0	2	7
Duck Creek	1	1	1	1	1	5
Muddy Gut	1	2	7	4	1	15
Totals	***2***	***8***	***21***	***5***	***4***	***40***

A total of 40 unusual condition forms were completed; 8 of these were used to provide additional comments for specific problems. For all 40 sites, the most common unusual conditions encountered were presence of ferric oxide (10 sites), stream bank destruction as a result of all terrain vehicle (ATV)/mountain bike trails (7 sites), invasive species such as English Ivy and Japanese Knot Weed (6 sites), and excessive algae (3 sites). Most unusual conditions encountered were rated as moderately severe environmental problems. The two very severe conditions were used as additional comments. One site was located in Duck creek and used to document a large area of English Ivy killing trees and invading a wetland (see Figure 3-25, left photo). The second site was used to document disturbance to the streambed, banks, and forested wetlands as a result of ATV use in Muddy Gut (see Figure 3-25, right photo). Unusual conditions documenting stream impacts related to ATV use and excessive algae may be addressed via public outreach/education type projects. For example, fertilizer reduction/education may help address algae growth resulting from nutrient or chemical use by adjacent properties.

Figure 3-25: Potentially Severe Unusual Conditions (rating = 2)

3.6.3.9 Representative Sites

Representative sites were selected in the field and were used to characterize the in-stream habitat and adjacent stream corridor conditions. As mentioned previously, the low gradient stream methodology was used to qualitatively rate10 habitat parameters at each representative site as optimal, suboptimal, marginal or poor based on observed conditions relative to a reference (healthy) stream. Once the field team selected a representative section of stream, they evaluated the 10 habitat parameters that are briefly described below.

- ***Epifaunal Substrate/Available Cover:*** Optimal substrate/cover conditions are those stream bottoms with more than 50 percent of favorable cover characteristics such as mix of snags, undercut banks or other stable habitat. Poor substrate would provide less than 10 percent stable habitat for epifaunal (benthic organisms) and fish colonies.

- ***Pool Substrate Characterization:*** Substrate in deeper portions of a representative stream section were rated as optimal if there was a good mixture of bottom materials such as gravel, firm sand, root mats, and SAV. Poor pool substrate conditions were those with no mat or vegetation and hard-pan or clay.

- ***Pool Variability:*** If there were a balance of large-shallow, large-deep, small-shallow, small-deep pools in a representative stream section, it was rated as optimal for pool variability. Poor pool variability was those sites were pools were mostly small and shallow or there were no pools.

- ***Sediment Deposition:*** Optimal sediment deposition conditions were those sites with little or no sand bars/islands and little impact to the bottom by sediment deposition. Sites where there were heavy deposits of fine material and indications of a frequently changing bottom were rated as poor.

- ***Channel Flow Status:*** Optimal channel flow status was those sites were there was sufficient flow such that minimal substrate was exposed. Poor channel flow was the opposite were very little flow was in the channel and water was present as standing pools.

- ***Channel Alteration:*** An optimal rating for channel alteration was assigned to representative sites with a natural stream pattern and little or no evidence of channelization or dredging. A poor rating was given to sites where more than 80 percent of the stream was channelized (concrete, gabions, etc.) and disrupted with little or no in-stream habitat.

- ***Channel Sinuosity:*** Optimal channel sinuosity is where bends in the stream increase the length by about 3 or 4 times longer than if it were straight. Sites were rated as poor if the channel section was straight or channelized for a long distance.

- ***Bank Stability:*** Representative sites with stable banks and little or no potential for erosion or failure were rated as optimal for bank stability. Poor ratings were assigned to unstable channels with significant erosion along banks.

- ***Bank Vegetative Protection:*** Optimal bank vegetative protection were those sites with more than 90 percent of bank surfaces covered by native vegetation including trees. Sites were rated as poor for this parameter if less than 50 percent of bank surfaces were covered by vegetation.

- ***Riparian Vegetative Zone Width:*** Representative sites with a riparian buffer of 50 to 60 feet and where human activities/development have not impacted the buffer were rated as optimal. Sites with less than 20 feet of riparian buffer zone and where there was little or no vegetation due to human activities were considered as poor for this category.

A total of 24 representative sites were assessed during the Tidal Back River SCA: 4 sites along Bread and Cheese Creek, 7 sites in Deep Creek, 5 sites in Duck Creek, and 8 sites in Muddy Gut. The table below presents the number of representative sites rated as optimal, suboptimal, marginal or poor for each habitat parameter assessed.

Table 3-30: Distribution of Ratings by Parameter for all Streams Surveyed

Rating	Epifaunal Substrate	Pool Substrate	Pool Variability	Sediment Deposition	Channel Flow Status	Channel Alteration	Channel Sinuosity	Bank Stability	Bank Vegetation Protection	Riparian Vegetation
Optimal	1	4	5	0	12	13	3	9	12	10
Suboptimal	11	9	5	10	12	9	9	10	7	3
Marginal	10	11	11	12	0	1	8	5	4	7
Poor	2	0	3	2	0	1	4	0	1	4

As shown in the table above, most sites were rated as suboptimal or marginal for epifaunal and pool substrate conditions, sediment deposition, and channel sinuosity. Most sites (11 out of 24) were rated as marginal for pool variability. Riparian vegetation conditions received mostly optimal or marginal ratings. While these sites consisted of some kind of vegetation to receive optimal or marginal ratings, mostly grassed lawn areas were observed rather than wooded buffers. Wooded areas are preferred because they provide the greatest water quality benefits. Potential stream restoration efforts may focus on these parameters with ratings mostly of less than optimal conditions (substrate, sediment deposition, sinuosity, pools and riparian vegetation). Channel flow status was good for all representative sites with a rating of either optimal or suboptimal. Similarly, channel alteration, bank stability, and bank vegetation conditions were mostly rated as optimal or suboptimal with some marginal ratings and only 2 poor ratings. Overall, the most common rating was suboptimal with a considerable portion of optimal and suboptimal ratings. Poor designations were the least common during the habitat assessment portion of the stream survey. Locations of representative sites are shown in the field maps included in Appendix A. A complete summary of data collected for individual habitat parameters and sort by stream is included in the tables in Appendix B.

3.7 Stormwater Management Facilities

Existing SWM facilities within the Tidal Back River watershed were investigated for potential conversion to water quality management facilities. As discussed in Chapter 2.3.6.2, there are a total of 49 SWM facilities that have been built in the Tidal Back River watershed according to Baltimore County DEPRM's database. These include dry and wet ponds, wetlands, infiltration/filtration practices, extended detention facilities, and proprietary BMPs (see Table 2-14 and Figure 2-13). Approximately 65 percent of the SWM facilities in the watershed (32 out of 49) are either filtration/infiltration practices or extended detention facilities. These practices are considered to have higher pollutant removal capabilities, since stormwater has a chance to infiltrate into the ground or through plant roots, compared to conventional SWM techniques which are designed for quantity control without water quality improvement features.

Of the 49 existing SWM facilities, there are 4 dry detention ponds which are typically designed to address water quantity only (flood control) and therefore, provide almost no pollutant removal. Dry ponds have the greatest potential for conversion to a type of facility that provides water quality benefits in addition to quantity control. Therefore, these 4 facilities were assessed for their potential to be converted to an extended detention facility. Dry extended detention ponds are designed to capture and retain stormwater runoff from a storm for a minimum duration (e.g., 24 hours) to allow sediment and pollutants to settle out while also being able to provide flood control if additional storage is incorporated into the design. The locations of the 4 detention ponds in the Tidal Back River watershed are show in Figure 3-26. Table 3-30 summarizes the available information obtained from Baltimore County DEPRM’s database including structure location, ownership, design capacity (drainage area, storm event), as-built date, and riser and barrel characteristics.

Table 3-31: Detention Pond Information from Baltimore County Database

Site ID	County Structure No.	Subwatershed	Structure Name	Nearest Rd	Ownership
SWM_04	327	Back River-A	Benhoff Property - West Facility Pond #2	North Point Rd	Private
SWM_06	381	Duck Creek	Urbanwood	Urbanwood Ct	Public
SWM_07	576	Deep Creek	Eyring Ave Roller Rink (Skateland)	Eastern Ave/ Eyring	Private
SWM_12	1007	Muddy Gut	Cape May Landing	Cape May Rd	Public

Site ID	Drainage Area (acres)	Pond Design	Pond As-built	Update	Pond Riser	Pond Barrel
SWM_04	3.18	2,10,100	10/ 2/1986	1/18/1996	Concrete Inlet	15" BCCMP
SWM_06	4.44	2,10,100	6/ 1/1991		21" BCCMP	15" BCCMP
SWM_07	2.53	100	8/ 1/1980		30" BCCMP	18" BCCMP
SWM_12	8.07	2,10			Concrete	18" RCCP

CMP – Corrugated Metal Pipe; RCCP – Reinforced Concrete Pipe

Information was collected in the field to assess the existing conditions and conversion potential of each dry detention pond in the Tidal Back River watershed including the following: orifice, riser, ponding, debris, vegetation, adjacent land use, physical expansion capabilities, outfall, and downstream conditions. The SWM assessment criteria used for this study is listed in Table 3-31. Field data findings are summarized in Table 3-32.

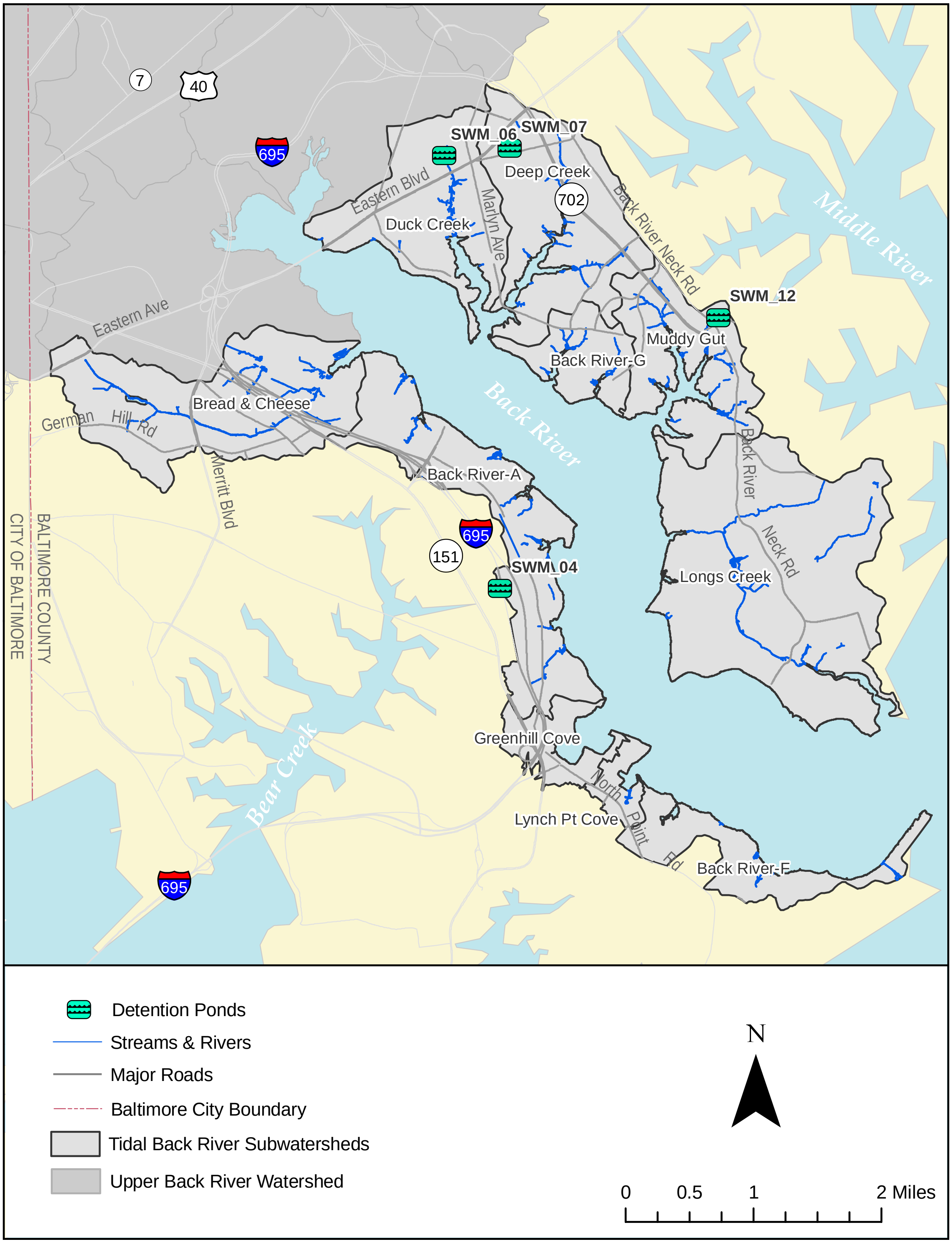


Figure 3-26: Detention Ponds Assessed for Conversion in Tidal Back River

Table 3-32: Tidal Back River Detention Pond Assessment Criteria

Orifice Condition - What is the condition of the area surrounding the orifice?		
D = debris and trash deposits clogging orifices		
S = sediment deposits clogging orifice		
W = orifice submerged by ponding water		
A = aggradation of sediment covering orifice		
Riser Condition - Structural Condition Assessment		
N = no riser		
G = good structural condition (no cracks or breaks, good coating)		
F = fair structural condition (few cracks, coating weathering)		
B = bad structural condition (significant cracks, breaks, etc.)		
O = other, see additional comments		
Ponding - Is ponding occurring during non-storm events?		
Y = yes	N = no	
Debris - Is there a debris problem at this facility? If so, what is the severity?		
L = low	M = medium	H = high
Vegetation - What is the density of vegetation in the facility? Is wetland vegetation present?		
N = none		
L = Low – patchy grass and shrubs		
M = Medium – full of grass, shrubs, and small trees		
H = Overgrown with shrubs and medium to large trees		
WT = Wetland vegetation present (cattails, etc.)		
Adjacent land condition - What is the adjacent land use type?		
FORest	RESidential	
OPEN land	INDustrial	
Physical Expansion Capabilities - Is there physical room for expansion? If there may be Limiting factors, select potentially.		
Y = Yes	N = No	P = Potentially
Barrell Condition (Outfall Condition) - This category looks at the general condition of the outfall		
Outfall general classification:		
G = good	F = fair	B = Bad
Outfall structure condition:		
D = Debris and trash	CS = Conc. Spalling	SP= Scour of outfall protection
CC = Conc. Cracking	MC = Metal Corrosion	SA = scour around apron
S = Submerged	SD = Sediment in Pipe	OD = Outfall Damage
O = Other – see comments	SDS = Storm Drain System	
D.S. Condition - Examine up to 300 feet d/s of the outfall. What is the condition of the channel?		
Downstream Channel Condition:		
G = good	F = fair	B = Bad
Downstream Channel Characteristics:		
BE = Bank Erosion	WT = Wetlands downstream	HC = Head Cut
SE = Substrate Erosion	ST = Stream	D = Debris
GAB = Gabion	SA = Substrate Aggradation	SD = Sediment Deposition
RR = Rip Rap	SDS = Storm Drain System	FB = Forest Buffer
FC = Filter Cloth		

Table 3-33: Detention Pond Field Assessment Summary

Site ID	Orifice	Riser	Ponding	Debris	Vegetation	Adjacent Land
SWM_04	N/A	Fair	No	Low	Low	Industrial
SWM_06	Sediment	Fair	No	Low	Medium	Forest, Residential
SWM_07	Good	Fair	No	Low	Low	Forest, Industrial
SWM_12	Good	Good/Fair	No	Low	Medium	Residential

Site ID	Expansion	Outfall	Outfall Comments	Downstream
SWM_04	Potential	Bad	-Debris and trash -Sediment in pipe -Outfall pipe contracted	Good
SWM_06	No	N/A	-Unable to access due to fence	N/A
SWM_07	Yes	N/A	-Storm drain system	N/A
SWM_12	No	N/A	N/A	N/A

* N/A denotes inability to access site or locate certain features.

Out of the 4 detention ponds assessed, only two (SWM-04 and SWM-07) have potential for conversion to an extended detention facility. Each are described briefly below including site photos.

SWM-04 (North Point Road, Back River-A)

Detention pond, SWM-04, is located within the North Point Self Storage property off of North Point Road in subwatershed Back River-A. The detention pond is enclosed within the storage property and bordered on three sides by a fence. Beyond the fence line at the rear of the property is 695 S. Adjacent land use conditions on either side are privately-owned industrial properties. An assortment of vehicles including storage trailers and RVs line the unfenced edge of the detention pond. The riser was considered as in fair condition since few cracks/minor weathering was noted. Orifice conditions are unknown since the entrance to the storage property was a secured gate. The existing vegetation is low consisting mainly of patchy grass. The outfall was in poor condition with debris, trash, and sediment noted. Downstream channel continues through a culvert under 695 S which was determined to be in good condition. The adjacent land use conditions make lateral expansion of this detention unlikely. However, since the pond is mainly open pervious/grassed area, there is potential for deepening the pond and incorporating vegetation to improve water quality treatment potential.

Figure 3-27: Detention Pond SWM-04 (North Point Rd, Back River-A)

SWM-06 (Urbanwood Ct, Duck Creek)

Detention pond, SWM-06, is located at the end of the cul-de-sac on Urbanwood Court. It is bordered by two private residential properties on either side and by a forested stream buffer area and Duck Creek at the outfall both of which restrict physical expansion potential. The orifice and riser conditions were considered as in fair condition since some sediment was observed at the inlet and few cracks/minor weathering was noted for the riser. The overall condition of the existing detention pond is good with little to no debris and medium vegetation (thick grass and shrubs/trees). The outfall and downstream conditions were inaccessible due to fence conditions. The main recommendation for this facility is to monitor the condition of the inlet and riser and make sure maintenance of the pond continues to ensure proper function. This pond could be considered for planting of native vegetation that requires low maintenance while providing some water quality benefit. However, it may not be a priority since vegetation other than grass is well established and there is no room for physical expansion.

Figure 3-28: Detention Pond SWM-06 (Urbanwood Ct, Duck Creek)

SWM-07 (Eyring Ave, Deep Creek)

Detention pond, SWM-07, is located off of Eyring Avenue adjacent to a commercial/industrial building and parking lot from which it receives stormwater runoff. It is bordered by forested and industrial areas. The orifice was rated as in good condition and the riser was considered fair since few cracks/minor weathering was observed. There is not a problem with debris. The status of existing vegetation was rated as low since it is completely open grassed area. Connection of the outlet of the pond was not clear but appeared to be connected to the storm drain system. This detention pond is the only facility out of the four surveyed considered to have conversion potential. The existing facility is enclosed by a fence; however, there is a large open grassed area in front of the pond adjacent to the parking lot and Eyring Avenue that is maintained (mowed) but does not appear to be utilized.

Figure 3-29: Detention Pond SWM-07 (Eyring Ave, Deep Creek)

SWM-12 (Cape May Landing, Muddy Gut)

Detention pond, SWM-12, is located off of Turkey Point and Back River Neck Roads in the Cape May Landing residential development. It is bordered by the roads and private residences. The orifice and riser conditions were rated as in good condition with minor spalling at the weir. There is no debris issue nor ponding during dry weather. The vegetation status was medium since it was full of grass, shrubs, and small trees. The field team was unable to locate the outfall and thus, downstream conditions. There is no room for physical expansion of this facility due to adjacent land use conditions and therefore, no potential for conversion. Since the condition of the existing detention pond is good, proper maintenance and inspection is the main recommendation.

Figure 3-30: Detention Pond SWM-12 (Cape May Landing, Muddy Gut)

CHAPTER 4: UPLANDS ASSESSMENT

4.1 Introduction

Upland areas were assessed according to the Unified Subwatershed and Site Reconnaissance (USSR) Manual developed by CWP (CWP 2004) to identify potential pollution sources influencing water quality and to restoration project opportunities. The USSR manual is the last manual in a series of 11 regarding techniques for restoring urban watersheds. It provides detailed guidance for field survey techniques and was developed to help watershed groups, municipal staff, and consults to quickly identify major stormwater pollution sources and assess subwatershed restoration potential for source controls, pervious area management, and improved municipal maintenance such as education, retrofits, street sweeping, and open space management.

The field survey of upland areas in the Tidal Back River watershed included four major components:

- Neighborhood Source Assessment (NSA)
- Hotspot Site Investigation (HSI)
- Institutional Site Investigation (ISI)
- Pervious Area Assessment (PAA)

Each of these components is described in detail in the following sections.

4.2 Neighborhood Source Assessment (NSA)

NSAs describe pollution source areas, stewardship behaviors, and restoration opportunities within individual neighborhoods. Each neighborhood has unique characteristics which determine the ability to implement restoration projects, source controls, and stewardship practices. The sections below describe the methods used to delineate and assess individual neighborhoods in the Tidal Back River watershed.

4.2.1 Assessment Protocol

Prior to conducting NSAs in the field, neighborhoods were delineated in the office using ADC street maps and GIS data such as tax parcels, historical development information and aerial photographs. A neighborhood was delineated based on a group of homes with similar characteristics including lot sizes, road widths, set backs, year houses were built, and house types (apartment complex, rowhomes, single family detached, etc.) NSAs were identified using the classification scheme “NSA_E_123”, where ‘E’ denotes the Tidal Back River watershed and neighborhoods were then numbered sequentially as delineated. Neighborhoods defined in the office using available information were verified in the field. Adjustments were made as necessary in the field to group similar neighborhoods or ungroup dissimilar neighborhoods. If NSA boundaries were modified in the field, additional letters were used to distinguish NSA IDs. For example, if a neighborhood was originally designated as NSA_E_10 but was divided into two separate NSAs because of characteristics observed in the field, they would be denoted as NSA_E_10a and NSA_E_10b.

The field team drove through every street in a defined neighborhood to identify potential pollution sources and restoration opportunities. To standardize the NSA process and be able to prioritize potential restoration efforts, data was collected in each neighborhood for four main source areas: yards and lawns; driveways, sidewalks, and curbs; rooftop runoff; and common areas. These are each described briefly below.

Yards and Lawns

Yards and lawns typically represent a significant portion of the pervious cover in an urban subwatershed and therefore, can be a major source of nutrients, pesticides, sediment, and runoff. Maintenance behaviors tend to be similar within individual neighborhoods and certain activities can impact subwatershed quality such as fertilization, pesticide use, watering, landscaping, and waste. Potential pollution sources evaluated under this source category include grass cover and management status (fertilization and irrigation methods), bare soil, outdoor swimming pools, and junk or trash. The amount of existing tree cover and landscaping in neighborhoods was also noted to evaluate potential for increasing these features and providing water quality benefits through interception and filtration of stormwater runoff.

Driveways, Sidewalks, and Curbs

Driveways, sidewalks, and curbs are common in many urban subwatersheds and link neighborhood runoff to the storm drain system. Activities such as car washing, deicing, and improper chemical storage can contribute pollutants such as nutrients, oil, sediment, and chlorides into the storm drain system. While driving through neighborhoods, data was collected for potential pollution sources including stained/dirty driveways, sidewalks covered with lawn clippings/leaves or receiving non-target irrigation (source of nutrients and sediment), pet waste (bacteria), long-term car parking (unused old cars with potential to leak chemicals, oil, and/or grease) and amount of sediment, organic matter, and/or trash present along curbs. Potential for street tree planting and street sweeping was also evaluated based on some of these factors.

Rooftops

Rooftop runoff is another contributor to stormwater runoff and pollutants in neighborhoods. Downspout retrofits can help reduce runoff and pollutants introduced to local streams. The field team identified whether downspouts discharged rooftop runoff to pervious areas, rain barrel, impervious surfaces (driveways, street), and/or directly to the storm drain system and the proportion of each within a neighborhood. The potential for disconnecting and redirecting downspouts from impervious surface or storm drain system was also evaluated.

Common Areas

Common areas such as community parks, parking lots and alleys are good opportunities to observe community behaviors such as pet waste disposal, storm water management, storm drain marking, and how natural areas or buffers are managed. Good upkeep of these areas indicates that residents or a homeowner’s association are active and may represent opportunities for restoration projects. Data was collected on the condition of storm drain inlets (whether they were clean or filled with debris) and presence of pet waste or dumping in common areas to identify potential pollution sources in a neighborhood. The potential for storm drain marking, storm water management practices, and stream buffer planting was also evaluated.

In addition to these four source areas, potential pollution sources were identified in individual neighborhoods by collecting basic information regarding presence of sewer service and amount of remodeling or redevelopment activities. Basic neighborhood information collected to help rate restoration potential included lot size, house types, fraction of houses with basements and garages, and whether a homeowner's association exists for the community. After driving around the entire neighborhood and completing the basic information and four major source area sections, any major pollutants that are potentially being generated by the neighborhood are indicated on the field form including nutrients, oil and grease, trash/litter, bacteria, and sediment. For example, if a neighborhood had several stained driveways and/or several long-term parked vehicles/boats, oil and grease would be flagged as a potential major pollutant being generated in that neighborhood. The presence of trash in several yards or dumping in common areas would be a significant indicator for trash/litter generated in a neighborhood. Sediment was flagged as a major pollutant source if erosion or bare soil was observed, significant amount of remodeling/redevelopment was occurring, and/or a considerable portion of the curb and gutters were covered with sediment.

After driving through and evaluating an entire neighborhood, specific actions were recommended for neighborhood restoration or retrofits based on initial field observations. Recommended actions included in the Tidal Back River watershed NSAs included:

- Downspout disconnection
- Fertilizer reduction/education
- Bayscaping
- Storm drain marking
- Street tree planting
- Trash management
- Multi-family parking lot or alley retrofit

The last step of the NSA involved rating the overall neighborhood pollution severity and restoration potential. The severity of pollution generated by a neighborhood is denoted by the Pollution Severity Index (PSI) based on benchmarks and scoring system in the USSR manual. An NSA PSI is rated as severe, high, moderate, or none. A neighborhood's potential for residential restoration projects is rated as high, moderate, or low according to the Restoration Opportunity Index (ROI). The USSR also provides benchmarks and guidelines to establish NSA ROI ratings.

4.2.2 Summary of Sites Investigated

A total of 46 neighborhoods were assessed throughout the Tidal Back River watershed (see Figure 4-1). The number of neighborhoods within each subwatershed is summarized in Table 4-1. Note that a neighborhood may encompass more than one subwatershed; in this case it counts for each subwatershed in which it falls. Analyses of acres of land or miles of road addressed by recommended actions, however, are based on the actual proportion of the neighborhood that falls within each subwatershed. This is explained further in subsequent sections.

Table 4-1: Neighborhoods Surveyed per Subwatershed

SUBWATERSHED	# of NSAs
Back River-A	4
Back River-F	1
Back River-G	6
Bread & Cheese	5
Deep Creek	15
Duck Creek	13
Greenhill Cove	3
Longs Creek	3
Lynch Pt Cove	2
Muddy Gut	7

Nearly half of the assessed neighborhoods, 22 out of 46, were rated as having a high PSI. Of these 22, 8 neighborhoods are considered as having a high ROI and 14 have a moderate ROI. The remaining 24 neighborhoods assessed were considered as having a moderate PSI with all moderate ROIs with the exception of one neighborhood considered as having a low ROI. The 8 neighborhoods with high PSI and high ROI ratings represent the best areas to target for restoration initially. The distribution of PSI and ROI ratings among the NSAs are shown in Figure 4-2.

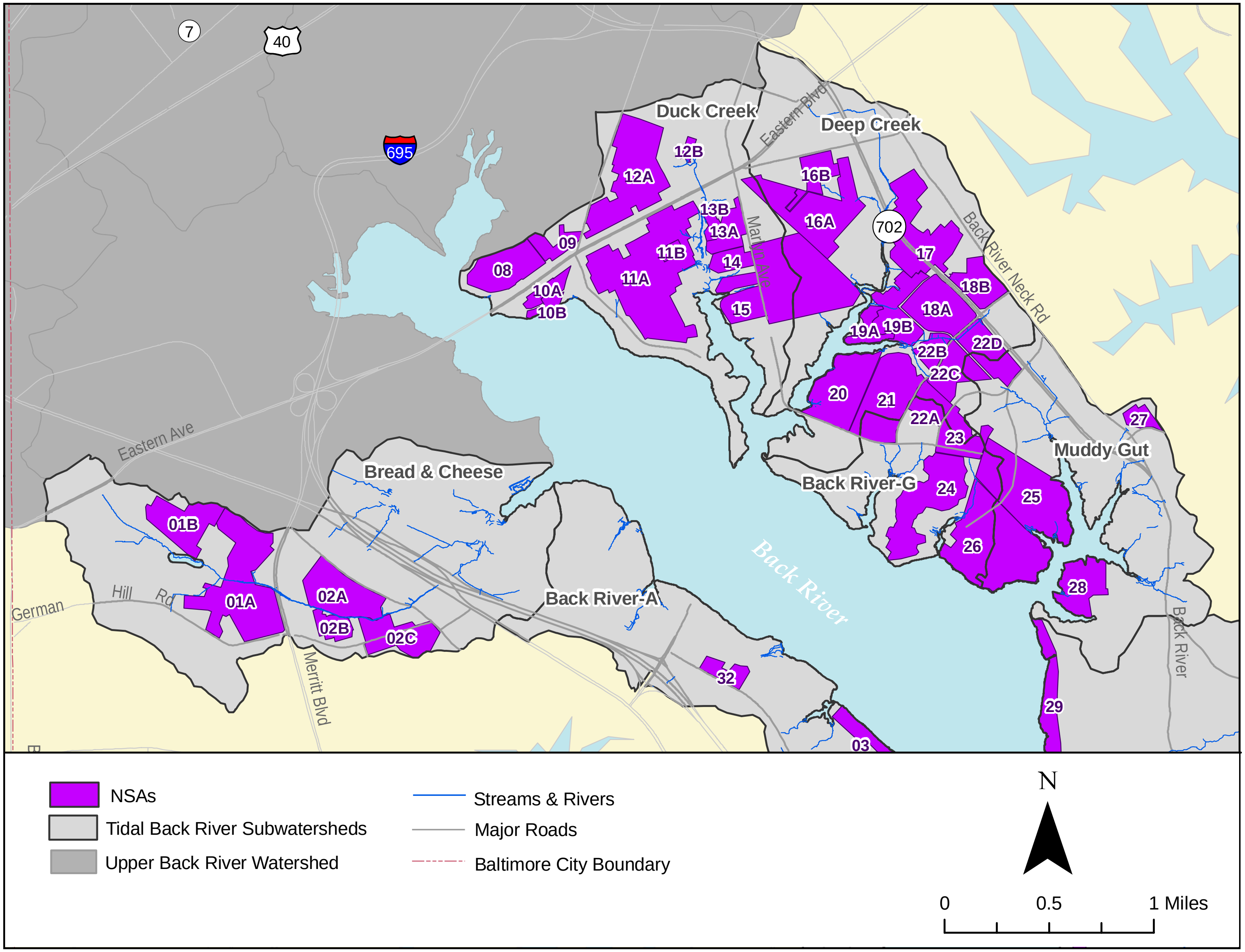


Figure 4-1: Location of NSAs in Tidal Back River

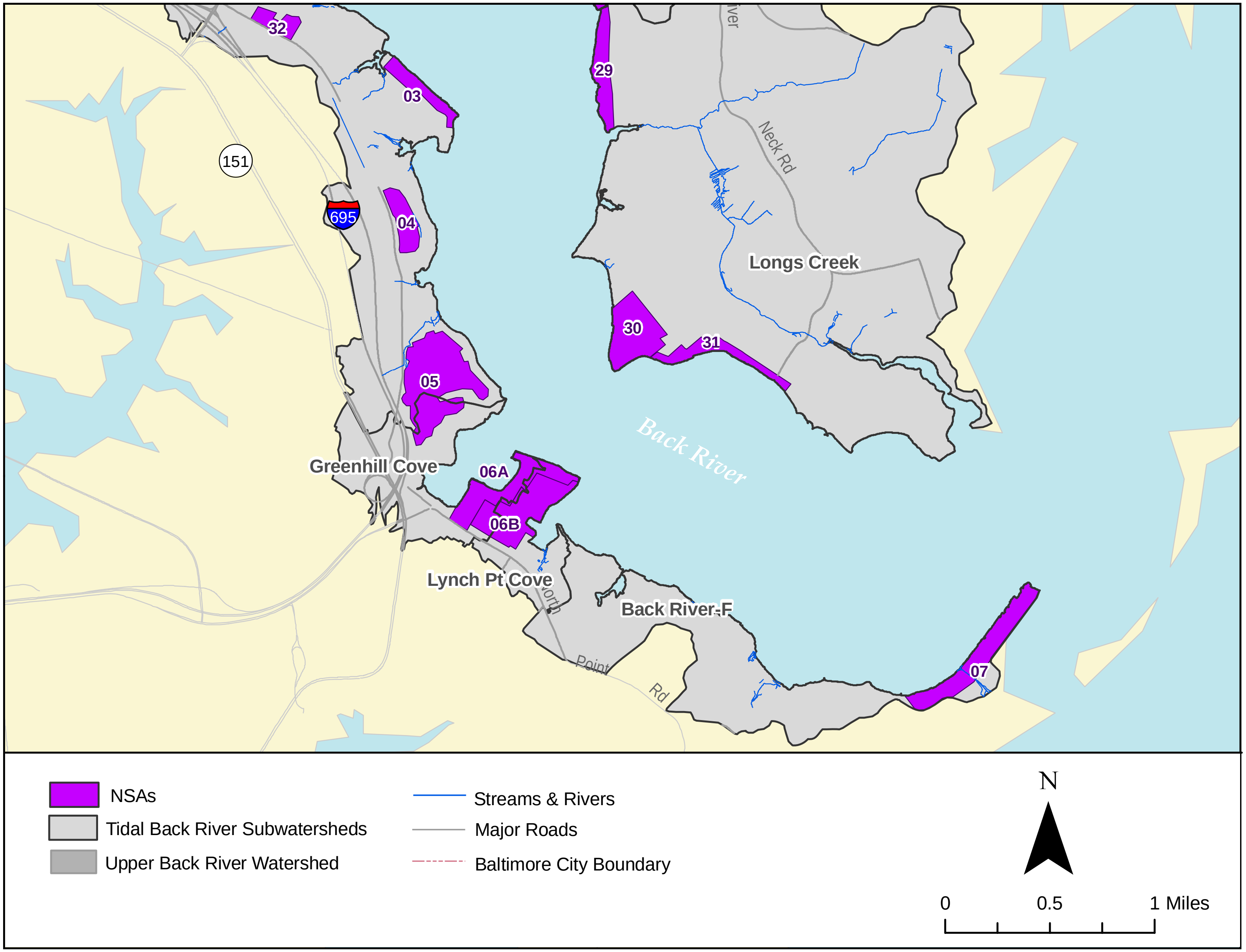


Figure 4-1 (continued): Location of NSAs in Tidal Back River

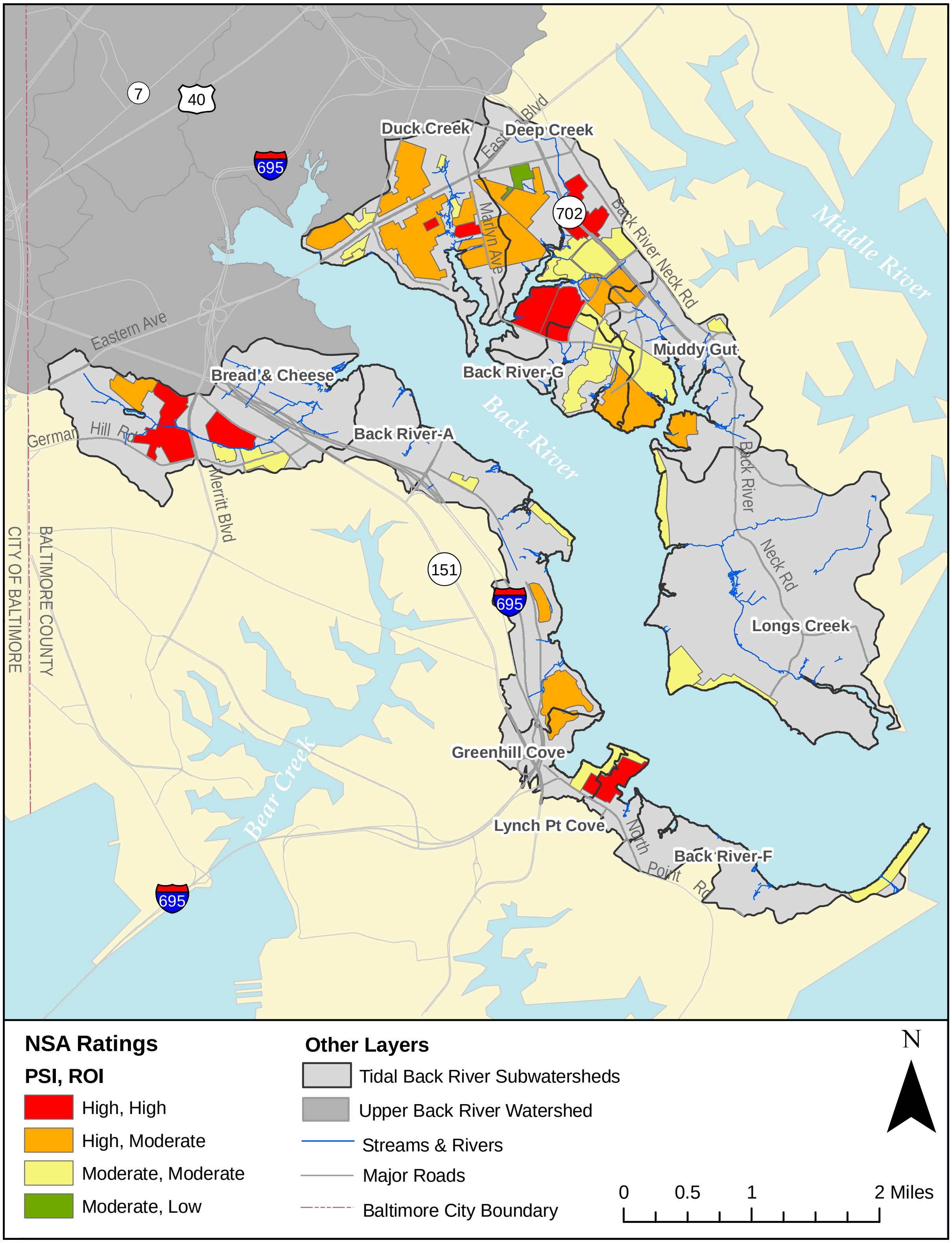


Figure 4-2: NSA Pollution Severity and Restoration Opportunity Indexes

4.2.3 General Findings

The following subsections describe the actions recommended based on the NSAs. This includes an explanation of the methodologies and criteria used to evaluate the potential for recommended actions and results expected if these actions were applied. Figures showing general locations of NSAs recommended for certain actions are included in each subsection. Appendix C includes a summary of NSA data collected and recommended actions by individual neighborhoods. Calculations supporting estimates of results for recommended actions are included in Appendix D.

4.2.3.1 Downspout Disconnection

Rooftop runoff is managed via downspouts which are considered as either connected or disconnected. Directly connected downspouts extend underground, discharging runoff directly to the storm drain system without treatment. Indirectly connected downspouts drain to impervious surfaces such as paved driveways, sidewalk, or curb and gutter system with little or no treatment. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. Downspout disconnection is desirable because it decreases flow to local streams during storm events; this helps prevent erosion and reduces pollutant loads to streams. Disconnection may involve redirecting connected downspouts from impervious areas or the storm drain system onto pervious areas such as yards and lawns. This requires at least 15 feet of pervious area down gradient from the downspout for infiltration to occur. Rain barrels and rain gardens are other disconnection options that can be recommended in lieu of redirection if certain conditions exist. Rain barrels, for example, may be used to store rooftop runoff for irrigation if there is limited pervious area available for downspout redirection. Rain gardens are the most desirable option in terms of water quality because they consist of native plants that capture and treat runoff; this is a potential option for disconnection if the typical neighborhood has several hundred square feet of lawn area available down gradient from the downspout.

Downspout redirection is recommended for neighborhoods where at least 25 percent of the downspouts are connected to impervious area or directly to the storm drain system and where the average lot has at least 15 feet of pervious area available down gradient from the connected downspout for redirection. Table 4-2 includes a summary of the number of neighborhoods recommended for downspout redirection and the acres of rooftop addressed if downspout redirection were implemented by subwatershed. Table 4-2 also lists the percent of impervious rooftop area addressed if downspout redirection were initiated; total impervious rooftop area per subwatershed was calculated using Baltimore County’s buildings GIS layer.

Table 4-2: Acres Addressed by Downspout Redirection

SUBWATERSHED	# of NSAs Recommended for Downspout Redirection*	Rooftop Acres Addressed	% of Subwatershed Rooftop Area Addressed
Back River-A	4	6.7	16
Back River-F	1	2.5	14
Back River-G	2	3.5	16
Bread & Cheese	4	12.7	11
Deep Creek	7	14.6	13
Duck Creek	12	32.1	29
Greenhill Cove	3	4.7	26
Longs Creek	2	3.1	21
Lynch Pt Cove	2	4.6	27
Muddy Gut	6	8.8	37
	Total	***93.2***	***19***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-3 illustrates the location of neighborhoods recommended for downspout redirection. Out of the 46 neighborhoods assessed, 35 have the potential for downspout disconnection through redirection. If implemented, this could address approximately 19 percent of the total impervious rooftop area in the watershed.

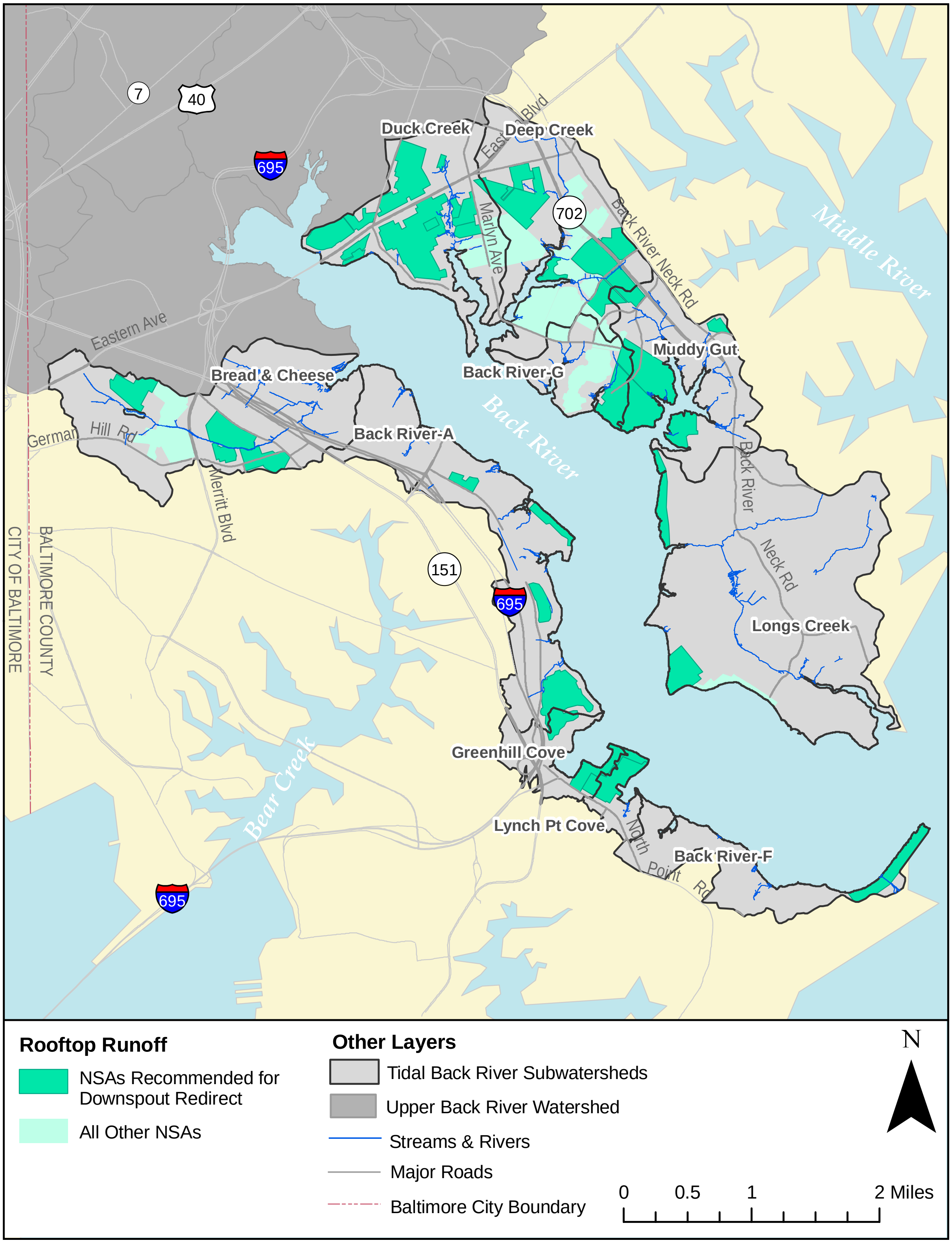


Figure 4-3: Neighborhoods Recommended for Downspout Disconnection

4.2.3.2 Fertilizer Reduction/Education

A well-maintained lawn can be beneficial to the watershed. However, lawn maintenance activities often involve over-fertilization, poor pest-management, and over-watering resulting in pollutant stormwater runoff to local streams. Lawns with a dense, uniform grass cover or signs designating poisonous lawn care indicate high lawn maintenance activities.

Neighborhoods where 20 percent or more of the homes appeared to employ high lawn maintenance practices were recommended for fertilizer reduction/education. Table 4-3 includes a summary of the number of neighborhoods recommended for fertilizer reduction/education and the acres of lawn addressed if this action were initiated by subwatershed. Note that the acres of lawn addressed were calculated based on fraction of high maintenance lawns present within each neighborhood recommended for this action (see Appendix D for supporting calculations). Table 4-3 also lists the percent of the total subwatershed area that would be addressed by implementing fertilizer reduction/education in the recommended neighborhoods.

Table 4-3: Acres of Lawn Addressed by Fertilizer Reduction

SUBWATERSHED	# of NSAs Recommended for Fertilizer Reduction*	Acres of Lawn Addressed	% of Subwatershed Area Addressed
Back River-A	3	15.9	2
Back River-F	0	0	0
Back River-G	2	9.5	3
Bread & Cheese	1	6.5	1
Deep Creek	3	15.5	2
Duck Creek	7	24.9	3
Greenhill Cove	1	3.0	1
Longs Creek	0	0	0
Lynch Pt Cove	0	0	0
Muddy Gut	1	7.1	1
	Total	***82.5***	***1***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-4 illustrates the location of neighborhoods recommended for fertilizer reduction/education (neighborhoods with 20 – 100% high maintenance lawns). Out of the 46 neighborhoods assessed, 15 (33%) were recommended for fertilizer reduction/education. Table 4-3 shows that only a small portion of the total watershed area would be addressed by this action; this is because many of the neighborhoods have small amount of cover due to small lot sizes and/or significant impervious cover.

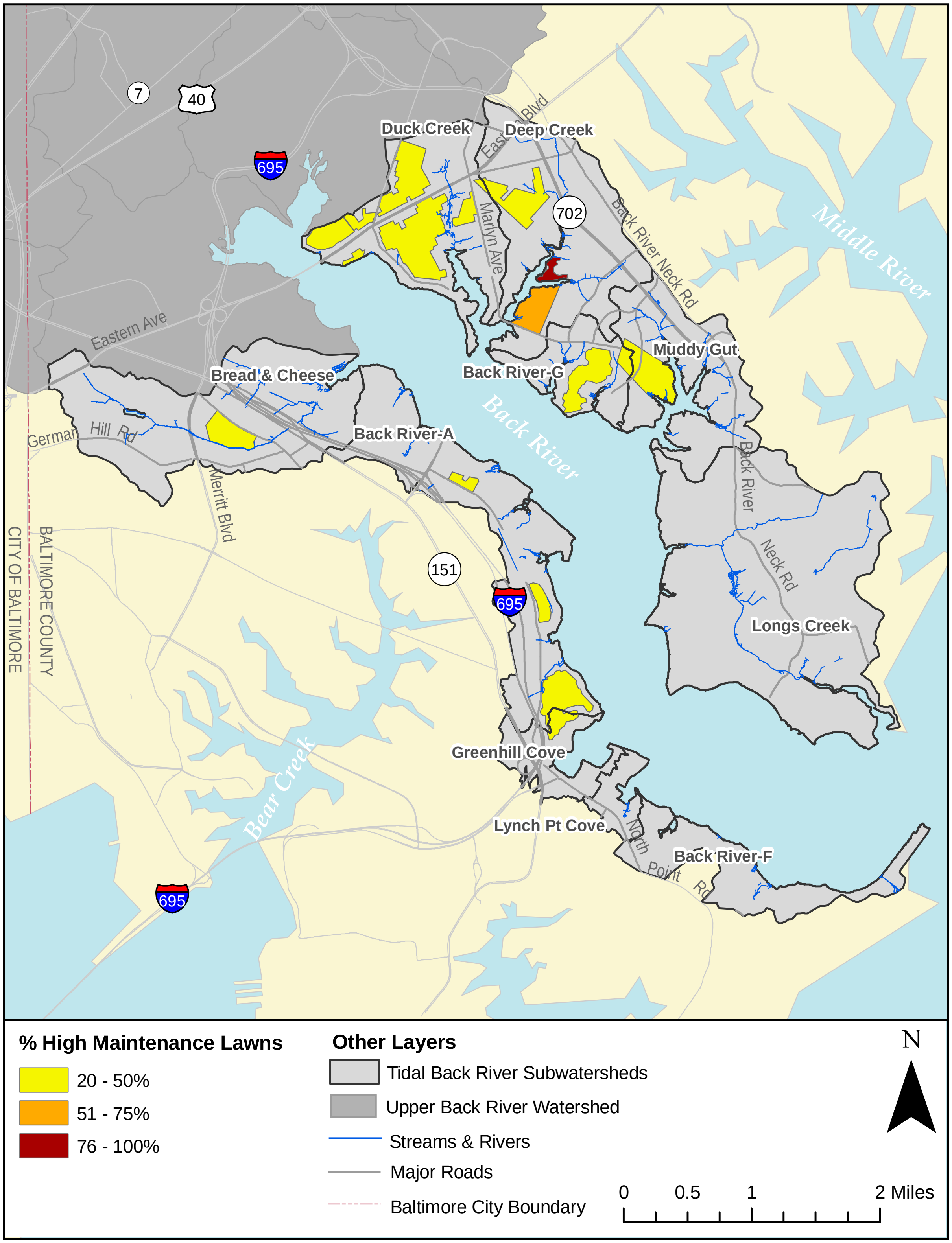


Figure 4-4: Neighborhoods with 20-100% High Maintenance Lawns

4.2.3.3 Bayscaping

Bayscaping refers to the use of plants native to the Chesapeake Bay watershed for landscaping. Because they are native to the region, these plants require less irrigation, fertilizers, and pesticides to maintain as compared to non-native or exotic plants. This means less stormwater pollution and lawn maintenance requirements. Bayscaping is also beneficial to wildlife.

All neighborhoods could use more bayscaping; however, the benefits and feasibility of this action are limited in this watershed by the small area available for landscaping. Similar to the lawn maintenance discussion, several neighborhoods are characterized by smaller lot sizes and/or significant impervious cover. Bayscaping was recommended in neighborhoods where the typical lot was at least ¼ acre in size, was less than 25 percent landscaped, and where there was sufficient grass area available (i.e., where impervious cover on the lot would not inhibit improvement of this percentage). Table 4-4 includes a summary of the number of neighborhoods recommended for bayscaping based on these criteria and the acres of land addressed if this action were initiated by subwatershed. Table 4-4 also lists the percent of the total subwatershed area that would be addressed by implementing bayscaping in the recommended neighborhoods.

Table 4-4: Acres of Land Addressed by Bayscaping

SUBWATERSHED	# of NSAs Recommended for Bayscaping*	Acres of Land Addressed	% of Subwatershed Area Addressed
Back River-A	2	3.8	0.4
Back River-F	0	0	0
Back River-G	4	18.9	6
Bread & Cheese	0	0	0
Deep Creek	10	40.4	4
Duck Creek	2	2.2	0
Greenhill Cove	1	4.7	2
Longs Creek	3	11.0	1
Lynch Pt Cove	1	1.6	2
Muddy Gut	5	21.0	3
	Total	***103.7***	***1***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-5 illustrates the location of neighborhoods recommended for bayscaping. Out of the 46 neighborhoods assessed, 21 (46%) met the criteria and were recommended for bayscaping. Table 4-4 shows that only a small portion of the total watershed area would be addressed by this action; this is because many of the neighborhoods have limited amount of area available due to small lot sizes and/or significant impervious cover.

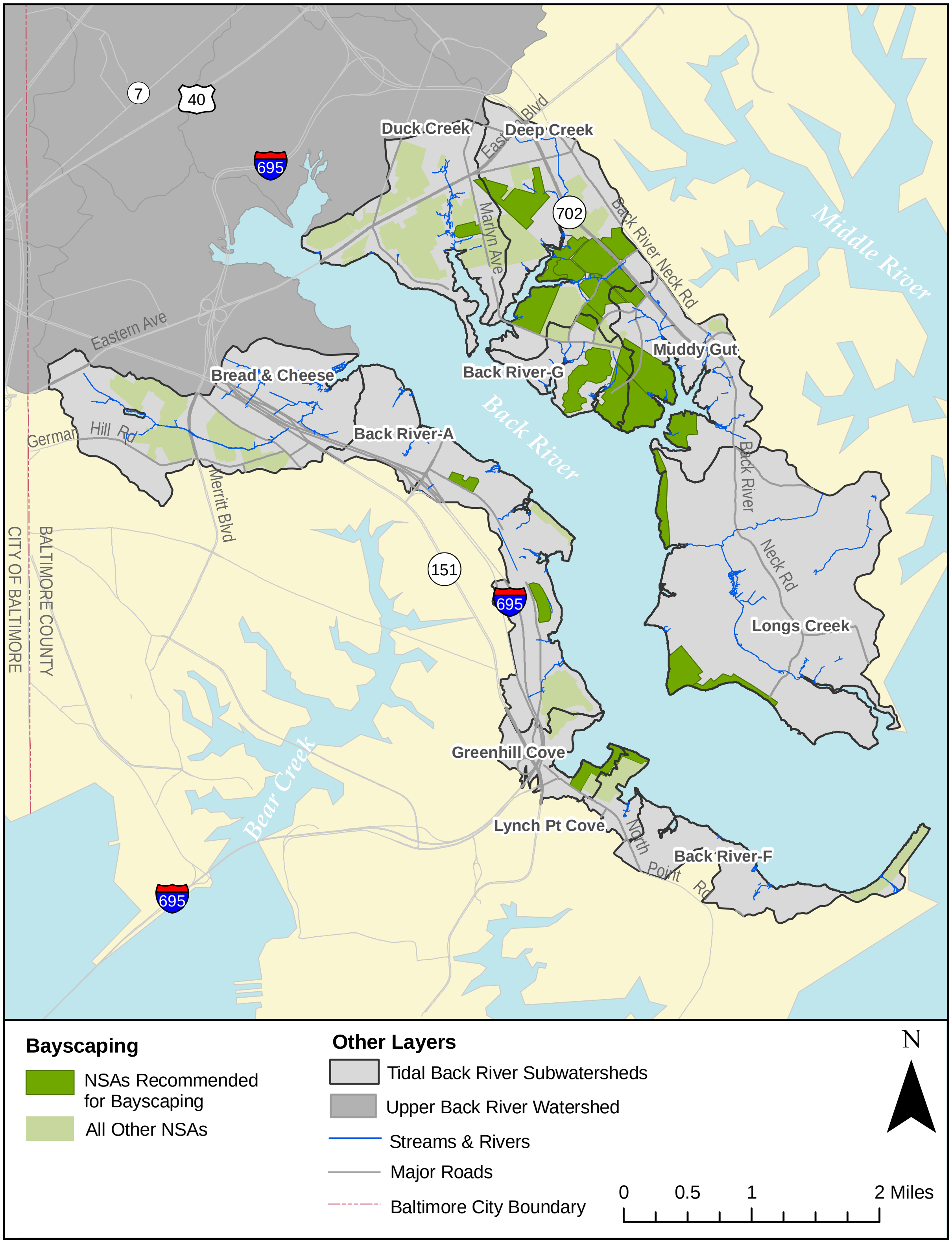


Figure 4-5: Neighborhoods Recommended for Bayscaping

4.2.3.4 Storm Drain Marking

Most of the neighborhoods in the Tidal Back River watershed consist of curb and gutter systems including storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. Some neighborhoods had inlets with faded storm drain marking but most did not have any indicators that the inlets drain to the Back River and eventually the Chesapeake Bay. Since there is little or no infiltration of stormwater in this type of system, there is more potential for pollutants to be carried to the stream system. Storm drain marking indicates that the inlets drain to the Chesapeake Bay; this is a way to educate residents that anything building up along the curbs and gutters such as trash and lawn clippings (potential for nutrient pollution) will be washed away after a storm event and end up in the Back River and/or the Bay.

Neighborhoods recommended for storm drain marking had curb and gutter systems with inlets appropriate for marking and where less than 10 percent of the existing inlets were already marked (and legible). Table 4-5 includes a summary of the number of neighborhoods recommended for storm drain marking and the number of inlets addressed if this action were initiated by subwatershed. The number of inlets addressed was estimated based on the inlet densities calculated by subwatershed in Chapter 2.3.6. Table 4-5 also lists the percent of the inlets that would be addressed if storm drain marking was implemented in the recommended neighborhoods.

Table 4-5: Number of Inlets Addressed by Storm Drain Marking

SUBWATERSHED	# of NSAs Recommended for Storm Drain Marking*	Approximate No. of Inlets Addressed	% of Subwatershed Inlets Addressed
Back River-A	2	1	10
Back River-F	0	0	0
Back River-G	4	4	29
Bread & Cheese	4	17	15
Deep Creek	14	51	44
Duck Creek	13	39	44
Greenhill Cove	3	2	22
Longs Creek	0	0	0
Lynch Pt Cove	2	5	42
Muddy Gut	4	0	0
	Total	***121***	***31***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-6 illustrates the location of neighborhoods recommended for storm drain marking. Out of the 46 neighborhoods assessed, 35 (76%) met the criteria and were recommended for storm drain marking. Table 4-4 also shows that about 31 percent of the inlets in the watershed could be addressed by this action just in the neighborhoods alone.

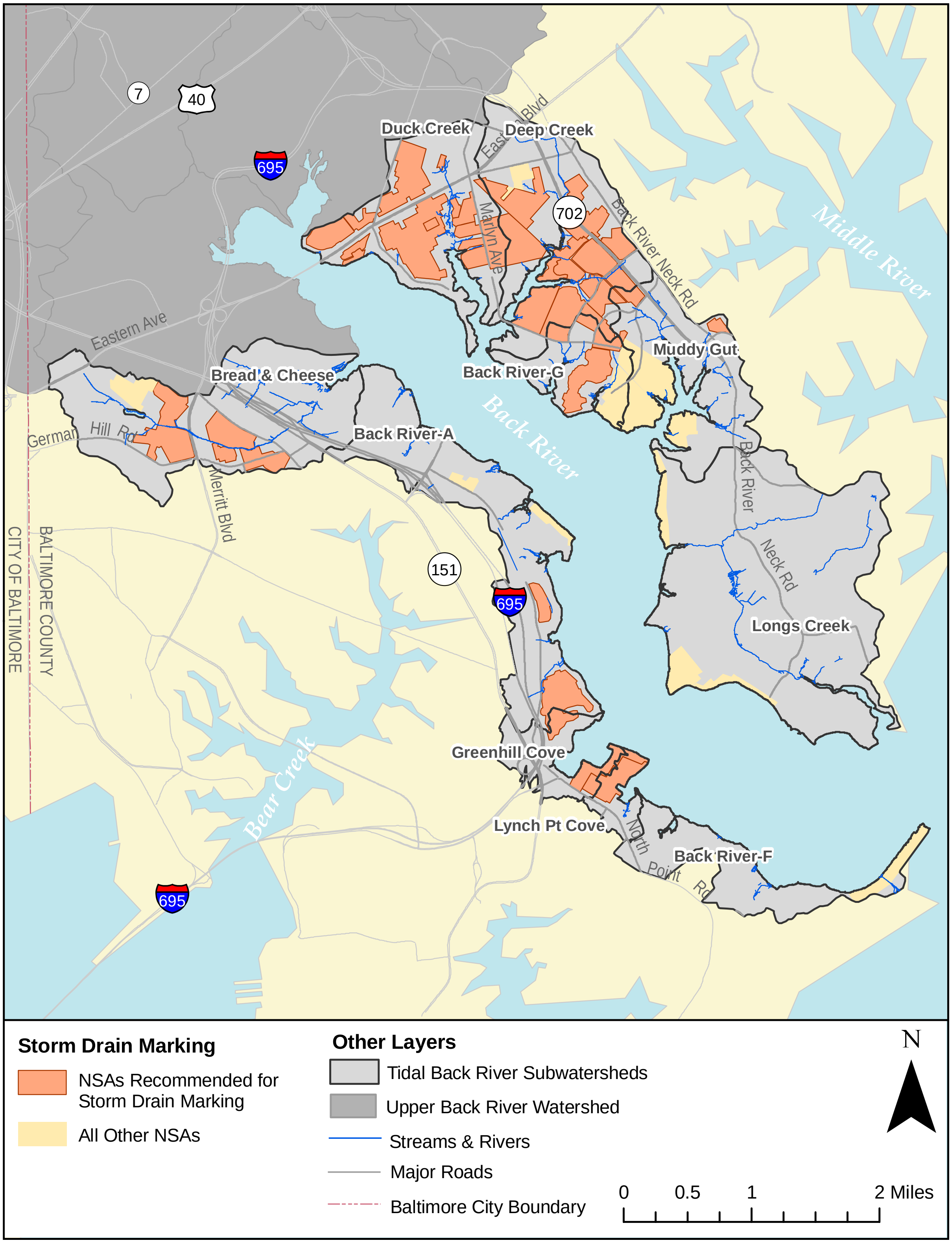


Figure 4-6: Neighborhoods Recommended for Storm Drain Marking

4.2.3.5 Street Trees

Street trees are not only an asset to a neighborhood aesthetically but also provide air and water quality improvement since they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root systems. This infiltration of precipitation through leaves or the root systems slows flow input and provides some treatment before stormwater runoff reaches the stream system.

Street trees were recommended for neighborhoods where at least 25 percent of the streets had a minimum of 4 feet of greenspace between the sidewalk and curb and less than 75 percent of these areas had trees planted. The number of trees was estimated based on a spacing of one tree per 15 to 20 feet. Street tree estimates were capped at a maximum of 100 per neighborhood but the potential for more than 100 street trees was noted in these cases. Table 4-6 includes a summary of the number of neighborhoods recommended for street tree planting and the number of street trees proposed per subwatershed.

Table 4-6: Street Tree Potential by Subwatershed

SUBWATERSHED	# of NSAs Recommended for Street Trees*	No. of Street Trees that Could be Planted
Back River-A	0	0
Back River-F	0	0
Back River-G	3	133
Bread & Cheese	3	300
Deep Creek	9	509
Duck Creek	7	378
Greenhill Cove	0	0
Longs Creek	0	0
Lynch Pt Cove	0	0
Muddy Gut	3	25
	Total	***1,345***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-7 illustrates the location of neighborhoods where street trees could be planted. Out of the 46 neighborhoods assessed, 18 (39%) met the criteria and were recommended for street trees. For the most part, neighborhoods not recommended for street trees either did not have sidewalks and a curb and gutter system or there was insufficient greenspace between the sidewalk and curb. There is potential for planting over 1,345 street trees throughout the watershed.

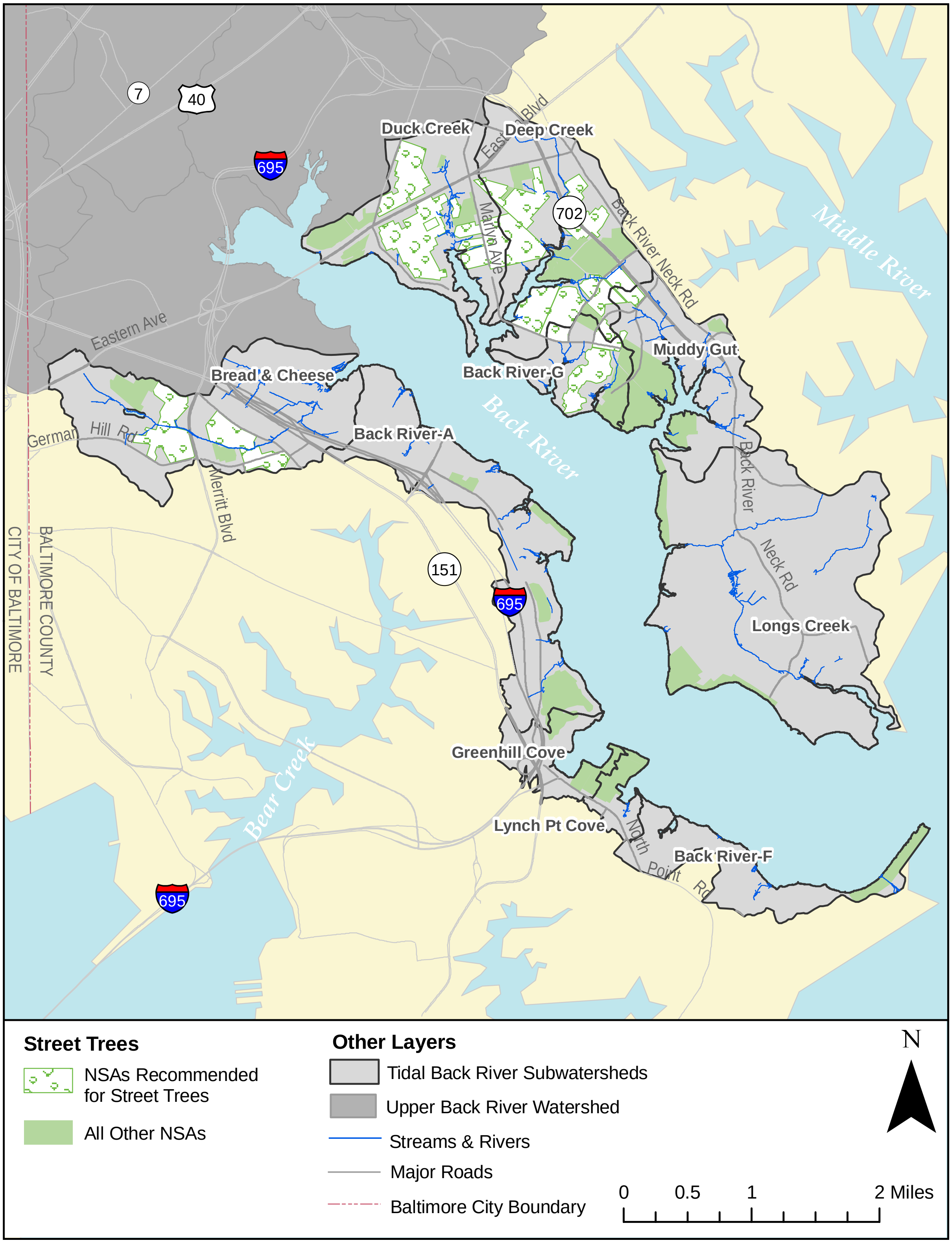


Figure 4-7: Neighborhoods Recommended for Street Trees

4.2.3.6 Street Sweeping

Street sweeping helps remove trash, sediment and other organic matter such as leaves and grass clippings from the curb and gutter system and prevents them from entering the storm drain system and nearby streams. Street sweeping also reduces sediment and other pollutant loads such as oil and metals to the stream system. Excessive organic matter, sediment, and trash can clog streams and the storm drain system resulting in costly maintenance and stream health impairment. Also, higher levels of oxygen than normal are used by the decay of an unbalanced amount of organic matter in a stream which deprives other aquatic life including fish of their oxygen demand. An aggressive street sweeping initiative can ease the effects of a curb and gutter storm drain system on receiving streams.

Neighborhoods where 20 percent or more of the curbs and gutters were covered with excessive trash, sediment, and/or organic matter were recommended for street sweeping. Table 4-7 includes a summary of the number of neighborhoods recommended for street sweeping and the miles of street addressed if it was implemented by subwatershed. Miles addressed by street sweeping were estimated using Baltimore County's roads GIS layer and determining the miles of roads within each neighborhood recommended for street sweeping.

Table 4-7: Miles Addressed by Street Sweeping

SUBWATERSHED	# of NSAs Recommended for Street Sweeping*	Miles Addressed by Street Sweeping
Back River-A	0	0
Back River-F	0	0
Back River-G	1	0.9
Bread & Cheese	1	6.8
Deep Creek	5	10.3
Duck Creek	4	5.0
Greenhill Cove	1	0.3
Longs Creek	0	0
Lynch Pt Cove	1	1.2
Muddy Gut	0	0
	Total	***24.5***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-8 illustrates the location of neighborhoods recommended for street sweeping. Out of the 46 neighborhoods assessed, 10 (22%) met the criteria for street sweeping. If initiated, this could address approximately 41 percent of the total miles of road within all neighborhoods surveyed in the watershed.

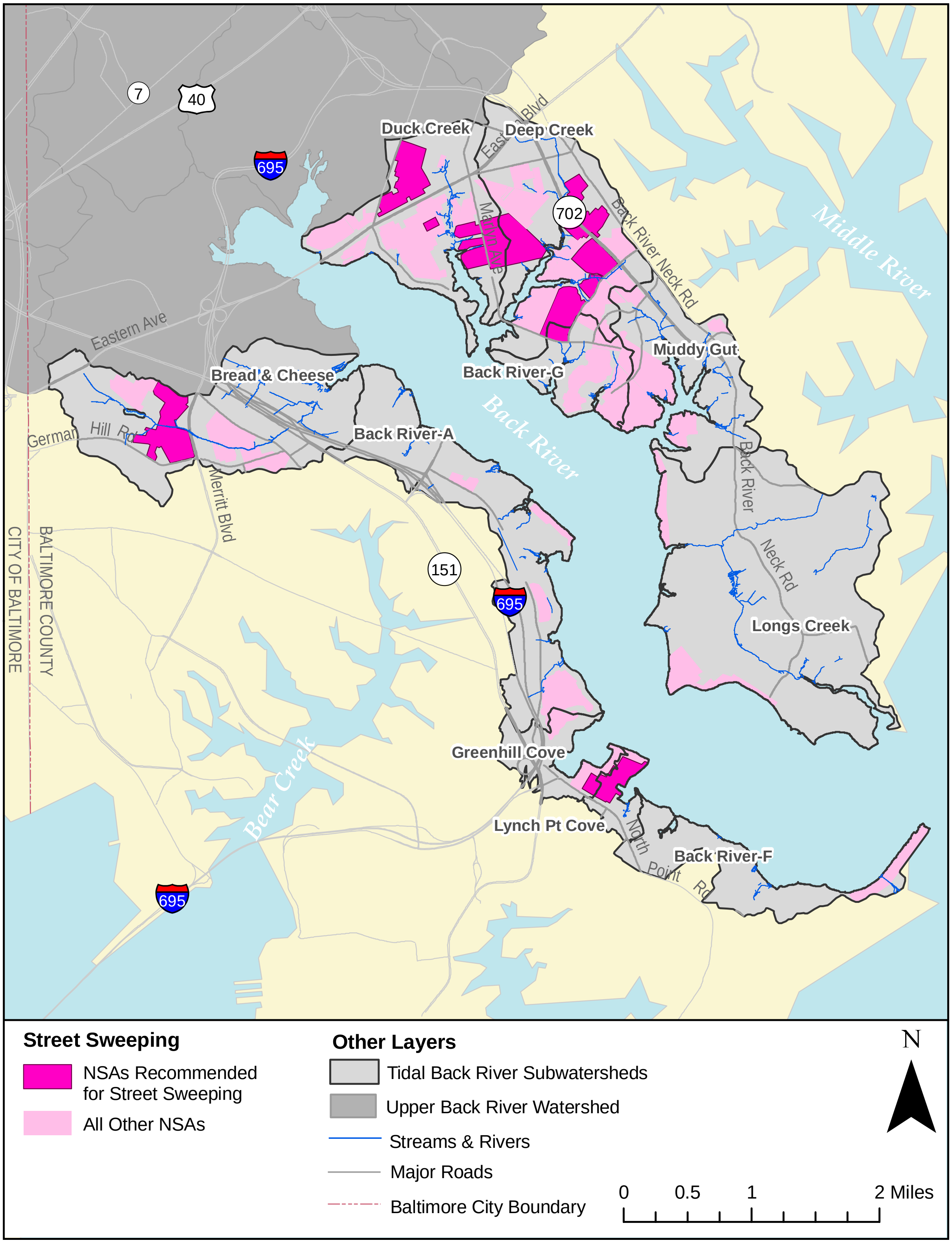


Figure 4-8: Neighborhoods Recommended for Street Sweeping

4.2.3.7 Neighborhood Trash Management

Trash is one of the main pollutants of concern in the Tidal Back River watershed. The uplands survey revealed that the watershed may benefit from trash management initiatives such as community cleanups, trash management education, and working with the Department of Public Works (DPW) to implement a bulk trash pick-up program.

Neighborhoods where junk or trash was observed in 25 percent of yards were recommended for trash management initiatives. Neighborhoods with less than 25 percent of yards with junk/trash but had other warning signs such as overflowing dumpsters or dumping in alleys or other common areas were also included. Table 4-8 includes a summary of the number of neighborhoods recommended for trash management initiatives and the acres of land addressed if it was implemented by subwatershed. Table 4-8 also includes a summary of the percent of the total subwatershed area addressed by initiating trash management.

Table 4-8: Acres of Land Addressed by Trash Management

SUBWATERSHED	# of NSAs Recommended for Trash Management*	Acres of Land Addressed	% of Subwatershed Area Addressed
Back River-A	0	0	0
Back River-F	0	0	0
Back River-G	1	13.6	4
Bread & Cheese	2	126.0	11
Deep Creek	6	172.3	17
Duck Creek	1	11.8	1
Greenhill Cove	0	0	0
Longs Creek	0	0	0
Lynch Pt Cove	0	0	0
Muddy Gut	3	48.4	7
	Total	***372.1***	***5***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-9 illustrates the location of neighborhoods recommended for trash management initiatives. Out of the 46 neighborhoods assessed, 10 (22%) were recommended for trash management. If initiated, this could address approximately 5 percent of the total watershed area. While this may only represent a small fraction of the entire watershed, trash management has the potential to address more developed and potential problem areas on the subwatershed scale; for example, targeting neighborhoods in Bread & Cheese and Deep Creek could potentially address 11 and 17 percent of these subwatershed areas, respectively.

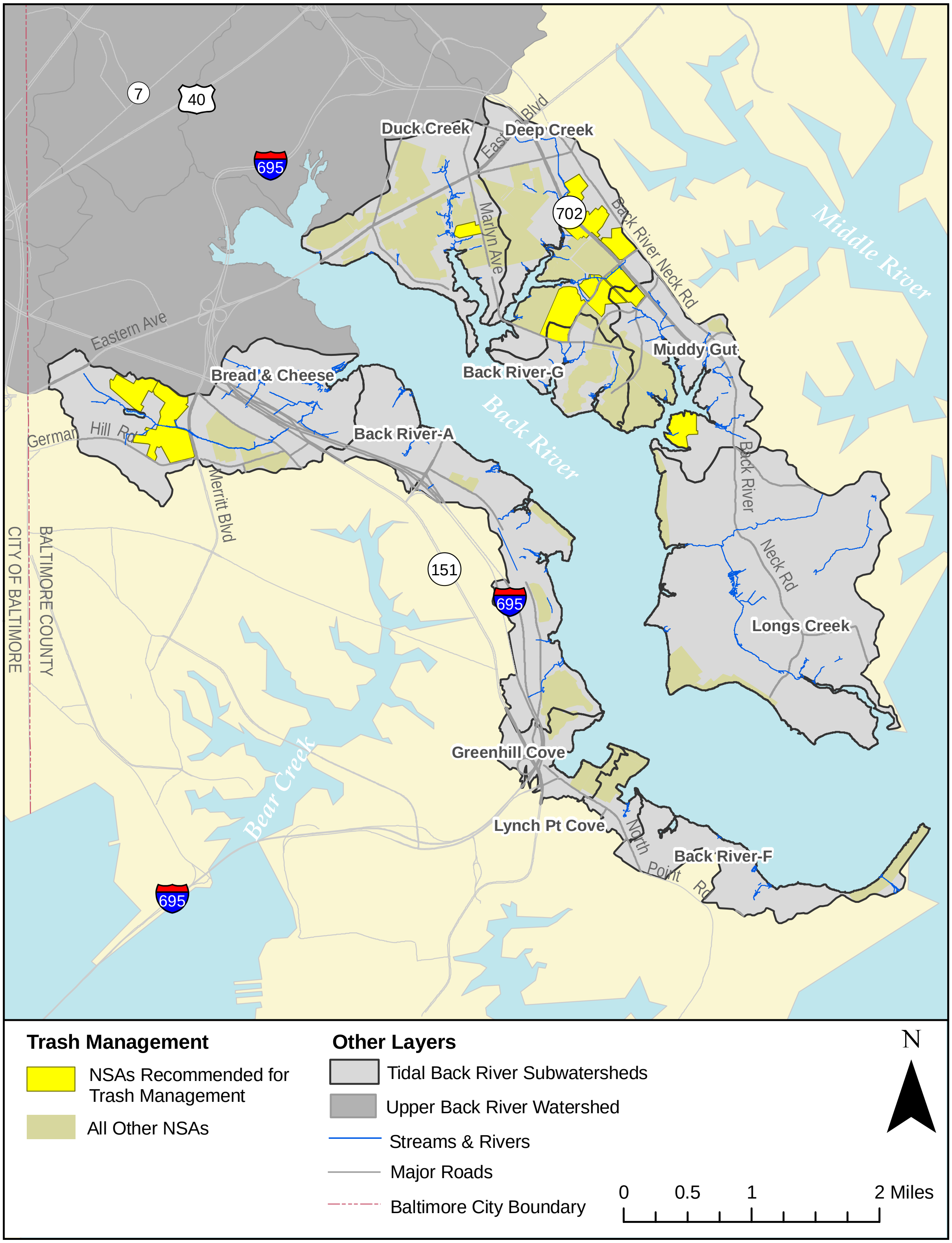


Figure 4-9: Neighborhoods Recommended for Trash Management

4.2.3.8 Parking Lot or Alley Retrofit

There are several apartment, townhouse, and condo complexes in the Tidal Back River. Mult-family parking lots in these types of neighborhoods can be an opportunity for a storm water retrofit to address stormwater runoff from impervious surfaces. In addition, neighborhoods with rowhomes often consisted of paved alleys which could also be an opportunity for stormwater retrofit if sufficient pervious area is available. As discussed previously in Chapter 2, infiltration/filtration practices such as bioretention areas with native plantings could be used to capture and treat storm water runoff from impervious parking lots and alleys while requiring minimal maintenance.

Neighborhoods where sufficient greenspace was available down gradient of a multi-family parking lot or alley were recommended for stormwater retrofit practice. Table 4-9 includes a summary of the number of neighborhoods recommended for stormwater retrofits and the approximate acres of impervious cover addressed if implemented by subwatershed.

Table 4-9: Acres of Impervious Cover Addressed by Stormwater Retrofit

SUBWATERSHED	# of NSAs Recommended for Stormwater Retrofit*	Acres of Impervious Cover Addressed
Back River-A	0	0
Back River-F	0	0
Back River-G	1	0.3
Bread & Cheese	1	0.6
Deep Creek	7	3.9
Duck Creek	2	0.5
Greenhill Cove	0	0
Longs Creek	0	0
Lynch Pt Cove	0	0
Muddy Gut	1	0.3
	Total	***5.7***

* If a neighborhood overlaps multiple subwatersheds, it is counted for each subwatershed it encompasses.

Figure 4-10 illustrates the location of neighborhoods recommended for multi-family parking lot or alley stormwater retrofits. Out of the 46 neighborhoods assessed, 10 (22%) have sufficient greenspace available for multi-family parking lot or alley stormwater retrofits. Note that the 5.7 acres of impervious cover addressed is an approximation based on potential sites identified in the field and area calculations using GIS and a visual inspection aerial photos. Actual area addressed will depend on a closer inspection of site conditions conducive to a stormwater retrofit application (e.g., grading requirements, cost, etc.)

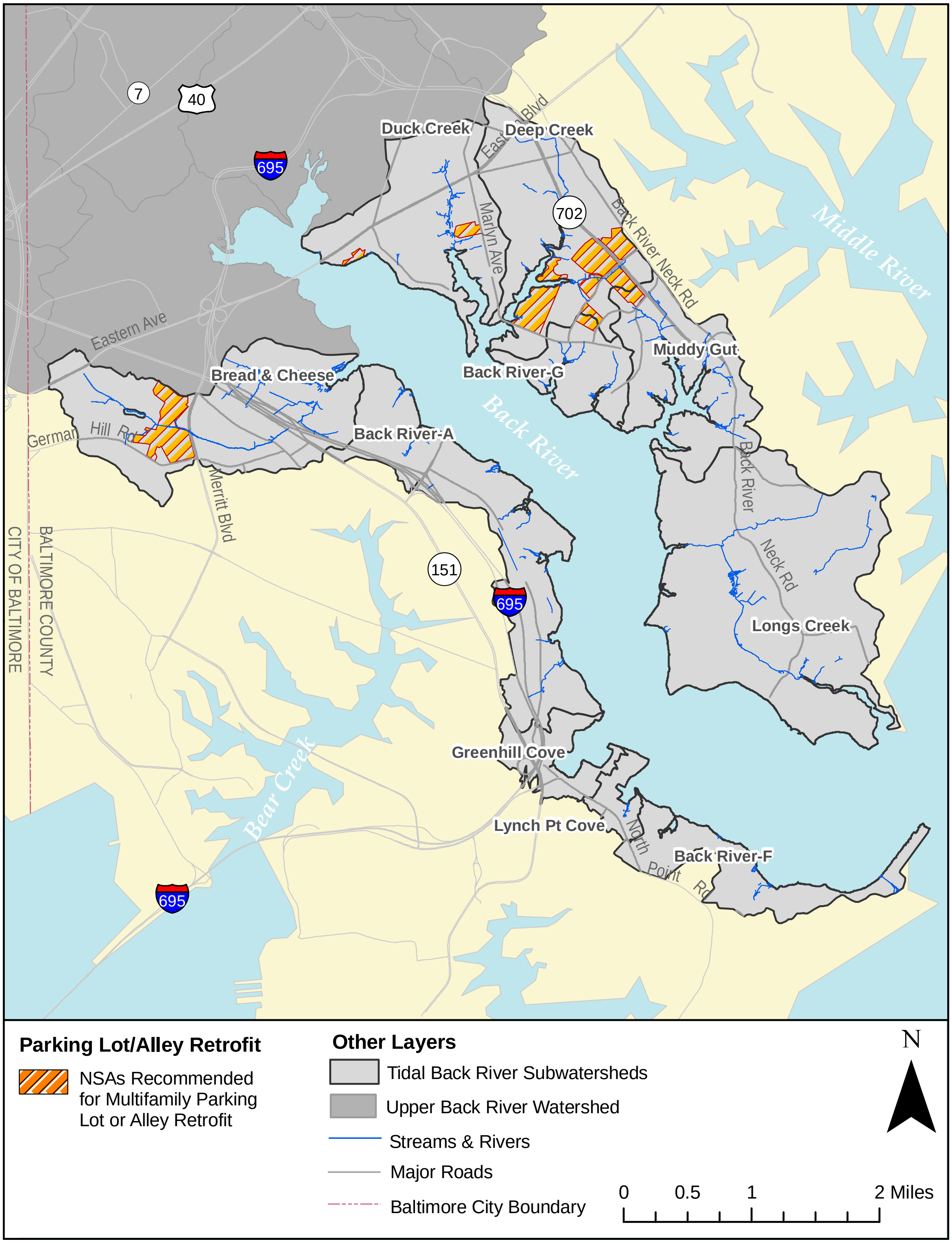


Figure 4-10: Neighborhoods Recommended for Parking Lot or Alley Stormwater Retrofit

4.3 Hotspot Site Investigation (HSI)

Stormwater hotspots are areas that have potential to generate higher concentrations of stormwater pollutants than typically found in urban runoff and/or have a higher risk of spills, leaks, or illicit discharges due to the nature of their operations (CWP 2007). These generally include commercial, industrial, municipal, or transport-related operations. Hotspots are either regulated or unregulated. Regulated hotspots are known sources of pollution that abide by applicable federal or state laws (e.g., NPDES permits). Unregulated hotspots are not regulated but the nature of their operations makes them likely to be potential pollutant sources. Stormwater pollutants generated as a result of hotspot operations depend on the specific activities but typically include nutrients, hydrocarbons, metals, chloride, pesticides, bacteria, and trash.

Commercial hotspots include a range of businesses and activities but are normally grouped together in subwatersheds. Operations characteristic of commercial hotspots include waste or wash water generation, outdoor material storage, fuel handling, or auto/boat repair. Common commercial hotspots include auto repair shops, car dealers, car washes, parking facilities, gas stations, marinas, garden centers, construction equipment and building material lots, swimming pools, and restaurants. Industrial operations utilize, generate, handle, and/or store pollutants that can be washed off with stormwater, spilled, or mistakenly discharged into the storm drain. Many industrial hotspots are regulated under NPDES industrial discharge permits and include various manufacturing operations such as metal production, chemical manufacturing, and food processing. Municipal hotspots typically refer to local government operations such as solid waste, wastewater, road and vehicle maintenance, and yard waste. Like industrial operations, many municipal hotspots are subject to NPDES stormwater permits. Transport-related hotspots normally include areas of significant impervious cover and extensive private storm drain systems. Many are regulated and include uses such as airports, ports, highway construction, and trucking centers.

The purpose of HSIs is to evaluate pollution potential from hotspot operations and identify potential restoration practices that may be necessary. The following subsections describe the methods used to identify and assess a sample of hotspots in the Tidal Back River watershed.

4.3.1 Assessment Protocol

Because there are numerous operations in the Tidal Back River watershed that qualify as stormwater hotspots, individual sites were not preselected in the office. Instead, commercial/industrial areas within the watershed were identified using GIS tax parcel information, land use data, NPDES locations and aerial photographs in the office. Commercial/industrial areas were depicted on base maps for field use and included clustered urban areas and distinct or larger hotspot type operations. During the uplands survey, these commercial/industrial areas were briefly explored for hotspot potential. Sites were selected for formal investigation based on several factors. One objective of the HSIs was to examine a variety of hotspots operations and select sites to represent common types of hotspots found in the Tidal Back River watershed. HSIs were also focused on unregulated hotspots since access to regulated hotspots was often limited (e.g., private marinas, secured manufacturing plants, etc.) and because regulated hotspots are previously documented/known pollutant sources. Regulated hotspots are already subject to NPDES permit regulations which normally require strict effluent concentration limits and periodic monitoring. Obvious sources of pollution observed during both the uplands and stream assessments were revisited for hotspot potential. Several problem areas identified by community members were also scouted for hotspot potential.

Unique ID numbers were assigned to HSIs using the classification scheme "HSI_E_100", where 'E' denotes the Tidal Back River watershed and the first number corresponds to a specific subwatershed. Subwatersheds were assigned the following unique numbers for the purposes of HSIs, ISIs, and PAAs (the subwatershed numbering scheme reflects the order in which the uplands survey was conducted): Deep Creek (1); Back River-G (2); Muddy Gut (3); Duck Creek (4, 6); Longs Creek (5); Bread and Cheese (7); Back River-A (8); Greenhill Cove (9); and Lynch Point Cove (10). Hotspot sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, HSIs in Bread and Cheese would be identified as 700, 701, 702, etc.

While hotspots have unique operations, drainage systems, and pollutant-related risks, stormwater quality problems can be characterized and evaluated by operations and activities common to most hotspots. Per the USSR manual, the HSI involved an evaluation of six common operations at each potential hotspot: vehicle operations, outdoor materials, waste management, physical plant, turf/landscaping, and stormwater infrastructure. The field team walked the entire property of each potential hotspot selected for an HSI to determine water quality impacts and restoration opportunities. These six categories were used to standardize the HSI process and be able to prioritize potential restoration efforts. Parameters evaluated within each operation category are described briefly below.

Vehicle Operations

Vehicle operations include maintenance, repair, recycling, fueling, washing or long-term parking. The presence of any of these activities was noted for each site since they can be a major source of metals, oil and grease, and hydrocarbons. Outdoor activities including vehicle storage, repair, fueling, and washing were also noted as potential pollution sources. Connections between vehicle operations and the storm drain system are the main focus of this category. The following were noted during the HSI as potential pollution sources: vehicle spills/leakage, lack of runoff diversion methods from storage/repair areas, directly connected fueling areas, and direct discharges to the storm drain from car washing.

Outdoor Materials

Stormwater quality issues results from improper handling or storage of outdoor materials at hotspots. Locations where materials were loaded or unloaded were examined to see if materials were uncovered and draining to a storm drain inlet. Storage areas were also evaluated for types of materials stored outdoors and their potential for entering the storm drain system. Uncovered materials and stained storage areas were used as indicators of poor outdoor storage practices and potential pollution sources. The field team also looked for improperly labeled storage containers, lack of secondary containment for liquids, and whether the storage area was directly or indirectly connected to the storm drain system. If any of these were observed, they were marked as potential pollution sources.

Waste Management

Every hotspot generates waste as a result of daily operations which can be potentially hazardous or source of stormwater pollution depending on the type of waste and how it is stored. The field team noted the type of waste generated (e.g., hazardous, garbage, etc.) and the condition of dumpsters. Dumpsters with no cover or open lids, with leaks, damaged/in poor condition, and/or overflowing were noted as potential pollution sources. Dumpsters located near storm drain inlets or lacking runoff diversion methods were also recorded as potential pollution sources.

Physical Plant

Common physical plant practices include cleaning, maintaining, or repairing the building, outdoor work areas, and parking lots. These activities can be a source of sediment, nutrients, paints, and solvents in stormwater runoff. For each hotspot, the condition of the building itself was evaluated. Stained, dirty, or damaged buildings were noted as potential pollution sources as well as staining or discoloration around the building which is evidence that maintenance activities (e.g., painting, power-washing, resealing, etc.) discharge to storm drains. Similarly, parking lots that were stained, dirty, breaking up, and/or impervious were recorded as potential pollution sources. Downspouts connected to impervious surfaces or the storm drain system were also recorded as pollution sources at a hotspot site. A stain leading to storm drains denoted poor cleaning practices (e.g., for construction activities).

Turf/Landscaping

Ground maintenance activities for turf/landscaped areas were also evaluated at hotspot sites. High turf management and improper irrigation practices were noted since they are potential pollution sources of nutrients, fertilizer, and pesticides. The field team also determined whether landscaped areas drained directly to storm drains or if organics (leaves, grass) accumulated on impervious surfaces. More than 20 percent of bare soil in turf/landscaped areas was flagged as a sediment pollution source.

Stormwater Infrastructure

If stormwater treatment practices were not present, this was flagged as a potential pollution source. Private storm drains were also evaluated for pollution potential. Storm drains with considerable amounts of sediment, organics, and/or trash were identified as potential pollution sources.

For each operation on the HSI field form, there is an observed pollution source box which was checked when there was clear evidence of pollution problems at the time of the investigation. One example was observed at a commercial shopping center while conducting an SCA in Deep Creek. Trash was spilling over the edges of the dumpster and directly into the local stream while the trash was being compacted. This site was revisited for an HSI and marked as an observed pollution source for waste management operations. After walking the entire property and evaluating hotspot operations, one or more of the follow-up actions listed below were recommended based on initial field observations:

- Refer for immediate enforcement

- Follow-up on-site inspection
- Test for illicit discharge
- Future education effort
- On-site non-residential retrofit

4.3.2 Summary of Sites Investigated

A total of 10 hotspot candidates were investigated in the Tidal Back River watershed. Most of the sites (8 out of 10) were commercial establishments with one transport-related site. The remaining site was a private residence (classified as other) and was investigated as a potential hotspot because heavy machinery and construction equipment were being stored immediately adjacent to a section of Duck Creek which was discovered during the SCA.

The hotspot candidates included as part of the Tidal Back River watershed uplands survey are listed in Table 4-10 including site ID, facility name, and subwatershed. Locations and initial hotspot status designations are shown in Figure 4-11. As shown in Table 4-10, 2 hotpots were investigated in Deep Creek, 3 in Duck Creek, and 5 in Bread and Cheese. As mentioned previously, hotspot candidates represent areas where urban development/commercial uses are concentrated and are intended to represent common types of hotspot operations located throughout the watershed. While based on this sample assessment, the overall watershed strategy should also encompass all hotspot operations occurring in the watershed.

Table 4-10: Summary of Hotspot Sites Investigated in Tidal Back River

Site_ID	Name	Type	Subwatershed
HSI_E_100	Village Thrift Store	Commercial	Deep Creek
HSI_E_101	GCR Tire Center	Commercial (auto-related)	Deep Creek
HSI_E_400	Auto Zone	Commercial (auto-related)	Duck Creek
HSI_E_401	End of Franklin Avenue	Other	Duck Creek
HSI_E_600	Essex Park & Ride	Transport-related	Duck Creek
HSI_E_700	Merritt Manor Shopping Center	Commercial	Bread & Cheese
HSI_E_701	AMF Bowling/Rita's	Commercial	Bread & Cheese
HSI_E_703	Plaza Flea Market	Commercial	Bread & Cheese
HSI_E_704	Walmart/North Point Plaza	Commercial	Bread & Cheese
HSI_E_705	Poor Boys Garden & Hearth/Rainbow Car Wash	Commercial (garden center)	Bread & Cheese

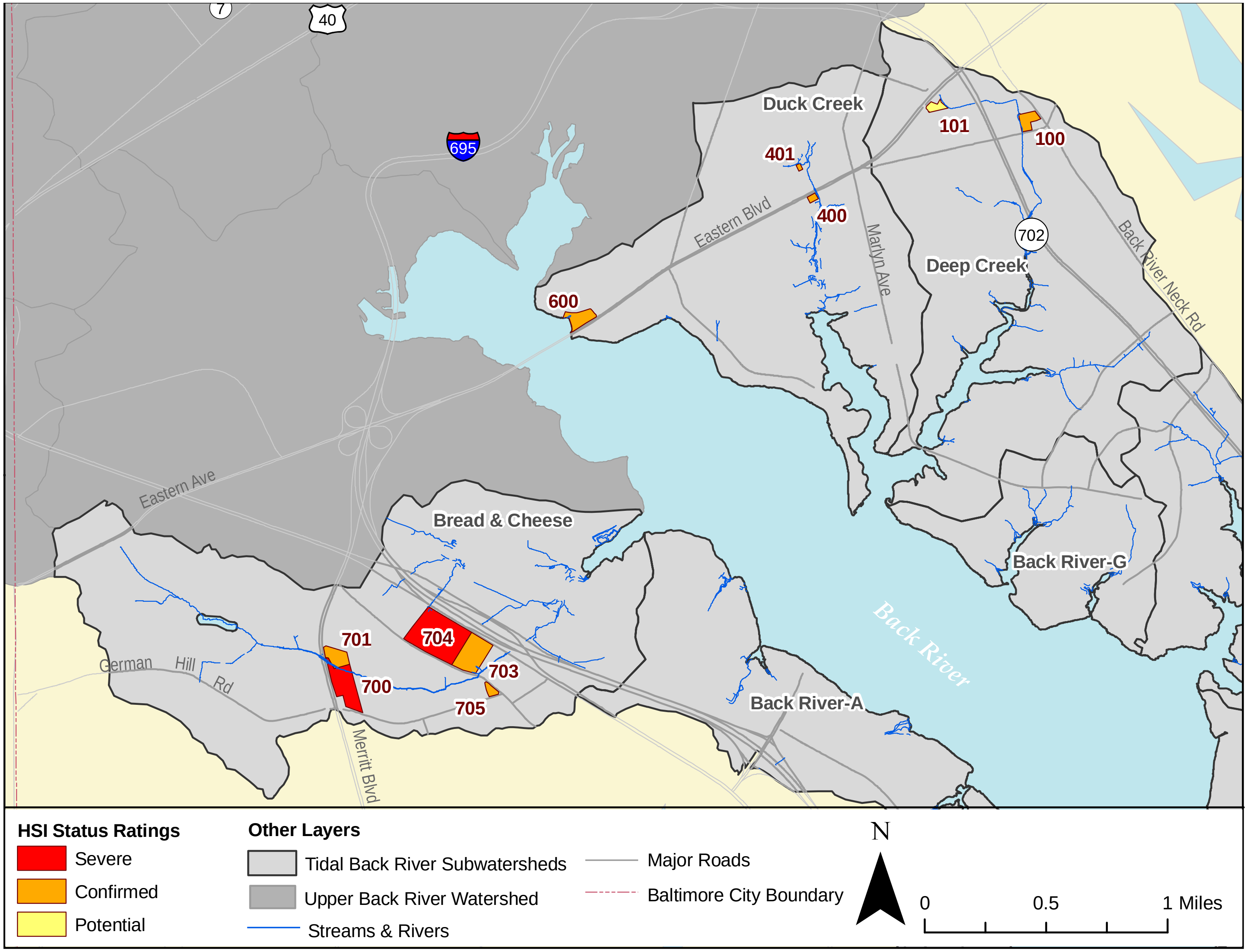


Figure 4-11: Locations of HSIs in Tidal Back River

4.3.3 General Findings

A summary of HSI results is presented in Appendix C including hotspot status, category, pollution sources, and comments regarding hotspot observations. Waste management and stormwater infrastructure (i.e., lack of stormwater management and/or condition of storm drains) were the most common operations contributing to hotspot stormwater pollution among this sample of hotspot candidates. Vehicle operations and outdoor materials storage were also common pollutant sources at investigated hotspots. Physical plant operations were marked as pollution sources for three sites. None of the sites were cited as pollution sources with respect to turf/landscaping operations. A brief description of the various hotspot categories assessed and general findings are provided below. This includes a description of how the pollution potential for specific sites can be ranked within a specific category.

Commercial

There are several commercial areas within the watershed, each with unique operations and pollution sources. Commercial hotspots were divided into three subcategories based on characteristic operations and pollution sources: auto-related; shopping centers; and nursery/garden centers. Each of these is described below.

<u>Auto-related</u>

There are several auto-related commercial establishments throughout the Tidal Back River watershed including auto repair shops, car dealerships, sales (e.g., car parts, accessories), tire service centers, gas stations, and car washes. The typical sources of stormwater pollution from this category of hotspots include vehicle, outdoor materials, physical plant, and waste management operations. Vehicle operations generally include repair, fueling, washing, and storing. Any of these activities can contribute potentially hazardous pollution to the storm drain system if proper housekeeping is not performed or if impervious surfaces lack diversions or treatment for stormwater runoff. In some cases, materials such as tires are stored outdoors. If materials are uncovered and stored on an impervious surface, there is potential for any vehicle-related pollutants attached to the materials to be washed off during a storm event into the stream or storm drain system (see Figure 4-12, left). It is also common for impervious surfaces (parking lots) at these type of hotspots to be stained as a result of vehicle operations or outdoor material storage which can also result in pollutants being transported by stormwater runoff (see Figure 4-12, right). The main recommended action for these types of operations is to include in future education efforts explaining proper storage of outdoor materials (covered, store on pallets not directly on pavement), ensure adequate buffer or diversion methods for stream/storm drain system, and incorporate treatment of stormwater runoff where possible.

All commercial operations generate waste and auto-related enterprises have potential to generate hazardous pollutants that can enter the stream or storm drain system. For example, at a sales establishment for car parts and accessories assessed, trash from the store was observed around the site and along the fence separating the nearby stream from the property (see Figure 4-13). This included an assortment of trash such as paper and plastic bottles with potentially hazardous liquid remains (antifreeze, oil, etc.) Again, future education could help address waste management related efforts. This may include proper waste management operations such as closing dumpster lids, creating runoff diversion between dumpsters and stream/storm drains, proper disposal of hazardous materials, and providing more trash receptacles in the parking area for clients. It may also involve educating clients about the hotspot and harmful effects of trash getting into the stream (community clean-up).

Figure 4-12: Examples of Potential Pollution Sources at Commercial (auto-related) Hotspots

Figure 4-13: Examples of Potential Pollution Sources from Waste Management Operations

<u>Shopping Centers</u>

There are several commercial shopping center areas within the watershed, each with unique operations and pollution sources. However, waste management and physical plant operations are common sources of pollutants from commercial hotspots. Dumpsters are often located on impervious surfaces at shopping centers and if in poor condition, staining or leaks can contribute pollutants directly into the storm drain system or nearby stream. There is also potential for wind or rain to carry trash from uncovered or overflowing dumpsters to the storm drain or stream system (see Figure 4-14). In one case, curb cuts allowed stormwater runoff from the impervious area behind a shopping area where dumpsters are stored to enter directly into Bread and Cheese Creek. Figure 4-15 shows an example of staining around a dumpster leading to the nearby stream corridor. During the stream assessment, the field team observed trash from dumpster compaction overflowing directly into the stream corridor. This is another example of potential for waste management operations education.

Figure 4-14: Examples of Overflowing Dumpsters and Curb Cuts Leading to Stream

Figure 4-15: Potential Pollution Source from Stained Parking Lot/Leaking Dumpster

Commercial areas sometimes have outdoor shopping areas where materials are stored outside. Similar to the discussion above, if materials are uncovered and on impervious surfaces, runoff from these areas can go directly into the storm drain system along with certain pollutants depending on the type of materials. For example, Figure 4-16 shows an outdoor pool display leaking/spraying water onto an adjacent impervious surfaces. This discharge may contain chemicals such as chlorine which can end up in the storm drains or streams. The left photo in Figure 4-17 shows a commercial shopping area where improperly labeled drums were stored outdoors on pavement and sideways. This has potential for potentially hazardous pollutants to leak into the adjacent stream. The photo on the right in Figure 4-17 shows an outdoor garden center. While the outdoor garden center was covered, runoff from non-target irrigation practices was observed on the adjacent sidewalk indicating lack of diversion methods for storm drain inlets.

Figure 4-16: Runoff from Outdoor Material Areas at Commercial Hotspots

Figure 4-17: Potential Pollution Sources at Commercial Hotspots

Diversions to prevent stormwater runoff and trash from discharging directly into the stream or storm drains are one recommended follow-up action for commercial hotpots. Another is to educate store owners about proper waste management and outdoor material storage techniques and conduct follow-up site inspections to enforce these measures. Stormwater management practices should be implemented where possible to treat runoff from the large impervious surfaces often found at commercial shopping centers.

Nursery/Garden Centers

There are some nurseries and garden centers located within the Tidal Back River watershed. Proper storage of outdoor materials such as plants, topsoil, and fertilizers is important to prevent nutrients and other pollutants from entering the storm drain system. Non-target irrigation and draining of landscaped areas to storm drains may also be a potential pollution source at these hotspots. These sites are recommended for follow-up site inspections and future education efforts related to outdoor material storage and maintenance of landscaped areas.

Pollution potential from commercial hotspots including auto-related, shopping centers, and nurseries/garden centers can be ranked as high, medium or low based on the following example criteria:

- *High pollution potential*: Staining of impervious surfaces leading to storm drain inlets or stream; dumpsters in poor condition (leaking, overflowing, uncovered, next to storm drain or stream without diversion); improper disposal of hazardous materials or wash water; uncovered repair/fueling areas or outdoor materials storage

- *Low pollution potential:* Proper disposal methods; good housekeeping (well maintained parking lot, waste management); stormwater management practices

Transport-Related

Transport-related hotpots generally include large impervious areas and significant amount of vehicle operations. They can also include waste management operations. An example of a transport-related hotspot in the Tidal Back River watershed was a park and ride facility. These areas can be potential sources of trash/dumping. They can also be sources of potentially hazardous pollutants such as oil and grease from leaking vehicles and stained parking lot surfaces. These sites may be good candidates for stormwater retrofits to treat at least a portion of the runoff from impervious surfaces before reaching the storm drain network. Adding more trash receptacles where necessary and future education efforts such as incorporating trash campaign signs are also recommended.

Pollution potential from transport-related hotspots can be ranked as high, medium or low based on the following example criteria:

- *High pollution potential:* Staining of impervious surfaces leading to storm drain inlets or stream; dumpsters in poor condition (leaking, overflowing, uncovered, next to storm drain or stream without diversion)

- *Low pollution potential:* Proper disposal methods; good housekeeping (well maintained parking lot, waste management); stormwater management practices

Other (Private Residence/Residential Business)

In various parts of the watershed, the field team observed storage of construction-related materials/equipment adjacent to stream corridors and wetland areas. This was mostly observed in residential areas. Stormwater runoff from these areas would be discharged directly to the stream and potentially carrying pollutants such as metals, oil and grease, and other harmful chemicals. Storage containers in poor condition (e.g., rusting) and improperly labeled were also noted. These hotspots are recommended follow-up inspection and future education effort. A community-based education campaign may be appropriate related to adequate stream buffer and diversion methods.

Pollution potential from these types of hotspots can be ranked as high, medium or low based on the following example criteria:

- *High pollution potential:* Potentially hazardous materials stored outside, uncovered and near streams without a buffer (e.g., construction materials, heavy machinery)

- *Low pollution potential:* Properly stored and maintained materials (covered, secondary containment for liquid materials); safe distance from stream corridor; vegetated or forested buffer between stream and property

Marinas

While specific marinas were not investigated as part of the HSI since many have individual NPDES permits, there are five located in the Tidal Back River watershed. Marinas have similar operations that qualify as hotspot activities and are important to consider since stormwater runoff would likely drain directly to the Tidal Back River. For example, boats are maintained, stored, repaired, washed and fueled at marinas. All of these activities have the potential to contribute pollutants to the watershed. Fueling and repair areas should be covered and located a safe distance from the river or storm drain inlets with diversion methods implemented as necessary. If boats are washed while in the river, environmentally friendly products should be utilized to prevent harmful chemicals from being washed off into the river. Regular maintenance and monitoring of boat conditions is important to ensure that boats are not leaking harmful pollutants directly into the river. Black flies and midges have been reported by several community members as an increasing problem in the Tidal Back River watershed. Some marina and waterfront property owners have responded by regularly spraying insecticides along waterfront and dock areas. These can contain harmful pollutants which will go directly into the river when sprayed in these areas. Environmental education efforts related to responsible and proper marina operations would help marina owners and community users. Impervious parking areas are often sloped toward the shoreline so that runoff goes directly into the river. Stormwater treatment practices should be implemented as feasible such as living shorelines to capture and treat some of this runoff before discharging into the river. Another possible stormwater treatment method is to incorporate grass filter strips along bulkheads at marinas. In addition, marina operators have the opportunity to be recognized and promoted by the Maryland Clean Marina Initiative. This program was developed by DNR as an alternative to additional regulations on the marina industry. Marinas that meet legal requirements and voluntarily adopt pollution prevention practices are recognized and promoted by Maryland DNR through the Clean Marina Initiative. Out of the five marinas in the Tidal Back River watershed, three are certified Maryland Clean Marinas in the Tidal Back River Riverside watershed including

Riverside Marine, Weaver's Marine Service, and West Shore Yacht Center. More information on this program can be found here: http://www.dnr.state.md.us/boating/cleanmarina/

Pollution potential from marinas can be ranked as high, medium or low based on the following example criteria:

- *High pollution potential*: Poorly maintained or completed paved parking areas that discharge directly to water body; uncovered fueling/repair areas without diversion methods; boat washing directly in water; spraying of harmful insecticides

- *Low pollution potential:* Well maintained parking areas (nicely graded gravel) or impervious area with living shoreline to treat runoff; covered fueling/washing/repair areas with proper diversion methods

4.4 Institutional Site Investigate (ISI)

The USSR manual does not treat institutional sites as a separate component of the uplands survey; instead, institutions can be assessed using HSI protocols. Consistent with the Upper Back River study, a modified version of the HSI field form was used to assess institutional sites since HSI protocols do not exactly match conditions encountered on institutional properties and because institutional areas make up nearly 5 percent of the watershed area. The ISI method was first developed and implemented for the Upper Back River study and was also used for the Tidal Back River watershed. Institutions surveyed as part of this study include the following types of community-based facilities: schools, cemeteries, faith-based facilities, community centers, municipal facilities (e.g, fire and rescue stations), and care centers (e.g., nursing homes). The following subsections describe the methods used to identify and evaluate pollution sources and restoration potential at institutional facilities.

4.4.1 Assessment Protocol

Institutional properties were identified in the office prior to conducting the field assessment using GIS tax parcel information, land use data, aerial photographs, and an ADC map. These were shown and labeled on maps created for NSAs and on larger base maps showing the entire watershed. Institutions were surveyed as encountered in the field during NSA surveys using these maps and list of institutions as guidance. Unique ID numbers were assigned to ISIs using the classification scheme "ISI_E_100", where 'E' denotes the Tidal Back River watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the following unique numbers for the purposes of HSIs, ISIs, and PAAs: Deep Creek (1); Back River-G (2); Muddy Gut (3); Duck Creek (4, 6); Longs Creek (5); Bread and Cheese (7); Back River-A (8); Greenhill Cove (9); and Lynch Pt Cove (10). Institutional sites were numbered sequentially in the ordered they were surveyed within a particular subwatershed. For example, ISIs in Bread and Cheese would be identified as 700, 701, 702, etc.

The entire property of an institutional site was walked by the field team to collect necessary data and take photographs. Basic information was filled out first including type of institution, address and ownership (public or private). Ownership is important because different approaches may be used to contact private versus public institutions. For example, a message may be received differently coming from the government as opposed to a non-profit group. Strategies for individual institutions will incorporate these different approaches. The ISI field form includes many of the pollution source categories used on the HSI form. Some of the restoration opportunities and recommended actions from the NSAs and PAAs are also incorporated into the ISI. The focus of ISIs is to identify potential restoration opportunities, educate the community and provide water quality benefits. The information collected for each of the pollution source and restoration categories are briefly described below.

Tree Planting

Potential tree planting locations at an ISI site were marked on aerial photographs while walking the property. After walking the entire site, the total number of trees that could be planted at the site was estimated based on a 15- to 20-foot spacing between trees. More accurate numbers can be determined during the post-fieldwork desktop analysis after restoration opportunities have been selected and prioritized.

Exterior

The exterior category is similar to the physical plant category in the HSI, except it also includes restoration opportunities. The condition of the building(s) and parking lot(s) were noted. Stained, dirty, damaged/breaking up surfaces were noted as potential pollution sources for both of these components. If no stormwater management was provided for impervious parking areas, this was also considered as a potential pollution source. Exterior storm drain inlets were inspected for evidence of maintenance or wash water dumping and poor erosion/sediment control, cleaning, or material storage practices for construction activities. Any observations of staining, discoloration, or mop threads around a storm drain inlet indicated a potential pollution source as a result of these activities. Building downspouts that were directly connected to the storm drain system or indirectly connected to impervious surfaces were also recorded as potential pollution sources.

Potential restoration opportunities evaluated in the exterior category included impervious cover removal and downspout disconnection. Locations where excess impervious cover could be removed were marked on aerial field maps. Examples include unused or underutilized parking areas and abandoned athletic courts/foot paths.

Waste Management

Every institution generates waste as a result of daily operations but unlike hotspots, it is typically just garbage. The field team noted the type of waste generated (e.g., hazardous, garbage, etc.) and the condition of dumpsters. Dumpsters with no cover or open lids, with leaks, damaged/in poor condition, and/or overflowing were noted as potential pollution sources. The field team also observed whether trash was present that could leave the site with wind or rain. Dumpsters located near storm drain inlets or lacking runoff diversion methods were also recorded as potential pollution sources.

Vehicle Operations

Most institutions did not have vehicle operations but a few (including churches and care facilities) did have buses on-site. Vehicle operations include maintenance, repair, recycling, fueling, washing or long-term parking. The presence of any of these activities was noted for each site since they can be a source of metals, oil and grease, and hydrocarbons. For the most part, it appeared that institutions likely only stored and washed vehicles on-site. Outdoor activities including vehicle storage, repair, fueling, and washing were also noted as potential pollution sources.

Outdoor Materials

Materials such as mulch piles, storage drums, and de-icing salt are sometimes stored on institution grounds. Locations where materials were loaded or unloaded were examined to see if materials were uncovered and draining to a storm drain inlet. Storage areas were also evaluated for types of materials stored outdoors and their potential for entering the storm drain system. Uncovered materials and stained storage areas were used as indicators of poor outdoor storage practices and potential pollution sources.

Turf/Landscaping

The percentage of forest canopy, turf grass, landscaping, and bare soil covering the pervious area of a site was recorded on the field form. Sites with more than 20 percent of bare soil were noted as a potential source of sediment pollution. Ground maintenance activities for turf/landscaped areas were also evaluated. High turf management and improper irrigation practices (non-target/over-watering) were noted since they are potential pollution sources of nutrients, fertilizer, and pesticides. The field team also determined whether landscaped areas drained directly to storm drains or if organics (leaves, grass) accumulated on impervious surfaces. Evidence of buffer encroachment and whether buffer was adequately planted was also recorded for evaluating restoration potential.

Stormwater Infrastructure

The field team checked whether storm drains were marked and whether stormwater treatment practices were present. These were evaluated for potential pollution sources and restoration potential.

After walking the entire property and evaluating the categories discussed above, one or more of the follow-up actions listed below were recommended based on initial field observations:

- Storm drain marking
- Tree planting
- Downspout disconnection
- Stormwater retrofit
- Education
- Impervious cover removal
- Pervious area restoration
- Stream buffer improvement
- Trash management

4.4.2 Summary of Sites Investigated

A total of 27 institutions were assessed throughout the Tidal Back River watershed. The number and type of institutions assessed within each subwatershed is summarized in Table 4-11. Note that Deep Creek Middle School overlaps two subwatersheds: Deep Creek and Back River-G. For this analysis it was counted toward Deep Creek since the majority of the area falls within this subwatershed. Similarly, Sparrows Point Jr. and Sr. High School encompasses portions of Lynch Pt Cove and Back River-F. Since the majority of the area falls within Lynch Pt Cove, it was counted toward this subwatershed for analysis purposes.

Table 4-11: Types of Institutions Assessed by Subwatershed

Subwatershed	Faith-based	Cemetery	Public School	Municipal Facility	Community Center	Care Center	Totals
Back River-A	-	-	-	-	-	-	0
Back River-F	-	-	-	-	-	-	0
Back River-G	-	-	-	-	-	-	0
Bread & Cheese	3	2	2	-	-	2	9
Deep Creek	-	-	4	-	-	-	4
Duck Creek	2	-	2	2	-	1	7
Greenhill Cove	-	-	-		1	1	2
Longs Creek	-	-	-	1	-	-	1
Lynch Pt Cove	-	-	2	-	-	-	2
Muddy Gut	-	-	-	1	1	-	2
Totals	***5***	***2***	***10***	***4***	***2***	***4***	***27***

Figure 4-18 shows the distribution of the various types of institutions assessed throughout the watershed.

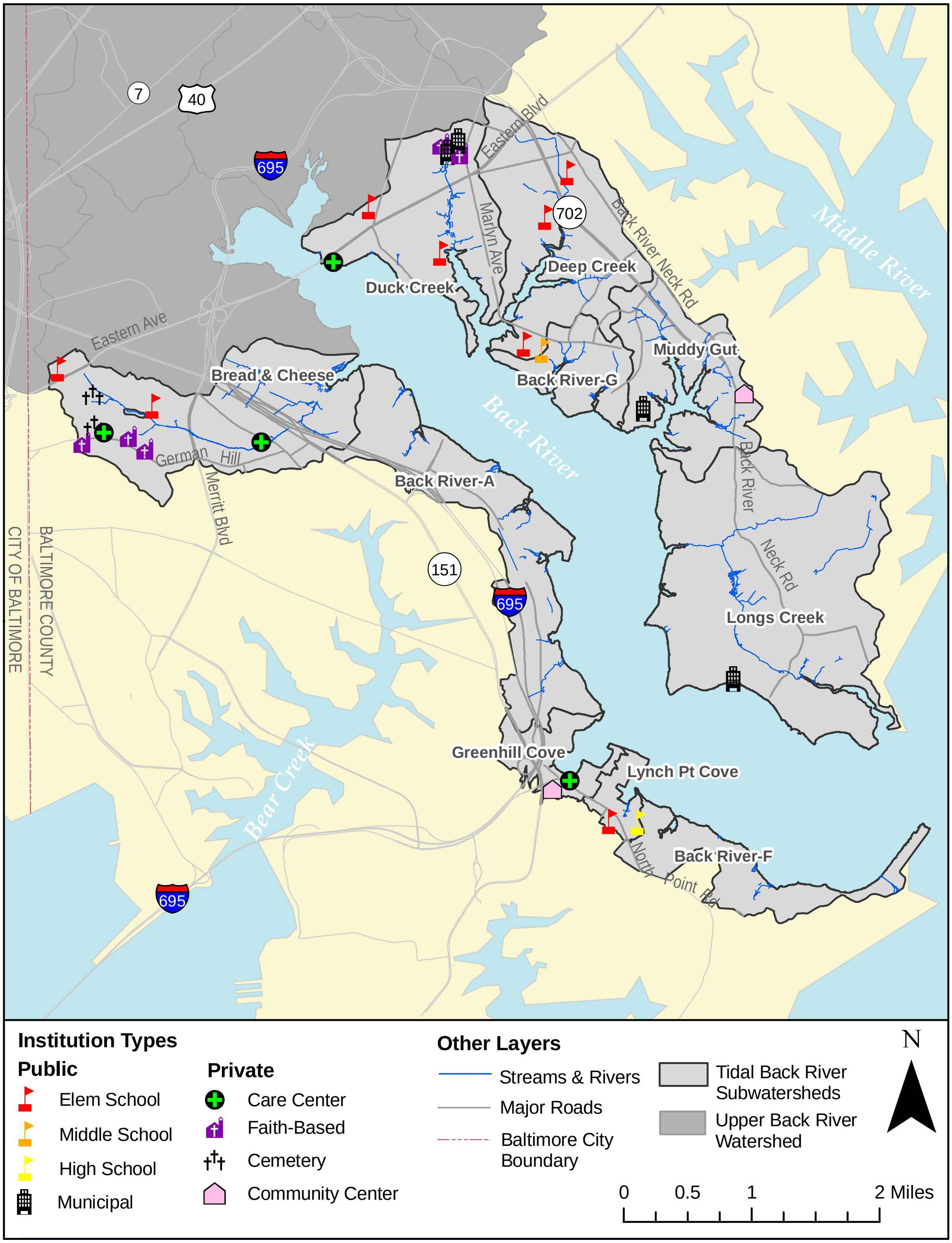


Figure 4-18: ISI Locations in Tidal Back River

4.4.3 General Findings

The number of the different types of recommended actions for ISIs is summarized in Table 4-12 by subwatershed.

Table 4-12: ISI Recommended Actions by Subwatershed

Subwatershed	# of Trees	SD Mark	Dwnspt Disconn	SW Retrofit	Educate	IC Removal	PA Restore	Buffer Imprvmt	Trash Mgmt
Back River-A	-	-	-	-	-	-	-	-	-
Back River-F	-	-	-	-	-	-	-	-	-
Back River-G	-	-	-	-	-	-	-	-	-
Bread & Cheese	395	6	2	5	-	2	-	2	2
Deep Creek	330	4	-	2	2	3	1	1	2
Duck Creek	340	5	2	5	1	2	-	2	2
Greenhill Cove	70	1	1	1	-	-	-	1	
Longs Creek	10	-	-	-	-	-	-	1	1
Lynch Pt Cove	150	2	-	1	-	-	-	-	
Muddy Gut	130	1	1	1	-	1	-	-	1
Totals	***1,425***	***19***	***6***	***15***	***3***	***8***	***1***	***7***	***8***

4.4.3.1 Tree Planting

It was estimated that a total of 1,425 trees could be planted at institutions located within 7 of the 10 subwatersheds comprising the Tidal Back River watershed. Trees were recommended for 25 out of the 27 institutions assessed. Tree planting sites were identified in the field and noted on field maps. The number of trees was estimated based on 15- to 20-foot spacing between trees. Table 4-12 represents planning level estimates which would be refined through follow-up site investigations if a site is selected for a restoration/improvement project(s). Like street trees, open space shade trees are not only an asset aesthetically but they also provide air and water quality improvement since they intercept precipitation with their leaves and can absorb precipitation and nutrients through their root systems. This infiltration of precipitation through leaves or the root systems slows flow input and provides some treatment before stormwater runoff reaches the stream system.

4.4.3.2 Stormwater Retrofits

As shown in the table above, the actions that were recommended the most were storm drain marking (19 sites) and stormwater retrofits (15 sites). Downspout disconnection was recommended for 1 public and 5 private institution sites where sufficient pervious area was available to redirect rooftop runoff. All of these actions present an opportunity to educate the community about the connection between the storm drain system and the Back River and how their actions can impact or improve water quality. Stormwater retrofits were recommended at 7 public institutions (6 schools, 1 police station) and 8 private facilities (4 faith-based, 2 community centers, 2 care centers). Stormwater retrofit opportunities included treating runoff from parking lots, inlet retrofits, and conversion of existing pervious area to wetlands. Sites where sufficient pervious area was available to treat a portion of the runoff from an impervious parking lot could implement infiltration/filtration practices such as trenches, basins, or bio-retention that incorporate vegetation and filter media through which storm water infiltrates for pollutant removal prior to groundwater recharge or entering the stream system. Two examples of stormwater retrofit recommendations for parking lots are shown in Figure 4-19. The photo on the left is the day care center at the Back River Community Center in Muddy Gut where a large pervious area is available adjacent to the impervious parking area. This is a good opportunity to address runoff from the parking and ponding that occurs in the adjacent ditch and also treat runoff before it enters the inlets in the grassed area. The photo on the right is a parking area at Sparrows Point Jr. and Sr. High School where runoff from the parking lot appears to be causing sediment buildup, erosion, and ponding.

Figure 4-19: Stormwater Retrofit Opportunities at ISI_E_300 (left) and ISI_E_1001 (right)

Inlet retrofits were recommended for sites where considerable ponding of water and/or bare soil was observed around storm drain inlets on the property. Planting native vegetation around these inlets would help stabilize soil, reduce sediment and flow input into the storm drain system, and provide some infiltration/treatment prior to runoff entering the ground and inlet. Figure 4-20 shows an example of a site recommended for this type of stormwater retrofit at Eastwood Center in Bread and Cheese.

Figure 4-20: Stormwater Retrofit Opportunities at ISI_E_700

Two schools have potential for wetland creation as a stormwater retrofit project. At Deep Creek Elementary School, a detention pond was observed next to a parking area that was grassed with some standing water and organic matter (see Figure 4-21). This site was noted as a good opportunity to retrofit the existing detention pond to a wetland area which would require less maintenance while providing more water quality benefits such as filtration of stormwater pollutants and wildlife habitat. Deep Creek Middle School appeared to have an unused field in the rear of the property suitable for a new wetland creation adjacent to a wooded stream buffer. This will be discussed further in the PAA section. Both of these sites represent an education opportunity for students and parents about stormwater retrofits and water quality benefits for Back River.

Figure 4-21: Stormwater Retrofit Opportunity for an Existing Detention Pond at ISI_E_101

4.4.3.3 Impervious Cover Removal

As discussed previously, impervious surfaces prevent precipitation from naturally infiltrating into the ground. Because runoff from impervious surfaces is often accelerated and concentrated when it reaches the storm drain and stream systems, it can lead to stream erosion, habitat destruction, and water pollution. Removing unused or underutilized impervious surfaces will help increase pervious area and the watershed's capacity for infiltrating and treating stormwater runoff.

Impervious cover removal was a recommended action for 8 out of the 27 institutions investigated. It was a recommended action for sites where a considerable impervious area appeared to be abandoned or underutilized such as parking lots, walking paths, and athletic courts. It also included areas where impervious cover was not absolutely necessary and appeared to be damaged (patched, breaking up) such as areas on the side or behind buildings, areas between building and parking lot, or areas between walkways/sidewalks. Of the 8 sites recommended for impervious cover removal, 6 are public schools. One of these was Mars Elementary School in Deep Creek shown in Figure 4-22. The photo on the left in Figure 4-22, shows an impervious area in the back of the school building that is breaking up and that has patchwork and grass growing through it. This indicates that the area is not used frequently or maintained and could potentially be removed to provide greater potential for runoff infiltration. Adjacent to the athletic field on the opposite side of the fence is a concrete-lined channel that could also be a potential opportunity for impervious cover removal and restoring the stream to a more natural system including buffer improvement.

Figure 4-22: Potential Impervious Cover Removal at ISI_E_100

4.4.3.4 Buffer Improvement

As discussed in the stream assessment section, forested buffer areas along streams are important for improving water quality and flood mitigation since they can reduce surface runoff, stabilize stream banks (root systems), shade streams, remove pollutants such as nutrients and sediment from runoff and provide habitat for various types of terrestrial and aquatic life including fish. Several institutions have streams that run through the property which is a potential opportunity for improving an inadequate stream buffer by introducing native vegetation and trees. Buffer improvement was identified as a recommended action for 7 out of the 27 institutions assessed including four public facilities (2 schools, 1 government property, 1 care center) and three private facilities (1 care center, 1 cemetery, and 1 faith-based). School properties typically represent a unique opportunity to combine restoration projects with education. One of the schools recommended for buffer improvement is Mars Elementary School in Deep Creek, shown previously in Figure 4-22. Two private facilities include stream sections identified as having inadequate stream buffers during the stream assessment. This includes the Oak Lawn Cemetery (see Figure 3-11) and Calvary Baptist (see Figure 3-20). At these sites, the stream runs through grassed areas on the property that likely have designated uses such as future grave sites or memorials for the cemetery and recreational fields for church parishioners. Buffer improvement options must be sensitive to property uses while striking a balance with protecting water resources. For example, a narrow buffer consisting of native vegetation might be an alternative to 50-foot wide wooded buffers on either side.

4.4.3.5 Trash Management

Trash management is an area in need of improvement throughout various areas of the watershed including institutions. A total of 8 institution sites (5 public, 3 private) were recommended for trash management action. Waste management education is recommended to address leaking dumpsters, open or uncovered dumpsters where trash can leave the site, and dumpster placement near storm drain inlets or streams. For example, uncovered, woven metal trash cans with no linings at the Oak Lawn Cemetery could be replaced by covered, solid waste receptacles to prevent trash from entering Bread and Cheese Creek which runs through the property. Several trash cans on this property were also noted as overflowing which indicates that waste management operations include more trash cans or more frequent trash pick-up. Dumping was also noted at multiple institutional areas including both litter and bulk items. One trash dumping problem was observed in the wildlife habitat project at Sandalwood Elementary School in Deep Creek. This may be addressed through various measures such as trash campaign, waste management education, improving bulk trash pick-up options, and community cleanups.

4.5 Pervious Area Assessment (PAA)

PAAs were conducted to identify and evaluate sites within the Tidal Back River watershed with potential for land reclamation, reforestation, or re-vegetation. The following subsections describe the methods used to identify and evaluate restoration potential of pervious areas.

4.5.1 Assessment Protocol

Large parcels of open land throughout the watershed were identified in the office prior to conducting the field assessment using GIS tax parcel information, land use data, aerial photographs, and an ADC map. These were shown and labeled on maps created for NSAs and on larger base maps showing the entire watershed. Upon visiting pervious areas identified in the office, a PAA was conducted if the field team verified the site as having sufficient space and potential for restoration. In some cases, sites were identified for PAAs while surveying other upland areas such as underutilized areas on institutional property and highway medians. The USSR manual recommends assessing publicly-owned pervious areas greater than two acres and privately-owned areas greater than five acres. Because many of the subwatersheds in Tidal Back River are highly urbanized, all sites greater than approximately 1 acre were considered. Unique ID numbers were assigned to PAAs using the classification scheme “PAA_E_100”, where ‘E’ denotes the Tidal Back River watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the following unique numbers for the purposes of HSIs, ISIs, and PAAs: Deep Creek (1); Back River-G (2); Muddy Gut (3); Duck Creek (4, 6); Longs Creek (5); Bread and Cheese (7); Back River-A (8); Greenhill Cove (9); and Lynch Pt Cove (10). Pervious areas were numbered sequentially in the ordered they were surveyed within a particular subwatershed. For example, PAAs in Bread and Cheese would be identified as 700, 701, 702, etc.

The entire property of a PAA site was walked by the field team to collect necessary data and take photographs. Basic information was filled out first including site accessibility, ownership, current management, and whether the site was connected to other pervious area. The area of the site was determined in the office using GIS tax parcel information and aerial photographs. Access to the site is important when considering its restoration potential. The field team checked whether access included foot, vehicle, and/or heavy equipment. A site that can only be accessed by foot may have less potential for restoration if they require greater disturbance or costs to restore (e.g., constructing an access road). Similar to institutions, ownership is important because different approaches may be used to contact private versus public institutions. Current management describes the current use of the land including the following: school, park, right-of-way, or vacant land. The presence and type of connected pervious area is also relevant to restoration potential of a pervious area. For example, if a site connects forested areas, reforesting the site would help to continue the forested corridor for wildlife habitat or stream buffer purposes. If a site is connected to an existing wetland area, it could be reforested to protect the wetland or revegetated to extend the wetland area. The other data categories assessed are briefly described below.

Current Vegetative Cover

The current vegetative cover was assessed including the proportion of the site covered by turf, herbaceous, bare soil, trees, or shrubs. Turf management status was also recorded including turf height, mowing frequency, and condition (e.g., thick, sparse, continuous, etc.) The presence of invasive species was noted including percent of site with invasive species and type.

Impacts

Impacts are assessed to indicate the amount of site preparation required to restore the pervious area. Possible impacts noted include soil compaction, erosion, trash and dumping, and poor vegetative health. Significant impacts from any of these factors will influence site preparation required, types of plants that can survive and success of an implemented project.

Reforestation Constraints

Similar to impacts, information regarding factors that may impede reforestation efforts was collected. The type of sun exposure was recorded as full sun, partial sun, or shade. The field team noted whether there was a nearby water source for supplemental water if necessary. Other constraints related to reforestation that were noted include overhead wires, underground utilities, pavement, and buildings. Private ownership was noted as a potential constraint.

Recommendations for pervious area restoration based on initial field observations included one or more of the following:

- Good candidate for natural regeneration
- May be reforested with minimal site preparation
- May be reforested with extensive site preparation
- Poor reforestation or regeneration site

4.5.2 Summary of Sites Investigated

A total of 9 pervious areas were assessed within the Tidal Back River watershed totaling 69.6 acres. The following number of PAAs were conducted according to subwatershed: 2 in Deep Creek, 1 Back River-G, 3 in Muddy Gut, 1 in Duck Creek, 1 in Bread and Cheese, and 1 in Back River-A. Parcel sizes ranged from 0.9 acres to 32.5 acres. Most sites assessed (7 out of 9) were less than 5 acres in size. All sites surveyed were considered as open pervious cover type. Figure 4-23 shows the location and size of PAAs within the watershed.

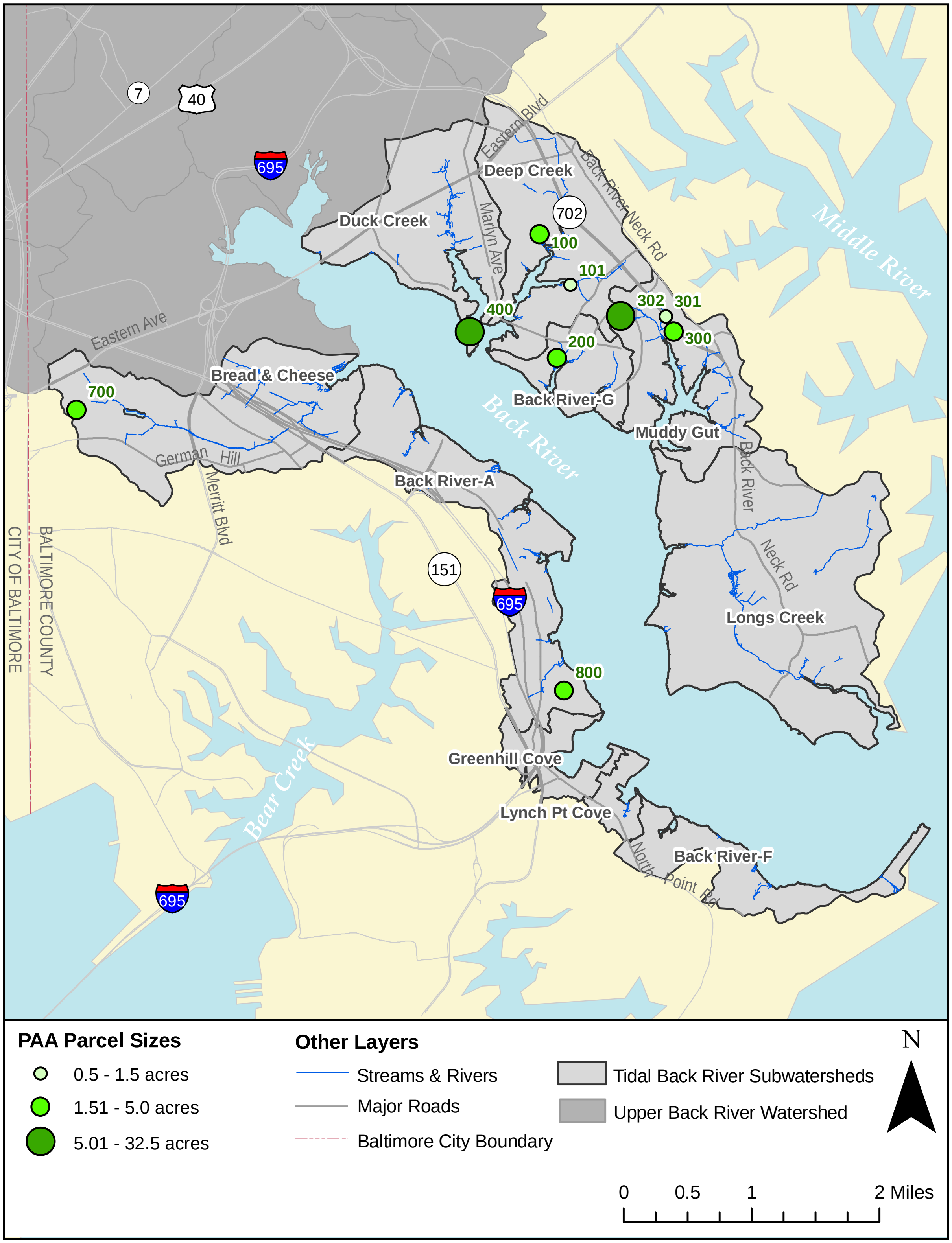


Figure 4-23: PAA Locations

4.5.3 General Findings

A summary of PAA results including parcel size, ownership, management, percent turf cover, and site preparation required for the sites assessed is provided in Table 4-13.

Table 4-13: Summary of PAA Results

Site ID	Name	Acres	Ownership	Management	% Turf	Site Prep
PAA_E_100	Martindale	3.20	Public	Park	85	Minimal
PAA_E_101	Fox Ridge	1.50	Public	Park	75	Minimal
PAA_E_200	Deep Creek Middle	2.60	Public	School	100	Minimal
PAA_E_300	Julio Bros.	3.60	Private	Vacant Land	0	Minimal
PAA_E_301	Rt 702	0.94	Public	ROW	100	Minimal
PAA_E_302	Daro Land Holding	32.50	Private	Vacant Land	10	Minimal
PAA_E_400	Cox's Point	18.50	Public	Park	50	Minimal
PAA_E_700	Harbor View	4.20	Public	Park	70	Minimal
PAA_E_800	Beachwood Estates	2.60	Public	Park	70	Minimal

The most likely candidates for successful pervious area restoration efforts are those on public lands with minimal site preparation required. Public sites are eligible for tree planting through DNR’s “Tree-mendous Maryland” program and are good opportunities for volunteer or community projects. Of the 9 sites surveyed, 7 are under public ownership and all were considered to require minimal site preparation. The 7 public pervious area sites assessed are briefly described below.

Martindale Park (Deep Creek)

Martindale Park is located at the end of Homberg Avenue in Deep Creek and is maintained by Baltimore County Parks and Recreation. The park is approximately 3.2 acres and consists mostly of turf cover (85%) with some existing trees. There is one maintained baseball field and another baseball field that appears to be no longer utilized. This site was recommended for reforestation with minimal site preparation to extend the existing forested buffer area between the park and Deep Creek based on initial field observations. This site receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment. Reforestation of a portion of the site would require verification that it would not interfere with the current use of the site and tree planting could be a potential community project.

Figure 4-24: Photo of PAA_E_100

Fox Ridge Park (Deep Creek)

Fox Ridge Park is located between Deep Creek and the alley behind Foxwood Lane. It is also maintained by Baltimore County Parks and Recreation and easily accessible by foot, vehicle, or heavy equipment. It is mostly covered by turf (75%) with some trees and a paved athletic court. This site was recommended for reforestation with minimal site preparation based on initial field observations. Since the site is only 1.5 acres, reforestation was recommended mostly to improve the forested buffer area along Deep Creek. The current use of the park will need to be evaluated during a follow-up visit if the site is selected for potential restoration to balance buffer improvement with pervious area available for recreation. This could also be a community tree planting project.

Figure 4-25: Photos of PAA_E_101

Deep Creek Middle School (Back River-G)

A PAA was conducted for an isolated pervious area between Deep Creek Middle School main building and Back River. It was considered to be a good candidate for natural regeneration and for reforestation within minimal site preparation. The site is approximately 2.6 acres with full sun exposure and 100 percent turf cover. This site was recommended because the open pervious area appeared to be an unused baseball field and was isolated from the rest of the school property by existing trees. Because the open pervious area is located so close to the Back River, it was also noted as having potential for wetland creation. This would connect the surrounding forested buffer area while providing increased wildlife habitat and water quality benefits as well as an education opportunity for the school. Reforestation and wetland planting using native plants would require less maintenance than current mowing operations. A follow-up site inspection would involve verifying that the field is no longer used by the school for recreational purposes and a closer look at invasive species noted at the edge of the adjacent forested buffer area.

Figure 4-26: Photos of PAA_E_200

Rt. 702 Median (Muddy Gut)

A PAA was conducted for the median on Southeast Boulevard (Rt. 702) between Hyde Park Road and Turkey Point Road, which is approximately 0.94 acres. The median is 100 percent turf cover with full sun exposure and easy access by foot, vehicle, and heavy equipment. This site was recommended for reforestation with minimal site preparation. Because this site is along a Maryland state route, it may be eligible for the State Highway Administration's (SHA) Partnership Planting Program. Through this program, SHA partners with local government and community organizations to beautify highways and improve the environment through projects such as streetscapes and reforestation plantings. A site is identified and submitted to SHA including an estimate of the number of volunteers and funds available to help with the project. When a site has been selected and meets approval from all parties, SHA provides a landscape design, landscape materials, and support for volunteers on the day of planting (or in some cases, will install the landscaping) for the project. Specific arrangements related to cost, labor, and maintenance vary and are determined on a project by project basis. Some organizations participate in the partnership program by helping with planting costs and/or by providing volunteers to do the work. SHA may also seek long-term support to maintain the project.

Providing volunteers to help plant trees or landscape materials provided by SHA would be a good opportunity for community involvement and education. More information regarding SHA's Partnership Program can be found here:
http://www.marylandroads.com/Index.aspx?PageId=321

Figure 4-27: Photos of PAA_E_301

Cox's Point Park (Duck Creek)

Cox's Point Park, located in Duck Creek at the end of Riverside Drive, is maintained by Baltimore County Parks and Recreation and is the largest public pervious site (~18.5 acres) assessed as part of this study. The pervious portion of the park was estimated as mostly turf cover (50%) and trees (35%) with some wetland plants, shrubs, and bare soil (15%). This site was recommended for reforestation with minimal site preparation mostly for stream buffer improvement purposes which needs to be balanced with park uses and public access to the river. Some trash and dumping was noted as an impact that may also influence pervious area restoration. Several areas were observed where there was bare soil, ponding, and where grass was not mowed as frequently as other turf areas. This indicates that these areas are not used for recreational purposes and where reforestation or planting could be enhanced. The field team also noted a potential storm water retrofit opportunity for one of the parking lot areas where practice such as bioretention would address bare soil and runoff prior to entering the Back River.

Figure 4-28: Potential Reforestation Areas at PAA_E_400

Figure 4-29: Potential Stormwater Retrofit Opportunity at PAA_E_400

Harbor View Park (Bread & Cheese)

Harbor View Park is located off of Woodrow Avenue in Bread and Cheese and is bordered by residential areas and Oak Lawn Cemetery. It is maintained by Baltimore County Parks and Recreation and is approximately 4.2 acres. The site is mostly turf cover (70%) with some trees (30%) and receives full sun exposure. It is easily accessible by foot, vehicle, or heavy equipment. The shape of the land at the park creates a natural grassed channel that leads to an inlet to the storm drain system. This site was recommended for reforestation with minimal site preparation since plantings would not interfere with use of the baseball field or basketball court areas and the limited flat pervious areas. The field team also noted an opportunity for stormwater retrofit to treat runoff from the small impervious parking area. This may involve filtering/filtration practices such as a bioretention area to treat runoff and address bare soil before entering the storm drain inlets on site.

Figure 4-30: Potential Reforestation Areas at PAA_E_700

Figure 4-31: Potential Stormwater Retrofit Opportunity at PAA_E_700

Beachwood Estates Park (Back River-A)

Beachwood Estates Park is located off of Greencove Circle in Back River-A and is easily accessible by foot, vehicle, or heavy equipment. It is maintained by Baltimore County Parks and Recreation and is approximately 2.6 acres. The site consists mostly of turf cover (70%) with some trees (15%) and a considerable amount of bare soil (15%) and receives full sun exposure. The site was recommended for reforestation with minimal site preparation. Erosion and backyards of private residences were noted as potential reforestation constraints. Some trees have been planted between private residences and the park; this buffer could be enhanced by planting additional trees while also stabilizing areas that appear to be prone to erosion.

Figure 4-32: Photos of PAA_E_800

CHAPTER 5: RESTORATION AND PRESERVATION OPTIONS

5.1 Introduction

This chapter presents an overview of the key management practice recommendations for the Tidal Back River watershed based on the information collected during both the office/desktop analysis and field assessments. The following restoration practices are recommended to address problem areas in the watershed and are discussed in the subsequent sections:

- Stream corridor restoration
- Tidal waters and shoreline preservation/enhancement
- Stormwater retrofits
- Dry weather discharge prevention
- Pervious area restoration
- Pollution prevention/source control education
- Municipal practices and programs.

5.2 Stream Corridor Restoration

Stream corridor restoration practices are used to enhance the appearance, stability, and aquatic function on urban stream corridors. These types of practices can range from simple stream clean-ups and localized bank stabilization to comprehensive repairs such as channel re-design and re-alignment. Stream restoration practices are often combined with stormwater retrofits and riparian management practices to meet subwatershed restoration objectives. Primary recommended practices for Tidal Back River stream corridors include buffer restoration, stream clean-ups, and stream repair.

5.2.1 Buffer Restoration

Forested buffers are linear wooded areas along rivers, stream and shorelines which help stabilize banks, prevent erosion, filter pollutants such as sediment and nutrients, and provide wildlife habitat. Several portions of the Tidal Back River stream system and shoreline have inadequate buffers as a result of human development activities. A significant amount of the watershed has been urbanized and as a result, the original forested stream buffer has been replaced by mowed lawn areas or impervious cover.

The main restoration strategy is to enhance/reforest impacted stream and shoreline buffers. This can be accomplished by a variety of methods including:

- Buffer planting with native vegetation
- Targeted education programs - Property owners, including private residences and institutions, need to learn the water quality benefits of buffers that are forested or planted

with native vegetation. Stream buffer signs are one way to remind residents of the importance of stream buffers. Educational programs can teach residents that by allowing their streams to have natural buffers can help preserve their property as well as provide water quality benefits. It also may help limit some of the trash dumping and yard waste observed in neighborhoods, along roadways, and in commercial areas

- Invasive species control – Invasive and non-native plant species such as English Ivy, Japanese Knotweed, and Multi-Flora Rose were identified in various portions of the watershed. This can be addressed through public education, training of County grounds maintenance staff, and developing a volunteer group dedicated to controlling invasive species in the watershed.

5.2.2 Stream Clean-ups

Trash dumping was a recurring issue observed during stream and uplands assessments. Stream clean-ups are a simple practice used to enhance the appearance of the stream corridor and shoreline by removing unsightly trash, litter, and debris. These are usually performed by volunteers and are one of the most effective methods for generating community awareness and involvement in watershed activities. Several stream clean-ups have already been conducted in the Tidal Back River watershed; however, they have been focused in the same general areas such as Bread and Cheese Creek. Public outreach tools should be used to encourage and inform residents about organizing stream clean-ups and support available from the County.

5.2.3 Stream Repair

Natural channel design techniques can be utilized to stabilize eroded, degraded stream banks and to protect infrastructure such as private property, buildings and utilities. Stabilizing the stream channel improves water quality by preventing eroded soils, and the pollutants contained in them, from entering the stream. In addition, protecting infrastructure such as sewer and storm drain pipes reduces and/or eliminates water quality impacts associated with leaking sewer pipes and manholes. Where conditions allow, reconnecting the stream channel to its floodplain provides additional water quality benefits. When considering stream repair, it is important to take into account what is occurring upstream in the watershed. The hydrology and stormwater management practices upstream of a restoration site will dictate the quantity and speed runoff will reach a site. In addition, the sediment supply of the upstream channel is also an important consideration during the design of stream restoration repairs.

5.3 Tidal Waters and Shoreline Preservation/Enhancement

The Tidal Back River watershed consists of tidal waters and shoreline areas that have numerous benefits and uses for recreation, wildlife habitat, aquatic life, and water quality. The main recommended strategies for preserving and enhancing tidal and shoreline resources include the following:

- Buffer improvement/preservation

- Navigation channels – Marking and maintaining navigation channels in Back River will help keep a balance between encouraging recreational boat use and submerged aquatic vegetation (SAV) growth. As noted previously, SAV is important for and a good indicator of water quality and habitat.

- Mudflat restoration – Community clean-ups of mudflat areas in the watershed have already taken place. Restoring these areas present good opportunities for wetland and SAV plantings which provide water quality benefits and habitat.

- Shoreline enhancement projects – site specific enhancement concepts were developed as part of DEPRM's Shoreline Feasibility Study for eight shoreline areas in the Tidal Back River watershed. Potential shoreline enhancement projects include the following:

    - North Point State Park: shoreline protection and ecological enhancement

    - Norris Farm Landfill: beneficial use of dredged material, beach nourishment

    - Back River WWTP: beneficial use of dredged material, marsh creation

    - Essex Sky Park: comprehensive shoreline protection, ecological enhancement, and beneficial use of dredged material

    - Rocky Point Park: shoreline protection and ecological enhancement of golf course and Longs Creek shoreline

5.4 Stormwater Retrofits

Stormwater retrofitting involves implementing stormwater Best Management Practices (BMPs) and/or treatment devices in existing developed areas where previous practices did not exist or were ineffective to help improve water quality. Stormwater retrofits improve water quality by capturing and treating runoff before it reaches receiving water bodies. Retrofits target specific objectives depending on BMP type including stormwater quality, soil stabilization, stormwater flow control, and stream restoration. Several considerations must be taken into account to select appropriate stormwater treatment measures such as space requirement, cost, and community acceptance. Based on initial field and desktop evaluations, the following stormwater retrofit categories are recommended for addressing water quality issues in the Tidal Back River watershed: conversion of existing detention ponds; parking lot/alley retrofits; impervious cover removal; downspout disconnection; and outfall retrofits. Each of these categories is described briefly in the sections below.

5.4.1 Detention Pond Conversion

Dry detention ponds are typically designed for flood control and have little or no pollutant removal capacity. These facilities have the greatest potential for conversion to an extended detention pond which is designed to capture and retain stormwater runoff to allow sediments and pollutants to settle out while also providing flood control if necessary. Two out of the four existing detention ponds assessed during the SWM facility survey were determined to have potential for conversion to an extended detention facility – one in Deep Creek off of Eyring Avenue and one in Back River-A off of North Point Road. An additional detention pond with potential for conversion to a wetland or extended detention facility was identified at Deep Creek Elementary School. All three facilities currently consist of a fenced in mowed, grassed area with an inlet(s). While open pervious area provides more filtration of stormwater runoff than impervious surfaces, an extended detention pond or wetland with more dense vegetation such as trees, shrubs, and/or native plants would provide even more water quality benefits and would require less maintenance.

5.4.2 Parking Lot/Alley Retrofits

The potential for installing new stormwater retrofits for treating runoff from existing developed areas is often limited by space availability. However, BMPs that require less space for treating runoff from portions of impervious surfaces can be an alternative to larger storage facilities such as wetlands and extended detention ponds. In areas where insufficient space is available for basin-scale retrofits, other infiltration/filtration practices such as bio-retention can be implemented. These types of practices incorporate vegetation and/or filter media through which stormwater infiltrates for pollutant removal prior to groundwater recharge. Bio-retention, for example, involves open space combined with vegetated areas where stormwater is temporarily stored and passed through vegetation and a filter bed of sand, organic matter, soil, or other suitable media. Filtered stormwater is collected and returned to the storm drain system or allowed to partially exfiltrate into soil. Several neighborhoods were identified as having open pervious areas with potential for incorporating bio-retention areas to treat a portion of stormwater runoff from multifamily parking lots or alleys. Many institutions were also identified as having sufficient open space for bio-retention areas to treat runoff from parking lots or as having potential to incorporate retrofits of inlets on a smaller scale. Another retrofit option for treating runoff from large impervious surfaces with limited open space is underground stormwater retention/infiltration systems. Stormwater retrofits would help address sediment and nutrient inputs to the stream system as well as standing water observed at several of these locations as a result of a lack of stormwater management measures.

5.4.3 Impervious Cover Removal

Impervious surfaces including roads, parking lots, roofs and other paved surfaces prevent precipitation from naturally seeping into the ground. Stormwater runoff from impervious surfaces is often concentrated, accelerated and discharged directly to the storm drain system or nearest stream. This can result in erosion, flooding, habitat destruction, and increased pollutant loads to receiving water bodies. Subwatersheds with high amounts of impervious cover are more likely to have more degraded stream systems and be significant contributors to water quality problems in a watershed than those that are less developed.

Unused or unmaintained impervious surfaces with the potential for removal were identified at several institutions, mostly on school properties. At sites where parking lots may be larger than necessary, portions of the impervious cover could be removed and converted to bio-retention areas for treating stormwater runoff from the remaining impervious surfaces. One site that may be considered for this option, for example, is the Essex Park and Ride. Some institutions may also have parking areas that are not frequently used (e.g., cemeteries) and could be suitable for conversion to permeable pavement which allows some infiltration of stormwater runoff while providing support for less frequent traffic/vehicle use. Several neighborhoods incorporated grass strips, gravel, or permeable pavers in private driveways which allows some infiltration of stormwater runoff. Completely paved driveways, however, were more common in the neighborhoods assessed during this study. Education and outreach tools could be used to inform residents of the water quality impacts associated with large impervious driveways or patios and options available for conversion to or incorporating more permeable surfaces.

Channelized sections of stream corridors were identified during the stream assessment and may be candidates for removal of existing concrete lining to restore streams to more natural systems. This would allow natural infiltration of stormwater and support pollutant removal prior to storm water discharge into receiving waters.

5.4.4 Downspout Disconnection

Most of the neighborhoods assessed in the Tidal Back River watershed were recommended for downspout disconnection. This is because downspouts were mostly directly connected to the storm drain system or indirectly connected, draining to impervious surfaces such as driveways, sidewalks, or the curb and gutter system. Disconnected downspouts allow rooftop runoff to infiltrate into the ground and enter streams through the groundwater system in a slower more natural fashion. This decreases flow to local streams during storm events and helps prevent erosion and reduce pollutants loads to streams. Many of the typical lots do not have sufficient room for rain gardens; however, redirecting downspouts to pervious areas such as yards or lawns or to rain barrels seems to be a viable option for most neighborhoods recommended for downspout disconnection.

Rain gardens are the most desirable option in terms of water quality because they consist of native plants that capture and treat runoff. This may be an option for multifamily neighborhoods like apartment complexes where there is several hundred square feet of open pervious area available down gradient from the downspout. Rain gardens may also be an option for disconnecting downspouts at institutional sites with sufficient space available. Redirecting downspouts to pervious areas or rain barrels is also an option for institutional sites.

5.4.5 Outfalls

Baltimore County's curb and gutter system consists of numerous inlets, pipes, and outfalls. While the curb and gutter system removes stormwater quickly from roadways, it often delivers increased runoff volumes and untreated pollutants to receiving water bodies. One way to address these potential water quality issues is to install proprietary BMPs at selected storm drain inlets. Various structural BMPs are commercially available and include catch basin inserts, water quality inlets, oil/grit separators, filtering devices and hydrodynamic devices. Proprietary BMPs are designed to address specific pollutants such as floatables and solid waste, nutrients, metals, sediment and oil/grease. Most are helpful for removing a portion of pollutants for pretreatment when used in conjunction with another BMP type such as an infiltration trench or a grassed swale for filtering pollutants upstream of an inlet. Some examples of propriety BMPs are described below:

- *Oil/Grit Separator:* Structural (proprietary) BMP that consists of three chambers: first removes material and debris; second separates oil, grease, and gasoline; and third provides safety relief in event of blockage. Requires hydrocarbons (organic compounds consisting of hydrogen and carbon) and frequent maintenance and disposal of trapped residuals.

- *Hydrodynamic Devices:* Sediment, oil and grease are removed through hydrodynamic separation which involves settlement of particles as flow circulates in a swirling path. One type of device uses centrifugal motion to remove litter, floatable debris and larger sediment particles from storm water runoff (e.g., CDS manufactured by Contech).

Another type removes sediment particles, oil and grease during low flow conditions where higher flows are diverted around the treatment chamber (e.g., Stormceptor and Baysavers). Floatable and settled debris that is collected in the treatment chamber of hydrodynamic devices should be removed regularly by a vacuum truck.

While proprietary devices can be costly, they are water improvement alternatives for areas where there is inadequate space for other stormwater management options. Inlets selected for proprietary devices can be prioritized based on the County's outfall screening program and the outfalls identified as potentially or moderately severe problems during the stream assessment.

Where space exists between and an outfall and the stream channel, other BMPs can be considered such as floodplain wetlands and energy dissipation devices. Floodplain wetlands can provide treatment of storm flows prior to entering the stream channel. Energy dissipation devices can reduce stream power and thus erosive forces of storm flows prior to entering the stream channel

5.5 Dry Weather Discharge Prevention

Discharge prevention targets dry weather flows that contain significant pollutant loads. Examples include illicit discharges, sewage overflows, or industrial and transportation spills. Dry weather discharges can be continuous, intermittent, or transitory. Resulting water quality problems can be extreme depending on the volume and type of discharge. For example, sewage discharges include bacteria and can directly affect public health while other discharges such as oil, chlorine, pesticides, and trace metals can be toxic to aquatic life. Dry weather discharge prevention focuses on four major sources that can occur in a subwatershed as described briefly below.

- ***Illicit Sewage Discharges:*** When septic systems fail or when sewer pipes are mistakenly or illegally connected to the storm drain pipe network, sewage can get into streams. Sometimes sewage is directly discharged to a stream or ditch without treatment or illegally dumped into the storm drain system from boats or RVs.

- ***Commercial and Industrial Illicit Discharges:*** Some businesses mistakenly or illegally dispose of liquid wastes that can adversely impact water quality into the storm drain system. Examples include hotspots where materials such as oil, paint, and solvents are improperly disposed, where business drains are directly connected to the storm drain system, or where untreated wash water or process water is dumped into the storm drain system.

- ***Industrial and Transport Spills:*** Pollutants can enter the storm drain system as a result of ruptured tanks, pipeline breaks, accidents/spills, or illegal dumping. These events are likely to occur in urban subwatersheds and may result in potentially hazardous materials reaching streams through the storm drain system.

- ***Failing Sewage Lines:*** Sewer lines often follow the stream corridor. If they leak, overflow, or break, sewage will be discharged directly into the stream. The frequency of failure depends on the age, condition, and capacity of the existing sanitary sewer system.

In addition to the County's outfall screening program, other discharge prevention measures can be implemented throughout the watershed. These can be simple activities that involve watershed volunteers and can increase community awareness about watershed issues. Examples of implementation projects include:

- Mark outfalls with potential problems and locations with known illicit discharges in the past. Unique identifiers would be used to facilitate locating and tracking suspicious discharges.

- Educate residents that live near outfalls with suspected problems about the Baltimore County 24-hour utilities emergency phone line (410-887-7415) for reporting suspicious discharges.

- Create and distribute illicit discharge fact sheets for homeowners and businesses and post online.

5.6 Pervious Area Restoration

Pervious areas offer a good opportunity for restoration in subwatersheds since they can be used to restore natural infiltration properties, enhance stream buffers, and provide wildlife habitat. These areas also present an opportunity for reforestation in the watershed which in the highest priority in terms of improving infiltration and recharge functions. Other techniques can also be used to improve natural functions including soil aeration, amendments, and establishing native plants and meadows. Sites prioritized for pervious area restoration should require minimal preparation for reforestation or regeneration with little evidence of soil compaction, invasive plant species, and trash/dumping. Parcels meeting these criteria are good candidates for follow-up investigations and landowner contact. Most of the pervious areas assessed were publicly owned. Several institutions assessed also had extensive opportunities for reforestation which would also require less ground maintenance and improve energy efficiency.

5.7 Pollution Prevention/Source Control Education

Residents and businesses engage in behaviors that can adversely impact water quality. Some of these behaviors observed during the assessment of neighborhoods, hotspots, and institutions in the watershed include over-fertilizing lawns, excessive use of pesticides, improper disposal/storage of potentially hazardous materials (e.g., household cleaners, paints, automotive fluid, etc.), and dumping into storm drains (e.g., wash water). Pollution prevention/source control education efforts should also target waste management activities in the watershed to address dumpsters located near storm drain inlets or streams without diversion methods, poor dumpster conditions (leaking, overflowing, and uncovered), and frequent occurrence of trash dumping throughout the watershed. Positive behaviors were also observed such as tree planting, disconnected downspouts, and picking up pet waste which can help improve water quality. A pollution prevention program can be designed to discourage negative behaviors and/or encourage positive behaviors. Either way, the goal is to deliver a specific message through targeted education to promote behavior changes. Local watershed organizations such as the Back River Restoration Committee (BRRC) can help influence these changes using pollution prevention education and outreach to teach citizens how to properly care for the watershed.

Pollution source control also refers to the management of hotspots. These are commercial, industrial, municipal, or transport-related operations in the watershed that tend to generate higher concentrations of stormwater pollutants and/or have a higher risk of spills, leaks, or illicit discharges. Pollution prevention practices can significantly reduce hotspot pollution problems. Local government agencies must adopt pollution prevention practices for their operations and lead by example. This should be followed by inspection and incentive-based educational efforts for privately operated sites with enforcement measures as a backstop. The ability to conduct such inspections and enforcement actions should be clearly articulated in local codes and ordinances and through education programs. As previously noted, some industrial/commercial sites are required to have NPDES permits for stormwater and/or wastewater discharges. While the County assists with the identification of these sites, MDE is responsible for regulating industrial/commercial sites that are required to have NPDES permits. Another potential program is to host workshops for local businesses that detail the permit requirements and how to prepare pollution prevention plans.

5.8 Municipal Practices & Programs

The Baltimore Watershed Agreement (BWA) is the commitment between Baltimore County and Baltimore City to work together on the management and monitoring of shared watersheds. It was first signed in 2002 and renewed in 2006. The 2006 Agreement identified five interrelated focus areas: stormwater, community greening, redevelopment and development, public health and trash. Municipal programs and practices can directly support subwatershed restoration efforts and contribute to progress within these focus areas. The following recommendations for improvement are presented based on initial watershed observations and community feedback: trash management/education; street sweeping; tree planting; storm drain marking; and erosion and sediment control. Each of these are described briefly below.

5.8.1 Trash Management/Education

Trash and dumping was frequently observed through the Tidal Back River watershed. Educating the public about the trash issues and impacts to water quality in the watershed through a trash campaign is one way to address trash and dumping problems. Baltimore City has implemented a Cleaner Greener Baltimore initiative including a trash campaign with a slogan (Don’t make excuses. Make a difference.) and signs with various messages posted throughout the city to encourage residents to use proper disposal methods and inform them that trash is an issue in the City. A similar campaign could be launched in the Tidal Back River watershed with a slogan and messages tailored to the residents and issues in the study area. By adopting a slogan and campaign for the watershed, residents will be aware of the issues and encouraged to take responsibility for the health of the Back River in their communities. Public education and awareness can also be accomplished through community clean-ups in neighborhoods or schools with observed trash management issues.

Dumping of bulk materials was noted as a problem in the watershed by field teams and residents. Residents voiced concerns about a lack of bulk trash-pick up options including limited times for drop-off and expensive fees for on-site pick-up. Working with the Department of Public Works to create a more user-friendly bulk trash pick up program would help address dumping problems in the watershed. This may involve extending existing hours for bulk trash drop off at landfills or implementing a monthly bulk trash pick-up service at various locations in the watershed.

As mentioned previously, the Baltimore Watershed Agreement includes a commitment between the City and County to improve the management of natural resources. Trash is one of five focus areas per this agreement. As specified in the Phase I Action Plan, the goal is to eliminate trash-related water quality impairments as defined by the Clean Water Act by 2020 in the Harbor, Back River, and tributary streams (BWA 2009). Trash-related actions presented in the Phase I plan to achieve this goal include:

- Watershed-based trash monitoring efforts;
- Expansion of littering and trash awareness campaigns;
- Continuation of trash reduction and removal technology pilot projects; and
- Assessment of existing street sweeping programs.

In addition to the Cleaner Greener Baltimore campaign, existing trash initiatives include Baltimore County's Clean Shores Program (removing trash and debris from shorelines, mudflats, and waterways) and Project Stream Clean (stream clean-ups throughout the region organized by the Alliance for the Chesapeake Bay). Implementing municipal practices and programs related to trash management/education in the Tidal Back River watershed would improve water quality and aesthetics of the Back River and also support the goals of the BWA.

5.8.2 Street Sweeping

Baltimore County has an active street sweeping program to remove debris, dirt and pollutants from the storm drain system. Effective street sweeping usually involves using a vacuum assisted sweeper and a schedule that coincides with things like trash pick-up days or seasonal changes such as leaf litter in the fall and more frequent lawn care activities in spring and summer. The frequency and locations of this program in the study area should be evaluated and updated to include neighborhoods identified as having significant sediment, organic matter, and/or trash in the curb and gutter system. An evaluation of existing street sweeping programs is included as part of the Baltimore Watershed Agreement. Street sweeping is also related to the trash component of the agreement.

5.8.3 Tree Planting

Several opportunities for reforestation and buffer improvement were identified during the field assessments including street tree and open space shade tree plantings in various neighborhoods, open pervious areas and institutions throughout the watershed. This presents an opportunity to apply for municipal tree planting programs including SHA's Partnership Program and DNR's Tree-mendous Maryland program to help reforest areas of the watershed. These types of programs also provide an opportunity to involve volunteers from various neighborhoods, businesses and schools to help plant trees throughout the watershed while also educating the community about the importance of trees for air and water quality benefits. The Growing Home Campaign is another way to increase the tree canopy in the watershed while also educating residents about the value of adding trees. This is a public-private partnership between Baltimore County, Baltimore City, Harford County, local retail nurseries/garden centers and homeowners to encourage planting new trees on private residential land.

Community greening is also one of five focus areas per the Baltimore Watershed Agreement. As specified in the Phase I Action Plan, the goal is to achieve City and County urban tree canopy and stream buffer goals and maximize vegetated areas as appropriate to improve water quality (BWA 2009). Community greening-related actions presented in the Phase I plan to achieve this goal include the following:

- Develop greening targets and guidelines;
- Develop measures and indicators for the condition and benefits of urban tree cover;
- Develop and improve Urban Tree Management Programs;
- Increase number of residential trees planted by 10% (by December 2010);
- Research urban and community forestry programs; and
- Implement streetscapes on City and County road and capital improvement projects

In addition to the Cleaner Greener Baltimore campaign, existing trash initiatives include Baltimore County's Clean Shores Program (removing trash and debris from shorelines, mudflats, and waterways) and Project Stream Clean (stream clean-ups throughout the region organized by the Alliance for the Chesapeake Bay). Implementing municipal practices and programs related to tree planting in the Tidal Back River watershed would improve air and water quality and aesthetics while also supporting the goals of the BWA.

5.8.4 Storm Drain Marking

Most of the developed areas in the Tidal Back River watershed consist of curb and gutter systems including storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. Some inlets had faded storm drain marking but for the most part, inlets did not have any indicators that they drain to the Back River and eventually the Chesapeake Bay. Since there is little or no infiltration of stormwater in a curb and gutter system, there is more potential for pollutants to be carried to the stream system. Storm drain marking is a way to educate residents that anything building up along the curbs and gutters such as trash and lawn clippings will be washed away after a storm event and end up in the Back River and/or the Bay.

5.8.5 Erosion and Sediment Control

Several in or near stream construction activities were observed during the stream and uplands assessments of the watershed. In many cases, erosion and sediment controls were not considered adequate to prevent erosion and other pollutants from entering the storm drain system or nearby stream. Follow-up inspection and improvement of erosion and sediment control practices at construction sites should be implemented to prevent sediment and other pollutant inputs into the storm drain system and stream network.

5.8.6 Environmental Awareness and Education

Community-based facilities including schools, community centers, marinas and care/nursing centers present good opportunities for educating the public about water quality issues and improvement methods for the watershed. This can be accomplished by implementing water quality BMPs such as rain gardens and bio-retention areas at these sites. In addition to environmental education, these BMPs have water quality and aesthetic benefits for property users. There is also potential for involving the community through BMP installation and maintenance. Environmental education can also be accomplished through water quality sampling and monitoring of stormwater management measures such as wetlands and extended detention ponds at schools, for example. Buffer and tree planting also presents an opportunity for combining community involvement and environmental education.

5.8.7 Preservation

While a significant portion of the watershed is highly developed, nearly a third of the area remains forested. These areas are recommended for preservation and resource conservation. Longs Creek is the least developed subwatershed, with the most acres of forest and currently zoned for resource conservation. This subwatershed should be a priority for preservation. Muddy Gut and Back River-G also have considerable portions of forested areas. They are also occupied by more recent residential and commercial developments than in other portions of the watershed. Preservation of forested areas and especially forested buffer areas in these subwatersheds should also be a priority. Deep Creek and Duck Creek are significantly developed including mostly residential and commercial uses. However, portions of the stream corridors in these subwatersheds remain forested and should be a priority for preservation.

Baltimore County also participates in the State’s Rural Legacy Program which was developed in 1997 to protect large, continuous tracts of valuable cultural and natural resource lands through grants made to local applicants (DNR 2007). Baltimore County’s Coastal Rural Legacy Plan aims to protect large blocks of forest, wetlands, farms, and other open spaces that are of significant ecological value as habitat for rare, threatened and endangered species and to preserve the environmental benefits that these areas provide to the Chesapeake Bay. A total of 15,340 acres of forests, wetlands, marshes, and farms including 109.3 miles of shoreline along tidal creeks and the Chesapeake Bay are included in the County’s Coastal Rural Legacy Area. The Coastal Rural Legacy Area consists of seven distinct areas. The Tidal Back River watershed includes portions of two of these areas, namely Back River/Holly Neck and Fort Howard (URS 2005). Back River/Holly Neck includes all of Longs Creek and a portion of Muddy Gut. Fort Howard includes all of Back River-F and a small portion of Lynch Point Cove. Approximately 2,730 acres are preserved through the Coastal Rural Legacy Program in the Tidal Back River watershed.

CHAPTER 6: REFERENCES

Baltimore County Department of Environmental Protection and Management (DEPRM). June 9, 2009 (last revise). *Coastline, Bathing Beach, and Recreational Water Sampling Program.* Website: *http://www.baltimorecountymd.gov/Agencies/environment/watersampling/index.html*

Baltimore County Department of Environmental Protection and Management (DEPRM). November 2008. *Upper Back River Small Watershed Action Plan*. Volumes 1 and 2. Prepared in consultation with Upper Back River SWAP Steering Committee.

Baltimore County Department of Environmental Protection and Management (DEPRM). April 1998. *Shoreline Enhancement Feasibility Study.* Volumes 1 and 2. Prepared by Bay Land Consultants and Designers, Inc. Hanover, Maryland.

Baltimore County Office of Information Technology (OIT). August 15, 2008 (revised). *Geographic Information Systems (GIS)*. Website: *http://www.baltimorecountymd.gov/Agencies/infotech/geographic_information_systems/*

Baltimore County Office of Planning. May 8, 2007 (revised). *Baltimore County Zoning*. Website: *http://www.baltimorecountymd.gov/Agencies/planning/zoning/index.html*

Baltimore Watershed Agreement (BWA). March 2009. *Phase 1 Action Plan*. Baltimore County and City of Baltimore, Maryland. Website: *http://resources.baltimorecountymd.gov/Documents/Environment/Watersheds/bwaactionplanfinal09.pdf*

Center for Watershed Protection (CWP). August 2007. *Urban Stormwater Retrofit Practices.* Urban Subwatershed Restoration Manual Series, Manual No. 3. Prepared for USEPA, Office of Watershed Management.

Center for Watershed Protection (CWP). March 2004. *Unified Subwatershed and Site Reconnaissance: A User's Manual*. Manual 11, Ellicott City, Maryland.

Center for Watershed Protection (CWP). March 2003. *The Impervious Cover Model*. Ellicott City, Maryland. Website: *http://www.stormwatercenter.net/monitoring%20and%20assessment/imp%20cover/impercovr%20model.htm*

Chesapeake Bay Program (CBP). June 29, 2009 (last modified). *The Bay Watershed*. A Watershed Partnership, Annapolis, Maryland. Website: *http://www.chesapeakebay.net/*

Chesapeake Bay Program (CBP). August 1998. *Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings*. Appendix I: Model Operations Manual. Annapolis, Maryland. Website: *http://www.chesapeakebay.net/data_modeling.aspx*

Kazyak, Paul F. February 2001. *Maryland Biological Stream Survey Sampling Manual*. Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources (DNR), Annapolis, Maryland.

Maryland Department of the Environment (MDE). August 2009. *Facts About…Back River Wastewater Treatment Plant Upgrade.* Prepared by MDE, Baltimore, Maryland.

Maryland Department of the Environment (MDE). June 2007. *Total Maximum Daily Loads of Fecal Bacteria for the Herring Run Basin in Baltimore City and Baltimore County, Maryland.* Prepared by MDE, Baltimore, Maryland. Submitted to USEPA, Watershed Protection Division, Philadelphia, PA. Website: *http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_final_herringrun_fc.asp*

Maryland Department of the Environment (MDE). February 2005. *Total Maximum Daily Loads of Nitrogen and Phosphorus for Back River in Baltimore City and Baltimore County, Maryland.* Prepared by MDE, Baltimore, Maryland. Submitted to USEPA, Watershed Protection Division, Philadelphia, PA. Website: *http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/TMDL_final_backriver_eutro.asp*

Maryland Department of the Environment (MDE). March 2004. *Water Quality Analysis of Zinc in Back River, Baltimore County and Baltimore City, Maryland.* Prepared by MDE, Baltimore, Maryland. Submitted to USEPA, Watershed Protection Division, Philadelphia, Pennsylania. Website: *http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/WQA_final_backriver_zinc.asp*

Maryland Department of the Environment (MDE). July 15, 2004. *Technical Memorandum: Nutrient Point Sources in the Back River Watershed*. Back River TMDL Nutrients.

Maryland Department of the Environment (MDE). 2000. *2000 Maryland Stormwater Design Manual, Volumes I & II.* Prepared by Center for Watershed Protection, Ellicott City, Maryland.

Maryland Department of the Environment (MDE). July 1999. *Total Maximum Daily Load Documentation for Chlordane in Back River.* Prepared by MDE, Baltimore, Maryland. Submitted to USEPA, Watershed Protection Division, Philadelphia, PA. Website: *http://textonly.mde.state.md.us/Programs/WaterPrograms/TMDL/ApprovedFinalTMDL/tmdl_backriver.asp*

Maryland Department of Natural Resources (DNR). August 2007. *Maryland Tributary Strategy Patapsco/Back Rivers Basin Summary Report for 1985-2005 Data*. Maryland DNR, Annapolis, Maryland. Website: *http://www.dnr.state.md.us/Bay/pdfs/PatBackBasinSum8505FINAL07.pdf*

Maryland Department of Natural Resources (DNR). January 2007. *Maryland's Rural Legacy Program*. Website: *http://www.dnr.maryland.gov/land/rurallegacy/allrurallegacyareas.asp*

Maryland Department of Natural Resources (DNR). December 2005. *A User's Guide to Watershed Planning in Maryland*. Prepared by Center for Watershed Protection for Maryland DNR, Annapolis, Maryland.

Maryland Geological Survey (MGS). *MGS Online – Guide to Maryland Geology*. Website: *http://www.mgs.md.gov/indexgeo.html*

National Climatic Data Center (NCDC). July 10, 2009 (data retrieved). *Station Locator: Baltimore Washington International Airport*. National Oceanic and Atmospheric Administration (NOAA), NCDC, Asheville, North Carolina. Website: *http://www.ncdc.noaa.gov/oa/climate/stationlocator.html*

New Jersey Department of Environmental Protection (NJDEP). January 4, 2007 (last updated). *Stream Habitat Assessment Forms*. NJDEP, Bureau of Freshwater and Biological Monitoring, Trenton, New Jersey. Website: *http://www.state.nj.us/dep/wms/bfbm/appendix/habitat.html*

Northeast Regional Climate Center (NRCC). July 10, 2009 (data retrieved). *US Comparative Climate Data*. Partner with National Climatic Data Center, Cornell University, Ithaca, New York. Website: *http://www.nrcc.cornell.edu/page_ccd.html*

Ouyang, Da. 2002. *RUSLE: On-Line Soil Erosion Assessment Tool.* Institute of Water Research, Michigan State University. Website: *http://www.iwr.msu.edu/rusle/*

U.S. Department of Agriculture (USDA). October 1993. *Soil Survey Manual.* Soil Survey Division Staff.

U.S. Department of Agriculture (USDA). June 1986. *Technical Release 55: Urban Hydrology for Small Watersheds.* Natural Resources Conservation Service (NRCS), Conservation Engineering Division.

U.S. Environmental Protection Agency (USEPA). August 19, 2009 (last updated). *National Recommended Water Quality Criteria.* Website: *http://www.epa.gov/waterscience/criteria/wqctable/*

Yetman, Kenneth T. September 2001. *Stream Corridor Assessment (SCA) Survey Protocols*. Watershed Restoration Division, Chesapeake & Coastal Watershed Services, Maryland Department of Natural Resources (DNR), Annapolis, Maryland.

APPENDIX A:

SCA FIELD MAPS

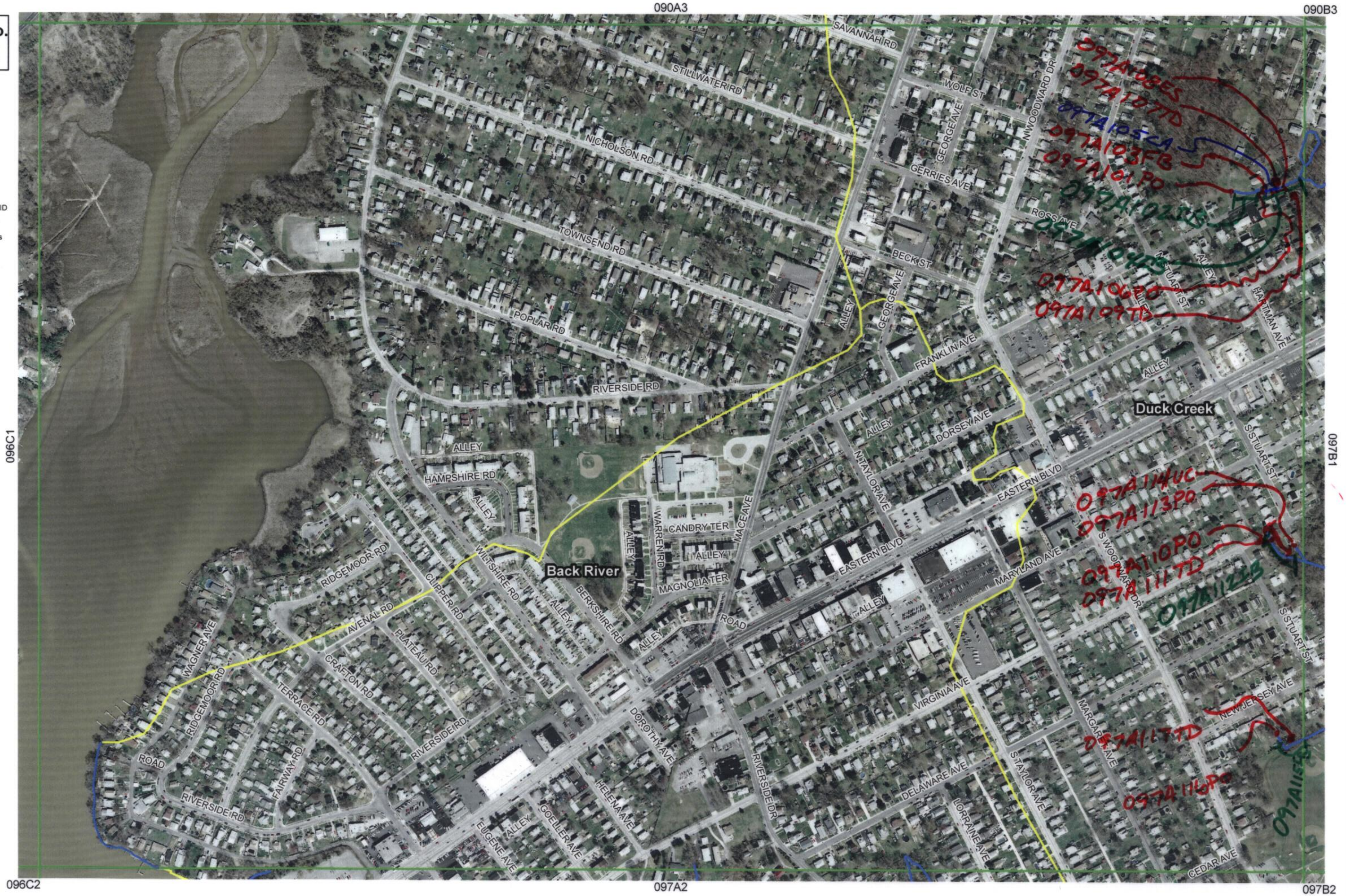
Map No. 097A1

N

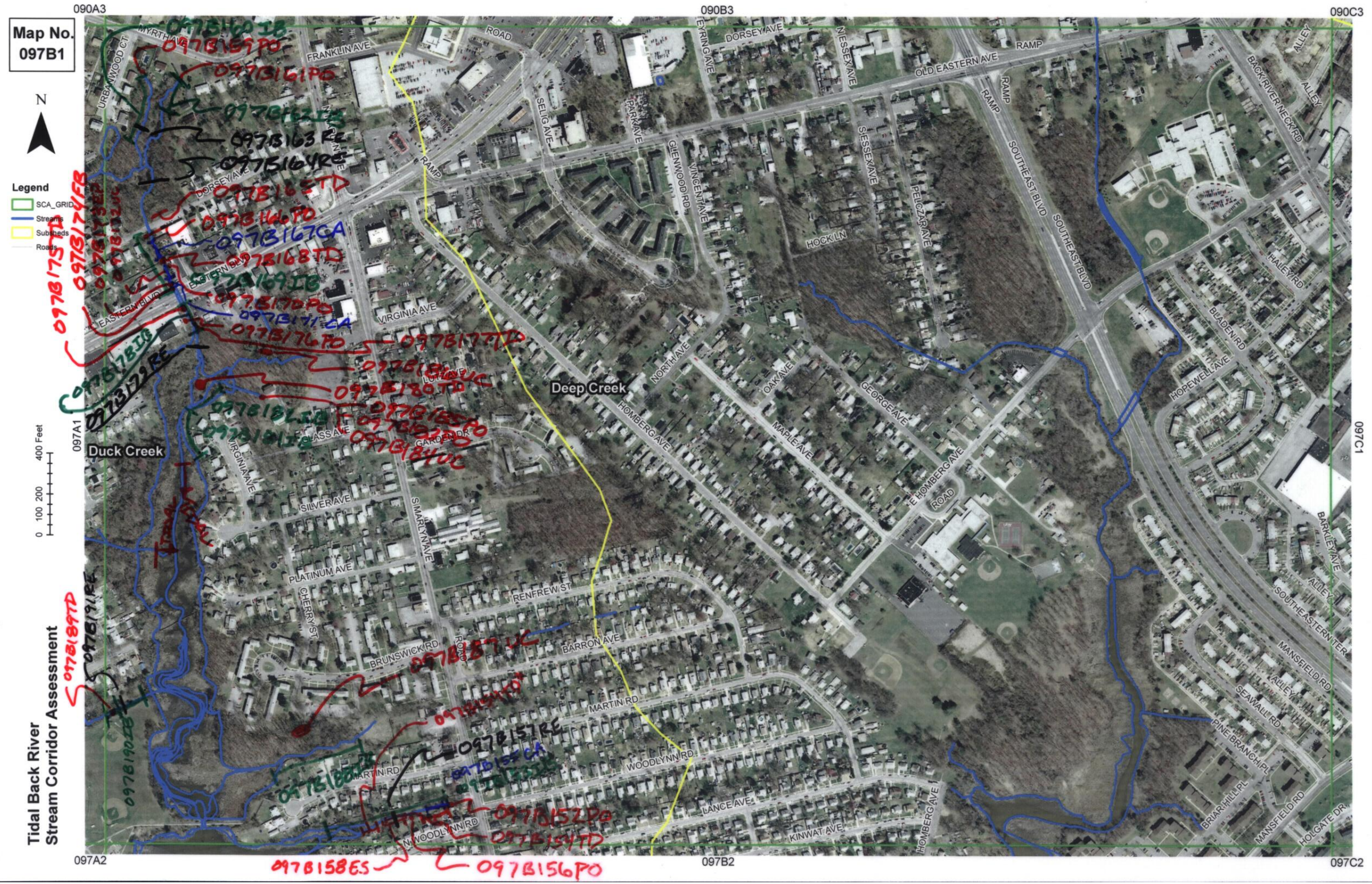
Legend

- SCA_GRID
- Streams
- Subsheds
- Roads

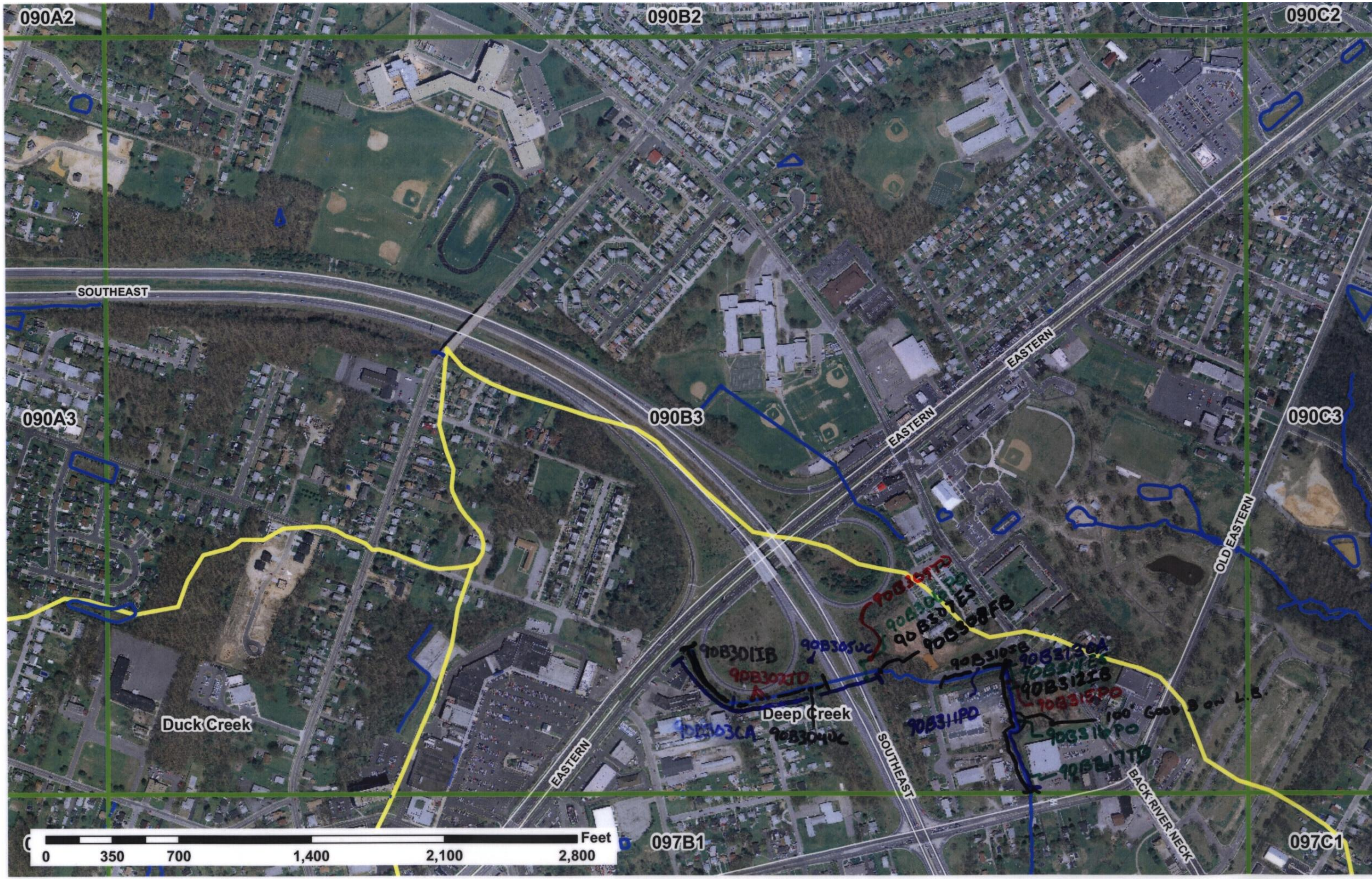
0 100 200 400 Feet



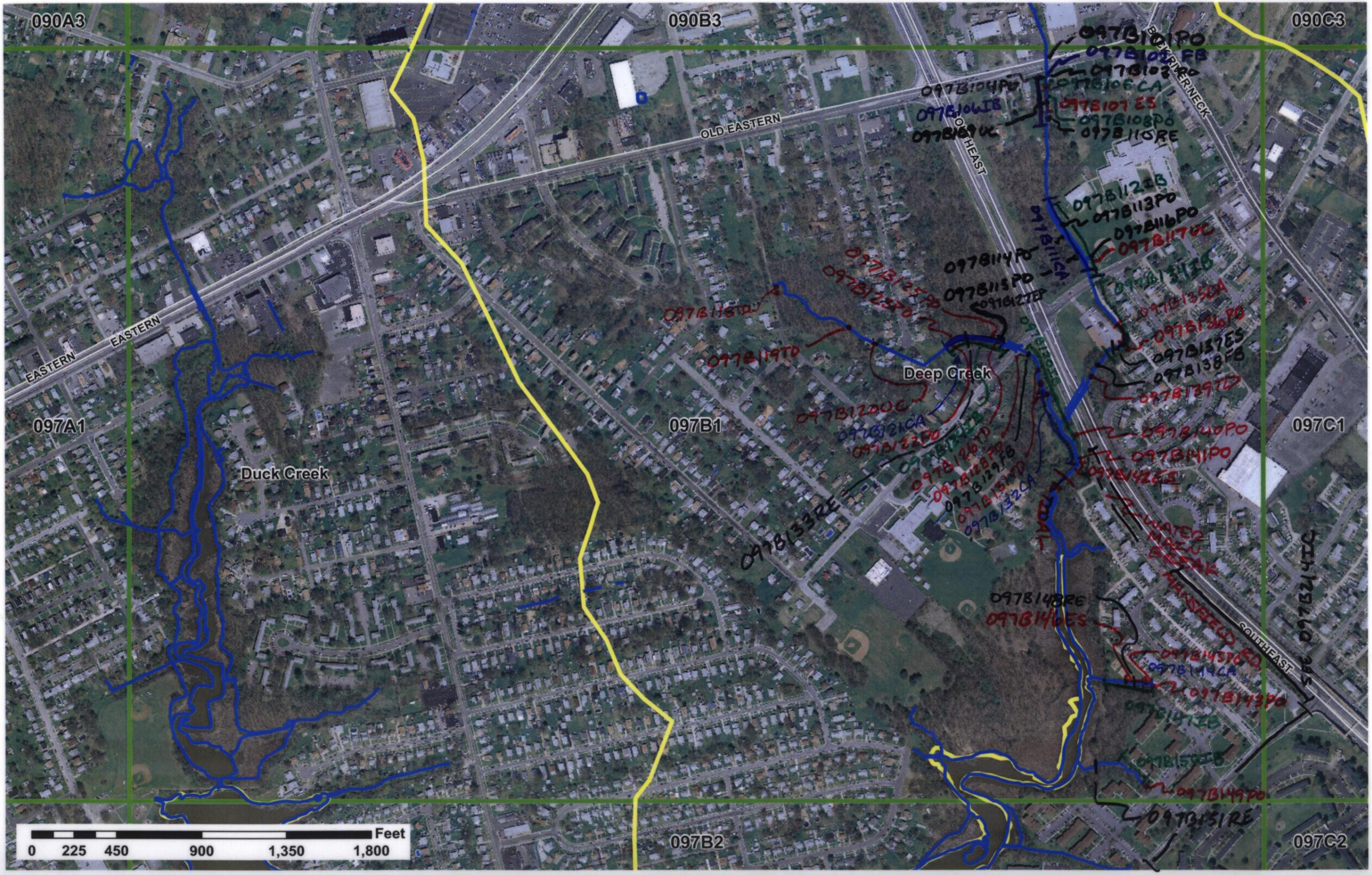
Tidal Back River Stream Corridor Assessment



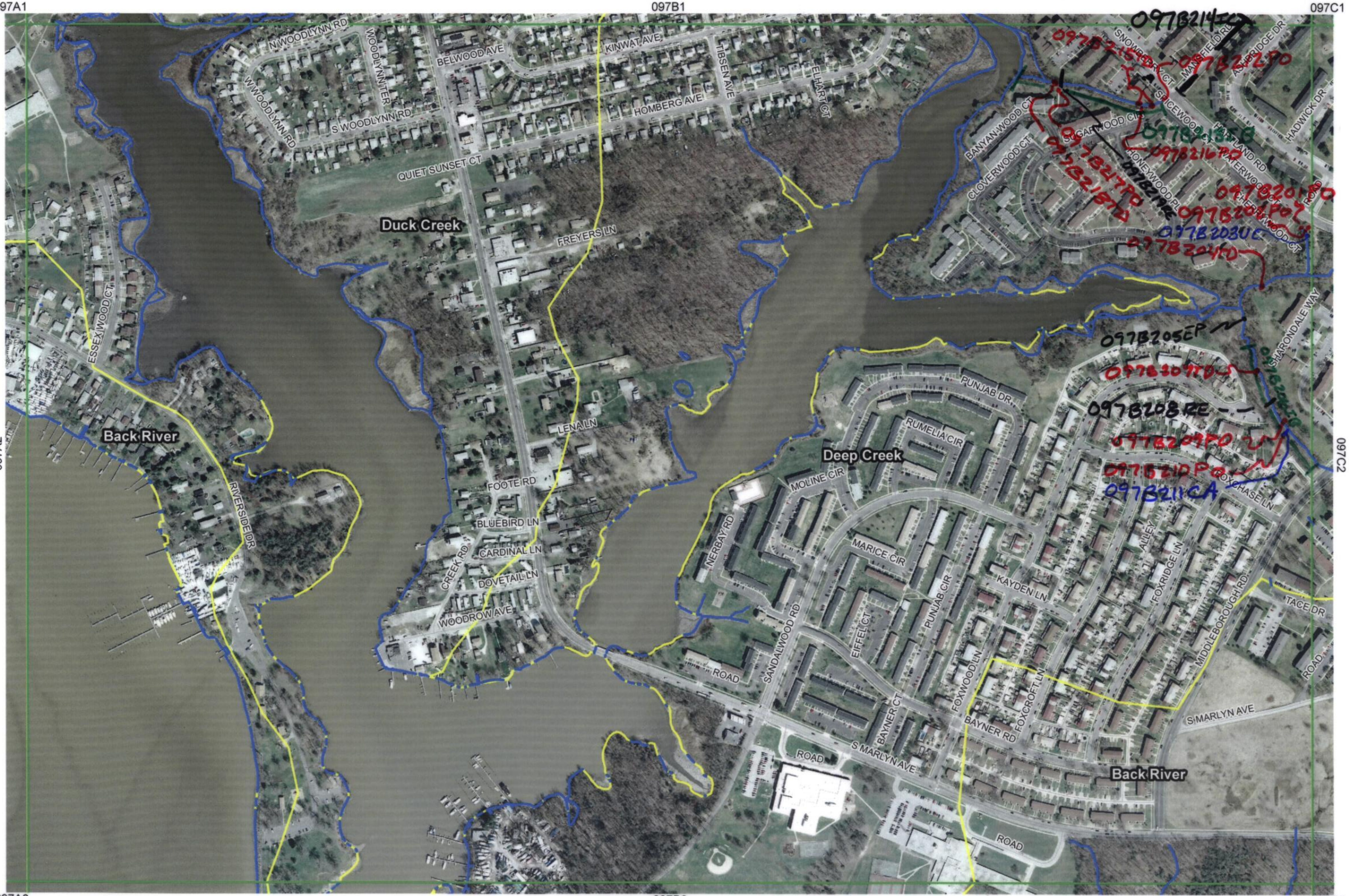
Map No. 097B1
N
Legend
SCA_GRID
Streams
Subsheds
Roads
0 100 200 400 Feet
Tidal Back River
Stream Corridor Assessment
090A3
090B3
090C3
097A1
097C1
097A2
097B2
097C2
Deep Creek
Duck Creek
FRANKLIN AVE
OLD EASTERN AVE
DORSEY AVE
EASTERN BLVD
VIRGINIA AVE
HOMBERG AVE
SOUTHEAST BLVD
BACK RIVER NECK RD
MARTIN RD
WOODLYNN RD
LANCE AVE
KINWAT AVE
BARRON AVE
RENFREW ST
BRUNSWICK RD
PLATINUM AVE
SILVER AVE
CHERRY ST
S MARLYN AVE
MAPLE AVE
OAK AVE
GEORGE AVE
NORTH AVE
HOCK LN
PELICZAR AVE
SESSEX AVE
VINCENT AVE
GLENWOOD RD
PARK AVE
SELIG AVE
NIESSEX AVE
EVERING AVE
HOPEWELL AVE
BLADEN RD
HALEY RD
MANSFIELD RD
SEAWALL RD
PINE BRANCH PL
BRIAR HILL PL
HOLGATE DR
BARKLEY AVE
SOUTHEASTERN TER
E HOMBERG AVE
ROAD
RAMP
ALLEY



090A2
090B2
090C2
SOUTHEAST
EASTERN
EASTERN
EASTERN
090A3
090B3
090C3
OLD EASTERN
Duck Creek
Deep Creek
90B301IB
90B302TD
90B303CA
90B304UC
90B305UC
90B307ES
90B308FB
90B310SB
90B311PO
90B312IB
90B315PO
90B316PO
90B317TD
100' GOOD B ON L.B.
SOUTHEAST
BACK RIVER NECK
097B1
097C1
Feet
0
350
700
1,400
2,100
2,800


090A3
090B3
090C3
OLD EASTERN
EASTERN
EASTERN
Deep Creek
Duck Creek
097A1
097B1
097C1
SOUTHEAST
097B2
097C2
Feet
0 225 450 900 1,350 1,800

Map No.
097B2

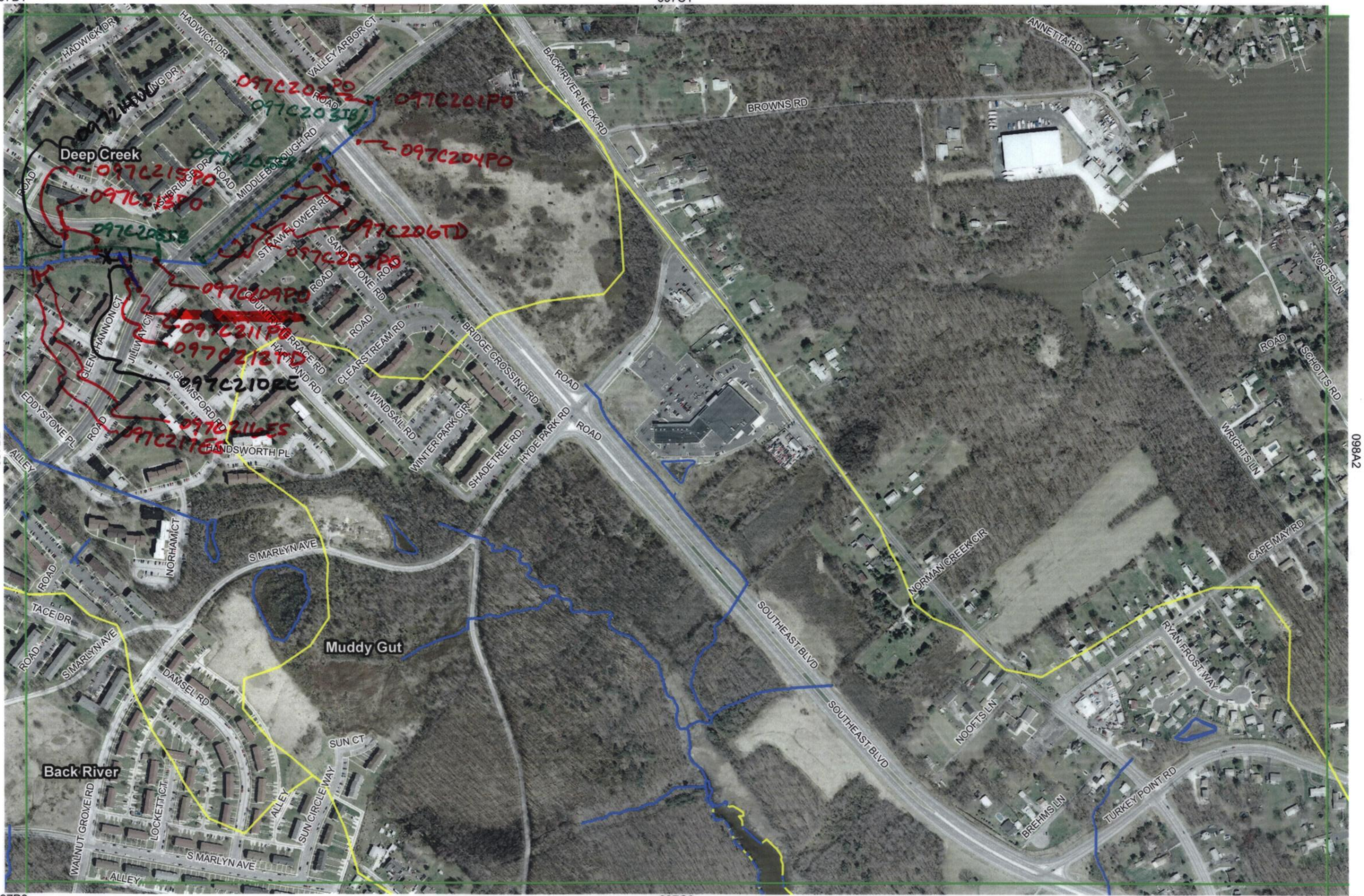


Tidal Back River
Stream Corridor Assessment

Map No. 097C2

097B1

097C1



097B2

098A2

097B3

097C3

098A3

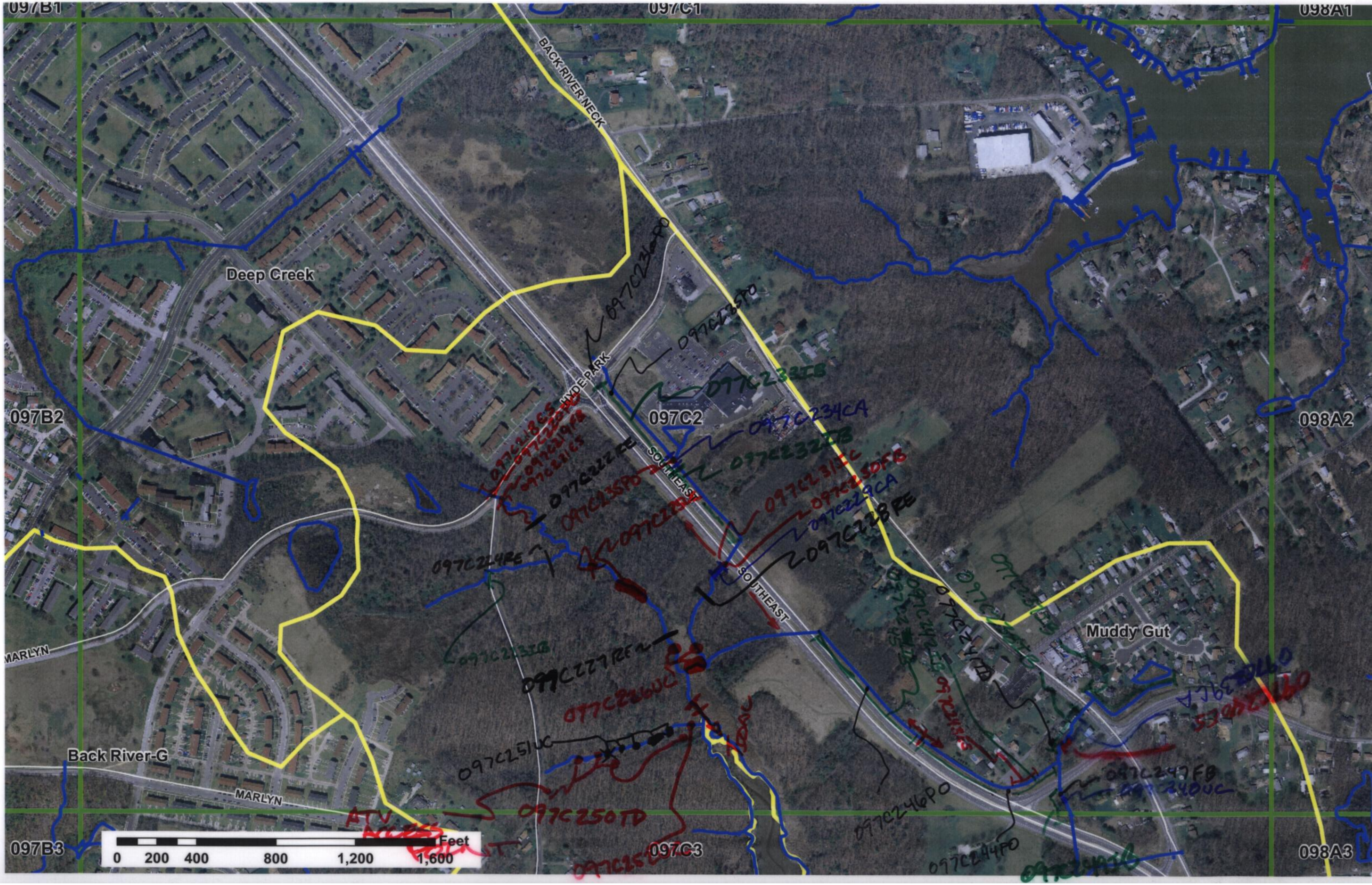
N

Legend

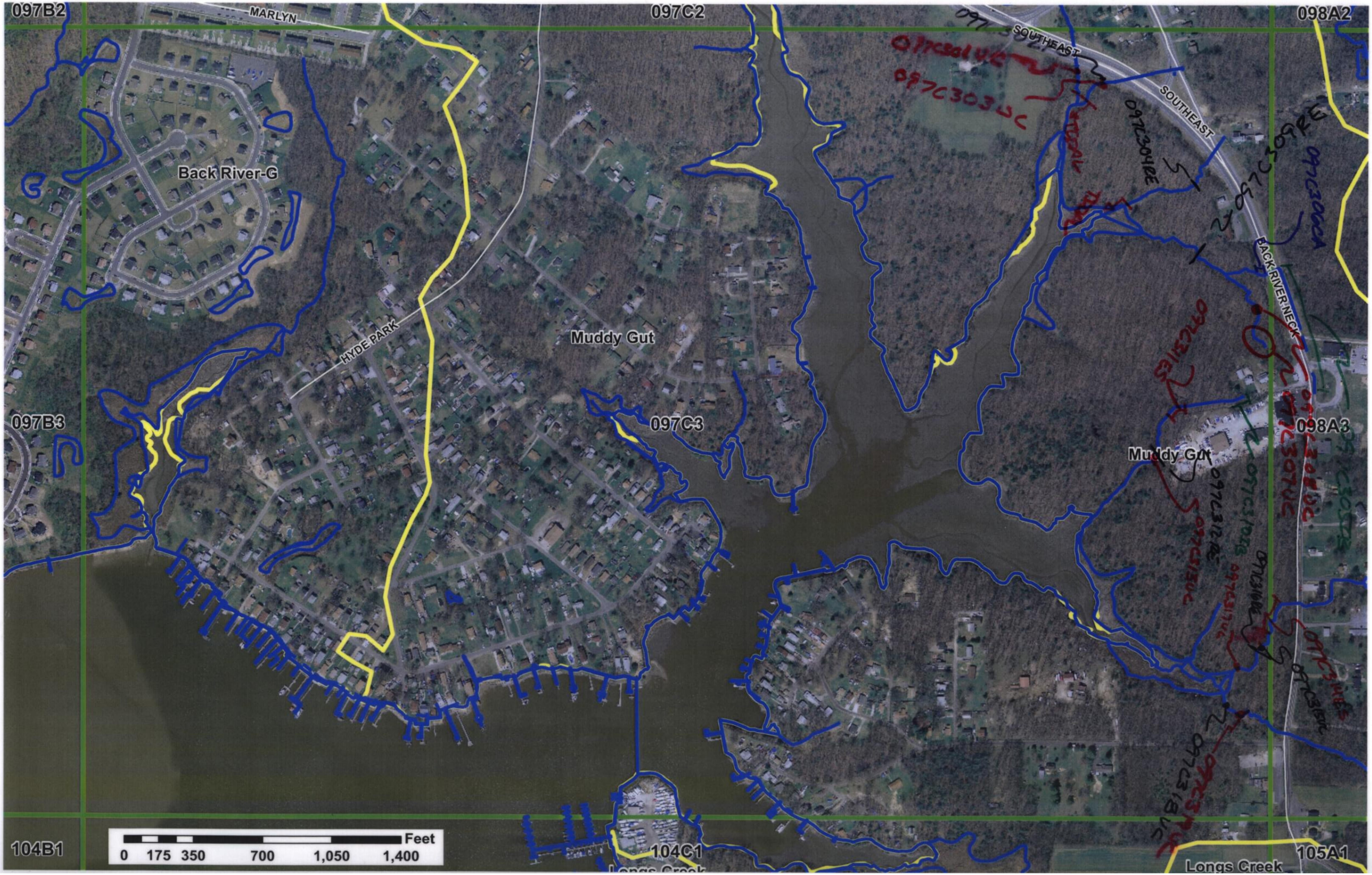
- SCA_GRID
- Streams
- Subsheds
- Roads

0 100 200 400 Feet

Tidal Back River Stream Corridor Assessment



097B1
097C1
098A1
BACK RIVER NECK
Deep Creek
HYDE PARK
097C2
097B2
098A2
SOUTHEAST
SOUTHEAST
Muddy Gut
MARLYN
Back River-G
MARLYN
097B3
097C3
098A3
Feet
0 200 400 800 1,200 1,600


097B2
MARLYN
097C2
SOUTHEAST
SOUTHEAST
098A2
Back River-G
HYDE PARK
Muddy Gut
097B3
097C3
098A3
BACK RIVER NECK
Muddy Gut
Feet
0 175 350 700 1,050 1,400
104B1
104C1
105A1
Longs Creek

Map No. 098A3
N
Legend
SCA_GRID
Streams
Subsheds
Roads
0 100 200 400 Feet
Tidal Back River
Stream Corridor Assessment
097C2
098A2
097C3
104C1
105A1
105B1
POTTERY FARM RD
LUCIANO RD
BACK RIVER NECK RD
ROAD
Muddy Gut
098A301EB
098A302 UC
098A303AA
MARSH RD
MAPLE RD
CEDAR CREEK RD
PINE RD
POPLAR RD
LOURDES RD
SILVER LN
GOFF RD
VANDERMAST LN
TONDO RD
SUE AVE
SUE CREEK DR
ABELL LN
ALTVOGS RD
WILLOW GREEN LN
HOLLY RD
WOODY RD
HOLLY CIR
WILTON RD
SUE GROVE RD
WEST SHORE RD

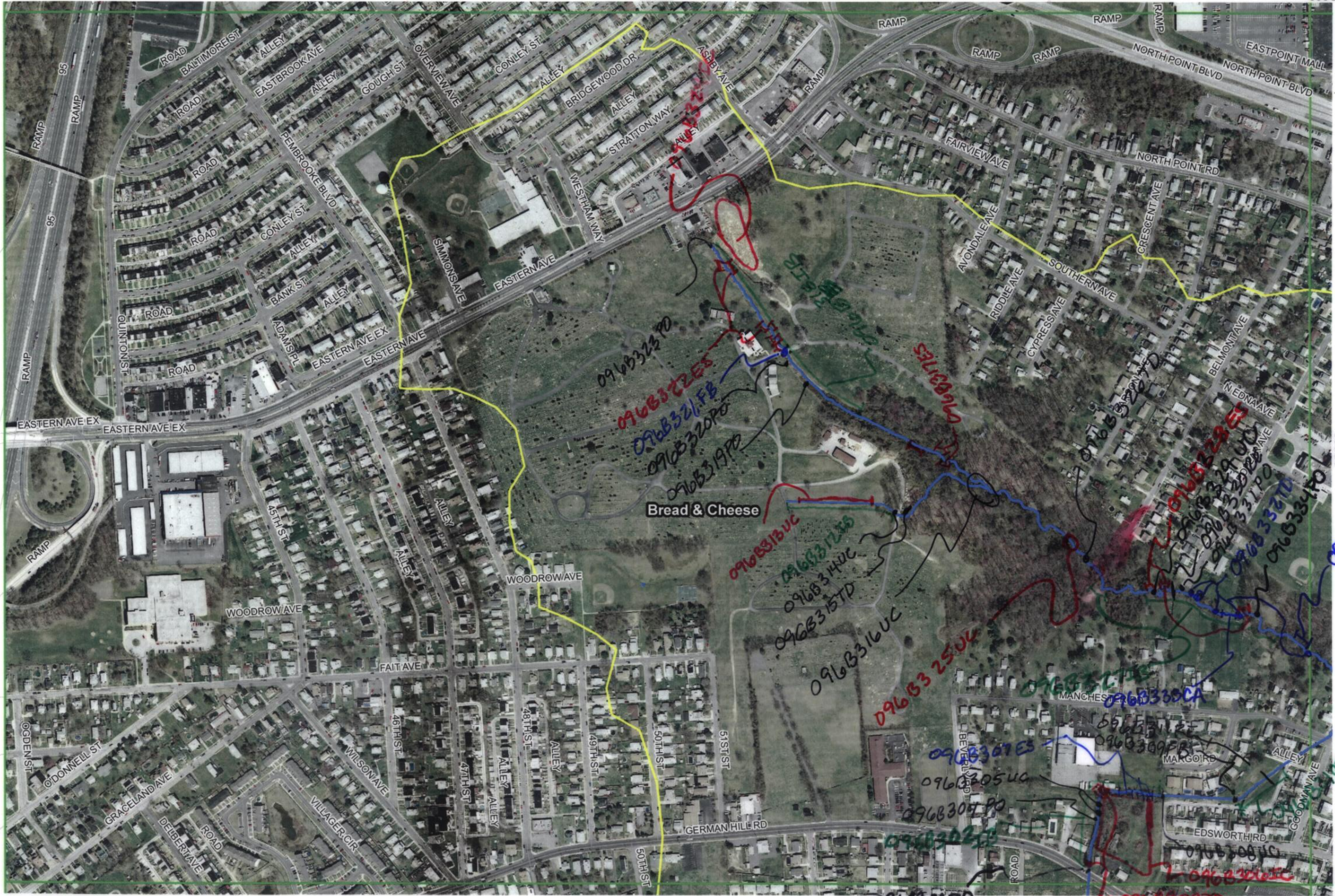
Map No. 096B3

N

Legend

- SCA_GRID
- Streams
- Subsheds
- Roads

0 100 200 400 Feet



Tidal Back River
Stream Corridor Assessment

Map No. 096C3

N

Legend
- SCA_GRID
- Streams
- Subsheds
- Roads

0 100 200 400 Feet

096B2 096C2 097A2

096B3 097A3

103B1 103C1 104A1

Tidal Back River Stream Corridor Assessment

Map No. 103C1

N

Legend

- SCA_GRID
- Streams
- Subsheds
- Roads

0 100 200 400 Feet

Tidal Back River
Stream Corridor Assessment

Tidal Back River
Stream Corridor Assessment

APPENDIX B:

SCA DATA

Tidal Back River SCA Survey Sites:
Inadequate Buffer

Map	Site	Stream	Date	Sides	Unshaded	Width Left (ft)	Width Right (ft)	Length Left (ft)	Length Right (ft)	LandUse Left	LandUse Right	Severity	Correct-ability	Access	Wetland
096B3	12	Bread & Cheese	06/10/09	Both	Both	0	0	450	450	Lawn; Stream in Oaklawn Cemetery	Lawn; Stream in Oaklawn Cemetery	1	2	2	2
096B3	18	Bread & Cheese	06/10/09	Both	Both	1	1	950	950	Lawn	Lawn	1	3	2	4
097A3	03	Bread & Cheese	05/19/09	Both	Both	0	10	1200	500	Paved	Paved	1	5	3	3
097A1	02	Duck Creek	04/30/09	Both	Both	0	0	80	80	Lawn	Lawn	1	2	2	5
096B3	02	Bread & Cheese	06/10/09	Both	Both	0	0	500	500	Lawn	Lawn	2	3	2	5
096C3	01	Bread & Cheese	05/19/09	Both	Both	0	0	40	40	Lawn	Lawn	2	3	1	5
090B3	01	Deep Creek	04/17/09	Both	Neither			800	1100	Shrubs & small trees	Residential	2	4	3	5
090B3	12	Deep Creek	04/17/09	Both	Both	15	5	1200	1300	Lawn	Paved	2	4	2	5
097B1	34	Deep Creek	04/28/09	Both	Neither	10	10	600	600	Medium density residential	Industrial	2	5	1	5
097B1	50	Deep Creek	04/30/09	Both	Neither	5	10	170	170	Lawn	Lawn	2	3	1	5
097B2	13	Deep Creek	04/30/09	Both	Both	10	10	600	450	Paved	Lawn	2	3	2	4
097B1	53	Duck Creek	04/30/09	Both	Both	5	5	600	600	Lawn	Lawn	2	3	3	3
097C2	42	Muddy Gut	06/10/09	Both	Right	20	0	800	800	Lawn	Lawn, Paved	2	5	1	3
097C2	45	Muddy Gut	06/10/09	Both	Left	0	20	500	200	Lawn, Paved	Lawn	2	5	1	3
097C2	33	Muddy Gut	05/05/09	Both	Both	0	0	650	650	Lawn	Roadway ROW	2	4	1	5
096B3	10	Bread & Cheese	06/10/09	Both	Both	5	5	150	150	Lawn	Lawn	3	2	2	3
096B3	27	Bread & Cheese	06/10/09	Both	Neither	5	10	700	600	Lawn	Lawn	3	3	2	5
096C3	37	Bread & Cheese	06/10/09	Both	Neither	15	15	900	1350	Lawn, Paved	Lawn, Paved	3	5	2	5
096C3	51	Bread & Cheese	06/10/09	Both	Neither	15	15	350	350	Paved	Paved	3	5	1	5
096C3	10	Bread & Cheese	05/19/09	Both	Neither	15	15	800	800	Lawn, Paved	Lawn, Paved	3	3	2	5
096C3	21	Bread & Cheese	05/19/09	Both	Neither	25	20	100	275	Lawn	Lawn	3	4	2	4
096C3	29	Bread & Cheese	05/19/09	Both	Neither	5	8	150	100	Lawn, Paved	Paved	3	5	1	5
096C3	35	Bread & Cheese	06/10/09	Both	Both	0	0	175	175	Lawn	Lawn	3	4	2	5
103C1	01	Bread & Cheese	05/19/09	Both	Neither	20	20	1600	1600	Lawn	Lawn	3	4	3	4

Tidal Back River SCA Survey Sites:
Inadequate Buffer

Map	Site	Stream	Date	Sides	Unshaded	Width Left (ft)	Width Right (ft)	Length Left (ft)	Length Right (ft)	LandUse Left	LandUse Right	Severity	Correct-ability	Access	Wetland
090B3	10	Deep Creek	04/17/09	Both	Neither	20	20	350	350	Road ROW	Industrial, Commercial	3	3	1	5
097B1	12	Deep Creek	04/17/09	Left	Left	0		350		Lawn	Forest	3	2	1	5
097C2	05	Deep Creek	04/28/09	Both	Neither	10	10	600	600	Lawn	Lawn	3	3	1	3
097C2	08	Deep Creek	04/28/09	Both	Neither	20	30	500	400	Lawn	Lawn	3	4	1	5
097A1	15	Duck Creek	05/05/09	Both	Neither	0	15	150	150	Lawn	Lawn	3	3	2	4
097B1	62	Duck Creek	04/30/09	Both	Neither	35	5	100	100	Lawn	Lawn	3	3	2	5
097B1	69	Duck Creek	04/30/09	Both	Neither	10	15	300	300	Lawn, Paving, Structures	Lawn, Paving	3	5	4	5
097B1	78	Duck Creek	04/30/09	Both	Neither	10	15	175	175	Paved	Paved	3	5	2	5
097B1	90	Duck Creek	05/05/09	Both	Neither	15	15	200	200	Lawn	Lawn	3	3	2	3
097C2	37	Muddy Gut	06/10/09	Both	Left	5	10	600	600	Lawn	Lawn	3	5	1	5
097C2	38	Muddy Gut	06/10/09	Both	Neither	5	5	200	200	Lawn	Lawn	3	5	2	5
097C2	23	Muddy Gut	05/05/09	Right	Right		0		40	Wetland	Paved	3	5	1	5
097C2	32	Muddy Gut	05/05/09	Right	Right		0		450	Shrubs & small trees	Roadway ROW	3	4	1	5
097C3	05	Muddy Gut	06/23/09	Both	Both	0	0	150	150	Lawn, Paved	Lawn, Shrubs & Small trees	3	3	1	4
098A3	01	Muddy Gut	06/25/09	Both	Both	0	0	300	300	Lawn	Lawn	3	3	2	4
096C3	25	Bread & Cheese	05/19/09	Right	Neither		15		200	Forest	Paved	4	5	1	5
096C3	30	Bread & Cheese	05/19/09	Left	Neither	30		800		Railroad	Forest	4	5	5	5
097B1	24	Deep Creek	04/28/09	Right	Neither		20		300		Paved	4	4	1	5
097B1	47	Deep Creek	04/30/09	Right	Neither		10		225	Forest	Lawn	4	3	1	5
097B1	06	Deep Creek	04/17/09	Both	Both	0	0	250	250	Lawn	Lawn	4	3	2	5
097B2	06	Deep Creek	04/28/09	Both	Neither	20	20	150	150	Lawn	Lawn	4	3	2	3
097A1	04	Duck Creek	04/30/09	Both	Neither	8	8	200	160	Lawn	Lawn	4	4	2	5
097A1	12	Duck Creek	05/05/09	Both	Neither	15	15	150	225	Lawn	Lawn	4	4	3	5
097B1	60	Duck Creek	04/30/09	Both	Neither	20	30	100	300	Lawn	Lawn	4	3	2	3
097B1	88	Duck Creek	05/05/09	Left	Neither	25		400		Lawn	Forest	4	3	3	4
097C2	49	Muddy Gut	06/23/09	Right	Neither		15		175	Shrubs & small trees	Lawn, Paved, Shrubs & Small trees	4	5	1	5

Tidal Back River SCA Survey Sites:
Inadequate Buffer

Map	Site	Stream	Date	Sides	Unshaded	Width Left (ft)	Width Right (ft)	Length Left (ft)	Length Right (ft)	LandUse Left	LandUse Right	Severity	Correct-ability	Access	Wetland
097C3	10	Muddy Gut	06/24/09	Left	Neither	25		700		Paved	Forest	4	5	3	4
097B1	30	Deep Creek	04/28/09	Left	Neither	20		900		Road right of way		5	5	1	5
097C2	03	Deep Creek	04/28/09	Right	Neither		25		200	Shrubs & small trees	Lawn	5	1	1	5
097B1	81	Duck Creek	05/05/09	Left	Neither	15		100		Lawn	Forest	5	3	4	3
097B1	82	Duck Creek	05/05/09	Left	Neither	25		150		Lawn	Forest	5	2	4	3

Tidal Back River SCA Survey Sites:
Trash Dumping

Map	Site	Stream	Date	Type	Truck-loads	Other measure	Extent	Volunteer Project?	Owner Type	Owner Name	Severity	Correct-ability	Access
097A1	09	Duck Creek	04/30/09	Construction	15		Single Site	No	Private		1	4	2
097C2	41	Muddy Gut	06/10/09	Construction, Machinery	25		Single Site	No	Private		1	4	2
096B3	15	Bread & Cheese	06/10/09	Yard waste	10		Single Site	No	Private		2	3	2
096C3	46	Bread & Cheese	06/10/09	Residential, Flotables, Commercial	5		Single Site	Yes	Unknown		2	3	2
096C3	52	Bread & Cheese	06/10/09	Residential, Flotables, Commercial	5		Large Area	Yes	Unknown		2	3	3
097A3	07	Bread & Cheese	05/19/09	Tires, Commercial	5		Large Area	No	Unknown		2	4	5
097C2	06	Deep Creek	04/28/09	Residential	5		Single Site	Yes	Private		2	3	2
090B3	02	Deep Creek	04/17/09	Residential	2		Single Site	No	Private	Private landowner	2	2	2
097B1	80	Duck Creek	04/30/09	Construction, Tires, Floatables	7		Large Area	No	Public		2	3	5
103C1	03	Bread & Cheese	05/19/09	Residential, Yard waste, Concrete rubble	7		Large Area	Yes	Unknown		3	3	3
103C1	11	Bread & Cheese	05/19/09	Residential	5		Single Site	Yes	Unknown		3	3	4
096B3	32	Bread & Cheese	06/10/09	Residential, Yard Waste	4		Large Area	Yes	Unknown		3	2	3
096C3	15	Bread & Cheese	05/19/09	Residential, Yard	4		Large Area	Yes	Unknown		3	3	3
096C3	07	Bread & Cheese	05/19/09	Commercial	3		Large Area	Yes	Unknown		3	3	2
096C3	28	Bread & Cheese	05/19/09	Residential	3		Single Site	Yes	Unknown		3	3	3
096C3	31	Bread & Cheese	05/19/09	Construction	2		Single Site	No	Unknown		3	4	5
097B1	31	Deep Creek	04/28/09	Residential	3		Large Area	Yes	Public	DOT ROW	3	3	2
090B3	09	Deep Creek	04/17/09	Roadside trash	2		Single Site	Yes	Public	ROW	3	1	1

Tidal Back River SCA Survey Sites:
Trash Dumping

Map	Site	Stream	Date	Type	Truck-loads	Other measure	Extent	Volunteer Project?	Owner Type	Owner Name	Severity	Correct-ability	Access
090B3	17	Deep Creek	04/17/09	Industrial		Note: Potential	Single Site	No	Private		3	2	1
097B1	54	Duck Creek	04/30/09	Yard waste	10		Large Area	Yes	Unknown		3	3	3
097A1	11	Duck Creek	05/05/09	Residential, Yard waste	9		Large Area	Yes	Unknown		3	2	1
097B1	68	Duck Creek	04/30/09	Concrete Rubble,	5		Single Site	No	Unknown		3	3	4
097B1	77	Duck Creek	04/30/09	Residential, Tires, Concrete Rubble	4		Single Site	No	Unknown		3	3	3
097A1	07	Duck Creek	04/30/09	Yard waste			Single Site	Yes	Public		3	3	2
096B3	03	Bread & Cheese	06/10/09	Residential	3		Single Site	Yes	Unknown		4	2	2
096C3	39	Bread & Cheese	06/10/09	Residential, Yard Waste	3		Large Area	Yes	Unknown		4	2	3
096B3	26	Bread & Cheese	06/10/09	Residential, Construction	2		Single Site	Yes	Unknown		4	3	4
097A3	04	Bread & Cheese	05/19/09	Road trash	1	Note: long-term pervasive	Single Site	Yes	Unknown		4	2	3
097B2	15	Deep Creek	04/30/09	Floatables, Yard	3		Single Site	Yes	Private		4	2	3
097C2	12	Deep Creek	04/28/09	Yard waste	3		Single Site	Yes	Private		4	2	2
097B2	04	Deep Creek	04/28/09	Residential	2		Large Area	Yes	Unknown		4	2	2
097B2	07	Deep Creek	04/28/09	Residential	2		Single Site	Yes	Unknown		4	2	2
097B1	18	Deep Creek	04/28/09	Residential	1		Single Site	Yes	Private		4	2	2
097B1	19	Deep Creek	04/28/09	Residential	1		Single Site	Yes	Private		4	2	3
097B1	26	Deep Creek	04/28/09	Residential	1		Large Area	Yes	Unknown		4	2	3
097B2	18	Deep Creek	04/30/09	Residential	1		Single Site	Yes	Private		4	1	2
097A1	17	Duck Creek	05/05/09	Yard waste	3		Single Site	Yes	Unknown		4	2	3
097B1	89	Duck Creek	05/05/09	Residential, Tires	3		Single Site	Yes	Unknown		4	2	2
097B1	75	Duck Creek	04/30/09	Commercial	2		Single Site	Yes	Private	Auto Zone	4	1	1
097B1	65	Duck Creek	04/30/09	Residential	1		Single Site	Yes	Public		4	1	1
097C2	50	Muddy Gut	06/23/09	Residential, Flotables, Appliances	1		Single Site	Yes	Unknown		4	2	2
096C3	13	Bread & Cheese	05/19/09	Commercial	1		Single Site	Yes	Unknown		5	1	3
097B1	39	Deep Creek	04/28/09	Residential	1		Single Site	Yes	Public		5	1	1

Tidal Back River SCA Survey Sites:
Channel Alteration

Map	Site	Stream	Date	Type	Bottom Width(in)	Length(ft)	Perennial Flow	Sediment-ation	Veg in Channel	Road Crossing	Length Above(ft)	Length Below(ft)	Severity	Correct-ability	Access
090B3	13	Deep Creek	04/17/09	Earth channel	45.6	1300	Yes	No	No	No			1	3	2
096B3	33	Bread & Cheese	06/10/09	Timber retaining wall; Failing in some locations	48	35	Yes	Yes	No	No			2	3	2
097B1	11	Deep Creek	04/17/09	Concrete	246	300	Yes		No	No			2	4	2
096B3	35	Bread & Cheese	06/10/09	Concrete	60	25	Yes	Yes	No	No			3	2	2
096C3	04	Bread & Cheese	05/19/09	Concrete	420	40	Yes	Yes	Yes	Both	0	40	3	3	1
096C3	09	Bread & Cheese	05/19/09	Concrete, Gabion	360	15	Yes	Yes	No	Below	0	15	3	1	2
096C3	36	Bread & Cheese	06/10/09	Timber retaining walls; Minor erosion around timber walls; Slightly undermined and rotting; Failure would threaten private infrastructure/driveway	46.8	100	Yes	Yes	No	No			3	3	1
097A3	06	Bread & Cheese	05/19/09	Concrete	180	500	Yes	Yes	Yes	No			3	4	3
090B3	03	Deep Creek	04/17/09	Earth channel	42	1300	Yes	No	No	No			3	3	2
097B1	32	Deep Creek	04/28/09	Rip-rap	114	450	Yes	Yes	No	No			3	3	2
097B1	44	Deep Creek	04/30/09	Concrete	164.4	12	Yes	Yes	No	Below	0	12	3	3	2
097B1	05	Deep Creek	04/17/09	Rip-rap	138	37	Yes	Yes	Yes	Below	0	37	3	3	1
097B1	71	Duck Creek	04/30/09	Rip-rap	87.6	100	Yes	No	No	Above	100	25	3	3	2
097C2	34	Muddy Gut	05/05/09	Rip-rap	144	25	Yes	Yes	Yes	No			3	1	1
098A3	03	Muddy Gut	06/23/09	Concrete	4	45	Yes	No	No	No			3	3	2
096C3	20	Bread & Cheese	05/19/09	Rip-rap	36	25	Yes	No	No	No			4	2	2
103C1	10	Bread & Cheese	05/19/09	Concrete rubble	144	30	Yes	No	No	No			4	3	3
097B1	21	Deep Creek	04/28/09	Concrete	204	300	Yes	Yes	Yes	No			4	4	2
097B1	35	Deep Creek	04/28/09	Concrete Rubble Bank Protection	55.2	100	Yes	Yes	No	No			4	3	1
097B1	67	Duck Creek	04/30/09	Concrete Rubble	67.2	150	Yes	No	No	No			4	3	4
097C2	29	Muddy Gut	05/05/09	Rip-rap	48	95	Yes	Yes	Yes	Below	0	95	4	1	2
097C2	39	Muddy Gut	06/10/09	Concrete Rubble	36	100	Yes	No	No	No			4	2	2
097C3	06	Muddy Gut	06/23/09	Rip-rap	24	30	Yes	Yes	Yes	Below		30	4	2	1

Tidal Back River SCA Survey Sites:
Channel Alteration

Map	Site	Stream	Date	Type	Bottom Width(in)	Length(ft)	Perennial Flow	Sediment-ation	Veg in Channel	Road Crossing	Length Above(ft)	Length Below(ft)	Severity	Correct-ability	Access
096C3	18	Bread & Cheese	05/19/09	Retaining wall	240	30	Yes	Yes	No	No			5	1	3
103C1	07	Bread & Cheese	05/19/09	Retaining wall	180	30	Yes	Yes	No	No			5	1	3
097B2	11	Deep Creek	04/28/09	Concrete Rubble	96	15	No	No	No	No			5	3	2
097A1	05	Duck Creek	04/30/09	Timber Tie Retaining Wall	42	25	Yes	No	Yes	Below	0	25	5	2	2
097B1	55	Duck Creek	04/30/09	Gabion	78	40	Yes	Yes	No	No			5	1	3

Tidal Back River SCA Survey Sites: Erosion

Map	Site	Stream	Date	Type	Possible Cause	Length (ft)	Height (ft)	Landuse Left	Landuse Right	Infra-structure Threatened?	Describe	Severity	Correct-ability	Access
090B3	07	Deep Creek	04/17/09	Scour	Pipe outfall	15	10	Roadside/ ROW	Roadside/ ROW	Yes		1	2	2
096C3	33	Bread & Cheese	05/19/09	Widening	Below road crossing	100	3	Forest	Forest	No		3	3	4
097C2	21	Muddy Gut	05/05/09	Widening	unknown	400	2.5	Forest	Forest	No		3	3	4
097C3	14	Muddy Gut	06/23/09	Widening	Below road	130	3	Forest	Forest	No		3	3	3
096B3	07	Bread & Cheese	06/10/09	Widening	Land use change upstream	50	5	Lawn	Lawn	No		4	2	2
096B3	17	Bread & Cheese	06/10/09	Widening	Meander Bend	120	5	Forest	Forest	No		4	3	4
096B3	22	Bread & Cheese	06/10/09	Widening	Land use change upstream	60	2.5	Lawn	Lawn	Yes	Cemetery	4	1	2
096B3	28	Bread & Cheese	06/10/09	Widening	Land use change upstream	80	3	Lawn	Lawn	Yes	Threat to private infrastructure	4	2	2
096C3	41	Bread & Cheese	06/10/09	Widening	Land use change upstream	75	3	Paved	Paved	Yes		4	2	2
103C1	02	Bread & Cheese	05/19/09	Widening	Below road crossing	100	5	Lawn	Lawn	No	Note: Failing fence line	4	2	3
103C1	04	Bread & Cheese	05/19/09	Widening	unknown	70	15	Lawn	Lawn	No		4	2	3
090B3	14	Deep Creek	04/17/09	Widening	Channel alteration	60	2.5	Lawn	Shrubs & Small Trees	No		4	2	3
097B1	46	Deep Creek	04/30/09	Widening	Pipe outfall	80	3	Forest	Lawn	No		4	3	2
097B1	07	Deep Creek	04/17/09	Widening	Land use change upstream	150	4	Lawn	Lawn	No		4	2	1
097C2	17	Deep Creek	04/28/09	Headcutting, Widening	Pipe outfall	40	3	Shrubs & Small Trees	Shrubs & Small Trees	No		4	3	2
097C2	43	Muddy Gut	06/10/09	Widening, Headcutting	Land use change upstream	50	1	Lawn	Lawn	No	Note: Headcut threatening to drain wetlands	4	2	1

Tidal Back River SCA Survey Sites:
Erosion

Map	Site	Stream	Date	Type	Possible Cause	Length (ft)	Height (ft)	Landuse Left	Landuse Right	Infra-structure Threatened?	Describe	Severity	Correct-ability	Access
097C2	18	Muddy Gut	05/05/09	Headcutting	unknown	100	0	Forest	Forest	No		4	3	3
097C3	11	Muddy Gut	06/23/09	Widening	Land use change upstream	80	2	Paved	Forest	No		4	2	2
096C3	22	Bread & Cheese	05/19/09	Widening	Land use change upstream	50	4	Forest	Forest	No		5	1	3
103C1	08	Bread & Cheese	05/19/09	Widening	Land use change	50	12	Lawn	Lawn	No		5	1	3
097B1	37	Deep Creek	04/28/09	Widening	Bend at steep	15	3	Lawn	Shrubs &	No		5	1	2
097B1	42	Deep Creek	04/28/09	Widening	Bend at steep slope	60	5	Lawn	Forest	Yes	Sidewalk undermined, collapse imminent	5	2	2
097C2	16	Deep Creek	04/28/09	Widening	Bend at steep slope	20	4	Shrubs & Small Trees	Shrubs & Small Trees	No		5	1	3
097A1	08	Duck Creek	04/30/09	Widening	Below road crossing	60	2.5	Lawn	Lawn	No		5	3	3
097B1	58	Duck Creek	04/30/09	Widening	Land use change	6	1	Lawn	Lawn	No		5	1	3
097C2	40	Muddy Gut	06/10/09	Widening	Land use change upstream	25	2	Lawn	Lawn	No		5	1	2

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
096B3	34	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe; Failed	Left bank	24			Yes	Clear; Green benthic growth	None	2	3	2
096C3	02	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Right bank	42			Yes	Orange	None	2	4	1
096C3	14	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	28			Yes	Clear; Note: Unusually high discharge	None	2	4	3
097B2	12	Deep Creek	04/30/09	Stormwater	Concrete Pipe	Head of stream	30			Yes	Dark Brown	None	2	3	1
097B1	59	Duck Creek	04/30/09	Stormwater	Concrete Pipe	Head of stream			68.4 x 36	Yes	Gray	Petroleum & Laundry water	2	5	2
097B1	66	Duck Creek	04/30/09	Unknown	Plastic	Right bank	1.5			Yes	Bright orange	None	2	2	2
097C3	02	Muddy Gut	06/23/09	Stormwater	Concrete Pipe	Right bank			18x24	Yes	Orange, concentrated Ferric Oxide	None	2	4	1
096B3	01	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Head of stream			54 x 30	Yes	Clear	Organic	3	2	1
096B3	19	Bread & Cheese	06/10/09	Stormwater	PVC	Right bank	8			Yes	Clear	None	3	3	2
096B3	20	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Right bank	12			Yes	Orange - Ferric oxide	None	3	3	2
096B3	23	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Head of stream	48			Yes	Clear; Evidence of road runoff/gravel/tras h	None	3	3	2
096B3	31	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Left bank	12			Yes	Orange, Ferric oxide	None	3	5	1
096C3	26	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	33			Yes	Algae growth inside pipe	Organic	3	3	2
096C3	38	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Left bank	33			Yes	Clear; Green benthic growth	None	3	3	2
096C3	42	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Left bank	12			Yes	Brown benthic growth and sheen	None	3	3	3

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
096C3	45	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Right bank	18			Yes	Clear	Organic	3	3	2
096C3	47	Bread & Cheese	06/10/09	Stormwater	Concrete gutter into earthen channel	Right bank		2		Yes	Clear	None	3	3	1
096C3	11	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Right bank	32			Yes	Clear; Note: Has broken joint	None	3	2	2
103C1	06	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Right bank	42			Yes	Clear	None	3	2	2
097B1	22	Deep Creek	04/28/09	Stormwater	CIP	Right bank	16			Yes	Light brown	None	3	2	2
097B1	23	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Left bank	16			Yes	Clear	None	3	2	2
097B1	25	Deep Creek	04/28/09	Stormwater	Concrete Channel	Left bank		2		Yes	Medium Brown	None	3	3	5
097B2	01	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	12			Yes	Dark Brown	Organic	3	3	3
097B2	02	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	30			Yes	Dark Brown	Organic	3	3	3
097C2	07	Deep Creek	04/28/09	Stormwater	Corrugated Metal	Left bank	36			Yes	Light brown	None	3	2	1
097B1	01	Deep Creek	04/17/09	Stormwater	Concrete Channel	Left bank		2.67		No			3	1	1
097A1	13	Duck Creek	05/05/09	Stormwater	Concrete Pipe	Left bank	36			Yes	Clear	Rotten eggs	3	3	2
097B1	83	Duck Creek	05/05/09	Stormwater	Concrete Pipe	Head of stream	36			Yes	Clear	None	3	3	2
097B1	56	Duck Creek	04/30/09	Stormwater	Concrete Pipe	Left bank	24			Yes	Clear	None	3	3	3
097A1	06	Duck Creek	04/30/09	Stormwater	Concrete Channel	Right bank		2		No			3	3	1
097C2	46	Muddy Gut	06/10/09	Stormwater	Concrete Pipe; Note: Trash at outfall	Left bank			30 x 16	Yes	Clear	None	3	2	1

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
096B3	04	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Left bank	24			Yes	Clear	None	4	2	2
096C3	16	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	30			Yes	Clear	None	4	1	3
096C3	19	Bread & Cheese	05/19/09	Stormwater	Clay	Left bank	15			Yes	Clear	None	4	2	2
096C3	23	Bread & Cheese	05/19/09	Stormwater	Corrugated Metal	Right bank			48 x 30	Yes	Clear	None	4	2	1
096C3	24	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	22			Yes	Clear; Evidence of algae & sooty silt deposition	None	4	2	1
096C3	40	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Right bank	30			Yes	n/a; Note: broken joint	n/a	4	2	2
096C3	50	Bread & Cheese	06/10/09	Stormwater	Concrete Pipe	Head of stream	36			Yes	Clear	None	4	2	1
097A3	02	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	24			Yes	Clear	None	4	2	3
097A3	05	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	60			Yes	Clear	None	4	2	3
103C1	09	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Left bank	18			Yes	Clear	None	4	1	3
103C1	12	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Right bank	18			Yes	Clear	None	4	2	3
096C3	06	Bread & Cheese	05/19/09	Stormwater	Concrete Channel	Right bank		7		No	None, but there is a black stain in channel		4	2	1
097B1	28	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	24			Yes	Dark Brown	Organic	4	2	2
097B1	40	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Left bank	30			Yes	Clear	None	4	2	3
097B1	41	Deep Creek	04/28/09	Stormwater	Galvanized Metal	Left bank	15			Yes	Light brown	None	4	3	1
097B1	43	Deep Creek	04/30/09	Stormwater	Concrete Pipe	Head of stream			75.6 x 45.6	Yes	Clear	None	4	2	1
097B2	09	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	18			Yes	Clear	None	4	1	1

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
097B2	10	Deep Creek	04/28/09	Stormwater	Corrugated Metal	Left bank			36 x 24	Yes	Green	None	4	2	1
097B2	16	Deep Creek	04/30/09	Stormwater	Concrete Pipe	Left bank	30			Yes	Clear	None	4	3	1
097B2	17	Deep Creek	04/30/09	Stormwater	Concrete Pipe	Left bank	24			Yes	Clear	None	4	2	1
097C2	01	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank			66 x 36	Yes	Light brown/ murky	None	4	1	1
097C2	02	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	24			Yes	Light brown	None	4	1	1
097C2	09	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Left bank	18			Yes	Clear	None	4	2	1
097C2	11	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Left bank	18			Yes	Clear	None	4	1	1
097C2	13	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	24			Yes	Clear	Organic	4	1	2
097C2	15	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Right bank	12			Yes	Light brown	None	4	2	3
097B1	45	Deep Creek	04/30/09	Stormwater	Concrete Channel	Right bank		6		No			4	2	1
097A1	16	Duck Creek	05/05/09	Stormwater	Concrete Pipe	Head of stream	24			Yes	Clear	None	4	2	3
097A1	01	Duck Creek	04/30/09	Stormwater	Concrete Pipe	Head of stream	54			Yes	Clear	None	4	2	2
097B1	85	Duck Creek	05/05/09	Stormwater	Plastic	Right bank	10			Yes	Clear	None	4	3	2
097B1	52	Duck Creek	04/30/09	Stormwater	Corrugated Metal	Head of stream			63.6 x 38.4	Yes	Clear	None	4	2	2
097B1	70	Duck Creek	04/30/09	Unknown	VCP	Left bank	24			Yes	Clear	None	4	4	2
097C2	20	Muddy Gut	05/05/09	Stormwater	Rip-rap	Left bank		2		Yes	Clear	None	4	2	2
097C2	35	Muddy Gut	05/05/09	Stormwater	Concrete Pipe	Left bank	48			Yes	Clear	None	4	2	1
097C2	44	Muddy Gut	06/10/09	Stormwater	Concrete Pipe	Right bank			30 x 16	Yes	Clear	None	4	2	1

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
103C1	05	Bread & Cheese	05/19/09	Stormwater	Corrugated Metal	Right bank	18			Yes	Clear	None	5	1	3
096C3	03	Bread & Cheese	05/19/09	Stormwater	Concrete Pipe	Right bank	18			No			5	1	1
090B3	06	Deep Creek	04/17/09	Stormwater	Corrugated Metal	Right bank	36			Yes	Clear	None	5	1	1
090B3	15	Deep Creek	04/17/09	French drain	Plastic	Left bank	1.5			Yes	Clear	None	5	1	1
090B3	16	Deep Creek	04/17/09	Stormwater	Corrugated Metal	Left bank	12			Yes	Clear	None	5	1	1
097B1	03	Deep Creek	04/17/09	Stormwater	Corrugated Metal	Left bank	48			Yes	Clear	None	5	1	1
097B1	04	Deep Creek	04/17/09	Stormwater	Corrugated Metal	Right bank	36			Yes	Clear	None	5	1	1
097B1	08	Deep Creek	04/17/09	Stormwater	Plastic	Left bank	4			Yes	Clear	None	5	1	1
097B1	13	Deep Creek	04/17/09	Stormwater	Concrete Pipe	Left bank	24			Yes	Clear	None	5	1	1
097B1	14	Deep Creek	04/17/09	Stormwater	Concrete Pipe	Right bank	15			Yes	Clear	None	5	1	1
097B1	15	Deep Creek	04/17/09	Stormwater	Concrete Pipe	Right bank	15			Yes	Clear	None	5	1	1
097B1	36	Deep Creek	04/28/09	Stormwater	Concrete Pipe	Left bank	48			Yes	Clear	None	5	1	1
097B1	49	Deep Creek	04/30/09	Stormwater	Concrete Pipe	Head of stream	16			Yes	Clear	None	5	1	1
097B1	16	Deep Creek	04/17/09	Stormwater	Concrete Pipe	Left bank	18			Yes	Algae growth	None	5	-1	0
090B3	11	Deep Creek	04/17/09	Stormwater	Concrete Pipe	Left bank	24			No			5	1	1
097C2	04	Deep Creek	04/28/09	Stormwater	Rip-rap Channel	Left bank		10.8		No			5	1	1
097A1	10	Duck Creek	05/05/09	Stormwater	Concrete Pipe	Head of stream	18			Yes	Clear	None	5	2	1
097B1	61	Duck Creek	04/30/09	Stormwater	Corrugated Metal	Head of stream	24			No			5	1	1
097B1	76	Duck Creek	04/30/09	Stormwater	PVC	Right bank	18			No			5	1	1

Tidal Back River SCA Survey Sites:
Pipe Outfalls

Map	Site	Stream	Date	Outfall Type	Pipe Type	Location of Pipe	Diameter (in)	Channel Width (ft)	Elliptical Pipe Size (in)	Discharge	Color	Odor	Severity	Correct-ability	Access
097C2	35	Muddy Gut	06/10/09	Stormwater	Concrete Pipe	Right bank			30 x 16	Yes			5	1	1
097C2	36	Muddy Gut	06/10/09	Stormwater	Concrete Pipe	Right bank			30 x 16	Yes			5	1	1

Tidal Back River SCA Survey Sites:
Exposed Pipe

Map	Site	Stream	Date	Location of Pipe	Type	Diameter (in)	Length (ft)	Purpose	Discharge	Color	Odor	Severity	Correct-ability	Access
096C3	53	Bread & Cheese	06/10/2009	Exposed manhole	concrete			sewage	No	-	-	2	4	3
097B2	05	Deep Creek	04/28/2009	Exposed across bottom of stream	concrete	30	18.4	unknown	No	-	-	3	4	3
097B1	73	Duck Creek	04/30/2009	Exposed across bottom of stream	Concrete encasement		7.3	unknown	No	-	-	3	3	1
096C3	44	Bread & Cheese	06/10/2009	Exposed manhole	unknown			sewage	No	-	-	4	2	2
096C3	48	Bread & Cheese	06/10/2009	Exposed manhole, grouted rip-rap protective encasement is undermined	unknown			sewage	No	-	-	4	2	1
096C3	49	Bread & Cheese	06/10/2009	Exposed manhole	unknown			sewage	No	-	-	4	2	1
097B1	27	Deep Creek	04/28/2009	Exposed manhole	Pipe not exposed		0	sewage	No	-	-	5	1	4

Tidal Back River SCA Survey Sites:
Fish Barrier

Map	Site	Stream	Date	Blockage	Type	Reason	Drop(In)	Depth(In)	Severity	Correct-ability	Access
097B1	02	Deep Creek	04/17/2009	Total	Road crossing	Too high	42		1	5	1
090B3	08	Deep Creek	04/17/2009	Total	Road crossing	Too shallow		0.75	2	5	2
097B1	74	Duck Creek	04/30/2009	Total	Failed rip-rap, Concrete sewer encasement	Too hight, Too shallow, Too fast	13.2	0.24	2	4	2
096B3	21	Bread & Cheese	06/10/2009	Total	Road crossing	Too high	43.2		3	4	2
096C3	08	Bread & Cheese	05/19/2009	Total	Pipe outfall	Too shallow		1.2	3	4	1
096C3	17	Bread & Cheese	05/19/2009	Total	Road crossing	Too high, too shallow	10	1.2	3	3	3
096C3	34	Bread & Cheese	06/10/2009	Partial	Road crossing	Too high	10.8		3	3	1
097A1	03	Duck Creek	04/30/2009	Total	Road crossing	Too shallow		0.75	3	3	2
097C2	19	Muddy Gut	05/05/2009	Total	Road crossing	Too shallow		0.36	3	3	2
097C2	30	Muddy Gut	05/05/2009	Total	Road crossing	Too shallow		0.6	3	3	2
096B3	09	Bread & Cheese	06/10/2009	Partial	Stream crossing under neighborhood	Too shallow		0.6	4	3	2
097B1	29	Deep Creek	04/28/2009	Partial	Debris dam	Too high	18		4	1	1
097B1	38	Deep Creek	04/28/2009	Total	Debris dam	Too high	24		4	1	3
097C2	47	Muddy Gut	06/23/2009	Partial	Stream crossing	Too shallow		1	4	3	2

Tidal Back River SCA Survey Sites:
In or Near Stream Construction

Map	Site	Stream	Date	Type of Activity	Sediment Control	Why, if inadequate	Excess Sediment?	Length (ft)	Company	Location	Severity
096B3	06	Bread & Cheese	06/10/09	Development of recreation area	Adequate	Note: Construction activities have completely cleared buffer.	No	500	unknown	End of Edsworth Rd.	2
097B2	14	Deep Creek	04/30/09	Road	Inadequate	No inlet protection utilized	Yes	450	Gray & Son	Mansfield Rd.	2
096B3	24	Bread & Cheese	06/10/09	Cemetery grading	Inadequate	Holes in sediment fence, insufficient length of sediment fence.	Yes	500	KEMP Contracting Inc.	Oaklawn Cemetery, Eastern Ave.	4
097C2	31	Muddy Gut	05/05/09	Utility	Adequate		Yes	30	completed	South bound shoulder of 702	5

Tidal Back River SCA Survey Sites:
Unusual Conditions

Map	Site	Stream	Date	Type	Describe	Description	Potential Cause	Severity	Correct-ability	Access
097B1	86	Duck Creek	05/05/2009	Comment		Invasive vegetation - English Ivy coverage 150' x 100'; Killing trees, multiple killed; Multiple large diameter trees in poor health; Invading a wetland		1	3	3
097C2	26	Muddy Gut	05/05/2009	Comment		ATV Trails; Disturbances to and destruction of streambed, bank, and forested wetlands.	ATV's	1	3	5
096C3	27	Bread & Cheese	05/19/2009	Unusual Condition	Sewage Discharge	Some evidence of possible sewage discharge, not certain; Dark black, organic-smelling deposits; Algae growth in heavily shaded area; Light grey tint to water		2	5	2
096B3	25	Bread & Cheese	06/10/2009	Unusual Condition		ATV trails destroying stream banks and bed	ATVs	2	2	3
096B3	16	Bread & Cheese	06/10/2009	Comment		Ferric oxide leachate		2	4	4
096B3	29	Bread & Cheese	06/10/2009	Unusual Condition		Small, private pedestrian bridge with abutment failure; collapse imminent		2	2	3
097C2	14	Deep Creek	04/28/2009	Unusual Condition		Invasive species		2	3	3
097B1	87	Duck Creek	05/05/2009	Comment		Invasive vegetation - English Ivy area 100' x 100'; Young growth; Killing trees, multiple killed; A lot of trees in poor helth; Invasion of wetland		2	3	3
097C2	25	Muddy Gut	05/05/2009	Comment		ATV Trails; Disturbances to and destruction of streambed, bank, and forested wetlands.	ATV's	2	1	5
097C2	48	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		2	5	2
097A3	01	Bread & Cheese	05/19/2009	Unusual Condition		Gravel and dirt fill destroying forested wetland; Likely not a permitted/ mitigated area	Construction company	3	3	1
096C3	32	Bread & Cheese	05/19/2009	Unusual Condition		Destruction of stream bed, bank, and buffer due to mountain bike trail	Mountain bikes	3	3	5
096C3	05	Bread & Cheese	05/19/2009	Comment		4 Cell CMP Culverts under commercial access road at AMF Dundalk Lanes: partial debris clogging at 2 culverts; 2 culverts are buckling, shifting and allowing for loss of raodway fill - partial to complete detachment from headwall.		3	4	1

Tidal Back River SCA Survey Sites:
Unusual Conditions

Map	Site	Stream	Date	Type	Describe	Description	Potential Cause	Severity	Correct-ability	Access
096B3	05	Bread & Cheese	06/10/2009	Unusual Condition	Excessive Algae	Large algal blooms in stream	Runoff from lawns; No buffer and no shade	3	2	2
096B3	08	Bread & Cheese	06/10/2009	Unusual Condition		Debris build-up at stream crossing		3	1	2
096C3	43	Bread & Cheese	06/10/2009	Unusual Condition		Small stand of japanese knotweed; Early treatment will prevent spread		3	2	2
097A3	09	Bread & Cheese	05/19/2009	Unusual Condition		Mountain bike tracks ruining stream bank and bank bed buffer	Mountain bikes	3	2	5
096B3	14	Bread & Cheese	06/10/2009	Unusual Condition		Clogging of stream crossing - debris and sediment; 25% of capacity remains		3	2	2
096B3	13	Bread & Cheese	06/10/2009	Comment		Ferric oxide leachate from streambed; Sheen from bacteria		3	4	2
090B3	05	Deep Creek	04/17/2009	Unusual Condition		Person living along stream bank just upstram of road crossing. Resident noted man has lived there for 6 years.		3	-1	1
097B2	03	Deep Creek	04/28/2009	Unusual Condition	Excessive Algae	Dark brown water; Large green algal blooms	Evidence of fertilizer	3	3	3
090B3	04	Deep Creek	04/17/2009	Unusual Condition		English Ivy; Good volunteer opportunity		3	1	1
097B1	17	Deep Creek	04/17/2009	Unusual Condition	Excessive Algae		Field fertilizers (school)	3	1	1
097B1	84	Duck Creek	05/05/2009	Unusual Condition		Evidence of pollutants in storm drain runoff; Foam; Sheen on water surface; Algal growth on concrete apron and outfall	unknown	3	3	3
097C2	51	Muddy Gut	06/23/2009	Unusual Condition		Multiple ATV trail crossings destroying stream banks and bed	ATVs	3	2	2
097C3	13	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	2
097C3	08	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	3
097C3	03	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	1

Tidal Back River SCA Survey Sites:
Unusual Conditions

Map	Site	Stream	Date	Type	Describe	Description	Potential Cause	Severity	Correct-ability	Access
097C3	01	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	2
097C3	17	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	4
097C3	19	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		3	5	4
097B1	72	Duck Creek	04/30/2009	Unusual Condition		Young growth of japanese knot weed. Early treatment could prevent spread.		4	2	1
097C3	15	Muddy Gut	06/23/2009	Unusual Condition		ATV trails destroying stream bank and bed	ATVs	4	2	3
097C2	52	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		4	4	3
098A3	02	Muddy Gut	06/23/2009	Unusual Condition		Ferric Oxide		4	4	2
097C3	18	Muddy Gut	06/23/2009	Unusual Condition		ATV trails destroying stream bank and bed	ATVs	4	2	4
097B1	09	Deep Creek	04/17/2009	Unusual Condition		Remains of washed-out stream crossing (concrete)	Failure of previous crossing	5	3	1
097B1	20	Deep Creek	04/28/2009	Unusual Condition		Drop inlet directly into the stream; No buffer surrounding inlet		5	3	3
097A1	14	Duck Creek	05/05/2009	Comment		Sheen, bubbles, and organic smell on the water surface at outfall		5	3	2
097C3	07	Muddy Gut	06/23/2009	Comment		Chesapeake Bay Critical Area Easement - Baltimore County DEPRM		5	1	3

Tidal Back River SCA Survey Sites:
Representative Sites

Map	Site	Stream	Date	Epifaunal Substrate	Pool Substrate	Pool Variability	Sediment Deposition	Channel Flow Status	Channel Alteration	Channel Sinuosity	Bank Stability	Bank Veg Protection	Riparian Veg.	Width Riffle (in)	Width Run (in)	Width Pool (in)	Depth Riffle (in)	Depth Run (in)	Depth Pool (in)	Bottom Type
096B3	11	Bread & Cheese	6/10/2009	1	2	1	1	2	1	0	2	1	0	27.6	14.4	24	0.6	1.8	4.2	Gravel
096B3	30	Bread & Cheese	6/10/2009	2	2	2	1	2	3	2	1	1	1	66	42	64.8	2.4	4.8	12	Gravel
096C3	12	Bread & Cheese	5/19/2009	2	3	3	2	3	2	1	2	3	1	75.6	66	91.2	3	4.2	8.4	Sand
097A3	08	Bread & Cheese	5/19/2009	1	2	3	1	3	3	2	2	2	3	72	72	144	1.2	3	7.8	Sand
097B1	10	Deep Creek	4/17/2009	1	2	2	2	3	2	1	2	1	1	66	60	72	1.8	5.4	12.6	Sand
097B1	33	Deep Creek	4/28/2009	0	1	0	0	3	0	0	3	1	1	120	110.4	146	7.8	9.6	10.2	Silt
097B1	48	Deep Creek	4/30/2009	2	1	2	1	3	2	0	1	2	1	114	116.4	152.4	9.6	10.8	18	Silt
097B1	51	Deep Creek	4/30/2009	1	1	1	1	3	2	2	1	2	1	43.2	31.2	42	1.2	1.8	3.6	Silt
097B2	08	Deep Creek	4/28/2009	1	1	1	2	2	3	2	3	3	2	10.8	27	63.6	0.6	3.6	4.44	Silt
097B2	19	Deep Creek	4/30/2009	1	1	1	1	3	3	1	2	2	0	45.6	57.6	62.4	2.4	4.2	10.8	Silt
097C2	10	Deep Creek	4/28/2009	1	2	1	1	2	3	1	3	3	1	19.2	33.6	56.4	2.52	4.2	11.4	Silt
097B1	57	Duck Creek	4/30/2009	0	1	0	0	3	2	0	1	0	0	93.6	93.6	88.8	7.2	8.4	12	Silt
097B1	63	Duck Creek	4/30/2009	2	2	1	2	2	3	3	3	3	2	66	48	66	1	3.6	8.4	Sand
097B1	64	Duck Creek	4/30/2009	2	2	2	1	2	3	2	3	3	3	80.4	90	72	0.6	1.8	4.8	Sand
097B1	79	Duck Creek	4/30/2009	3	3	3	2	3	3	1	3	3	3	42	48	110.4	1.2	1.8	13.2	Sand
097B1	91	Duck Creek	5/5/2009	1	1	0	1	2	2	1	3	2	0	27.6	42	92.4	4.8	7.2	7.2	
097C2	22	Muddy Gut	5/5/2009	2	3	3	2	2	3	3	1	2	3	18	24	49.2	1.2	2.64	5.04	Silt
097C2	24	Muddy Gut	5/5/2009	2	2	1	2	3	3	1	3	3	3	14.4	39.6	81.6	3	3.6	3.6	Silt
097C2	27	Muddy Gut	5/5/2009	2	2	1	1	3	2	2	2	3	3	33.6	30	40.8	3.6	4.8	6	Silt
097C2	28	Muddy Gut	5/5/2009	2	1	1	1	3	2	1	2	3	3	43.2	46.8	48	6	6	9.6	
097C3	04	Muddy Gut	6/23/2009	1	1	1	2	2	3	2	2	3	3	7	17	25	1	1.5	2.5	Silts
097C3	09	Muddy Gut	6/23/2009	2	1	2	2	2	3	2	3	3	3	11	35	52	1	4	8	Silts
097C3	12	Muddy Gut	6/23/2009	1	1	1	1	2	3	2	2	2	2	10	12	33	0.19	0.75	3	Silts
097C3	16	Muddy Gut	6/23/2009	2	3	3	2	2	2	3	2	3	3	8	36	34	0.38	2	4.5	Sands

Habitat Parameter Ratings:

3 - Optimal
2 - Suboptimal
1 - Marginal
0 - Poor

APPENDIX C:

UPLANDS SURVEY DATA

Tidal Back River Uplands Survey:
NSA Data

NEIGHBORHOOD INFORMATION																
NSA_ID	Subshed	Name	PSI	ROI	NSA Acres	Imperv. Acres	% Imperv.	LotSize (acres)	%Lot Imperv.	%Connected Spouts	%Lot Scape	%Lot Canopy	%Lawns High	%Lots with Trash	%Homes with Pools
NSA_E_01A	Bread & Cheese	Berkshire/ Beverly Hills	High	High	89.50	39.4	44	<1/8	50	65	10	15	10	20	4
NSA_E_01B	Bread & Cheese	Eastview/ Eastern Heights	High	Moderate	36.50	7.9	22	<1/4	40	80	15	20	5	25	4
NSA_E_02A	Bread & Cheese	Northshire	High	High	43.40	10.3	24	<1/4	35	70	10	15	30	0	15
NSA_E_02B	Bread & Cheese	Meadow/ Plainfield Rd	Moderate	Moderate	12.10	2.9	24	<1/4	35	60	10	10	10	0	9
NSA_E_02C	Bread & Cheese	Gray Manor	Moderate	Moderate	32.20	8.8	27	<1/4	45	60	10	15	10	0	14
NSA_E_03	Back River-A	North Point	Moderate	Moderate	16.30	4.9	30	<1/4	50	50	10	30	0	15	15
NSA_E_04	Back River-A	Beachwood North	High	Moderate	17.90	3.5	20	1/2	25	25	10	10	50	0	33
NSA_E_05	Back River-A	Beachwood Estates	High	Moderate	76.20	24.6	32	<1/4	50	25	5	10	50	0	1
NSA_E_06A	Greenhill Cove/ Lynch Pt	River Drive Rd	Moderate	Moderate	37.40	12.3	33	<1/4	45	65	5	15	10	5	8
NSA_E_06B	Greenhill Cove/ Lynch Pt	Lynch Point	High	High	48.90	16.2	33	<1/4	50	55	5	20	10	10	10
NSA_E_07	Back River-F	Swan Point	Moderate	Moderate	43.70	15.1	35	<1/4	40	35	10	30	15	5	8
NSA_E_08	Duck Creek	Eastern Terrace	High	Moderate	35.00	12.9	37	<1/4	40	60	10	15	20	0	15
NSA_E_09	Duck Creek	Wiltshire/ Magnolia Terrace	Moderate	Moderate	12.60	5.4	43	<1/8	60	75	10	15	20	10	0
NSA_E_10A	Duck Creek	Mt Holly Terrace	Moderate	Moderate	9.00	3.6	40	<1/4	40	70	10	15	10	0	6
NSA_E_10B	Duck Creek	Villa Capri	Moderate	Moderate	6.00	2.9	51	<1/8	70	70	10	5	50	10	0
NSA_E_11A	Duck Creek	Essex	High	Moderate	120.00	42.4	34	<1/4	40	70	10	10	30	0	9
NSA_E_11B	Duck Creek	Delaware Ave (Duplexes)	High	High	4.40	1.4	32	<1/8	30	70	5	15	0	10	0
NSA_E_12A	Duck Creek	Franklin/Dorsey	High	Moderate	73.10	23	32	<1/4	50	40	10	15	25	0	10
NSA_E_12B	Duck Creek	Urbanwood	Moderate	Moderate	3.10	0.7	23	<1/4	50	60	10	25	10	0	36
NSA_E_13A	Duck Creek	Silver Manor/ Glassco	High	Moderate	16.90	5.4	32	<1/4	45	40	10	20	25	10	24
NSA_E_13B	Duck Creek	Virginia Ave	Moderate	Moderate	5.50	1.9	35	<1/4	50	60	10	5	5	0	22
NSA_E_14	Duck Creek	Essex Village/ Marlyn Gardens	High	High	11.80	3.9	33	Multifamily	40	90	5	30	0	0	0
NSA_E_15	Duck Creek/ Deep Creek	Martindale	High	Moderate	117.00	39.2	34	<1/4	40	35	15	25	5	15	10
NSA_E_16A	Duck Creek/ Deep Creek	Homburg	High	Moderate	65.80	14.9	23	1/4	30	60	15	20	20	0	11
NSA_E_16B	Deep Creek	Edgewood Park	Moderate	Low	17.10	4.3	25	<1/4	50	40	5	20	10	10	14
NSA_E_17	Deep Creek	Country Ridge	High	High	59.00	26.5	45	<1/8	70	50	10	15	5	35	10

Tidal Back River Uplands Survey:
NSA Data

NEIGHBORHOOD INFORMATION																
NSA_ID	Subshed	Name	PSI	ROI	NSA Acres	Imperv. Acres	% Imperv.	LotSize (acres)	%Lot Imperv.	%Connected Spouts	%Lot Scape	%Lot Canopy	%Lawns High	%Lots with Trash	%Homes with Pools
NSA_E_18A	Deep Creek	Kings Mill	Moderate	Moderate	38.50	11.9	31	Multifamily	40	30	0	15	0	0	0
NSA_E_18B	Deep Creek	Middleborough Apts/Pebble Creek	Moderate	Moderate	23.20	9.2	40	Multifamily	40	70	5	25	0	5	1
NSA_E_19A	Deep Creek	Waterford Landing	Moderate	Moderate	11.60	4.1	36	Multifamily	60	75	15	25	100	0	0
NSA_E_19B	Deep Creek	Mansfield Woods	Moderate	Moderate	31.80	12.2	38	Multifamily	50	25	0	25	0	0	0
NSA_E_20	Deep Creek	East Roc/Harbor Point Estates	High	High	49.60	18.8	38	Multifamily	50	70	5	20	65	10	1
NSA_E_21	Deep Creek/ Back River-G	Fox Ridge Manor (West)	High	High	56.70	25.7	45	<1/8	60	50	15	15	0	20	7
NSA_E_22A	Deep Creek/ Back River-G	Hyde Park Apts	Moderate	Moderate	15.60	5.5	36	Multifamily	50	30	5	25	0	0	0
NSA_E_22B	Deep Creek	South Woods Apts	High	Moderate	11.60	3.4	29	Multifamily	40	60	0	30	0	5	0
NSA_E_22C	Deep Creek/ Muddy Gut	Queens Purchase	High	Moderate	24.70	8.6	35	Multifamily	35	70	10	25	0	0	0
NSA_E_22D	Deep Creek/ Muddy Gut	Hartland Apts	High	Moderate	28.30	11.7	41	Multifamily	55	80	0	20	0	0	0
NSA_E_23	Deep Creek/ Back River-G	Fox Ridge Manor (East)	Moderate	Moderate	24.80	8.9	36	<1/8	40	50	5	20	0	0	2
NSA_E_24	Muddy Gut	Walnut Point	Moderate	Moderate	58.90	14.6	25	1/4	40	0	5	0	30	0	0
NSA_E_25	Muddy Gut/ Back River-G	Goodwood Farms	Moderate	Moderate	76.70	10.5	14	1/2	25	60	10	20	20	0	4
NSA_E_26	Muddy Gut/ Back River-G	Hyde Park	High	Moderate	97.10	24.2	25	1/4	35	60	10	25	10	10	9
NSA_E_27	Muddy Gut	Cape May	Moderate	Moderate	8.40	2.2	26	<1/4	80	70	5	7	10	0	16
NSA_E_28	Muddy Gut	Cherry Gardens	High	Moderate	30.80	4.9	16	1/4	40	30	15	30	0	25	5
NSA_E_29	Longs Creek	Back River Neck Park	Moderate	Moderate	30.20	6.9	23	1/4	40	60	15	15	10	5	7
NSA_E_30	Longs Creek	Evergreen Park	Moderate	Moderate	40.50	7.3	18	1/4	50	30	10	30	0	10	1
NSA_E_31	Longs Creek	Wildwood Beach/Holly Farm	Moderate	Moderate	20.20	3.9	20		45	30	10	10	15	5	0
NSA_E_32	Back River-A	Beachwood	Moderate	Moderate	11.50	5.6	49	Mobile Home	60	80	10	10	40	0	0

Tidal Back River Uplands Survey:
NSA Data

	RECOMMENDED ACTIONS															
NSA_ID	Dwn-spout Redirect	Rain barrel	Rain garden	Stencil	Bay Scape	Lot Canopy	Fertilizer Reduction	Pet Waste	Trash Mgmt	Buffer Impact	#Street Trees	#Shade Trees	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other Action/Comments
NSA_E_01A		X		X				X	X	X	100			X	X	Long-term car parking, cars parked near stream along buffer, trash
NSA_E_01B	X	X				X			X	X	0					Trash/junk in several yards, outdoor chemical storage
NSA_E_02A	X	X		X		X	X			X	100					Pool education
NSA_E_02B	X	X		X		X					0					
NSA_E_02C	X	X		X		X				X	100					
NSA_E_03	X	X						X		X	0					Pool education
NSA_E_04	X	X	X	X	X	X	X				0					Pool education
NSA_E_05	X	X		X		X	X				0					Community pool, some street trees but < 4 ft
NSA_E_06A	X	X		X	X	X				X	0	10				Community park, standing water in streets
NSA_E_06B	X	X		X		X	X			X	0	20			X	Strong fertilizer odor, mostly organic matter along curb, pool education, long-term parking
NSA_E_07	X	X				X					0					No curb & gutter but sediment issues
NSA_E_08	X	X		X			X	X			0					
NSA_E_09	X	X		X		X	X				0					
NSA_E_10A	X	X		X							0					
NSA_E_10B	X	X		X		X	X			X	0	15	X			Runoff (e.g., car washing) from backyard and parking lot straight into Back River
NSA_E_11A	X	X		X		X	X				100					
NSA_E_11B	X	X	X	X							50				X	Curb & gutter sediment
NSA_E_12A	X	X		X		X	X				100				X	Pool education, long-term car parking
NSA_E_12B	X	X		X		X				X	0					SWM pond
NSA_E_13A	X	X		X		X	X			X	0					Pool education, no curb but inlets adjacent to lawns - sediment
NSA_E_13B	X	X		X		X				X	30					Pool education
NSA_E_14	X	X	X	X	X	X			X	X	40	30	X		X	Curb & gutter org matter, bulk trash dumping in parking lot
NSA_E_15		X		X		X					100				X	Pool education, long-term car parking
NSA_E_16A	X	X		X	X	X	X				75					Pool education
NSA_E_16B	X	X				X					0					
NSA_E_17		X		X				X	X	X	100			X	X	Dumping in backyards, pool education

Tidal Back River Uplands Survey:
NSA Data

NSA_ID	Dwn-spout Redirect	Rain barrel	Rain garden	Stencil	Bay Scape	Lot Canopy	Fertilizer Reduction	Pet Waste	Trash Mgmt	Buffer Impact	#Street Trees	#Shade Trees	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other Action/Comments
	RECOMMENDED ACTIONS															
NSA_E_18A	X		X	X	X	X					0	50	X		X	Potential bioretention; significant open space for trees
NSA_E_18B	X	X	X	X	X	X			X		0	75	X			Lids open on most dumpsters, trash on ground and animals in dumpsters
NSA_E_19A	X	X		X	X	X	X			X	0	50	X			Curb cuts & riprap channel direct runoff to river
NSA_E_19B				X	X	X				X	0	100				
NSA_E_20				X	X	X	X			X	100	75	X			Community pool, buffer planting, playgrd/storage area retrofit, bare soil
NSA_E_21		X		X				X	X		100			X	X	Fox Ridge park, outdoor chemical storage, alley dumping
NSA_E_22A				X	X	X					0	75	X			Bare soil, concrete channels to inlet & grass areas (standing water and erosion)
NSA_E_22B				X	X	X			X	X	40	100	X		X	Bare soil, buffer planting, educate to keep dumpster lids closed, cigarette receptacles
NSA_E_22C	X	X		X	X	X			X		50	75				Overflowing dumpsters, pollen & grass clippings on sidewalks & parking lot
NSA_E_22D	X	X		X	X	X			X	X	10	100	X			Overturned dumpster near stream, pollen & grass clippings on sidewalks
NSA_E_23				X							100					
NSA_E_24				X	X	X	X				50					Several SWM ponds, 2 locations w/ curb cut & swale
NSA_E_25	X	X	X		X	X	X				0					Cheseapeake Bay critical area
NSA_E_26	X	X			X	X					0	5				Sediment, mechanic
NSA_E_27	X	X		X		X					0					
NSA_E_28	X	X			X	X			X	X	0					Junk in most yards, most have a boat
NSA_E_29	X	X	X		X	X				X	0					No curbs, standing water, some junk in yards
NSA_E_30	X	X	X		X	X				X	0					No curbs, standing water & erosion, bare soil in several yards
NSA_E_31		X	X		X	X				X	0					
NSA_E_32	X	X			X	X	X				0					

Tidal Back River Uplands Survey:
HSI Data

Site_ID	HSI Status*	Category	Vehicle Operations	Outdoor Materials	Waste Mgmt	Physical Plant	Turf/ Landscape	Storm-Water	Comments
HSI_E_100	Confirmed	Commercial			X			X	Dumpster overflowing to stream, potential parking lot retrofit
HSI_E_101	Potential	Commercial	X	X					Tire service center, tires stored on asphalt near stream
HSI_E_400	Confirmed	Commercial	X		X	X		X	Trash dumping on east side of parking lot into stream
HSI_E_401	Confirmed	Other		X					Heavy machinery/construction materials stored adj to stream on residential property
HSI_E_600	Confirmed	Transport-related	X		X			X	Potential bioretention areas; more trash cans (with lids) needed
HSI_E_700	Severe	Commercial			X	X		X	Dumping, leaks from pool store/dumpster stains to stream
HSI_E_701	Confirmed	Commercial			X				Dumping, overflowing dumpsters
HSI_E_703	Confirmed	Commercial			X			X	Unlabeled drums (some sideways) & trash in fenced area
HSI_E_704	Severe	Commercial	X	X				X	Tire/service & garden center drain to inlets, housekeeping reminders
HSI_E_705	Confirmed	Commercial		X		X		X	Plants stored outside & uncovered, no inlets

*Notes:
- Potential hotspot – no observed pollution, some potential sources present
- Confirmed hotspot – pollution observed, many potential sources
- Severe hotspot – multiple polluting activities observed

Tidal Back River Uplands Survey:
ISI Data

Site ID	Subshed	Name	Type	Ownership	Storm Drain Stenciling	Estimated #Trees for Planting	Dwnspout Disconnect	Stormwater Retrofit
ISI_E_100	Deep Creek	Mars Elementary	Elem School	Public	X	100		
ISI_E_101	Deep Creek	Deep Creek Elementary	Elem School	Public	X	30		X
ISI_E_102	Deep Creek	Sandalwood Elementary	Elem School	Public	X	100		
ISI_E_103	Deep Creek/ Back River-G	Deep Creek Middle	Middle School	Public	X	100		X
ISI_E_300	Muddy Gut	Hyde Park VFD	Municipal	Public		30		
ISI_E_301	Muddy Gut	Back River Community Center	Community Center	Private	X	100	X	X
ISI_E_400	Duck Creek	St. Clare Parish	Faith-Based	Private	X	50	X	X
ISI_E_401	Duck Creek	Essex Fire Station	Municipal	Public		15		
ISI_E_402	Duck Creek	Apostolic Life Center	Faith-Based	Private		10	X	X
ISI_E_403	Duck Creek	Balt. Co. Precinct 11	Municipal	Public	X	75		X
ISI_E_404	Duck Creek	Sussex Elementary	Elem School	Public	X	100		X
ISI_E_500	Longs Creek	Maryland Environmental Services	Municipal	Public		10		
ISI_E_600	Duck Creek	Essex Elementary	Elem School	Public	X	50		
ISI_E_601	Duck Creek	Riverview Care Center	Care Center	Private	X	40		X
ISI_E_700	Bread & Cheese	Eastwood Center	Elem School	Public	X	30		X
ISI_E_701	Bread & Cheese	Oak Lawn	Cemetery	Private	X	100		
ISI_E_702	Bread & Cheese	Berkshire Elementary	Elem School	Public	X	75		X

Tidal Back River Uplands Survey:
ISI Data

Site ID	Subshed	Name	Type	Ownership	Storm Drain Stenciling	Estimated #Trees for Planting	Dwnspout Disconnect	Stormwater Retrofit
ISI_E_703	Bread & Cheese	Holy Cross	Cemetery	Private		0		
ISI_E_704	Bread & Cheese	Freedom Baptist	Faith-Based	Private		50	X	
ISI_E_705	Bread & Cheese	Heritage Center	Care Center	Private	X	0		X
ISI_E_706	Bread & Cheese	Calvary Baptist	Faith-Based	Private	X	75		X
ISI_E_707	Bread & Cheese	The Arc of Baltimore	Care Center	Private	X	15	X	
ISI_E_708	Bread & Cheese	Dundalk Assembly of God	Faith-Based	Private		50		X
ISI_E_900	Greenhill Cove	VFW Post 2678	Community Center	Private		60		X
ISI_E_901	Greenhill Cove	Edgemere Senior Center	Care Center	Private	X	10	X	
ISI_E_1000	Lynch Pt Cove	Edgemere Elementary	Elem School	Public	X	50		
ISI_E_1001	Lynch Pt Cove/ Back River-F	Sparrows Point Jr & Sr High	High School	Public	X	100		X

Tidal Back River Uplands Survey:
ISI Data

Site ID	Education	Impervious Cover Removal	Pervious Area Restoration	Buffer Improvement	Trash Management	Comments
ISI_E_100		X		X		Buffer improvement, algae in outfall discharge
ISI_E_101	X	X				Convert existing grassed det pond to wetland planting; inlet & downspout planting
ISI_E_102					X	Community cleanup of wetland/habitat project, leaking dumpster
ISI_E_103	X	X	X		X	Dumping, bare soil to inlets, Wetland creation/education opportunity (see PAA_E_200)
ISI_E_300						
ISI_E_301		X			X	Dumpster lids open, pervious pavement?, YMCA and daycare center, prkg lot retrofit
ISI_E_400		X				Partial SW retrofit - front of Madonna Center
ISI_E_401		X				Car washing to drain, concrete channel removal
ISI_E_402						Prkg lot retrofit
ISI_E_403					X	Sediment & org matter build-up in parking lot, inlet retrofit
ISI_E_404				X		Grass clippings to drain, prkg lot retrofit
ISI_E_500				X	X	Buffer Improvement, dumpster next to river
ISI_E_600						
ISI_E_601	X			X	X	Trash near dumpters & dumping at rivers edge adj to Eastern Blvd); prkg lot retrofits
ISI_E_700		X			X	Retrofit inlets (bare soil), New playgrd construction - sediment to inlets
ISI_E_701				X	X	Buffer improvement, woven metal trash cans w/ no lining & overflowing
ISI_E_702		X				Prkg lot retrofit

Tidal Back River Uplands Survey:
ISI Data

Site ID	Education	Impervious Cover Removal	Pervious Area Restoration	Buffer Improvement	Trash Management	Comments
ISI_E_703						Pervious pavement?
ISI_E_704						
ISI_E_705						Inlet retrofit, pervious pavement?
ISI_E_706				X		Buffer improvement, erosion & dumping in stream, ponding, owners concerned w/ losing fields; prkg lot retrofit
ISI_E_707						Clearing next to stream (bare soil)
ISI_E_708						Previously disconnected downspouts, owners concerned w/ undergrd pipes in front property; prkg lot retrofit
ISI_E_900						Prkg lot retrofit
ISI_E_901				X		Nearly no pervious space, discharge goes directly to river, pervious pavement?
ISI_E_1000						
ISI_E_1001						Outdoor storage area w/ greenhouse (soil, garden matls, canoes, etc), near Lynch Pt SW Improvement Project

APPENDIX D:

SUPPORTING CALCULATIONS FOR NSA ANALYSIS

Supporting Calculations for NSA Analysis

Downspout Disconnection

Table 4-2 in the Tidal Back River watershed characterization report summarizes rooftop acres and % of subwatershed rooftop area addressed by downspout redirection for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Rooftop Acres Addressed

NSAs not recommended for downspout disconnection contribute 0 acres to this analysis. Rooftop acres addressed by disconnecting downspouts in a recommended neighborhood were calculated as follows:

Acres of Buildings x %Connected Downspouts

For example, NSA_E_16A was recommended for downspout redirect and has a total of 8.73 acres of buildings (i.e., rooftop) based on Baltimore County's GIS buildings layer. During the uplands survey, it was estimated that 60% of the downspouts in NSA_E_16A were connected. Therefore, the total rooftop acres addressed by disconnecting downspouts in NSA_E_16A would be 8.73 acres x 0.60 = 5.24 acres.

In some cases, NSAs encompass more than one subwatershed. The rooftop acres addressed for a given subwatershed is calculated as the total rooftop acres in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_E_16A, for example, overlaps Deep Creek and Duck Creek where 95% of its area is within Deep Creek and 5% is within Duck Creek. The rooftop acres addressed by disconnecting downspouts in NSA_E_16A in Deep Creek were calculated as 5.24 acres x 0.95 = 4.98 acres. The rooftop acres addressed through disconnecting downspouts in Duck Creek would be 5.24 acres x 0.05 = 0.26 acres.

% of Subwatershed Rooftop Area Addressed

For a given subwatershed, the % of subwatershed rooftop area addressed was calculated as:

Σ Individual NSA Rooftop Acres Addressed / Total Subwatershed Rooftop Acres

The total acres of rooftop within a subwatershed were determined using Baltimore County's GIS buildings layer.

Fertilizer Reduction/Education

Table 4-3 in the Tidal Back River watershed characterization report summarizes the acres of lawn and % of subwatershed area addressed by fertilizer reduction for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Acres of Lawn Addressed

NSAs not recommended for fertilizer reduction (i.e., have less than 20% high maintenance lawns) contribute 0 acres to this analysis. Acres of lawn addressed by fertilizer reduction/education in a recommended neighborhood were calculated as follows:

(NSA Total Acres - NSA Road Acres) x %Lot Grass Cover x %High Maintenance Lawns

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA. Multiplying this by the % of grass cover estimated for a typical lot in the NSA yields the total acres of lawn in an NSA. Finally, multiplying this result by the % of lawns using high management lawn practices yields the acres of lawn that would be addressed via fertilizer reduction. For example, NSA_E_16A was recommended for fertilizer reduction and has a total area of 65.76 acres. Based on Baltimore County's GIS roads layer, there are approximately 6.17 acres of roads in this NSA. This means NSA_E_16A consists of approximately 65.76 – 6.17 = 59.59 acres for individual lots. During the uplands survey, it was estimated that the average lot in NSA_E_16A consists of 50% grass cover which equates to 59.59 acres x 0.50 = 29.80 total acres of lawn. It was also noted that about 20% of the lawns in NSA_E_16A were employing high maintenance practices. So there are approximately 29.80 acres x 0.20 = 5.96 acres of high maintenance lawn that could be addressed by fertilizer reduction in NSA_E_16A.

As mentioned above, some NSAs encompass more than one subwatershed. The acres of lawn addressed for a given subwatershed is calculated as the total high maintenance lawn acres in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_E_16A, for example, overlaps Deep Creek and Duck Creek where 95% of its area is within Deep Creek and 5% is within Duck Creek. The acres of lawn addressed by fertilizer reduction in NSA_E_16A in Deep Creek were calculated as 5.96 acres x 0.95 = 5.66 acres. The acres of lawn addressed through fertilizer reduction in Duck Creek would be 5.96 acres x 0.05 = 0.30 acres.

<u>% of Subwatershed Area Addressed</u>

For a given subwatershed, the % of the total subwatershed area addressed was calculated as:

Σ Individual NSA Lawn Acres Addressed / Total Subwatershed Acres

Bayscaping

Table 4-4 in the Tidal Back River watershed characterization report summarizes the acres of land and % of subwatershed area addressed by bayscaping for the recommended neighborhoods. The method in which these two columns were calculated is described below.

<u>Acres of Land Addressed</u>

NSAs not recommended for bayscaping contribute 0 acres to this analysis. Acres of land addressed by bayscaping in a recommended neighborhood were calculated as follows:

(NSA Total Acres - NSA Road Acres) x %Lot Available for Bayscaping

The first expression in parentheses in the equation above represents the total acres of individual lots in an NSA. According to CWP, the minimum recommended proportion of bayscaping is 25% of an individual lot. Therefore, the %Lot Available for Bayscaping was calculated as 25% minus the existing fraction of landscaping of the typical lot in a recommended NSA. Multiplying these two factors yields the total acres of land in an NSA recommended/available for bayscaping. For example, NSA_E_16A was recommended for bayscaping and has a total area of 65.76 acres. Based on Baltimore County's GIS roads layer, there are approximately 6.17 acres of roads in this NSA. This means NSA_E_16A consists of approximately 65.76 – 6.17 = 59.59 acres for individual lots. During the uplands survey, it was estimated that the average lot in NSA_E_16A consists of 15% landscaping which means 10% would be recommended for additional bayscaping (25%-15%). This equates to 59.59 acres x 0.10 = 5.96 acres of land that could be addressed by bayscaping in this NSA.

As mentioned above, some NSAs encompass more than one subwatershed. The acres of land addressed for a given subwatershed is calculated as the total acres of land recommended for bayscaping in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_E_16A, for example, overlaps Deep Creek and Duck Creek where 95% of its area is within Deep Creek and 5% is within Duck Creek. The acres of land addressed by bayscaping in NSA_E_16A in Deep Creek were calculated as 5.96 acres x 0.95 = 5.66 acres. The acres of land addressed through bayscaping in Duck Creek would be 5.96 acres x 0.05 = 0.30 acres.

<u>% of Subwatershed Area Addressed</u>

For a given subwatershed, the % of the total subwatershed area addressed was calculated as:

Σ Individual NSA Land Acres Addressed / Total Subwatershed Acres

Storm Drain Stenciling

Table 4-5 in the Tidal Back River watershed characterization report summarizes the number of inlets and % of subwatershed inlets addressed by storm drain stenciling for the recommended neighborhoods. The method in which these two columns were calculated is described below.

<u>Approximate No. of Inlets Addressed</u>

NSAs not recommended for storm drain stenciling contribute 0 inlets to this analysis. The approximate number of inlets addressed in a neighborhood recommended for storm drain stenciling was calculated as follows:

NSA Area [sq miles] x Subwatershed Inlet Density [#inlets/sq mile]

The approximate number of inlets was determined for all 10 subwatersheds in the Tidal Back River watershed using Baltimore County's storm drain system database. Inlet density for each subwatershed was calculated as the number of inlets divided by the total subwatershed area (see Chapter 2.3.6).

As mentioned previously, some NSAs encompass more than one subwatershed. For these cases, the number of inlets addressed for a given subwatershed was calculated using the results from the equation above multiplied by the proportion of the NSA area within that subwatershed. For example, NSA_E_16A was recommended for storm drain stenciling and has a total area of 65.76 acres or 0.10 square miles. NSA_E_16A overlaps Deep Creek and Duck Creek where 95% of its area is within Deep Creek and 5% is within Duck Creek. The number of inlets addressed by storm drain stenciling for this NSA in Deep Creek would be 0.10 sq miles x 75.68 inlets/sq mile in Deep Creek x 0.95 = 7.39 inlets (~ 7 inlets). The number of inlets addressed by storm drain stenciling for this NSA in Duck Creek would be 0.10 sq miles x 68.27 inlets/sq mile in Duck Creek x 0.05 = 0.34 inlets (~1 inlet). The total number of inlets addressed within a subwatershed was rounded to the nearest whole number.

<u>% of Subwatershed Inlets Addressed</u>

For a given subwatershed, the % of the total subwatershed inlets addressed was calculated as:

Σ Individual NSA Inlets Addressed / Total Subwatershed Inlets

APPENDIX E:

ACCESS DATABASES & OTHER ELECTRONIC DOCUMENTS

APPENDIX E:

TMDLs for Nitrogen and Phosphorus in Back River

Total Maximum Daily Loads of Nitrogen and Phosphorus for Back River in Baltimore City and Baltimore County, Maryland

FINAL

Prepared by:

Maryland Department of the Environment
Montgomery Business Park Center
1800 Washington Boulevard, Suite 540
Baltimore MD 21230-1718

Submitted to:

Watershed Protection Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Submittal date: March 9, 2005
Approval date: June 29, 2005
Document version: February 14, 2005

Table of Contents

List of Figures

List of Tables

List of Abbreviations

BNR	Biological Nutrient Removal
BREM	Back River Eutrophication Model
CBP	Chesapeake Bay Program
CE-QUAL-ICM	Army Corps pf Engineers Water Quality Integrated Compartment Model
CEAM	Center for Exposure Assessment Modeling
CEWES	Army Corps of Engineers Waterways Experiment Station
CH3D-WES	Curvilinear Hydrodynamics in Three Dimensions – Waterways Experiment Station
Chla	Active Chlorophyll *a*
COMAR	Code of Maryland Regulations
CWA	Clean Water Act
CWAP	Clean Water Action Plan
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphorus
DO	Dissolved Oxygen
DON	Dissolved Inorganic Nitrogen
DOP	Dissolved Organic Phosphorus
ENR	Enhanced Nutrient Removal
EPA	Environmental Protection Agency
FSA	Farm Service Agency
HSPF	Hydrological Simulation Program Fortran
LA	Load Allocation
lbs/yr	Pounds per Year
LPON	Labile Particulate Organic Nitrogen
LPOP	Labile Particulate Organic Phosphorus
m^3/s	Cubic Meters per Second
MD	Maryland
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/l	Milligrams per Liter
mgd	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Cover
NBOD	Nitrogenous Biochemical Oxygen Demand
NH_3	Ammonia
NOAA	National Oceanic and Atmospheric Administration
NO_{2-3}	Nitrate + Nitrite
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source

ON	Organic Nitrogen
OP	Organic Phosphorus
PO_4	Ortho-Phosphate
RPON	Refractory Particulate Organic Nitrogen
RPOP	Refractory Particulate Organic Phosphorus
SOD	Sediment Oxygen Demand
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WQIA	Water Quality Improvement Act
WQLS	Water Quality Limited Segment
WWTP	Waste Water Treatment Plant
µg/l	Micrograms per Liter

EXECUTIVE SUMMARY

This document establishes Total Maximum Daily Loads (TMDLs) for nitrogen and phosphorus in the tidal stream segment of the Back River (basin number 02130901). The Back River drains into the Chesapeake Bay and is part of the Patapsco/Back River Tributary Strategy Basin. The tidal stream segment of the Back River (basin number 02130901) was first identified on the 1996 303(d) list submitted to EPA by the Maryland Department of the Environment (MDE) as being impaired by nutrients due to signs of eutrophication, expressed as high chlorophyll *a* levels. Eutrophication is the over-enrichment of aquatic systems by excessive inputs of nutrients (nitrogen and/or phosphorus). The nutrients act as a fertilizer leading to the excessive growth of aquatic plants. These plants eventually die and decompose, leading to bacterial consumption of dissolved oxygen (DO). For these reasons, this document proposes to establish TMDLs for the nutrients nitrogen and phosphorus in the Back River. The Back River was also identified on the 303(d) list as being impaired by bacteria (fecal coliform), toxics (PCBs), metals (Zinc) and suspended sediments. The impairments due to these contaminants have been or will be addressed in separate analyses by MDE.

The water quality goal of these TMDLs is to reduce high chlorophyll *a* concentrations that reflect excessive algal blooms, and to maintain the dissolved oxygen criterion at a level whereby the designated uses for the Back River will be met. The TMDLs for the nutrients nitrogen and phosphorus were determined using a time-variable, three-dimensional water quality eutrophication model package, which includes the water quality model, Corps of Engineers-Water Quality-Integrated Compartment Model (CE-QUAL-ICM), a sediment process model, and the hydrodynamic model, Curvilinear Hydrodynamic in Three Dimensions (CH3D). Loading caps for total nitrogen and total phosphorus entering the Back River are established for low flow conditions and for annual average flow conditions.

The low flow TMDL for nitrogen is 113,321 lbs/month, and the low flow TMDL for phosphorus is 7,995 lbs/month. These TMDLs apply during the period May 1 through October 31. The allowable loads have been allocated between point and nonpoint sources. The nonpoint sources are allocated 1,345 lbs/month of total nitrogen, and 34 lbs/month of total phosphorus. The point sources, including a National Pollutant Discharge Elimination System (NPDES) wastewater treatment plant (WWTP) loads and NPDES stormwater loads are allocated 111,299 lbs/month of nitrogen, and 7,888 lbs/month of phosphorus. An explicit margin of safety makes up the remainder of the nitrogen and phosphorus allocations.

The average annual TMDL for nitrogen is 1,773,100 lbs/yr, and the average annual TMDL for phosphorus is 99,171 lbs/yr. The allowable loads have been allocated between point and nonpoint sources. The nonpoint source loads are allocated 26,323 lbs/year of total nitrogen and 1,239 lbs/year of total phosphorus. The point sources, including a NPDES wastewater treatment plant (WWTP) loads and NPDES stormwater loads are allocated 1,737,626 lbs/year of total nitrogen and 96,896 lbs/year of total phosphorus. An explicit margin of safety makes up the balance of the allocation.

Four factors provide assurance that these TMDLs will be implemented. First, National Pollutant Discharge Elimination System (NPDES) permits (including both wastewater treatment plants and stormwater permits) and point source loading goals under the Chesapeake Bay Program's Enhanced Nutrient Removal Strategy (ENR) will play important roles in assuring implementation. Second, Maryland has several well-established programs that will be drawn upon, including Maryland's Tributary Strategies for Nutrient Reductions developed in accordance with the Chesapeake Bay Agreement. Third, Maryland's Water Quality Improvement Act of 1998 requires that nutrient management plans be implemented for all agricultural lands throughout Maryland. Finally, Maryland has adopted a watershed cycling strategy, which will assure that routine future monitoring and TMDL evaluations are conducted.

1.0 INTRODUCTION

Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each State to develop a Total Maximum Daily Load (TMDL) for each water quality limited segment (WQLS) on the Section 303(d) list, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty. A TMDL reflects the total pollutant loading of the impairing substance a water body can receive and still meet water quality standards.

TMDLs are established to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The tidal stream segment of the Back River (basin number 02130901) was first identified on the 1996 303(d) list submitted to EPA by the Maryland Department of the Environment (MDE) as being impaired by nutrients due to signs of eutrophication, expressed as high chlorophyll *a* levels. Eutrophication is the over-enrichment of aquatic systems by excessive inputs of nutrients (nitrogen and/or phosphorus). The nutrients act as a fertilizer leading to the excessive growth of aquatic plants. These plants eventually die and decompose, leading to bacterial consumption of dissolved oxygen (DO). For these reasons, this document proposes to establish TMDLs for the nutrients nitrogen and phosphorus in the Back River. The Back River was also identified on the 303(d) list as being impaired by bacteria (fecal coliform), toxics (PCBs), metals (Zinc) and suspended sediments. The impairments due to these contaminants have been or will be addressed in separate analyses by MDE.

2.0 SETTING AND WATER QUALITY DESCRIPTION

2.1 General Setting and Source Assessment

The Back River Watershed is located in the western shore region of Maryland, northeast of the Baltimore Harbor and it drains into the Chesapeake Bay (Figure 1). It is located on the western shore of the Upper Chesapeake Bay about 160 miles from the Virginia Capes at the entrance to the Bay. It is a relatively small estuary, with average depths of approximately 25 feet (near the mouth), nine feet (lower estuary), and five feet (upper estuary). The tidal range in the estuary is approximately 1.2 feet (Maryland Environmental Service, 1974).

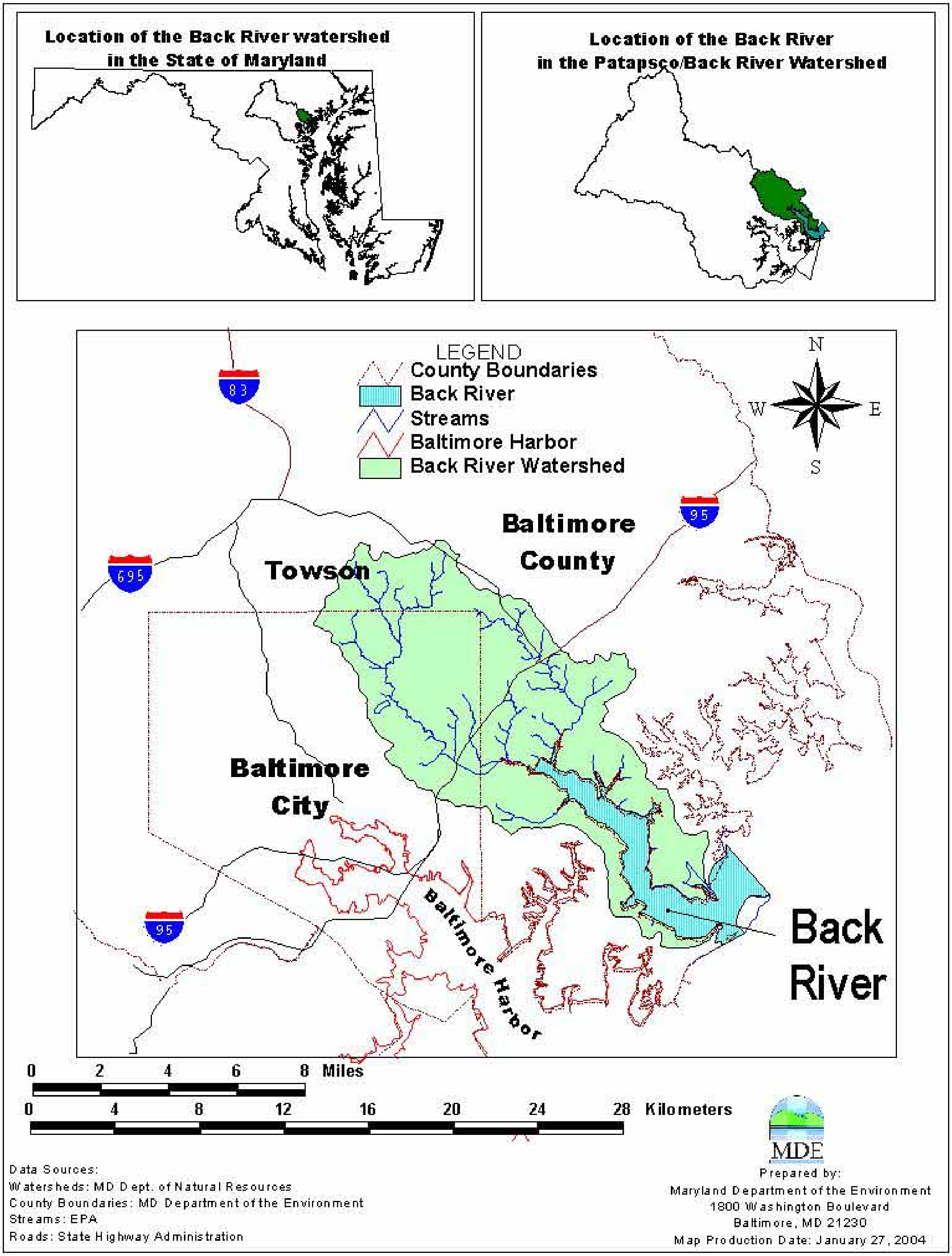


Figure 1: Location Map of Back River Drainage Basin

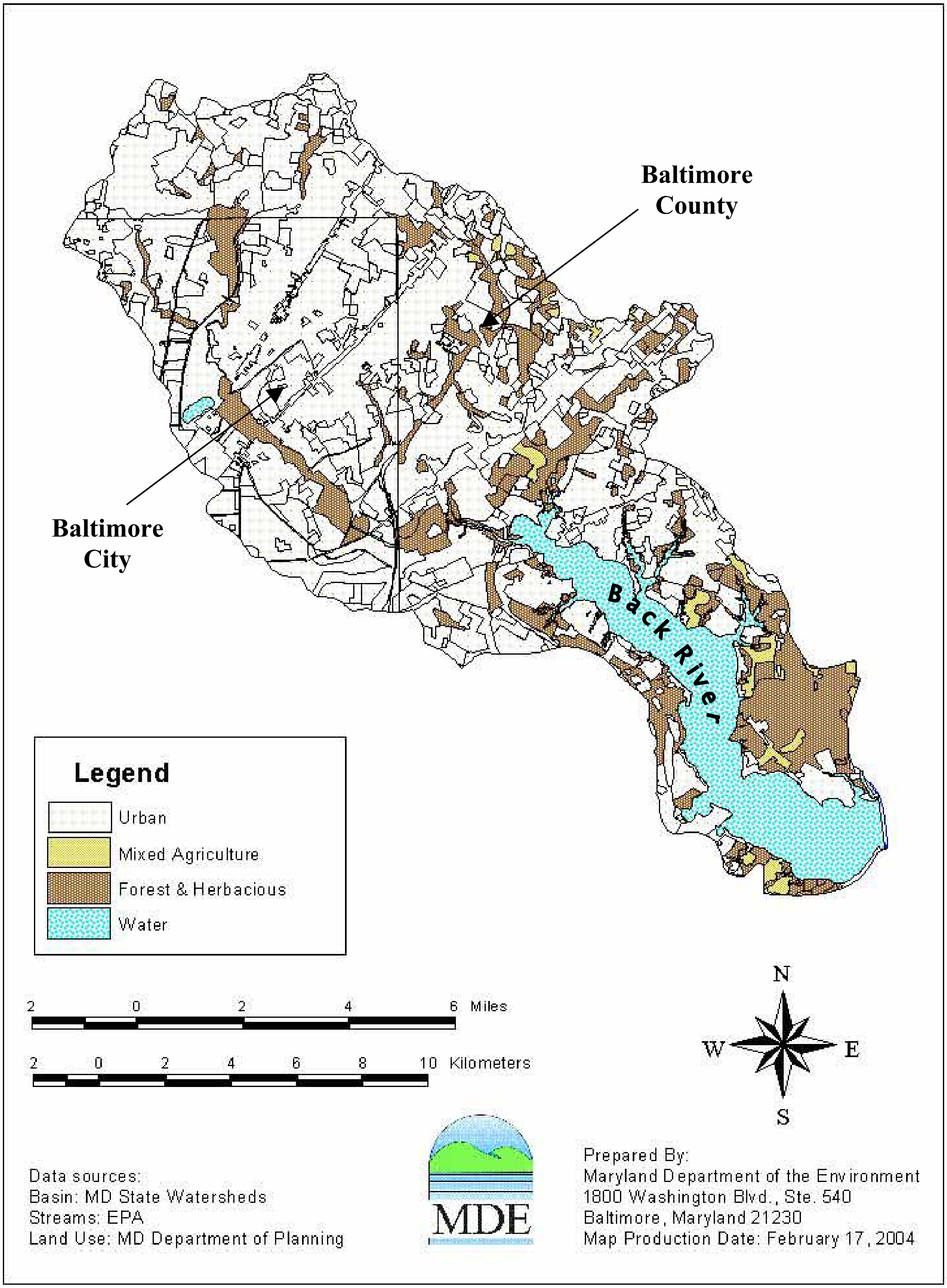


Figure 2: Predominant Land Uses in the Back River Drainage Basin

2.2 Land Use

Land Use in the Back River Watershed is primarily urban but also consists of some forested areas, rural areas and farms, suburban areas, and industrial areas. The Back River Watershed has an area of approximately 39,075 acres or 158.1 square kilometers. The land uses in the watershed consist of urban (28,037 acres or 71.7 %), and non-urban which comprises mixed agriculture and forest and other herbaceous (6,753 acres or 17.3 %) and water (4,295 acres or 11.0 %). The land use is based on 1997 Maryland Office of Planning land use/land cover data. Figure 3 shows the relative amounts of the different land uses in the Back River Watershed.

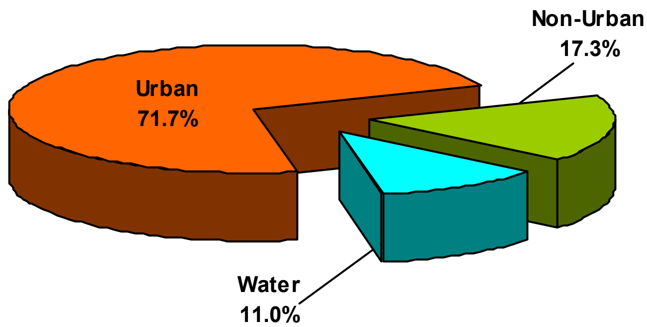


Figure 3: Proportions of Land Use in the Back River Drainage Basin

2.3 Geology

The Back River Watershed lies within the Piedmont and Coastal Plain provinces of Central Maryland. The surficial geology is characterized by crystalline rocks of volcanic and sedimentary origin consisting primarily of schist and gneiss. These formations are resistant to short-term erosion, and often determine the limits of stream bank and streambed. These crystalline formations decrease in elevation from northwest to southwest and eventually extend beneath the younger sediments of the Coastal Plain. The fall line represents the transition between the Atlantic Coastal Plain Province and the Piedmont Province. The Atlantic Coastal Plain surficial geology is characterized by thick, unconsolidated marine sediments deposited over the crystalline rock of the piedmont province (*Coastal Environmental Services, 1995*).

2.4 Point Sources: Wastewater Treatment Plants Loads

The model was calibrated using point source loading data and flows from the period 1992-1997. The Back River WWTP is the only municipal point source that currently discharges into the Back River, and which was discharging during the model calibration period. Eastern Stainless is the only industrial point source that discharged into the Back River during the 1992-1997 period. The estimated average annual nitrogen and phosphorus loads from the Back River WWTP for the 1992 to 1997 period is *4,080,417 lbs/yr or 1,854,735 kg/yr and 84,427 lbs/yr or 38,375 kg/yr, respectively.* This information was obtained from discharge monitoring reports stored in MDE's point source database. The Back River WWTP average annual point source loads for 1992 to 1997 are presented in Table 1.

Table 1: Back River WWTP Flows and Loads for the Period 1992 to 1997

Back River Flows and Point Source Loads					
Year	**Flow**	**TN**		**TP**	
	mgd	lbs/yr	kg/day	lbs/yr	kg/day
1992	107	4,587,967	5,771	194,534	241
1993	117	4,521,061	5,691	79,674	99
1994	113	4,335,097	5,477	71,456	91
1995	104	3,985,318	5,005	63,574	79
1996	115	4,081,197	5,084	57,872	72
1997	86	2,971,863	3,703	39,451	49
Average	107	4,080,417	5,122	84,427	105

These average annual flows and point source load estimates represent actual discharge into the Back River from the WWTP from 1992 to 1997. It is important to note that this WWTP, while not discharging at its maximum flow capacity during this period, had nitrogen concentrations around 12 mg/l – 12.5 mg/l, higher than current nitrogen concentrations. The Biological Nutrient Removal (BNR) process went into operation in July 1998, the year after the model calibration period and concentrations since then are lower, averaging 8-9 mg/l. In the same context, the phosphorus concentrations discharged from 1992 to 1997 are higher than the current permitted concentrations. For the Back River WWTP, the average annual load, with current permit flow and concentrations, could decrease to 3,167,002 lbs/yr from 4,080,417 lbs/yr of total nitrogen and to 79,175 lbs/yr from 84,427 lbs/yr of total phosphorus assuming the plant is discharging at its maximum allowable current permit flow of 130 MGD and the current goal concentration for TN of 8 mg/l and TP permit limit concentration of 0.2 mg/l. The flow discharged from the Back River WWTP into Back River does not represent the total output of the Back River WWTP. Of the 180 MGD design capacity of the plant, 50-70 MGD are discharged into Outfall 002, to be used by Bethlehem Steel (currently International Steel Group, ISG) as cooling water, and then discharged into Bear Creek and other tributaries of the Baltimore Harbor.

The Eastern Stainless point source discharged into Back River an average TN load of 62,755 lbs/yr and an average TP load of 106 lbs/yr from 1992 to 1997.

2.5 Nonpoint Source Loads and Urban-Stormwater Loads

Nonpoint source loads and urban-stormwater loads entering the Back River were estimated using the Hydrologic Simulation Program-Fortran (HSPF). The HSPF model is used to estimate flows, suspended solids and nutrient loads from the watershed's sub-basins, which are linked to a three-dimensional, time variable hydrodynamic model and a water quality model designed specifically for the Back River. The water quality model is used to determine the maximum load of nutrients that can enter Back River while maintaining the water quality criteria associated with the designated use of Back River. The water quality modeling framework is shown in Section 4.2. The simulation of the Back River Watershed used the following assumptions: (1) variability in patterns of precipitation were estimated from existing National Oceanic and Atmospheric Administration (NOAA) meteorological stations; (2) hydrologic response of land areas were estimated for a simplified set of land uses in the basin; and (3) agricultural information was estimated from the Maryland Department of Planning (MDP) land use data, the 1997 Agricultural Census Data, and the Farm Service Agency (FSA). The HSPF simulates nonpoint source and urban-stormwater loads and integrates all natural and human induced sources, including direct atmospheric deposition, and loads from septic tanks, which are associated with river base flow during low flow conditions. Details of the HSPF watershed model developed to estimate these urban and non-urban loads can be found in "Patapsco/Back River Watershed HSPF Model Report, (MDE, 2001)".

Figure 4 shows the relative amounts of nitrogen and phosphorus nonpoint, point source and urban loadings during the 1995 to 1997 period for the Back River.

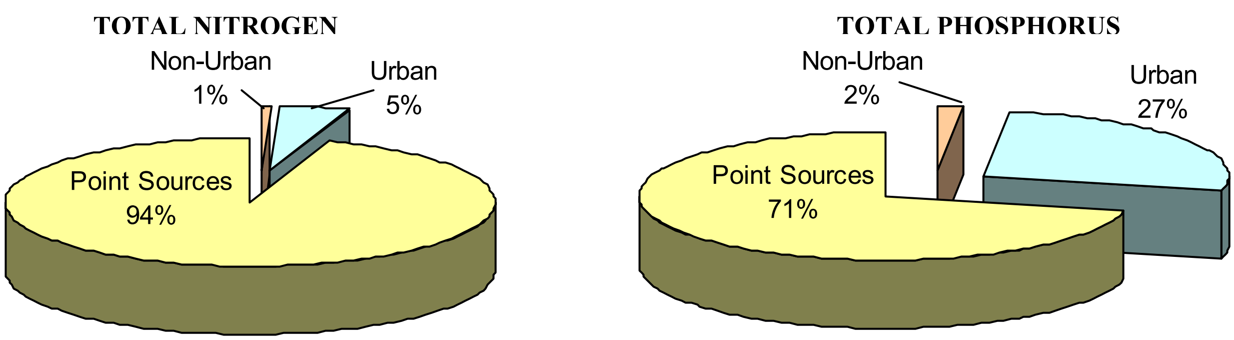


Figure 4: Percentages of Average Annual Nitrogen and Phosphorus Loads from WWTP point sources, urban and non-urban sources in the Back River between 1995 and 1997

2.6 Water Quality Characterization

Historical and recent data show clear indications of extreme eutrophication in the Back River. Some of the highest chlorophyll-*a* concentrations observed in the entire Chesapeake system have been routinely recorded in the Back River (Boynton *et al*., 1998). Abnormally high chlorophyll *a* concentrations, 200-300 µg/l, were observed in the upstream reaches of this river. In contrast, the chlorophyll *a* levels in Baltimore Harbor, just 10 km south of Back River, are 50-100 µg/l, which are also much higher than the values usually observed in the Chesapeake Bay. As for the DO concentrations, hypoxia/anoxia have rarely occurred in Back River although large diel excursions of DO have been documented (Boynton *et al*., 1998).

There are 10 water quality stations located in the Back River that were surveyed during the model calibration period 1992 to 1997. One of these is a Chesapeake Bay Program long-term monitoring station. Five are MDE water quality stations and four more stations are Baltimore City stations. The reader is referred to Figure 5 for the locations of the water quality sampling stations. Table 2 presents the distance of each station from station M01 located at the mouth of the river.

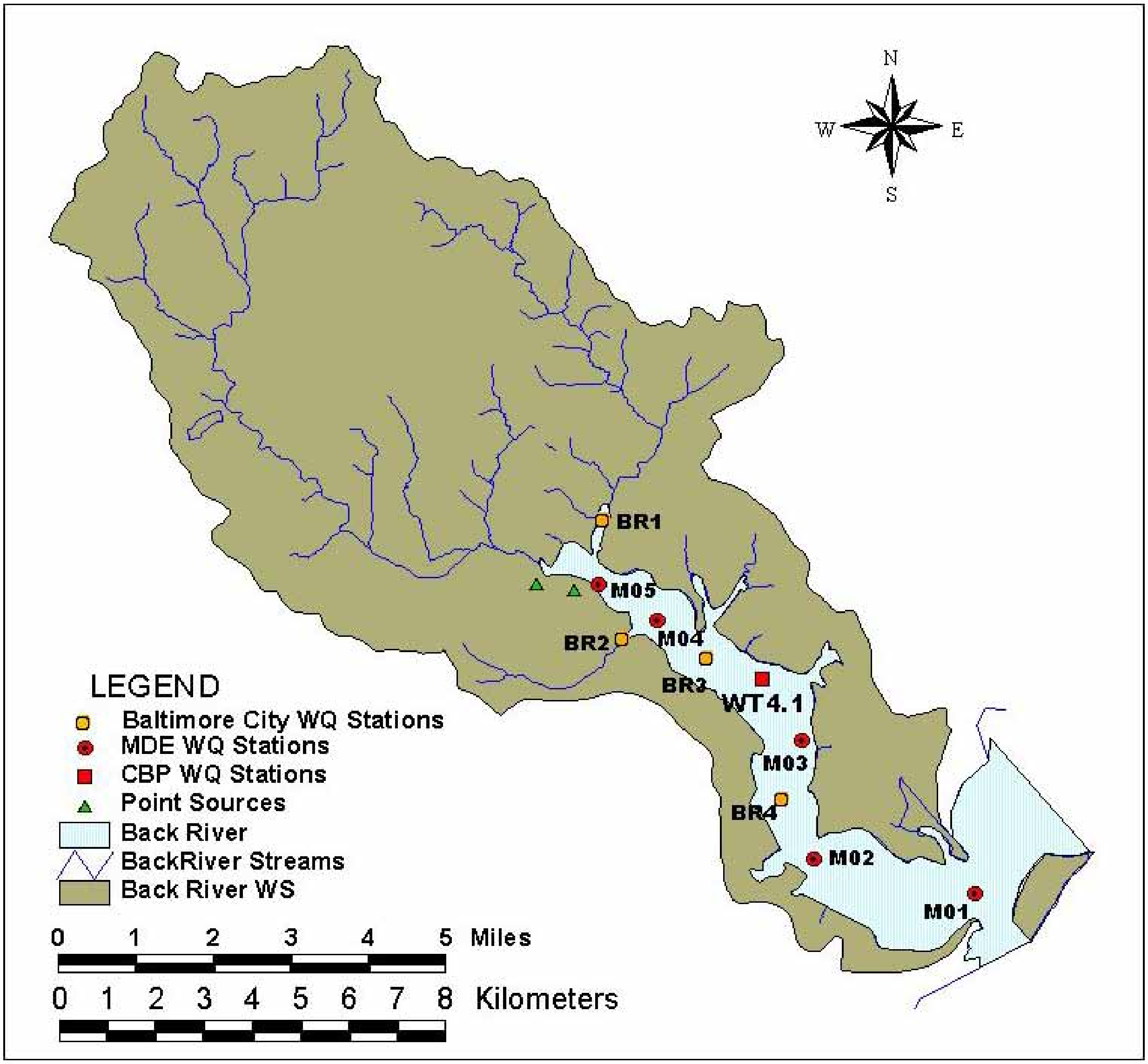


Figure 5: Location of Water Quality Stations in the Back River

Table 2: Location of Water Quality Monitoring Stations

Water Quality Station	Kilometers from the Mouth of the River
BACK RIVER	
M01 (mouth)	0
M02	3.6
BR4	4.5
M03	6.1
WT4.1 (middle)	7.1
BR3	7.5
M04 / BR2	8.5 / 9.5
M05 / BR1 (head)	10.0 / 11.2

Data for the 1992-1997 period have been selected for the development of the eutrophication model for subsequent nutrients TMDLs analysis. During this period, monitoring was sponsored by the Chesapeake Bay Program (CBP), MDE, and the City of Baltimore.

The Chesapeake Bay Program has maintained a long-term water quality sampling station (WT4.1) in the Back River since 1984 to monitor its physical, chemical, and biological parameters. MDE also monitored the Back River intensively at the other five stations during the period March 1994 to May 1995 for parameters similar to those monitored by the CBP. Baltimore City (BC) also sponsored monitoring at sites located close to the MDE surveys during the period June to December 1993, 1994, 1995, 1996 and 1997 for similar parameters. A detailed list of all the parameters measured in these surveys can be found in the Back River section of the report "The development of a water quality model for Baltimore Harbor, Back River and the adjacent Upper Chesapeake Bay" Part II: "Biological, chemical and physical characteristics of the Baltimore Harbor and Back River in the Upper Chesapeake Bay, (Wang *et al*, 1999)".

The water quality time series for chlorophyll *a*, DO, TN and TP for the period 1992 to 1997 of the CBP long-term station WT 4.1 in the Back River are presented in Figures 6, 8, 10, and 12. The water quality longitudinal profiles of the river showing MDE and BC data for the same parameters at stations M01 (mouth), M02, BR4, M03, WT 4.1, BR3, M04 and M05 (upstream) are also presented in figures 7, 9, 11, and 13. Stations BR1 and BR2 located outside the model domain near stations M05 and M04 respectively, were included in the data set as follows: water quality data at station BR1 was included with data from station M05, and data from station BR2 was included with data from station M04. Please note the not all stations show data for all the parameters shown. The discussion below is a summary of the data from these monitoring programs for the period used in the development of the eutrophication model. Detailed analyses and interpretation of the results are presented in the Back River section of the report "The development of a water quality model for Baltimore Harbor, Back River and the adjacent Upper Chesapeake Bay" Part II: "Biological, chemical and physical characteristics of the Baltimore Harbor and Back River in the Upper Chesapeake Bay", (Wang *et al*, 1999) and in Part A of Appendix 1.

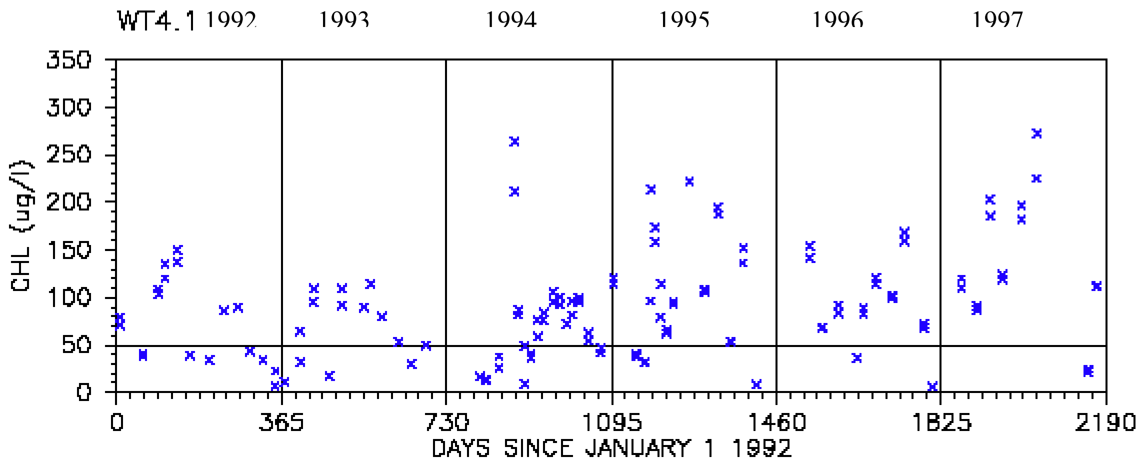


Figure 6: Time Series of Chlorophyll *a* Data at Back River Station WT 4.1

Figure 6 presents the time series of chlorophyll *a* concentrations in the Back River from January 1992 to December 1997 for the CBP long-term monitoring station WT4.1, a seven-year period that includes wet and dry years. WT4.1 is located in the middle of the Back River, approximately 7.8 km from the mouth. Chlorophyll *a* concentrations throughout the water column are above 50 µg/l every year with maximum concentrations close to 300 µg/l during the summers of 1994 and 1997. Chlorophyll *a* concentrations have a seasonal pattern: higher during the warmer months and lower during the coldest months.

Figure 7 below presents a longitudinal profile of chlorophyll *a* from May 1 to October 31, and from January 1 to April 30/November 1 to December 31 of 1995, 1996 and 1997 in the Back River. Water quality data for BC stations BR1 and BR2 were combined with the data from MDE stations M05 and M04, respectively. The figures show symbols representing the mean values of chlorophyll *a* concentrations with minimum/maximum value bars at each station and period in the Back River. The numbers on the upper part of each graph represents the number of samples averaged at each particular station.

A difference of chlorophyll *a* distribution between the May-October period and the November-April period was observed in the surface water along the longitudinal profile of the river system as shown in the figure. Highest chlorophyll *a* concentrations in surface water were located at the head of the river throughout the May 1 to October 31 period and concentrations decreased downstream. In 1995, chlorophyll *a* values were the highest of the three years with concentrations decreasing in 1996 and 1997. Spring algal blooms developed throughout the water column and the chlorophyll *a* concentrations were relatively high throughout both periods.

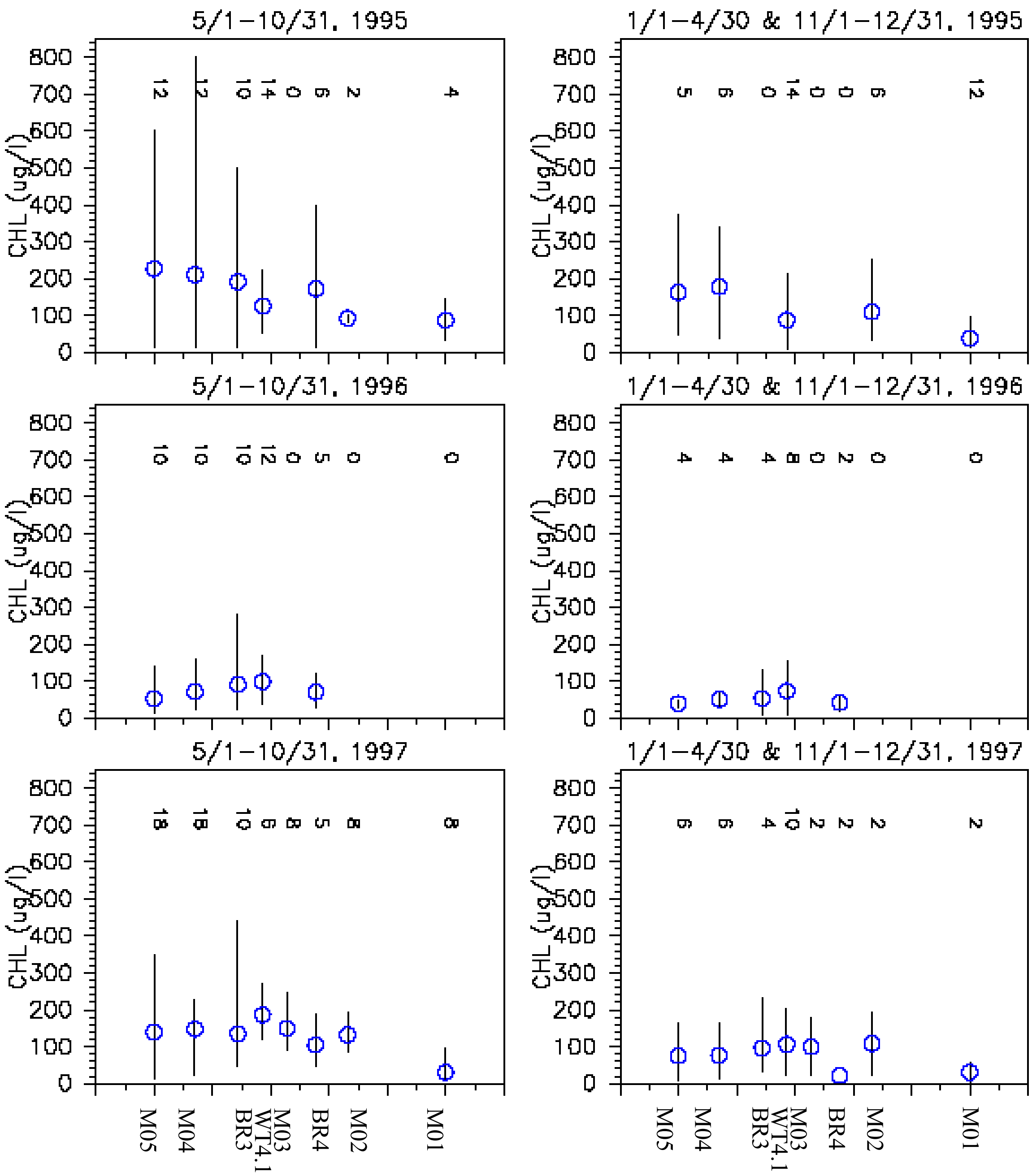


Figure 7: Longitudinal Profile of Chlorophyll *a* During the Period of May 1 to October 31, and during the periods of January 1 to April 30 and November 1 to December 31 of 1995, 1996 and 1997 in the Back River.

A similar time series for DO concentrations at station WT4.1 is depicted in Figure 8. It shows that the observed DO levels at station WT4.1 do not fall below 5.0 mg/l, except in the summer of 1992. The DO ranged from 3.8 to 18.8 mg/l with average DO concentrations close to 10 mg/l. The DO concentrations fall slightly every summer to levels close to 5.0 mg/l but only fell below

5.0 mg/l in 1992. DO concentrations in 1997 appear to be slightly elevated relative to prior years, consistent with reduced nutrient loads as shown in Table 1.

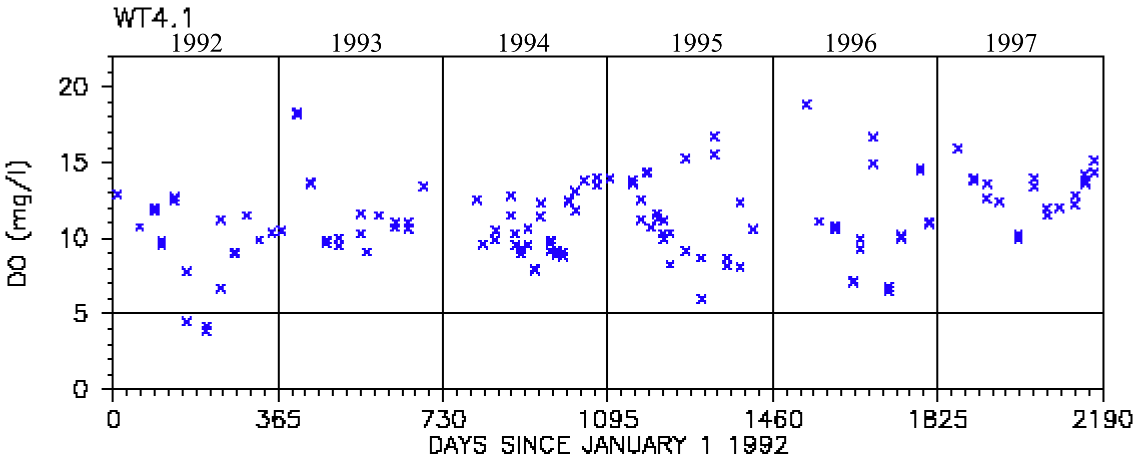


Figure 8: Time Series of Dissolved Oxygen Data at Back River Station WT 4.1

Figure 9 presents a longitudinal profile of chlorophyll *a* from May 1 to October 31, and from January 1 to April 30/November 1 to December 31 of 1995, 1996 and 1997 in the Back River. The figures show symbols representing the mean values of chlorophyll *a* concentrations with minimum/maximum value bars at each station and period in the Back River. The numbers on the upper part of each graph represents the number of samples averaged at each particular station. There was no significant seasonal variation in the Back River system. DO levels remained high at the region. DO concentrations increased upstream during the warmer months but slightly decreased or remained constant heading upstream during the colder months.

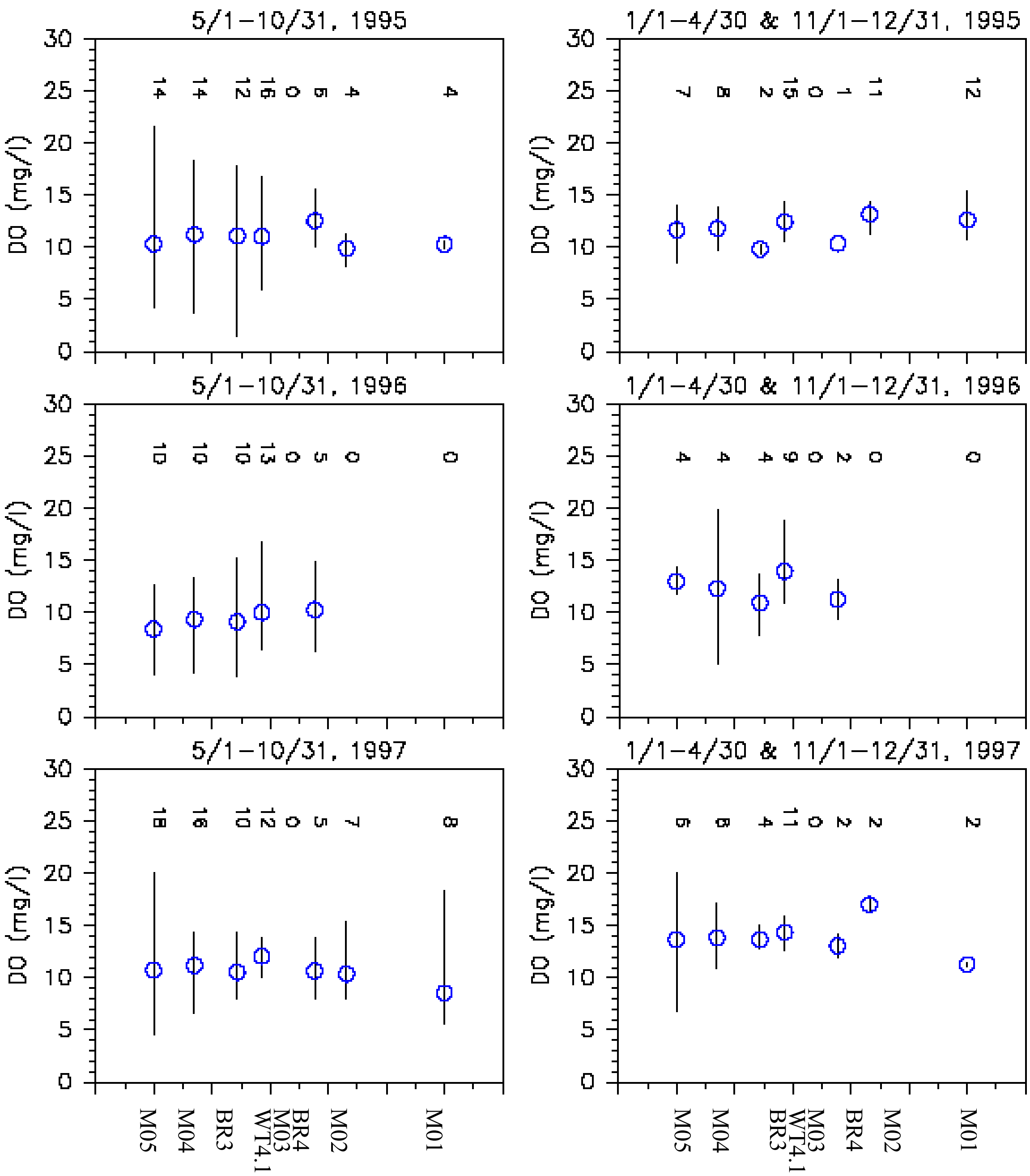


Figure 9: Longitudinal Profile of Dissolved Oxygen (DO) During the Period of May 1 to October 31, and during the periods of January 1 to April 30 and November 1 to December 31 of 1995, 1996 and 1997 in the Back River.

Figure 10 presents a time series of Total Nitrogen (TN), Total Dissolved Nitrogen (TDN) and Particulate Nitrogen (PN) levels measured during the 1992-1997 period at station WT 4.1 in the Back River. The TN levels of most samples are below 9 mg/l with the highest values near 10 mg/l only in the winter of 1993 and spring of 1995. The dissolved species (TDN) of this total nitrogen, which includes NH_4 and NO_{23}, represents approximately 70-75% of the TN in the water column (between 2 and 6 mg/l), while the PN accounts for approximately 25% of the total nitrogen (between 0 and 3 mg/l for most samples).

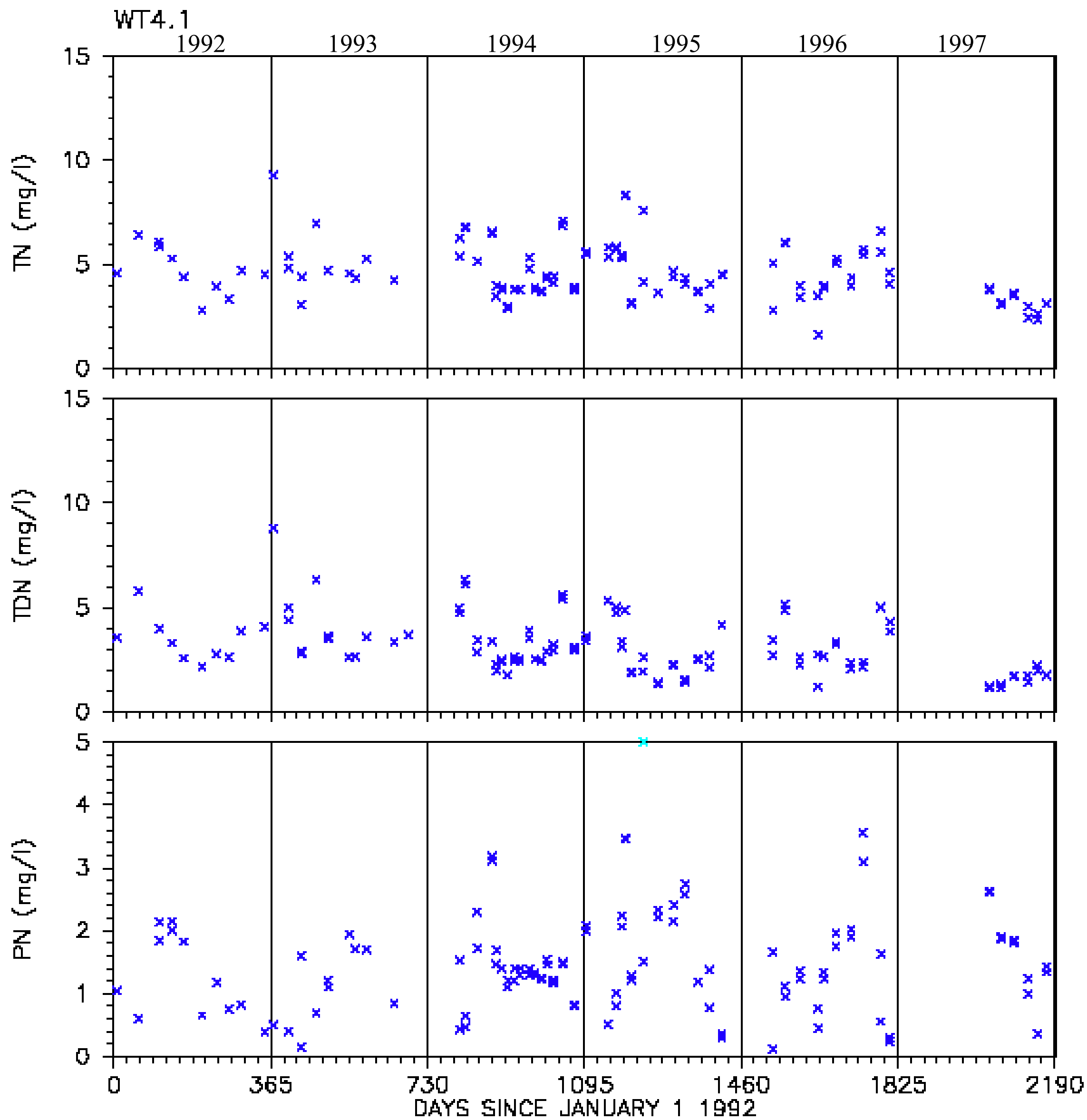


Figure 10: Time Series of Total Nitrogen (TN), Total Dissolved Nitrogen (TDN) and Particulate Nitrogen (PN) Data at Back River Station WT 4.1

Figure 11 presents the longitudinal profile of TN during the period of May 1 to October 31, and during the period of January 1 to April 30/November 1 to December 31 of 1995, 1996 and 1997 in the Back River. The figures show symbols representing the mean values of chlorophyll *a* concentrations with minimum/maximum value bars at each station and period in the Back River. The numbers on the upper part of each graph represents the number of samples averaged at each particular station. In general, TN concentrations are higher upstream and appear to decrease over time when comparing 1995 with 1996 and 1997 values. TN concentrations do not show any seasonality, with average values in the warmer months very similar to those in the colder months.

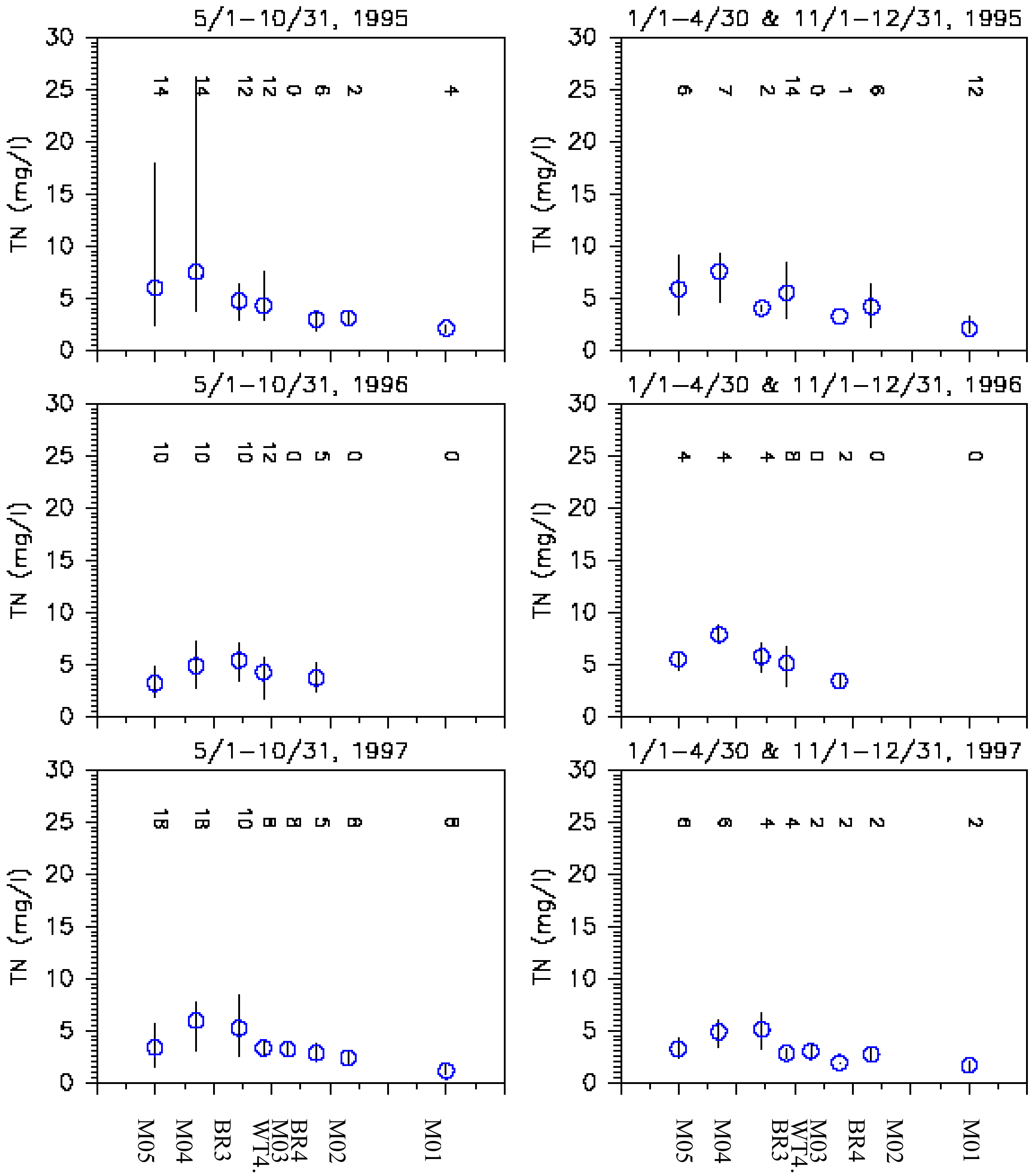


Figure 11: Longitudinal Profile of TN During the Period of May 1 to October 31, and during the periods of January 1 to April 30 and November 1 to December 31 of 1995, 1996 and 1997 in the Back River.

Figure 12 present time series of Total Phosphorus (TP), Total Dissolved Phosphorus (TDP) and Particulate Phosphorus (PP) levels measured during the 1992-1997 period at station WT4.1 in the Back River. The TP levels of most samples are between 0.1 mg/l and 0.5 mg/l, with a one time highest value near 1.1 mg/l, in the spring of 1995. The reason for this high TP concentration is unclear. The total dissolved phosphorus (TDP) of this total phosphorus represents a smaller percentage of the TP than the percentage of PP in the water column. This suggests a higher concentration of phosphorus in the suspended solids of the system than in dissolved form.

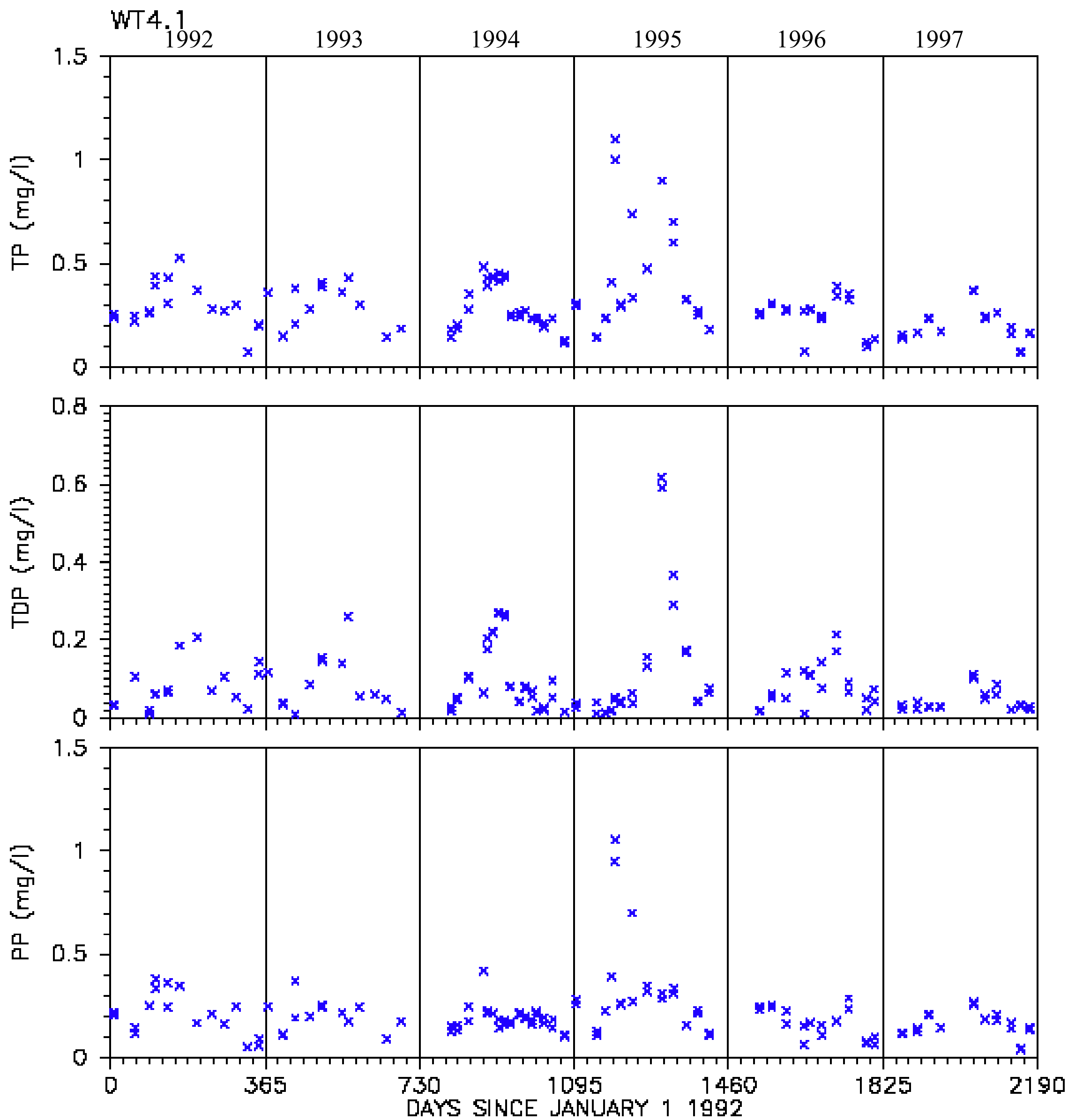


Figure 12: Time Series of TP, TDP, and PP Data at Back River Station WT 4.1

Figure 13 presents the seasonal variation of TP during the period of May 1 to October 31, and during the period of January 1 to April 30/November 1 to December 31 of 1995, 1996 and 1997 in the Back River. The figures show symbols representing the mean values of chlorophyll *a* concentrations with minimum/maximum value bars at each station and period in the Back River. The numbers on the upper part of each graph represents the number of samples averaged at each particular station.

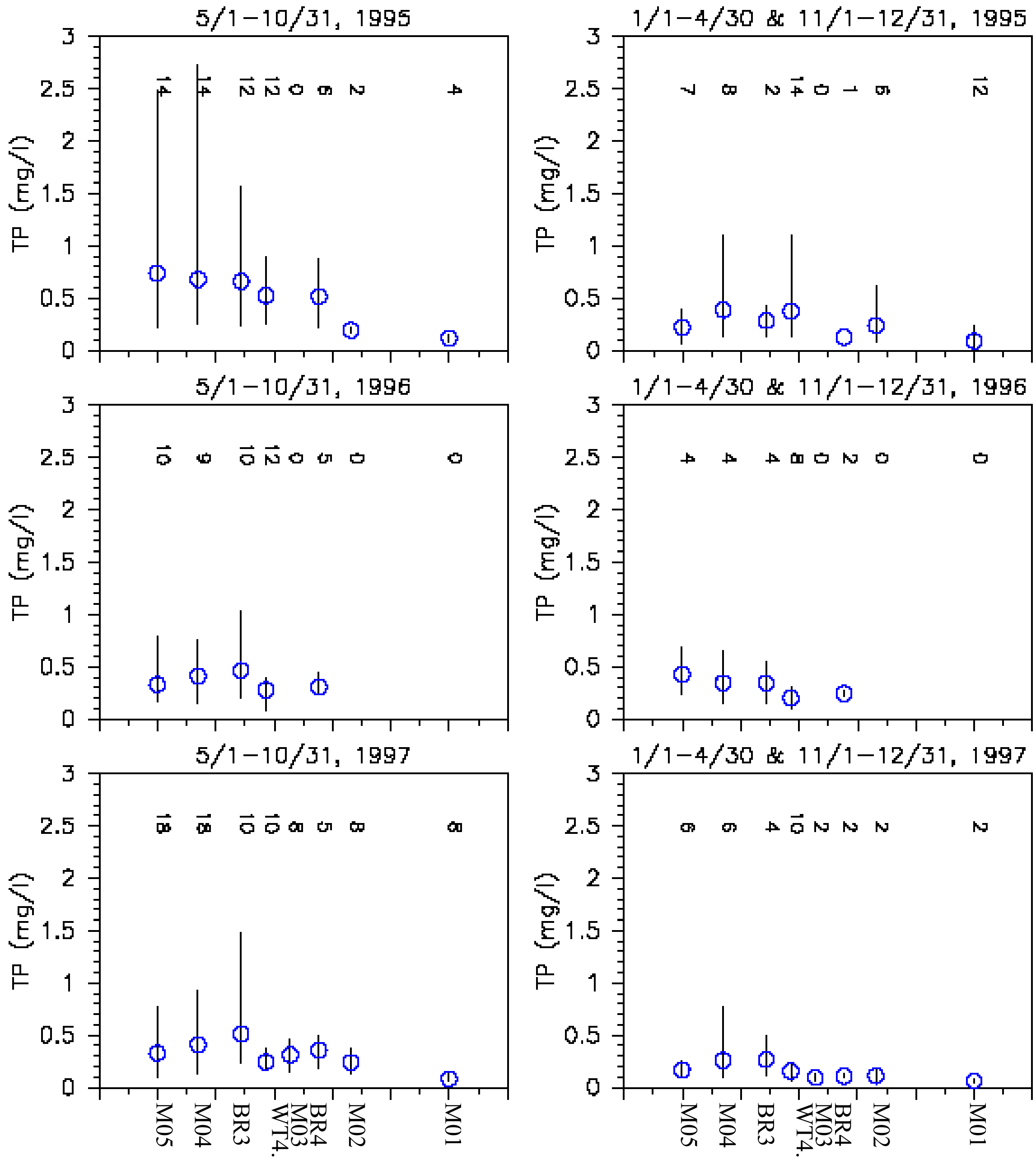


Figure 13: Longitudinal Profile of TP during the period of May 1 to October 31, and during the periods of January 1 to April 30 and November 1 to December 31 of 1997 in the Back River.

TP concentrations are higher at the upstream stations compared to the downstream stations. These TP concentrations are higher during the warmer months than concentrations observed during the colder months, especially during 1995. Seasonality is not so obvious in 1996 but it is significant again in 1997. In general, TP concentrations seem to decrease slightly over time.

2.7 Water Quality Impairment

The Maryland Water Quality Standards Surface Water Use Designation [Code of Maryland Regulations (COMAR) 26.08.02.07] for the tidal waters of the Back River is Use I - water contact recreation, fishing, and protection of aquatic life and wildlife. The water quality impairment of the Back River system being addressed by this TMDL analysis consists of a higher than acceptable level of chlorophyll *a* (See Section 2.6 figures). The substances causing this water quality exceedance are the nutrients - nitrogen and phosphorus. Excessive nitrogen and phosphorus over-enrich aquatic systems. The nutrients act as a fertilizer leading to the excessive growth of aquatic plants. These plants eventually die and decompose, leading to bacterial consumption of dissolved oxygen (DO).

According to the numeric criteria for DO for Use I waters, concentrations may not be less than 5.0 mg/L at any time unless resulting from natural conditions (COMAR 26.08.02.03.A(2)). The achievement of 5.0 mg/L is expected in the well-mixed surface waters and throughout the water column of the Back River system.

Maryland's General Water Quality Criteria prohibit pollution of waters of the State by any material in amounts sufficient to create a nuisance or interfere directly or indirectly with designated uses. See Code of Maryland Regulations (COMAR) 26.08.02.03B(2). Excessive eutrophication, indicated by elevated levels of chlorophyll *a*, can produce nuisance levels of algae and interfere with designated uses such as fishing and swimming. The chlorophyll *a* concentration in the upper reaches of Back River regularly exceeds the desired level of 50 µg/L. These levels have been associated with excess eutrophication.

3.0 TARGETED WATER QUALITY GOAL

The objective of the nutrient TMDLs established in this document is to assure the chlorophyll *a* levels support the Use I designations for the tidal waters of the Back River. Specifically, the TMDLs for nitrogen and phosphorus in Back River are intended to control excessive algal growth. Excessive algal growth can lead to violations of the numeric DO criteria, associated fish kills, and the violation of various narrative criteria associated with nuisances, such as odors, and impedance of direct contact use and the loss of habitat for the growth and propagation of aquatic life and wildlife.

In summary, the TMDLs for nitrogen and phosphorus are intended to:

1. Assure a minimum DO concentration of 5.0 mg/l is maintained throughout the tidal waters of the Back River; and

2. Resolve violations of narrative criteria associated with excess nutrient enrichment of the Back River, as reflected in chlorophyll *a* levels greater than 50 µg/l in the Back River system.

The dissolved oxygen level is based on specific numeric criteria for Use I waters set forth in the COMAR 28.08.02. The chlorophyll *a* level is based on the designated uses of Back River, guidelines set forth by Thomann and Mueller (1987) and by the EPA Technical Guidance Manual for Developing Total Maximum Daily Loads, Book 2, Part 1 (1997). These guidelines acknowledge it is acceptable to maintain chlorophyll *a* concentrations below a maximum of 100 µg/L, with a target threshold of less than 50 µg/L.

4.0 TOTAL MAXIMUM DAILY LOADS AND ALLOCATIONS

4.1 Overview

The following section describes the modeling frameworks for simulating nutrient loads, hydrology, and water quality responses. The second sections summarize the scenarios that were explored using the model. The third section describes how the nutrient TMDLs and load allocations for point sources and nonpoint sources were developed for the Back River. The assessment investigates water quality responses using 1995 to 1997 stream flow and different nutrient loading conditions. The fourth section presents the modeling results in terms of a TMDL and allocate the TMDL between point sources and nonpoint sources. The last section explains the rationale for the margin of safety. Finally, the pieces of the equations are combined in a summary accounting of the TMDL for seasonal low flow conditions and for average annual flows.

4.2 Analysis Framework

4.2.1 Computer Modeling Framework

To develop a TMDL, a linkage must be defined between the selected targets or goals and the identified sources. This linkage establishes the cause-and-effect relationship between the sources of the pollutant of concern and the water quality response of the impaired water quality segment to that pollutant. The relationship can vary seasonally, particularly for nonpoint sources, with factors such as precipitation. Once defined, the linkage yields the estimate of total loading capacity or TMDL (U.S. EPA, 1999).

The Department chose a time variable water quality model as the analysis tool to link the nutrient source loadings to the DO criteria and chlorophyll *a* goal. The computational framework chosen for the Back River TMDLs is the three-dimensional, time-variable water quality model CE-QUAL-ICM package. This water quality simulation package provides a generalized framework for modeling contaminant fate and transport in surface waters and is based on the unstructured cell-centered finite-volume approach (Cerco and Cole, 1995). CE-QUAL-ICM was originally developed by U.S. Army Corps of Engineers Waterways Experiment Station (CEWES), Vicksburg, MS (Cerco and Cole, 1995) for the Chesapeake Bay. This eutrophication model package, which includes a sediment flux sub-model, incorporates twenty-two water quality constituents in the water column and in the sediment bed. For detailed information, please refer to the report "The development of a water quality model for Baltimore Harbor, Back River and the adjacent Upper Chesapeake Bay, (Wang *et al*, 2004)".

The CE-QUAL-ICM model is externally coupled with the three-dimensional, time-variable hydrodynamic model CH3D-WES (Curvilinear Hydrodynamic in Three Dimensions), which was developed at the U.S. Army Engineer Waterways Experiment Stations. As its name indicates, CH3D-WES makes hydrodynamic computations on a curvilinear or boundary-fitted platform grid that provides enhancement to fit the deep navigation channel and the irregular shoreline. The CH3D-WES simulates physical processes such as tides, wind, density effects (salinity and temperature), freshwater inflows, turbulence, and the effect of the earth's rotation. The outputs include three-dimensional velocities, water surface elevation, salinity, temperature, and the turbulent mixing coefficients, which in turn are used to drive the water quality model CE-QUAL-ICM, (Johnson *et al*., 1991).

Since many studies have shown significant influence of Chesapeake Bay water on its tributaries, the spatial domain of the Back River Eutrophication Model (BREM) extends longitudinally from the mouth of the Susquehanna River about 90 miles seaward to the mouth of the Patuxent River, which is defined as the upper Chesapeake Bay. Back River is a relatively small estuary located on the western shoreline of the upper Chesapeake Bay. This modeling domain is represented by CE-QUAL-ICM model segments. A diagram of the model segmentation is presented also in Wang *et al*, (2004). There are 3,758 active horizontal cells and a maximum of 19 vertical layers, resulting in 16,149 computational cells. The grid resolution is 1.52 m in the vertical, approximately 0.2 km laterally and 0.4 km longitudinally. Freshwater flows and nonpoint loadings from watersheds are evenly distributed into the adjacent water quality model cells.

The sediment flux model developed by DiToro and Fitzpatrick (1993) and coupled with CE-QUAL-ICM for the Chesapeake Bay water quality modeling is used in the present model application. The model state variables and the resulting fluxes in this sediment flux model and complete model documentation of the sediment flux model can be found in Wang *et al*, (2004) and also in DiToro and Fitzpatrick, (1993).

The water quality model CE-QUAL-ICM described above was calibrated to reproduce observed water quality characteristics for 1992 to 1997 conditions. The calibration of the model for these six years establishes an analysis tool that may be used to assess a range of scenarios with differing flow and nutrient loading conditions. Observed 1992 to 1997 water quality data were used to support the calibration process, as explained further in Wang *et al*, (2004).

4.2.2 TMDL Analysis Framework

The nutrient TMDL analysis consists of two broad elements: an assessment of low flow loading conditions and an assessment of average annual loading conditions. Both the low flow and the average annual flow TMDL analysis investigate the critical conditions under which symptoms of eutrophication are typically most acute, i.e. for average annual flow in dry years or very wet years and/or for low flow, especially late summer when flows are very low, when this system is poorly flushed and when sunlight and temperatures are most conducive to excessive algal production.

The eutrophication model simulates twenty-two state variables, constituting five interacting systems: e.g., phytoplankton dynamics, nitrogen cycle, phosphorus cycle, silicate cycle, and oxygen dynamics. The water column eutrophication model solves the mass-balance equation for each state variable and for each model cell. A detailed description of the water column eutrophication model can be found in Cerco and Cole (1994).

Stream flow used in the calibration of the model was based on the three-dimensional, time-variable hydrodynamic model CH3D-WES developed at the US Army Engineer Waterways Experiment Station. The numerical grid employed in the model domain is shown in Wang *et al*, (2004). The number of cells and the grid resolution are the same as those of the water quality eutrophication model as described above. The detailed description of this model can be found in Johnson *et al*. (1991).

There were only two point sources of nutrients in the Back River watershed during the 1992-1997 model calibration period: the Back River municipal WWTP located in Baltimore County and one minor industrial discharge, Eastern Stainless. The Eastern Stainless plant stopped discharging into the Back River in 1999 and it is only considered in the calibration of the model. The Back River treatment plant had a flow that averaged 107 mgd or 4.7 m^3/s during the 1992-1997 model calibration period, and the flow from the Eastern Stainless plant was very small, approximately 0.2 mgd or 0.0088 m^3/s. (See Section 2.1, General Setting and Source Assessment for more discussion). The Back River WWTP and the Esatern Stainless plant have been accounted for at the water quality model cells 3617 and 3634 of the eutrophication model, respectively.

As stated above, the stormwater loads and nonpoint source loads estimation is described in Section 4.3. In brief, the HSPF model, which simulates the fate and transport of pollutants over the entire hydrologic cycle, was used to estimate nutrient loads from the watershed sub-basins. See “Patapsco/Back River Watershed HSPF Model Report, (MDE, 2001)”.

The concentrations of the nutrients (nitrogen and phosphorus) are modeled in their speciated forms. Nitrogen is simulated as ammonium nitrogen (NH_4), nitrate+nitrite nitrogen ($NO_{2\text{-}3}$), refractory particulate organic nitrogen (RPON), labile particulate organic nitrogen (LPON), and dissolved organic nitrogen (DON). Phosphorus is simulated as total phosphate (PO_4t), refractory particulate organic phosphorus (RPOP), labile particulate organic phosphorus (LPOP), and dissolved organic phosphorus (DOP). NH_4, $NO_{2\text{-}3}$, DON and PO_4, and DOP represent the dissolved forms of nitrogen and phosphorus. The dissolved forms of nutrients are the forms more readily available for biological processes such as algae growth, which affect chlorophyll *a* levels and DO concentrations.

4.3 Scenario Descriptions

The Back River eutrophication model was applied to investigate different nutrient loading scenarios under the stream flow conditions of the period between 1995 to 1997. These analyses allow a comparison of conditions, when water quality problems exist with future conditions that project the water quality response to various simulated load reductions of the impairing substances. By modeling three years consecutively, the analyses account for seasonality, a necessary element of the TMDL development process. The analyses are grouped according to *baseline conditions* and *future conditions,* the latter being associated with the TMDLs. Both scenarios were used to estimate low flow and average annual TMDLs.

Observed water quality and hydrological data collected in the last three years of the five-year model calibration period – 1995 through 1997 – were used to establish the baseline conditions. The baseline conditions are intended to provide a point of reference by which to compare the future scenarios that simulate conditions of a TMDL. The baseline conditions correspond roughly to the notion of "current conditions"; however, these current conditions have limitations. The notion of "current" is unstable and confusing because there is no single reference point in time over the long process of TMDL analysis, review and approval.

The baseline condition for urban-stormwater loads and nonpoint source loads typically reflects an approximation of loads during the monitoring time frame, in this case, the last three years of the calibration period (1995 to 1997). Baseline point source loads were also estimated using 1995 to 1997 discharge monitoring data for nutrients and flow. The baseline condition reflects a fixed current condition. Specific baseline loading assumptions for the point sources are presented in Wang *et al*, (1999).

4.3.1 Baseline Conditions Scenario

The baseline conditions scenario represents the observed conditions of the stream 1995 to 1997. This scenario simulates these three consecutive years, each with different flow and nutrient loadings. Simulating the system for three years accounts for different loading conditions and different hydrological conditions, addressing likely critical conditions of the system. For example, the 1995 – 1997 period simulates an average year (1995), a very wet year (1996) and a dry year (1997), and the summer months when the river system is poorly flushed, and sunlight and warm water temperatures are most conducive to creating the water quality problems associated with excessive nutrient enrichment. The hydrodynamics of the system was simulated using the CH3D-WES model and it is described in more detail in Wang *et al*, (1999).

The urban-stormwater concentrations and the nonpoint nutrient concentrations for the calibration and baseline scenario were estimated from the HSPF model of the Back River watershed, using observed data collected from 1995 to 1997. The HSPF simulates stormwater and nonpoint loads and integrate all natural and human induced sources, including direct atmospheric deposition, and loads from septic tanks, which are associated with river base flow during low flow conditions.

The 1995 to 997 point sources loadings used in this scenario were the same as in the calibration of the model. The WWTP discharge and the industrial discharge monitoring information were obtained from discharge monitoring reports stored in MDE's point source database. For more details on the calibration/baseline conditions scenario, please refer to Wang *et al*, (1999).

4.3.2 Baseline Condition Scenario Results

Results for this scenario, the calibration of the model, of which the three last years also represent the baseline conditions scenario, are summarized in Figures 14 to 17. Only DO and chlorophyll *a* calibration time series for water quality station WT4.1, and longitudinal profiles of the Back River for the same parameters are shown below. Model calibration results showing the other parameters time series and longitudinal profiles are presented in Part B of Appendix 1.

Figures 14 to 17 represent the 1992 – 1997 calibration of the model and also serve to show the 1995-1997 period used as the baseline condition scenario. As shown in figures 14 and 15, under the 1995-1997 baseline conditions, chlorophyll *a* concentrations throughout the length of the river exceed 50 µg/l, with values reaching close to 300 µg/l. Figures 16 and 17 show average DO concentrations remain above the water quality criterion of 5.0 mg/l throughout the entire length of the river and throughout the simulation period with minimum values below 5.0 mg/l at the headwaters near the Back River WWTP (For all other stations figures, see Appendix 1B).

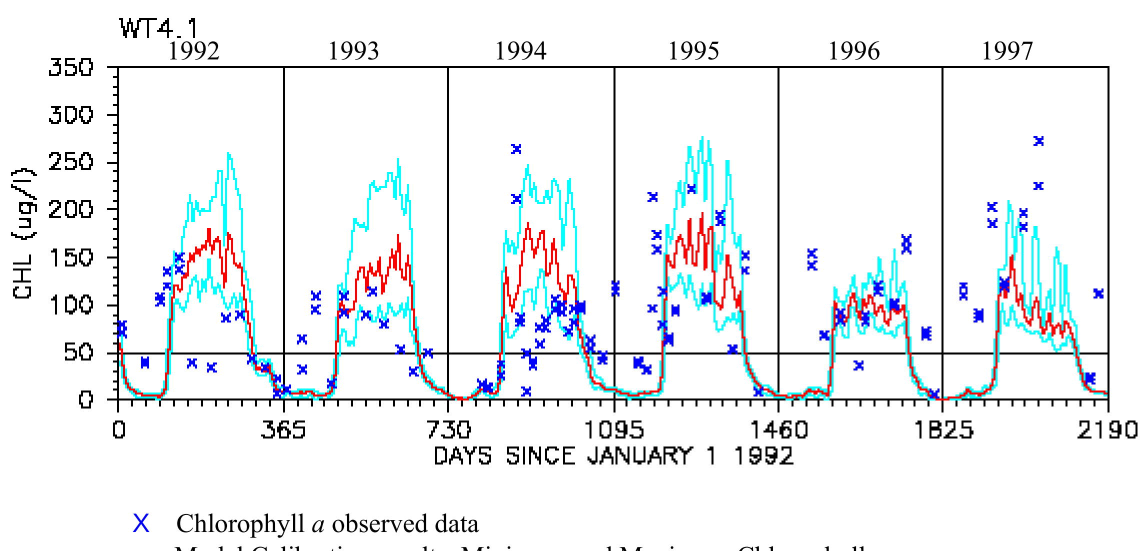


Figure 14: Station WT4.1: Model Results for the Calibration (1992 to 1997) and Baseline Conditions Scenario (1995 to 1997) for Chlorophyll *a* in the Back River

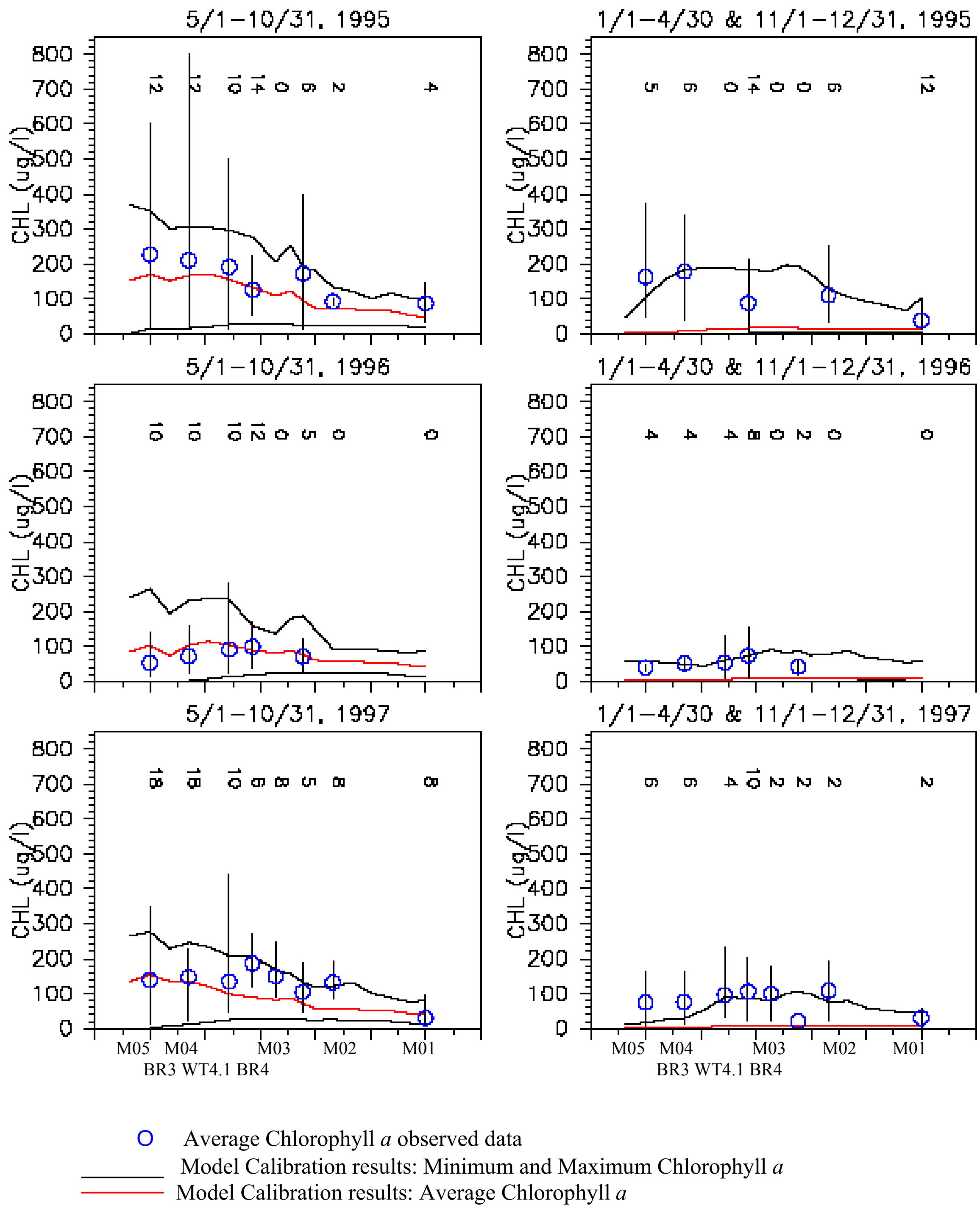


Figure 15: Longitudinal Profile of the Calibration (1992 to 1997) and/or Baseline Conditions (1995 to 1997) for Chlorophyll *a* in the Back River

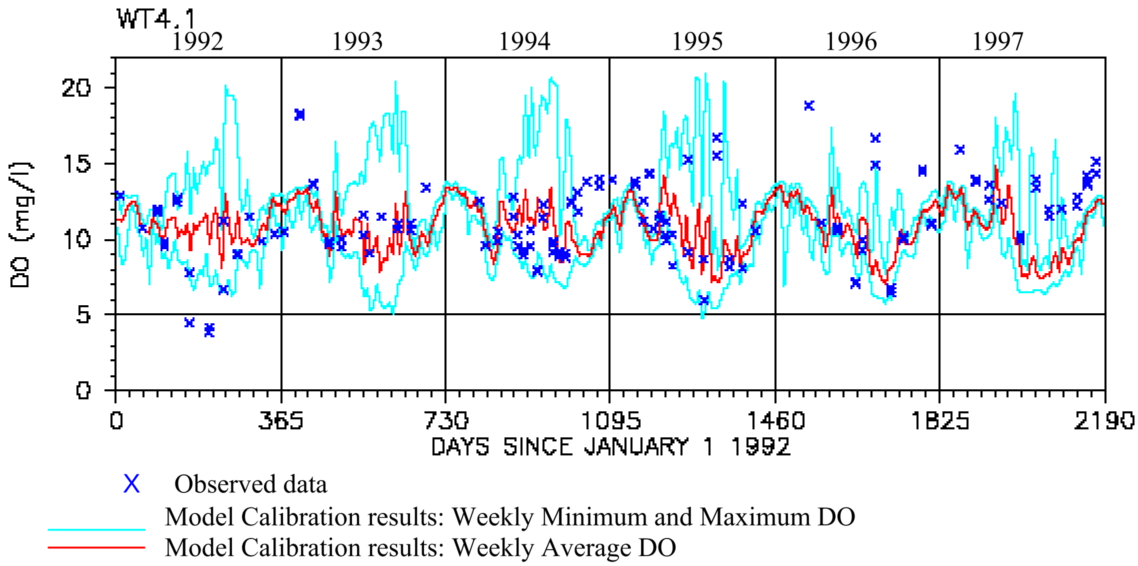
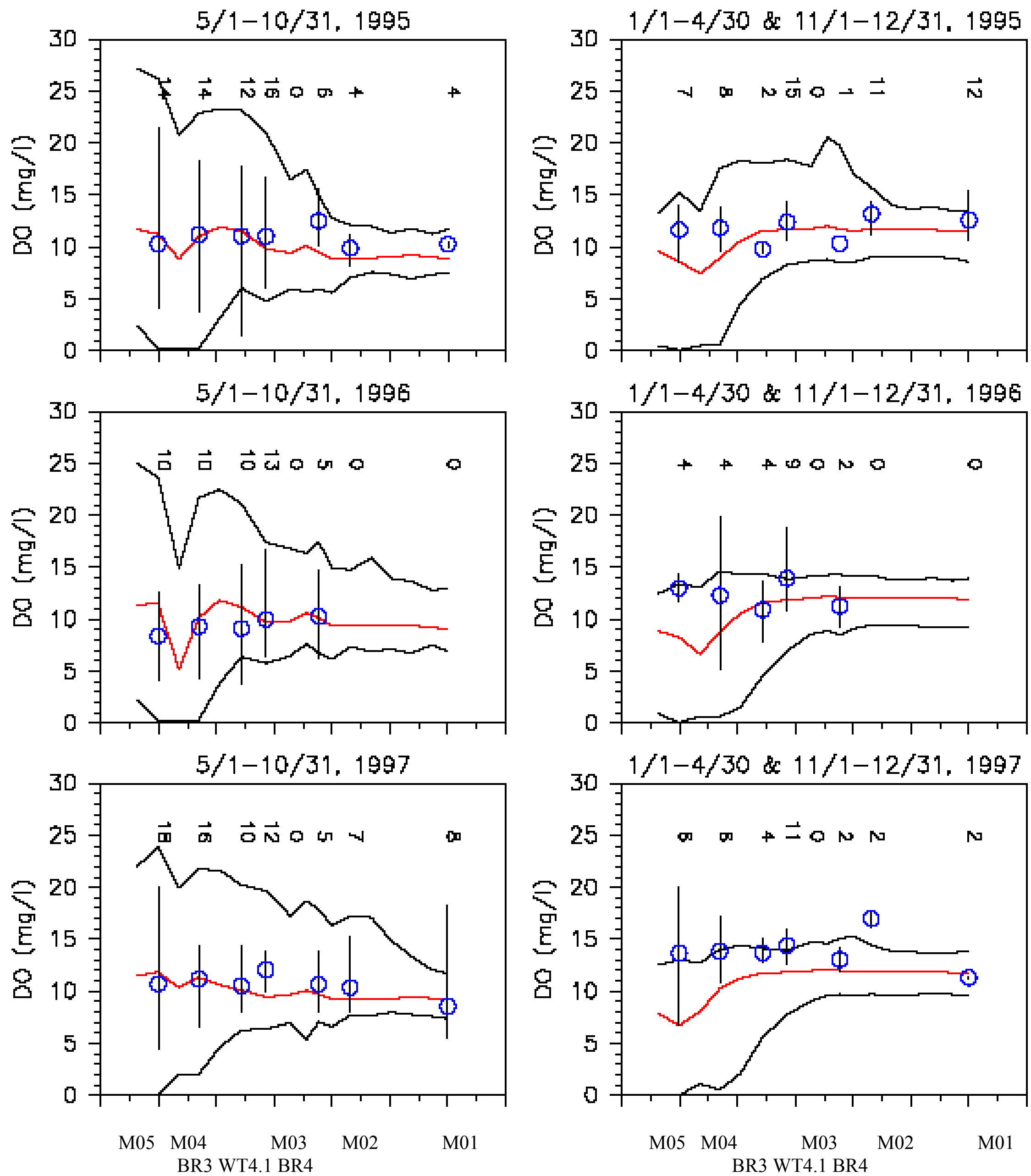


Figure 16: Station WT4.1: Model Results for the Calibration (1992 to 1997) and/or Baseline Conditions Scenario (1995 to 1997) for DO in the Back River



○ Average DO observed data
Model Calibration results: Weekly Minimum and Maximum DO
Model Calibration results: Weekly Average DO

Figure 17: Longitudinal Profile of the Calibration (1992 to 1997) and/or Baseline Conditions (1995 to 1997) for DO in the Back River

4.3.3 Future Conditions (TMDLs) Scenario

This scenario provides an estimate of future conditions of the Back River system at maximum allowable average annual and summer (May 1st to October 31st) loads. The scenario uses the same flows and hydrological and environmental conditions as the calibration/baseline scenario, but simulates a maximum design flow with lower concentrations of PS nitrogen and phosphorus discharges and a 15% reduction in nitrogen and phosphorus urban loads for the four subwatersheds of the Back River system. This future conditions scenario was used to estimate both low flow and average annual flow TMDLs.

In summary, the future conditions scenario represents a reduction in the point source nutrient loadings and a reduction taken from the baseline urban loads estimated by the HSPF watershed model, as described in "Patapsco/Back River Watershed HSPF Model Report", (MDE, 2001).

In this scenario, the point source loads from the Back River WWTP were set at very stringent limits necessary to meet water quality criteria. These point source loads (Back River WWTP only) were based on the NPDES permit flow of 130 MGD and concentrations of TN equal to 4 mg/l annual average (3 mg/L in May - October, 5 mg/L in November – April) and current NPDES permit limit for TP of 0.2 mg/l.

The nonpoint source load reduction was applied to urban-stormwater loads only. Urban areas account for approximately 80% of the total area of the Back River watershed, with corresponding urban-stormwater loads representing 87.4% of the annual average TN loads from the watershed (not including treatment plants loads), 94.4% of the annual average TP, 91.0% of the summer TN and 97.7% of the summer TP. Therefore, non-urban loads, including agricultural and forest loads represents a minor contribution to the total load.

Urban-stormwater TN and TP loads for this scenario were reduced by 15% from the baseline urban-stormwater loads in order to reach the water quality goals for Chesapeake Bay waters. This reduction is based on a combination of Best Management Practices (BMPs) efficiencies over the different land uses in the Back River watershed and followed the same assumptions made by the Chesapeake Bay Program and MD's Tributary Strategies. The urban-stormwater load reduction was also based on the combination of management programs implemented in both jurisdictions comprised by the watershed (Baltimore City and Baltimore County) during and after the 1995 – 1997 period. These management programs are still being implemented in the watershed and already account for reductions in nutrients loadings. For example, the 2003 Municipal Stormwater Discharge Permit (NPDES) Annual Report from Baltimore County shows among several projects that in the Back River watershed, nine stormwater retrofit/conversion projects, addressing 598 acres of drainage area have either been completed or are in the design stage. Also in the Baltimore County part of the Back River watershed, seven stream restoration projects addressing 7,181 linear feet of degraded stream channel have either been completed or are in the design phase (Baltimore County NPDES Municipal Stormwater Discharge Permit, 2003 Annual Report (June 15, 2003). From a similar report from Baltimore City Department of Public Works, there are currently five stormwater projects being initiated in the City's Back River watershed; three stormwater retrofits, which are in the design phase (costs: $1,500,000 and $1,000,000 and $174,000), one stream channel study ($205,788), and one monitoring station that is under construction ($100,000) (City of Baltimore, NPDES Stormwater Permit Program Annual Report. May 3, 2004).

4.3.4 Future Condition (TMDLs) Scenario Results

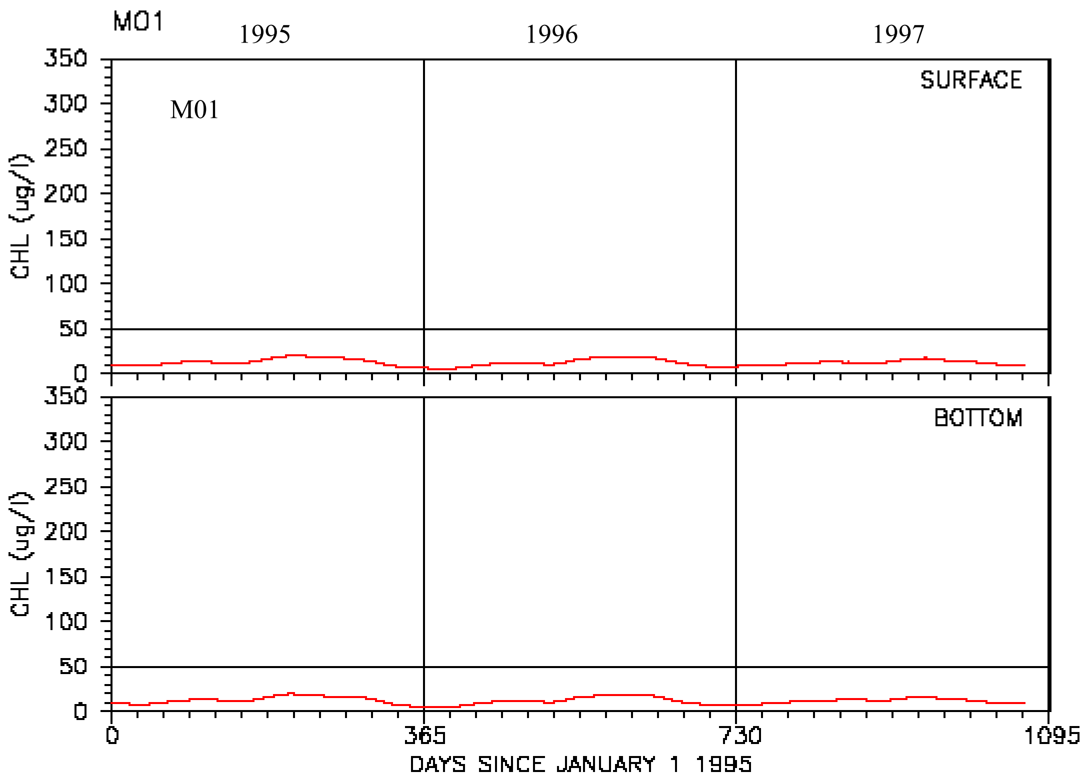
Figures 18 to 23 below represent the results of the TMDLs scenario.

As shown in the figures, under the nutrient load reduction conditions described above for this scenario, rolling monthly average chlorophyll *a* concentrations remain below 50 µg/l along the entire simulation period and throughout length of the Back River. The chlorophyll *a* attainment was checked using time series of "rolling monthly average Chla concentrations" against the 50 µg/l goal. For DO, the attainment was also checked comparing time series of minimum DO concentrations against the DO criteria of 5 mg/l. The comparison shows the nutrient load reductions result in little change, maintaining the minimum DO concentrations above 5 mg/l along the length of the river.

For the Back River WWTP, the total nitrogen concentration for this scenario is set at a level determined by the Enhanced Nutrient Removal Strategy (ENR) to a maximum of 5.0 mg/l from November 1 to April 30th and a maximum of 3.0 mg/l from May 1st to October 31st. The total phosphorus is set at the current permit limit of 0.2 mg/l, with a maximum allowable flow of 130 mgd, which corresponds to the current permit flow of the facility that can be discharged into the Back River. The Eastern Stainless industrial plant does not discharge any longer into the Back River and was not considered for this scenario.

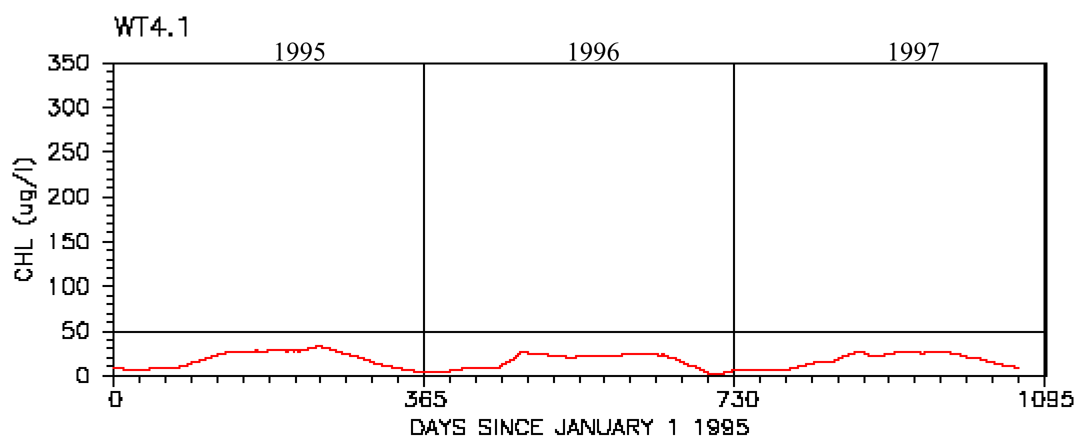
Model results for the TMDL scenario are summarized in Figures 18 to 23. Only DO and chlorophyll *a* TMDLs time series for water quality stations M01 (mouth of the river), WT4.1 (long term station, middle of the river) and M05 (upstream of the river), are shown below. Model results for all parameters associated with this scenario can be found in Part C of Appendix 1.

As seen in the figures below, under the TMDLs scenario conditions, the minimum DO in the Back River during the 1995-1997 period is above 5.0 mg/l and monthly average chlorophyll *a* concentrations is below the goal of 50 µg/l. Using rolling monthly average chlorophyll *a* values as a statistical tool to estimate chlorophyll *a* criteria attainment, the TMDL scenario model results show the river maintains chlorophyll *a* attainment, below 50 µg/l, throughout the TMDL period of 1995 to 1997. Chlorophyll *a* rolling monthly average values were used to estimate criteria attainment. The system shows a maximum chlorophyll *a* monthly rolling average of 49.8 µg/l for May 1 to October 31 at station M05, the most critical location in the estuary. Minimum DO levels also are always above 5.0 mg/l at all locations and throughout the 1995-1997 TMDL scenario period.



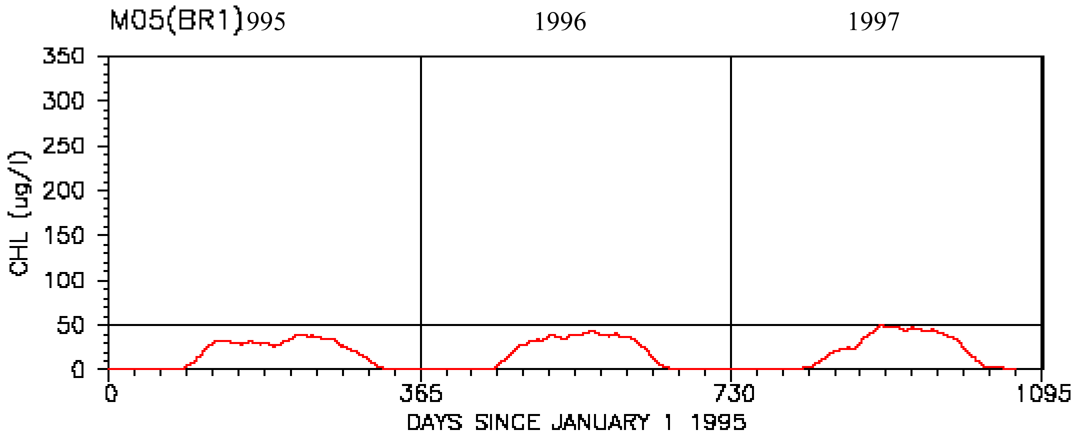
TMDLs Scenario results: Rolling monthly average Chlorophyll *a*

Figure 18: Station M01: Model Results for the TMDLs Scenario for Chlorophyll *a*



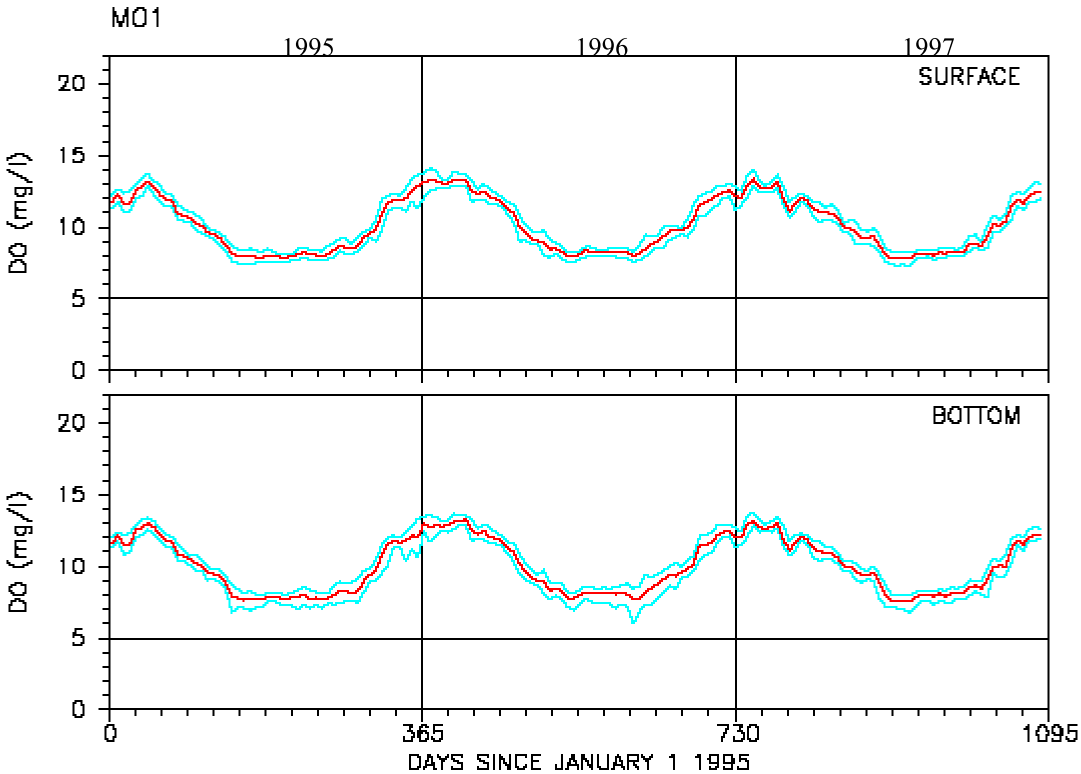
TMDLs Scenario results: Rolling monthly average Chlorophyll *a*

Figure 19: Station WT4.1: Model Results for the TMDLs Scenario for Chlorophyll *a*



TMDLs Scenario results: Rolling monthly average Chlorophyll *a*

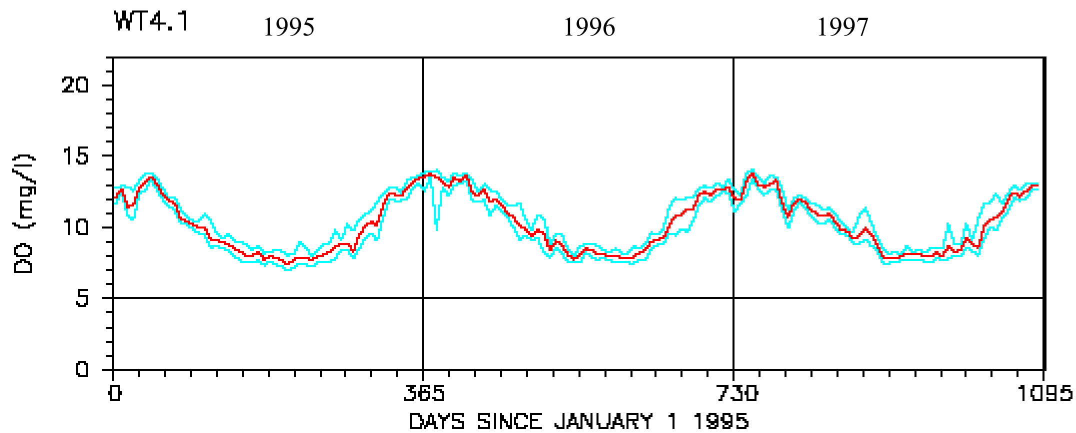
Figure 20: Station M05: Model Results for the TMDLs Scenario for Chlorophyll *a*



TMDLs Scenario results: Weekly Minimum and Maximum DO

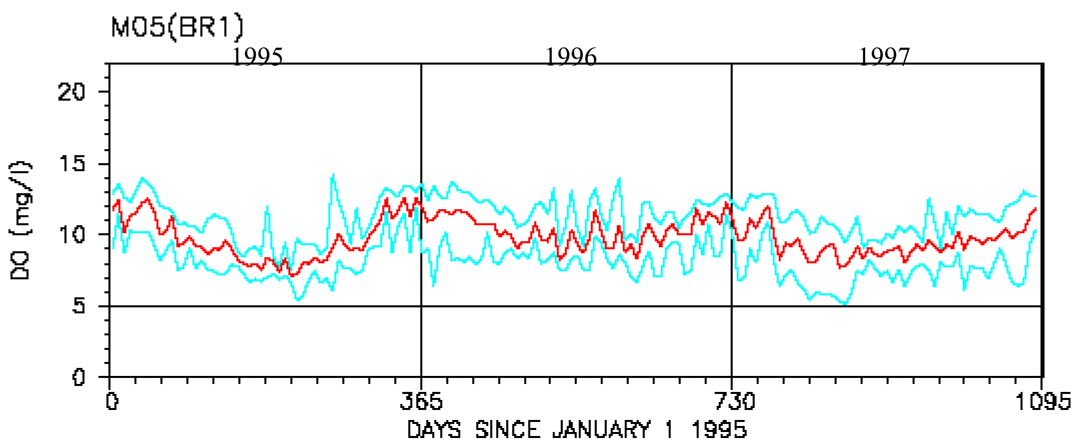
TMDLs Scenario results: Weekly Average DO

Figure 21: Station M01: Model Results for the TMDLs Scenario for Dissolved Oxygen



TMDLs Scenario results: Weekly Minimum and Maximum DO
TMDLs Scenario results: Weekly Average DO

Figure 22: Station WT4.1: Model Results for the TMDLs Scenario for Dissolved Oxygen



TMDLs Scenario results: Weekly Minimum and Maximum
TMDLs Scenario results: Weekly Average DO

Figure 23: Station M05: Model Results for the TMDLs Scenario for Dissolved Oxygen

4.4 TMDL Loading Caps

This section presents the TMDLs for nitrogen and phosphorus. The outcomes are presented in terms of an average annual TMDL and a low flow TMDL. The TMDLs were estimated based on the nutrient loadings as explained in Section 4.3 and the resulting water quality of the Back River for the simulated years 1995, 1996 and 1997. This period was selected to estimate the TMDLs because it covers a period with a dry year as well as wet year, accounting for seasonality and critical conditions. The low flow TMDLs are stated in monthly terms because this critical condition occurs for a limited period of time. The detailed calculation of TMDL loading caps can be found in Part D of Appendix 1.

For the period of May 1 through October 31, the following TMDLs apply:

Low Flow TMDLs:

NITROGEN TMDL	113,321 ***lbs/month***
PHOSPHORUS TMDL	7,995 ***lbs/month***

The average annual TMDLs for nitrogen and phosphorus are:

Average Annual TMDLs:

NITROGEN TMDL	1,773,100 ***lbs/year***
PHOSPHORUS TMDL	99,171 ***lbs/year***

4.5 Load Allocations Between Point Sources and Nonpoint Sources

During the 1995 to 1997 period, the watersheds draining into the Back River had two permitted point sources discharging nutrients directly to the river. For the TMDL scenario, only the Back River WWTP is given an allocation. The Eastern Stainless plant has not discharged into the Back River since 1999. The allocations described in this section demonstrate how the TMDLs can be implemented to achieve water quality criteria in local waters and Chesapeake Bay waters. Specifically, these allocations show that the sum of nitrogen and phosphorus nutrient loadings to the Back River from existing point and nonpoint sources can be maintained safely within the TMDLs established herein. The State reserves the right to adjust future allocations provided such adjustments are consistent with achieving water quality standards.

4.5.1 Low Flow TMDL Allocations

Low flow TMDL allocations are intended for the period of May 1st to October 31st.

Load Allocations (LA)

- **Nonpoint Source Loads**
  The nonpoint loads of nitrogen and phosphorus simulated in the TMDLs scenario represent the same loads as in the calibration/baseline scenario for both the low flow period and the remaining months of the year from 1995 to 1997. Nonpoint source loads including agricultural loads and forest loads are assigned to the TMDL as LA. The calibration/baseline scenario loads were based on the MDE HSPF model of the Back

River watershed. The modeling of the watershed accounted for both "natural" and human-induced components, including atmospheric deposition and septic loadings. Details on the HSPF model can be found in "Patapsco/Back River Watershed HSPF Model Report", (MDE, 2001).

Waste Load Allocations (WLA)

- **Stormwater Loads**
  In November 2002, EPA advised States that NPDES-regulated stormwater discharges must be addressed by the wasteload allocation (WLA) component of a TMDL. See 40 C.F.R. § 130.2(h). NPDES-regulated stormwater discharges may not be addressed by the load allocation (LA) component of a TMDL. EPA also provided guidance on ways to reflect the stormwater wasteload allocation (WLA) in a TMDL. As explained in Section 4.3.3, the stormwater discharges loads of nitrogen and phosphorus simulated in the Back River TMDL scenario represent a 15% reduction in TN and TP from baseline urban-stormwater loads for both the low flow and the remaining months of the year. Urban-stormwater loads are now part of the WLA.

  Current stormwater Phase I individual permits and new stormwater Phase II permits will be considered point sources subject to WLA assignment in the TMDL, instead of LA assignment as in the past. EPA recognizes that limitations in the available data and information usually preclude stormwater allocations to specific outfalls. Therefore, the Agency guidance allows this stormwater WLA to be expressed as a gross allotment, rather than individual allocations for separate pipes, ditches, construction sites, etc. Available information for the Back River allows the stormwater WLA for this analysis to be defined separately for Baltimore City and Baltimore County; however, these WLAs aggregate municipal and industrial stormwater, including the loads from construction activity.

  Waste load allocations from point source dischargers are usually based on the relative contribution of pollutant load to the waterbody. Estimating a load contribution to a particular waterbody from the stormwater Phase I and II sources is imprecise, given the variability in sources, runoff volumes, and pollutant loads over time. Therefore, the stormwater WLA portion of the TMDL is based on the best loadings estimate currently available.

- **Wastewater Treatment Plants Loads**
  In addition to nonpoint source loads and stormwater point sources, waste load allocations to the Back River WWTP for these low flow TMDLs plus a 5% MOS, estimated as explained in the next section, make up the balance of the total allowable load.

  The Back River WWTP maximum allowable current permit flow of 130 MGD is used for this scenario, with concentrations set to achieve water quality goals to a maximum of total nitrogen of 3 mg/l from May 1st to October 31st. Total phosphorus limit is 0.2 mg/l year round. As explained before, the Eastern Stainless industrial plant did not discharge into Back River since 1999, and it is not considered in the TMDLs scenario. All significant point sources are addressed by this allocation and are described further in the technical memorandum entitled "*Significant Nutrient Point Sources in the Back River Watershed"*. The nitrogen and phosphorus allocations for low flow conditions are presented in Table 3.

The TMDL including loads from stormwater discharges are expressed as:

TMDL = WLA [non-stormwater point sources + regulated stormwater point source] + LA + MOS

Table 3: Low Flow Allocations

	Total Nitrogen *(lbs/month)*	**Total Phosphorus *(lbs/month)***
Nonpoint Source[1]	1,345	34
Point Source[2]	111,299	7,888
MOS[3]	677	73
Total	113,321	7,995

1. Excluding urban-stormwater loads.
2. Including urban-stormwater loads.
3. Representing 5% of baseline urban/stormwater loads.

4.5.2 Average Annual TMDL Allocations

Load Allocations (LA)

- **Nonpoint Source Loads**
  The average annual nonpoint nitrogen and phosphorus allocations are represented as the average of the HSPF simulated loads from 1995 to 1997. The nonpoint loads simulated in the HSPF model account for both "natural" and human-induced components. Nonpoint source loads include agricultural loads, forest loads and atmospheric.

Waste Load Allocations (WLA)

- **Stormwater Loads**
  The stormwater discharge loads of nitrogen and phosphorus simulated in the TMDLs scenario represent a 15% reduction in TN and TP from baseline urban-stormwater loads for the average annual TMDL scenario. Urban-stormwater loads are now part of the WLA.

- **Wastewater Treatment Plants Loads**
  Waste load allocations to the Back River WWTP plus a 5% MOS for the average annual conditions make up the balance of the total allowable load.

The Back River WWTP flow is the same as set for the low flow TMDLs allocations. TN concentration was set to a maximum of total nitrogen of 5 mg/l from November 1^{st} to April 30^{th} and to a maximum of 3 mg/l from May 1^{st} to October 31^{st} as indicated above. The load from urban-stormwater discharge is incorporated into the point source load as part of the annual waste load allocations. The point sources are addressed by this allocation and are described further in the technical memorandum entitled, *"Significant Nitrogen and Phosphorus Nonpoint Sources and Point Sources in the Back River Watershed*." The nonpoint and point source nitrogen and phosphorus allocations for average annual flow conditions are shown in Table 4.

Table 4: Average Annual Allocations

	Total Nitrogen *(lbs/yr)*	**Total Phosphorus *(lbs/yr)***
Nonpoint Source[1]	26,323	1,239
Point Source[2]	1,737,626	96,896
MOS[3]	9,151	1,036
Total	1,773,100	99,171

1. Excluding urban-stormwater loads.
2. Including urban-stormwater loads.
3. Representing 5% of baseline urban/stormwater loads.

4.6 Margins of Safety

A MOS is required as part of a TMDL in recognition of many uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

Based on EPA guidance, the MOS can be achieved through two approaches (EPA, April 1991). One approach is to reserve a portion of the loading capacity as a separate term in the TMDL (i.e., TMDL = Load Allocation (LA) + Waste Load Allocation (WLA) + MOS). The second approach is to incorporate the MOS as conservative assumptions used in the TMDL analysis.

Maryland has adopted a MOS for these TMDLs using the above-mentioned first approach. The reserved load allocated to the MOS was computed as 5% of the urban-stormwater loads for nitrogen and phosphorus. For the low flow and the average annual flow TMDLs in the Back River, this MOS also represents a 5% of the total urban-stormwater loads. These explicit nitrogen and phosphorus margins of safety are summarized in Table 5.

Table 5: Low Flow and Average Annual Margins of Safety (MOS)

	Total Nitrogen	Total Phosphorus
MOS Low Flow	677 lbs/month	73 lbs/month
MOS Annual	9,151 lbs/yr	1,036 lbs/yr

4.7 Summary of Total Maximum Daily Loads

The Low Flow TMDLs, applicable from May 1 – October 31 for the Back River follow:

For Nitrogen:

TMDL (*lbs/month*)	=	**LA**	+	**WLA**	+	**MOS**
113,321	=	**1,345**	+	**111,299**	+	**677**

For Phosphorus:

TMDL (*lbs/month*)	=	**LA**	+	**WLA**	+	**MOS**
7,995	=	**34**	+	**7,888**	+	**73**

The average annual flow TMDLs for the Back River follow:

For Nitrogen

TMDL (*lbs/year*)	=	**LA**	+	**WLA**	+	**MOS**
1,773,100	=	**26,323**	+	**1,737,626**	+	**9,151**

For Phosphorus (*lbs/year*):

TMDL (*lbs/year*)	=	**LA**	+	**WLA**	+	**MOS**
99,171	=	**1,239**	+	**96,896**	+	**1,036**

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation (Nonpoint Source)
WLA = Waste Load Allocation (Point Source)
MOS = Margin of Safety

Average Daily Loads:

On average, the low flow TMDLs will result in loads of approximately 3,777 lbs/day of nitrogen and 266 lbs/day of phosphorus. Similarly, the average annual flow TMDLs will result in loads of approximately 4,852 lbs/day of nitrogen and 271 lbs/day of phosphorus.

5.0 ASSURANCE OF IMPLEMENTATION

This section provides the basis for reasonable assurances that the nitrogen and phosphorus TMDLs will be achieved and maintained. For both TMDLs, Maryland has several well-established programs that will be drawn upon: the Water Quality Improvement Act of 1998 (WQIA), the Clean Water Action Plan (CWAP) framework, and the Chesapeake Bay Agreement's Tributary Strategies for Nutrient Reduction. Also, Maryland has adopted procedures to assure that future evaluations are conducted for all TMDLs that are established.

The implementation of point source nutrient controls will be executed through ENR strategy and NPDES permits. The ENR program provides cost-share grant funds to local governments to retrofit or upgrade wastewater treatment plants (WWTP) to remove a greater portion of nutrients from discharges. Enhanced nutrient removal technologies allow sewage treatment plants to provide a highly advanced level of nutrient removal. The ENR strategy builds on the success of the biological nutrient removal (BNR) program already in place. The NPDES permits for the Back River WWTP will include nutrient goals that have been established, and, upon completion of the upgrade, the permittee shall make a best effort to meet the load goals, which provide a reasonable assurance of implementation. The NPDES permits should also be consistent with the assumptions made in the TMDL (e.g., flow, nutrients effluent concentrations, CBOD, DO, etc.).

Maryland’s WQIA requires that comprehensive and enforceable nutrient management plans be developed, approved and implemented for all agricultural lands throughout Maryland. This act specifically requires that nutrient management plans for nitrogen be developed and implemented by 2002, and plans for phosphorus to be done by 2005. Maryland’s CWAP has been developed in a coordinated manner with the State's 303(d) process. All Category I watersheds identified in Maryland's Unified Watershed Assessment process are totally coincident with the impaired waters list for 2002 approved by EPA. The State is giving a high-priority for funding assessment and restoration activities to these watersheds.

In 1983, the States of Maryland, Pennsylvania, and Virginia, the District of Columbia, the Chesapeake Bay Commission, and the U.S. EPA joined in a partnership to restore the Chesapeake Bay. In 1987, through the Chesapeake Bay Agreement, Maryland made a commitment to reduce nutrient loads to the Chesapeake Bay. In 1992, the Bay Agreement was amended to include the development and implementation of plans to achieve these nutrient reduction goals. Maryland's resultant Tributary Strategies for Nutrient Reduction provide a framework supporting the implementation of nonpoint source controls in the Patapsco/Back Tributary Strategy Basin, which includes the Back River watershed. Maryland is in the forefront of implementing quantifiable nonpoint source controls through the Tributary Strategy efforts. This will help to assure nutrient control activities are targeted to areas in which nutrient TMDLs have been established.

In November 1990, EPA required jurisdictions with a population greater than 100,000 to apply for NPDES Permits for stormwater discharges. In 1983, the EPA Nationwide Urban Runoff Program found that stormwater runoff from urban areas contains the same general types of pollutants found in wastewater, and that 30% of identified cases of water quality impairment were attributable to stormwater discharges. The two jurisdictions where the Back River watershed is located, Baltimore City and Baltimore County, are required to participate in the stormwater NPDES program, and have to comply with the NPDES Permit regulations for stormwater discharges. Several management programs have been implemented in different areas served by the County and the City municipal separate storm sewer system. These jurisdiction-wide programs are designed to control stormwater discharges to the maximum extent practicable.

It is reasonable to expect that nonpoint loads can be reduced during low flow conditions. The nutrient loads sources during low flow include dissolved forms of the impairing substances from groundwater, the effects of agricultural ditching and animals in the stream, and deposition of nutrients and organic matter to the stream bed from higher flow events. When these sources are controlled in combination, it is reasonable to achieve nonpoint reductions of the magnitude identified by this TMDL allocation.

Finally, Maryland uses a five-year watershed cycling strategy to manage its waters. Pursuant to this strategy, the State is divided into five regions and management activities will cycle through those regions over a five-year period. The cycle begins with intensive monitoring, followed by computer modeling, TMDL development, implementation activities, and follow-up evaluation. The choice of a five-year cycle is motivated by the five-year federal NPDES permit cycle. This continuing cycle ensures that every five years intensive follow-up monitoring will be performed. Thus, the watershed cycling strategy establishes a TMDL evaluation process that assures accountability.

REFERENCES

Ambrose, Robert B., Tim A. Wool, James A. Martin. "The Water Quality Analysis Simulation Program, Wasp5.1". Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. 1993.

Boynton, W. R., Burger, N. H., Stankelis, R. M., Rohland, F.M., Hagy III, J. .D., Frank, J. M., Matteson, L. L. and Weir, M. .M. An environmental evaluation of Back River with selected data from Patapsco River. Prepared for Baltimore City Department of Public Works for Project 613, Comprehensive Wastewater Facilities Master Plan, University of Maryland Center for Environmental Science, Chesapeake Biological Lab., MD. 1998.

Cerco, C.F. and T.M. Cole. Three-dimensional eutrophication model of Chesapeake Bay: Volume 1, main report. Technical Report EL-94-4, US Army Engineer Waterways Experiment Station, Vicksburg, MS. 1994.

Cerco, C.F. and T.M. Cole. User's guide to the CE-QUAL-ICM three-dimensional eutrophication model. Technical Report EL-95-15, US Army Engineer Waterways Experiment Station, Vicksburg, MS. 1995.

Coastal Environmental Services (1995). Patapsco/Back Rivers watershed study: ambient conditions, pollutant loads and recommendation for further action. Prepared for Maryland Department of the Environment, Coastal Environmental Services, Inc., Linthicum, MD.

Code of Maryland Regulations, 26.08.02.08G, 26.08.02.03B(2).

Di Toro, D.M., J.J. Fitzpatrick, and R.V. Thomann "Documentation for Water Quality Analysis Simulation Program (WASP) and Model Verification Program (MVP)." EPA/600/3-81-044. 1983.

DiToro, D. M. and J.J. Fitzpatrick. Chesapeake Bay sediment flux model. Contract Report EL-93-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS, 1993.

DiToro, D. M., S. Lowe and J. Fitzpatrick: Application of a water column-sediment eutrophication model to a mesocosm experiment I. Calibration. J. Environ. Engr. ASCE. 2001.

Ferguson, J.F. and D. Simmons. The fate of nutrients in Back River. CRC Publication No. 32, Chesapeake Research Consortium, Inc., The Johns Hopkins University, MD, 1974.

Johnson, B. H., Heath, R.E. and Bernard B. Hsieh. User's guide for a three-dimensional numerical hydrodynamic, salinity, and temperature model of Chesapeake Bay. Technical Report HL-91-20, US Army Engineer Waterways Experiment Station, Vicksburg, MS. 1991.

Maryland Department of Environment, "Patapsco/Back River Watershed HSPF Model Report. 2001.

Maryland Department of Planning. 2000 Reference for Land Use.

Maryland Environmental Service. Seminar on Water Pollution in the Baltimore Area. Maryland Environmental Service, Annapolis, MD. 1974.

Mortimer, C. H. The exchange of dissolved substances between mud and water. I and II. J. Ecol., 29:29:280-329, 1941.

Mortimer, C. H. The exchange of dissolved substances between mud and water in lakes. III and IV. J. Ecol., 30:147-201. 1942.

Thomann, Robert V., John A. Mueller "Principles of Surface Water Quality Modeling and Control." HarperCollins Publisher Inc., New York, 1987.

U.S. EPA, "*Technical Support Document for Water Quality-based Toxics Control*." Office of Water/OW Environment Protection (OW/OWEP) and Office of Water Regulations and Standards (OWRS), Washington, D. C., April 23, 1991.

U.S. EPA Chesapeake Bay Program, "Chesapeake Bay Program: Watershed Model Application to Calculate Bay Nutrient Loadings: Final Findings and Recommendations," and Appendices, 1996.

U.S. Environmental Protection Agency. 1999. "Protocol for Developing Nutrient TMDLs". EPA 841-B-99-007. Office of Water (4503F), United States Environmental Protection Agency, Washington D.C. 135 pp.

U.S. EPA, "Technical Guidance Manual for Developing Total Maximum Daily Loads, Book2: Streams and Rivers, Part 1: Biochemical Oxygen Demand/ Dissolved Oxygen and Nutrients/ Eutrophication," Office of Water, Washington D.C., March 1997.

Wang, Harry V., Sin, Yongsik, Kim, Sung-Chan; "The development of a Water Quality Model for Baltimore Harbor, Back River and the adjacent Upper Chesapeake Bay. Part I: Biological, Chemical and Physical Characteristics of the Baltimore Harbor (Patapsco River) and Back River in the Upper Chesapeake Bay" Virginia Institute of Marine Science. School of Marine Science. College of William and Mary. Gloucester, VA. 1999.

Wang, Harry V., Sin, Yongsik, Kim, Sung-Chan; "The development of a Water Quality Model for Baltimore Harbor, Back River and the adjacent Upper Chesapeake Bay. Part II: The Hydrodynamic and Eutrophication Model for the Baltimore Harbor, Back River and the Upper Chesapeake Bay" Virginia Institute of Marine Science. School of Marine Science. College of William and Mary. Gloucester, VA. 1999.

APPENDIX F:
TMDL for Chlordane in Back River

Total Maximum Daily Load (TMDL) Documentation for Chlordane in Back River

Prepared by the
Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224

Submitted to:

Water Protection Division
U.S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia PA 19103-2029

July 1999

TABLE OF CONTENTS

ATTACHMENTS

Total Maximum Daily Load (TMDL)
for Chlordane in Back River
Basin Code: 02-13-09-01

EXECUTIVE SUMMARY

Chlordane, a pesticide no longer authorized for use in the United States, has been detected in certain Back River fish tissues at levels that required the issuance of a consumption advisory. This advisory has been in place since February 5, 1986 (attachment 1). As a consequence of this impairment by chlordane, Back River was identified as a water quality limited segment on the 1996 Section 303(d) list. This document establishes a TMDL of 0.00059 ug/L in the water column based on the United States Environmental Protection Agency water quality criterion for chlordane and the U.S. Food and Drug Administration guidance level of 0.3 mg/kg in fish tissue. Since the TMDL value is impracticable to monitor directly in the water column, the U.S. FDA guidance level will serve as the targeted endpoint. In the absence of any defined current sources of chlordane other than sporadic low levels from urban runoff sources, there is no opportunity to allocate loadings among point and non-point sources. The State intends to periodically monitor the contaminant levels of fish and sediments in Back River to track the expected gradual declines, which are indicated in currently available sediment data. The goal of the monitoring program will be to identify fish tissue levels that would allow for the withdrawal of the fish consumption advisory.

PREFACE

Section 303(d) of the federal Clean Water Act directs States to identify and list waters, known as water quality limited segments (WQLSs), in which current, required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is to establish a Total Maximum Daily Load (TMDL) of the specified substance that the water can receive without violating water quality standards.

On the basis of water quality problems associated with Back River, the watershed was identified on the Maryland's 1996 list of WQLSs as being impaired by toxic contaminants, specifically the pesticide chlordane. This report documents the proposed establishment of the chlordane TMDL for the Back River.

Once the TMDL is approved by the United States Environmental Protection Agency (EPA), the approved TMDL will be documented through the State's Continuing Planning Process. In the future, the established TMDL will document monitoring activities required to track restoration of the impaired resource and the lifting of the associated fish consumption advisory.

1.0 INTRODUCTION

The Clean Water Act Section 303(d)(1)(C) and federal regulation 40 CFR 130.7(c)(1) direct each State to develop a Total Maximum Daily Load (TMDL) for all impaired waters on its Section 303(d) list. A TMDL reflects the maximum pollutant loading of the impairing substance a waterbody can receive and still meet water quality standards. A TMDL can be expressed in mass per time, toxicity, or any other appropriate measure (40 CFR 130.2(i)). TMDLs must take into account seasonal variations and a margin of safety (MOS) to allow for uncertainty. Maryland's 1996 303(d) list, submitted to EPA by the Maryland Department of the Environment (MDE), lists the Back River watershed segment for toxics, specifically the pesticide chlordane. That 1996 listing was prompted by historical fish tissue data and an associated fish consumption advisory based on 1980s monitoring of the fish resources.

This report documents the development of a Total Maximum Daily Load (TMDL) for chlordane in the estuarine portion of Back River. This watershed, referred to as basin 02-13-09-01, was first identified as being impaired because of chlordane on Maryland's 303(d) list for 1996.

Chlordane has been identified as a pollutant of concern because it is a bioaccummulative pesticide that can cause both acute toxic and longer-term chronic effects, and it has carcinogenic potential in animals. Chlordane was used from its introduction in the 1940s until it was withdrawn from the market in 1988 as a broad-spectrum pesticide for agricultural, home, and commercial control of insects. Its polycyclic chlorinated organic structure produces biological effects similar to those of DDT, PCBs, and other related substances.

The Maryland Department of Agriculture suspended broad-based uses of chlordane in 1975 by restricting its use to termite control. Only certified applicators were authorized to purchase quantities greater than ½ gallon after that date. The U.S. Environmental Protection Agency (EPA) reached an agreement with the sole producer of the product on July 1, 1986, which led to the further restriction of use to the exterior of buildings, and to the ultimate termination of all sales by April 15, 1988. EPA officially cancelled the product's registration in 1993.

Concerns with the substance were largely brought to the State's attention through results of its fish tissue monitoring, which has been an element of the State's water quality monitoring efforts since the 1970s. Water quality impairments in the estuary of Back River were initially suggested as a result of fish taken from waters of the tidal portion of the basin in 1981. The levels were of sufficient magnitude to justify the issuance of a fish consumption advisory. All available evidence indicates that the source of the chlordane in the fish tissue is the historical accumulation of chlordane in the sediments of the tidal reaches of the watershed.

The river's designation as a "water quality limited segment" is based upon violations of the use designation for the waterbody and the narrative standard for toxic substances in the State's regulations. Specifically, the use designation of Class I waters, which requires at Code of Maryland Regulations (COMAR) Title 26.08.02.01 B (2) (a), that "All waters of this State shall be protected for the basic uses of water contact recreation, fish, other aquatic life, wildlife, and water supply." Later in the regulations at COMAR 26.08.02.01 C, the narrative statement concerning toxic pollution states that "the waters of this State may not be polluted by: . . . (3) high temperature, toxic, corrosive or other deleterious substances attributable to sewage, industrial wastes, or other waste in concentrations or combinations which: . . . (b) are harmful to human, animal, plant, or aquatic life." Because the fish inhabiting the waters cannot be consumed without restriction, the river is considered to be impaired.

2.0 WATERSHED CHARACTERIZATION AND WATER QUALITY DESCRIPTION

2.1 General Setting

Back River is a tidal estuary of the Chesapeake Bay located on the western shore just north of Baltimore Harbor (see attachment 2). The watershed of Back River is fed primarily by Herring Run, Redhouse Run, and Stemmers Run. The entire watershed is about 15 miles long and 6 miles wide at its widest point. The watershed has a northwest to southeast longitudinal orientation.

The upper-most portion of the watershed originates in the Piedmont Plateau region of the State. At about six miles from its origin, the primary tributary, Herring Run begins to traverse the Fall Line, which separates the Piedmont Plateau from the Coastal Plain. Thus, a majority of the watershed lies within the Coastal Plain Province.

The watershed is largely developed, with most being in residential use. There is some industrial development along the lower end of the free flowing portion of Herring Run, and along the south shore of the tidal portion of the basin. The largest wastewater discharge is from the Back River sewage treatment plant. It discharges approximately 120 million gallons per day of treated wastewater to the upper tidal reaches of the estuarine portion of the system.

2.2 Water Quality Characterization

Water quality information on chlordane in ambient waters of the basin is limited. Data from an unpublished 1994 urban stormwater runoff study by the Department of the Environment (MDE draft August 1997) suggests that the occurrence of chlordane is unpredictable in spatial scope and temporal extent. Seven of the ten samples taken from Back River watershed stations (ZHR0001-upstream and HRR0033-downstream) produced chlordane levels that were either not detected (ND), or less than the level of quantification. Of the three that were measurable, one was at the level of quantification (0.02 ug/L or parts per billion - ppb), one was at 0.03 ug/L, and the third was at 0.08 ug/L (Table 1). Downstream observations were equal to or less than upstream observations.

Table 1 Pesticides in Back River Tributary – 1994

Herring Run	Winter	Spring	Summer-1	Summer-2	Fall
ZHR0001[a]	0.03	ND	0.02	<0.02	0.08
HRR0033[b]	<0.02	ND	<0.02	<0.02	<0.02

Units in ug/L or ppb.

a. Upstream

b. Downstream

Since the level of detection in this study was two orders of magnitude above the EPA water quality criterion for chlordane, and the measured levels were relatively close to the level of detection, the reliability of the data for determining absolute conditions is considered to be questionable.

The only chlordane data from point sources in the watershed is from the Back River wastewater treatment plant. In 1989 no chlordane was detected. More recent sampling in May and August 1998 also produced no detectable chlordane. The detection levels in 1998 were 0.086 ug/L (personal communication – John Martin, Baltimore City DPW).

2.3 Supporting Data

Fish tissue samples serve as a key source of data for chlordane. Two or more fish species, representing bottom feeders and higher trophic level predators, are targeted for collection at each statewide monitoring location. Species having a wide range of occurrence are targeted to allow for regional comparisons in addition to the temporal trends at each network site. Chlordane has been identified in almost every fish tissue sample collected under the State's fish tissue monitoring program, which was institutionalized in 1976. The fish tissue monitoring program currently consists of a network of over thirty monitoring locations where triennial sampling allows for statewide trend assessments. This network is supplemented with additional monitoring sites of suspected concern.

Statewide, most fish tissue chlordane levels have been well below the 0.3 ppm action level established by the U.S. Food and Drug Administration (USFDA). Elevated levels of chlordane in fish tissue have appeared most commonly in urban areas, especially those located near the head of tidal influence. Among the sites of greatest accumulation were Baltimore Harbor (Patapsco River) and Back River. In these water bodies, and Lake Roland (an impoundment on Jones Falls and a tributary to the Patapsco River), the levels of chlordane in selected fish tissues frequently exceeded the action guidelines of the USFDA.

Following the initial surveys of the 1970s, where the results indicated a potential for problems in selected urban areas, additional monitoring efforts were focused on the areas of greatest concern, which included Back River. The limited monitoring conducted in Back River in 1981 substantiated the concern for urban waters and resulted in additional and more definitive monitoring in subsequent years. Results of the monitoring in the Back River watershed are contained in the files of the Department of the Environment and are summarized in Table 2.

Table 2. Fish Tissue Data from Back River

Sampling Year	Species	Sample Type	Concentration mg/kg wet weight	Number of Fish	River Region
1981	Brown bullhead	Whole fish	**0.50**	N/A	1
	White perch	Whole fish	**0.46**	N/A	1
1982	Gizzard shad	Edible portion	0.24	N/A	N/A
	Channel catfish	Edible portion	0.15	N/A	N/A
	White catfish	Edible portion	**0.60**	N/A	N/A
	White perch	Edible portion	0.13	N/A	N/A
1983	American eel	No skin, no head	0.07	1	4
	Brown bullhead	Fillet	**0.31**	15	1
	Channel catfish	Fillet	**0.67**	14	1
	White perch	Fillet	**0.49**	5	1
	White perch	Fillet	0.20	14	4
	Yellow perch	Fillet	0.10	3	1
1985	Channel catfish	Fillet	**1.06**	10	1
	Channel catfish	Fillet	**0.82**	4	2
	Channel catfish	Fillet	**0.77**	5	3
	Channel catfish	Fillet	0.17	24	4
	White perch	Fillet	0.29	20	1
	White perch	Fillet	0.08	3	2
	White perch	Fillet	0.16	19	3
	White perch	Fillet	0.10	27	4
	American eel	No skin, no head	**0.33**	5	1
	American eel	No skin, no head	**0.44**	1	2
	American eel	No skin, no head	0.18	1	4
	Brown bullhead	Fillet	0.24	23	1
	Brown bullhead	Fillet	0.16	18	2
	Brown bullhead	Fillet	0.13	18	3
	Brown bullhead	Fillet	0.15	38	4
	Spot	Fillet	0.08	1	4
	White catfish	Fillet	0.12	1	4
1986	Brown bullhead	Fillet	**0.31**	16	1
	Brown bullhead	Fillet	**0.38**	4	2
	Channel catfish	Fillet	**1.34**	2	1
	Hogchoker	Whole fish	0.15	31	3
	White catfish	Fillet	**1.25**	5	1
	White catfish	Fillet	**0.39**	2	2
	White perch	Fillet	**0.38**	4	1
	White perch	Fillet	0.16	4	2
	White perch	Fillet	0.17	7	3
1987	Channel catfish	Fillet	0.25	11	2
	White catfish	Fillet	**0.39**	1	1
	White catfish	Fillet	0.26	2	4
	Hogchoker	Whole fish	0.08	5	2
	Hogchoker	Whole fish	0.08	5	3
	White perch	Fillet	0.05	1	1
	White perch	Fillet	0.12	11	3
	White perch	Fillet	**0.34**	2	4

N/A – Information not available

*River region = 1 – head of tide, 2 – upper middle, 3, lower middle, 4 – lower region (attachment 3)

Concentrations in bold exceed the USFDA guidance level of 0.3 mg/kg

Since chlordane was detected in a number of fish tissue samples above the 0.3 ppm USFDA action level, primarily in the headwaters region of the estuary, the waterbody was considered to be impaired.

2.4 Technical Methods

Because chlordane was banned nearly 15 years ago, chlordane loadings other than those from existing bottom sediments are expected to be negligible (see Section 4.0, Source Assessment). Consequently the bottom sediments are assumed to be the dominant current day source of chlordane in Back River water and fish tissue[1]. This means that the rate of reduction of chlordane concentrations in the biologically active sediment layer will ultimately control the water column and fish tissue concentrations. Chlordane concentrations in sediments are reduced by a number of processes.

- Burial/dilution of contaminated sediments;
- Dissolution into, followed by vaporization from, the water column;
- Uptake by biota living in the sediment;
- Chemical degradation; and
- Biological degradation.

The dominant processes are likely burial and/or dissolution followed by volatilization from the water body. Eskin *et al.* (1996) estimated sedimentation rates in the Back River estuary to range from 0.2 to 0.93 cm/yr. Howard (1991) provides estimated volatilization half-lives from a representative environmental pond, river and lake as 8-26, 3.6-5.2, and 14.4-20.6 days, respectively. Howard also states that adsorption to sediments can significantly affect the importance of volatilization. Within this system, neither uptake by biota or degradation are expected to significantly reduce chlordane levels in sediments.

Water quality criteria have been developed by EPA to protect marine aquatic life from toxic effects (0.004 ug/L) and to protect humans from the consumption of aquatic organisms (0.0022 ug/L) (EPA 1999). These values were recently updated from the earlier water quality criteria developed by EPA to protect marine aquatic life from toxic effects (0.0043 ug/L) and to protect humans from the consumption of aquatic organisms (0.00059 ug/L) (EPA 1999). As an added margin of safety, the earlier and more conservative ambient water quality criteria for the protection of humans from the consumption of organisms was employed, adding a safety margin of over a factor of three to the TMDL.

An equilibrium approach, based on the EPA 1993 sediment criteria development methodology (EPA 1993), was employed to provide an upper estimate of the dissolved water column concentration based on recent sediment concentrations following the steps provided below.

[1] Note that Observed data (Eskin 1996), and other analyses (See Section 2.4) suggest that the sediment concentrations of chlordane in the Back River are declining over time due to natural recovery of the estuary, through gradual biodegradation, dispersal, and natural burial by sedimentation.

First, the log K_{oc} is estimated from the log K_{ow} from the empirically derived equation provided below.

$$\log K_{oc} = 0.00028 + 0.983 \times \log K_{ow}$$

where:

K_{ow} = octanol/water equilibrium partition coefficient
K_{oc} = octanol/organic carbon equilibrium partition coefficient

Substituting the experimentally determined log K_{ow} chlordane (5.54) from Howard, 1991 into this equation yields:

$$\log K_{oc} = 0.00028 + 0.983 \times 5.54$$

$$\log K_{oc} = 5.45$$

$$K_{oc} = 279{,}000 \text{ L/kg}$$

The concentration in water in equilibrium with this sediment can be estimated by the equation provided below. It should be emphasized that this best represents the pore water concentration and the overlying water column may be subject to greater dilution.

$$C_w = C_s / (f_{oc} \times K_{oc})$$

where:

C_w = concentration in water (ug/L)
C_s = concentration in sediment (ug/kg)
f_{oc} = fraction organic carbon (unitless)
K_{oc} = organic carbon/water equilibrium partition coefficient (L/kg)

Recent measurements of Back River sediments (Baker *et al.* 1997) indicate an average concentration of 1.12 ng/g (dry weight) for chlordane, 5.06% total carbon (dry weight). Applying these values yields a predicted water column concentration of 0.0000793 ug/L (7.93×10^{-5} ug/L), significantly lower than the most conservative water quality criteria.

$$C_w = C_s / (f_{oc} \times K_{oc})$$

$$C_w = 1.12 \text{ ug/kg} / (0.0506 \text{ g/g} \times 279{,}000 \text{ L/kg})$$

$$C_w = 0.0000793 \text{ ug/L} = 7.93 \times 10^{-5}$$

This equilibrium approach can also be used to estimate a sediment quality benchmark (SQB) from the water quality criteria as shown in the equation below (EPA 1993).

$$SQB = WQC \times f_{oc} \times K_{oc}$$

where:

WQC = water quality criteria

Substituting 0.00059 ug/L value for the water quality criteria in the above equation:

$$SQB = 0.00059 \text{ ug/L} \times 0.0506 \text{ g/g} \times 279{,}000 \text{ L/kg}$$

$$SQB = 8.33 \text{ ug/kg or } 8.33 \text{ ng/g}$$

Current sediment levels (1.12 ng/g dry weight) are well below the calculated SQB. This represents indirect evidence that sediment concentrations of chlordane have declined below levels that would result in elevated fish tissue levels.

Direct evidence of this decline is provided by comparing the recent concentration of chlordane in Back River sediments to older studies. Baker *et al.* 1997 report an average chlordane concentration of 1.12 ng/g in Back River sediments while Eskin *et al.* 1996 report 22.4 ng/g in 1991. Although historical data are sparse, these data indicate a twenty-fold decrease in measured chlordane concentrations over a five year period. This indicates that natural attenuation processes have already reduced chlordane levels below all pertinent water quality criteria and sediment quality benchmarks. Further, it is anticipated that continued watershed monitoring efforts will indicate a corresponding reduction in fish tissue concentrations as well as continued reductions in sediment concentrations.

3.0 TARGETED WATER QUALITY GOALS

Although the State has not adopted any specific guidance levels for chlordane in its regulations or water quality standards, it does take action on environmental contaminants that significantly increase the risk of cancer. The level of significance used by the State in these analyses is that level that produces an increased risk greater than one in 100,000 of the population. This is generally expressed as a risk that is greater than 1.0×10^{-5}. Assuming that the general population has a risk of cancer from all causes of at least 25%, or 25,000 in 100,000, the threshold for concern for a single substance would increase the general risk to 25,001 in 100,000.

The United States Food and Drug Administration (USFDA) has established specific guidance levels for fish tissue in the commercial market. This level of 0.3 mg/kg (≈ parts per million (ppm)), in association with the assumed average daily consumption of fish (6.5 grams per day), produces an estimated excess cancer risk associated with chlordane of 1.0×10^{-5}. Since this value approximates the 1.0×10^{-5} level of risk used by the State for determining levels of significant excess cancer risk, Maryland generally considers waters to be impaired when edible fish tissue levels for any species exceed the USFDA guidance level of 0.3 mg/kg. Project endpoints for the control or mitigation of chlordane as it affects the edibility of fish taken from Back River in the future would be linked to the achieving of a reduction of chlordane in the targeted fish tissues to a level of 0.3 mg/kg or less.

4.0 SOURCE ASSESSMENT

The majority of environmental loadings of chlordane were required to cease as of 1988 with the end of authorized commercial use. However, stocks held by homeowners could be a continuing source, as would be the erosion and transport of existing soils previously contaminated by chlordane and related compounds. Occasional studies of urban and agricultural runoff, as presented in Section 2.2, detect minute amounts of chlordane, but the occurrence is not sufficiently stable to allow for the identification of definitive sources (MDE draft 1997, see Section 2.2). Thus, there do not appear to be any defined sources of chlordane to control or regulate at this time. These undefined sources are gradually diminishing, and are not believed to constitute a significant contribution to the existing conditions in the estuary.

Chlordane is not an expected substance in point source discharges. If it were to occur in municipal discharges, it would be through intermittent, illicit, and generally untraceable sources. Therefore, further regulation and control of point sources is not considered to be a viable means of controlling the environmental occurrence of chlordane. Efforts to enhance these source reductions are being promoted by local governments through the offering of "household hazardous chemical disposal days." These offerings have been ongoing since the late 1980s and are continuing to provide local citizens with an environmentally acceptable means of disposal. Similar efforts have been extended to farmers for disposal of agricultural chemicals no longer suitable for use.

5.0 TOTAL MAXIMUM DAILY LOADS AND LOAD ALLOCATIONS

Chlordane is a persistent substance, which has a high affinity for sediment adsorption and generally settles to the bottom with the sediment in the estuary. Water column measurements are thus generally extremely low and difficult to achieve in a manner that would allow for the adequate characterization of a large estuarine system. Sediment analyses are also costly and provide information only on the precise location where sampling occurred. Fish tissue, however, serves to accumulate and integrate bioaccumulative contaminants, such as chlordane, and is, therefore, the preferred endpoint measure of environmental contamination for this substance.

Water Quality Endpoint: As noted above, the water quality endpoint for this TMDL is expressed in terms of achieving the specific criterion for which Back River was identified on the 303(d) list. Specifically, the current US FDA guidance level for fish tissue concentrations of 0.3 mg/kg were used to determine the need to list Back River as being impaired by chlordane. Consequently, this value is the appropriate water quality endpoint.

Total Maximum Daily Load: The computations provided above establish a linkage of the fish tissue water quality endpoint of 0.3 mg/kg to a water column concentration of 0.00059 ug/L or less (EPA 1980). Thus, MDE is establishing a concentration of 0.00059 ug/L as the appropriate measure for the Back River chlordane TMDL.

Seasonal Variations and Critical Conditions: The TMDL is represented as a concentration level that is protective of toxic human health effects *at all times*. Implicitly, the TMDL accounts for seasonal variations since it is protective throughout the year (i.e., "at all times"). This situation does not present an issue of controlling for critical conditions for several reasons. First, the notion of "critical conditions" does not arise in the traditional sense for this TMDL. The allowable concentrations of chlordane are based on human fish consumption over a long time period, which averages out any critical events. Additionally, human health standards, upon which the TMDL is founded, account critical sub-populations that might be more susceptible to toxic risk. Second, the TMDL is protective at all times, which implies that any "critical conditions" within that timeframe are considered. Finally, the TMDL level established to be protective of human health are more conservative than the chlordane levels established to protect environmental resources, implying that critical conditions for environmental resources are also addressed by the previous logic that applied to human health.

TMDL Allocation: The studies referenced above suggest that the transient events, in which minute levels of chlordane have been observed in association with point and nonpoint sources, are too insignificant to support the quantification of meaningful allocations to these sources. Existing chlordane in the bottom sediment layer of the estuary is the only significant source causing elevated fish tissue concentrations. Therefore, the sole allocation of chlordane is to the existing bottom sediments of the Back River estuary.

Margin of Safety: EPA's TMDL guidance requires each TMDL to include a margin of safety (MOS) that accounts for uncertainty in the relationship between pollutant sources and the quality of the receiving waters. The USDA fish tissue guidance level, which serves as the water quality measurement endpoint, identified the specific need for a TMDL.
The older and more conservative US EPA ambient water quality standard for the protection of humans from the ingestion of aquatic life (0.00059 ug/L) serves as the basis of the TMDL. This criterion is more conservative than the current ambient water quality criteria (0.0022 ug/L) and was employed to add a margin of safety.

TMDL Summary:

Based on the previous discussion, the TMDL or Chlordane may be summarized as follows:

TMDL	=	WLA	+	LA	+	MOS
0.00059	=	0	+	0.00059	+	built-in

(ug/l – at all times). No future allocation is provided.

Where, WLA is Waste Load Allocation
LA is Load Allocation, and
MOS is Margin of Safety

Reasonable Assuredness of Implementation: The State of Maryland is committed to protecting the State's rivers, streams, lakes, wetlands, and estuaries. Observed data (Eskin 1996) suggest that the sediment concentrations of chlordane in the Back River are declining over time due to natural recovery of the estuary, through gradual biodegradation, dispersal, and natural burial by sedimentation. The computations provided in Section 2.4 suggest that current sediment concentrations of chlordane are below levels expected to result in elevated fish tissue concentrations. No observations of fish tissue are currently available to confirm this, and older fish may continue to have elevated levels due to past bioaccumulation.

Aside from the processes of natural recovery, dredging of this shallow estuary would be the only other means of removing the chlordane-contaminated sediments. Environmental concerns and the high costs associated with dredging place the chlordane impairment in Back River in the category of "Extremely Difficult Problems" as defined in Chapter 6 of the Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program.

In consideration of the very difficult and extremely costly process that would be involved in removing the contaminated sediments, Maryland is proposing to institute an iterative monitoring and evaluation process to track the natural attenuation of the contaminant as the means of ensuring minimal impact to human health and the environment. Routine sediment and fish tissue monitoring in the estuary, with occasional stream and water column samples, will be established on a time frame sufficient to ensure the discernment of trends. At a minimum, triennial monitoring of the fish and surficial sediments will be conducted in the estuarine or tidal portion of the river. An evaluation of the required sampling frequency will be considered each year as information from the statewide monitoring network is developed.

6.0 PUBLIC INVOLVEMENT

Maryland's inventory of water quality is documented in a report prepared under section 305(b) of the Clean Water Act (CWA). This report, commonly called the "305(b) Report", serves as the primary source of information used to develop Maryland's 303(d) list of water quality limited segments. The 305(b) report is developed with consideration of information provided by State agencies, local governments, and citizens. The 303(d) list, which is updated every two years, undergoes a formal public comment process.

In reviewing options for managing the concerns regarding chlordane in fish tissue, the State opted to issue fish consumption guidelines. A press release issued on February 5, 1986 provided the initial information to the public and continuing information is provided via notification in the fishing guidebooks provided to all licensed anglers in the State.

Notice has been published annually in the State's tidewater fishing guide since the late 1980's. The specific language in the guide is as follows:

Salt Water Fishing Health Advisory

- “Individuals are advised to limit their consumption of channel catfish and American eels from Back River and the Baltimore Harbor because the contamination level of chlordane exceeds FDA’s approved standards.
- These fish should not be used as a substantial part of the daily diet.
- These fish should be avoided by women of childbearing age, infants, and children.”

Various public information and education documents have been prepared to help reduce the potential for unacceptable exposure by the fish-consuming public. Fact sheets advising of “Contaminants and Toxicity” (attachment 4) and “Monitoring Contamination Levels in Fish, Shellfish and Crabs” (attachment 5) have been produced and distributed by the Department of the Environment. Additional public information literature has been prepared to assist individuals in minimizing risks through proper preparation of fish for consumption.

7.0 REFERENCES

- Baker, J., Mason, R., Cornwell, J., Ashley, J., Halka, J., Hill, J., 1997, “Spatial mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System.” Report to the Maryland Department of the Environment.

- Eskin, R.A., Rowland, K.H., Alegre, D.Y. 1996. “Contaminants in Chesapeake Bay Sediments 1984-1991”, Chesapeake Bay Program, CBP/TRS 145/96.

- Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume III, Pesticides. Howard, P.H. ed., 1991, Lewis Publishers, Inc.

- Maryland Department of the Environment, 1997. Residential Use Pesticides in Streams of Four Metropolitan Baltimore Neighborhoods 1994 (draft).

- U.S. Environmental Protection Agency, Jul. 1998. Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program, The National Advisory Council for Environmental Policy and Technology (NACEPT). EPA 100-R-98-006.

- U.S. Environmental Protection Agency (EPA), Feb. 1998. Integrated Risk Information System (IRIS) – Chlordane (Technical) CASRN 12789-03-06. http://www.epa.gov.ngispgm3/iris/subst/0142.htm

- U.S. EPA. 1980. "Ambient Water Quality Criteria for Chlordane", Office of Water, EPA 440/5-80-027, October 1980.

- U.S. EPA. 1999. "National Recommended Water Quality Criteria", Office of Water, May 21, 1999.

- U.S. EPA. 1993. "Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning", Office of Water, EPA-822-R-93-001, September 1993.

APPENDIX G:

Water Quality Assessment of Zinc in Back River

Water Quality Analysis of Zinc in Back River, Baltimore County and Baltimore City, Maryland

FINAL

Prepared by:

Maryland Department of the Environment
Montgomery Park Business Center
1800 Washington Boulevard, Suite 540
Baltimore MD 21230-1718

Submitted to:

Watershed Protection Division
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

March 2004

Submittal Date: April 1, 2004
Approval Date: December 23, 2004

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Ag	Silver
As	Arsenic
AVS	Acid Volatile Sulfide
BWO	Baltimore/Washington International Airport
CBL	Chesapeake Biological Laboratory
Cd	Cadmium
cm	Centimeter
COMAR	Code of Maryland Regulations
Cr	Chromium
Cu	Copper
CWA	Clean Water Act
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EPA	Environmental Protection Agency
ERM	Effects Range Median
HAC	Hardness Adjusted Criteria
MDE	Maryland Department of the Environment
mg/l	Milligrams per Liter
NPDES	National Pollution Discharge Elimination System
NWS	National Weather Service
Pb	Lead
PCBs	Polychlorinated biphenyls
ppt	Parts per Thousand
SCS	Soil Conservation Service
SEM	Simultaneously Extracted Metals
SSURGO	Soil Survey Geographic
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WER	Water Effects Ratio
WQA	Water Quality Analysis
WQLS	Water Quality Limited Segment
µg/l	Micrograms per Liter
Zn	Zinc

EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) for the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

Back River (basin code 02-13-09-01), located in Baltimore County and Baltimore City, MD, was identified on the State's list of WQLSs as impaired by nutrients (1996 listing), suspended sediments (1996 listing), chlordane (1996 listing), polychlorinated biphenyls (PCBs) - sediments (1998 listing), zinc (Zn) (1998 listing), fecal coliform (2002 listing) and impacts to biological communities (2002 listing). All impairments were listed for the tidal waters except for the impacts to biological communities, which are listed for the non-tidal region. Code of Maryland Regulations (COMAR) defines the Back River as a fresh waterbody. This report provides an analysis of recent monitoring data, including hardness data, which shows that the aquatic life criteria and designated uses associated with Zn are being met in the Back River. The analyses support the conclusion that a TMDL for Zn is not necessary to achieve water quality standards in this case. Barring the receipt of any contradictory data, this report will be used to support the removal of the Back River from Maryland's list of WQLSs for Zn when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. The listings for nutrient, PCBs, suspended sediment, fecal coliform and impacts to biological communities will be addressed separately at a future date. A TMDL for chlordane was completed in 1999.

Although the tidal waters of the Back River do not display signs of toxic impairments due to Zn, the State reserves the right to require additional pollution controls in the Back River watershed if evidence suggests that Zn from the basin is contributing to downstream water quality problems.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and U.S. Environmental Protection Agency (EPA)'s implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. This list of impaired waters is commonly referred to as the "303(d) list". For each WQLS, the state is to either establish a Total Maximum Daily Load (TMDL) for the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

A segment identified as a WQLS may not require the development and implementation of a TMDL if current information contradicts the previous finding of an impairment. The most common factual scenarios obviating the need for a TMDL are as follows: 1) more recent data indicating that the impairment no longer exists (i.e., water quality criteria are being met); 2) more recent and updated water quality modeling demonstrates that the segment is now attaining criteria; 3) refinements to water quality criteria, or the interpretation of those standards, which result in standards being met; or 4) correction to errors made in the initial listing.

Back River (basin code 02-13-09-01) was identified on the State's 1996 303(d) list as impaired by nutrients, suspended sediment and chlordane, with zinc (Zn) and polychlorinated biphenyls (PCBs) impairments added to the list in 1998, and fecal coliform and impacts to biological communities added to the list in 2002. All impairments were listed for the tidal waters except for the biological impairment, which is listed for the non-tidal region. Code of Maryland Regulations (COMAR) defines the Back River as a fresh waterbody.

The initial listing for Zn was based on seven sediment samples collected in the Back River for the Baltimore Harbor Spatial Mapping Study conducted in 1996 (Baker, 1997). All seven samples exceeded the Effects Range Median (ERM) for Zn indicating the potential for toxicity. Current studies suggest that an exceedance of the ERM is an insufficient indicator of toxicity due to mitigating factors such as the presence of sulfide, which binds metals in a non-toxic form. A Water Quality Analysis (WQA) of Zn for the tidal waters of Back River was conducted using recent water column chemistry data, sediment chemistry data and sediment toxicity data. Results show no impairment for Zn. The nutrient, suspended sediment, PCB, sedimentation and fecal coliform impairments will be addressed separately at a future date. A TMDL for chlordane was completed in 1999.

The remainder of this report lays out the general setting of the waterbody within the Back River watershed, presents a discussion of the water quality characterization process, and provides conclusions with regard to the characterization. The most recent data establishes that the Back River is achieving water quality standards for Zn.

2.0 GENERAL SETTING

The Back River watershed is located in the Patapsco/Back River region of the Chesapeake Bay watershed within Maryland (see Figure 1). The watershed covers a portion of Baltimore County and Baltimore City. The watershed area covers 34,887 acres.

The Back River watershed lies within the Piedmont and Coastal Plain provinces of Central Maryland. The Piedmont Province is characterized by gentle to steep rolling topography, low hills and ridges. The surficial geology is characterized by crystalline rocks of volcanic origin consisting primarily of schist and gneiss. These formations are resistant to short-term erosion and often determine the limits of stream bank and stream bed. These crystalline formations decrease in elevation from northwest to southeast and eventually extend beneath the younger sediments of the Coastal Plain. The fall line represents the transition between the Atlantic Coastal Plain Province and the Piedmont Province. The Atlantic Coastal Plain surficial geology is characterized by thick, unconsolidated marine sediments deposited over the crystalline rock of the piedmont province. The deposits include clays, silts, sands and gravels (Coastal Environmental Services, 1995).

The Back River watershed drains from northwest to southeast, following the dip of the underlying crystalline bedrock in the Piedmont Province. The surface elevations range from approximately 500 feet to sea level at the Chesapeake Bay shorelines. Stream channels of the sub-watersheds are well incised in the Eastern Piedmont, and exhibit relatively straight reaches and sharp bends, reflecting their tendency to following zones of fractured or weathered rock. The stream channels broaden abruptly as they flow down across the fall line and into the soft, flat Coastal Plain sediments (Coastal Environmental Services, 1995).

The watershed is comprised primarily of B and C type soils. Soil type is categorized by four hydrologic soil groups developed by the Soil Conservation Service (SCS). The definitions of the groups are as follows (SCS, 1976):

> Group A: Soils with high infiltration rates, typically deep well-drained to excessively drained sands or gravels.
> Group B: Soils with moderate infiltration rates, generally moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
> Group C: Soils with slow infiltration rates, mainly soils with a layer that impedes downward water movement or soils with moderately fine to fine texture.
> Group D: Soils with very slow infiltration rates, mainly clay soils, soils with a permanently high water table, and shallow soils over nearly impervious material.

The soil distribution within the watershed is approximately 1.6% soil group A, 38.2% soil group B, 38.7% soil group C and 21.5% soil group D. Soil data was obtained from Soil Survey Geographic (SSURGO) coverages created by the National Resources Conservation Service.

The Back River watershed is comprised primarily of residential, commercial and industrial land uses (see Figure 2). There are no major industrial facilities discharging zinc within the watershed. The Back River Waste Water Treatment Plant, a major municipal waste facility, discharges metals including zinc at the outlet of Bread and Cheese Creek, a tributary of the Back River Estuary. The land use distribution in the watershed is approximately 17.7 % forest/herbaceous, 79.0 % urban, 1.9 % agricultural and 1.4 % water (Maryland Department of Planning, 2000).

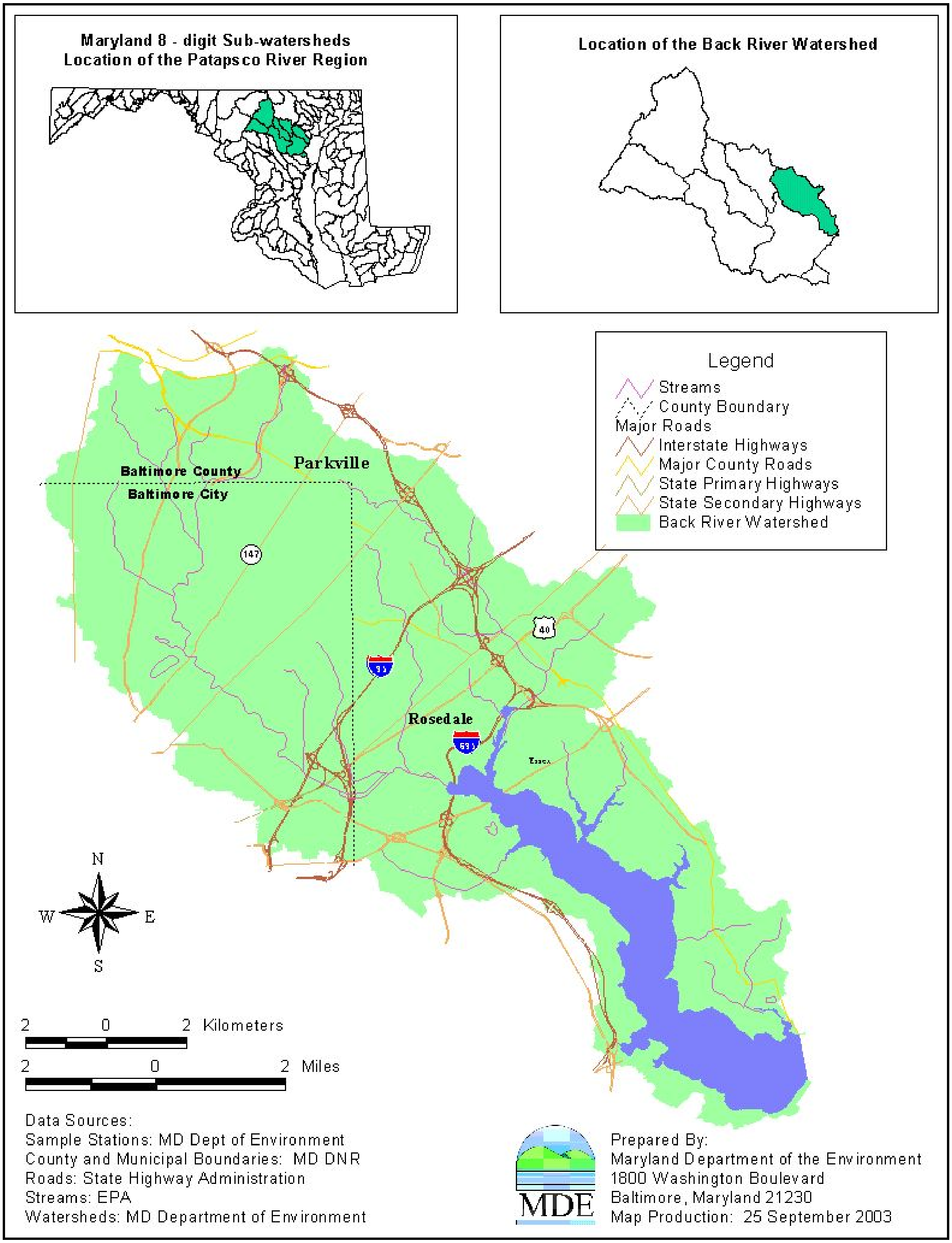


Figure 1: Watershed Map of the Back River

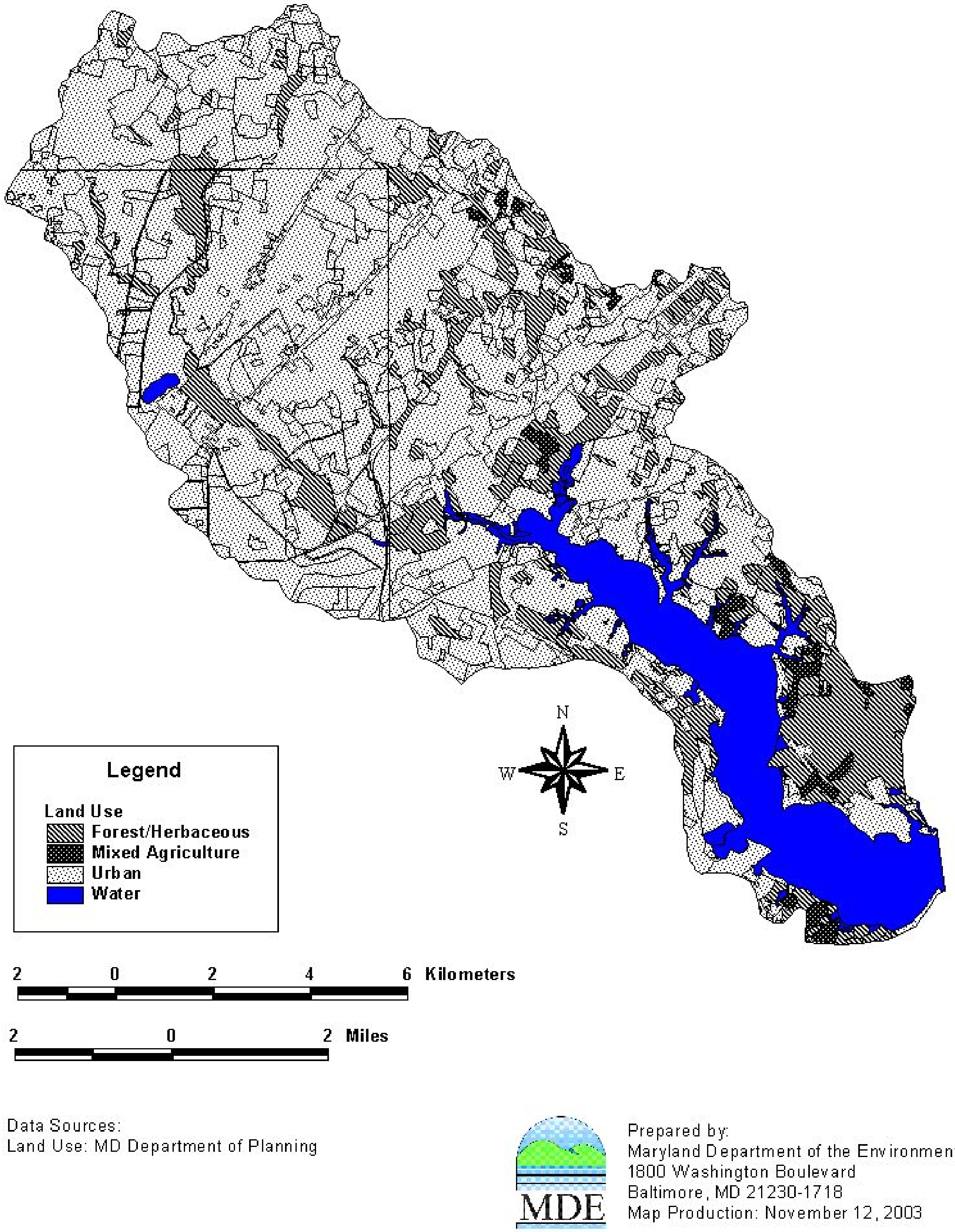


Figure 2: Land Use Map of Back River Watershed

3.0 WATER QUALITY CHARACTERIZATION

A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include support of aquatic life, primary or secondary contact recreation, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. The criteria developed to protect different designated uses may differ and are dependent on the specific designated use(s) of a waterbody. Maryland's water quality standards presently include numeric criteria for metals and other toxic substances based on the need to protect aquatic life, wildlife and human health. Water quality standards for toxic substances also address sediment quality to ensure the bottom sediment of a waterbody is capable of supporting aquatic life, thus protecting the designated uses.

The Maryland Surface Water Use Designation (COMAR 26.08.02.08J) for the Patapsco River (basin code 02-13-09) and its tributaries (including Back River) is Use I – *water contact recreation, fishing, and protection of aquatic life and wildlife.* COMAR 26.08.02.03-1(B)(3)(j)(ii) defines the tidal region of the Back River basin considered in this WQA as being freshwater.* The freshwater aquatic life criterion for Zn is displayed below in Table 1 (COMAR 26.08.02.03-2G). The water column data presented in Section 3.1, Table 5 through Table 9, show that concentrations of Zn in the water column do not exceed water quality criterion. An ambient sediment bioassay and sediment chemistry analysis conducted in the Back River establishes that there is no toxicity in the sediment bed as a result of zinc contamination. The water column and sediment in the Back River are, therefore, not impaired by Zn. Thus the designated uses are supported and the water quality standard is being met.

Table 1: Numeric Water Quality Criteria

Metal	Fresh Water Aquatic Life Acute Criteria (µg/l)	Fresh Water Aquatic Life Chronic Criteria (µg/l)
Zn	120	120

Water column surveys, used to support this WQA, were conducted at five stations throughout the Back River estuary from January 2001 to September 2001. For every water column sample, the dissolved concentration of Zn was determined. Water column sampling was performed four times at each station from January 2001 to September 2001 to capture seasonal variation. The sampling dates were as follows: 1/24/01 (winter dry weather); 2/25/01 (winter wet weather); 7/23/01 (summer dry weather); 9/20/01 (summer wet weather). Sediment samples were also collected at 21 stations throughout the Back River estuary including those sampled in the water column survey. Sediment samples were analyzed for metals chemistry and toxicity. Table 2

* Even though COMAR 26.08.02.03-1(B)(3)(j)(ii) defines the Back River as a freshwater body, significant variability in salinity concentrations were found during the water column survey. A comparison of zinc concentrations with saltwater aquatic life criteria was also conducted based on new EPA guidance and no exceedances occurred.

shows the list of stations with their geographical coordinates, descriptive location and water quality characterization analyses performed. The station locations are presented in Figure 3.

Table 2: Sample Stations for Back River

Station	Latitude	Longitude	Description	Water Column Chemistry	Sediment Chemistry	Sediment Toxicity
BR-14	39.241	-76.416	Mid Channel below Claybank Point	-	X	X
BR-26	39.243	-76.400	Outlet of Back River between Cedar and Cuckold Point	-	X	X
BR-27	39.247	-76.449	Greenhill Cove	-	X	X
BR-29	39.247	-76.435	East of Lynch Point	-	X	X
BR-36	39.265	-76.453	Shoreline southwest of Stansbury Point	-	X	X
BR-50	39.254	-76.411	Rock Point Park	-	X	X
BR-55	39.259	-76.446	Mid-Channel west of Witchcoat Point	-	X	X
BR-60	39.269	-76.453	Cove below Stansbury Point	-	X	X
BR-74	39.275	-76.445	Mid-Channel northeast of Stansbury Point	-	X	X
BR-89	39.283	-76.439	Muddy Gut	-	X	X
BR-91	39.287	-76.467	Mid-Channel below Cox Point	-	X	X
BR-101	39.289	-76.485	Bread & Cheese Creek	-	X	X
BR-120	39.300	-76.485	Mid-Channel above Greenmarsh Point	-	X	X
BR-126	39.305	-76.499	Headwaters of Back River	-	-	X
BR-134	39.309	-76.490	Northeast Creek	-	-	X
BR-169	39.303	-76.491	Mid-Channel above Eastern Avenue Bridge	-	-	X
XIF-4450	39.238	-76.409	West of Cuckold Point	X	-	-
XIF-5633	39.256	-76.441	Mid-Channel Northwest of Porter Point	X	-	-
XIF-6633	39.272	-76.440	Near Shoreline east of Stansbury Point	X	X	-
XIF-7615	39.290	-76.472	East of Wetherby Point	X	X	X
XIF-8008	39.300	-76.484	Mid-Channel above Greenmarsh Point	X	X	X

X means data is available - means no data available

For the water quality evaluation, a comparison is made between Zn water column concentrations and fresh water aquatic life chronic criterion, the most stringent of the numeric water quality criterion for Zn. Hardness concentrations were obtained for each station to adjust the fresh water aquatic life chronic criteria that were established at a hardness of 100 mg/l for Zn. The State uses hardness adjustment to calculate fresh water aquatic life chronic criteria for Zn whose toxicity is a function of total hardness. According to EPA's National Recommended Water

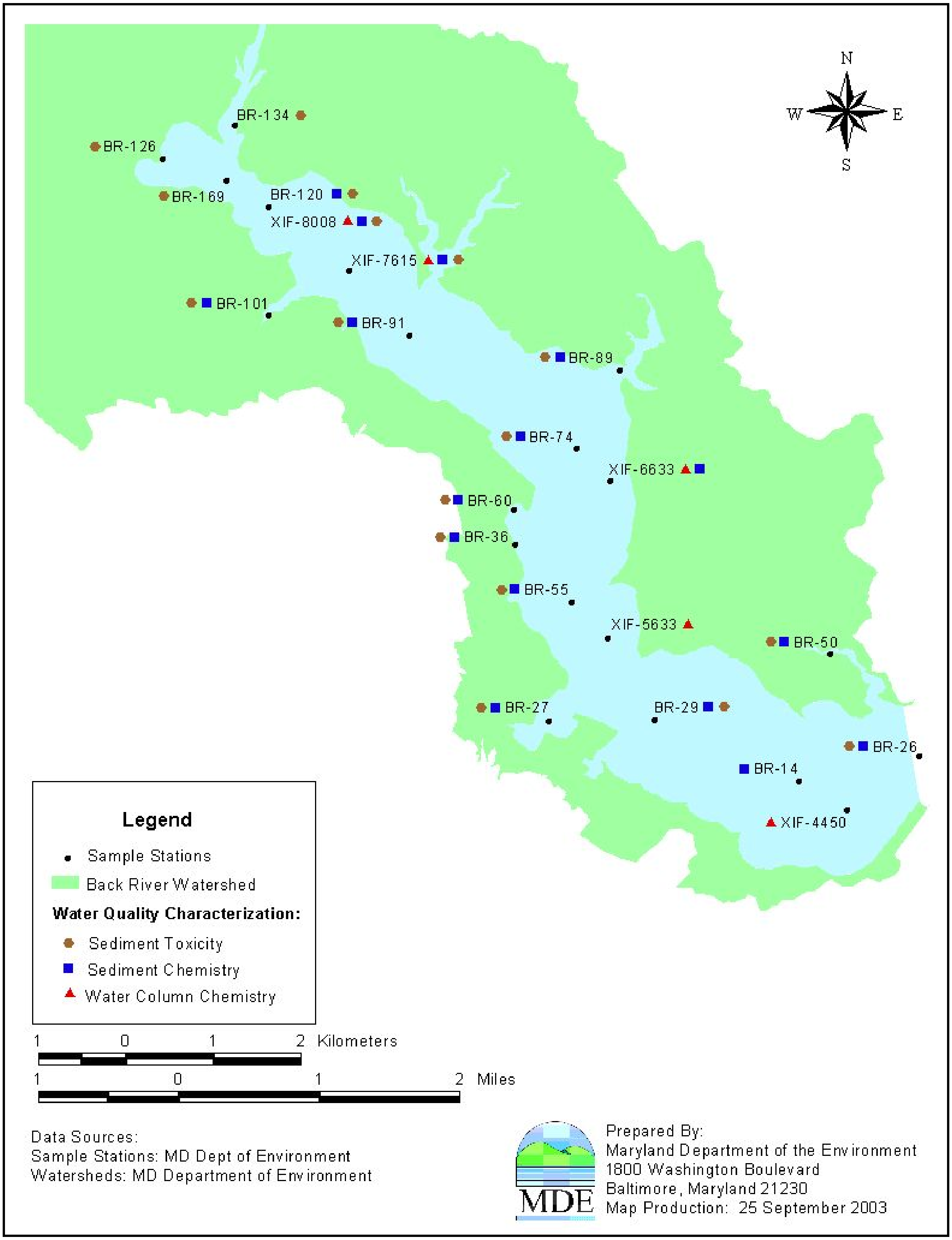


Figure 3: Sample Station Location Map

Quality Criteria (EPA, 2002), allowable hardness values must fall within the range of 25 - 400 mg/l. MDE uses an upper limit of 400 mg/l in calculating the hardness adjusted criteria (HAC) when the measured hardness exceeds this value. Based on technical information, EPA's Office of Research and Development does not recommend a lower limit on hardness for adjusting criterion (EPA, 2002). MDE adopts this recommendation. The HAC equation for Zn is as follows (EPA, 2002):

$$HAC = e^{(m[\ln(Hardness(mg/l))]+b)} * CF$$

Where,

HAC = Hardness Adjusted Criteria (µg/l)
m = slope
b = y intercept
CF = Conversion Factor (conversion from totals to dissolved numeric criteria)

The HAC parameters for Zn are presented in Table 3 (EPA, 2002).

Table 3: HAC Parameters (Fresh Water Aquatic Life Chronic Criteria)

Chemical	Slope (m)	y Intercept (b)	Conversion Factor (CF)
Zn	0.8473	0.884	0.986

The State performs a scientific review of all data submitted where a water quality criterion exceedance was the result of a hardness adjustment below 50 mg/l. This review is necessary because of the scientific uncertainty existing for hardness-toxicity relationships below 50 mg/l due to:

A. Paucity of toxicity test data below 50 mg/l that was used to develop the relationship between hardness and toxicity.
B. Presence/absence of sensitive species in the waterbody of concern.
C. Existence of other environmental conditions (e.g. high Dissolved Organic Carbon (DOC)), which might mitigate the toxicity of metals due to competitive binding/complexation of metals.

In instances where hardness data is not available, the State will calculate an average of existing hardness concentrations for each station. In applying average hardness, the sampling date for which hardness data is unavailable must not fall during a storm event substantially greater than the sampling dates used to calculate the average. A major rainfall event has the potential to reduce hardness below the average. An analysis of rainfall data from the National Weather Service (NWS) precipitation gauge (0180465) at Baltimore/Washington International Airport (BWI) shows no significant variation in storm events for the sampling dates, thus the average will apply. This is the closest gauge to Back River and is likely to be representative of the rainfall events that occur within the watershed.

3.1 WATER COLUMN EVALUATION

A data solicitation for metals was conducted by MDE, and all readily available data from the past five years was considered in the WQA. The water column data is presented in Table 5 through Table 9 for each station and is evaluated using the fresh water aquatic life chronic HAC, the more stringent of the numeric water quality criterion for Zn (Baker, 2001). Each table displays hardness (mg/l), sample concentration (µg/l) and fresh water chronic HAC (µg/l) by sampling date. For example, in Table 5 for the sampling date of 9/20/01 the hardness is 1862 mg/l (400mg/l is used for HAC calculation because of the hardness limit), the hardness adjusted criterion for Zn is 382.4 µg/l and the Zn sample concentration is 5.74 µg/l. The hardness concentrations reported in bold are for sampling dates in which hardness was not measured and an average value was applied. The detection limits for the zinc analysis is displayed in Table 4. A hardness limit of 400 mg/l is applied for fresh water HAC as defined by EPA's National Recommended Water Quality Criteria (EPA, 2002).

Table 4: Metals Analysis Detection Limits

Analyte	Detection Limit (µg/l)
Zn	0.25

Table 5: Station XIF-4450 Water Column Data

Sampling Date	1/24/01		2/25/01		7/23/01		9/20/01	
Hardness (mg/l)	**1490**		**1490**		1118		1862	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Zn	0.3	382.4	14.8	382.4	ND	382.4	5.74	382.4

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected
If hardness is greater than 400 mg/l, then a hardness value of 400 mg/l is used for the HAC calculation.

Table 6: Station XIF-5633 Water Column Data

Sampling Date	1/24/01		2/25/01		7/23/01		9/20/01	
Hardness (mg/l)	**1207**		**1207**		881		1533	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Zn	12.9	382.4	11.3	382.4	ND	382.4	11.1	382.4

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected
If hardness is greater than 400 mg/l, then a hardness value of 400 mg/l is used for the HAC calculation.

Table 7: Station XIF-6633 Water Column Data

Sampling Date	1/24/01		2/25/01		7/23/01		9/20/01	
Hardness (mg/l)	1038		1038		755		1322	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Zn	16.9	382.4	15.1	382.4	ND	382.4	4.3	382.4

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected
If hardness is greater than 400 mg/l, then a hardness value of 400 mg/l is used for the HAC calculation.

Table 8: Station XIF-7615 Water Column Data

Sampling Date	1/24/01		2/25/01		7/23/01		9/20/01	
Hardness (mg/l)	539		539		320		758	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Zn	38.3	382.4	21.6	382.4	ND	316.5	6.1	382.4

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected
If hardness is greater than 400 mg/l, then a hardness value of 400 mg/l is used for the HAC calculation.

Table 9: Station XIF-8008 Water Column Data

Sampling Date	1/24/01		2/25/01		7/23/01		9/20/01	
Hardness (mg/l)	354		354		221		486	
Analyte	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)	Sample (µg/l)	Criteria* (µg/l)
Zn	24.6	344.8	24	344.8	ND	231.3	2.9	382.4

* Fresh Water Aquatic Life Chronic HAC
ND - Not detected
If hardness is greater than 400 mg/l, then a hardness value of 400 mg/l is used for the HAC calculation.

The range of concentrations for Zn sampled in the field survey is as follows:

Zn = ND to 38.3 µg/l

Hardness ranged from 221 mg/l to 1862 mg/l. The concentration range of Zn is well below the associated fresh water aquatic life chronic HAC. The criterion was not exceeded by any of the Zn samples.

3.2 SEDIMENT QUALITY EVALUATION

To complete the WQA, sediment quality in the Back River was evaluated using 28-day whole sediment tests with the estuarine amphipod *Leptocheirus plumulosus* (Fisher, 2002*)*. This species was chosen because of its ecological relevance to the waterbody of concern. *L. plumulosus* is an EPA-recommended test species for assessing the toxicity of marine and estuarine sediments (EPA, 2001). Eighteen surficial sediment samples were collected using a petite ponar dredge (top 2 cm) by in the Back River. Refer back to Figure 3 for the station locations. The samples were collected in two batches. The first batch was collected by CBL on 7/23/01 at fifteen stations throughout the Back River. The second batch was collected by the MDE field office on 8/17/01 at three stations in the upper tidal reaches of Back River. A separate sediment toxicity test was required for each batch. The results of Test I (fifteen samples) and Test II (three samples) are presented in Table 10 and Table 11. Twenty amphipods were exposed to the sediment in each sample test. The table displays amphipod survival (#), amphipod growth rate (mg/day), neonates (#), average amphipod survival (%), average amphipod growth rate (mg/day) and average neonates per survivor.

The test considers three performance criteria, which are survival, growth rate, and reproduction. For the test to be valid the average survival of control sample replicates must be greater than 80%, and there must be a measurable growth rate and reproduction of neonates in the control samples. Survival of amphipods in the field sediment samples was not significantly less than the average survival demonstrated in the control samples. This comparison was made using Fisher's Least Significance Difference (LSD) test ($ά = 0.05$). The average survival for control samples in Test I and II were 84% and 89%. The field sediment sample average survival results were no lower than 77% for Test I and no lower than 88% for Test II. No sediment samples in the Back River exhibited toxicity contributing to mortality.

Table 10: Sediment Toxicity Test I Results

Sample	Amphipod Survival (#)	Amphipod Growth Rate (mg/day)	Neonates (#)	Average Amphipod Survival (%)	Average Amphipod Growth Rate (mg/day)	Average Neonates/survivor
Control A	18	0.052	61	84	0.046	3.3
Control B	15	0.057	75			
Control C	16	0.05	46			
Control D	20	0.036	80			
Control E	15	0.035	30			
BR-126 A	16	0.026	7	77	0.039	1.2
BR-126 B	18	0.045	21			
BR-126 C	14	0.054	7			
BR-126 D	18	0.038	25			
BR-126 E	11	0.034	29			
BR-134 A	16	0.064	58	82	0.045	1.7
BR-134 B	17	0.036	31			
BR-134 C	17	0.027	21			
BR-134 D	14	0.057	7			
BR-134 E	18	0.039	16			
BR-169 A	15	0.033	20	82	0.041	1.5
BR-169 B	15	0.048	18			
BR-169 C	19	0.036	0			
BR-169 D	20	0.042	25			
BR-169 E	13	0.045	51			

Table 11: Sediment Toxicity Test II Results

Sample	Amphipod Survival (#)	Amphipod Growth Rate (mg/day)	Neonates (#)	Average Amphipod Survival (%)	Average Amphipod Growth Rate (mg/day)	Average Neonates/survivor
Control A	17	0.069	86	89	0.068	4.1
Control B	17	0.065	76			
Control C	20	0.075	118			
Control D	16	0.068	43			
Control E	19	0.063	49			
BR-14 A	20	0.05	47	99	0.057	3.6
BR-14 B	20	0.067	145			
BR-14 C	20	0.051	58			
BR-14 D	20	0.054	72			
BR-14 E	19	0.064	37			
BR-26 A	20	0.058	64	98	0.055*	3.3
BR-26 B	19	0.066	95			
BR-26 C	20	0.056	89			
BR-26 D	19	0.045	36			
BR-26 E	20	0.052	64			
BR-27 A	20	0.056	149	99	0.063	8.3
BR-27 B	20	0.059	191			
BR-27 C	20	0.067	120			
BR-27 D	20	0.064	184			
BR-27 E	19	0.066	172			
BR-29 A	19	0.076	139	93	0.063	4.7
BR-29 B	20	0.061	87			
BR-29 C	17	0.053	51			
BR-29 D	18	0.069	101			
BR-29 E	19	0.057	65			
BR-36 A	16	0.047	88	89	0.055*	4.9
BR-36 B	18	0.058	33			
BR-36 C	19	0.058	95			
BR-36 D	16	0.06	109			
BR-36 E	20	0.051	107			
BR-50 A	20	0.05	239	99	0.059	7
BR-50 B	20	0.065	146			
BR-50 C	19	0.061	128			
BR-50 D	20	0.064	117			
BR-50 E	20	0.053	70			
BR-55 A	19	0.071	169	97	0.058	6.7
BR-55 B	20	0.053	132			
BR-55 C	20	0.06	75			
BR-55 D	19	0.053	141			
BR-55 E	19	0.055	131			

* Sample Toxicity

BR-60 A	18	0.048	72	89	0.06	6.5
BR-60 B	20	0.055	111			
BR-60 C	17	0.065	182			
BR-60 D	15	0.079	109			
BR-60 E	19	0.053	100			
BR-74 A	20	0.067	157	92	0.07	6.6
BR-74 B	19	0.064	79			
BR-74 C	19	0.063	134			
BR-74 D	17	0.064	147			
BR-74 E	17	0.092	88			
BR-89 A	18	0.06	142	95	0.059	6.7
BR-89 B	20	0.046	110			
BR-89 C	21	0.064	158			
BR-89 D	19	0.063	89			
BR-89 E	18	0.064	140			
BR-91 A	19	0.056	65	95	0.073	7.6
BR-91 B	20	0.081	263			
BR-91 C	18	0.092	134			
BR-91 D	18	0.076	142			
BR-91 E	22	0.061	131			
BR-101 A	19	0.064	79	90	0.053*	3.3
BR-101 B	20	0.056	83			
BR-101 C	18	0.056	55			
BR-101 D	17	0.048	72			
BR-101 E	16	0.041	19			
BR-120 A	19	0.064	130	88	0.063	5.1
BR-120 B	17	0.066	87			
BR-120 C	17	0.057	36			
BR-120 D	18	0.055	25			
BR-120 E	17	0.072	170			
XIF-7615 A	20	0.051	119	90	0.06	6.1
XIF-7615 B	18	0.052	141			
XIF-7615 C	20	0.07	121			
XIF-7615 D	15	0.057	74			
XIF-7615 E	17	0.068	101			
XIF-8008 A	19	0.065	92	94	0.065	5.3
XIF-8008 B	19	0.067	108			
XIF-8008 C	19	0.055	132			
XIF-8008 D	17	0.074	111			
XIF-8008 E	20	0.062	46			

* Sample Toxicity

Similarly, measurable average amphipod reproduction observed in the field sediment samples, which ranged from 1.2 to 1.7 neonates/survivor in Test I and 3.3 to 8.3 neonates/survivor in Test II, were not significantly less than the reproduction of 3.3 and 4.1 neonates/survivor observed in the control samples for Test I and Test II. This comparison was made using Fisher's Least Significance difference (LSD) test. No sediment samples exhibited toxicity contributing to a lower reproduction.

Average amphipod growth rates were not significantly less than the control samples, with the exception of three stations in Test II, BR-26, BR-36 and BR-101. This comparison was made using Fisher's Least Significance difference (LSD) test. The control sample exhibited an average growth rate of 0.068 mg/day, in contrast to 0.055 mg/day at stations BR-26 and BR-36 and 0.053 mg/day at station BR-101, therefore these stations exhibit toxicity contributing to a reduction in growth.

Ambient sediment bioassays are only capable of establishing the existence of sediment toxicity therefore further analysis was required to determine whether zinc contamination was the primary source of toxicity. A sediment chemistry analysis was conducted in order to measure Zn concentrations within the sediment (Baker, 2001). The analysis was conducted on sixteen of the sediment samples. The sediment concentrations are presented in Table 12 in units of mg/kg dry weight.

Table 12: Zinc Sediment Concentrations

Station	Date	Concentration (mg/kg)
BR-14	7/23/01	349
BR-26	7/23/01	237
BR-27	7/23/01	573
BR-29	7/23/01	358
BR-36	7/23/01	87
BR-50	7/23/01	384
BR-55	7/23/01	664
BR-60	7/23/01	461
BR-74	7/23/01	508
BR-89	7/23/01	132
BR-91	7/23/01	1107
BR-101	7/23/01	1569
BR-101	8/14/03	1110
BR-120	7/23/01	437
XIF-6633	7/23/01	275
XIF-7615	7/23/01	788
XIF-8008	7/23/01	721
XIF-8008	8/13/03	627

The Effects Range Median (ERM) concentration has been used as a screening level indicator of toxicity within the sediment. If the concentration of the pollutant exceeds the ERM it is likely (i.e., a 50% chance) that sediment toxicity will occur. The ERM cannot solely predict toxicity due to mitigating factors such as the presence of acid volatile sulfide (AVS) which reduces the bioavailability of Zn through the formation of an insoluble metallic sulfide compound. The ERM concentration of Zn is 410 mg/kg (dry weight). Stations BR-27, BR-55, BR-60, BR-74, BR-91, XIF-7614 and XIF-8008 exceeded the ERM but did not show signs of sediment toxicity as established by the ambient sediment bioassay, therefore Zn has likely formed an insoluble metallic sulfide and is biologically unavailable to the benthic organisms. Stations BR-26 and BR-36 have Zn concentrations of 237 mg/kg and 87 mg/kg, which are significantly lower than the ERM of 410 mg/kg, thus Zn is not a source of toxicity. Station BR-101 has Zn concentrations of 1569 mg/kg and 1110 mg/kg, which are significantly higher than the ERM.

An AVS-Simultaneously Extracted Metals (SEM) analysis was conducted for station BR-101 to determine whether AVS had completely bound Zn within the sediment (Baker, 2003). AVS-SEM is generally used as an indicator of toxicity due to metals. When the AVS/SEM concentration ratio is greater than one, metals within the sediment are no longer bioavailable due to the formation of insoluble metallic sulfides resulting in no metals toxicity. The concentrations of AVS and its associated metals (Zn, Chromium (Cr), Copper (Cu), Arsenic (As), Silver (Ag), Cadmium (Cd) and Lead (Pb)) are presented in Table 13 in units of µmol/g (dry weight).

Table 13: AVS-SEM Concentrations

Substance	Concentration (umol/g)
AVS	20.4
Cr	1.34
Cu	0.349
Zn	12.3
As	0.0081
Ag	0.0022
Cd	0.0427
Pb	0.823
Sum SEM umol/g=	**14.9**
AVS/SEM Ratio =	**1.4**

With an AVS/SEM ratio of 1.4, Zn is not a source of toxicity. A porewater analysis of this sample was conducted at the same time to confirm that Zn was primarily bound as a metallic sulfide compound and did not partition into the dissolved phase (Baker, 2003). The Zn porewater concentration was 0.65 µg/l which is significantly lower than the fresh water chronic aquatic life criterion of 120 µg/l. The dissolved Zn concentration in the porewater is much lower than in the water column due to anoxic conditions and high levels of sulfide in the sediment.

Significant sulfide binding results in greater partitioning of metals to the sediment relative to the partitioning of metals to suspended particles in the water column.

4.0 CONCLUSION

The WQA shows that the water quality standard for Zn is being achieved. Water column samples collected at five monitoring stations in the Back River, from January 2001 to September 2001, demonstrate that numeric water quality criterion is being met. Bottom sediment samples collected at eighteen monitoring stations, and used for bioassay toxicity tests, demonstrate no impacts on survival and reproduction, and growth rate impacts at three of the eighteen stations, BR-26, BR36 and BR-101. A sediment chemistry analysis demonstrated that Zn concentrations at Stations BR-26 and BR-36 were significantly below the ERM, therefore Zn was not an impairing substance. Even though station BR-101 exhibited a zinc concentration much greater than the ERM, an AVS-SEM and porewater analysis also demonstrated that Zn was not a source of toxicity. Barring the receipt of any contradictory data, this information provides sufficient justification to revise Maryland’s 303(d) list to remove Zn as impairing substances in the Back River.

5.0 REFERENCES

Baker, J.E., Ko, F., Beard, E.B., Burrell, T., Stapleton, H. *Back River Chemical Contaminant Survey 2001, Final Report*. University of MD, Chesapeake Biological Laboratory, December 2001.

Baker, J.E. *Upper Chesapeake Bay Chemical Contaminant Study*. University of MD, Chesapeake Biological Laboratory, December 2003.

Baker, J.E., Mason, R., Cornwell, J., Ashley, J., Halka, J., Hill, J. *Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System*. University of MD, Chesapeake Biological Laboratory, August 4, 1997.

Coastal Environmental Service, Inc. *Patapsco/Back River Watershed Study*, prepared for the MDE and TARSA, September 30, 1995.

COMAR 26.08.02.03-2G. *Numerical Criteria for Toxic Substances in Surface Waters*.

COMAR 26.08.02.03-(B)(3)(j)(ii). *Toxic Substance Water Quality Criteria for Surface Waters.*

COMAR 26.08.02.08J. *Stream Segment Designations***.**

Fisher, D., Yonkos, L., Ziegler, G., Shepard, M. *Assessment of Sediment Toxicity in Back River, Middle River and in Three Reservoirs*. University of MD, Wye Research and Education Center, May 20, 2002.

Maryland Department of Planning, 2000 Land Use, Land Cover Map Series. 2000.

Soil Conservation Service (SCS). *Soil Survey of Baltimore County, MD*, 1976.

U.S. Environmental Protection Agency. *Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod Leptocheirus plumulosus*. EPA-600-R-01-020. First Edition. Office of Research and Development, Washington, D.C. 103 pp. 2001.

U.S. Environmental Protection Agency. *National Recommended Water Quality Criteria: 2002*. EPA-822-R-02-047. November 2002.