Bear Creek/Old Road Bay
Small Watershed Action Plan

Volume II

Prepared for:

Department of Environmental Protection and Sustainability

Submitted by: Parsons Brinckerhoff

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APPENDIX E:

Bear Creek/Old Road Bay Watershed Characterization Report

(PB 2012)

Bear Creek/Old Road Bay
Watershed Characterization Report

Prepared for:

Department of Environmental Protection & Sustainability

Prepared by:

PARSONS BRINCKERHOFF

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FINAL

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CHAPTER 1: INTRODUCTION

1.1 Purpose

The purpose of the Bear Creek/Old Road Bay Watershed Characterization Report is to:

1. Summarize the factors that may affect the water quality of the Bear Creek/Old Road Bay watershed such as landscape, geomorphology, hydrology, and biological characteristics;
2. Explain the current conditions of the Bear Creek/Old Road Bay watershed and its natural resources;
3. Describe human impacts on the watershed such as development and land use; and
4. Identify restoration and preservation strategies appropriate for accomplishing watershed goals.
5. Consider Environmental Justice concerns while working to improve water quality.

The observations and conclusions presented in this watershed characterization report will be used to develop a Small Watershed Action Plan (SWAP) for the Bear Creek/Old Road Bay watershed planning area.

1.2 Watershed Location and Scale

The Baltimore Harbor watershed is located in the Western Coastal Plain physiographic province of Maryland and encompasses Baltimore County, Baltimore City, and Anne Arundel County. Only the portion of the watershed that resides within Baltimore County is addressed in this SWAP and herein will be simply referred to as the Bear Creek/Old Road Bay watershed (see Figure 1-1). The Bear Creek/Old Road Bay watershed planning area has an extent of approximately 11,413 acres (17.8 square miles). The watershed drains to the Patapsco River and the Chesapeake Bay. It is bordered in the West by Baltimore City, in the North and East by the Back River watershed, and in the South by the Patapsco River and the Chesapeake Bay.

The Bear Creek/Old Road Bay watershed was subdivided into smaller drainage areas or subwatersheds, which are listed in Table 1-1 along with respective acreages. In addition to characterizing the entire planning area, 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. Figure 1-2 shows the 14 subwatersheds comprising the Bear Creek/Old Road Bay watershed. Methods for the delineation of the watersheds and subwatersheds are described in further detail in Chapter 2.

Table 1-1: Bear Creek/Old Road Bay Subwatershed Areas

Subwatershed	Area (Acres)	Area (Sq Miles)
Colgate Creek	1,649.3	2.58
Peach Orchard Cove	450.2	0.70
Bullneck Creek	632.2	0.99
Lynch Cove	648.4	1.01
Chink Creek	364.8	0.57
Bear Creek Headwaters	592.0	0.92
Charlesmont/Tobasco Coves	417.4	0.65
Oakleigh/Schoolhouse Coves	328.8	0.51
Country Club Cove/Humphrey Creek Remnant	797.9	1.25
Jones Creek	922.9	1.44
North Point Creek	576.2	0.90
Shallow Creek	706.2	1.10
Black Marsh	569.2	0.89
Sparrows Point	2,757.9	4.31
Total	***11,413.4***	***17.83***

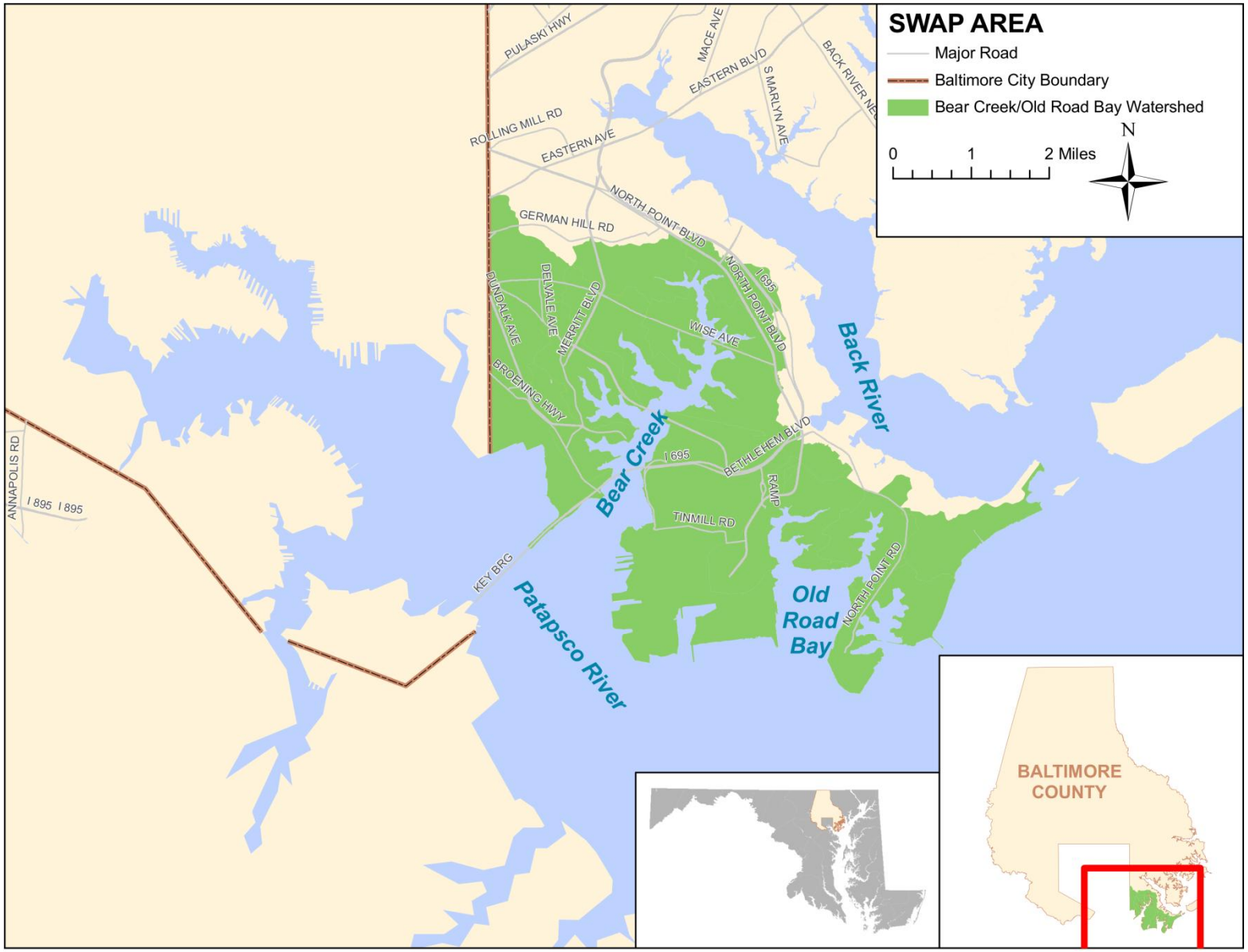

Figure 1-1: Location of Bear Creek/Old Road Bay Watershed

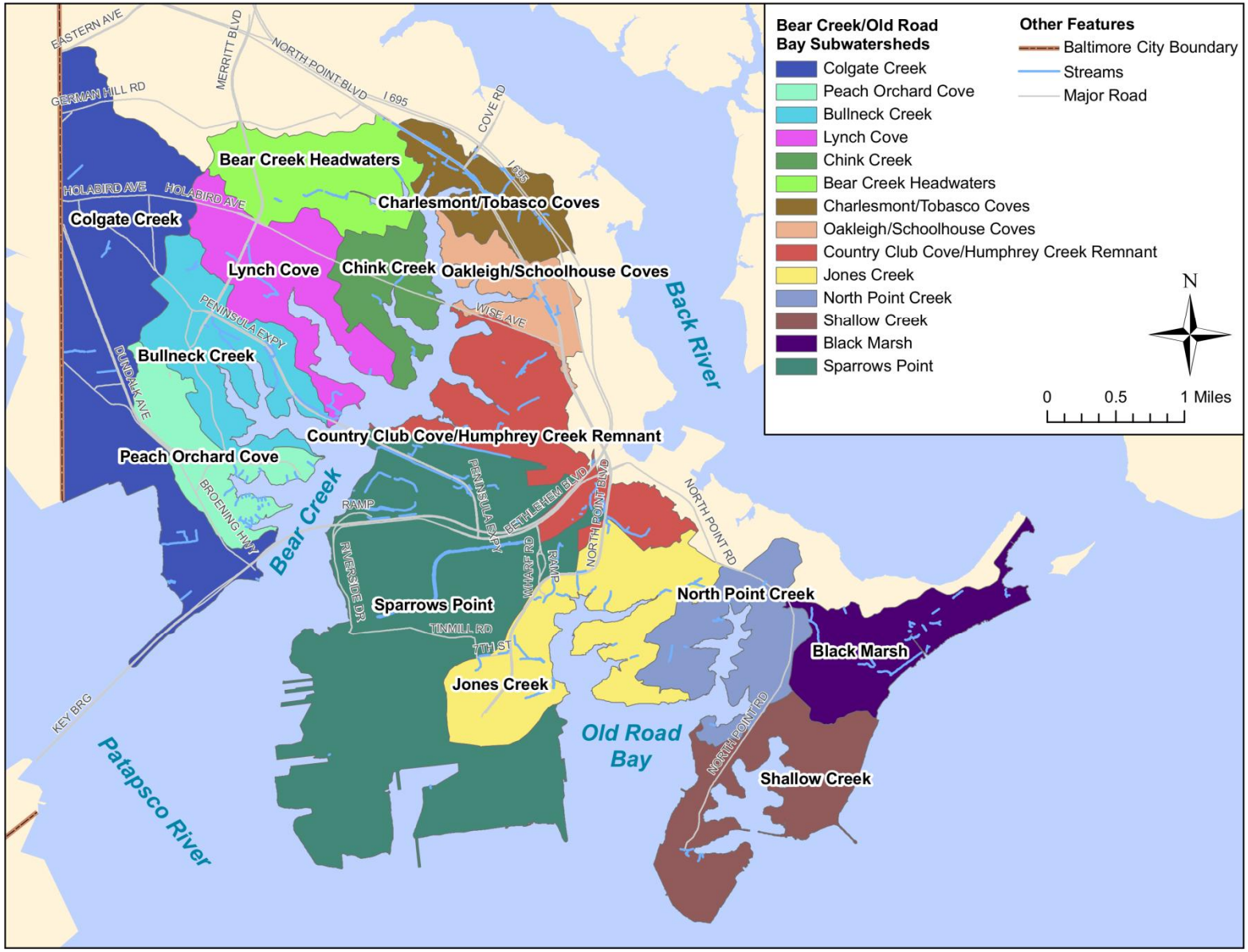

Figure 1-2: Bear Creek/Old Road Bay Subwatersheds

1.3 Report Organization

The Bear Creek/Old Road Bay Watershed Characterization report is organized into the following six chapters:

Chapter 1 – Explains the purpose of the report and the location and scope of the watershed characterization.

Chapter 2 – Summarizes characteristics related to landscape and land use that may affect natural resources and water quality in the Bear Creek/Old Road Bay watershed. This chapter contains landscape information related to natural features such as geology, topography, soils, forest cover, streams, and shoreline characteristics. Information pertaining to human influence on landscape is also discussed, including land use, population, impervious cover amount, water distribution and stormwater infrastructure.

Chapter 3 – Discusses water quality and quantity conditions in the watershed based on available monitoring data.

Chapter 4 – Describes the upland assessments conducted to identify pollutant sources and restoration opportunities for four assessment categories: neighborhoods, institutions, pervious areas, and hotspots.

Chapter 5 – Presents restoration and preservation strategies appropriate for accomplishing watershed goals developed by the community and the Bear Creek/Old Road Bay Steering Committee.

Chapter 6 – Lists the references consulted during the development of this report.

CHAPTER 2: LANDSCAPE AND LAND USE

2.1 Introduction

This chapter discusses land cover and land use in the Bear Creek/Old Road Bay watershed, describing characteristics of both the natural land surface as well as development activities taking place within the watersheds. Natural characteristics, such as soil type, and development related features, such as impervious cover, strongly influence the quantity and quality of watershed runoff. For example, the infiltration capacity of soils on pervious ground affects the amount and rate at which precipitation will be absorbed into the ground surface; impervious surfaces such as buildings and paved areas impede rainfall infiltration, which can lead to flooding, erosion, and eventually decrease in groundwater supply. In addition, the type and extent of pollutants carried by stormwater is affected by land use characteristics. Residential or agricultural areas may contribute fertilizers and pesticides to stormwater runoff. Depending on the land use activities taking place, developed areas may transmit pollutants such as trash, bacteria from livestock and pet waste, and chemicals directly to receiving water bodies because there is often inadequate vegetative buffer to filter out the pollutants before the runoff reaches the water. The information presented in this chapter provides the physical setting and background necessary to evaluate other watershed elements including water quality, natural resources, restoration and management.

2.2 Natural Landscape

Natural land surface characteristics relevant to watershed properties and processes are described in the following sections. These topics include climate, watershed delineation, topography, geology, soil properties, forest cover, streams, and tidal water features.

2.2.1 Climate

Climate is an important consideration because it can influence soil and erosion processes, stream flow patterns, and topography. Climate also affects vegetative growth and determines the species composition of terrestrial and aquatic life of a region. In addition, rainfall patterns are an important component of the hydrology of a watershed and can affect watershed management strategies.

The Bear Creek/Old Road Bay 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), the region is also in the path of low pressure systems that move across the country resulting in frequent changes in wind direction and weather (NCDC 2009). Average annual rainfall in Baltimore, Maryland is 41.94 inches based on 30 years of data (1971-2000) (NRCC 2009). Rainfall is uniformly distributed throughout the year, with monthly averages ranging from 3.00 inches for April to 3.98 inches for September. Most snowfall occurs in December, January, February and March, with an average annual snowfall of 21.4 inches based on 58 years of data (1961-2008).

2.2.2 Watershed Delineation

A watershed-based approach for evaluating water quality conditions and improvement potential involves determining the drainage areas that contribute 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 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 Upper Western Shore sub-basin. Sub-basins are further subdivided into watersheds and then 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, and these are comprised of over 1,100 subwatersheds (called 12-digit watersheds) identified by Maryland Department of Natural Resources (DNR); a subwatershed refers to the drainage area of a specific stream and typically covers 10 square miles or less (DNR 2005).

There are 14 state-defined, 8-digit watersheds in Baltimore County. The 8-digit Baltimore Harbor watershed (02-13-09-03) is approximately 87 square miles and encompasses portions of Baltimore County, Baltimore City, and Anne Arundel County. The portion of the Baltimore Harbor 8-digit watershed located in the County comprising the Bear Creek/Old Road Bay watershed is approximately 18 square miles (11,413 acres). For planning and management purposes, the Bear Creek/Old Road Bay watershed has been further subdivided into 14 subwatersheds by Baltimore County, as illustrated in Figure 1-2. Watershed delineations were provided by the Baltimore County Office of Information Technology (OIT) via spatial data based on 1998 Maryland state-defined 8-digit and 12-digit watershed information.

2.2.3 Topography

The topography of a region describes the shape of the land including locations and elevations of surface features such as ridges and valleys. Land shape characteristics such as steepness affect the direction and magnitude of surface water flows, degree of soil erosion, and suitability for development. Land surface topography has importance in water quality because steeper slopes are more prone to overland flow and soil erosion, which means that these areas have a greater potential to generate pollutants in runoff. Soil slope data for the Bear Creek/Old Road Bay watershed were obtained from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database (USDA 2010) and divided into the following five slope ranges which were derived from slope classification definitions provided in the U.S. Department of Agriculture (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% slopes)
- Steep (15 to 65% slopes)

Table 2-1 provides a summary of the percent breakdown of soil slopes by subwatershed. The majority of the Bear Creek/Old Road Bay watershed is comprised of a nearly level topography (63%) while the remainder of the area would be mostly classified as gently sloping (33%). The Oakleigh/Schoolhouse Coves and Country Club Cove/Humphrey Creek Remnant subwatersheds are the only areas with a significant amount of strongly sloping topography at 20% and 21%, respectively. Figure 2-1 illustrates the distribution of the slope ranges within the Bear Creek/Old Road Bay watershed.

Table 2-1: Bear Creek/Old Road Bay Slope Classification by Subwatershed

	SLOPE CATEGORY %			
Subwatershed	**Nearly Level* (0-5%)**	**Gently sloping, undulating (2-10%)**	**Strongly sloping, rolling (4-16%)**	**Moderately steep, hilly (10-30%)**
Colgate Creek	27.6	65.3	6.7	0.4
Peach Orchard Cove	45.9	54.1	0.0	0.0
Bullneck Creek	45.1	54.5	0.3	0.0
Lynch Cove	75.0	22.9	2.1	0.0
Chink Creek	54.3	45.7	0.0	0.0
Bear Creek Headwaters	67.9	26.3	5.8	0.0
Charlesmont/Tobasco Coves	87.5	12.5	0.0	0.0
Oakleigh/Schoolhouse Coves	57.5	23.0	19.5	0.0
Country Club Cove/Humphrey Creek Remnant	47.8	31.0	21.2	0.0
Jones Creek	42.0	58.0	0.0	0.0
North Point Creek	36.8	61.5	1.7	0.0
Shallow Creek	80.6	19.4	0.0	0.0
Black Marsh	88.7	5.9	5.4	0.0
Sparrows Point	91.2	5.8	3.0	0.0
Total	***62.7***	***32.7***	***4.5***	***0.1***

* Includes water features shown in Figure 2-1.

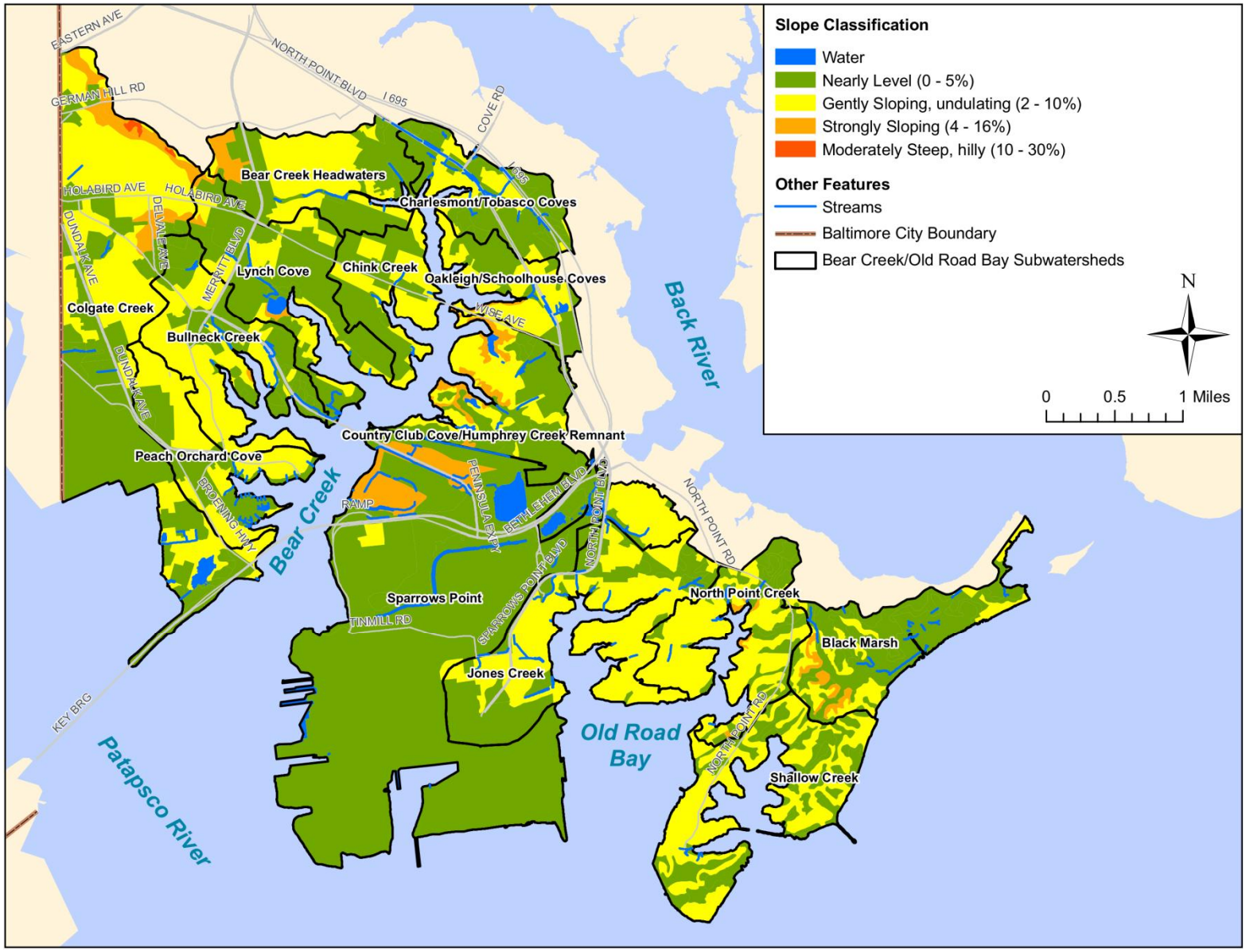

Figure 2-1: Bear Creek/Old Road Bay Topography based on Soil Slopes

2.2.4 Geology

The geology of an area affects the chemical composition of surface water and groundwater, as well as groundwater and well recharge rates. It is also relevant to soil formation and influences the buffering of pollutants to water bodies in developed areas. Consequently, geology often has a close correlation to water quality.

The Bear Creek/Old Road Bay watershed is located in the Western Shore Lowlands Region of the Coastal Plain Province of Maryland. Soils in this region consist of unconsolidated sediments including gravel, sand, silt, and clay (MGS 2009). Surficial geology in the study area is comprised of the Patapsco formation except for a small area of Arundel (clay and sand) formation located south of German Hill Road and north of Holabird Avenue. The Patapsco formation sand facies are well sorted, medium to fine-grained quartz sand with local deposits of quartz gravel and clays. The Patapsco formation clay facies are typically buff, red-yellow and brown mottled kaolinitic clays. These relatively young deposits of gravel, sand, silt and clay are the parent materials for the soils in the Baltimore Harbor Watershed (DEPRM 2000).

The Sassafras-Woodstown-Fallsington and the Mattapex-Barclay-Othello soil associations dominate the watershed, commonly in the Urban Land Complex form. These natural soils in the area range from well drained to poorly drained in the Urban Land Complex form. The “Urban Land Complex” designates areas consisting of soils that have mostly been cut, filled or graded for land development. Therefore, groundwater recharge rates are generally poorer in developed areas where the natural infiltration rates of the soils have been decreased through urban fill and compaction. As such, the geology is closely correlated with water quality, and affects the buffering of pollution to stream systems in developed areas.

2.2.5 Soils

Soil characteristics are an important consideration when evaluating water quantity and quality in streams and rivers. Soil type and moisture content, for example, impact how land may be used and its potential for vegetation and habitat. Soil conditions are also evaluated for projects aimed at improving water quality and/or habitat.

Soils data including hydrologic soil groups and soil erodibility for the Bear Creek/Old Road Bay watershed were obtained from spatial data provided by the NRCS SSURGO database (USDA 2010).

2.2.5.1 Hydrologic Soil Groups

The NRCS classifies soils into four hydrologic soil groups (HSG) based on their runoff potential and infiltration rates. Infiltration rate can be described as the ability of a soil to absorb precipitation, and runoff potential as just the opposite. Soils with high runoff potential have low infiltration capacity and tend to cause overland flow instead of allowing runoff to infiltrate. Infiltration rates are highly variable among soil types and are also influenced by disturbances to the soil profile such as land development activities. For example, urbanization on land composed of high infiltration soils (such as sands and gravels) will greatly increase runoff; whereas development on land composed of low infiltration soils such as silts and clays will have less of an impact on runoff.

The four hydrologic soil groups range from A to D, from lowest runoff potential to highest, respectively. Brief descriptions of each hydrologic soil group are provided below. Further explanation can be found in the USDA/NRCS publication, *Urban Hydrology for Small Watersheds, 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. These are soils with moderately fine texture or fine texture, and have a low rate of water transmission.
- **Group D** soils include clay loam, silty clay loam, sandy clay, silty clay, or clay types. These soils have a very low infiltration rate and high runoff potential when thoroughly wet. These consist mainly of clays with high swell potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission.

As shown in Table 2-2 and Figure 2-2, over 84% of soils in the Bear Creek/Old Road Bay planning area fall into hydrologic soil groups C and D, which have low to very low infiltration rates and therefore, relatively high runoff potential.

Table 2-2: Bear Creek/Old Road Bay Hydrologic Soil Groups

Subwatershed	Hydrologic Soil Group (%) A	B	C	D	Water (%)
Colgate Creek	0.0	30.7	22.9	45.4	1.0
Peach Orchard Cove	0.0	36.4	21.4	41.8	0.4
Bullneck Creek	1.7	55.1	16.3	26.9	0.0
Lynch Cove	0.0	21.5	17.5	59.5	1.5
Chink Creek	0.0	35.0	12.7	52.2	0.0
Bear Creek Headwaters	0.0	18.4	76.9	4.7	0.0
Charlesmont/Tobasco Coves	0.0	0.0	67.8	32.1	0.1
Oakleigh/Schoolhouse Coves	0.0	0.0	83.6	3.1	13.3
Country Club Cove/Humphrey Creek Remnant	0.0	13.2	73.2	10.7	2.9
Jones Creek	0.0	0.0	52.7	47.2	0.1
North Point	0.0	22.2	67.1	10.7	0.0
Shallow Creek	0.0	2.1	51.2	46.7	0.0
Black Marsh	0.0	4.1	50.7	45.1	0.0
Sparrows Point	0.0	0.0	23.4	75.3	1.3
Total	***0.1***	***14.6***	***39.4***	***44.7***	***1.2***

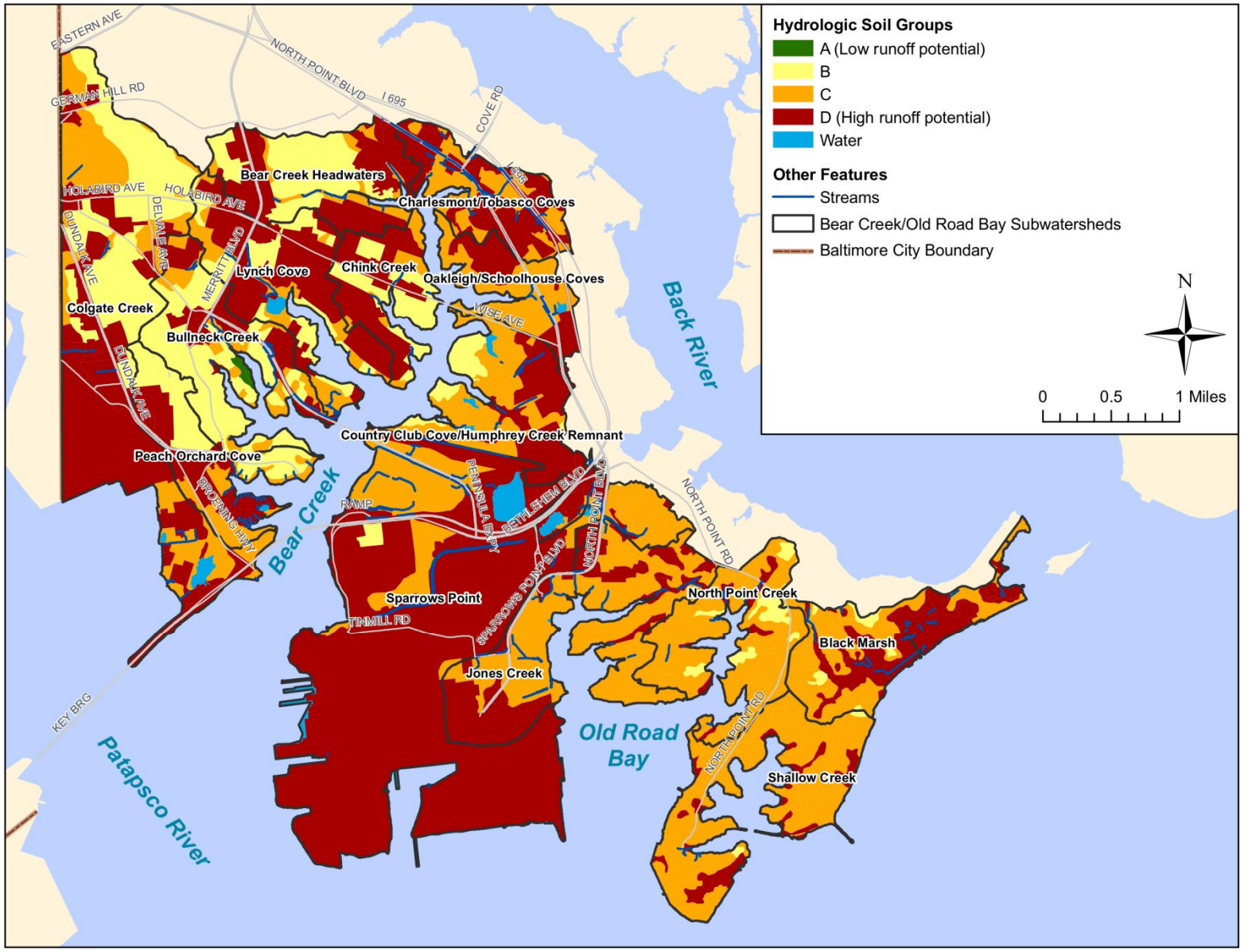

Figure 2-2: Bear Creek/Old Road Bay Hydrologic Soil Groups

2.2.5.2 Erodibility

Erodibility is the susceptibility of soil to erosion. It is quantified by the K factor, which is used in 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. Soil erodibility is determined based on the physical and chemical properties of the soil, which represent how strongly soil particles cohere with one another. Soils with low K factors indicate low erodibility or high resistance to detachment, and soils with high K factors indicate high erodibility potential. For example, soils high in clay content are least erodible with K values of about 0.05 to 0.15, and soils with high silt content are most erodible with K values often greater than 0.4 (Ouyang 2002).

Table 2-3 summarizes soil erodibility values in the Bear Creek/Old Road Bay watershed by subwatershed. Erodibility K factors range from 0 to 0.49 and were grouped into three categories as follows:

- Low Erodibility (0 ≤ K factor ≤ 0.2);
- Medium Erodibility (0.24 ≤ K factor ≤ 0.32); and
- High Erodibility (0.37 ≤ K factor ≤ 0.49)

Table 2-3: Bear Creek/Old Road Bay Soil Erodibility Categorization Based on K factor

	Soil Erodibility Category (%)		
Subwatershed	**Low***	**Medium**	**High**
Colgate Creek	44.4	40.0	15.6
Peach Orchard Cove	42.2	40.0	17.8
Bullneck Creek	27.4	69.2	3.4
Lynch Cove	61.0	35.5	3.5
Chink Creek	52.2	36.7	11.1
Bear Creek Headwaters	5.7	25.1	69.3
Charlesmont/Tobasco Coves	4.8	1.5	93.7
Oakleigh/Schoolhouse Coves	14.9	3.3	81.8
Country Club Cove/Humphrey Creek Remnant	10.7	24.7	64.6
Jones Creek	46.8	0.3	52.9
North Point Creek	10.3	27.4	62.3
Shallow Creek	44.1	15.8	40.1
Black Marsh	38.1	26.9	35.0
Sparrows Point	76.6	12.3	11.1
Total	***43.8***	***24.2***	***31.9***

* Includes Water features shown in Figure 2-3

As shown in Table 2-3 and Figure 2-3, there is significant presence of all three soil erodibility categories in the Bear Creek/Old Road Bay planning area. Highly erodible soils are more evident in the Bear Creek Headwaters, Charlesmont/Tobasco Coves, Oakleigh/Schoolhouse Coves, Country Club Cove/Humphrey

Creek Remnant, and North Point Creek subwatersheds, which all have over 60% highly erodible soils. These soils also correspond to soils classified as having low infiltration rates (pertaining to hydrologic soil group C), which means high erodibility and relatively high runoff potential in these areas. In contrast, soils within the Bullneck Creek subwatershed mostly fall within the moderately erodible category. Low erodibility soils occur mostly in the Lynch Cove and Sparrows Point subwatersheds. These soils, however, correspond to soils with very low infiltrations rates (pertaining to hydrologic soil group D). This is because most of these soils are classified as Urban Land, which over time have been graded and compacted for urban development. Areas that are relatively undeveloped, on the other hand, are suitable for preservation of forested area especially in locations with high soil erodibility but low slopes.

Subwatersheds with the largest percentages 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 from streams to determine where other BMPs, such as retirement of highly erodible land, are appropriate. High K factor values also serve as a warning for planning of urban activities near streams such as road construction or utility placements.

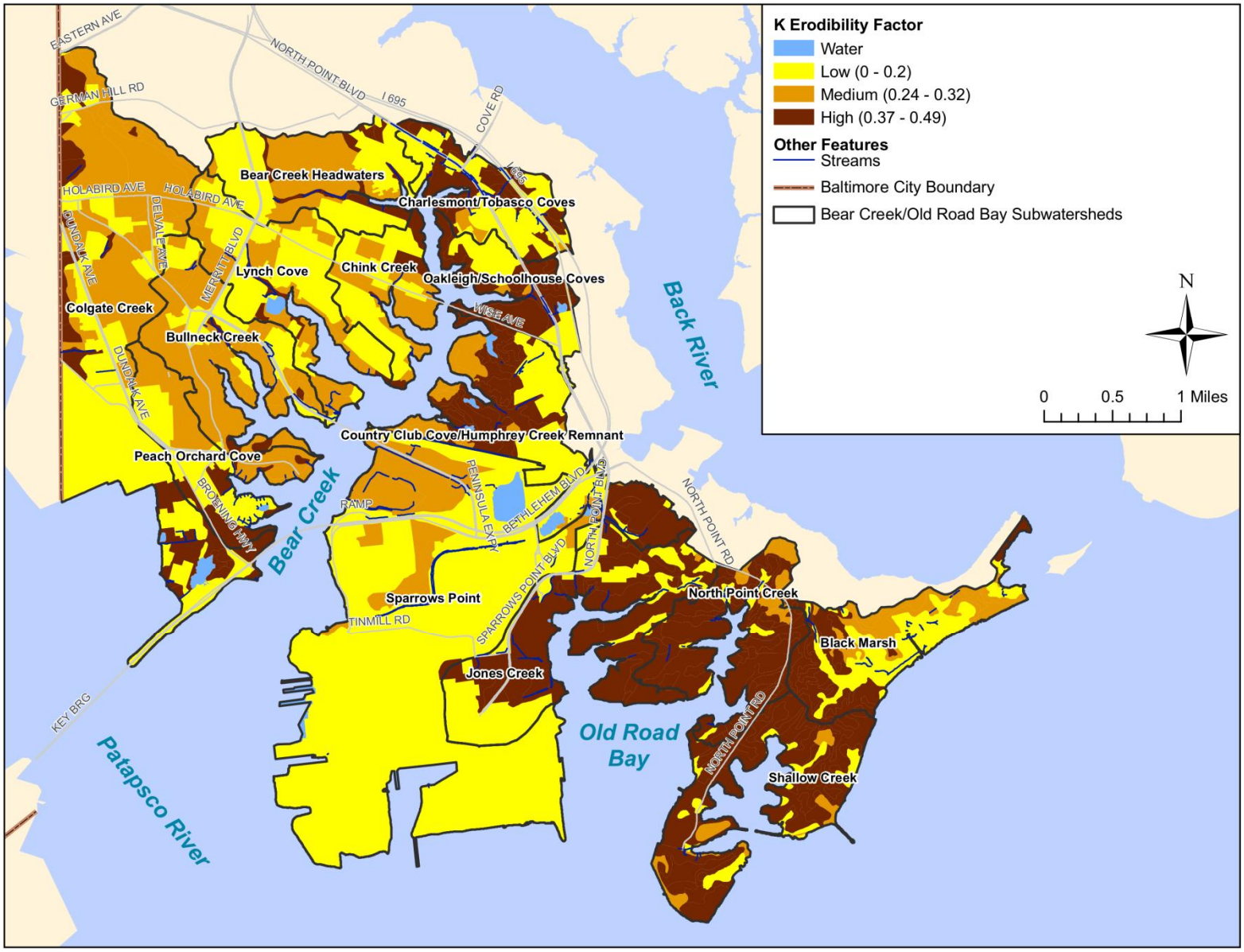

Figure 2-3: Bear Creek/Old Road Bay Soil Erodibility Based on K factor

2.2.6 Forest Cover

Forests provide 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 Bear Creek/Old Road Bay watershed consisted mainly of old-growth forest prior to colonial settlement, as is true for the entire Chesapeake Bay basin. Much deforestation has occurred since then; however, even in developed systems, forest cover can still provide many benefits such as reducing erosion potential and protecting water quality if carefully planned and conserved.

Forest cover data for the Bear Creek/Old Road Bay watershed were obtained from various sources. Spatial data from Baltimore County OIT showing wooded areas delineated before 1998 were used as a base. As some of the planning area has undergone further deforestation over the years, this data was then edited based on aerial imagery provided by Baltimore County OIT as well as 2007 Urban Tree Canopy Land Cover spatial data for Baltimore County. The latter was created based on 2007 infrared aerial imagery and 2005 LiDAR data by the University of Vermont Spatial Analysis Laboratory.

Table 2-4 lists the number of acres of forest cover for each subwatershed in the Bear Creek/Old Road Bay planning area, along with percent of the subwatershed that is forested. Figure 2-4 shows the distribution of forest cover within the planning area. The Bear Creek/Old Road Bay watershed contains approximately 2,599 acres of forest cover, or slightly more than one-fifth of the planning area. The Maryland Department of Planning's (MDP) 2007 land use/land cover classification scheme estimates that 10% of forest cover remains in the planning area. Variations between the two sources are attributable to the large amount of small forested patches in the western portion of the watershed and the different scales the studies utilize. The subwatersheds of North Point Creek, Shallow Creek, and Black Marsh contain portions of North Point Park providing a forest cover of at least 44% in each. The western portion of the watershed around Bear Creek along with the Jones Creek subwatershed is more developed containing a smaller percentage of forest cover. These areas offer a potential opportunity for reforestation.

Table 2-4: Bear Creek/Old Road Bay Forested Area by Subwatershed

Subwatershed	Total Acres	Forested Acres	% Forested
Colgate Creek	1649.3	246.8	15.0%
Peach Orchard Cove	450.2	85.4	19.0%
Bullneck Creek	632.2	151.0	23.9%
Lynch Cove	648.4	94.4	14.6%
Chink Creek	364.8	63.0	17.3%
Bear Creek Headwaters	592.0	85.8	14.5%
Charlesmont/Tobasco Coves	417.4	105.0	25.1%
Oakleigh/Schoolhouse Coves	328.8	70.8	21.5%
Country Club Cove/Humphrey Creek Remnant	797.9	294.1	36.9%
Jones Creek	922.9	283.1	30.7%
North Point Creek	576.2	253.3	44.0%
Shallow Creek	706.2	312.1	44.2%
Black Marsh	569.2	322.4	56.6%
Sparrows Point	2757.9	231.4	8.4%
Total	**11,413.4**	***2,598.5***	***22.8%***

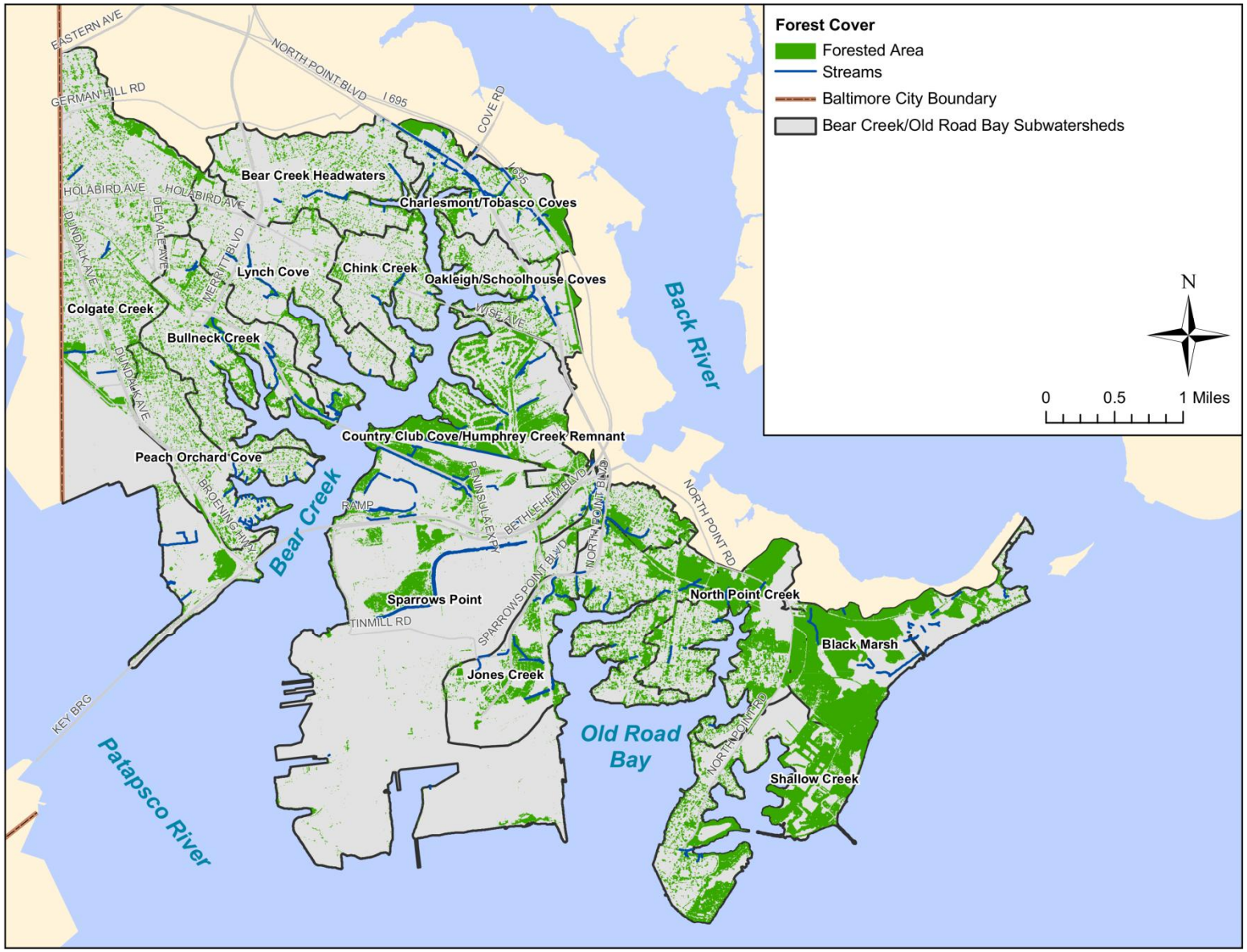

Figure 2-4: Bear Creek/Old Road Bay Forest Cover

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 groundwater 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 ensuring that stream flows and water quality closely mimic the conditions found in un-impacted watersheds.

2.2.7.1 Stream System Characteristics

The subwatersheds with the most stream miles include Colgate Creek, Country Club Cove/Humphrey Creek Remnant, Jones Creek, Black Marsh, and Sparrows Point. These four watersheds comprise over 62% of all stream miles in the planning area. Sparrows Point alone contains over 5 miles of stream, constituting over a quarter of all stream miles in the planning area. Because North Point Creek, Shallow Creek, and Black Marsh contain over 40% forest coverage, these subwatersheds may represent a priority for stream preservation, whereas streams in more urbanized areas may present a priority for stream restoration opportunities.

The Bear Creek/Old Road Bay watershed was divided into a series of subwatersheds based on the drainage areas contributing to major creeks and rivers as well as geographic/property considerations within the watershed. Figure 2-5 shows the system of streams and subwatersheds comprising the Bear Creek/Old Road Bay watershed. Table 2-5 summarizes number of stream miles in each subwatershed along with stream density, defined as miles of stream per square mile of subwatershed area. There are approximately 16.9 miles of stream in the planning area, all of which eventually drains to the Chesapeake Bay. Stream data for the planning area was provided by Baltimore County OIT based on hydrology lines captured from 3D compilation processes using imagery captured in 2005.

Table 2-5: Bear Creek/Old Road Bay Stream Mileage and Density

Subwatershed	Area (Sq Miles)	Stream Miles	Stream Density (mi./sq. mi.)
Colgate Creek	2.58	0.75	0.29
Peach Orchard Cove	0.70	0.92	1.31
Bullneck Creek	0.99	0.81	0.82
Lynch Cove	1.01	0.79	0.78
Chink Creek	0.57	0.29	0.51
Bear Creek Headwaters	0.92	0.67	0.73
Charlesmont/Tobasco Coves	0.65	1.19	1.82
Oakleigh/Schoolhouse Coves	0.51	0.34	0.66
Country Club Cove/Humphrey Creek Remnant	1.25	1.24	1.00
Jones Creek	1.44	1.70	1.18
North Point Creek	0.90	0.56	0.62
Shallow Creek	1.10	0.06	0.05
Black Marsh	0.89	1.79	2.01
Sparrows Point	4.31	5.76	1.34
Total	***17.8***	***16.9***	***0.9***

Compared to other watersheds in Baltimore County, the stream density in the Bear Creek/Old Road Bay planning area is relatively low. For comparison, in the less-urbanized Windlass Run subwatershed located in the Bird River SWAP planning area of Baltimore County contains a stream density of 2.7 miles of stream per square mile. In more urbanized areas of the County where the stream density is especially low, this could indicate the burial of streams during past development into pipe systems.

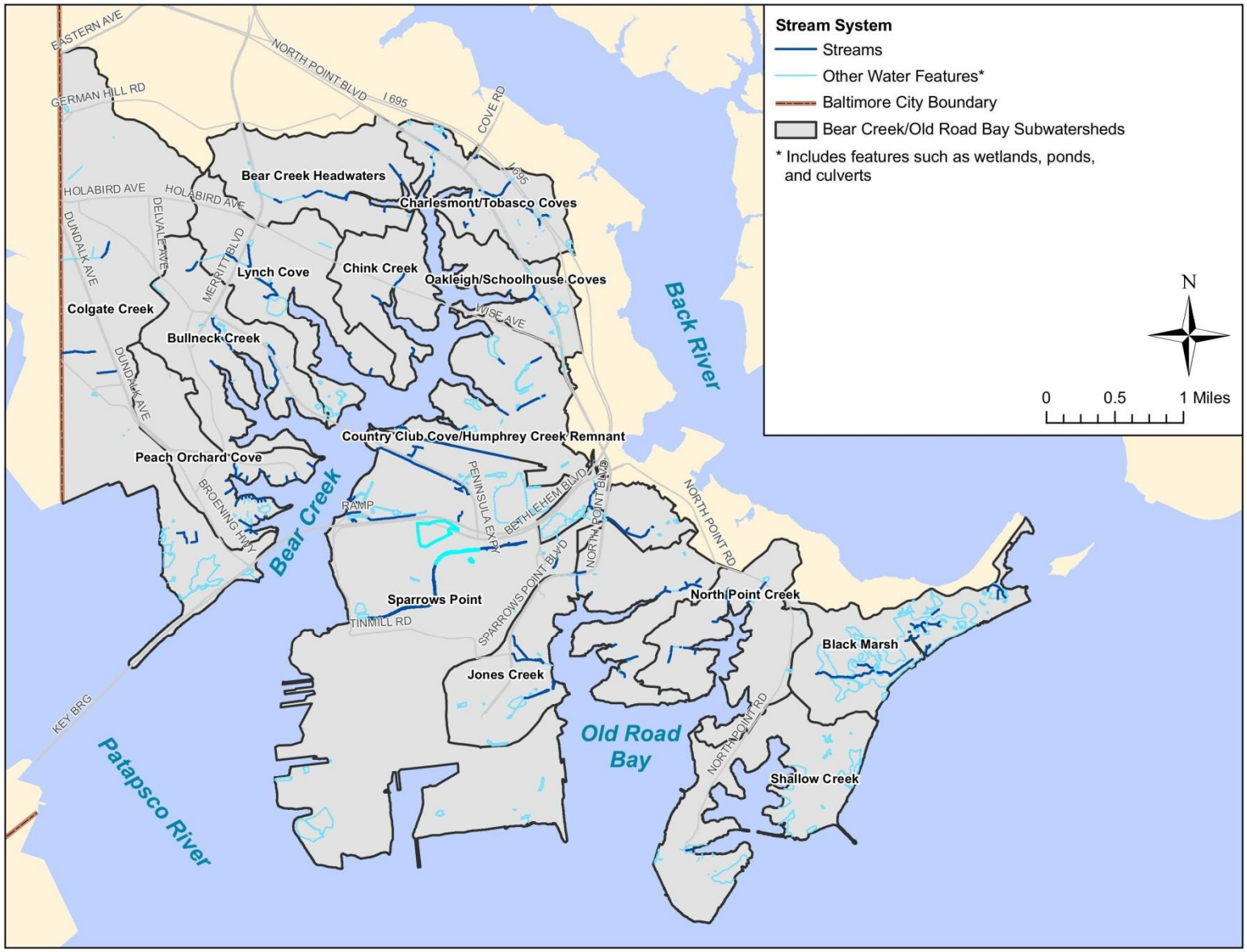

Figure 2-5: Bear Creek/Old Road Bay Stream System

2.2.7.2 Stream Riparian Buffers

Riparian buffers refer to the vegetated areas adjacent to streams and other water bodies that protect them 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 intercept and reduce surface runoff, stabilize stream banks, trap sediment, and provide habitat for various types of terrestrial and aquatic life. For example, tree roots capture and remove pollutants including excess nutrients such as nitrogen from shallow flowing water; the tree root structure also holds soil together to reduce erosion potential, and slows water flow which reduces sediment load and risk of flooding. Tree canopies provide shading that helps to keep cool water temperatures preferred by many aquatic organisms, particularly cold-water species like trout. In smaller streams, terrestrial plant material falling into the stream is the primary source of food for stream life. While leaves provide seasonal food for stream life at the base of the food chain, fallen tree branches and trunks provide a more consistent, slow-release food source throughout the year. Tree roots and snags also offer habitat and spawning areas for fish and other aquatic species.

Maintaining healthy streams and forest buffers are important for reducing nutrient and sediment loadings to the Bear Creek/Old Road Bay watershed, and thus to the Chesapeake Bay. When stream riparian buffers are converted from forest to agriculture or urban development, 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 condition of the stream riparian buffers in the Bear Creek/Old Road Bay watershed was analyzed based on a 100-foot buffer on both sides of all streams. The condition of the riparian buffer was classified using four categories: impervious, open pervious, forest, or wetland. Wetland areas were included as a separate category because they are a common feature within the planning area and also provide significant ecological and water quality benefits. The stream data described in the previous section were used as a base to create the 100-foot buffer. First, road and building data were overlaid on the 100-foot buffer area to obtain the impervious areas lying within the buffer zone. Similarly, forested areas were obtained by overlaying the urban tree canopy data over the buffer area and removing portions that overlapped with impervious areas. Wetland areas extracted from 2007 land use data provided by Baltimore County OIT were also overlaid with the buffer area; portions that overlapped with impervious and forest cover were removed from the layer. Remaining areas that were not impervious, forested, or wetlands were classified as open pervious. Table 2-6 summarizes stream riparian buffer conditions by subwatershed, and the distribution is shown in Figure 2-6.

Table 2-6: Bear Creek/Old Road Bay Land Cover in the 100-ft Stream Buffer

	IMPERVIOUS		OPEN PERVIOUS		FOREST		WETLAND		Total	Total % of
Subwatershed	Acres	%	Acres	%	Acres	%	Acres	%	Acres	Watershed
Colgate Creek	5.4	21.6%	13.1	52.5%	6.4	25.9%	0.0	0.0%	24.9	4.8%
Peach Orchard Creek	7.3	18.6%	25.9	66.1%	6.0	15.3%	0.0	0.0%	39.1	7.5%
Bullneck Creek	4.5	17.3%	8.8	34.2%	12.5	48.5%	0.0	0.0%	25.8	4.9%
Lynch Cove	2.7	10.0%	17.1	64.1%	6.9	25.9%	0.0	0.0%	26.7	5.1%
Chink Creek	1.7	16.1%	5.2	48.2%	3.9	35.8%	0.0	0.0%	10.8	2.1%
Bear Creek Headwaters	2.8	12.6%	12.3	55.9%	6.9	31.5%	0.0	0.0%	21.9	4.2%
Charlesmont/ Tobasco Coves	10.9	25.2%	19.4	44.8%	13.0	30.0%	0.0	0.0%	43.3	8.2%
Oakleigh/Schoolhouse Coves	4.4	36.8%	4.5	37.6%	3.1	25.6%	0.0	0.0%	12.0	2.3%
Country Club Cove/Humphrey Creek Remnant	4.7	9.5%	18.2	36.7%	26.7	53.8%	0.0	0.0%	49.6	9.5%
Jones Creek	5.8	11.2%	18.3	35.5%	27.6	53.3%	0.0	0.0%	51.7	9.9%
North Point Creek	1.6	7.5%	6.3	29.9%	13.2	62.6%	0.0	0.0%	21.1	4.0%
Shallow Creek	0.2	8.5%	2.0	80.8%	0.3	10.8%	0.0	0.0%	2.5	0.5%
Black Marsh	0.5	0.9%	8.9	16.9%	8.0	15.0%	35.6	67.2%	52.9	10.1%
Sparrows Point	23.1	16.2%	87.8	61.7%	19.6	13.8%	11.8	8.3%	142.3	27.1%
Total	***75.5***	***14.4%***	***247.9***	***47.2%***	***153.9***	***29.3%***	***47.3***	***9.0%***	***524.7***	***100.0%***

Total impervious areas within the stream riparian buffers zone are relatively high at approximately 14% for the planning area. The largest percentage of the riparian buffer falls under open pervious (approximately 47%). The Charlesmont/Tobaso Coves and Oakleigh/Schoolhouse Coves subwatersheds have the highest percentages of impervious area in the buffer zone, both over 25%. Seven (7) subwatersheds are comprised of at least 15% impervious area. These areas may present potential opportunities for impervious cover removal or buffer reestablishment. At least 30% of stream buffers in 13 of the 14 subwatersheds are comprised of open pervious areas, providing potential for reforestation.

Subwatersheds with the highest acreages of forested buffer include Bullneck Creek, Charlesmont/Tobasco Coves, Country Club Cove/Humphrey Creek Remnant, Jones Creek, North Point Creek, and Sparrows Point ranging from approximately 11 to 28 acres. These areas may present potential preservation opportunities. It is also noteworthy that Jones Creek and North Point Creek have significant residential development and high percentages of forested buffer, ranging from approximately 53% to 63%. It appears that stream riparian buffers are relatively well maintained in these areas despite the urbanization, which also offers preservation and public education opportunities. Subwatersheds with the greatest amount of wetland areas within the riparian buffer include Black Marsh and Sparrows Point, potentially also providing preservation opportunities.

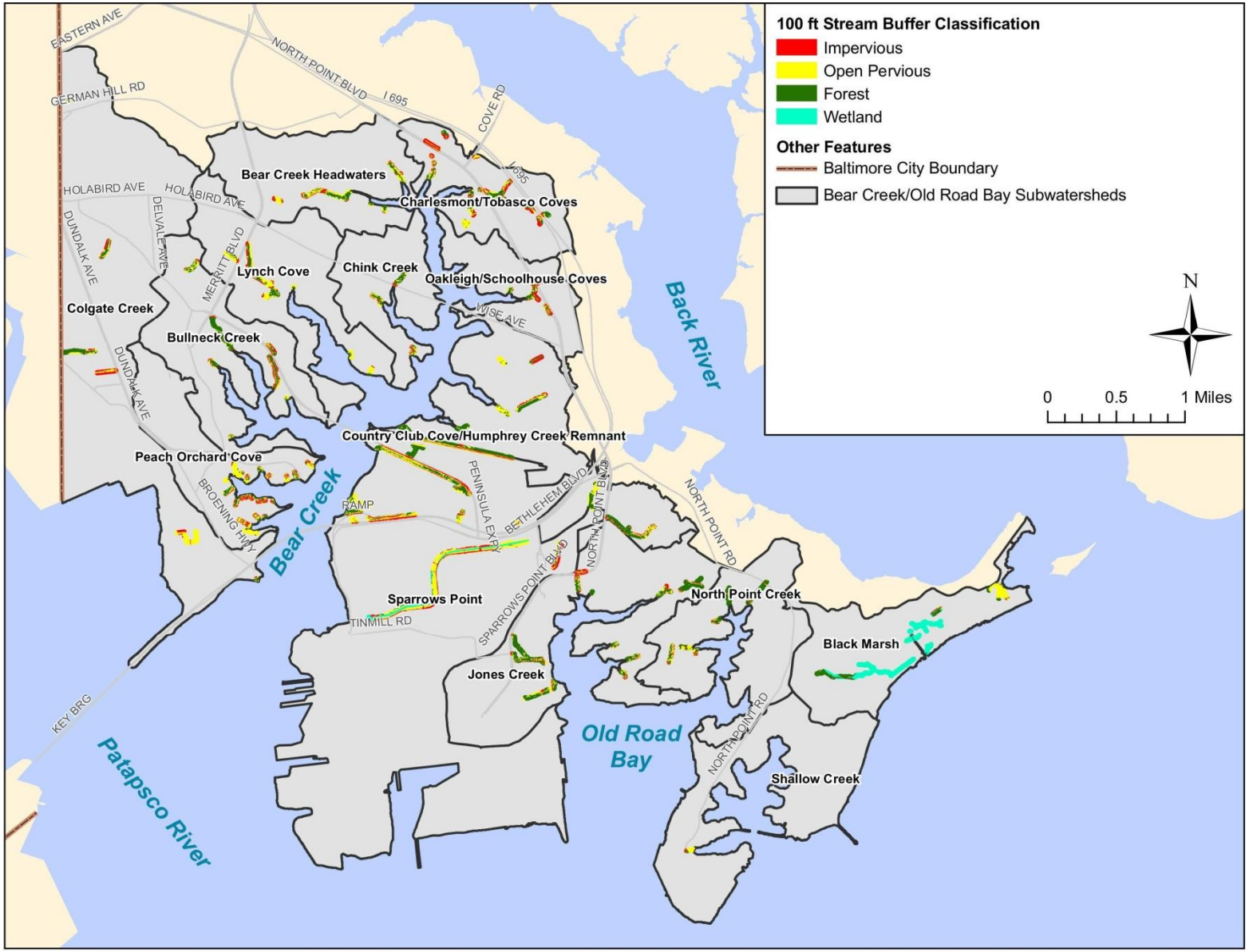

Figure 2-6: Bear Creek/Old Road Bay 100-ft Stream Buffer Condition

2.2.8 Tidal Waters

The tidal waters of Bear Creek/Old Road Bay encompass approximately 2,073 acres not including direct drainage from Sparrows Point to outer Baltimore Harbor or the direct drainage from the Blackmarsh subwatershed to the Bay. Figure 2-7 shows the state-defined tidal water segments surrounding the Bear Creek/Old Road Bay planning area. Tidal water acreages for Bear Creek, Old Road Bay, and Shallow Creek are 1,033 acres, 858 acres, and 182 acres, respectively.

The tidal waters of Bear Creek/Old Road Bay are mesohaline, characterized by very low species diversity with salt concentrations of 5 to 18 parts per thousand (ppt). Water quality impairments related to nutrients, Chlordane, and polychlorinated biphenyls (PCBs) in fish tissue have been identified for the tidal waters of Bear Creek/Old Road Bay according to MDE's 2010 Integrated Report of Surface Water Quality in Maryland (MDE 2010). This is the most recent final report approved by USEPA regarding the status of water quality within the state of Maryland, required pursuant to Section 303(d) of the Clean Water Act. The impairment listings reflect the inability to meet water quality standards for the designated uses of Bear Creek/Old Road Bay, which is Use II– support of estuarine and marine aquatic life and shell fish harvesting according to the Maryland Water Quality Standards Surface Water Use Designation [Code of Maryland Regulations (COMAR) 26.08.02.07]. Pollutant load limits for these tidal waters have been established for the various pollutants of concern and can be found in Section 3.2 of this report. Targets have also been established for submerged aquatic vegetation (SAV) and water quality as these are both indicators of good water quality and habitat.

A Chesapeake Bay TMDL has been developed and is being used to assign nutrient (nitrogen and phosphorus) and sediment load reductions to Bay segments and individual local jurisdictions. Impairments in tidal receiving waters are related to pollutants coming from the entire watershed; therefore, any impairment listings or TMDLs developed for Bear Creek/Old Road Bay tidal segments will require watershed pollutant load reductions. A detailed discussion of water quality status and targets for the planning area is included in Chapter 3.

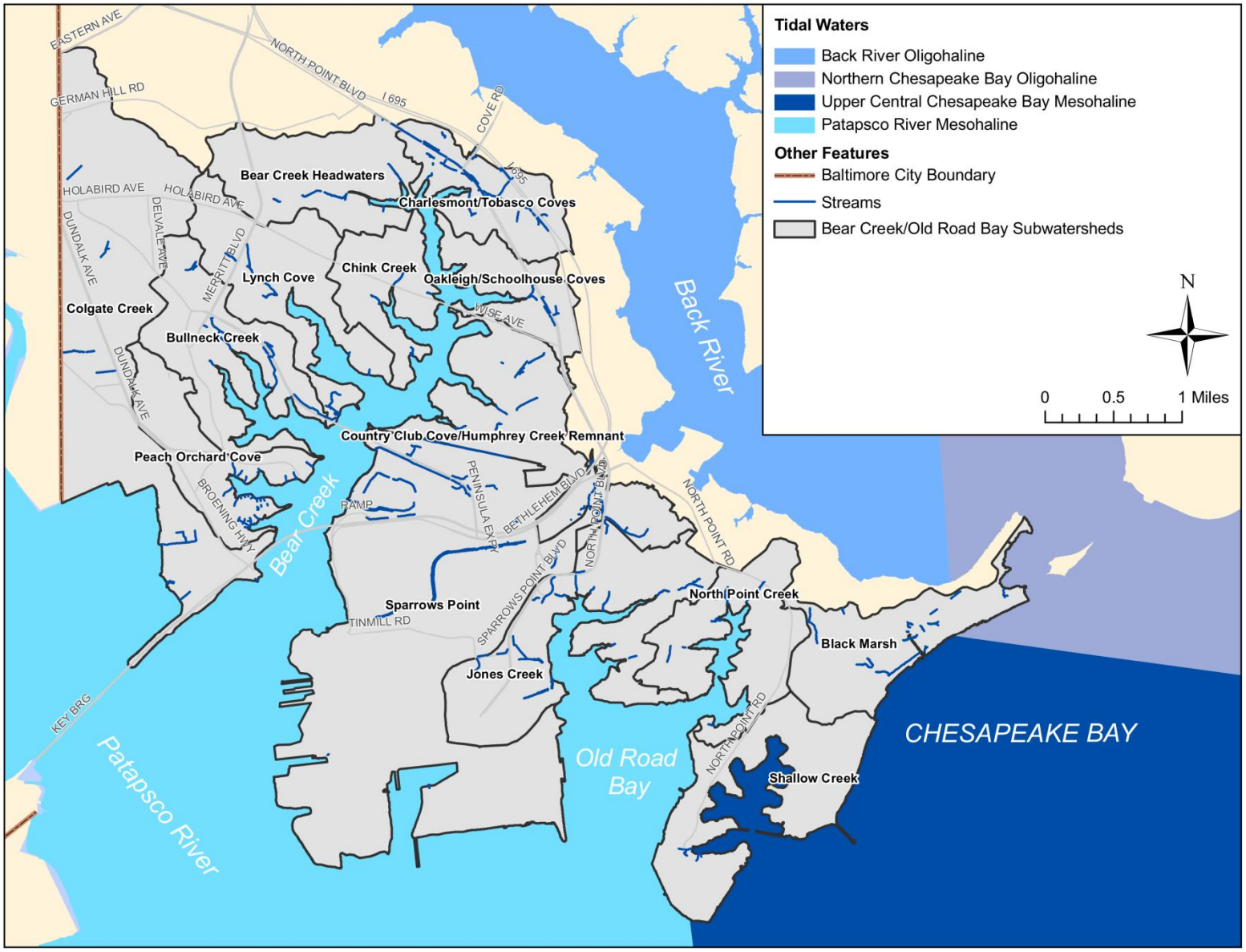

Figure 2-7: Tidal Waters of Bear Creek/Old Road Bay

The Bear Creek/Old Road Bay watershed contains approximately 61 miles of coastline. Coastline data was derived from water feature and County boundary spatial data obtained from Baltimore County OIT. Table 2-7 presents the number of coastline miles for each subwatershed and coastline density, defined as miles of coastline per square mile of subwatershed area. Jones Creek, Shallow Creek, and Sparrows Point have the greatest lengths of coastline, ranging from approximately 5 miles to 13 miles. These three subwatersheds comprise approximately 45% of all coastline miles in the planning area.

Table 2-7: Bear Creek/Old Road Bay Shoreline Mileage and Density

Subwatershed	Area (Sq Miles)	Coastline Miles	Coastline Density (mi./sq. mi.)
Colgate Creek	2.58	4.15	1.61
Peach Orchard Cove	0.70	2.40	3.42
Bullneck Creek	0.99	4.35	4.40
Lynch Cove	1.01	3.06	3.02
Chink Creek	0.57	3.32	5.83
Bear Creek Headwaters	0.92	1.35	1.46
Charlesmont/Tobasco Coves	0.65	1.22	1.87
Oakleigh/Schoolhouse Coves	0.51	2.44	4.75
Country Club Cove/Humphrey Creek Remnant	1.25	3.50	2.81
Jones Creek	1.44	5.42	3.76
North Point Creek	0.90	4.11	4.56
Shallow Creek	1.10	9.58	8.68
Black Marsh	0.89	3.32	3.73
Sparrows Point	4.31	12.64	2.93
Total	***17.8***	**60.87**	***3.4***

A riparian buffer analysis similar to the stream riparian buffer study was conducted to characterize the vegetative condition of coastline buffers in the Bear Creek/Old Road Bay planning area. Coastline buffer condition was analyzed based on a 100-foot buffer along tidal waters and classified as one of four categories: impervious, open pervious, forest, or wetland. The coastline data described above were used as a base to create the 100-foot buffer. Road and building data were overlaid on the 100-foot buffer area to obtain the impervious areas. Similarly, forested areas were obtained by overlaying the urban tree canopy data over the buffer area and removing any overlapping impervious area. Wetland areas extracted from 2007 land use data provided by Baltimore County OIT were also overlaid with the buffer area, and portions that overlapped with impervious and forest cover were removed from the layer. Remaining areas that were not impervious, forested, or wetland were classified as open pervious. Table 2-8 summarizes coastline riparian buffer conditions by subwatershed, and the distribution is shown in Figure 2-8.

Table 2-8: Bear Creek/Old Road Bay Land Cover in the 100-ft Shoreline Buffer

Subwatershed	IMPERVIOUS		OPEN PERVIOUS		FOREST		WETLAND		Total	Total % of
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	Watershed
Colgate Creek	11.6	23.6%	30.1	61.0%	5.3	10.7%	2.3	4.7%	49.3	17.7%
Peach Orchard Creek	2.2	7.9%	18.7	67.6%	6.7	24.4%	0.0	0.0%	27.6	9.9%
Bullneck Creek	4.7	9.3%	25.8	50.9%	20.2	39.8%	0.0	0.0%	50.7	18.2%
Lynch Cove	6.7	18.3%	15.4	42.4%	14.0	38.5%	0.3	0.8%	36.3	13.0%
Chink Creek	6.6	17.0%	16.5	42.7%	14.6	37.8%	1.0	2.5%	38.6	13.8%
Bear Creek Headwaters	0.4	2.4%	8.5	52.0%	7.4	45.6%	0.0	0.0%	16.3	5.8%
Charlesmont/ Tobasco Coves	2.3	16.4%	7.0	49.4%	4.8	34.2%	0.0	0.0%	14.2	5.1%
Oakleigh/Schoolhouse Coves	4.0	14.1%	12.1	42.6%	12.3	43.3%	0.0	0.0%	28.3	10.1%
Country Club Cove/Humphrey Creek Remnant	3.5	8.8%	13.8	34.4%	22.7	56.8%	0.0	0.0%	40.0	14.3%
Jones Creek	10.2	16.3%	29.6	47.1%	23.0	36.6%	0.0	0.0%	62.8	22.5%
North Point Creek	5.9	12.3%	18.9	39.5%	23.1	48.2%	0.0	0.0%	48.0	17.2%
Shallow Creek	4.0	3.9%	44.0	42.7%	49.5	48.0%	5.7	5.5%	103.1	36.9%
Black Marsh	3.6	9.8%	13.1	35.5%	5.2	14.1%	15.0	40.6%	37.0	13.2%
Sparrows Point	14.4	10.4%	106.9	76.9%	13.7	9.9%	4.1	2.9%	139.1	49.8%
Total	***22.0***	***7.9%***	***164.0***	***58.8%***	***68.4***	***24.5%***	***24.7***	***8.9%***	***279.2***	***100.0%***

Over half of the coastline in the planning area, approximately 59%, is designated as open pervious. Open pervious areas present potential buffer re-establishment opportunities. The amount of coastline buffer that is forested is approximately 25% of the total planning area; wetland areas make up significantly less, approximately 9% of the coastline buffer. Subwatersheds with the highest acreages of forested coastline buffer are Shallow Creek, North Point Creek, Jones Creek, Bullneck Creek, and Country Club Cove/Humphrey Creek Remnant. These subwatersheds also have high percentages of forested stream buffer as described in the previous section. The only subwatersheds with a large amount of wetlands in the coastline buffer is Black Marsh. These forested and wetland areas may present potential opportunities for preservation. There is a relatively low percentage of impervious area in the coastline buffer zone at approximately 8%. The subwatersheds with the most acres of impervious area in the coastline buffer zone include Jones Creek, Sparrows Point, and Colgate Creek, which all contain large amounts of private shoreline properties. Impervious coastline areas in these subwatersheds range from approximately 10 to 14 acres. These areas may present opportunities for shoreline restoration; however, restoration potential will be heavily influenced by property ownership.

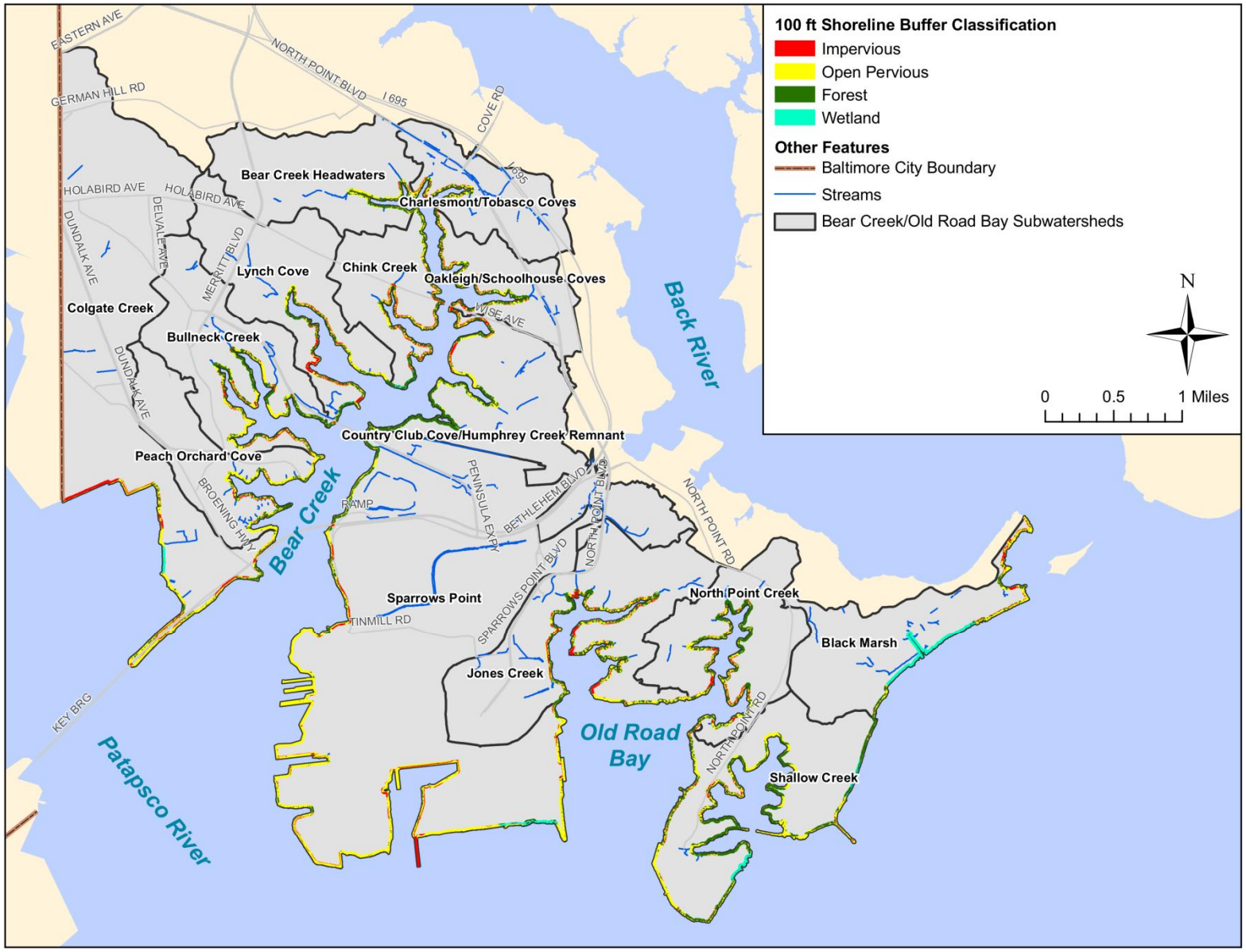

Figure 2-8: Bear Creek/Old Road Bay 100-ft Shoreline Buffer Condition

2.3 The Human Modified Landscape

Human activities have altered the natural landscape over time through the use of land and water resources. The intensity of development activities has increased since the colonization of Maryland in the 1600s, which 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 of the Bear Creek/Old Road Bay watershed. This includes a description of land use and land cover, population, impervious cover, drinking water and wastewater, stormwater systems, discharge permits, and zoning.

2.3.1 Land Use and Land Cover

Land use represents the types of human activities taking place within a watershed and has pronounced impacts on water quality and habitat. The extent of these impacts, including types and amounts of pollutants generated, varies depending on the types of land uses that are present in the watershed. As discussed previously, a forested watershed has the ability to absorb pollutants such as sediment and nutrients and reduce the flow rate of water into streams. Developed areas have impervious surfaces that block the natural seepage of precipitation into the ground. These 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 behavior can cause bank erosion and destruction of in-stream and riparian habitat of the receiving water body. Undeveloped watersheds and those with smaller 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 statewide land use/land cover spatial data to provide a general overview of predominant land cover and usage, and to monitor development activities throughout the state. The land use/land cover delineations are based on high altitude aerial photography and satellite imagery. In this report, land use analyses were performed using 2007 MDP land use spatial data provided by Baltimore County OIT. This data was originally based on the 2002 MDP-developed land use/land cover data which were later refined using 2005 aerial imagery and 2006 tax parcel data. Table 2-9 summarizes land use categories in the Bear Creek/Old Road Bay watershed and their percent composition in each subwatershed. Figure 2-9 illustrates the land use/land cover distribution in the planning area.

Predominant land use types present within the Bear Creek/Old Road Bay planning area are residential areas (approximately 3,700 acres or 32% of total area) and industrial (approximately 3,596 acres or 32% of total area). Forest (1,171 acres) and wetlands (370 acres) uses make up 10% and 3% of the planning area, respectively. As mentioned in section 2.2.6, forest and wetland areas provide a good opportunity for preservation. Residential areas were subdivided into four subcategories based on density: very low density (5 to 20-acre lots); low density (1/2 to 5-acre lots); medium density (1/8 to 1/2-acre lots); and high density (less than 1/8-acre lots). Medium and high density residential subcategories make up the vast majority of residential areas within the planning area (approximately 99%). No areas classified as very low density were present in the planning area. Subwatersheds with the highest percentages of

residential areas include Peach Orchard Cove and Chink Creek. Over 75% of the land area in these subwatersheds are comprised of high density and medium density residential areas. Residential areas present an opportunity for community involvement in restoration efforts, neighborhood pollutant source control, and environmental stewardship.

Two-thirds of industrial land uses within the Bear Creek/Old Road Bay planning area occur within the Sparrows Point subwatershed. In addition, because of the nature of the operations that occur in the Sparrows Point subwatershed, 87% of the subwatershed area is comprised of industrial uses. The remaining area consists of forests, wetlands, open urban land, open water and transportation uses.

Other urban land uses including commercial, institutional, open urban land, and transportation also make up a significant portion of the planning area (approximately 2,036 acres or 18% of total area). The majority of commercial land use occurs in the Bear Creek Headwaters, Charlesmont/Tobasco Coves, and Oakleigh/Schoolhouse Coves subwatersheds. Institutional areas such as community centers, schools, churches, medical facilities, and government offices comprise about 5% of the total area and may present opportunities to initiate environmentally sensitive management of the property and to promote environmental awareness education. Other land uses including open urban land, agriculture, water, and transportion make up the remaining 13%. Agriculture lands, which comprise approximately 3% of the planning area, may contribute to nutrient loading into surface waters.

Table 2-9: Bear Creek/Old Road Bay Land Use/Land Cover Classification (%)

Land Use Type	Colgate Creek	Peach Orchard Cove	Bullneck Creek	Lynch Cove	Chink Creek	Bear Creek Headwaters	Charlesmont/Tobasco Coves	Oakleigh/Schoolhouse Coves	Country Club Cove/Humphrey Creek Remnant	Jones Creek	North Point Creek	Shallow Creek	Black Marsh	Sparrows Point	*Total % of SWAP AREA*
Low Density Residential	0.0	0.0	2.3	0.5	2.3	0.0	0.0	2.2	0.0	1.3	0.9	0.0	0.0	0.0	0.4
Medium Density Residential	25.9	8.0	12.0	15.2	28.3	24.5	17.1	36.8	12.3	33.7	46.4	13.0	8.9	0.0	16.6
High Density Residential	23.8	73.4	38.3	40.4	47.5	35.4	8.4	18.8	2.3	1.2	2.9	0.0	0.0	0.0	15.3
Commercial	3.4	3.6	1.6	9.4	1.9	20.6	27.9	30.2	0.9	4.3	0.3	0.0	0.5	0.0	4.7
Industrial	31.1	4.0	5.7	3.5	0.0	0.0	21.4	6.9	28.7	28.5	0.0	0.0	0.0	87.1	31.5
Institutional	6.3	2.3	18.5	18.1	16.4	6.7	4.8	0.4	0.2	0.8	2.6	13.1	0.0	0.0	5.1
Open Urban Land	2.7	7.0	19.7	11.6	1.0	11.6	1.6	1.3	35.4	11.2	0.0	0.0	0.0	0.9	6.8
Agriculture - Cropland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.3	26.2	7.4	0.0	3.0
Deciduous Forest	1.6	0.0	0.0	0.0	0.0	0.0	11.8	1.2	14.5	9.9	25.1	37.0	47.4	3.2	9.2
Mixed Forest	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.2
Brush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	7.9	0.0	1.7	0.5	0.0	0.9
Water	1.1	1.6	2.0	0.4	0.5	0.1	0.6	1.1	2.3	1.3	1.6	2.4	0.3	3.2	1.7
Wetland	0.4	0.0	0.0	1.0	2.1	0.0	0.0	0.0	0.7	0.0	0.0	6.7	32.4	4.1	3.2
Transportation	3.8	0.0	0.0	0.0	0.0	0.0	6.4	1.2	1.3	0.0	0.0	0.0	0.0	1.4	1.2

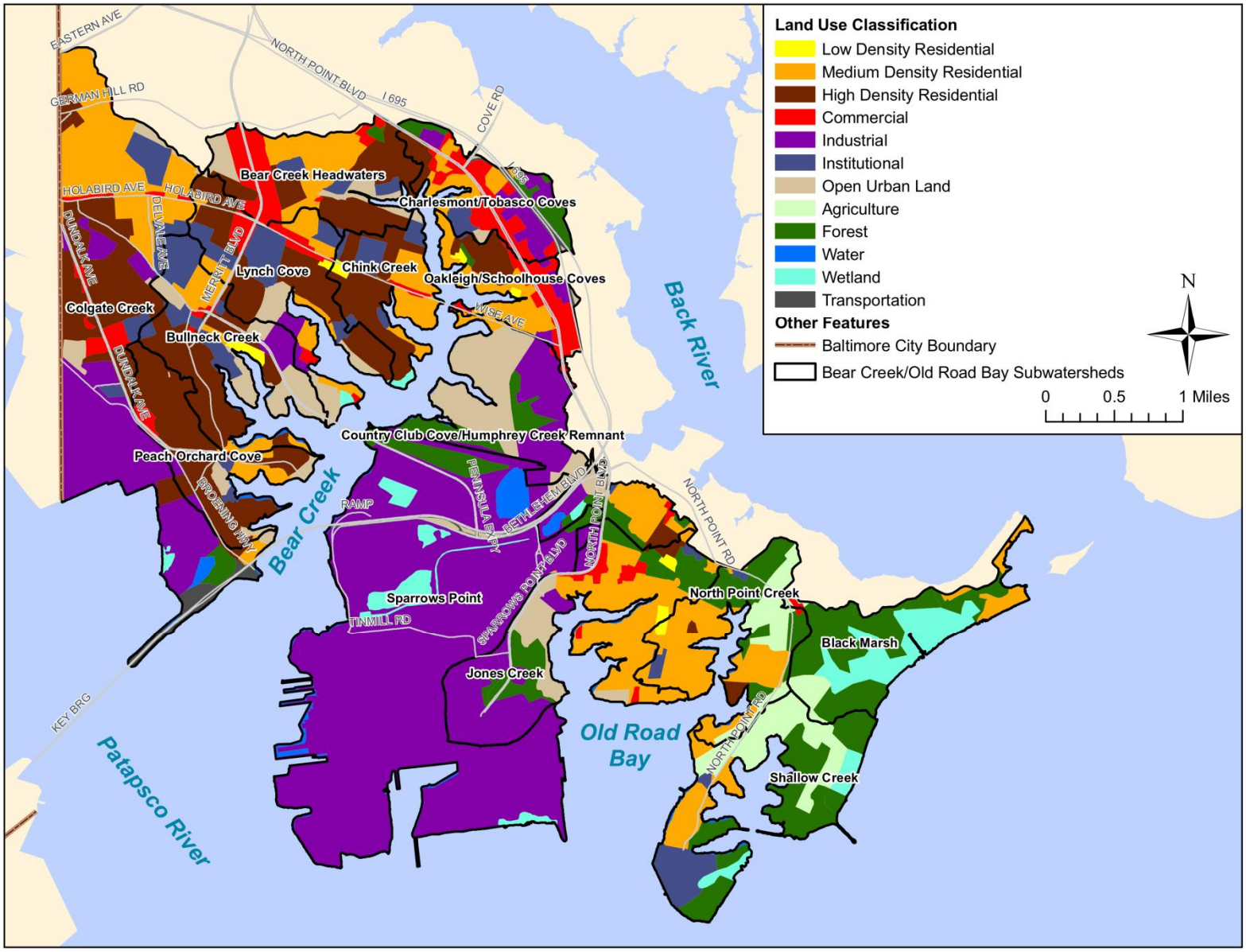

Figure 2-9: Bear Creek/Old Road Bay Land Use/Land Cover

2.3.2 Population

Population data provides another method of evaluating the intensity of land use. Areas of concentrated population normally represent more intense use of the land and potential for environmental degradation. Much of the degradation from these locations (likely found in urban and suburban areas) is related to the extent of impervious cover and depletion of land covers such as forests that help to protect water resources. Smart growth principles are aimed at directing future growth to areas of existing services and locations where development has already begun. This strategy will result in less conversion into residential and commercial land uses, and therefore promote conservation of land uses with less environmental impact such as forest and agriculture.

Population data presented in this section are based on 2010 Census blocks and population data from the U.S. Census Bureau. Table 2-10 summarizes population and population densities with respect to total area and total impervious area for each subwatershed. Figure 2-10 shows the distribution of population density throughout the Bear Creek/Old Road Bay planning area. Not surprisingly, population is generally most dense in areas occupied by medium to high density residential land uses. The subwatersheds with the highest population densities are Peach Orchard and Chink Creek. Lynch Cove and Bear Creek Headwaters subwatersheds also have relatively high population densities. The total population of the Bear Creek/Old Road Bay planning area is 56,495 with a population density of 4.9 people/acre. Excluding Sparrows Point which has no residential areas and a very low population (2 people), the population density of the remainder of the planning area is 6.5 people/acre.

Table 2-10: Bear Creek/Old Road Bay Population Data

Subwatershed	Total Population (2000 census)	Total Area (Acres)	Population Density (per acre)	Impervious Area (Acres)	Impervious Acres per person	Population Density (per impervious acre)
Colgate Creek	12,690	1,649.3	7.69	708.0	0.06	17.92
Peach Orchard Cove	6,186	450.2	13.74	163.6	0.03	37.81
Bullneck Creek	4,967	632.2	7.86	187.9	0.04	26.44
Lynch Cove	8,010	648.4	12.35	234.4	0.03	34.18
Chink Creek	5,794	364.8	15.88	128.7	0.02	45.01
Bear Creek Headwaters	7,589	592.0	12.82	221.0	0.03	34.34
Charlesmont/Tobasco Coves	1,511	417.4	3.62	185.1	0.12	8.16
Oakleigh/Schoolhouse Coves	3,246	328.8	9.87	132.8	0.04	24.45
Country Club Cove/Humphrey Creek Remnant	1,082	797.9	1.36	195.8	0.18	5.53
Jones Creek	2,591	922.9	2.81	245.7	0.09	10.54
North Point Creek	1,937	576.2	3.36	92.8	0.05	20.88
Shallow Creek	605	706.2	0.86	58.0	0.10	10.43
Black Marsh	285	569.2	0.50	25.2	0.09	11.30
Sparrows Point	2	2,757.9	0.00	756.5	478.20	0.00
Baltimore Harbor Total	***56,495***	***11,413.4***	***4.9***	***3335.5***	***0.06***	***16.9***

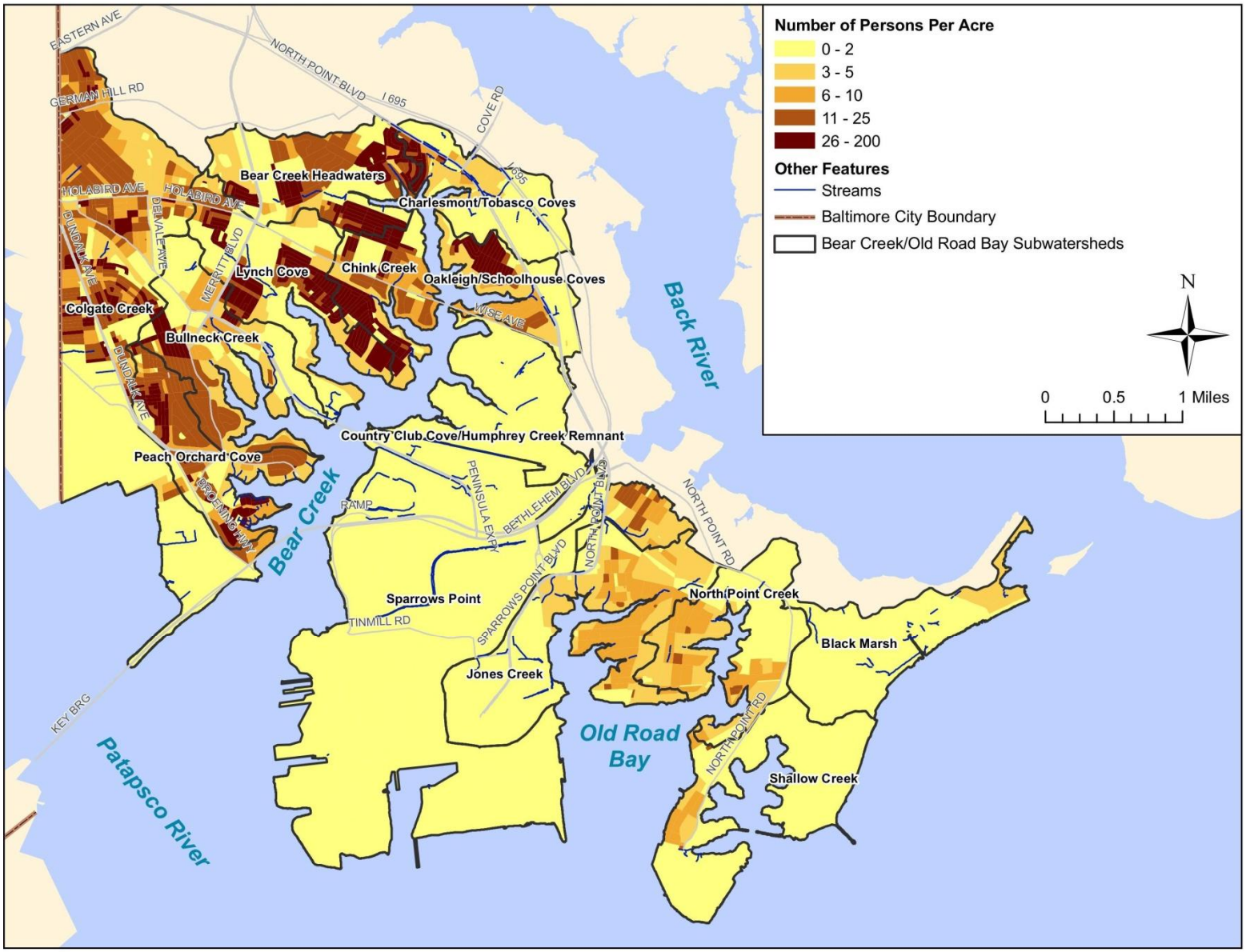

Figure 2-10: Bear Creek/Old Road Bay Population Distribution

2.3.3 Impervious Surfaces

Impervious surfaces such as roads, parking lots, roofs, and other paved areas prevent precipitation from naturally infiltrating into the ground. Stormwater runoff from these areas becomes overland flow and is typically concentrated, accelerated, and conveyed directly to the nearest stream. Consequently, the high energy flows of stormwater runoff from impervious surfaces can cause stream erosion and habitat destruction. This runoff is also likely to be more polluted than runoff 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 quantities 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 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 present. CWP's impervious cover model is shown in Figure 2-11.

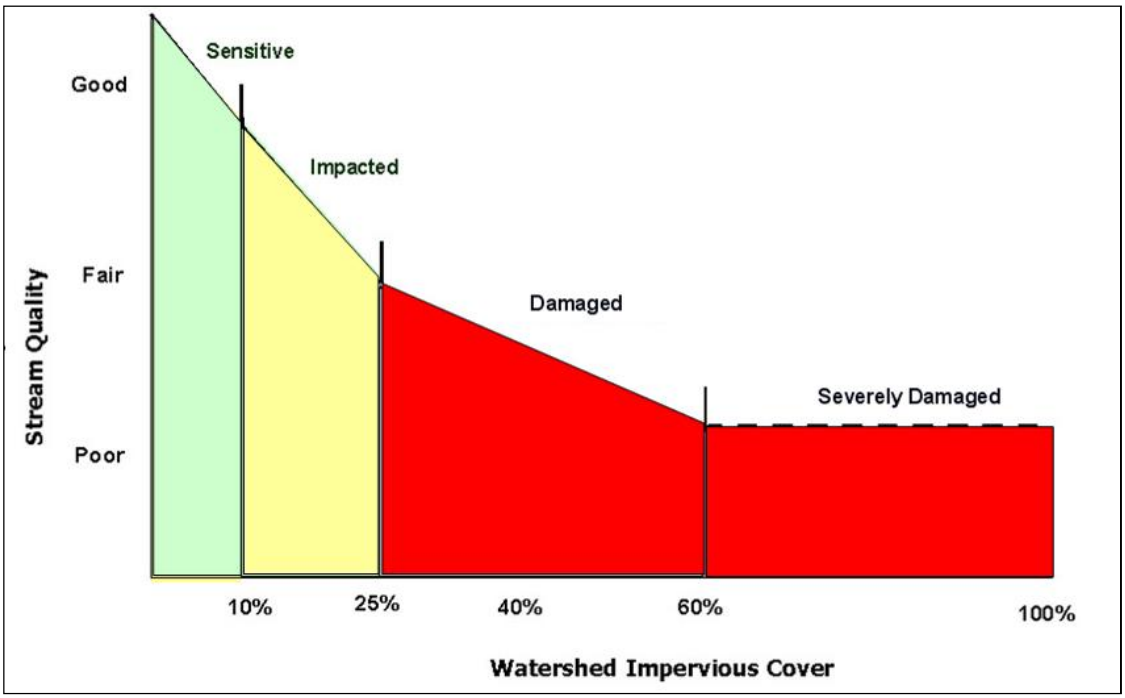

Figure 2-11: Impervious Cover Model (adapted from CWP 2003)

Based on the compiled research, CWP determined four classifications to predict stream quality based on watershed imperviousness: sensitive; impacted; damaged; or severely damaged. Watersheds with less than 10% 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. These watersheds are called

sensitive because they are susceptible to environmental degradation with increased urbanization and 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 and 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 2-11 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 may also contribute sediment and nutrient loads to receiving waters. Furthermore, the ability of BMPs to offset adverse impacts from urbanized areas is not specifically accounted for in the model.

Impervious cover data were obtained from 2008 roads and buildings spatial data provided by Baltimore County OIT. Impervious area quantities shown in Table 2-11 are the sum of road and building areas. The table also shows the percentage of impervious cover within each subwatershed. Figure 2-12 illustrates the location of impervious surfaces within the Bear Creek/Old Road Bay watershed. The total impervious area calculated is approximately 3,336 acres, 29% of the planning area. Subwatersheds with the highest percentages of impervious cover include Colgate Creek, Charlesmont/Tobasco Coves, and Oakleigh/Schoolhouse Coves.

Table 2-11: Bear Creek/Old Road Bay Impervious Area Estimates

Subwatershed	Total Area (Acres)	Roads (Acres)	Buildings (Acres)	Impervious Area (Acres)	% Impervious
Colgate Creek	1,649.3	524.85	183.12	707.97	42.9%
Peach Orchard Cove	450.2	95.55	68.07	163.62	36.3%
Bullneck Creek	632.2	117.75	70.13	187.88	29.7%
Lynch Cove	648.4	152.37	81.98	234.35	36.1%
Chink Creek	364.8	71.61	57.12	128.73	35.3%
Bear Creek Headwaters	592.0	137.97	83.06	221.03	37.3%
Charlesmont/Tobasco Coves	417.4	138.79	46.35	185.14	44.3%
Oakleigh/Schoolhouse Coves	328.8	92.49	40.28	132.77	40.4%
Country Club Cove/Humphrey Creek Remnant	797.9	130.88	64.89	195.77	24.5%
Jones Creek	922.9	171.06	74.67	245.74	26.6%
North Point Creek	576.2	56.78	35.98	92.76	16.1%
Shallow Creek	706.2	40.54	17.51	58.04	8.2%
Black Marsh	569.2	19.39	5.81	25.20	4.4%
Sparrows Point	2,757.9	469.06	287.47	756.53	27.4%
Total	***11,413.4***	***2,219.1***	***1,116.4***	***3,335.5***	***29.2%***

Figure 2-13 shows impervious cover ratings for the subwatersheds in the Bear Creek/Old Road Bay planning area based on the CWP model. Because of the extent of urbanization and impervious cover percentages, the majority of the planning area is considered damaged. "Impacted" subwatersheds include Country Club Cove/Humphrey Creek Remnant and North Point Creek. The Country Club Cove/Humphrey Creek Remnant subwatershed is comprised mostly of industrial and open urban land uses while North Point Creek has a relatively high residential component. "Damaged" subwatersheds have more residential, commercial, and industrial development, which is associated with more impervious cover density. The two subwatersheds classified as "sensitive," Shallow Creek and Black Marsh also have the highest composition of natural areas (forests and wetlands). There are no subwatersheds in the Bear Creek/Old Road Bay planning area classified as "severely damaged" under the CWP impervious cover model.

The Sparrows Point subwatershed has an impervious percentage of 27% which is considered "damaged" according to the CWP model. Analysis of the aerial maps in this subwatershed along with the nature of the industrial operations here indicates that the impervious percentage may not be indicative of the limited capacity for infiltration of rainfall. In GIS analysis, roads and buildings are used to determine the impervious surfaces within the study areas. Industrial areas may contain highly compacted areas along with material stockpiles that limit rainfall infiltration without being considered impervious surface.

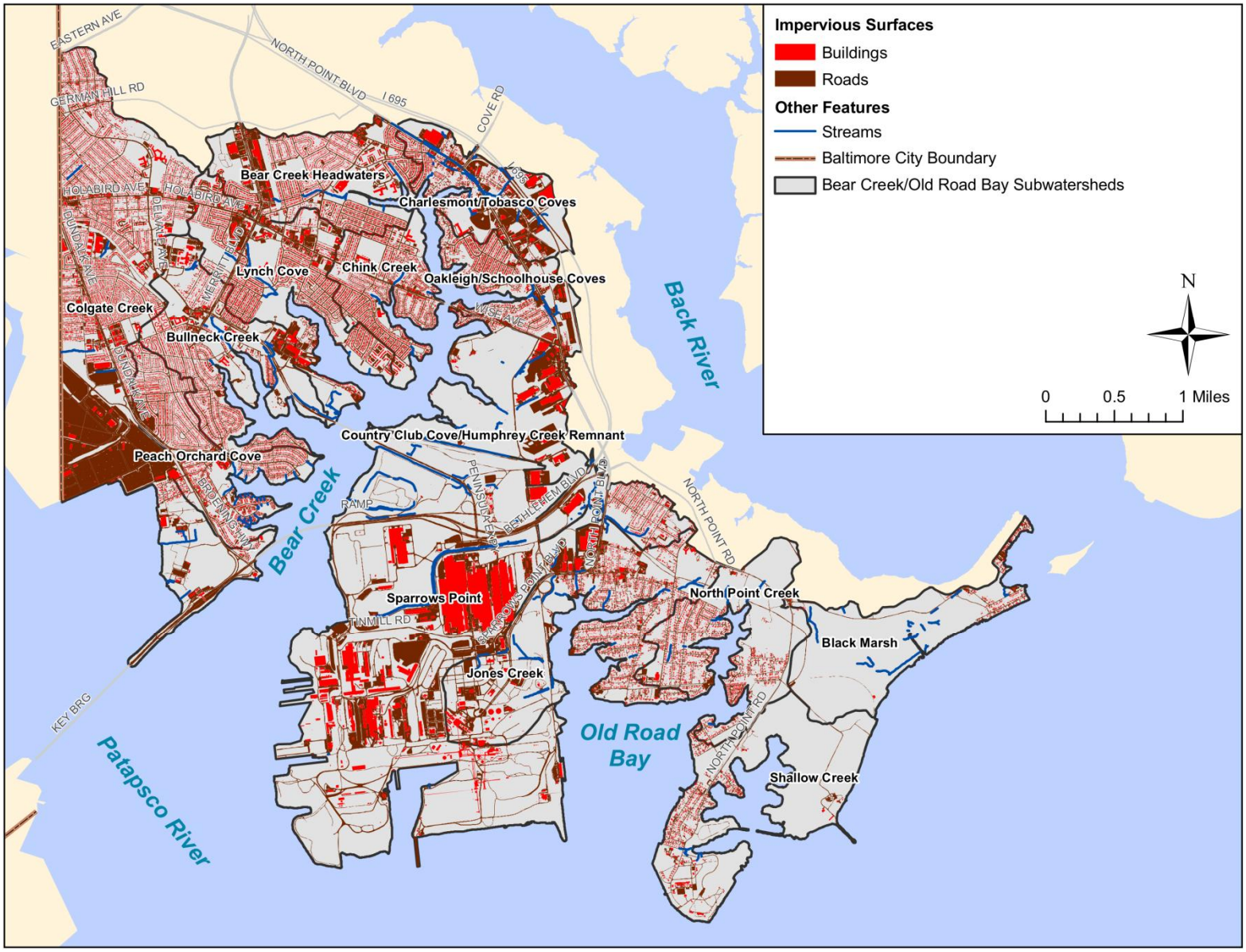

Figure 2-12: Bear Creek/Old Road Bay Impervious Surfaces

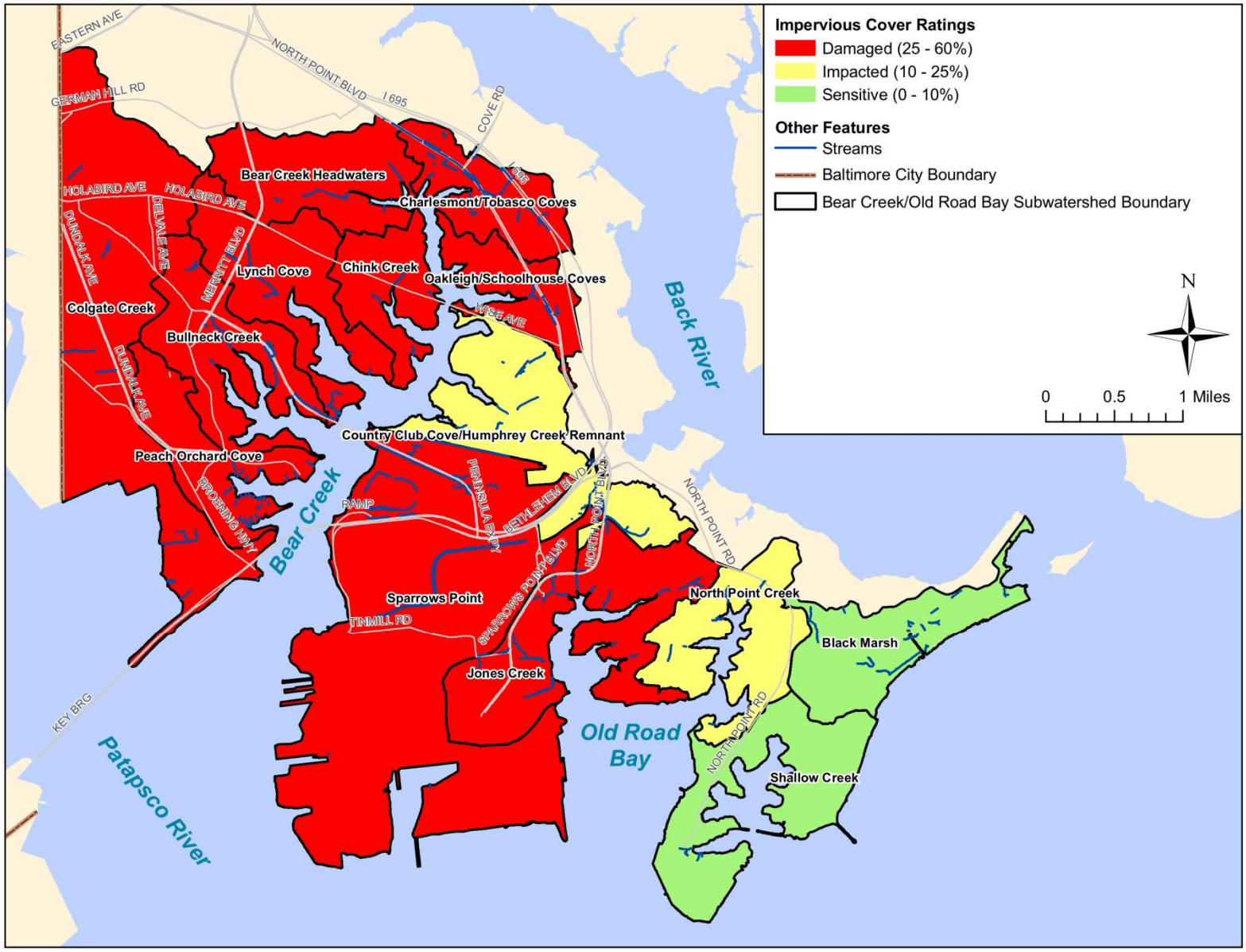

Figure 2-13: Bear Creek/Old Road Bay Impervious Cover Ratings

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 and a method for its conveyance is essential to the human population.

2.3.4.1 Public Water Supply

Environmental impacts associated with public supply of water include the potential for increased residential development with the associated effects of increased impervious cover as discussed in the previous section, as well as 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 the stream channels; this can bury aquatic benthic communities and degrade habitat.

2.3.5 Wastewater

Wastewater produced by human processes must be treated and disposed properly. This is accomplished either through public conveyance to a treatment facility or through individual wastewater treatment systems such as septic systems. Residential wastewater consists of all water typically used by residents including wash water, bathroom water, and any other rinse water such as paint brush, floor washing, etc. Industrial wastewater could contain various contaminants such as metals, organic compounds, detergents, or synthetic compounds depending on the operation. 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 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 buffers. Failing systems can release nitrogen, phosphorous, and other chemicals, and in turn, contaminate the aquatic environment. They can also result in increased bacterial contamination of nearby streams and therefore increased potential for human health concerns. Table 2-12 summarizes the approximate number of septic systems present in the Bear Creek/Old Road Bay planning area by subwatershed. Septic systems data are based on 2011 septic and public sewer spatial data from Baltimore County EPS. Based on this data, the Bullneck Creek subwatershed contains the most septic systems of all subwatersheds in the planning area, all but six of which are residential. Figure 2-14 shows the distribution of residential and non-residential septic systems in the Bear Creek/Old Road Bay watershed.

Table 2-12: Bear Creek/Old Road Bay Septic Systems by Subwatershed

Subwatershed	# of Septic Systems
Shallow Creek	8
Black Marsh	8
North Point Creek	29
Jones Creek	3
Peach Orchard Cove	3
Bullneck Creek	109
Chink Creek	4
Lynch Cove	0
Bear Creek Headwaters	0
Charlesmont/ Tobasco Coves	8
Sparrows Point	39
Country Club Cove/ Humphrey Creek Remanant	6
Colgate Creek	15
Oakleigh/Schoolhouse Coves	11
Total	***243***

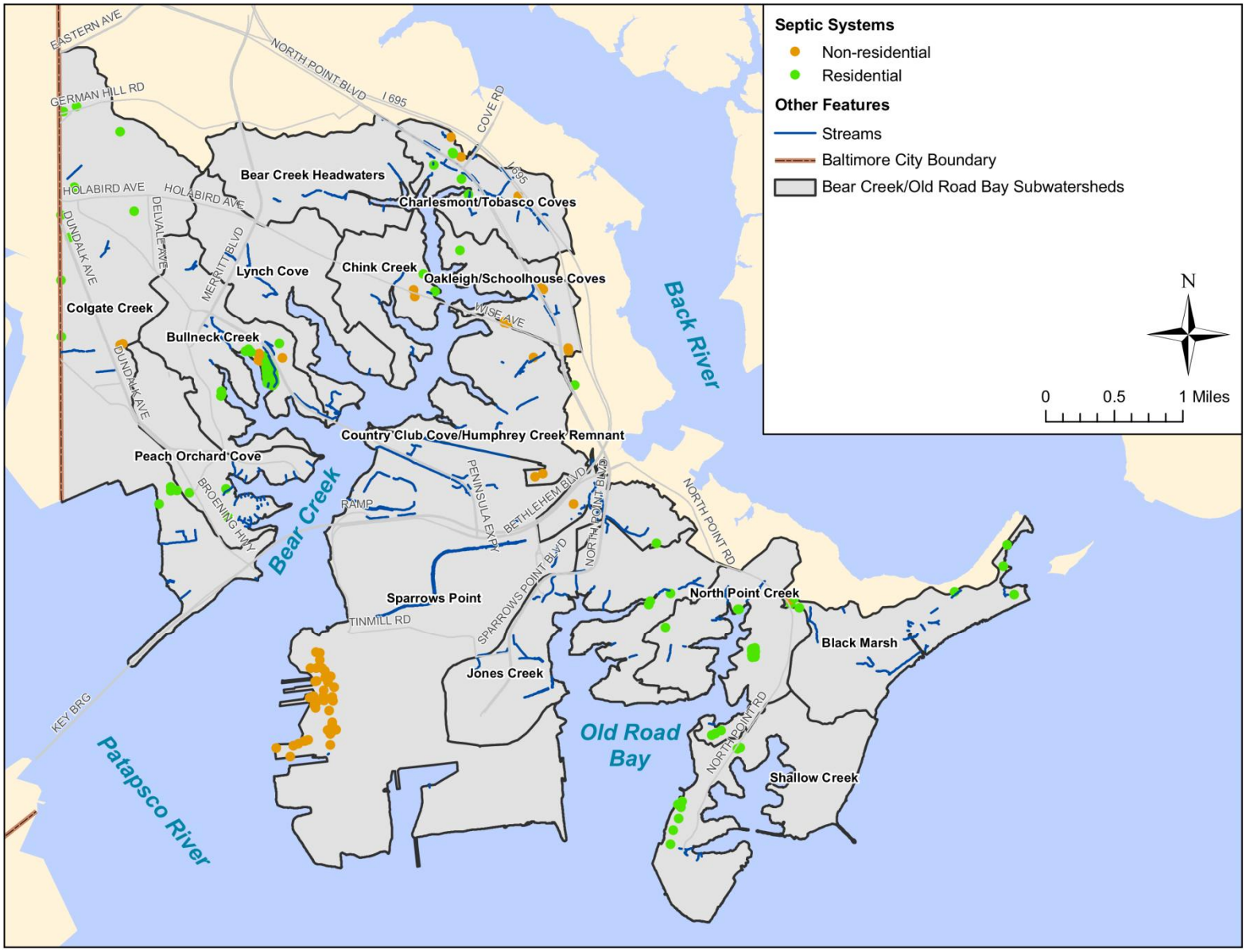

Figure 2-14: Location of Septic Systems in Bear Creek/Old Road Bay Watershed

2.3.5.2 Public Sewer

The public sewer system conveys wastewater from individual households or businesses 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 their individual cleanouts. The portion of the system within the public right-of-way is owned and maintained by the local government, including the gravity piping system, access manholes, pumping stations, and force mains. Table 2-13 below summarizes the lengths of public sewer piping in the Bear Creek/Old Road Bay planning area by type (gravity main or pressurized main) and by subwatershed. This data was compiled from gravity main, manhole, and force main spatial data provided by Baltimore County OIT. Table 2-14 summarizes public sewer piping density (length of sewer main per square mile of subwatershed area) for each subwatershed. Peach Orchard Cove subwatershed contains the most pressurized sanitary sewer mains while Colgate Creek has over twice as much gravity sewer piping than any other subwatershed; Peach Orchard Cove subwatershed also has the most sanitary sewer piping, gravity and pressurized combined, per subwatershed area.

Table 2-13: Public Sewer Piping Length in Bear Creek/Old Road Bay Watershed

Subwatershed	Pressurized Main (ft)	Gravity Main (ft)	Gravity Main Abandoned (ft)	Total (ft)
Colgate Creek	3,130	167,938	1,360	172,429
Peach Orchard Cove	12,492	80,615	30	93,137
Bullneck Creek	5,406	60,803	0	66,209
Lynch Cove	5,945	73,722	143	79,810
Chink Creek	9,845	53,614	0	63,458
Bear Creek Headwaters	11,370	70,207	540	82,117
Charlesmont/Tobasco Coves	5,003	36,520	62	41,585
Oakleigh/Schoolhouse Coves	5,224	42,348	234	47,806
Country Club Cove/Humphrey Creek Remnant	2,013	23,489	64	25,567
Jones Creek	10,464	64,670	2,354	77,488
North Point Creek	11,489	40,613	7,683	59,785
Shallow Creek	3,819	14,865	404	19,088
Black Marsh	7,681	8,615	0	16,296
Sparrows Point	796	23	0	819
Total	***94,677***	***738,042***	***12,875***	***845,594***

Table 2-14: Public Sewer Piping Density in Bear Creek/Old Road Bay Watershed

Subwatershed	Area (Sq Miles)	Pressurized Main (ft/sq mi)	Gravity Main (ft/sq mi)
Colgate Creek	2.58	1,215	65,170
Peach Orchard Cove	0.70	17,759	114,604
Bullneck Creek	0.99	5,473	61,556
Lynch Cove	1.01	5,868	72,764
Chink Creek	0.57	17,273	94,067
Bear Creek Headwaters	0.92	12,293	75,905
Charlesmont/Tobasco Coves	0.65	7,670	55,990
Oakleigh/Schoolhouse Coves	0.51	10,167	82,420
Country Club Cove/Humphrey Creek Remnant	1.25	1,615	18,841
Jones Creek	1.44	7,257	44,847
North Point Creek	0.90	12,761	45,107
Shallow Creek	1.10	3,461	13,472
Black Marsh	0.89	8,636	9,686
Sparrows Point	4.31	185	5
Total	*17.8*	*5,309*	*41,386*

Environmental impacts associated with public sewers are usually the result of sewage overflows. Sanitary sewer overflows (SSOs) typically result from blockages in the sewage system, pumping station failure, or rainwater inflows exceeding pipe capacity. Contamination can also occur during dry weather due to leaks in the sewer system. Water quality concerns related to sewer overflows and leaks include high bacteria concentrations, release of nutrients, increased turbidity (cloudiness), and low dissolved oxygen concentrations.

2.3.5.3 Wastewater Treatment Facilities

There are no public wastewater treatment facilities in the Bear Creek/Old Road Bay planning area. Wastewater from the Bear Creek/Old Road Bay watershed is conveyed to the Back River Wastewater Treatment Plant located in the Tidal Back River watershed. A private wastewater treatment facility is located at the Sparrows Point facility in the Sparrows Point subwatershed. This treatment plant has an NPDES permit and is used to treat process water from steel-making operations.

2.3.6 Stormwater

Stormwater is generated during and immediately after storm events. Precipitation that does not seep into the ground becomes stormwater runoff and flows directly to receiving water bodies. The quantity and characteristics of stormwater runoff is affected by rainfall amount and intensity, soil properties, land slope, and land use/land cover type. Concerns associated with stormwater include 1) volume and rate of runoff and 2) water pollution.

As previously discussed, larger volumes of stormwater runoff are generated from areas with impervious cover than from undeveloped land; impervious surfaces prevent infiltration of runoff into the ground, conveying it to the stream system more swiftly and in larger quantities. The increase in runoff rate and

volume can cause flooding and stream erosion, which results in 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 also contains various contaminants depending on land use characteristics and human activities that take place within a watershed. The contaminants that are carried by stormwater to the stream systems include pollutants deposited on impervious surfaces and other developed lands from daily human activity. Common pollutants found in impervious surface runoff (such as from highways and parking lots) are sediment, metals, bacteria, nutrients, and petroleum; pollutants such as these accumulate over time from sources such as road maintenance activities (de-icing and roadside fertilizer use), vehicles (exhaust and leaks), and accidents or spills and are washed off during storm events. While the runoff from other developed lands, for example agriculture and residential areas, 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 watershed impacts associated with each method differ significantly. The curb and gutter system drains stormwater more quickly from impervious surfaces and typically conveys water directly into the stream system. In doing so, however, it delivers increased runoff volumes and more untreated pollutants to receiving water bodies. Drainage swales typically convey stormwater at a slower rate than 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, thereby reducing the amount of water delivered to the streams and providing some filtering of pollutants.

Table 2-15 summarizes the curb and gutter system components in the Bear Creek/Old Road Bay planning area by subwatershed. The summary includes estimates of major outfalls (greater than 3 feet in diameter) and minor outfalls (less than 3 feet in diameter), along with corresponding number of inlets and pipe length draining to those outfalls. Storm drain system data used to compile this information were created by Baltimore County EPS based on storm drain plans and topographic data. This data provides a reasonable approximation of storm drain pipe lengths which were rounded to the nearest tens of feet. Table 2-16 provides a summary of the percentage of each subwatershed that is covered by the storm drain system, or in other words, the drainage areas of the storm drain system in a subwatershed divided by the total subwatershed area. It also shows the inlet density (number of inlets per square mile) of each subwatershed. Figure 2-15 shows the location of major and minor outfalls within the Bear Creek/Old Road Bay watershed.

Table 2-15: Stormwater System Components in Bear Creek/Old Road Bay Watershed

	MAJOR (> 3ft)			MINOR (< 3ft)			ALL OUTFALLS		
Subwatershed	Oufalls (#)	Inlets (#)	Pipe (ft)	Oufalls (#)	Inlets (#)	Pipe (ft)	Total Oufalls (#)	Total Inlets (#)	Total Piping (ft)
Colgate Creek	5	87	4,260	9	38	3,880	14	125	8,140
Peach Orchard Cove	2	19	2,230	2	2	245	4	21	2,475
Bullneck Creek	5	57	6,000	4	11	2,640	9	68	8,640
Lynch Cove	5	46	5,300	10	41	4,640	15	87	9,940
Chink Creek	2	21	1,355	8	19	2,460	10	40	3,815
Bear Creek Headwaters	7	76	7,910	5	25	3,000	12	101	10,910
Charlesmont/Tobasco Coves	1	5	700	4	11	890	5	16	1,590
Oakleigh/Schoolhouse Coves	3	17	4,000	5	21	2,840	8	38	6,840
Country Club Cove/Humphrey Creek Remnant	1	14	1,500	0	0	0	1	14	1,500
Jones Creek	3	13	1,650	1	4	840	4	17	2,490
North Point Creek	3	17	2,120	4	13	1,150	7	30	3,270
Shallow Creek	0	0	0	0	0	0	0	0	0
Black Marsh	0	0	0	0	0	0	0	0	0
Sparrows Point	0	0	0	0	0	0	0	0	0
Total	***37***	***372***	***37,030***	***52***	***185***	***22,590***	***89***	***557***	***59,610***

Table 2-16: Stormwater System Coverage in Bear Creek/Old Road Bay Watershed

Subwatershed	Subwatershed Area (Acres)	Stormwater System Drainage Area (Acres)	Area Covered by Stormwater System (%)	No. of Inlets (#)	Inlet Density (#/sq mi)
Colgate Creek	1,649	325	20%	125	48.5
Peach Orchard Cove	450	124	27%	21	29.9
Bullneck Creek	632	343	54%	68	68.8
Lynch Cove	648	278	43%	87	85.9
Chink Creek	365	162	45%	40	70.2
Bear Creek Headwaters	592	305	51%	101	109.2
Charlesmont/Tobasco Coves	417	297	71%	16	24.5
Oakleigh/Schoolhouse Coves	329	155	47%	38	74.0
Country Club Cove/Humphrey Creek Remnant	798	31	4%	14	11.2
Jones Creek	923	135	15%	17	11.8
North Point Creek	576	118	21%	30	33.3
Shallow Creek	706	0	0%	0	0.0
Black Marsh	569	0	0%	0	0.0
Sparrows Point	2,758	0	0%	0	0.0
Total	***11,413***	***2,273***	***20%***	***557***	***31.2***

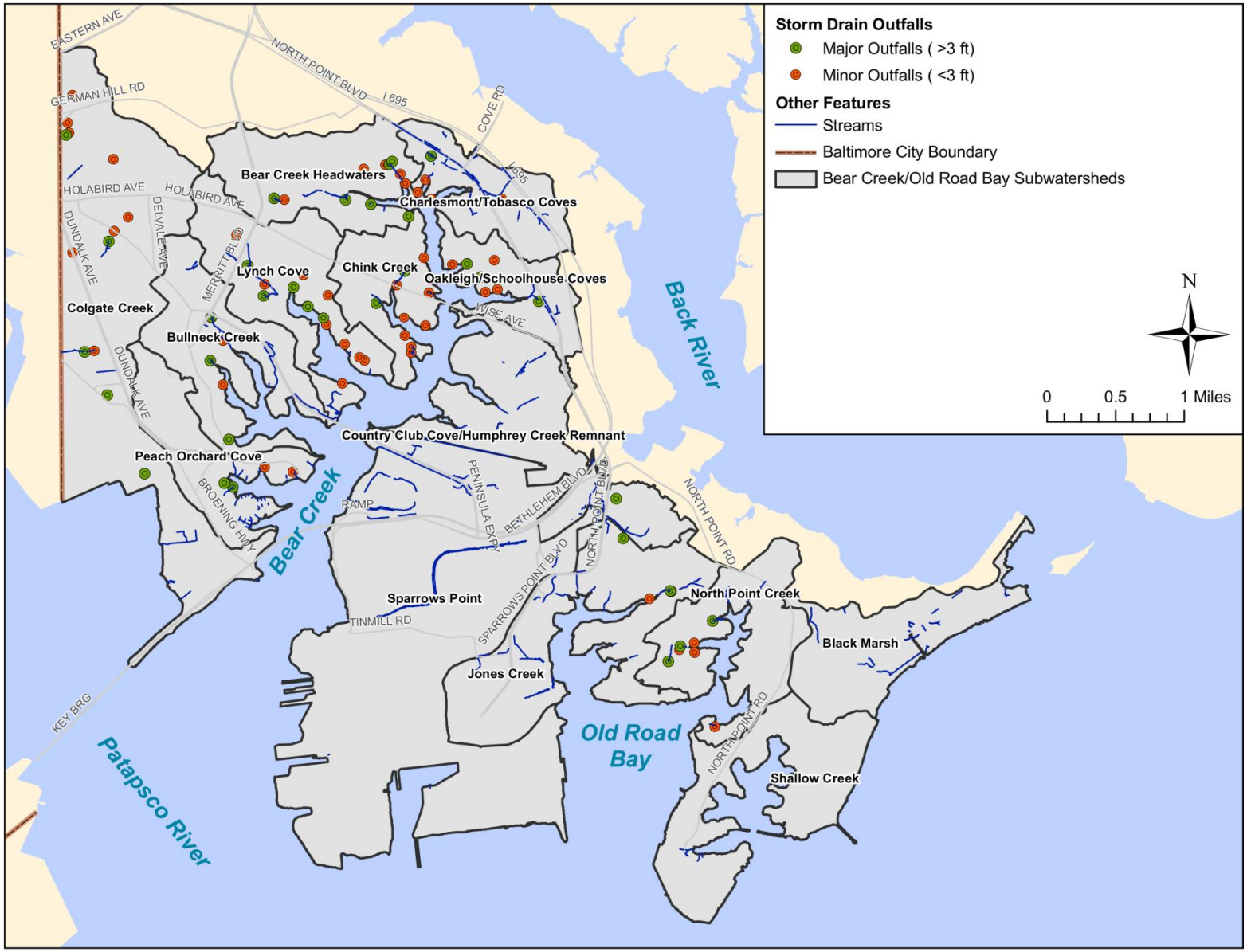

Figure 2-15: Bear Creek/Old Road Bay Storm Drain Outfalls

Subwatersheds with the highest number of total outfalls are Lynch Cove, Colgate Creek, and Bear Creek Headwaters. Charlesmont/Tobasco Coves, Bullneck Creek, and Bear Creek Headwaters have the largest percentages of storm drain coverage. Bear Creek Headwaters and Lynch Cove also have the highest inlet densities. Approximately 20% of the Bear Creek/Old Road Bay watershed is covered by the storm drainage system with an inlet density of approximately 31 inlets per square mile. Locations with higher inlet densities represent potential locations for management of pollution sources and community education measures such as storm drain marking.

2.3.6.2 Stormwater Management Facilities

The Maryland Department of the Environment (MDE) developed stormwater management (SWM) regulations over 25 years ago to control the quantity of runoff. SWM practices have evolved since then, and will continue to grow as new technology and research are developed. SWM is a significant consideration for new and redevelopment within the state. Per Title 4, Subtitle 3, of the Environment Article of Annotated Code of Maryland, management of stormwater runoff is required to reduce erosion, sedimentation, pollution, and flooding (MDE 2000). Increased importance of water quality and water resource protection has led to the development of the Maryland Stormwater Design Manual to provide Best Management Practice (BMP) design standards and environmental incentives (MDE 2000), and promoting a general shift toward low-impact SWM practices that mimic natural hydrologic processes 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 innovative design techniques.

There are many types of BMP options for managing stormwater runoff and providing stormwater quality treatment. SWM facilities 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 pond designs for SWM have low pollutant removal efficiency compared to practices that filter stormwater or allow it to infiltrate into the ground or through plant roots. Considerations such as space requirement, maintenance needs, cost, and community acceptance are taken into account when selecting the appropriate stormwater treatment measures.

Table 2-17 summarizes the number of various types of SWM facilities in the Bear Creek/Old Road Bay planning area including the sum of their drainage areas per subwatershed. The SWM facilities are categorized into detention ponds, wet ponds, wetlands, infiltration/filtration practices, extended detention, proprietary BMPs, grassed swales and channels, and others. Figure 2-16 shows the distribution of these SWM facilities within the planning area. Data for SWM facilities and their drainage areas were obtained from Baltimore County EPS.

Table 2-17: Stormwater Management Facilities in Bear Creek/Old Road Bay Watershed

SWM Facility Type	Colgate Creek	Peach Orchard Cove	Bullneck Creek	Lynch Cove	Chink Creek	Bear Creek Headwaters	Charlesmont/ Tobsaco Coves	Oakleigh/ Schoolhouse Coves	Country Club Cove/ Humphrey Creek Remnant	Jones Creek	North Point	Shallow Creek	Black Marsh	Sparrows Point	*Bear Creek/Old Road Bay Subtotals*
Dry Pond (#)	1	0	1	1	0	2	1	1	2	0	0	0	0	0	***9***
Drainage Area (acres)	78.9	0.0	42.5	7.3	0.0	68.1	12.4	1.4	16.0	0.0	0.0	0.0	0.0	0.0	***226.7***
Wet Pond (#)	0	0	0	0	0	0	0	2	1	1	1	0	0	0	***5***
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.5	4.7	6.3	89.6	0.0	0.0	0.0	***137.1***
Underground Detention (#)	3	0	0	0	0	1	2	0	0	0	0	0	0	0	***6***
Drainage Area (acres)	1.9	0.0	0.0	0.0	0.0	0.4	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	***7.7***
Wetland (#)	0	1	0	0	1	1	1	0	0	0	0	0	0	0	***4***
Drainage Area (acres)	0.0	3.4	0.0	0.0	90.8	0.0	165.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	***259.2***
Infiltration (#)	1	0	3	0	1	0	0	0	0	0	0	0	0	0	***5***
Drainage Area (acres)	0.4	0.0	7.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	***8.0***
Filtration (#)	0	0	0	0	0	1	0	1	0	0	0	0	0	1	***3***
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	17.0	***17.7***
Extended Detention (#)	1	0	0	0	0	1	1	1	5	1	0	0	0	0	***10***
Drainage Area (acres)	13.7	0.0	0.0	0.0	0.0	1.9	3.9	4.1	56.1	3.3	0.0	0.0	0.0	0.0	***82.9***
Proprietary BMP (#)	0	0	0	0	0	1	0	0	0	1	0	0	0	0	***2***
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	***2.4***
Grassed Swale/Channel (#)	0	0	0	0	0	0	0	2	0	0	0	0	0	0	***2***
Drainage Area (acres)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	***2.5***
Other (#)	2	0	0	0	0	0	0	1	1	2	0	0	0	0	***6***
Drainage Area (acres)	1.8	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.7	0.8	0.0	0.0	0.0	0.0	***5.3***
Total SWM Facilities (#)	***8***	***1***	***4***	***1***	***2***	***7***	***5***	***8***	***9***	***5***	***1***	***0***	***0***	***1***	***52***
Total Drainage Area Acres to SWM	***96.5***	***3.4***	***49.7***	***7.3***	***91.2***	***72.3***	***186.7***	***46.7***	***77.5***	***11.5***	***89.6***	***0.0***	***0.0***	***17.0***	***749.3***

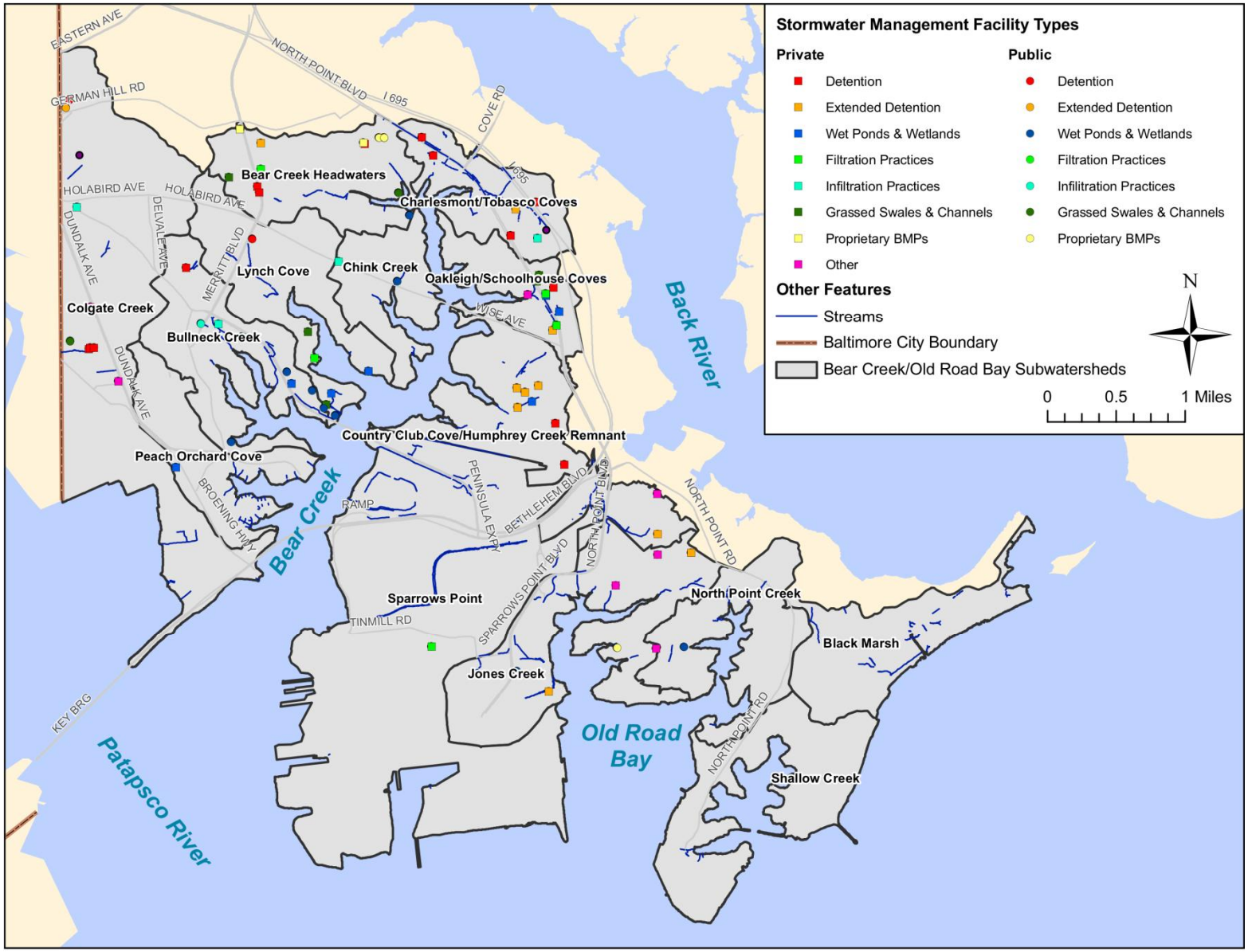

Figure 2-16: Distribution of Stormwater Management Facilities in Bear Creek/Old Road Bay Watershed

SWM facilities are present in most subwatersheds of the Bear Creek/Old Road Bay planning area with the exception of Shallow Creek and Black Marsh. The most common SWM facility type in both watersheds is the dry detention pond. Subwatersheds with the most SWM facilities tend to be those with more commercial and industrial activity. Detention pond facilities represent the best opportunity for conversion to BMPs with higher pollutant removal capabilities, such as extended detention ponds. Infiltrative practices include facilities like infiltration basins and trenches while filtrative practices include bioretention facilities, and surface and underground sand filters. The proprietary BMPs that are listed include oil & grit separators and Stormceptor devices which remove sediment, oil and grease; these are removed through a hydrodynamic separation process where they settle out as the stormwater flows in a circular path. Floatables and debris that are collected in the treatment chamber are typically removed by a vacuum truck at regular intervals. SWM facilities that are classified under "other" include stilling basins and porous pavement.

Table 2-18 shows the total drainage area and the percentage of urban land treated by SWM facilities in each subwatershed. Urban land in this case refers to low, medium and high density residential, commercial, industrial, institutional, open urban, and transportation land uses. This is important to evaluate because subwatersheds with high amounts of urban land but low SWM coverage percentages present opportunities to implement BMPs. BMPs can be implemented in existing developed areas with no current SWM practices or for retrofitting facilities that are not providing adequate stormwater treatment. Most of the development in the Bear Creek/Old Road Bay planning area occurred prior to the enforcement stormwater management requirements; therefore the amount of area treated by SWM facilities is lower than in other parts of Baltimore County. Approximately 82% of the planning area is classified as urban land, and 8% of this area is treated by SWM facilities compared to 27% of urban land treated in Baltimore County in total. Chapter 3 provides more details on assessed SWM facilities within the Bear Creek/Old Road Bay planning area.

Table 2-18: Area Treated by Stormwater Management Facilities in Bear Creek/Old Road Bay Watershed

Subwatershed	Area (Acres)	Urban Land Use (Acres)	Area Treated by SWM (Acres)	Urban Land Use Treated by SWM (%)
Colgate Creek	1,649	1,598	97	6%
Peach Orchard Cove	450	443	3	1%
Bullneck Creek	632	620	50	8%
Lynch Cove	648	639	7	1%
Chink Creek	365	355	91	26%
Bear Creek Headwaters	592	585	72	12%
Charlesmont/Tobasco Coves	417	365	187	51%
Oakleigh/Schoolhouse Coves	329	321	47	15%
Country Club Cove/Humphrey Creek Remnant	798	648	77	12%
Jones Creek	923	747	11	2%
North Point Creek	576	306	90	29%
Shallow Creek	706	184	0	0%
Black Marsh	569	54	0	0%
Sparrows Point	2,758	2,466	17	1%
Direct Harbor Total	***11,413***	***9,332***	***749***	***8%***

2.3.7 NPDES Discharge Permits

Businesses and other 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 type of NPDES permit required depends on the nature of the activities conducted by the facility. Table 2-19 summarizes the number of facilities holding NPDES permits in the Bear Creek/Old Road Bay watershed, by subwatershed and permit type. While some facilities hold multiple permits, only one per facility is reflected in the table.

Table 2-19: NPDES-Permitted Facilities in Bear Creek/Old Road Bay Watershed

Subwatershed	# General Industrial Stormwater Permits	# Surface Industrial Discharge Permits	# Groundwater Municipal Discharge Permits	# General Permits	Total # of Permits in Subwatershed
Colgate Creek	2	1			3
Peach Orchard Cove	1				1
Bullneck Creek	2			1	3
Lynch Cove	2			1	3
Chink Creek					0
Bear Creek Headwaters				1	1
Charlesmont/Tobasco Coves	3				3
Oakleigh/Schoolhouse Coves	2				2
Country Club Cove/Humphrey Creek Remnant	3		1	1	5
Jones Creek	3	1		1	5
North Point Creek				1	1
Shallow Creek					0
Black Marsh					0
Sparrows Point	2	1			3
Total	***20***	***3***	***1***	***6***	***30***

The federal NPDES permits listed above also function as MDE water management permits. Descriptions of each type of NPDES permit are provided as follows by MDE:

- **General Industrial Stormwater Permits** are required for industrial facilities discharging stormwater to storm drains or surface waters.
- **Surface Industrial Discharge Permits** are required for any industrial facility or landfill discharging wastewater to any place other than a sanitary sewer.
- **Groundwater Municipal Discharge Permits** are required for facilities discharging wastewater to any place other than a sanitary sewer, or for facilities operating a sewage or water treatment plant.
- **General Permits** are required for facilities discharging wastewater or stormwater to any place other than a sanitary sewer, or for any manufacturing, fleet vehicle, or recycling facility.

NPDES permit data for the Bear Creek/Old Road Bay watershed was estimated from spatial data provided by Baltimore County EPS, based on 2008 MDE records; this data was cross-referenced with more recent data obtained from MDE in 2011. As of 2008, there are a total of 30 facilities holding NPDES permits in the Bear Creek/Old Road Bay planning area. Most of these facilities hold General Industrial Stormwater or General Permits. General Industrial Stormwater permits have been issued to a variety of industrial facilities including chemical and machine manufacturers, automobile recycling centers, and

transportation facilities. Of the six (6) General Permit holders in Bear Creek/Old Road Bay, three (3) are marinas. The other General Permit holders include an apartment complex, a golf course, and the Community College of Baltimore County's Dundalk campus. Surface Industrial Discharge Permits are held by Constellation Power for the Riverside Generating Station and RG Steel for the Sparrows Point facility. Sparrows Point Country Club holds the only Groundwater Municipal Discharge Permit for spray irrigation of treated wastewater from the Back River Wastewater Treatment Plant on the golf course. Sparrows Point Shipyards holds the only Surface Industrial Discharge permit in the watershed discharging process water to state surface waters; the discharge must meet applicable federal effluent guidelines and/or state water quality standards. Subwatersheds with the most NPDES permitted facilities include Country Club Cove/Humphrey Creek Remnant and Jones Creek. Subwatersheds with the most General Industrial Stormwater permits include Bullneck Creek, Charlesmont/Tobasco Coves, Country Club Cove/Humphrey Creek Remnant, Jones Creek, Lynch Cove, Oakleigh/Schoolhouse Coves, and Sparrows Point. Figure 2-17 shows the locations of NPDES-permitted facilities in the Bear Creek/Old Road Bay watershed.

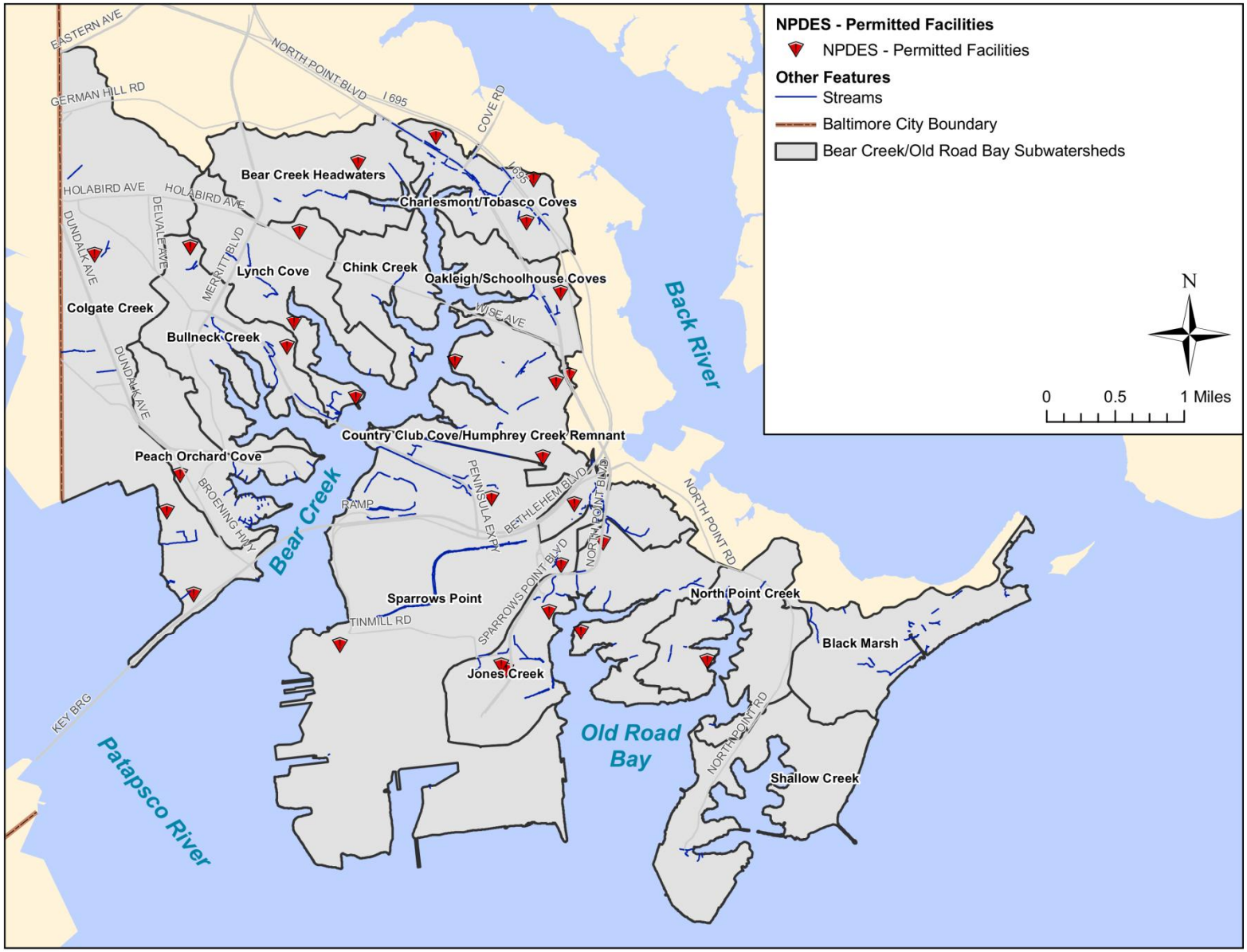

Figure 2-17: Location of NPDES-Permitted Facilities in Bear Creek/Old Road Bay Watershed

2.3.8 Zoning

According to the Baltimore County Office of Planning (2009), 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. Table 2-20 shows the various zoning categories present in the Bear Creek/Old Road Bay watershed broken down by subwatershed.

As shown in Figure 2-18, significant portions of the Colgate Creek, Charlesmont/Tobasco Coves, Oakleigh/Schoolhouse Coves, Country Club Cove/Humphrey Creek Remnant, Jones Creek, and Sparrows Point subwatersheds permit industrial development. Residential and commercial areas are located in the same subwatersheds because they are considered compatible land uses as population is typically concentrated in these areas. The largest remaining zoning categories in the Bear Creek/Old Road Bay planning area include rural residential and resource conservation critical area. These areas cover the majority of the Black Marsh and Shallow Creek subwatersheds and may represent potential for forest preservation or restoration.

Table 2-20: Baltimore County Zoning in Bear Creek/Old Road Bay Watershed

Zoning Code	Zoning Description	Colgate Creek	Peach Orchard Cove	Bullneck Creek	Lynch Cove	Chink Creek	Bear Creek Headwaters	Charlesmont/Tobsaco	Oakleigh/Schoolhouse Coves	Country Club Cove/ Humphrey Creek Remnant	Jones Creek	North Point	Shallow Creek	Black Marsh	Sparrows Point	*Baltimore Harbor Subtotals*	*% of Watershed Area*
DR 1	Density Residential - 1 unit/acre	56	-	7	-	-	-	-	-	-	-	-	-	-	-	***63***	***0.5%***
DR 3.5	Density Residential - 3.5 units/acre	-	-	45	11	21	-	4	-	-	-	12	-	-	-	***93***	***0.8%***
DR 5.5	Density Residential - 5.5 units/acre	718	235	319	120	159	226	81	139	158	358	298	194	57	-	***3,062***	***26.8%***
DR 10.5	Density Residential - 10.5 units/acre	133	59	47	291	142	155	47	61	-	-	-	-	-	-	***936***	***8.2%***
DR 16	Density Residential - 16 units/acre	47	76	25	41	22	45	1	-	-	-	-	-	-	-	***257***	***2.3%***
Commercial	Office/Business	83	31	44	65	11	140	71	75	28	64	6	3	13	-	***634***	***5.6%***
Industrial	Manufacturing	608	21	57	75	-	-	213	54	416	441	-	-	-	2,758	***4,642***	***40.7%***
RC 2	Agricultural	-	-	-	-	-	-	-	-	-	-	4	-	11	-	***16***	***0.1%***
RC 5	Rural Residential	-	-	-	-	-	-	-	-	-	61	81	40	2	-	***185***	***1.6%***
RC 20, 50	Resource Conservation Critical Area	5	27	87	44	10	26	-	-	195	-	174	469	486	-	***1,524***	***13.4%***
Total		***1,649***	***450***	***632***	***648***	***365***	***592***	***417***	***329***	***798***	***923***	***576***	***706***	***569***	***2,758***	***11,413***	***100%***

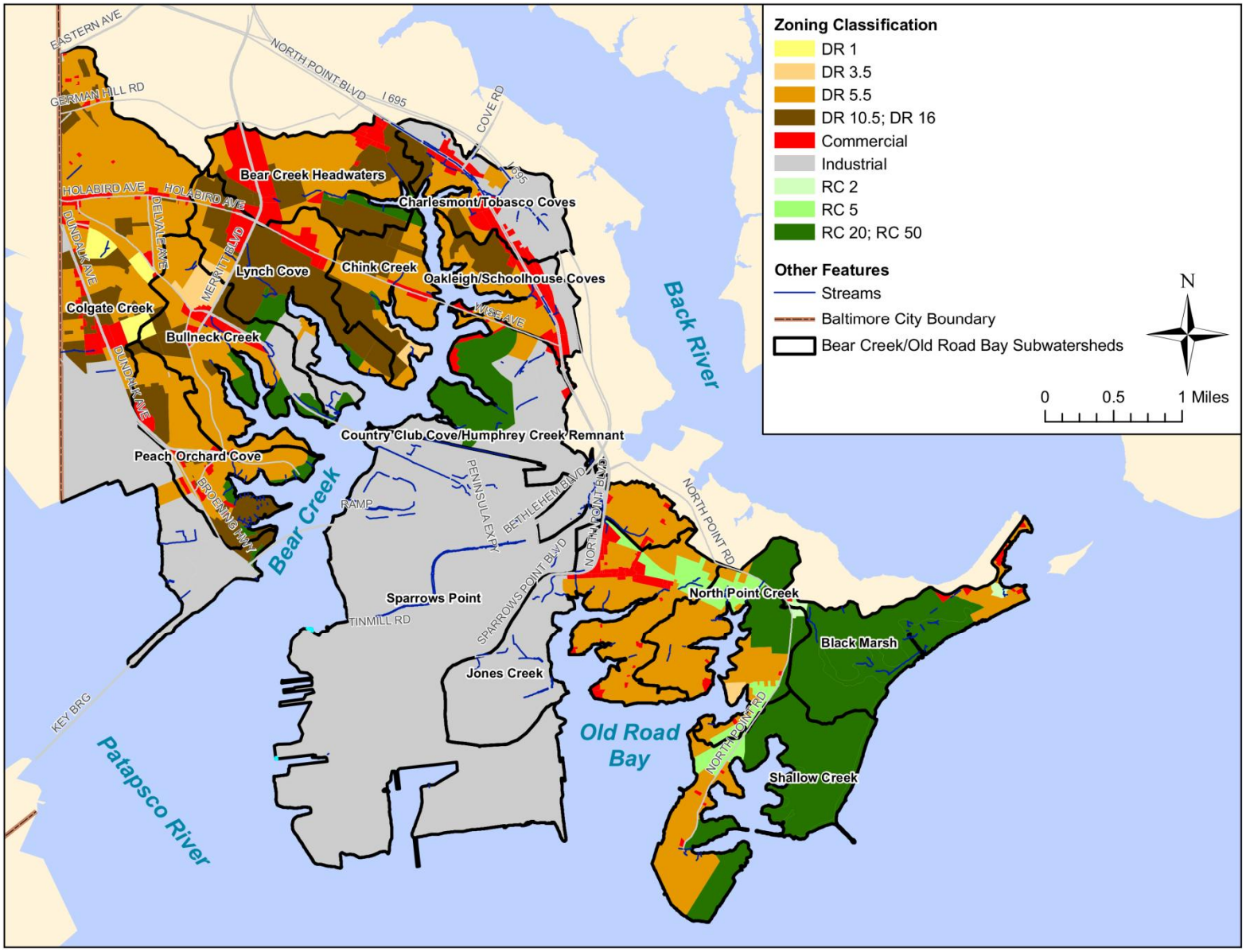

Figure 2-18: Bear Creek/Old Road Bay Zoning

As presented in Table 2-20, approximately 39% of the Bear Creek/Old Road Bay watershed is zoned for residential land use, the most common being categories DR 5.5 and DR 10.5 which generally correspond to the MDP-classified medium density and high residential land use categories, respectively. Industrial use is permitted in approximately 41% of the Bear Creek/Old Road Bay watershed, which is a considerable fraction. Agricultural, rural residential, and resource conservation critical area zoning categories make up 15% of the study area.

2.3.9 Environmental Justice

Environmental Justice (EJ) is defined as the equal distribution of environmental benefits and harms regardless of race, income, or socioeconomic status. Addressing EJ concerns acts to minimize the disproportionate burden of environmental concerns that are placed on disadvantaged and vulnerable segments of the population. A white paper and memo of findings on water quality issues and EJ indicators was produced for Baltimore County in 2010 by Biohabitats. Informed by that research, a GIS mapping model was developed to identify priority at-risk environmental justice communities in the County. After collecting available GIS data layers, relevant indicators were grouped into social and demographic indicators, major human health indicators, major watershed health indicators, and minor watershed health indicators (Mapping Environmental Justice, 2011).

Figure 2-19 displays the weighting of the twelve indicators used to quantify EJ concerns. Social and demographic layers (in red) have the highest weighting factors for a combined total of 50%. Major human health indicator layers (in orange) including bacteria and toxics TMDL and 303d stream impairments have the second highest weighting factors at a combined total of 28% due to their direct impact on public health, another key component in EJ. Major watershed health layers (in blue) including SSOs, impervious cover, storm drain outfalls, and hot spots are ranked in the third level of indicators as a total of 20% of the composite. Tree canopy (in purple) is weighted as a minor watershed health indicator at 2% of the total composite (Mapping Environmental Justice, 2011). These indicators were analyzed using subwatersheds and census block groups to divide the County into smaller blocks.

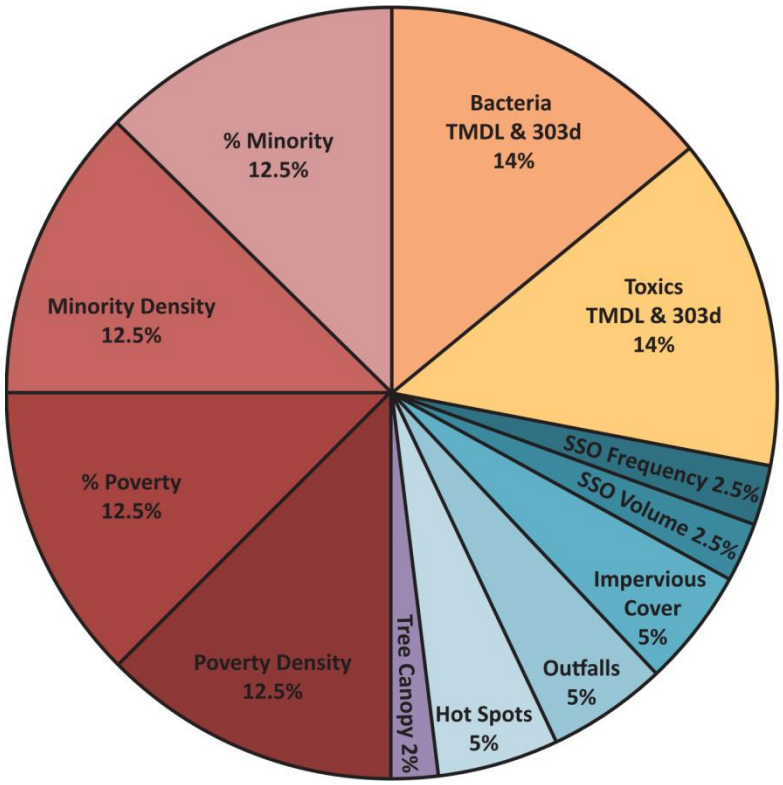

Figure 2-19: Weighting of Environmental Justice Indicator Categories

After the analysis, a composite score was developed for each census block group based on the indicators in Figure 2-19 and graded as high, medium, or low in regards to potential EJ concerns. Five (5) distinct areas in the County were shown to indicate high potential EJ concerns. The top ranked EJ area in the County lies mostly within the Peach Orchard Cove subwatershed while overlapping small portions of Bullneck Creek and Colgate Creek as seen in Figure 2-20. This area encompasses seven (7) neighborhoods (NSA_D_01, NSA_D_02, NSA_D_03, NSA_D_04, NSA_D_06, NSA_D_07, and NSA_D_08), two (2) institutions (ISI_D_0104 and ISI_D_0201) and two (2) pervious areas (PAA_D_0201 and PAA_D_0202) assessed in the Uplands Assessment. These assessment sites constitute locales where restoration activities would be a higher priority due to their presence in an EJ concern area. More information on the neighborhoods, institutions, and pervious areas located in this area can be found in Chapter 4 and Appendix B of this report.

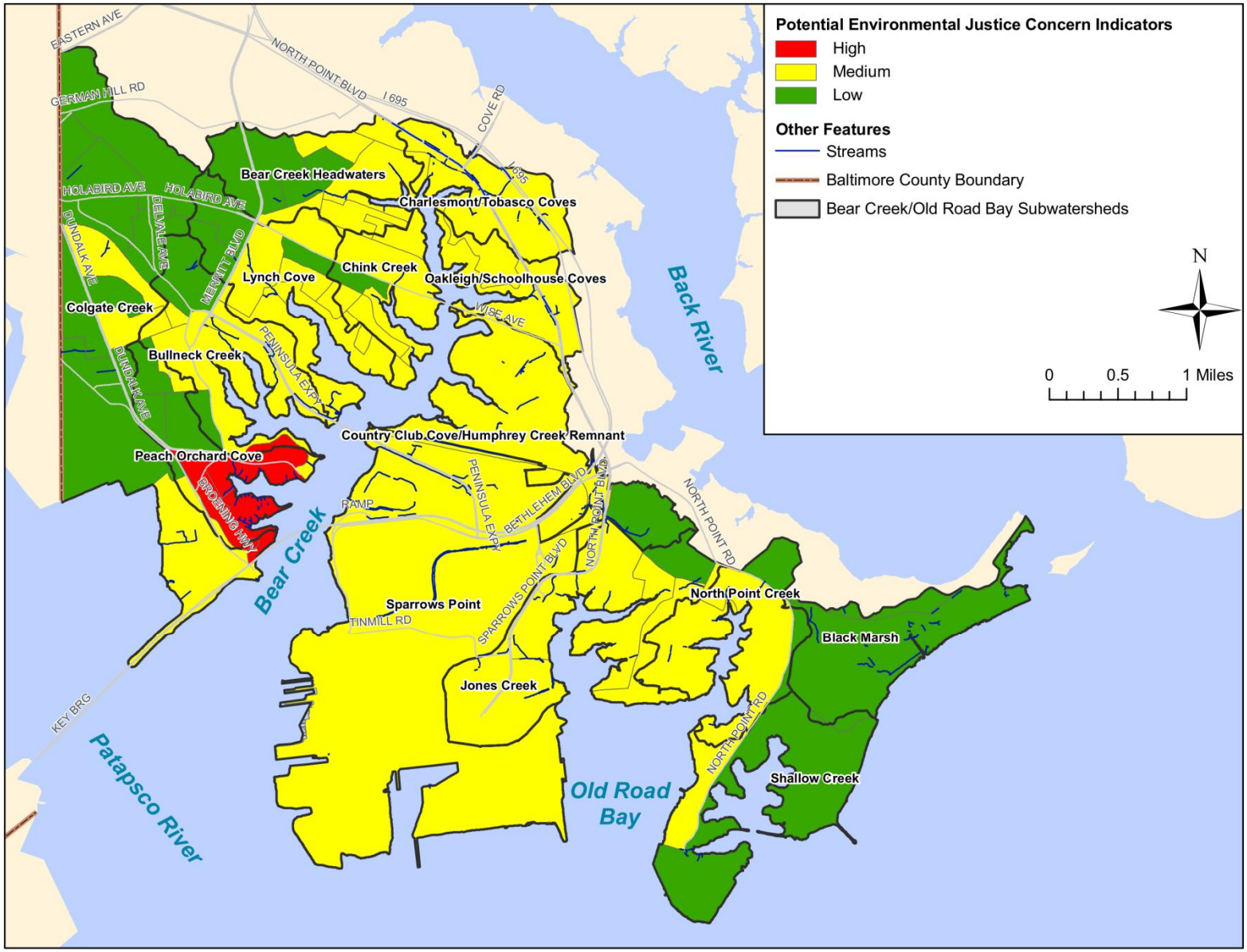

Figure 2-20: Potential Environmental Justice Concern Indicators in Bear Creek/Old Road Bay

2.3.10 Historical Influences

The Bear Creek/Old Road Bay watershed has been the location for important historical events that influence the area to this day. Specifically, in 1814, the area was the setting for an important battle between British forces and American militia in the Battle of North Point. The state of Maryland commemorates the skirmish yearly through the celebration of Defender's Day. In addition, plans have been developed to celebrate the culture and history of the area through the inclusion of the area on the Star-Spangled Banner Trail network which will go through key environmental features in the watershed. These types of activities provide an opportunity for the recognition of the importance of historical influence on the culture of the area and its waterfront location as well as connecting local residents with the waterfront areas.

CHAPTER 3: WATER QUALITY AND LIVING RESOURCES

3.1 Introduction

Water is an integral part of the habitat of all species. The SWAP goals for maintaining and improving water quality also aim to provide for plants, animals, and their habitat. Because habitat conditions affect the ability of natural communities to find food and shelter and carry on natural processes, it is necessary to evaluate the state of existing land, water, and biological elements that provide for their needs. This chapter describes the water quality, living resources, and habitat for the Bear Creek/Old Road Bay watershed based on existing conditions.

Living resources including all animals and plants require water to survive; they and their habitats are intimately connected to and respond sensitively to water quality and habitat conditions. Their dependence on water quality provides a gauge with which to measure and evaluate the status of water bodies and the effects that watershed characteristics and activities have on these water bodies. For example, 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 Bear Creek/Old Road Bay 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 Bear Creek/Old Road Bay watershed: impairments per Maryland state water quality standards, pollutant loading analysis for total nitrogen and total phosphorus, water quality monitoring data available to date, sewer overflow occurrences and impacts, and stormwater management facility assessments.

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

The Clean Water Act (CWA) requires states, territories and authorized tribes to: develop water quality standards for all jurisdictional surface waters; monitor these surface waters; and identify and list impaired waters. More specifically, Section 305(b) of the CWA requires annual water quality assessments to determine the status of jurisdictional waters. Section 303(d) requires states to identify and periodically update a list of impaired waters that fail to meet applicable state water quality standards. States must also establish priority rankings and develop Total Maximum Daily Loads (TMDLs) for waters on the 303(d) list, which generally target pollutants including sediment, metals, bacteria, nutrients, and pesticides. 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.

Water quality standards are developed from a combination of the designated use for a given water body and the water quality criteria designed to protect that use. Surface waters (e.g., streams) within the Bear Creek/Old Road Bay watershed are designated as Use I – water contact recreation, fishing, and protection of aquatic life and wildlife. The receiving tidal water segment of this watershed, Patapsco River Mesohaline (MD-PATMH), is designated as Use II – support of estuarine and marine aquatic life and shell fish harvesting including Subcategories 1, 2, 3, 4, and 5 described as follows (Baltimore County, 2010):

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.
2. Shallow Water – Submerged Aquatic Vegetation - Underwater bay grasses and the many fish and crab species that depend on this shallow-water habitat.
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.
4. Deep-Water Fish and Shellfish - The many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.
5. Deep-Channel Seasonal Refuge - Bottom sediment-dwelling worms and small clams which provide food for bottom-feeding fish and crabs in the very deep channel in summer.

Based on the water quality criteria associated with the above designated uses, the Bear Creek/Old Road Bay watershed and receiving tidal waters are listed as impaired in the Maryland 303(d) list of impaired waters for various pollutants of concern. Each impairment is applicable to one or more of the multiple water quality segments comprising the watershed, including basin 02130903 (refers to the land and streams in the Bear Creek/Old Road Bay watershed), segment MD-PATMH (refers to the tidal receiving water body), and the tidal subsegments draining to MD-PATMH.

The water quality segments in Bear Creek/Old Road Bay that are applicable to the current SWAP area are listed for the following impairments: nutrients (1996 listing), chlordane (1996 listing), polychlorinated biphenyls (PCBs, 1998 listing), zinc (1998 listing), chromium (1998 listing), and impacts to biological communities (2002 and 2004 listings) and submerged aquatic vegetation (1996 listing). Impairment listings reflect the inability to meet water quality standards. When a water quality segment is listed as impaired, action can be taken by developing and/or adhering to a TMDL or by submitting a Water Quality Analysis (WQA) to remove a specific pollutant from the impairment listing. TMDLs can be developed for a single pollutant or group of pollutants of concern. Impairment in the tidal receiving waters is related to pollutants coming from the entire watershed; therefore, TMDLs developed for the tidal segment MD-PATMH and its subsegments will require watershed pollutant load reductions. 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. Maryland's 2010 Integrated Report (IR) of Surface Water Quality represents a fully combined 303(d) and 305(b) report approved by USEPA (MDE 2010). Table 3-1 summarizes the status of the current impairment listings for portions of the Bear Creek/Old Road Bay watershed that are applicable to the current SWAP area.

Table 3-1: Bear Creek/Old Road Bay Water Quality Impairment Listings and Status Applicable to SWAP Area

Impairment	Applicable Segment	Status	Approval Date
Nitrogen	Tidal Segment MD-PATMH	TMDL Complete	December 2010
Phosphorus	Tidal Segment MD-PATMH	TMDL Complete	December 2010
Sediment	Tidal Segment MD-PATMH	TMDL Complete	December 2010
Chlordane	02130903	TMDL Complete	March 2001
PCBs - Fishing	02130903	TMDL Pending	
PCBs - Aquatic Life	Tidal Subsegment of MD-PATMH: Bear Creek	TMDL Pending	
Zinc	Tidal Subsegment of MD-PATMH: Middle Harbor	TMDL Pending	
Zinc*	Tidal Subsegments of MD-PATMH: Northwest Branch and Bear Creek	WQA	January 2005
Lead*	Tidal Subsegments of MD-PATMH: Northwest Branch and Bear Creek	WQA	January 2005
Chromium*	Tidal Subsegments of MD-PATMH: Northwest Branch and Bear Creek	WQA	January 2005
Fish and Benthic Community	02130903	Impaired	
Benthic Community	Tidal Segment MD-PATMH	Impaired	
Submerged Aquatic Vegetation	Tidal Segment MD-PATMH	Impaired	

*Delisted as an impairment with EPA concurrence on January 18, 2005

As shown in Table 3-1, the Bear Creek/Old Road Bay watershed has ten impairment listings applicable to the current SWAP area. Two TMDLs and two WQAs have been completed. TMDLs have been developed for nutrients (nitrogen and phosphorus), sediment and chlordane. The Chesapeake Bay TMDL addresses both nutrients and sediment. TMDLs will be developed in the future for PCBs, which will address two of the listings; it should be noted that the listings for PCBs in the Bear Creek/Old Road Bay are based on sediment data and not fish tissue. WQAs have been approved for chromium and zinc for the Northwest Branch and Bear Creek subsegments of the Patapsco River; however, no WQAs have been developed for zinc in the Middle Harbor subsegment (applicable to the Colgate Creek subwatershed) and a TMDL will need to be developed for this listing. The WQAs for zinc, lead, and chromium in the Northwest Branch and Bear Creek concluded that pollutant levels did not exceed water quality standards in these tidal waters, and that TMDLs are not currently necessary because the source of sediment toxicity cannot be attributed to these pollutants (MDE, 2004). However, the study results for zinc and lead were deemed inconclusive and additional study is warranted before the listing can be removed; furthermore, additional data for chromium is also expected, postponing the delisting of chromium as well (MDE, 2010). In addition to the impairment listings shown in the table above, there are also listings for segments of the Bear Creek/Old Road Bay watershed outside of the SWAP area including the Inner Harbor/Northwest Branch and the Middle Branch. Some of these impairments include lead (WQA developed), trash, and fecal coliform.

The two TMDLs that have been approved by USEPA for the Bear Creek/Old Road Bay watershed are briefly discussed in the following sections.

3.2.1 Nutrients

TMDLs for nitrogen and phosphorus in the MD-PATMH tidal segment were approved by USEPA in December 2007 (MDE, 2007). The development of the Chesapeake Bay TMDLs for nutrients and sediments in 2010 now supersedes earlier TMDLs for nutrients. Section 3.2.3 contains a discussion on the new TMDL requirements for nutrients and sediments. Discussion of nutrient impairments from earlier TMDLs is included in this section for completeness.

The MD-PATMH tidal segment was first listed as impaired by nutrients in 1996 due to signs of eutrophication. Eutrophication is the over-enrichment of water bodies by excessive nutrient input which causes excessive growth of algae (algal blooms) and bacterial consumption of dissolved oxygen as the algae decompose. High algal abundance measured by chlorophyll *a* concentration and low dissolved oxygen levels in a water body are indicators of eutrophication and possible excessive nutrient concentrations. Therefore, the water quality goals of the TMDLs for nitrogen and phosphorus are to reduce excessive algal blooms and cholorphyll *a* concentrations, and to maintain dissolved oxygen levels above the water quality criteria for the designated use of the Bear Creek/Old Road Bay (MDE, 2007). Although USEPA only provides narrative water quality criteria for chlorophyll *a*, MDE has established acceptable maxima of 100 µg/L at all times and 30-day mean levels of 50 µg/L.

Total nitrogen and total phosphorus TMDLs were assigned to contributing nonpoint and point sources in the Bear Creek/Old Road Bay watershed. Table 3-2 summarizes the average annual allocations of total nitrogen and phosphorus developed based on existing relative contributions and reductions necessary to meet TMDLs for the MD-PATMH tidal segment.

Table 3-2: Average Annual Nutrient Allocations for the Patapsco River (lbs/year)

Source	Total Nitrogen	Total Phosphorus
Nonpoint Source	1,246,036	34,654
Point Source	3,976,215	243,127
Margin of Safety*	101,712	46,528
Total	***5,323,963***	***324,309***

*Includes a margin of safety (MOS) and a future allocation (FA) load to account for future growth

Nonpoint source loads represent loads from agricultural land, forest and other herbaceous land, and septic systems. These sources are the least significant contributors of nutrients to the MD-PATMH tidal segment. 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 for nitrogen and phosphorus. Nutrient levels established by the TMDLs for nonpoint source loads represent a 15% reduction from the baseline annual average agricultural loads, but loads from septic systems and forest land were not reduced from baseline levels. Point source loads include NPDES urban stormwater loads, NPDES municipal wastewater treatment plant loads, and NPDES industrial discharge. Analyses showed that the point sources were the major contributors to nutrient loading and

thus make up nearly 75% of the total nutrient allocation. Urban stormwater loads established by the TMDLs require a 15% reduction in nitrogen and phosphorus from average annual baseline levels. The Bear Creek/Old Road Bay SWAP intends to address some of the actions needed to achieve reduction in nitrogen and phosphorus from urban stormwater systems and help meet water quality standards. Municipal wastewater treatment plants (WWTPs) discharging to the MD-PATMH tidal segment include the Patapsco WWTP and the Cox Creek WWTP (not located within the current SWAP area). Nutrient load limits were set to a maximum of 3 mg/L of nitrogen from May through October and 5mg/L from November through April, and 0.3 mg/L of phosphorus year round for both WWTPs. Industrial point sources comprise five industrial facilities throughout the watershed. Analyses showed that average annual nutrient loads from the industrial point sources were comparable to the loads from the municipal WWTPs for nitrogen but were less for phosphorus. TMDLs set for industrial point sources vary from plant to plant and are based on implementation of available technologies to achieve water quality criteria.

3.2.2 Chlordane

Chlordane is a pesticide introduced in the 1940s that was used to control insects for agricultural, home, and commercial purposes. It is a bioaccumulative chemical that is carcinogenic and can cause both acute and chronic toxic effects, and its sale was banned in the U.S. in 1988. Chlordane has been detected in certain Bear Creek/Old Road Bay fish tissues at levels that prompted a fish consumption advisory in 1986, resulting in an impairment listing of the Bear Creek/Old Road Bay watershed for chlordane in 1996. Because the majority of chlordane use has ceased since 1988, the only significant source of chlordane in the watershed is from in-situ Bear Creek/Old Road Bay sediments that were exposed to chlordane in the past (MDE, 2001).

MDE uses 0.00059 µg/L as the basis for the TMDL of chlordane for the Bear Creek/Old Road Bay watershed. This concentration level is the USEPA-established ambient water quality standard for protection from the ingestion of contaminated aquatic organisms, and includes a built-in margin of safety. Chlordane concentrations in the watershed are expected to decline over time through biodegradation and dispersal during the natural recovery process of the estuary; however, Maryland State proposes triennial monitoring of fish and surficial sediment in the Bear Creek/Old Road Bay to track the natural attenuation of chlordane.

3.2.3 Chesapeake Bay Nutrient and Sediment Impairment

The Chesapeake Bay Program (CBP) has developed the Phase 5 Watershed Model. This model, in conjunction with the Estuary Model, is used to determine the sources and reductions of nitrogen, phosphorus, and sediment needed to meet Chesapeake Bay tidal water quality standards. The Phase 5 model was used to develop a Chesapeake Bay-wide TMDL and to assign nutrient and sediment load reductions to individual states and ultimately local jurisdictions based on the segment loads. In Maryland, nutrient and sediment load reductions were assigned on a County basis for achievement by a 2025 timeframe. 2017 was established as an intermediary milestone with specific targeted load reductions to be achieved. Table 3-3 below lists the pollutant load reduction requirements for Baltimore County, and in turn the Bear Creek/Old Road Bay watershed, under the Chesapeake Bay TMDL.

Table 3-3: Baltimore County Stormwater Sector Pollutant Load Reductions

TMDL Pollutant	% Pollutant Load Reduction Requirements for Baltimore County 2017	2025
Nitrogen	20.3%	29.0%
Phosphorous	31.6%	45.1%

Table 3-4 lists the dissolved oxygen criteria for Use II waters, applicable to the MD-PATMH tidal segment, based on COMAR 26.08.02.03-2. Programs to reduce nutrient concentrations are aimed to achieve water quality standards for all designated use subcategories of Use II.

Table 3-4: Tidal Water Dissolved Oxygen Criteria

Use II Subcategory	Dissolved Oxygen Criteria	Applicable Time Period
1. Migratory Fish Spawning and Nursery	7 day mean >= 6 mg/liter Instantaneous minimum >= 5 mg/liter	February 1 - May 31
2. Shallow Water – Submerged Aquatic Vegetation	30 day mean of >=5.5 mg/l in low salinity; 5 mg/l in high salinity 7 day mean of >= 4 mg/l Instantaneous minimum of >= 3.2 mg/l	Year-round
3. Open-Water Fish and Shellfish	30 day mean of >=5.5 mg/l in low salinity; 5 mg/l in high salinity 7 day mean of >= 4 mg/l Instantaneous minimum of >= 3.2 mg/l	Year-round
4. Deep-Water Seasonal Fish and Shellfish	30 day mean of >=3 mg/l 1 day mean of >= 2.3 mg/l Instantaneous minimum of >= 1.7 mg/l	June 1 - September 30
5. Deep-Channel Seasonal Refuge	Instantaneous minimum of >= 1 mg/l	June 1 - September 30

3.3 Pollutant Loading Analysis

Pollutant loading analyses are intended to assess the impacts of current and future development on water quality. For the Bear Creek/Old Road Bay watershed, a pollutant loading analysis was completed based on land-uses in the watershed along with the presence of septic systems and point sources within the watershed.

3.3.1 Land-Use Pollutant Loading

Land use analyses have been performed for each of the Maryland designated 8-digit watersheds located entirely or in part within Baltimore County. As part of these analyses, Baltimore County derived watershed-specific pollutant loading rates for nitrogen, phosphorus, and sediment based on the Chesapeake Bay Program (CBP) July 2011 Watershed Model. The model derived segment-specific loading rates for urban and non-urban land uses. Pollutant loading rates corresponding to different land use types in the Bear Creek/Old Road Bay watershed are summarized in Table 3-5.

Table 3-5: Annual Pollutant Loading Rates for WRE Land Use Classifications (lbs/acre/yr)

WRE Land Cover	Nitrogen Per Acre	Phosphorus Per Acre	Sediment Per Acre
Impervious Urban	9.64	1.48	675.86
Pervious Urban	6.40	0.28	92.26
Cropland	21.38	1.32	664.57
Pasture	7.97	0.74	118.85
Livestock (AFO/CAFO)*	94.26	23.95	2452.00
Forest and Wetlands	1.53	0.04	31.05
Water**	10.26	0.61	0.00

* AFO/CAFO refers to animal feeding operations and concentrated animal feeding operations;

** Nutrient loading rates from water represent atmospheric deposition; this was not included in the watershed pollutant loading analysis

As presented in Chapter 2, land use information for the Bear Creek/Old Road Bay watershed was obtained from Baltimore County and is based on MDP's 2007 land use/land cover (LU/LC) GIS spatial data. For purposes of the watershed pollutant loading analysis, Baltimore County uses a consolidated version of MDP's LU/LC classifications because loading rates do not differ significantly between certain land use classes (e.g., various forest types). The MDP LU/LC categories present in the Bear Creek/Old Road Bay watershed and the corresponding WRE land use classes used for the pollutant loading analysis are summarized in Table 3-6.

Table 3-6: Reclassification of MDP LU/LC to WRE Land Use for Bear Creek/Old Road Bay

MDP LU/LC Classification	WRE Land Cover
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 Land	Urban*
21 Cropland	Cropland
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
80 Transportation	Urban*

*These categories were split into pervious urban and impervious urban areas using Baltimore County roads and buildings spatial data.

Total acreages of each WRE land use category were calculated for the Bear Creek/Old Road Bay watershed. These were multiplied by the corresponding loading rates presented in Table 3-5, yielding annual pollutant loads for total nitrogen, total phosphorus, and total sediment from the watershed. The total annual land use pollutant loadings calculated for the Bear Creek/Old Road Bay watershed are summarized in Table 3-7. Note that pollutant loading rates developed for the Water land cover category represent atmospheric deposition of nitrogen and phosphorus to water. Because this nutrient delivery system is not addressed in the Baltimore County SWAPs, it was not included in the analysis.

Table 3-7: Total Annual Nutrient Loads for Bear Creek/Old Road Bay Watershed

		NITROGEN		PHOSPHORUS		SEDIMENT	
WRE Land Use	Area (acres)	Loading Rate (lbs/ac)	Load (lbs)	Loading Rate (lbs/ac)	Load (lbs)	Loading Rate (lbs/ac)	Load (lbs)
Impervious Urban	3,335.5	9.64	32,142	1.48	4,937	675.86	2,254,352
Pervious Urban	5,996.2	6.40	38,374	0.28	1,671	92.26	553,213
Cropland	344.2	21.38	7,358	1.32	453	664.57	228,722
Pasture	0.0	7.97	0	0.74	0	118.85	0
Livestock (AFO/CAFO)	0.0	94.26	0	23.95	0	2,452.00	0
Forest	1,171.2	1.53	1,790	0.04	42	31.05	36,366
Wetlands	370.5	1.53	566	0.04	13	31.05	11,503
Water*	195.8	-	-	-	-	-	-
Total	***11,413.4***		***80,230***		***7,117***		***3,084,155***

*Nutrient loadings from Water were not included in the analysis

Total annual nitrogen and phosphorus loads estimated for the Bear Creek/Old Road Bay watershed are 80,230 lbs TN/year and 7,117 lbs TP/year, respectively. Total annual sediment loading from land use sources into the Bear Creek/Old Road Bay watershed is 3,084,155 lbs Sediment/year. Pollutant loadings were also calculated on a subwatershed basis using the same loading rates and land use classification. These estimates will provide baseline pollutant loads before implementation of restoration projects and will allow a better assessment of both progress made to date and further progress needed to meet watershed goals or anticipated TMDLs for urban nonpoint source reduction.

Table 3-8 summarizes the acreages of WRE land use categories by subwatershed in the Bear Creek/Old Road Bay watershed. The resulting nitrogen, phosphorus, and sediment loads for the 14 subwatersheds are presented in Table 3-9 , Table 3-10, and Table 3-11, respectively. These three tables also include annual nitrogen, phosphorus, and sediment loading rates per acre (lbs/ac/yr) calculated for each subwatershed. The tables show that the subwatersheds generating the greatest pollutant loads are Colgate Creek and Sparrows Point. It is important to note that these subwatersheds also have larger surface areas compared to the remaining subwatersheds. However, North Point Creek and Shallow Creek are predicted to generate the highest amount of annual pollutant loading per acre out of all subwatersheds. This is due to the cropland present in these two subwatersheds that generates a higher nitrogen loading rate than any other land use present in the study area. In general, the subwatersheds surrounding and draining to Bear Creek or subwatersheds containing cropland are expected to have the highest pollutant loading rates in the Bear Creek/Old Road Bay watershed because of the abundance of highly urbanized land in this area. Subwatershed pollutant loadings and rates will be used to prioritize restoration efforts. Total planning level pollutant load estimates will be used to determine necessary reductions to meet watershed goals and any future TMDL reductions.

Table 3-8: Bear Creek/Old Road Bay WRE Land Use Acreages by Subwatershed

SUBWATERSHED	WRE LAND COVER						
	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock (AFO/CAFO)	Forest	Wetlands
Colgate Creek	708	890	0	0	0	26	7
Peach Orchard Cove	164	279	0	0	0	0	0
Bullneck Creek	188	432	0	0	0	0	0
Lynch Cove	234	405	0	0	0	0	6
Chink Creek	129	226	0	0	0	0	8
Bear Creek Headwaters	221	364	0	0	0	7	0
Charlesmont/Tobasco Coves	185	180	0	0	0	49	0
Oakleigh/Schoolhouse Coves	133	189	0	0	0	4	0
Country Club Cove/Humphrey Creek Remnant	196	453	0	0	0	126	5
Jones Creek	246	501	0	0	0	165	0
North Point Creek	93	213	117	0	0	145	0
Shallow Creek	58	126	185	0	0	273	47
Black Marsh	25	29	42	0	0	288	184
Sparrows Point	757	1,710	0	0	0	90	113
Total	***3,336***	***5,996***	***344***	***0***	***0***	***1,171***	***370***

Table 3-9: Bear Creek/Old Road Bay Annual Nitrogen Loads by Subwatershed Based on WRE Land Use (lbs/yr)

SUBWATERSHED	Total Area (acres)	WRE LAND COVER							Total Nitrogen Load (lbs/yr)	Nitrogen Loading Rate (lbs/acre/yr)
		Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock (AFO/CAFO)	Forest	Wetlands		
Colgate Creek	1,649.3	6,822	5,698	0	0	0	39	11	12,571	7.6
Peach Orchard Cove	450.2	1,577	1,787	0	0	0	0	0	3,364	7.5
Bullneck Creek	632.2	1,810	2,764	0	0	0	0	0	4,574	7.2
Lynch Cove	648.4	2,258	2,592	0	0	0	0	10	4,860	7.5
Chink Creek	364.8	1,240	1,449	0	0	0	0	12	2,701	7.4
Bear Creek Headwaters	592.0	2,130	2,328	0	0	0	10	0	4,468	7.5
Charlesmont/Tobasco Coves	417.4	1,784	1,154	0	0	0	75	0	3,014	7.2
Oakleigh/Schoolhouse Coves	328.8	1,279	1,207	0	0	0	6	0	2,493	7.6
Country Club Cove/Humphrey Creek Remnant	797.9	1,886	2,897	0	0	0	192	8	4,983	6.2
Jones Creek	922.9	2,368	3,205	0	0	0	252	0	5,825	6.3
North Point Creek	576.2	894	1,362	2,501	0	0	221	0	4,978	8.6
Shallow Creek	706.2	559	806	3,960	0	0	418	72	5,815	8.2
Black Marsh	569.2	243	183	897	0	0	440	282	2,044	3.6
Sparrows Point	2,757.9	7,290	10,942	0	0	0	137	172	18,541	6.7
Total	***11,413.4***	***32,142***	***38,374***	***7,358***	***0***	***0***	***1,790***	***566***	***80,230***	***7.0***

Table 3-10: Bear Creek/Old Road Bay Annual Phosphorus Loads by Subwatershed Based on WRE Land Use (lbs/yr)

SUBWATERSHED	Total Area (acres)	WRE LAND COVER							Total Phosphorus Load (lbs/yr)	Phosphorus Loading Rate (lbs/acre/yr)
		Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock (AFO/CAFO)	Forest	Wetlands		
Colgate Creek	1,649.3	1,048	248	0	0	0	1	0.3	1,297	0.79
Peach Orchard Cove	450.2	242	78	0	0	0	0	0	320	0.71
Bullneck Creek	632.2	278	120	0	0	0	0	0	398	0.63
Lynch Cove	648.4	347	113	0	0	0	0	0.2	460	0.71
Chink Creek	364.8	191	63	0	0	0	0	0.3	254	0.70
Bear Creek Headwaters	592.0	327	101	0	0	0	0.2	0	429	0.72
Charlesmont/Tobasco Coves	417.4	274	50	0	0	0	2	0	326	0.78
Oakleigh/Schoolhouse Coves	328.8	197	53	0	0	0	0.1	0	249	0.76
Country Club Cove/Humphrey Creek Remnant	797.9	290	126	0	0	0	5	0.2	421	0.53
Jones Creek	922.9	364	140	0	0	0	6	0	509	0.55
North Point Creek	576.2	137	59	154	0	0	5	0	356	0.62
Shallow Creek	706.2	86	35	244	0	0	10	2	376	0.53
Black Marsh	569.2	37	8	55	0	0	10	7	118	0.21
Sparrows Point	2,757.9	1,120	476	0	0	0	3	4	1,604	0.58
Total	***11,413.4***	***4,937***	***1,671***	***453***	***0***	***0***	***42***	***13***	***7,117***	***0.62***

Table 3-11: Bear Creek/Old Road Bay Annual Sediment Loads by Subwatershed Based on WRE Land Use (lbs/yr)

		WRE LAND COVER								
SUBWATERSHED	Total Area (acres)	Impervious Urban	Pervious Urban	Cropland	Pasture	Livestock (AFO/CAFO)	Forest	Wetlands	Total Sediment Load (lbs/yr)	Sediment Loading Rate (lbs/acre/yr)
Colgate Creek	1,649.3	478,489	82,145	0	0	0	796	228	561,658	340.5
Peach Orchard Cove	450.2	110,586	25,762	0	0	0	0	0	136,348	302.9
Bullneck Creek	632.2	126,982	39,845	0	0	0	0	0	166,827	263.9
Lynch Cove	648.4	158,388	37,365	0	0	0	0	195	195,948	302.2
Chink Creek	364.8	87,003	20,888	0	0	0	0	240	108,132	296.4
Bear Creek Headwaters	592.0	149,386	33,565	0	0	0	203.0	0	183,154	309.4
Charlesmont/Tobasco Coves	417.4	125,127	16,640	0	0	0	1,529	0	143,297	343.3
Oakleigh/Schoolhouse Coves	328.8	89,734	17,401	0	0	0	124.6	0	107,259	326.2
Country Club Cove/Humphrey Creek Remnant	797.9	132,312	41,761	0	0	0	3,902	163	178,137	223.3
Jones Creek	922.9	166,086	46,201	0	0	0	5,118	0	217,405	235.6
North Point Creek	576.2	62,691	19,630	77,746	0	0	4,494	0	164,562	285.6
Shallow Creek	706.2	39,230	11,624	123,096	0	0	8,485	1,461	183,895	260.4
Black Marsh	569.2	17,029	2,637	27,879	0	0	8,934	5,722	62,201	109.3
Sparrows Point	2,757.9	511,309	157,749	0	0	0	2,781	3,495	675,333	244.9
Total	***11,413.4***	***2,254,352***	***553,213***	***228,722***	***0***	***0***	***36,366***	***11,503***	***3,084,155***	***270.2***

3.3.2 Septic and Point Source Pollutant Loading

An analysis was completed by Baltimore County based on the presence of septic systems and point source pollution contributions within the Bear Creek/Old Road Bay watershed. Septic systems are classified based on their location in the watershed and their proximity to streams. For septic systems located in the Chesapeake Bay Critical Area, a loading rate of 16.44 lbs Nitrogen/year is used. For systems outside the critical area, rates of 10.27 lbs Nitrogen /year if the system is located within 1,000 feet of a stream and 6.16 lbs Nitrogen/year if the system is located further than 1,000 feet of a stream are used. Septic systems do not provide phosphorus to the nutrient loading of the watersheds. Table 3-12 presents the yearly load for septic systems in the Bear Creek/Old Road Bay watershed.

Point sources are made up of pollutant loads accounted for by NPDES permit holders within the watershed. In the Bear Creek/Old Road Bay watershed, these consist of major industrial facilities and marinas. Table 3-12 presents the annual nutrient loads attributable to point sources within the study area.

Table 3-12: Annual Nitrogen, Phosphorus, and Sediment Loads from Septic and Point Sources (lbs/year)

Other Pollution Sources	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Sedimen (lbs/year)
Septic Systems	3,736	0	0
Point Sources	73,151	59,671	4,213,283

3.4 Water Quality Monitoring Data

Baltimore County and Maryland DNR have conducted chemical, physical, and biological monitoring for the Bear Creek/Old Road Bay watershed through various programs. Section 3.4.1 presents the County's tidal recreational water sampling program for chemical sampling and section 3.4.2 presents DNR's tributary strategy for the Patapsco/Back Rivers Basin. Baltimore County also conducts a baseflow monitoring program for chemical sampling in streams as well as biological monitoring of benthic health, but the Bear Creek/Old Road Bay watershed was excluded from these programs due to limited free flowing streams in the watershed. The County's SAV monitoring program and illicit connection program are also briefly presented in sections 3.4.3 and 3.4.4, respectively.

3.4.1 County Recreational Water Sampling Program

Baltimore County has approximately 217 miles of tidal coastline and approximately 61 miles are located in the Bear Creek/Old Road Bay watershed. The County regularly conducts bacteriological and chemical sampling on its receiving tidal waters and recreational beaches. The water quality information is provided to the public and encourages the safe use of the tidal resources that support recreational activities such as fishing, camping, and boating.

The bacteriological sampling program tests for the indicator organism, enterococci, found in the intestines of 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 organisms in the water samples. Sampling for tidal waters is generally performed biweekly by boat from

April through November as weather permits. Additional sampling may be conducted in response to unusual conditions that could adversely impact water quality.

Figure 3-1 shows four water sampling areas in the tidal waters of Bear Creek/Old Road Bay: Patapsco River - East; Bear Creek; Old Road Bay; and North Point State Park. Among these four sampling areas, there are 12 individual sampling locations, one in Patapsco River - East, five in Bear Creek, three in Old Road Bay, and three in North Point State Park. Note that Figure 3-1 shows only one sampling location in North Point State Park because two more locations were added in 2010. The most recent sampling data results for these sampling locations are summarized in Table 3-13. The USEPA/MDE bacteriological standard for consideration of beach closure at tidal beaches is a geometric mean of 35 MPN enterococci. Measurements are typically denoted as MPN/100 mL which stands for the most probable number of bacteria colonies expected to be found in a 100-mL sample of water (DEPRM, 2011, see also COMAR 26.08.02.03).

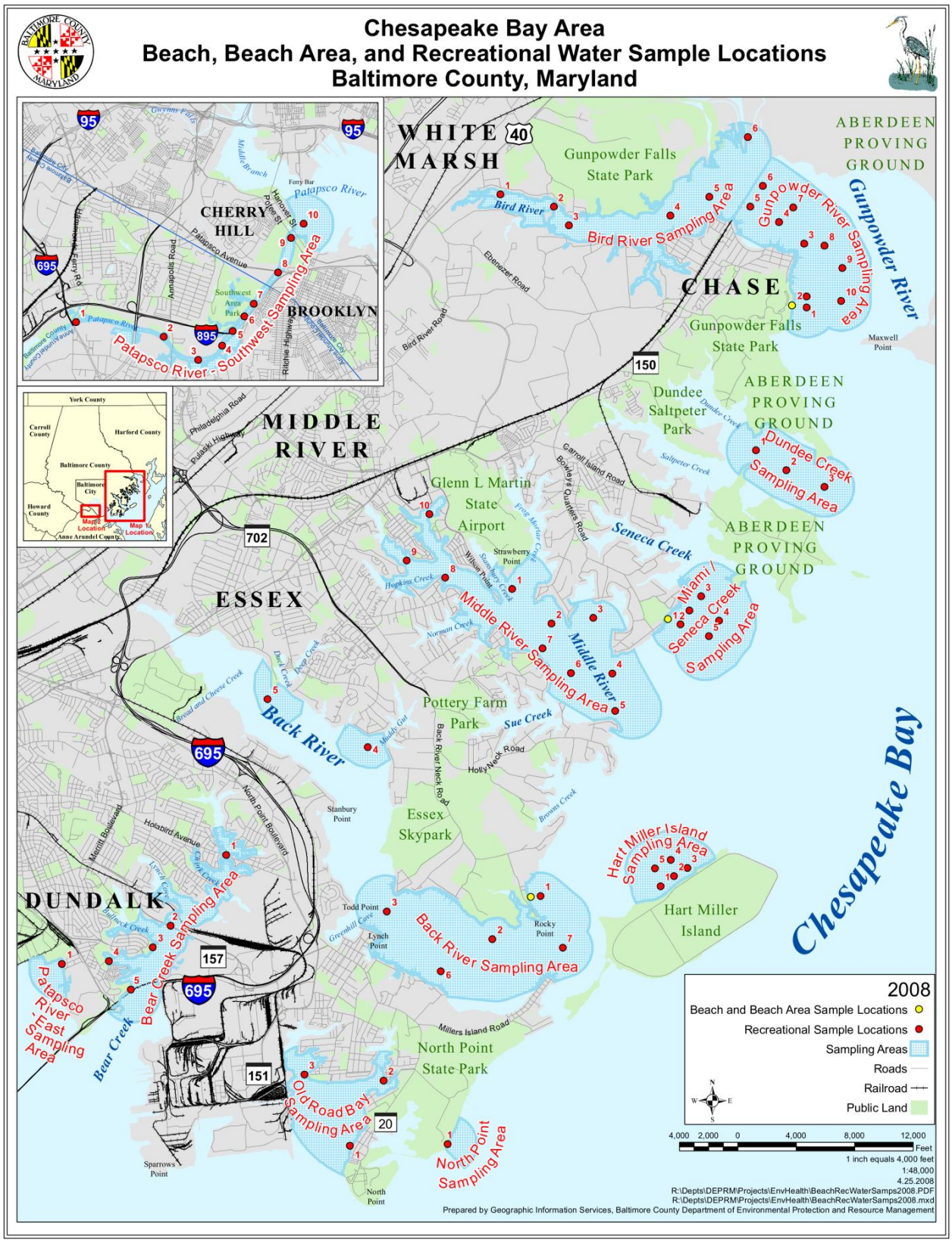

Figure 3-1: Baltimore County Recreational Water Sampling Locations (Excerpt from EPS 2011)

Table 3-13: Recreational Waters Sampling Results Summary for Bear Creek/Old Road Bay Sampling Areas (MPN Enterococci)

Site	Sampling Location ID	Number of Samples	Geometric mean	High value	% > 35MPN
Bear Creek	1	36	5.9	> 2010	19%
Bear Creek	2	35		> 2010	11%
Bear Creek	3	36		> 2010	11%
Bear Creek	4	36		> 2010	17%
Bear Creek	5	36		> 2010	8%
Patapsco River East	1	35	3.3	150	9%
Old Road Bay	1	36	8.0	90	8%
Old Road Bay	2	36		> 2010	25%
Old Road Bay	3	36		830	22%
North Point State Park	1	33	4.1	310	12%
North Point State Park	2	14		50	14%
North Point State Park	3	14		50	7%

All four sampling areas showed bacteria levels exceeding the USEPA/MDE limit of concern of 35 MPN Enterococci on multiple occasions between 2008 and 2009. Although most sampling events had results below the limit, in some instances levels exceeded the limit by an order of magnitude. The highest enterococci levels recorded during 2008 to 2009 occurred in May and November of 2009, when levels reached 695 MPN Enterococci in Bear Creek, 150 MPN Enterococci in Patapsco River - East, 531 MPN Enterococci in Old Road Bay, and 310 MPN Enterococci North Point State Park. Aside from these instances, the Old Road Bay sampling area exceeded the 35 MPN Enterococci limit six other times during 2008 to 2009, the most number of times out of all four sampling areas in this period.

Historical sampling results for enterococci are also available for years 2002 to 2008 for the Bear Creek and Patapsco River - East sampling areas, and for year 2008 for the North Point State Park sampling area. Baltimore County maintains an archive of these sampling results at the following website: http://www.baltimorecountymd.gov/Agencies/health/environmentalhealth/watersampling/results.html

Figure 3-2 shows the approximate locations of the historical sampling sites corresponding to the data archived in the website above. Table 3-14 provides a comparison of the ranges of geometric means of MPN Enterococci measured during various sampling years (2002-2007, 2008-2009, and 2010-2011). Because of the isolated instances of extremely high bacteria levels in 2009, the ranges of geometric means do not indicate a clear decrease in bacteria population in the Bear Creek/Old Road Bay watershed from 2002 to 2011. The sampling results do show, however, that geometric means have not exceeded the 35 MPN Enterococci limit in the most recent years of 2010-2011 in the North Point State Park sampling area.

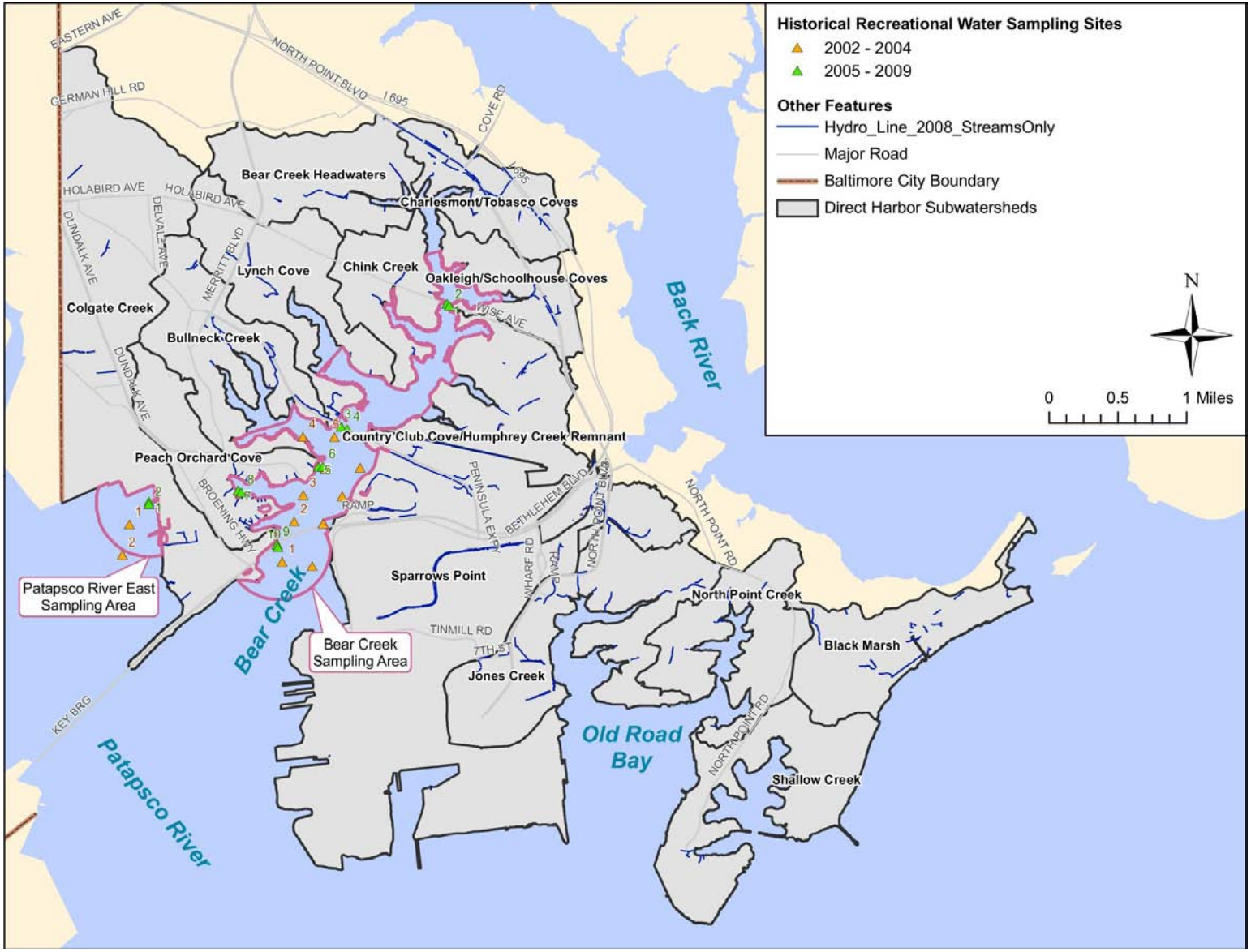

Figure 3-2: County Historical Recreational Sampling Locations in Bear Creek/Old Road Bay Planning Area

Table 3-14: Recreational Waters Sampling Results - Range of Geometric Means (MPN Enterococci)

SAMPLING AREA	SAMPLING PERIOD					
	2002-2007		2008-2009		2010-2011	
	min	max	min	max	min	max
Bear Creek	9.9	264.9	1.0	695.9	-	-
Patapsco River - East	9.9	589.0	1.0	150.0	-	-
Old Road Bay	-	-	1.0	531.5	-	-
North Point State Park	-	-	1.0	310.0	1.0	31.1

Other water quality parameters are also measured as part of the tidal recreational waters monitoring program including total suspended solids (TSS), nutrients, and metals. 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 an increase in the algae communities and the 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 can 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.

The Patapsco River is subject to toxic substance criteria established for ambient surface waters. COMAR defines the boundary between fresh waters and estuarine or salt waters in the Patapsco River as the line created by the Bear Creek/Old Road Bay Tunnel (COMAR 26.08.02.03-1); therefore, the portion of the Patapsco River that is within the current SWAP area is considered an estuarine or salt water body and is subject to USEPA National Recommended Water Quality Criteria (USEPA 2011) pertaining to aquatic life in salt water. These criteria are summarized in Table 3-15, along with the reporting limits for measured water quality parameters in tidal waters. Note that chloride criteria are not provided for salt water. As discussed in Section 3.2, the effect of nutrients in the Patapsco River is measured by chlorophyll *a* and dissolved oxygen concentrations. Suspended solids are expressed as a water clarity requirement, which is 22 percent light through water for the Patapsco River.

Table 3-15: Numeric Water Quality Criteria for Salt Water Aquatic Life and Reporting Limits (mg/L)

Parameter	CMC* (acute)	CCC** (chronic)	Reporting Limit
Total Suspended Solids (TSS)	N/A	N/A	1
Total Nitrogen (TN)	N/A	N/A	0.2
Total Phosphorus (TP)	N/A	N/A	0.02
Cadmium (Cd)	0.04	0.0088	0.001
Copper (Cu)	0.0048	0.0031	0.001
Lead (Pb)	0.21	0.0081	0.001
Zinc (Zn)	0.09	0.081	0.001
Chloride (Cl)	N/A	N/A	N/A

* 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.

Table 3-16 shows the geometric mean of data sampled in the 4 locations shown in Figure 3-1 for total suspended solids, nutrients, and metals. Dates of sampling range between 2002 and 2009, with the Bear Creek sampling site having the longest continuous sample readings.

Table 3-16: Water Quality Sampling for Suspended Solids, Nutrients, and Metals in Bear Creek/Old Road Bay Sampling Areas (mg/L)

Site	Number of Samples	Geometric Mean of Sampling Data (mg/L)						
		TSS	TN	TP	Cadmium	Copper	Lead	Zinc
Bear Creek	135	27.02	1.04	0.08	0.000	0.011	0.000	0.007
Patapsco River East	35	13.74	1.06	0.05	0.001	0.004	0.001	0.005
Old Road Bay	83	29.24	0.78	0.05	0.001	0.004	0.001	0.009
North Point State Park	20	9.77	0.75	0.04	0.001	0.003	0.001	0.010

Table 3-17 and Table 3-18 display the number of exceedances for the “Criteria Maximum Concentration” and the “Criterion Continuous Concentration,” respectively at each of the sites. Copper concentrations had the most number of exceedances with at least 50% of samples exceeding the “Criteria Maximum Concentration” in each sampling area and over 80% at the Bear Creek site. Zinc was the only other metal that was measured above the “Criteria Maximum Concentration.”

Table 3-17: Exceedance of CMC for Metals in Bear Creek/Old Road Bay Sampling Areas (mg/L)

Site	Exceedances of CMC			
	Cadmium	Copper	Lead	Zinc
Bear Creek	0	109	0	0
Patapsco River East	0	45	0	0
Old Road Bay	0	19	0	1
North Point State Park	0	10	0	0

* 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.

Table 3-18: Exceedance of CCC for Metals in Bear Creek/Old Road Bay Sampling Areas (mg/L)

Site	Exceedances of CCC			
	Cadmium	Copper	Lead	Zinc
Bear Creek	0	112	0	1
Patapsco River East	0	46	0	0
Old Road Bay	0	20	0	1
North Point State Park	0	13	0	0

** 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.

3.4.2 Patapsco/Back Rivers Basin Tributary Strategy Data

To help achieve Maryland's portion of the reduction in nitrogen, phosphorus and sediment to the Chesapeake Bay, a Tributary Strategy Team was selected for each of the 10 basins comprising the Chesapeake Bay including the Patapsco/Back Rivers 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 the 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).

Figure 3-3 shows two long-term fixed monitoring locations in the Patapsco/Back Rivers Basin, one of which is located in the Baltimore County jurisdiction of the Patapsco River, also the current SWAP area. One continuous monitoring station is located in the Baltimore City jurisdiction of the Patapsco River and will not be discussed in this report. Six water quality parameters including nitrogen, phosphorus, chlorophyll-a (algal abundance), total suspended solids, water clarity and dissolved oxygen are measured at the long-term fixed tidal monitoring station. Results from the monitoring station 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 (tidal fresh, oligohaline, and mesohaline). 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

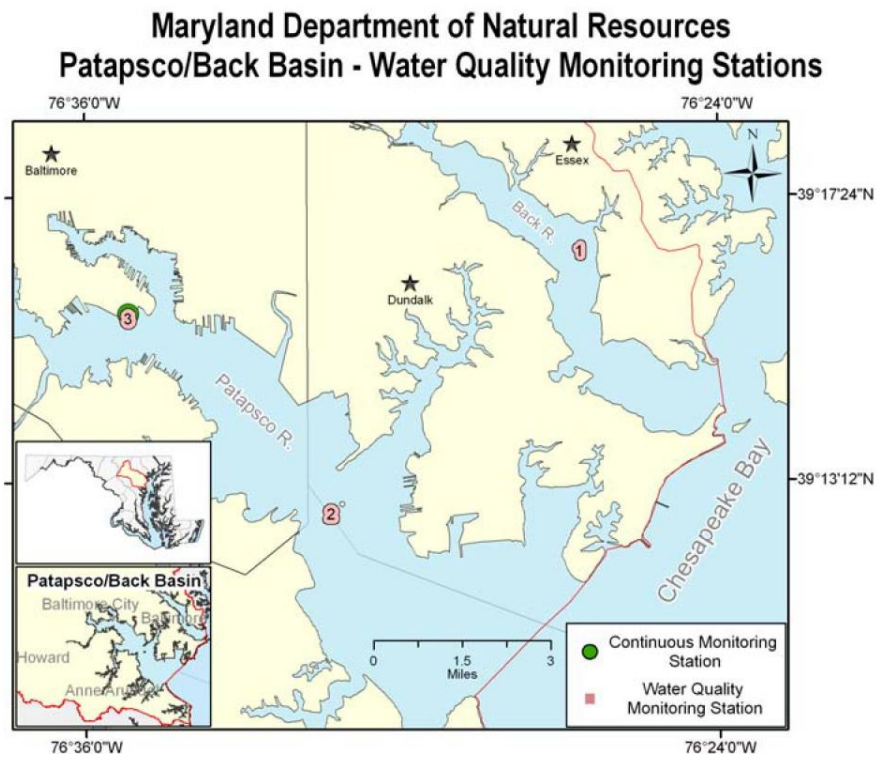

Figure 3-3: Location of Maryland DNR's Tidal Monitoring Stations

Figures 3-4 to 3-6 show the water quality monitoring results reported by DNR for the Patapsco River (Station WT5.1) during the period 1985-2005. The black lines in the figures denote concentrations for each sampling date and annual medians of these values are shown as red bars. Note that Station WT5.1 corresponds to water quality monitoring station 2 in Figure 3-3 above.

Figure 3-4 shows that total nitrogen concentrations range from approximately 1 to 4 mg/L in Patapsco River, and total phosphorus concentrations range from approximately 0 to 0.3 mg/L during the 1985 to 2005 monitoring period. Total phosphorus levels show improving trends, with levels ranging from 0.02

to 0.15 mg/L during the last five years of the monitoring period (2001-2005). Total nitrogen levels improved during the 1990s but have increased again slightly in the early 2000s, ranging from approximately 1 to 2.5 mg/L during 2001 to 2005. Figure 3-5 shows that algal abundance measured as chlorophyll a concentration reached as high as 150 µg/L in the mid-1990s but have decreased over the monitoring period; in more recent years, chlorophyll a maxima did not exceed 120 µg/L with most measurements staying below 50 µg/L. Figure 3-5 also shows improving trends in total suspended solids, with levels exceeding 40 mg/L during the earlier decade of the monitoring period but staying below 25 mg/L during recent years.

Figure 3-6 shows degrading trends for both water clarity measured as Secchi depth and summer bottom dissolved oxygen. Secchi depths were as high as 2 m in the late 1980s but have remained below 1.5 m in the early 2000s, and dissolved oxygen levels exceeded 5 mg/L during the earlier decade of the monitoring period but have remained below approximately 3 mg/L during the latter decade.

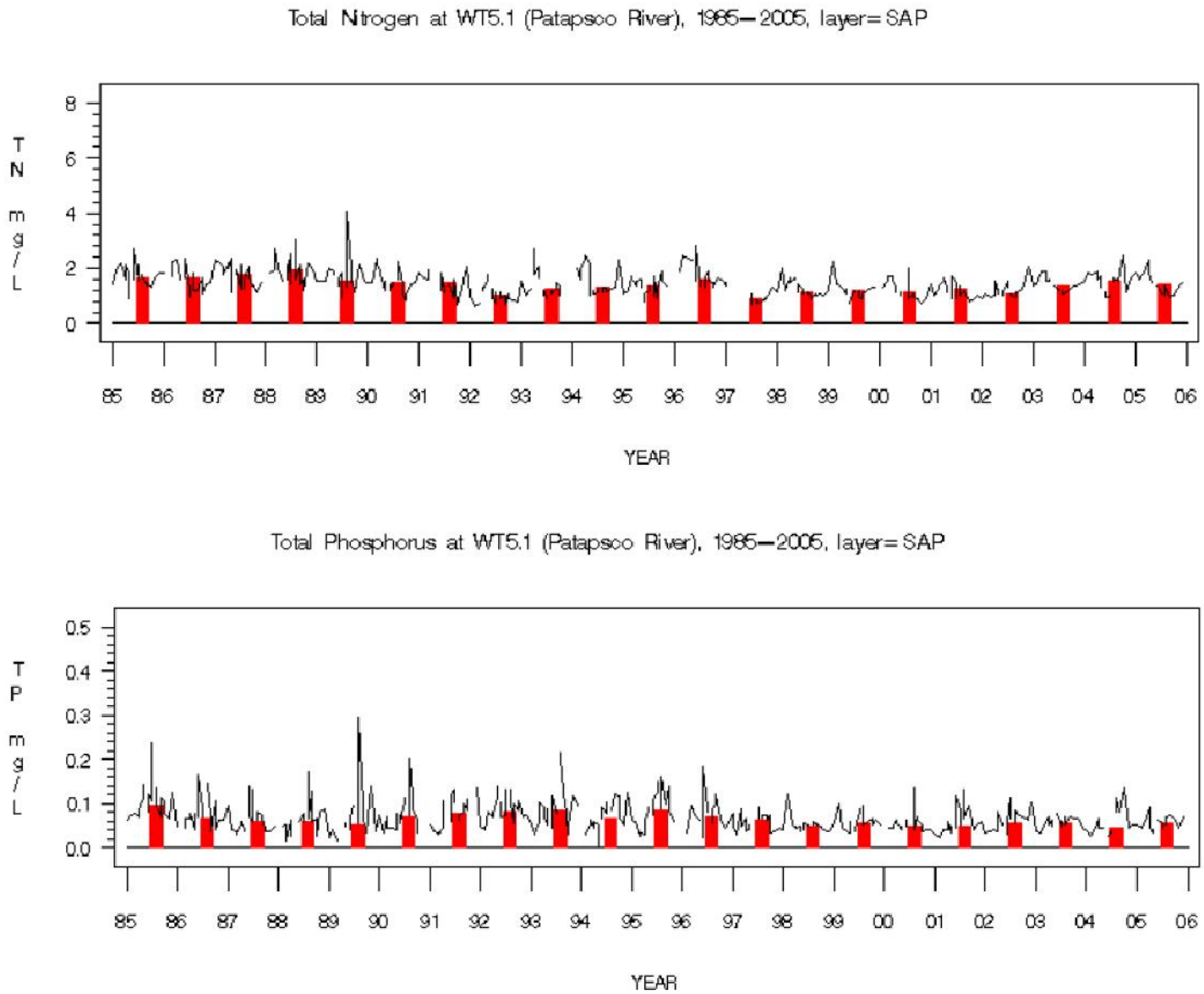

Figure 3-4: Total Nitrogen and Total Phosphorus in Patapsco River – Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

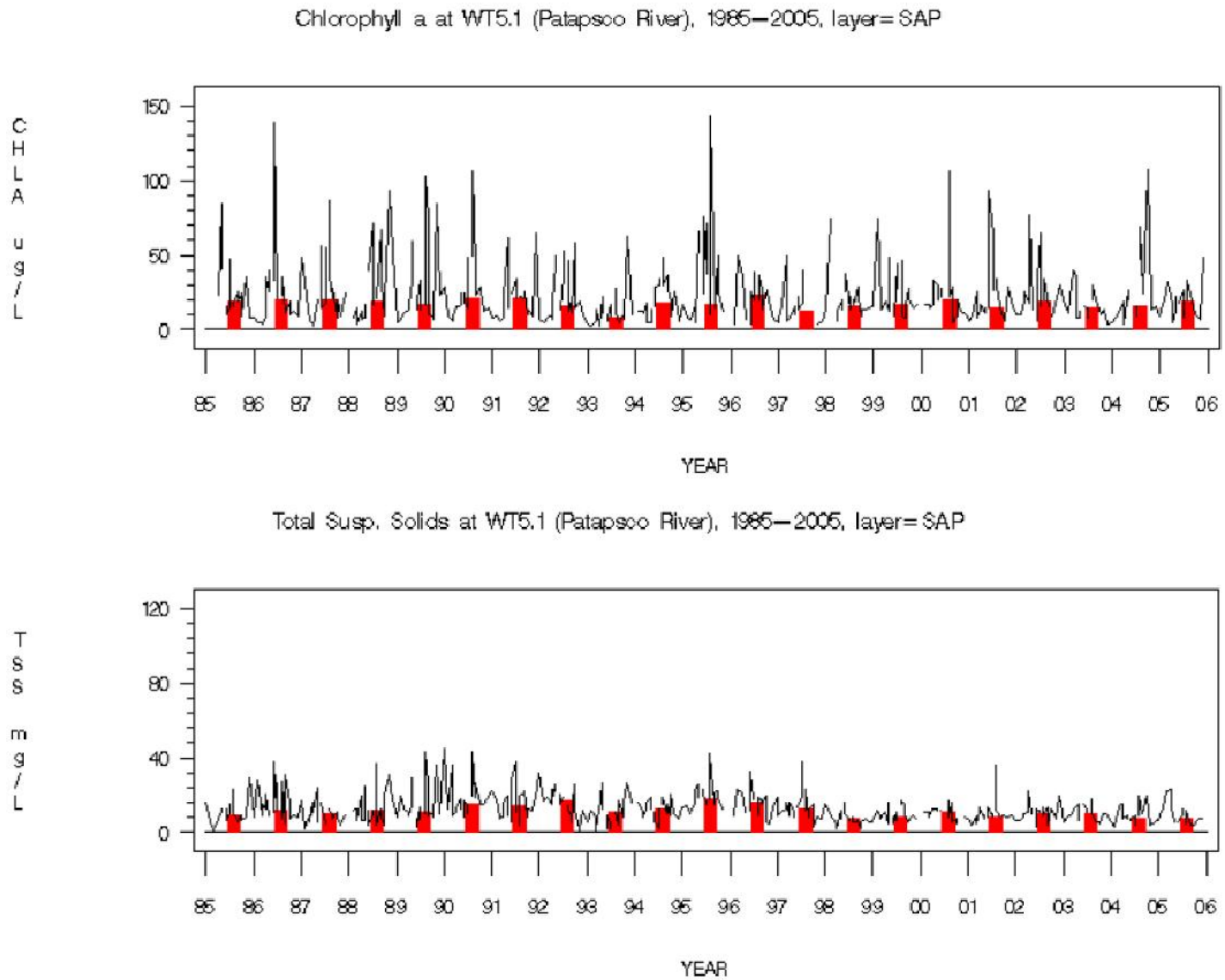

Figure 3-5: Chlorophyll *a* and Total Suspended Solids in Patapsco River – Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

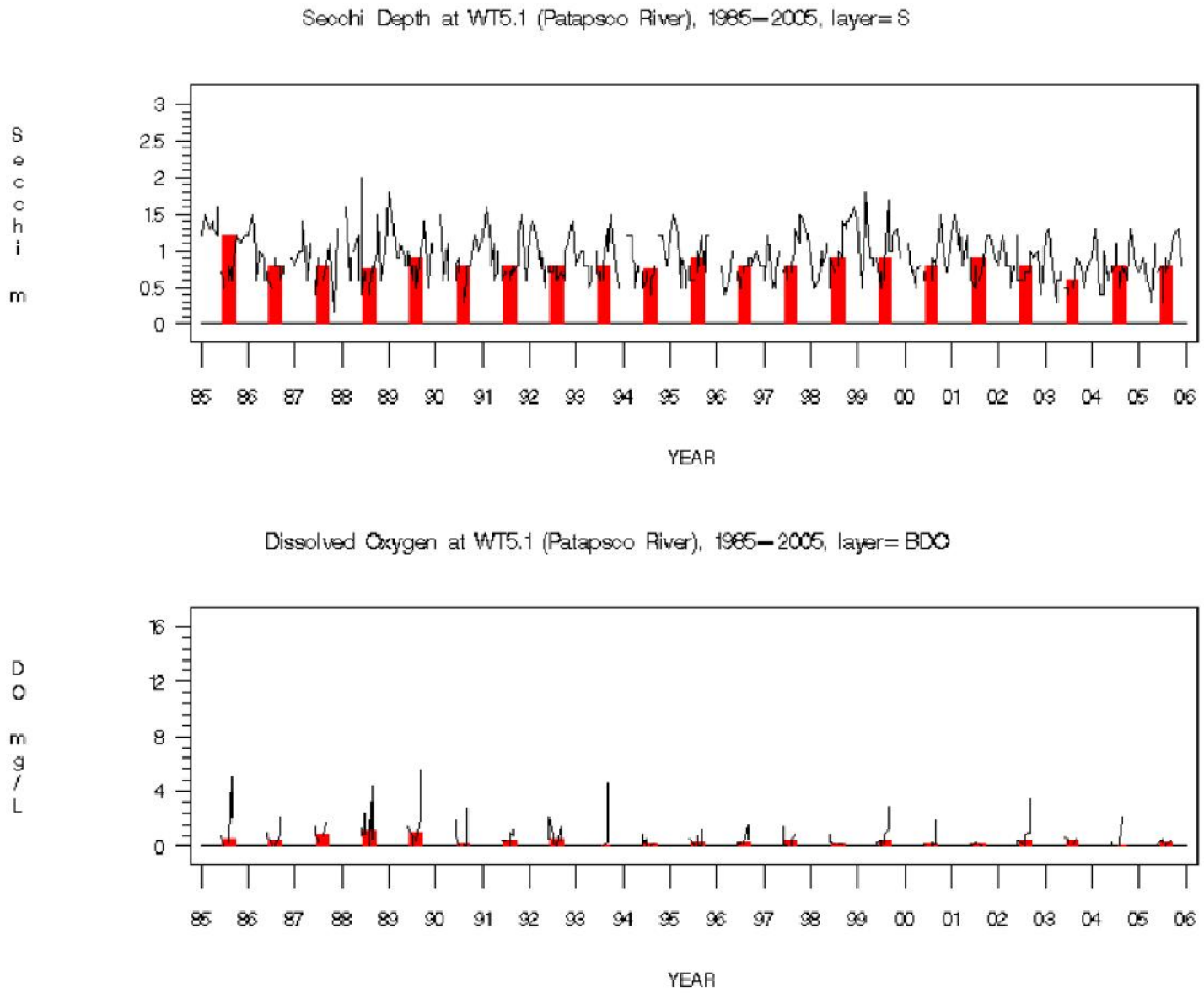

Figure 3-6: Water Clarity and Dissolved Oxygen in Patapsco River – Tidal Waters Monitoring Results for 1985-2005 (DNR 2007)

Based on the monitoring results obtained from the Patapsco River long-term fixed monitoring station, the Patapsco River is considered as having poor water and habitat quality for all six parameters except for total suspended solids which was rated as fair. Trends in total phosphorus, algal abundance, and total suspended solids are all improving based on the 1985-2005 data range, but water clarity and dissolved oxygen concentrations are degrading. As previously noted, total nitrogen levels improved during the 1990s but have increased again slightly in the early 2000s. For more information, please refer to the *Maryland Tributary Strategy Patapsco/Back Rivers Basin Summary Report for 1985-2005 Data* (DNR 2007).

The Patapsco/Back Rivers Basin tributary team also monitors submerged aquatic vegetation (SAV) and the benthic community of the Patapsco River. SAV is 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). Only small amounts of SAV have been recorded in the Patapsco River from 1985 to 2004 with the highest coverage reaching only 14.5 acres during this time. In 2005, the last year of the monitoring period, 280 acres of SAV were identified, which is 72% of the MDE-established goal of 389 acres for the tidal segment MD-PATMH. The SAV beds were identified in Old Road Bay, Masonville Cove, and Cox, Wharf, Shallow, Rock, Marley and Stony Creeks. The seven species of SAV found in these areas included Eurasian watermilfoil, horned pondweed, elodea, redhead grass, wild celery, curly pondweed, and coontail.

The benthic community is an essential component of estuarine ecosystems, and its health can be a good indicator of habitat quality. For example, small worms and crustaceans are a key food source for larger aquatic species such as crabs and bottom-feeding fish, and clams can remove excess algae from the water column. Benthic community is monitored in the Patapsco River at four long-term benthic monitoring sites as well as at randomly selected sites that change from year to year. After sampling, each site is given a benthic index of biotic integrity (B-IBI), which is a single-number indicator of benthic community health. The B-IBI is rated between four categories: meets goal, marginal, degraded, and severely degraded. All four long-term benthic monitoring sites were determined to be degraded or severely degraded during 2003 to 2005. However, many of the random site samples collected during this period met goals or were marginal. This variation may be due to precipitation differences between 2003 and 2004, causing differences in stream flow that affect nutrient and dissolved oxygen levels in the river. Analysis of the overall benthic condition of the Patapsco River indicates high contaminant impact and low dissolved oxygen stress on the benthic community. The most severely degraded benthic conditions were detected in the upper part of the Patapsco River, Curtis Creek, Stony Creek, and Sparrows Point.

3.4.3 County SAV Monitoring

The presence of SAV is a key indicator of the health of a water body. MDE has developed SAV acreage goals for all tidal water segments in the state including the Patapsco River (PATMH) and portions of the Chesapeake Bay near Shallow Creek (CB3MH). CB3MH consists of the portion of the mainstem of the Chesapeake Bay bordering the eastern end of the SWAP study area and extending to the Eastern Shore of Maryland. The SAV acreage goal for these areas is shown in Table 3-19 below along with the associated water clarity application depth. Baltimore County has conducted SAV monitoring since 1989,

and currently 30 waterways are monitored in the County. In the Bear Creek/Old Road Bay study area, not all of the tidal waters, but only select embayments are monitored. SAV distributions are measured in the spring and summer of each year during peak growth periods in accordance with U.S. Fish and Wildlife methodologies. SAV location, density, and species types are all recorded. Total SAV coverage is calculated by the following formula to account for overlap between the seasons:

$$\text{Total SAV}_{acres} = (\text{Spring SAV}_{acres} - \text{Overlap}_{acres}) + (\text{Summer SAV}_{acres} - \text{Overlap}_{acres}) + \text{Overlap}_{acres}$$

Table 3-19: Tidal Segment SAV Acreage and Water Clarity Targets (Baltimore County, 2010)

Tidal Segment Designation	SAV Acres	Water Clarity Application Depth (meters)
PATMH	389	1.0
CB3MH	1,370	0.5

The Chesapeake Bay Program has also recognized SAV acreage and water clarity as standards for meeting designated Use II, Subcategory 2 – Shallow-water SAV. The recommended procedure for reporting SAV condition is to use the single best year SAV acreage based on the most recent three-year period of data. Table 3-20 shows the acres of SAV observed in the Patapsco River tidal segment for the latest three-year monitoring period from 2006 to 2008.

Table 3-20: Baltimore County SAV Monitoring Results for Tidal Receiving Waters of Bear Creek/Old Road Bay (2006-2008)

Tidal Segment Designation	2008		2009		2010	
	Acres	% of Goal	Acres	% of Goal	Acres	% of Goal
MD-PATMH	6.1	1.6	17.7	4.6	17.0	4.4
CB3MH	77.4	5.6	155.7	11.4	16.2	11.7

It is important to note that these acreages only reflect SAV amounts within the Baltimore County jurisdiction and cannot be used alone to assess SAV criteria attainment. However, the 303(d) listing of the Patapsco River tidal segment for SAV coverage indicates that overall coverage does not meet the restoration goal (MDE, 2010). Despite low SAV acreages in the Patapsco River, total SAV acreages measured across Baltimore County have generally increased over the last 20 years. While there has been some variability in certain years due to climatic events, SAV coverage has increased countywide from 0.37% in 1989 to 27.4% of the overall coverage goal in 2008 (Baltimore County, 2010).

In the Bear Creek/Old Road Bay planning area, SAV coverage data has been collected for several tidal areas in the watershed, since 2003. The coverage data in these areas does not cover all tidal waters but select embayments. In Bear Creek, four (4) distinct tidal areas corresponding to specific subwatersheds were surveyed while two (2) areas were measured in Old Road Bay. The SAV present in the tidal waters comprising Shallow Creek were also measured. Table 3-21 and Figure 3-7 provide results of SAV monitoring in the Bear Creek/Old Road Bay planning area.

Table 3-21: Baltimore County SAV Coverage Monitoring Results for Tidal Waters of Bear Creek/Old Road Bay in acres (2003-2011)

Waterway	2003 (acres)		2004 (acres)		2003 (acres)		2006 (acres)		2007 (acres)		2008 (acres)		2009 (acres)		2010 (acres)		2011 (acres)	
	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer	Spring	Summer
Bear Creek	3.17	0.00	1.97	11.22	31.35	20.09	0.56	0.00	5.89	0.01	1.74	0.10	4.28	0.04	1.83	0.00	2.52	0.00
Lynch Cove	1.3	0.0	0.6	3.0	8.7	5.8	0.0	0.0	2.6	0.0	1.3	0.0	1.9	0.0	0.8	0.0	0.2	0.0
Chink Creek	0.2	0.0	0.0	2.6	2.4	2.1	0.4	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.7	0.0	0.7	0.0
Charlesmont/Tobasco Cove	0.7	0.0	0.2	0.7	9.2	6.2	0.2	0.0	0.2	0.0	0.1	0.0	0.6	0.0	0.2	0.0	0.7	0.0
Oakleigh/Schoolhouse Coves	1.0	0.0	1.1	4.9	11.0	6.1	0.0	0.0	2.9	0.0	0.3	0.1	1.5	0.0	0.1	0.0	0.9	0.0
Old Road Bay	2.44	0.00	4.81	5.78	12.82	12.08	3.58	1.32	1.63	0.83	0.15	4.34	9.37	7.51	14.22	4.23	2.96	6.05
Jones Creek	1.5	0.0	2.6	2.4	5.2	3.7	0.4	0.0	1.6	0.1	0.1	0.1	2.0	2.8	2.4	0.0	1.7	0.8
North Point Creek	0.9	0.0	2.3	3.4	7.7	8.4	3.2	1.3	0.0	0.7	0.1	4.3	7.4	4.7	11.9	4.2	1.3	5.2
Shallow Creek	13.2	12.7	36.6	18.6	1.2	9.8	11.7	55.9	19.9	37.0	18.9	77.4	64.2	155.4	141.9	158.6	60.0	100.5
Total	***18.8***	***12.7***	***43.3***	***35.6***	***45.4***	***42.0***	***15.8***	***57.2***	***27.4***	***37.9***	***20.8***	***81.9***	***77.9***	***163.0***	***158.0***	***162.9***	***65.4***	***106.5***

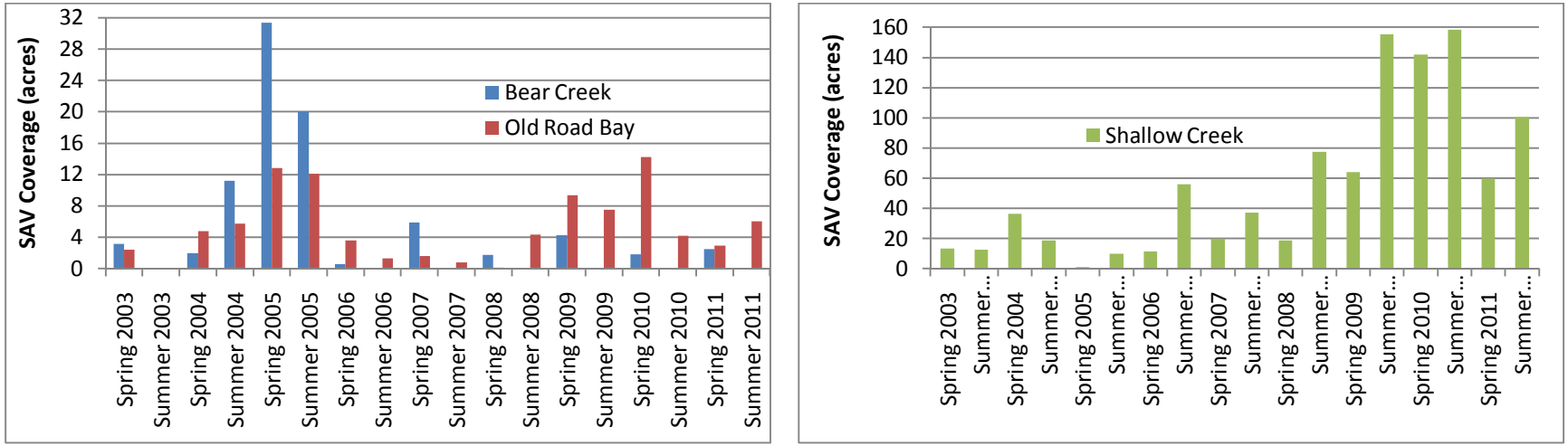

Figure 3-7: SAV Coverage Graphs in Bear Creek and Old Road Bay (left) and Shallow Creek (right)

As seen in Figure 3-7, SAV coverage in the planning area is much higher in the tidal waters of Shallow Creek than in Bear Creek or Old Road Bay. SAV growth is directly related to water clarity as clearer water allows greater amounts of sunlight through the water column to reach plants. Upland area draining to Shallow Creek has a much higher percentage of forest and wetland compared to Bear Creek and Old Road Bay. In addition, the presence of forested areas in North Point Park and Fort Howard State Park along the shoreline of Shallow Creek offers a buffer which can intercept sediments that would otherwise harm water clarity. SAV coverage in Bear Creek has steadily declined since its peak in 2005, while SAV coverage in Old Road Bay and Shallow Creek saw peaks in 2010.

3.4.4 Baltimore County Shoreline Enhancement Feasibility Study

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 & Sustainability (EPS), formerly known as the Department of Environmental Protection & Resource Management (DEPRM), has a well established program for waterway improvement and coastal management to protect these resources and meet public demands for access and recreation. Approximately 13 miles of shoreline in the Bear Creek/Old Road Bay watershed were identified as having enhancement potential in EPS'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 work 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 Bear Creek/Old Road Bay watershed are presented in Table 3-22 by subwatershed. This table includes property ownership, reach lengths, adjacent land cover and land use, shoreline change rates, and presence of SAV.

As shown in Table 3-22, a total of 27 reaches within 24 different shoreline properties were investigated in the Bear Creek/Old Road Bay watershed, including 25 publicly-owned properties and two private properties. The locations of these 27 shoreline reaches are approximately shown in Figure 3-8. 11 of the 14 subwatersheds had at least one potential shoreline enhancement property. The shoreline areas investigated are either forested or open pervious. Forested areas present good opportunities for preservation, and open pervious areas such as grassland and open fields may offer opportunities for reforestation. All areas represent an opportunity for resource conservation because there are no impervious surfaces along these shoreline reaches.

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 Table 3-22 were based on scaled measurements and comparisons of Maryland Geological Survey's oldest and more recent shoreline maps. The table shows the greatest rates of changes for shoreline reaches surveyed in the Bullneck Creek, Chink Creek, Bear Creek Headwaters, and Shallow Creek subwatersheds.

Table 3-22: Shoreline Study Results for Bear Creek/Old Road Bay Watershed

					LAND COVER (%)					
	Subwatershed	Reach Name	Ownership	Reach Length (ft)	Open Pervious	Forest	Impervious	Land Use	Erosion/Accretion Rate (ft/yr)	SAV
1	Colgate Creek	Fleming Park - Beach Segment	County	1,100	20%	80%	0%	Park	-1.0	Absent
1A	Peach Orchard Cove	Fleming Park - Marsh Segment	County	2,000	100%	0%	0%	Park	0	Absent
2	Peach Orchard Cove	Turners Park	County	600	100%	0%	0%	Park	0	Absent
3	Peach Orchard Cove	Southeastern Tech Magnet	County	200	50%	50%	0%	School	0	Absent
4	Peach Orchard Cove	Peach Orchard Park	County	4,100	100%	0%	0%	Park	0	Absent
5	Peach Orchard Cove	Watersedge Beach	County	2,600	100%	0%	0%	Park	0	Absent
6	Bullneck Creek	Concrete Homes Park	County	4,200	100%	0%	0%	Park	0	Absent
7	Bullneck Creek	Merritt Point Park	County	5,300	70%	30%	0%	Park	0	Absent
8	Bullneck Creek	Chesterwood Park	County	2,700	30%	70%	0%	Park	-2.9	Absent
9	Lynch Cove	Stansbury Park	County	300	70%	30%	0%	Park	0	Absent
10	Lynch Cove	Lynch Cove Park	County	2,600	60%	40%	0%	Park	-1.4	Absent
11	Lynch Cove	West Inverness Park	County	2,600	100%	0%	0%	Park	0	Present
12	Chink Creek	Sandy Plains ES	County	1,000	70%	30%	0%	School	-2.9	Absent
13	Bear Creek Headwaters	Bear Creek ES	County	2,200	85%	15%	0%	School	-1.4	Absent
14	Bear Creek Headwaters	Bear Creek Park	County	1,900	80%	20%	0%	Park	-2.9	Absent
15	Bear Creek Headwaters	Charlesmont ES	County	1,000	0%	100%	0%	School	0	Absent
16	Bear Creek Headwaters	Battle Monument School	County	1,000	10%	90%	0%	School	-2.9	Absent
17	Bear Creek Headwaters	Charlesmont Park	County	1,200	60%	40%	0%	Park	0	Absent
18	Oakleigh/Schoolhouse Coves	Battle Grove Park	County	300	95%	5%	0%	Park	0	Absent
19	Sparrows Point	Country Club to Lloyd Point	Private	10,000	60%	40%	0%	Industrial	0 to +0.61	Unobserved
20	Jones Creek	Jones Creek - West Shoreline	Private	9,000	60%	40%	0%	Industrial	-1.4	Absent
21	North Point Creek	North Point State Park - Segment I	State	1,200	0%	100%	0%	Park	0	Absent
21A	North Point Creek	North Point State Park - Segment II	State	400	0%	100%	0%	Park	0	Absent
22	Shallow Creek	North Point State Park - Segment III	State	2,200	0%	100%	0%	Park	-5.1	Absent
23	Shallow Creek	Fort Howard Park - Fastland Park Segment	County	2,200	40%	60%	0%	Park	+0.6 to -0.6	Absent
23A	Shallow Creek	Fort Howard Park - Bay Marsh Segment	County	1,600	0%	100%	0%	Park	+0.6 to -0.6	Present
23B	Shallow Creek	Fort Howard Park - Shallow Creek Segment	County	8,200	0%	100%	0%	Park	0	Present

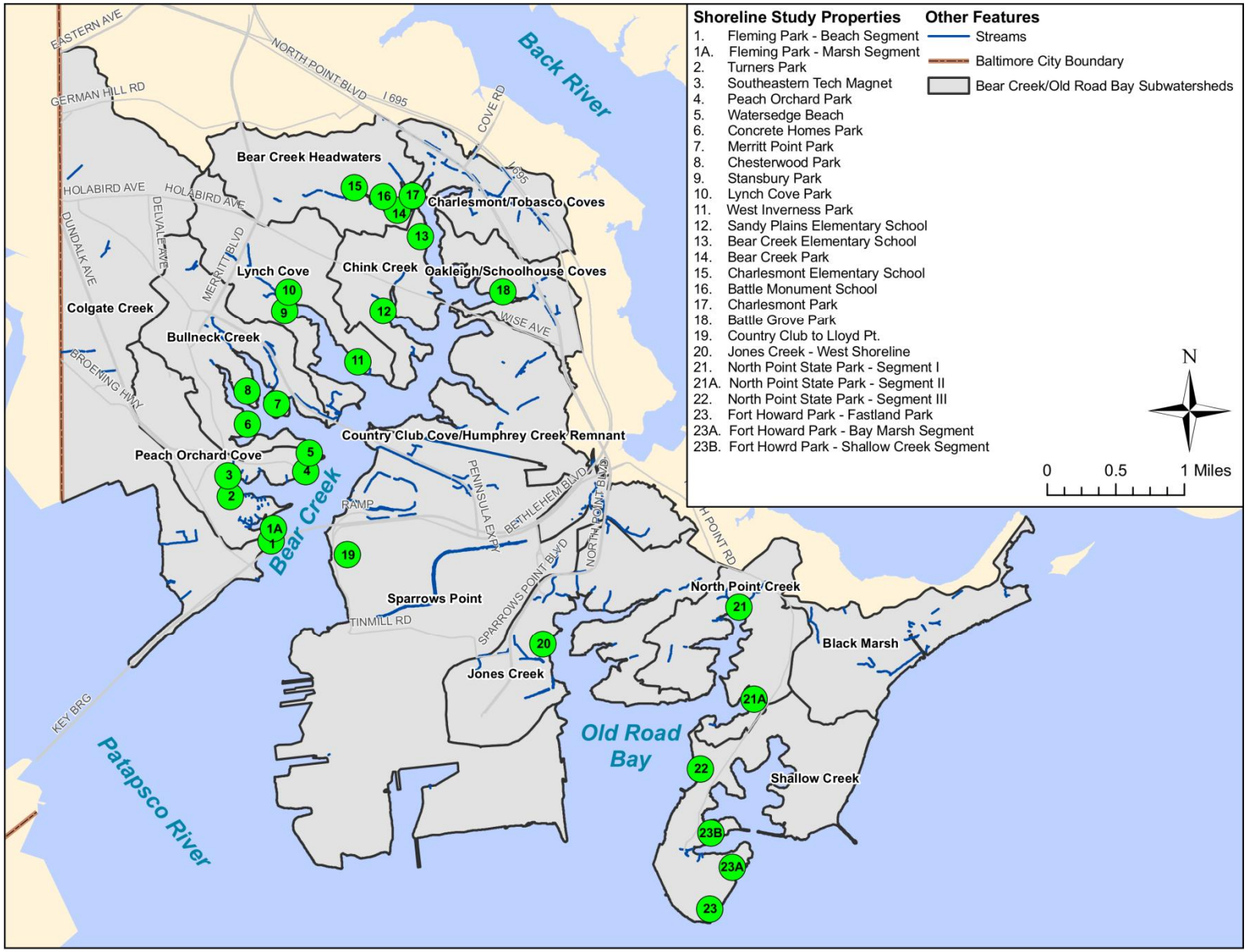

Figure 3-8: Potential Shoreline Enhancement Properties in Bear Creek/Old Road Bay Watershed

After baseline conditions were established and reviewed, Baltimore County EPS 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/feasibility for each category was rated as high (H), medium (M) or low (L) 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 3-23.

Table 3-23: Shoreline Enhancement Feasibility Ratings

	Subwatershed	Reach Name	Erosion Control	Habitat Enhancement	Expand Existing Project	Retrofit Existing Project	Beneficial Use	Completed?
1	Colgate Creek	Fleming Park - Beach Segment	H					**Yes**
1A	Peach Orchard Cove	Fleming Park - Marsh Segment		H				**Yes**
2	Peach Orchard Cove	Turners Park	Complete/Stable					**Yes**
3	Peach Orchard Cove	Southeastern Tech Magnet		L				No
4	Peach Orchard Cove	Peach Orchard Park	L	L				No
5	Peach Orchard Cove	Watersedge Beach				H		**Yes**
6	Bullneck Creek	Concrete Homes Park		H		H		No
7	Bullneck Creek	Merritt Point Park	Complete/Stable					**Yes**
8	Bullneck Creek	Chesterwood Park		M				**Yes**
9	Lynch Cove	Stansbury Park		H				No
10	Lynch Cove	Lynch Cove Park	Complete/Stable					**Yes**
11	Lynch Cove	West Inverness Park			M			No
12	Chink Creek	Sandy Plains ES	M	H				**Yes**
13	Bear Creek Headwaters	Bear Creek ES				M		No
14	Bear Creek Headwaters	Bear Creek Park	L	L		M		**Yes**
15	Bear Creek Headwaters	Charlesmont ES		L				No
16	Bear Creek Headwaters	Battle Monument School		M				No
17	Bear Creek Headwaters	Charlesmont Park				M		**Yes**
18	Oakleigh/Schoolhouse Coves	Battle Grove Park	Complete/Stable					**Yes**
19	Sparrow's Point	Country Club to Lloyd Point	M	H			L	No
20	Jones Creek	Jones Creek - West Shoreline		H			H	No
21	North Point Creek	North Point State Park - Segment I		L				No
21A	North Point Creek	North Point State Park - Segment II		L				No
22	Shallow Creek	North Point State Park - Segment III		M				No
23	Shallow Creek	Fort Howard Park - Fastland Park Segment	H	H			L	No
23A	Shallow Creek	Fort Howard Park - Bay Marsh Segment	H	H			L	No
23B	Shallow Creek	Fort Howard Park - Shallow Creek Segment	Complete/Stable					**Yes**

Potential shoreline enhancement sites were narrowed down based on the feasibility ratings. Projects labeled as complete/stable were completed prior to the study. During the screening process, sites that were labeled as complete/stable or had only one or two low priority ratings were dropped from further consideration. In addition to these, seven other properties were not carried forward:

- The reach at Bear Creek Elementary School has an existing project that could be retrofitted but was not moved forward.
- The reach at Battle Monument School is heavily used for social gatherings and suffers significant degradation due to littering, vandalism, etc. A project of any nature will likely be difficult to construct and maintain.
- The reach at Charlesmont Park has potential for a minor retrofit project that can be addressed through a design-build type contract and was not moved forward.
- The reach at North Point Park – Segment III was thought to have limited erosion control potential for habitat enhancement other than phragmites control.
- Chesterwood Park was, during the time of the study, under design for waterside improvements including derelict boat removal facilities.
- Sandy Plains Elementary School was implemented and improved during the study.
- The reach from Bear Creek Country Club to Lloyd Point was dropped from consideration because the site is privately owned and the beneficial use component of the project was not needed since all channels in Bear Creek had been recently dredged.

In addition to the Complete/Stable projects shown in Table 3-23, Baltimore County has completed shoreline enhancement projects at Fleming Park, Watersedge Park, and Bear Creek Park subsequent to the 1998 feasibility study. After the screening process and eliminating the subsequent projects, 6 shoreline enhancement projects remained in the Bear Creek/Old Road Bay watershed for potential enhancement including:

- Concrete Homes Park – shoreline protection retrofit and ecological enhancement
- Stansbury Park – habitat enhancement
- West Inverness Park – shoreline protection expansion and ecological enhancement
- Jones Creek – beneficial use of dredged material, marsh creation
- Fort Howard Park (Fastland Park and Bay Marsh segments) – shoreline protection retrofit, ecological enhancement, and beneficial use of dredged material
- North Point State Park – shoreline protection and ecological enhancement

3.4.5 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 Baltimore County's 219 miles of

shoreline. Recreational and commercial boating and the industries it supports have become a significant component of the County's economy.

Baltimore County EPS 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 Vessel 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 EPS 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 carrying out 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 EPS has planned, designed, permitted, and overseen the construction of dredging projects in several locations within the Bear Creek/Old Road Bay planning area. Figure 3-9 shows the waterway dredging projects that have been completed within the Bear Creek/Old Road Bay watershed. Baltimore County EPS and DNR maintains aids to navigation on these waterways, however DNR will maintain all aids to navigation effective 2013. EPS also collects SAV data as a key indicator of waterway health and conducts annual monitoring for all creeks that are dredged (see Chapter 3.4.3). Bathymetry surveys in the next several years will help to determine the need and frequency of future maintenance dredging.

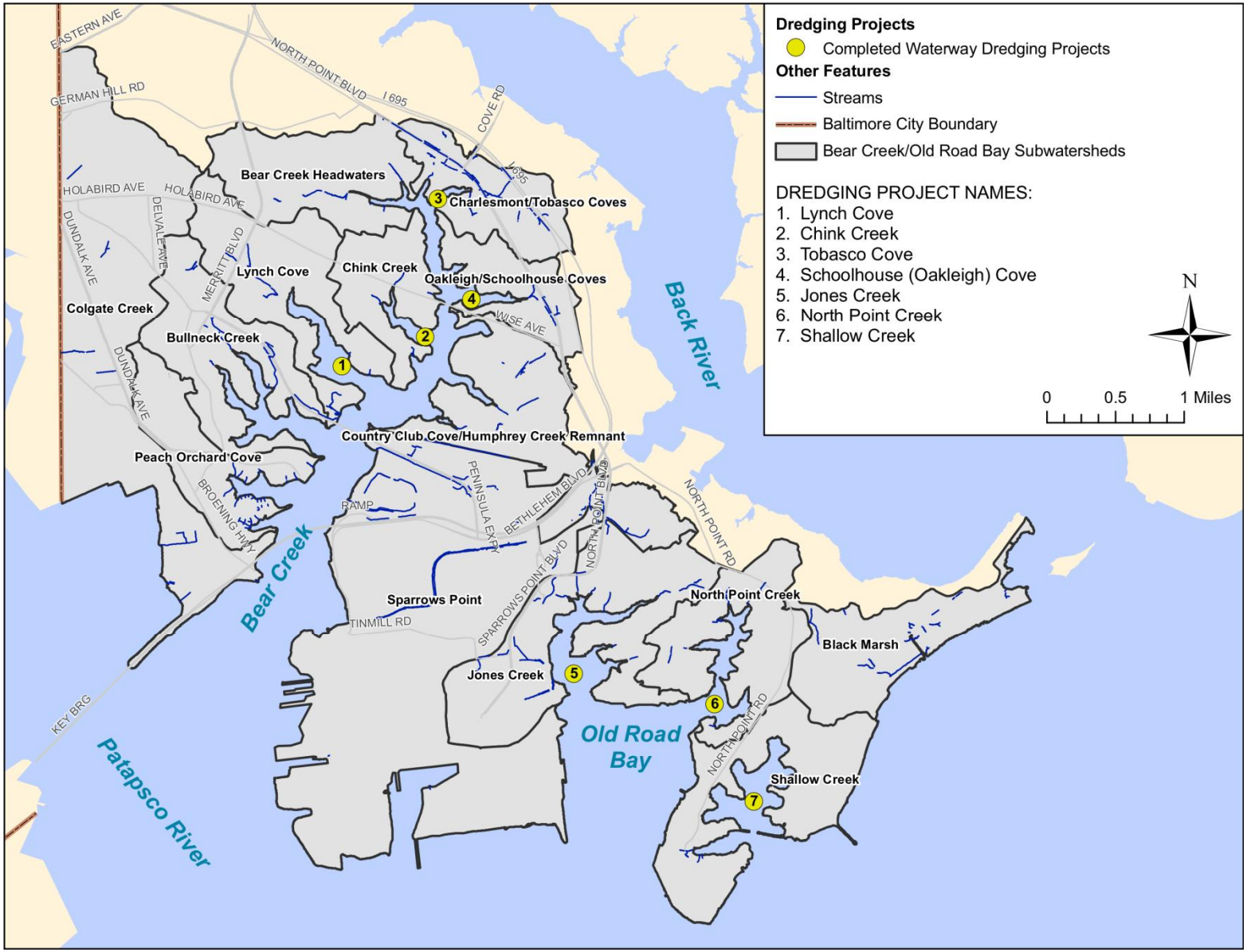

Figure 3-9: Bear Creek/Old Road Bay Completed Waterway Dredging Projects

3.4.6 Illicit Discharge and Elimination Data

Baltimore County monitors illicit discharges from its storm sewer system 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 3,628 outfalls based on storm drain spatial data provided by Baltimore County EPS. About 80 percent of these (2,912) are minor outfalls (less than 3 feet in diameter) which are not prioritized. Of the remaining 716 major outfalls (greater than 3 feet in diameter), 593 of them have a prioritization rating. 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 that have been screened only once or have not been screened 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.

Under the 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 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.
- ***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.

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 37 major outfalls in the Bear Creek/Old Road Bay watershed (see Figure 2-15). Table 3-24 summarizes the priority ratings for these outfalls by subwatershed.

Table 3-24: Baltimore County Storm Drain Outfall Prioritization Results for Bear Creek/Old Road Bay

Subwatershed	OUTFALL PRIORITY RATING				Total
	Priority 1	Priority 2	Priority 3	Priority 0	
Colgate Creek	2	1	0	2	5
Peach Orchard Cove	1	0	1	0	2
Bullneck Creek	2	1	0	2	5
Lynch Cove	1	1	0	3	5
Chink Creek	0	1	1	0	2
Bear Creek Headwaters	3	1	2	1	7
Charlesmont/Tobasco Coves	0	1	0	0	1
Oakleigh/Schoolhouse Coves	0	2	1	0	3
Country Club Cove/Humphrey Creek Remnant	0	0	0	1	1
Jones Creek	1	1	0	1	3
North Point Creek	0	0	3	0	3
Shallow Creek	0	0	0	0	0
Black Marsh	0	0	0	0	0
Sparrows Point	0	0	0	0	0
Total	***10***	***9***	***8***	***10***	***37***

As shown, Bear Creek Headwaters has the most number of major outfalls as well as the most number of Priority 1 outfalls out of all subwatersheds in Bear Creek/Old Road Bay. Colgate Creek, Bullneck Creek, and Lynch Cove have the next highest number of major outfalls, each having one or two Priority 1 outfalls. These subwatersheds have large stretches of medium and high density residential and commercial areas that are contributing runoff to the critical and high priority outfalls.

3.5 Sewer Overflow Impacts

Sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) are often unavoidable 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 oil and grease, and vandalism. Raw sewage can enter nearby streams when flows exceed the sanitary sewer system's capacity 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. For example, *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 such as nitrogen and phosphorus which are toxic to aquatic life and can lead to depletion of 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 in compliance with the consent decree, such as capital projects, equipment upgrades, and operations improvements, will reduce nutrients and bacteria entering streams in the Bear Creek/Old Road Bay watershed. However, this may not address all impacts associated with the sanitary sewer system since the consent decree only targets overflows and does not include sewer main leaks. Depending on the location of the leaks, which are typically at pipe joints, the sanitary sewer system may still have adverse impacts to the stream system.

Table 3-25 summarizes the number of SSO events documented and approximate volume discharged between 2000 and 2011, based on Baltimore County's SSO spatial data. Table 3-26 summarizes the estimated volume of overflow and associated pollutant loads during this period by subwatershed.

Table 3-25: Sanitary Sewer Overflow Volumes in Bear Creek/Old Road Bay (2000-2011)

Year	# of SSO Events	Volume of Overflow (gal)
2000	1	43,000
2001	3	1,275
2002	8	225,915
2003	7	10,343
2004	2	141,000
2005	1	50
2006	3	4,900
2007	2	7,700
2008	2	2,010
2009	0	0
2010	4	2,750
2011	2	1,050
Total	**35**	**439,993**

From 2000 through 2005, SSO events accounted for 421,583 gallons of leaked sewage in the Bear Creek/Old Road Bay planning area compared with 18,410 gallons from 2006-2011, after the consent decree was finalized. This 95% decline could be attributed to projects implemented after the release of the consent decree. For example, improvements to pumping stations in the area have improved the

sewer system and decreased overflows. Events with the largest overflows were attributed to power outages, defective valves, or other problems that occurred at pumping stations.

Table 3-26: Sanitary Sewer Overflow Volumes and Pollutant Loads by Subwatershed

Subwatershed	# of SSO Events	Volume of Overflow (gal)	TP (lbs)	TN (lbs)	FC (MPN)
Colgate Creek	2	4,125	0.3	1.0	9.9E+11
Peach Orchard Cove	6	21,693	1.8	5.4	5.2E+12
Bullneck Creek	1	6,000	0.5	1.5	1.4E+12
Lynch Cove	4	1,710	0.1	0.4	4.1E+11
Chink Creek	1	140,000	11.6	35.0	3.4E+13
Bear Creek Headwaters	4	2,315	0.2	0.6	5.6E+11
Charlesmont/Tobasco Coves	1	1,500	0.1	0.4	3.6E+11
Oakleigh/Schoolhouse Coves	10	257,700	21.4	64.4	6.2E+13
Country Club Cove/Humphrey Creek Remnant	2	2,500	0.2	0.6	6.0E+11
Jones Creek	0	0	0	0.0	0
North Point Creek	1	2,400	0.2	0.6	5.8E+11
Shallow Creek	0	0	0	0.0	0
Black Marsh	1	50	4.2.E-03	1.3.E-02	1.2E+10
Sparrows Point	0	0	0	0.0	0
Total	***33***	***439,993***	***36.6***	***110.0***	***1.1E+14***

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 3-10 shows the location of SSO events reported during 2000 to 2011 in the Bear Creek/Old Road Bay watershed. The largest overflow events during this period have occurred in the Oakleigh/Schoolhouse Cove, Chink Creek, and Peach Orchard Cove subwatersheds. The two largest SSO events were 140,000 gal (pumping station on Wise Avenue in the Chink Creek subwatershed) and 190,000 gal (on East Battle Grove Road in the Oakleigh/Schoolhouse Cove subwatershed). The greatest number of SSO incidents by far has been reported in the Oakleigh/Schoolhouse Cove subwatershed, where ten events occurred at the sewage pumping station on North Point Boulevard. All of these areas have the potential for follow-up inspection and addressing SSO problems.

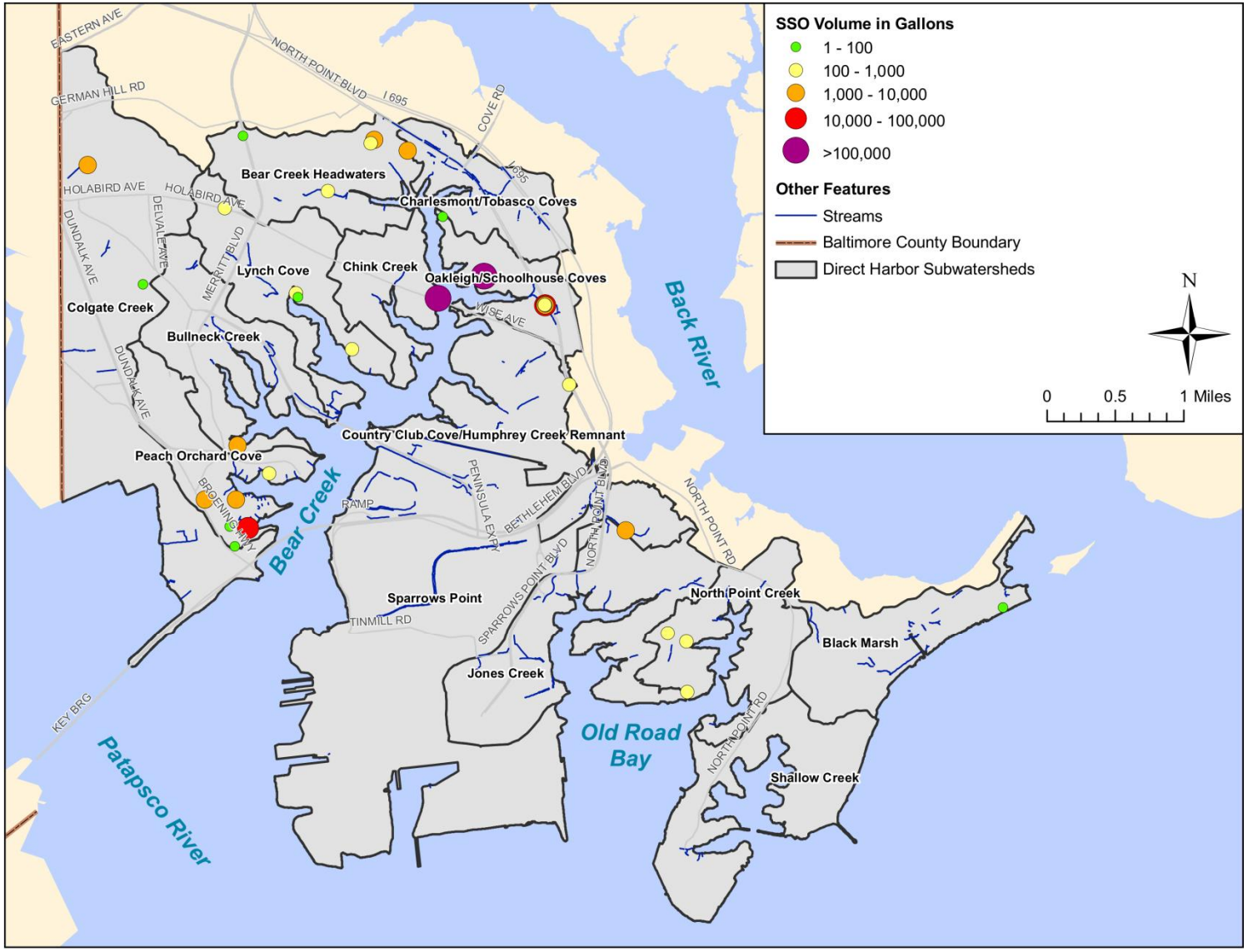

Figure 3-10: Sanitary Sewer Overflow Locations in Bear Creek/Old Road Bay Watershed (2000-2011)

3.6 Stormwater Management Facilities

Existing SWM facilities within the Bear Creek/Old Road Bay watershed were investigated for potential conversion to water quality management facilities. As discussed in Chapter 2, there are a total of 52 SWM facilities that have been built within the planning area according to Baltimore County EPS's database. These include dry and wet ponds, underground detention facilities, wetlands, filtration/infiltration practices, extended detention, proprietary BMPs, grassed swales and channels. Approximately 30% of these SWM facilities are filtration/infiltration practices or extended detention facilities. These practices are considered to have higher pollutant removal capabilities, since storm water 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 improvements features.

Of the 52 existing facilities, nine (9) are dry detention ponds which are typically designed to address water quantity only (flood control), providing 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. Each of the nine (9) facilities was assessed for potential conversion to an extended detention facility.

Dry extended detention ponds are designed to capture and retain stormwater runoff for a minimum duration (e.g., 24 hours) to allow pollutants to settle out while also being able to provide flood control if additional storage is incorporated into the design. The locations of the 9 assessed detention ponds in the Bear Creek/Old Road Bay watershed are shown in Figure 3-11. Information was collected in the field to assess the existing conditions and conversion potential of each dry detention pond in the Bear Creek/Old Road Bay watershed. SWM assessment criteria are listed in Table 3-27. SWM_D_926 and SWM_D_927 are listed in the County's database as separate ponds, but due to their hydraulic-conductivity, they are treated as one facility in this report. Each of the detention ponds are described briefly below including key findings, pond maintenance and retrofit recommendations, and site photos. Field evaluation forms and conceptual design sketches are included in Appendix B.

Table 3-28 summarizes the available information obtained from Baltimore County EPS's database including structure location, ownership, design capacity (drainage area, storm event), and as-built date (if available). Note that Site ID numbers correspond to structure numbers in the County database. Field data findings are summarized in Table 3-29. Six (6) out of the nine (9) detention ponds have potential for water quality improvements such as conversion to an extended detention facility or incorporation of filtration/infiltration practices.

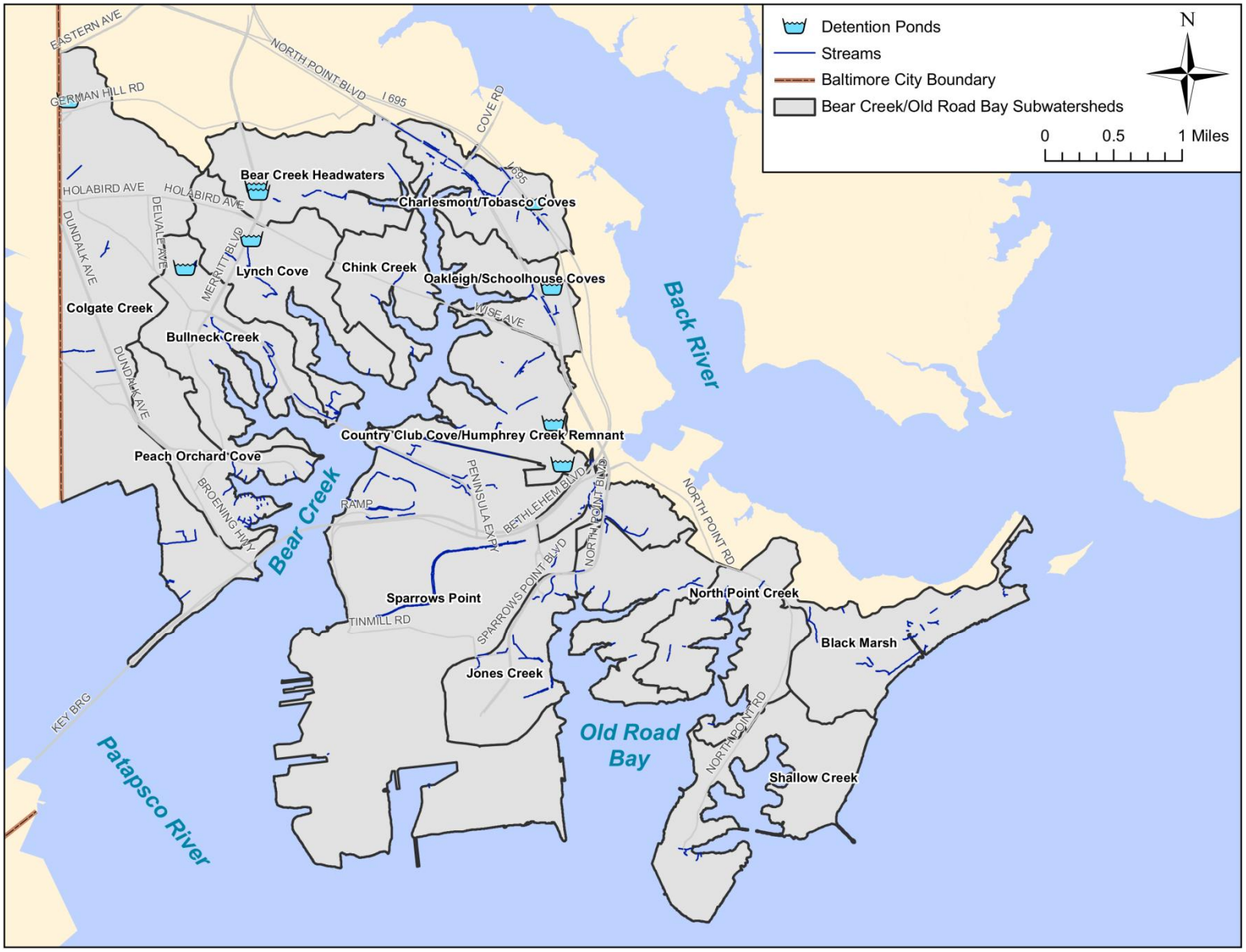

Figure 3-11: Detention Ponds Assessed for Conversion Potential in Bear Creek/Old Road Bay

Table 3-27: SWM Facility Assessment Criteria

Pond No._____ Staff:_____ Date:_____

ADC Map:_____ Nearest Road:_____

Database Pond Type:_____ Field Pond Type:_____

Pond Drainage Area:_____

Pond Ownership: (circle one) Public Private Unknown

Pond Condition: Check all that apply

Riser: ☐ Good Condition ☐ Damaged

Describe Damage:_____

Embankment ☐ No problems ☐ Trees on Embankment ☐ Erosion

☐ Holes in the embankment

Vegetation Pond bottom ☐ Wetland vegetation ☐ Trees ☐ Bare soil erosion

Fence/gate ☐ Fence in good condition ☐ Fence need repair ☐ No Fence

☐ Gate locked ☐ Gate unlocked ☐ No Gate

Conversion Potential: Check all that apply

Pond field type conducive to conversion: ☐ Yes ☐ No

Pond is on line: ☐ Yes ☐ No

Ease of access: ☐ Easy ☐ Moderate ☐ Difficult

Flow routing: ☐ Short flow path ☐ Long flow path

Comments On Conversion Potential:

_____

_____

Table 3-28: Detention Pond Information from Baltimore County Database

Site ID	Subwatershed	Structure Name	Nearest Road	Ownership	DA_Acres	Pond Design	Pond As-Built
SWM_D_234	Country Club Cove/Humphrey Creek	Greif Brothers	Grays Rd	Private	7.14	2, 10, 100	5/13/1991
SWM_D_290	Country Club Cove/Humphrey Creek	Amtrol Inc	Grays Rd	Private	8.90	2, 10, 100	6/1/1980
SWM_D_326	Charlesmont/Tobasco Cove	Benhoff Property - East Facility Pond 1	North Point Rd	Private	1.44	2, 10, 100	10/2/1986
SWM_D_463	Bullneck Creek	Dundalk Community College	Community College Dr	Private	42.49	2, 10, 100	
SWM_D_722	Charlesmont/Tobasco Cove	National Wire Product	Fischer Rd	Private	12.40	2, 10, 100	
SWM_D_726	Lynch Cove	North Point Government Center	Merritt Blvd/Wise Ave	Public	7.28	2, 10	
SWM_D_926	Bear Creek Headwater	Towne Center Shopping Center South Basin	Merritt Blvd/Ives Ln	Private	40.00	10	5/16/1980
SWM_D_927	Bear Creek Headwater	Towne Center Shopping Center North Basin	Merritt Blvd/Ives Ln	Private	28.10	10	5/16/1980
SWM_D_1420	Colgate Creek	Boston Courts Pond 1	Villager Circle	Public	78.90	2, 10, 100	

Table 3-29: Detention Pond Field Assessment Summary

Site ID	Riser	Embankment	Bottom	Fence	Gate	Water Quality Potential	Connection	Access	Flowpath
SWM_D_234	N/A	No Problems	Wetland Veg.	No Fence	No Gate	Y	Offline	Easy	Long
SWM_D_290	Unable to Verify	Unable to Verify	Wetland Veg.	No Fence	No Gate	Y	Unable to Verify	Moderate	Unable to Verify
SWM_D_326	Good Condition	Trees	Turf Grass	Good Condition	Locked	Y	Offline	Easy	Long
SWM_D_463	Good Condition	Trees	Turf Grass	No Fence	No Gate	Y	Online	Easy	Long
SWM_D_722	Good Condition	Holes	Turf Grass	Good Condition	Locked	Y	Offline	Easy	Short
SWM_D_726	Good Condition	Trees	Turf Grass	No Fence	No Gate	Y	Offline	Easy	Long
SWM_D_926	Good Condition	No Problems	Wetland Veg.	Good Condition	Unlocked	N	Online	Easy	Long
SWM_D_927	Good Condition	No Problems	Wetland Veg.	Good Condition	Unlocked	N	Online	Easy	Long
SWM_D_1420	Good Condition	Trees	Wetland Veg.	Repair Needed	Locked	N	Offline	Difficult	Unable to Verify

SWM_D_234

Detention Pond, SWM_D_234, is a privately-owned facility, located in the Country Club Cove and Humphrey Creek subwatershed at an industrial facility off of Grays Road. This pond is designed to handle runoff from the 2-, 10-, and 100-year events from a 7.14-acre industrial facility. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- The facility lacks a downstream berm or dam, causing captured runoff to flow directly to the downstream channel without any significant detention.
- There is easy access from the truck loading area and employee parking lots.
- The facility shows signs of invasive vegetation including Phragmites in the facility and Japanese honeysuckle along the embankment.
- There is potential for horizontal expansion to the existing turf area between the existing building and the north side of the facility.

Pond Maintenance Recommendation

- Remove small trees from the embankment on the sides of the pond.
- Invasive species management

Pond Retrofit Recommendation

- Install pretreatment forebays at existing grass swale outfalls.
- To increase the limited detention time of the facility, construct a protected earthen berm or weir at the outfall.
- Extend the flow path from the inflow to the outfall by constructing zigzagging swales and berms and/or baffle boards on the bottom of pond.

Figure 3-12: Invasive Species (left) and Outlet Channel (right) at Detention Pond SWM_D_234

SWM_D_290

Detention Pond, SWM_D_290, is a privately-owned facility, located in the Country Club Cove and Humphrey Creek subwatershed at the end of Grays Road. This pond is designed to handle runoff from the 2-, 10-, and 100-year events from an 8.9-acre industrial facility. SWM_D_290 was engulfed by phragmites on the embankment and pond bottom, making an assessment of the operating conditions of the pond difficult. If maintenance at the pond in question occurs the pond may have some conversion potential. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- The exterior of the pond is accessible from a truck loading area.
- Excessive invasive species vegetation was found on the bottom and along the embankment.
- Inflow from the pond arrives through a curb cut from the truck loading area.

Pond Maintenance Recommendation

- Mow the embankment of the pond.
- Invasive Species Management

Pond Retrofit Recommendation

- Install pretreatment forebays at existing curb cut.
- Investigate possibilities for relandscaping pond with native species in order to enhance accessibility to the pond for proper vegetative maintenance in the future.

Figure 3-13: Excessive Invasive Vegetation (left) and Curb Cut Entrance (right) at Detention Pond SWM_D_290

SWM_D_326

Detention Pond, SWM_D_326, is a privately-owned facility, located in the Charlesmont and Tobasco Cove subwatershed off of North Point Road. This pond is designed to handle runoff from the 2-, 10-, and

100-year events from a 1.44-acre industrial facility. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- The pond is easily accessible from North Point Road.
- Long term vehicular storage is contained within the ponding limits. (Boats, RV's, and old Cars)
- Trees were found growing on the pond embankment
- The pond bottom is mostly comprised of turf grass.

Pond Maintenance Recommendation

- Investigate impact of trees on the pond embankment and underground barrel from the riser structure.
- Remove vehicular storage within ponding limits.

Pond Retrofit Recommendation

- Investigation potential for conversion of pond to a sand filter or bioretention facility, due to small drainage area and evidence of alternative uses within the facility limits.
- Investigate potential for inclusion of native vegetation within the pond.

Figure 3-14: Vehicular Storage at Detention Pond SWM_D_326

SWM_D_463

Detention Pond, SWM_D_463, is listed as a privately-owned facility, located in the Bullneck Creek subwatershed off of Community College Driveway. Its location at the Community College of Baltimore County's Dundalk campus indicates that the pond could be considered public. This pond is designed to handle runoff from the 2-, 10-, and 100-year events from a 42.49-acre community college campus and parking lots. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- The pond is easily accessible from Community College Driveway.
- There are trees on pond embankment.
- The pond bottom is mostly comprised of turf grass with some invasive species (Phragmites) present.
- There were significant channelized areas in the pond bottom from the inflow pipes to the outflow pipes, causing smaller storms to not utilize the entire pond surface area. The channels act to decrease the detention time and potential evapotranspiration during smaller storm events.
- There is room for horizontal expansion on the south side of the pond. This area is currently grassed lawn with some pine trees.
- There were signs of the emergency spillway being used during Tropical Storm Lee.
- Concrete along the emergency spillway channel is starting to deteriorate.

Pond Maintenance Recommendation

- Remove trees from pond embankment.
- Invasive Species Management
- Repair emergency spillway channel.

Pond Retrofit Recommendation

- Install pretreatment forebays at existing grass swale outfalls.
- Construct maintenance access roads directly to the forebays.
- Excavate below the existing pond bottom in order to provide additional water quality volume.
- The large area of the pond provides potential retrofit possibilities including installation of forebays that could flow into shallow wetlands and then into a deep micropool before discharge.
- Existing low-flow channels could be removed to utilize the entire pond's surface area or converted into vegetative swales to provide water quality treatment to smaller storms which contain the majority of pollutants from the drainage area.

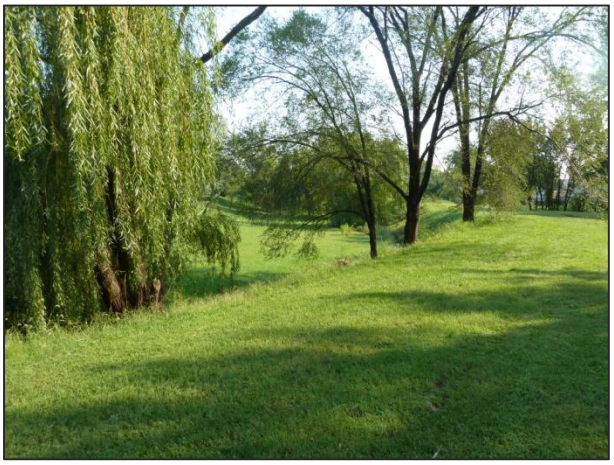

Figure 3-15: Channelized Inflow Path (left) and Potential Expansion Area (right) at Detention Pond SWM_D_463

SWM_D_722

Detention Pond, SWM_D_722, is a privately-owned facility, located in the Charlesmont/Tobasco Cove subwatershed at the end of Fischer Road. This pond is designed to handle runoff from the 2-, 10-, and 100-year events from a 12.4-acre industrial facility. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- Pond is accessible along the north side from gravel parking lot.
- Inflow enters into the facility from curb cuts from the gravel parking lot.
- Pond bottom is mowed with some invasive vegetation (Phragmites).
- The area on the northeast side of the pond is currently gravel parking lot at an industrial facility that currently appears to not be in use. There is potential for horizontal expansion on this side of the pond if the facility is truly not in use.

Pond Maintenance Recommendation

- Repair embankment from damage incurred from burrowing animals.
- Invasive Species Management
- Unclog existing inflow filled with sediment from the adjacent gravel parking lot draining to the pond.

Pond Retrofit Recommendation

- Extend the short flow path from the inflows to the outfall by constructing small swales along the perimeter of the pond and the berm in the center of the pond.
- Excavate below the existing pond bottom in order to provide water quality volume. Construct a shallow wetland along the perimeter and a micropool at the end of the pond.
- Extend the detention time by decreasing the low flow orifice size from the present 24” opening.

Figure 3-16: Outlet Structure (left) and Adjacent Gravel Lot (right) at Detention Pond SWM_D_722

SWM_D_726

Detention Pond, SWM_D_726, is a public-owned facility, located in the Lynch Cove subwatershed off of Merritt Boulevard near the County Police Station. This pond is designed to handle runoff from the 2-and 10-year events from a 7.28-acre police station and county park. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- The facility is easily accessible from the police station entrance.
- Flow enters the facility through curb cuts from the gravel parking lot. Trash and sandy sediment were present at inflows.
- The pond bottom consists of mowed turf grass with channelized areas leading from the inflows directly to the outlet structure, lessening detention time and evapotranspiration during smaller storm events.
- Trees were found on the downstream side of the pond embankment.
- The low flow orifice is missing a trash rack.
- There is potential for horizontal expansion on the eastern side of the pond. This area is currently grass.

Pond Maintenance Recommendation

- Clean out sediment around inflows.
- Add trash rack to low flow orifice.
- Remove trees from pond embankment.

Pond Retrofit Recommendation

- Install pretreatment forebays at existing grass swale outfalls.
- Construct maintenance access roads directly to proposed forebays.

- Excavate below the existing pond bottom in order to provide water quality volume. Direct flow from the forebays into a shallow wetland and then into a deep micropool before discharging with a submerged reverse slope low flow pipe.
- Extend the short flow path from the inflows to outfall by constructing a small meandering swale along the bottom of the pond.

Figure 3-17: Channelized Areas Leading to Outlet Structure (left) and Receiving Stream (right) at Detention Pond SWM_D_726

SWM_D_926 and SWM_D_927

Detention Ponds, SWM_D_926 and SWM_D_927, are privately-owned facilities, located in the Bear Creek Headwaters subwatershed off of Merritt Boulevard. The ponds are separated by an earthen berm with a 36" culvert providing hydraulic connectivity. SWM_D_927 is designed to handle runoff from the 10-year events from the Dundalk Professional Center and Merritt Boulevard 28.1-acre development. Flow exiting through the 36" culvert at SWM_D_927 then enters SWM_D_926, which is designed to handle runoff from the 10-year events from the Dundalk Professional Center and Merritt Boulevard 40.0-acre development. Key findings, pond maintenance and retrofit recommendations are listed below.

<u>Key findings</u>

- Both facilities are easily accessible from the Dundalk Professional Center.
- The facilities are hydraulically connected by a 36" culvert through an earthen berm.
- Both facilities have invasive vegetation (phragmites) along the bottom.
- Both facilities are constrained horizontally on all sides, so there is no potential for horizontal expansion.
- Both facilities are constrained vertically by the steep side slopes, so there is no potential for excavation for water quality treatment.

<u>Pond Maintenance Recommendation</u>

- Invasive Species Management

- Remove trees threatening the stability of the pond embankment or over existing outlet pipes.

Pond Retrofit Recommendation

- No recommendation due to limited expansion capability.

Figure 3-18: Invasive Species (left) and Embankment Separating Facility from Parking Area (right) at Detention Pond SWM_D_926

Figure 3-19: Invasive Species (left) and Hydraulic Connection Pipe (right) at Detention Pond SWM_D_927

SWM_D_1420

Detention Pond, SWM_D_1420, is a publicly-owned facility, located in the Colgate Creek subwatershed off of Villager Circle. This pond is designed to handle runoff from the 2-, 10-, and 100-year events from a 78.9-acre townhouse development. Key findings, pond maintenance and retrofit recommendations are listed below.

Key findings

- There is an access gate in the perimeter fence at Villager Circle, but dense vegetation makes vehicle access difficult. The side embankments are extremely steep.

- Pond is hydraulically connected to a wet detention facility by three (3) 42" reinforced concrete pipes.
- The facility's bottom has invasive vegetation (Phragmites and Japanese Honeysuckle).
- Evidence of trash dumping was observed along the embankments. No trees were observed on the pond embankment.
- The facility has an existing micro-pool that flow enters prior to the outfall pipes.
- The existing pond is constrained horizontally on all sides, so there is no potential for horizontal expansion.
- The existing pond is constrained vertically by the steep side slopes, so there is no potential for excavation for water quality treatment.

Pond Maintenance Recommendation

- Invasive Species Management
- Clean up trash around pond.

Pond Retrofit Recommendation

- No recommendation due to limited expansion capability.

Figure 3-20: Dense Invasive Vegetation (left) and Access Gate (right) at Detention Pond SWM_D_1420

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 evaluate 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 consultants 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, inlet cleaning, and open space management.

The field survey of upland areas in the Bear Creek/Old Road Bay watersheds included six major components:

- Neighborhood Source Assessment (NSA)
- Hotspot Site Investigation (HSI)
- Institutional Site Investigation (ISI)
- Pervious Area Assessment (PAA)
- Marina Site Visits (MAR)
- Industrial Site Visits (IND)

The last two components, Marina and Industrial Site Visits, have been added to the typical list of upland categories as they are unique to the Bear Creek/Old Road Bay planning area. Each of the above 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 Bear Creek/Old Road Bay watersheds.

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 photography provided by Baltimore County OIT. A neighborhood was delineated based on a group of homes with similar characteristics including lot sizes, road widths, setbacks, year houses were built, and house types (apartment complex, row homes, single family detached, etc.) NSAs were identified using the classification scheme “NSA_D_01”, where ‘D’ denotes the Bear Creek/Old Road Bay planning area, 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 separate 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_D_28 but was divided into two separate NSAs because of characteristics observed in the field, they would be denoted as NSA_D_28a and NSA_D_28b.

The field team conducted the initial assessments together in order to calibrate many of the assessment criteria. To complete an assessment, the field team drove through 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, parking lots, 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 management. Potential pollution sources evaluated under the yards and lawns category include grass cover and management status (fertilization and irrigation methods), bare soil, outdoor swimming pools, and junk or trash. The field team also identified the proportions of impervious cover, grass cover, landscaping, and bare soil within each neighborhood. The amount of existing tree cover and landscaping was then compared to the other cover types to evaluate potential for increasing these features and providing water quality benefits through interception and filtration of stormwater runoff.

Driveways, Parking Lots, Sidewalks, and Curbs

Driveways, sidewalks, and curbs are common in many urban subwatersheds and convey 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 (source of 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 barrels, 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, stormwater management, storm drain marking, and how natural areas or buffers are managed. Good maintenance of these areas indicates that residents or a homeowner's association are active in caring for the neighborhood 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, stormwater management practices, and stream buffer planting was also evaluated.

Other NSA Information

In addition to these four source areas, basic information was collected in individual neighborhoods to help rate restoration potential. This information included lot size, house types, fraction of houses with basements and garages, and whether a homeowners' association exists for the community. Presence of sewer service and amount of remodeling or redevelopment activities were also identified for additional potential pollution sources. 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 in the following categories: 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 or boats, oil and grease would be flagged as a potential major pollutant being generated in that neighborhood. The presence of trash in yards, dumping in common areas, or overflowing/uncovered dumpsters 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 or redevelopment was occurring, and/or a considerable portion of the curb and gutters were covered with sediment.

Recommended Actions

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 Bear Creek/Old Road Bay watershed NSAs included:

- Downspout disconnection
- Fertilizer reduction/education
- Bayscaping
- Storm drain marking
- Street tree and shade tree planting
- Street sweeping
- 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. A 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 91 neighborhoods were assessed throughout the Bear Creek/Old Road Bay watersheds (see Figure 4-1). The number of neighborhoods within each subwatershed is summarized in Table 4-1. Note that a neighborhood may overlap multiple subwatersheds; in this case, the neighborhood is counted once 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
Colgate Creek	34
Peach Orchard Cove	15
Bullneck Creek	10
Lynch Cove	13
Chink Creek	10
Bear Creek Headwaters	9
Charlesmont/Tobasco Coves	7
Oakleigh/Schoolhouse Coves	4
Country Club Cove/Humphrey Creek Remnant	5
Jones Creek	7
Northpoint Creek	6
Shallow Creek	4
Black Marsh	2
Sparrows Point	0

The majority of the assessed neighborhoods, 70 out of 91, were rated as having moderate PSI and moderate ROI. Three (3) neighborhoods were considered to have both high PSI and high ROI; and two (2) neighborhoods had high ROI and moderate PSI. Of the neighborhoods with a moderate PSI, ten (10) had a high ROI and four (4) were categorized as having a low ROI. The remaining two (2) neighborhoods were registered as "None" under PSI and had a moderate ROI. The neighborhoods with high PSI or 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.

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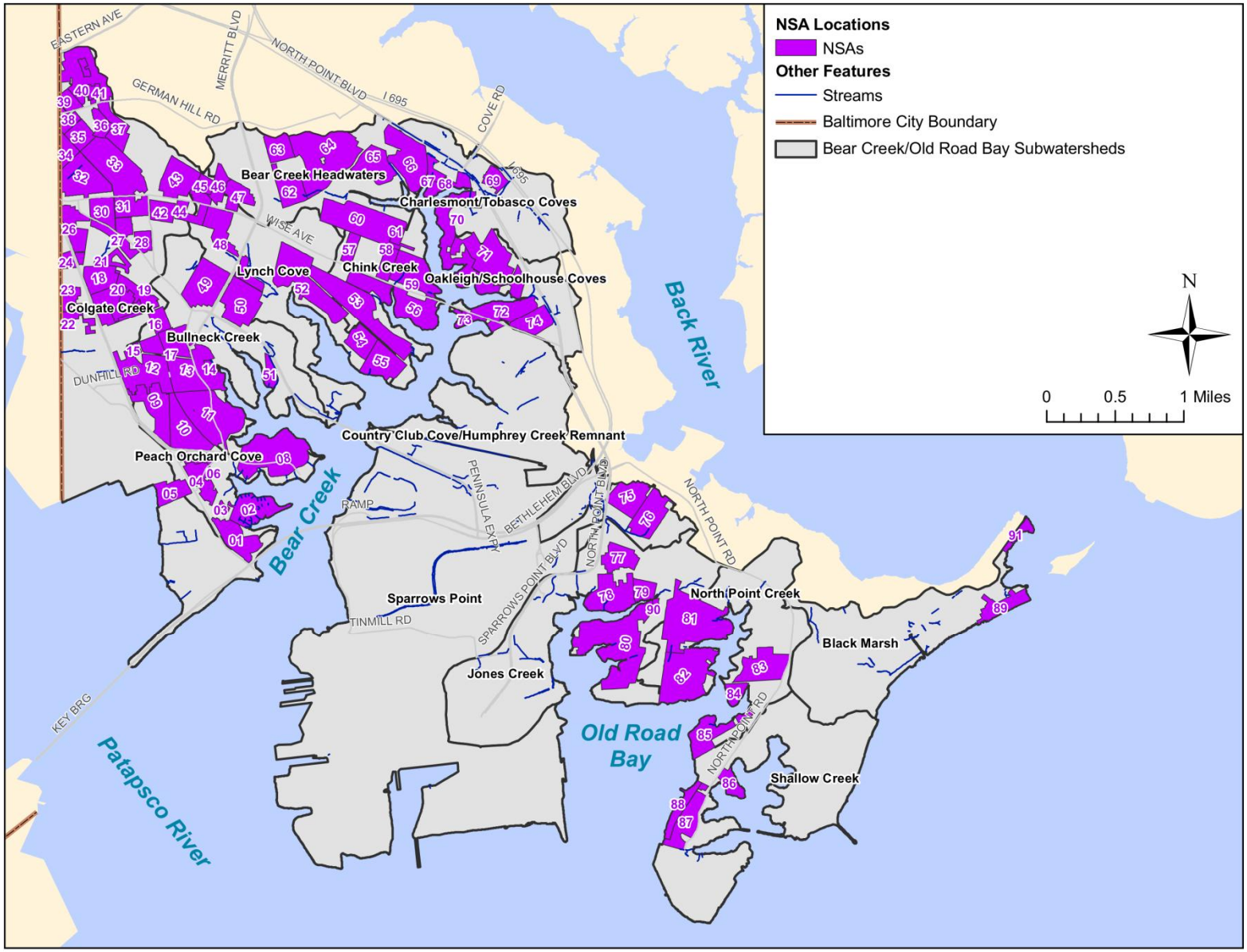

Figure 4-1: Location of NSAs in Bear Creek/Old Road Bay Watersheds

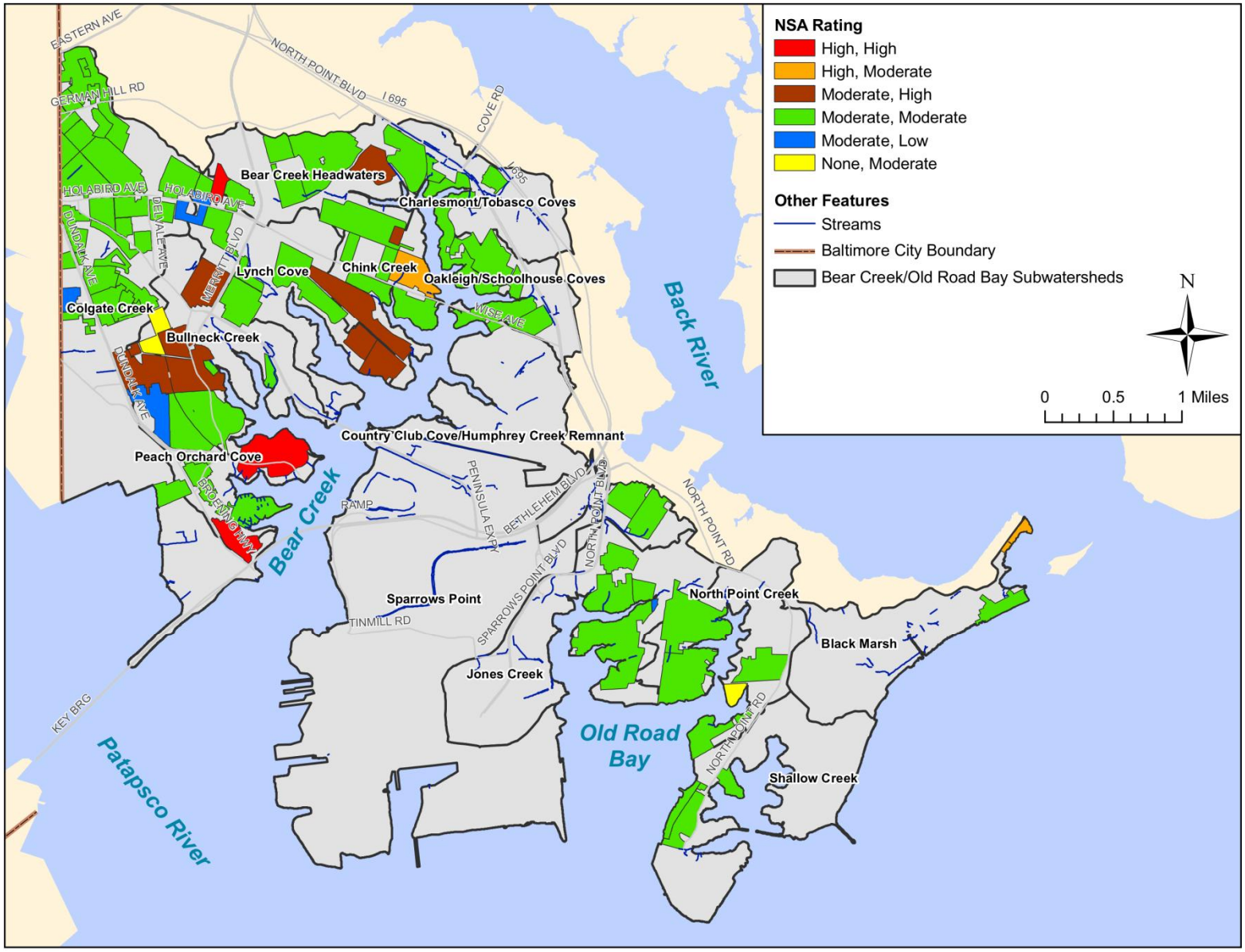

Figure 4-2: NSA Pollution Severity and Restoration Opportunity Indices in Bear Creek/Old Road Bay Watersheds

4.2.3 General Findings

The following subsections describe the actions recommended based on evaluation of the NSAs. This includes an explanation of the methodologies and criteria used to evaluate the potential for recommended actions, as well as 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 classified 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 to the 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 yard has over one-hundred square feet of lawn area available down gradient from the downspout.

Downspout redirection is recommended for neighborhoods where at least 25% 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 total impervious rooftop area in each subwatershed that would be addressed if downspout redirection were implemented. The total impervious rooftop area per subwatershed was calculated using 2008 buildings spatial data provided by Baltimore County OIT.

Table 4-2: Rooftop Acres Addressed by Downspout Redirection

Subwatershed	# of NSAs Recommended for Downspout Redirection*	Rooftop Acres Addressed	% of Subwatershed Rooftop Area Addressed
Colgate Creek	30	83.8	45.8%
Peach Orchard Cove	10	31.2	45.8%
Bullneck Creek	9	24.0	34.2%
Lynch Cove	10	32.9	40.1%
Bear Creek Headwaters	8	21.5	37.6%
Chink Creek	8	37.5	45.1%
Charlesmont/Tobasco Coves	4	6.5	14.0%
Oakleigh/Schoolhouse Coves	4	8.3	20.7%
Country Club/Humphrey Creek Remnant	5	7.7	11.9%
Jones Creek	5	14.7	19.7%
Northpoint Creek	6	12.9	35.8%
Shallow Creek	4	4.4	25.3%
Black Marsh	2	2.3	39.6%
Sparrows Point	0	0.0	0.0%
Bear Creek/Old Road Bay Total	***76***	***287.7***	***25.8%***

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

Figure 4-3 illustrates the location of neighborhoods recommended for downspout redirection. Out of the 91 neighborhoods assessed, 76 have the potential for downspout disconnection through redirection. If implemented, this could address approximately 26% of the total impervious rooftop area in the Bear Creek/Old Road Bay watersheds.

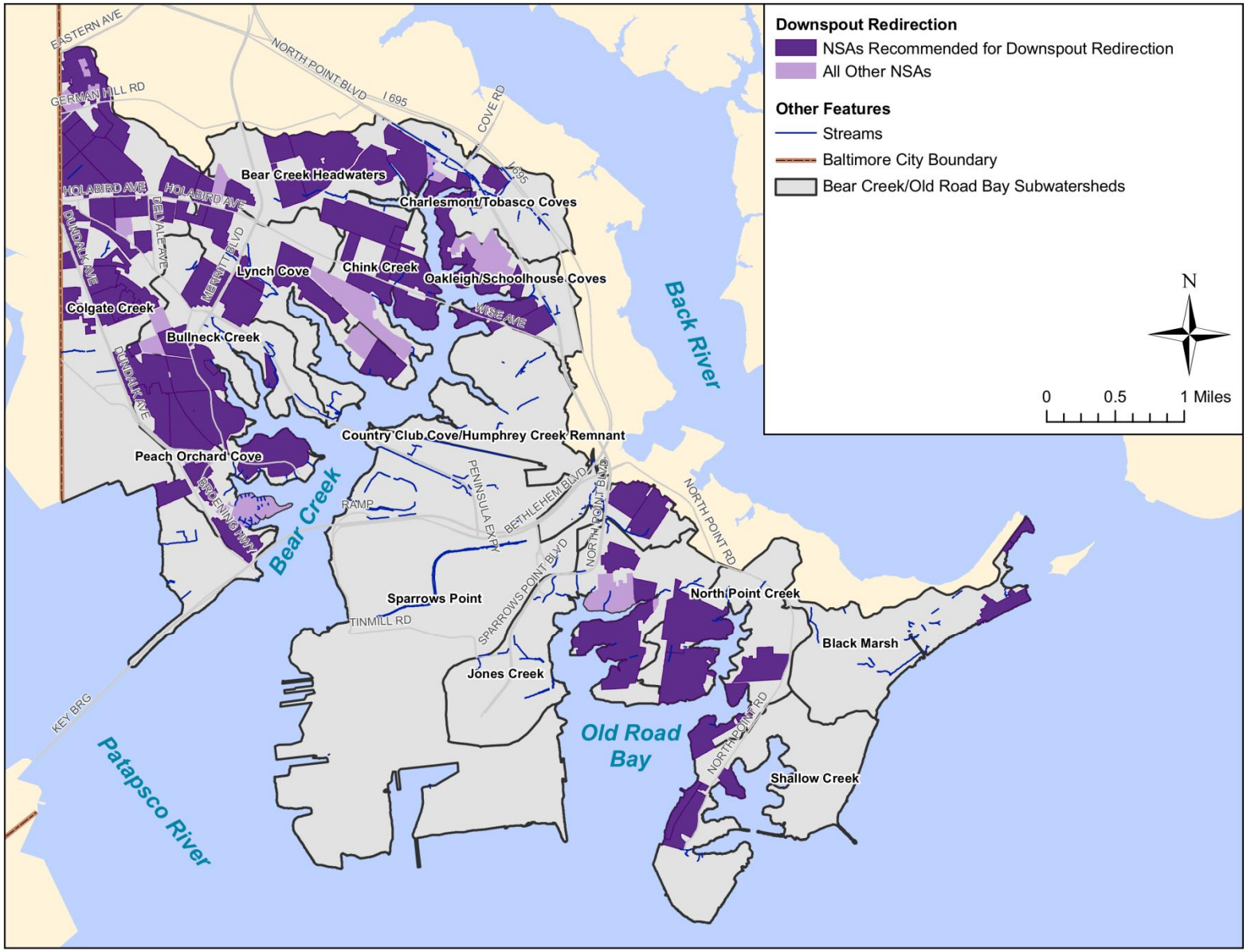

Figure 4-3: Neighborhoods Recommended for Downspout Disconnection

4.2.3.2 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 by the space available for landscaping. Several neighborhoods are characterized by smaller lot sizes and/or significant impervious cover, where bayscaping might be difficult. In addition, neighborhoods with a significant amount of landscaping already were not considered a priority. Therefore, bayscaping was recommended in neighborhoods where the typical lot was at least ¼ acre in size, was less than 25% landscaped, and where there was sufficient grass area available. Table 4-3 includes a summary of the number of neighborhoods recommended for bayscaping based on these criteria and the area of available lawn addressed if this action were initiated by subwatershed. Table 4-3 also lists the percent of the total subwatershed area that would be addressed by implementing bayscaping in the recommended neighborhoods.

Table 4-3: Acres of Land Addressed by Bayscaping

Subwatershed	# of NSAs Recommended for Bayscaping*	Acres of Available Lawn Addressed	% of Subwatershed Area Addressed
Colgate Creek	2	5.1	0.3%
Peach Orchard Cove	1	6.2	1.4%
Bullneck Creek	2	9.2	1.5%
Lynch Cove	1	1.4	0.2%
Chink Creek	1	5.5	1.5%
Bear Creek Headwaters	0	0.0	0.0%
Charlesmont/Tobasco Coves	2	5.1	1.2%
Oakleigh/Schoolhouse Coves	3	10.8	3.3%
Country Club/Humphrey Creek Remnant	3	5.2	0.7%
Jones Creek	6	28.0	3.0%
Northpoint Creek	*5*	*23.4*	*4.1%*
Shallow Creek	4	10.1	1.4%
Black Marsh	2	4.7	0.8%
Sparrows Point	0	0.0	0.0%
Bear Creek/Old Road Bay Total	***23***	***114.7***	***1.0%***

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

Figure 4-4 illustrates the location of neighborhoods recommended for bayscaping. Out of the 91 neighborhoods assessed, 23 (25%) met the criteria and were recommended for bayscaping. Table 4-3 shows that only approximately 1% of the Bear Creek/Old Road Bay planning area would be addressed by

this action; this is because many of the neighborhoods have limited amount of area available for bayscaping due to small lot sizes and/or significant impervious cover.

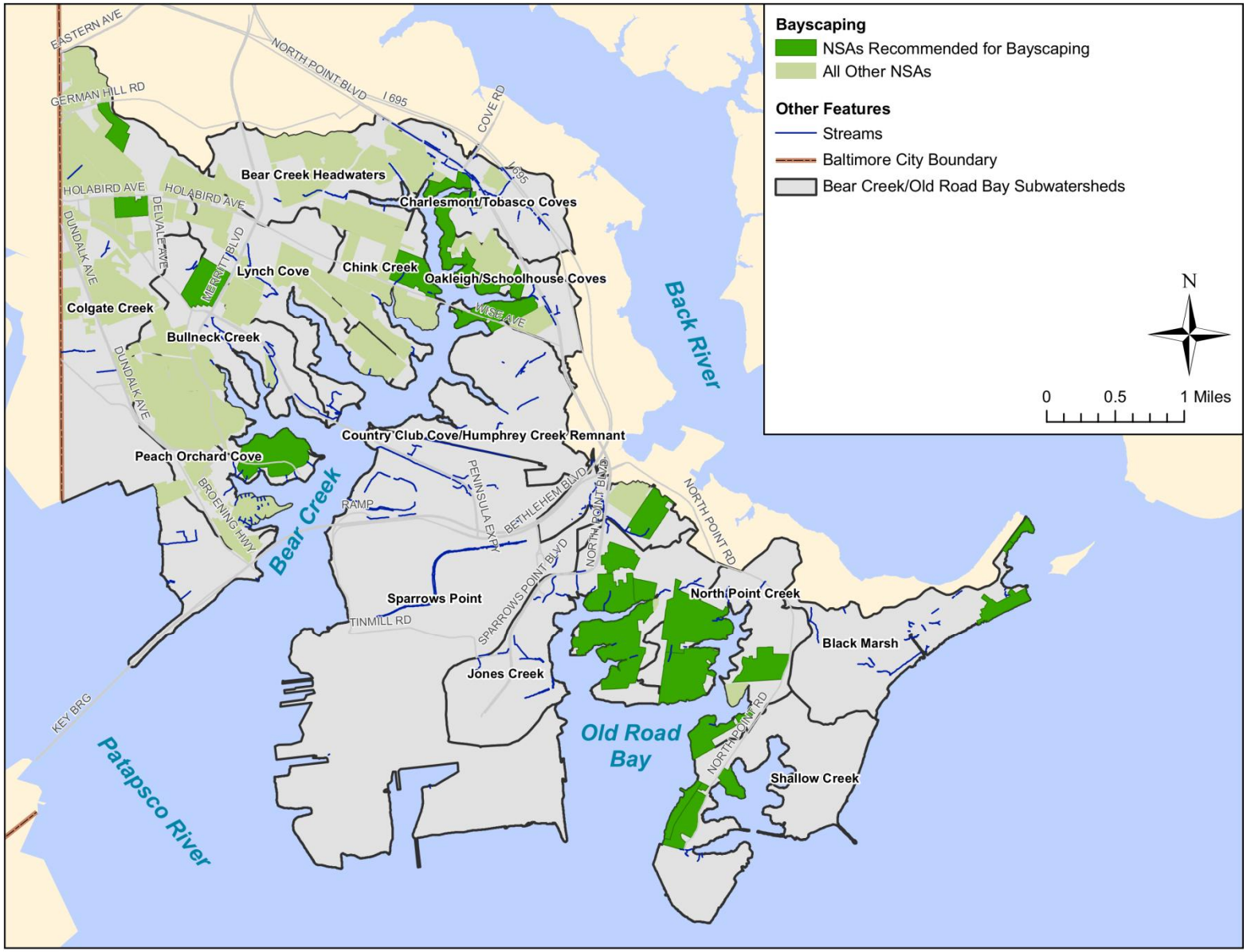

Figure 4-4: Neighborhoods Recommended for Bayscaping

4.2.3.3 Storm Drain Marking

Most of the neighborhoods in the Bear Creek/Old Road Bay watershed consist of curb and gutter systems with storm drain inlets that convey stormwater runoff quickly and directly to the stream system and ultimately to the Chesapeake Bay. Most neighborhoods do not have any storm drain markings or indicators that the inlets eventually drain to 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 markings indicate that the inlets drain to the Chesapeake Bay; this is a way to educate residents that any trash or lawn clippings (potential for nutrient pollution), or other debris accumulating along the curbs and gutters will be washed away during a storm event and end up in Bear Creek, Old Road Bay, Shallow Creek, or the Bay.

Neighborhoods recommended for storm drain marking have curb and gutter systems with inlets appropriate for marking and where less than 10% of the existing inlets were already marked and legible. Table 4-4 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 is estimated based on the inlet densities calculated by subwatershed in Chapter 2.3.6. Table 4-4 also lists the percent of the total inlets in each subwatershed that would be addressed if storm drain marking was implemented in the recommended neighborhoods.

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

Subwatershed	# of NSAs Recommended for Storm Drain Marking*	Approximate # of Inlets Addressed	% of Inlets in Subwatershed Addressed
Colgate Creek	27	42	86.6%
Peach Orchard Cove	12	12	41.2%
Bullneck Creek	7	25	35.8%
Lynch Cove	12	31	36.2%
Chink Creek	9	18	25.0%
Bear Creek Headwaters	9	51	46.3%
Charlesmont/Tobasco Coves	3	2	7.3%
Oakleigh/Schoolhouse Coves	4	20	27.6%
Country Club/Humphrey Creek Remnant	4	1	11.8%
Jones Creek	4	3	26.0%
Northpoint Creek	***5***	*10*	*29.2%*
Shallow Creek	0	0	0.0%
Black Marsh	0	0	0.0%
Sparrows Point	0	0	0.0%
Bear Creek/Old Road Bay Total	**68**	**215**	**37.9%**

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

Figure 4-5 illustrates the location of neighborhoods recommended for storm drain marking. Out of the 91 neighborhoods assessed, 68 (75%) met the criteria and were recommended for storm drain marking. Table 4-4 also shows that about 38% of the inlets in the watershed could be addressed by this action just in the neighborhoods alone.

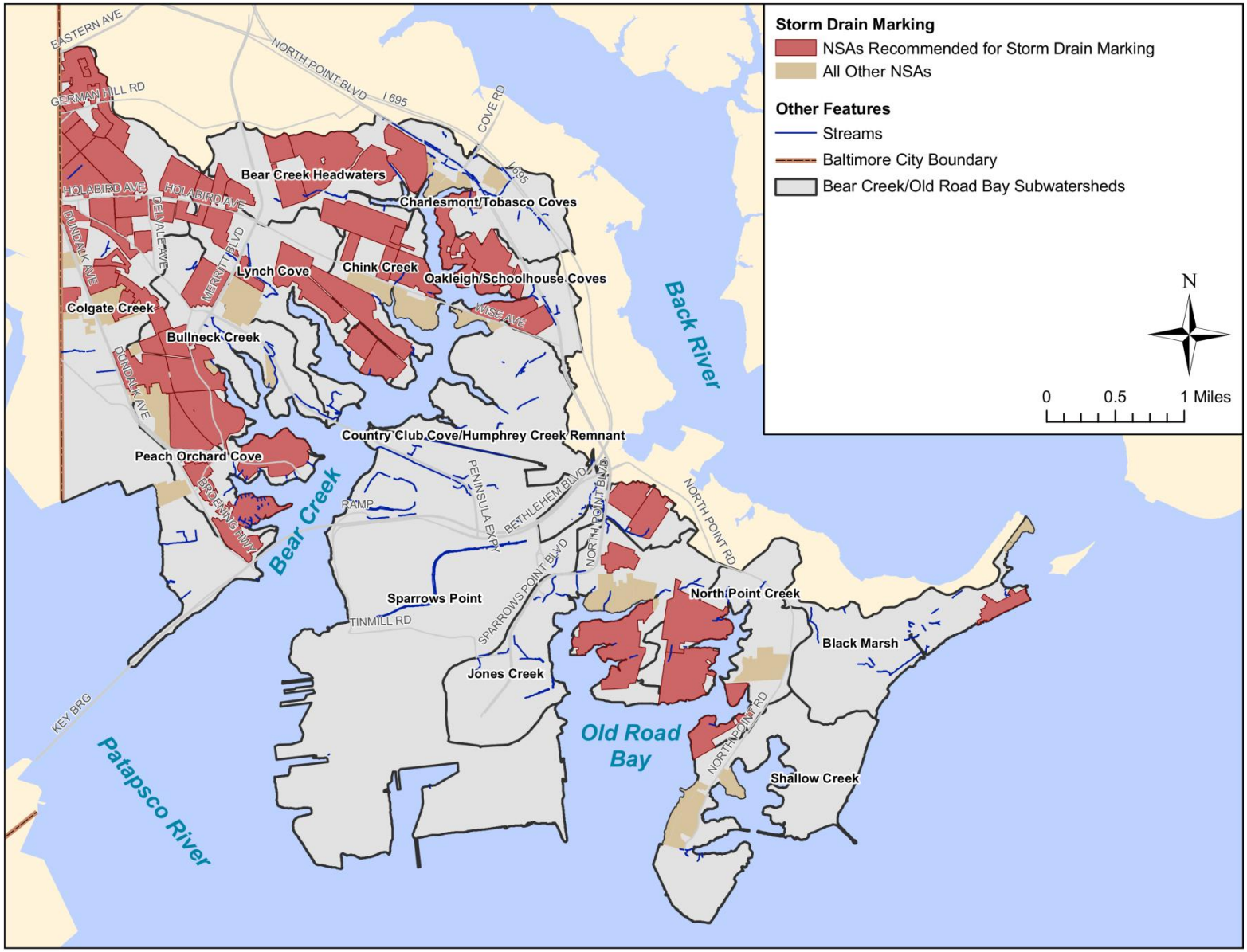

Figure 4-5: Neighborhoods Recommended for Storm Drain Marking

4.2.3.4 Street Trees and Shade Trees

Street trees and shade 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 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% of the streets had a minimum of 4 feet of green space between the sidewalk and curb and less than 75% of these areas had trees planted. The number of trees was estimated based on a spacing of one tree per 30 feet. Open space shade trees were recommended for open pervious areas in neighborhoods where the space had no apparent current use. The number of shade trees was estimated based on a planting density of 135 trees per acre for larger areas. This density was taken from the *Baltimore County Policy and Guidelines for Community Tree Planting Projects* and assumes a survival density of 100 trees per acre after 25 years. Table 4-5 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 shows a summary of the number of neighborhoods recommended for shade tree planting and the number of shade trees proposed per subwatershed.

Table 4-5: Street Tree Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Street Trees*	# of Street Trees that Could be Planted
Colgate Creek	10	562
Peach Orchard Cove	1	31
Bullneck Creek	2	45
Lynch Cove	9	707
Chink Creek	6	612
Bear Creek Headwaters	7	911
Charlesmont/Tobasco Coves	2	130
Oakleigh/Schoolhouse Coves	1	175
Country Club/Humphrey Creek Remnant	0	0
Jones Creek	0	0
Northpoint Creek	0	0
Shallow Creek	0	0
Black Marsh	0	0
Sparrows Point	0	0
Bear Creek/Old Road Bay Total	***25***	***3,171***

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

Table 4-6: Shade Tree Potential by Subwatershed

Subwatershed	# of NSAs Recommended for Shade Trees*	# of Shade Trees that Could be Planted
Colgate Creek	8	106
Peach Orchard Cove	8	199
Bullneck Creek	4	207
Lynch Cove	2	45
Chink Creek	2	39
Bear Creek Headwaters	3	43
Charlesmont/Tobasco Coves	0	0
Oakleigh/Schoolhouse Coves	0	0
Country Club/Humphrey Creek Remnant	1	7
Jones Creek	0	0
Northpoint Creek	0	0
Shallow Creek	0	0
Black Marsh	0	0
Sparrows Point	0	0
Bear Creek/Old Road Bay Total	**18**	**646**

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

Figure 4-6 illustrates the location of neighborhoods where street trees could be planted. Out of the 91 neighborhoods assessed, 25 (27%) 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 green space between the sidewalk and curb. There is potential for planting 3,171 street trees throughout the watershed.

Figure 4-7 shows the location of neighborhoods where shade trees are recommended. Out of the 91 neighborhoods assessed, 18 (20%) met the criteria for potential shade tree planting. 646 shade trees are estimated for the Bear Creek/Old Road Bay watersheds.

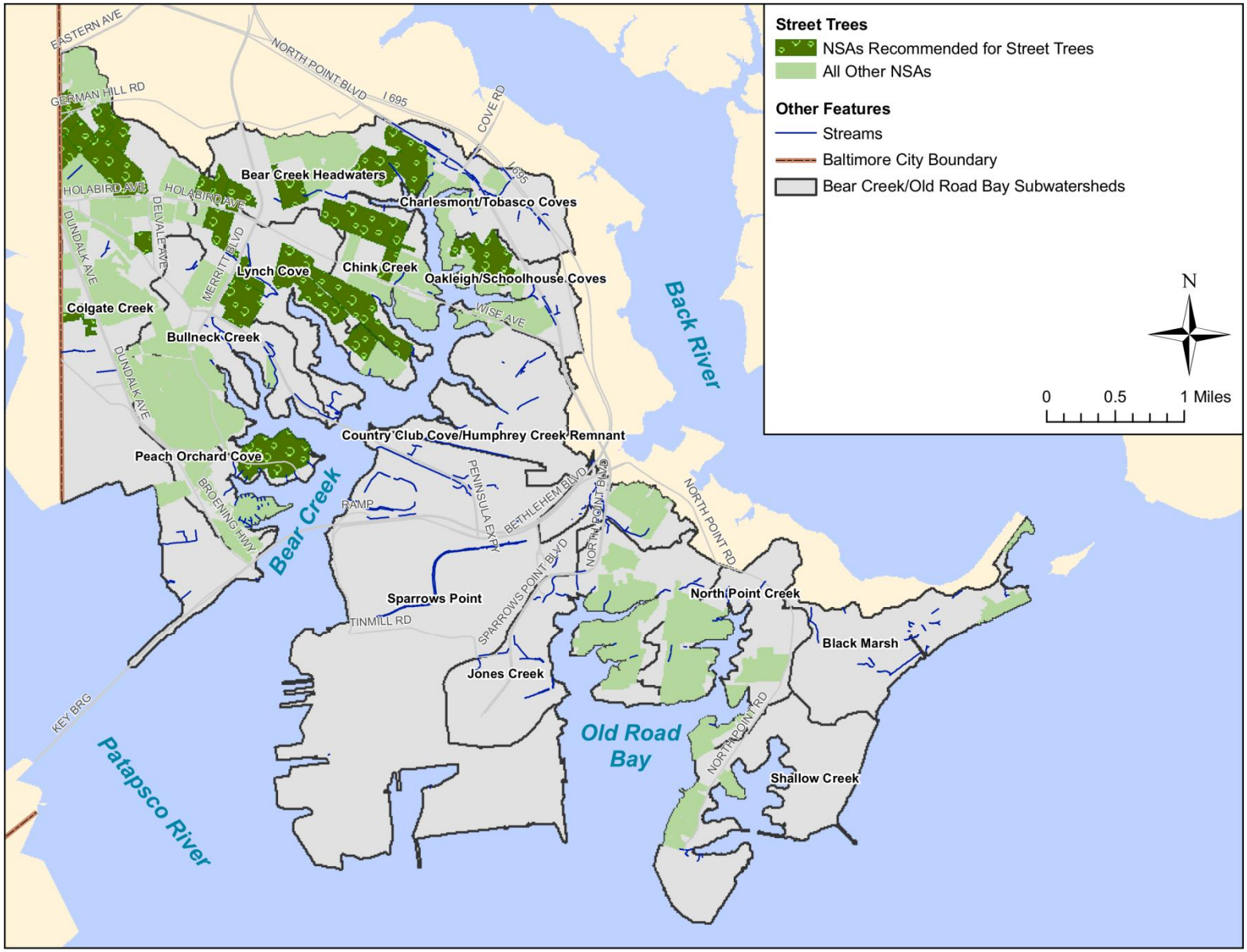

Figure 4-6: Neighborhoods Recommended for Street Tree Planting

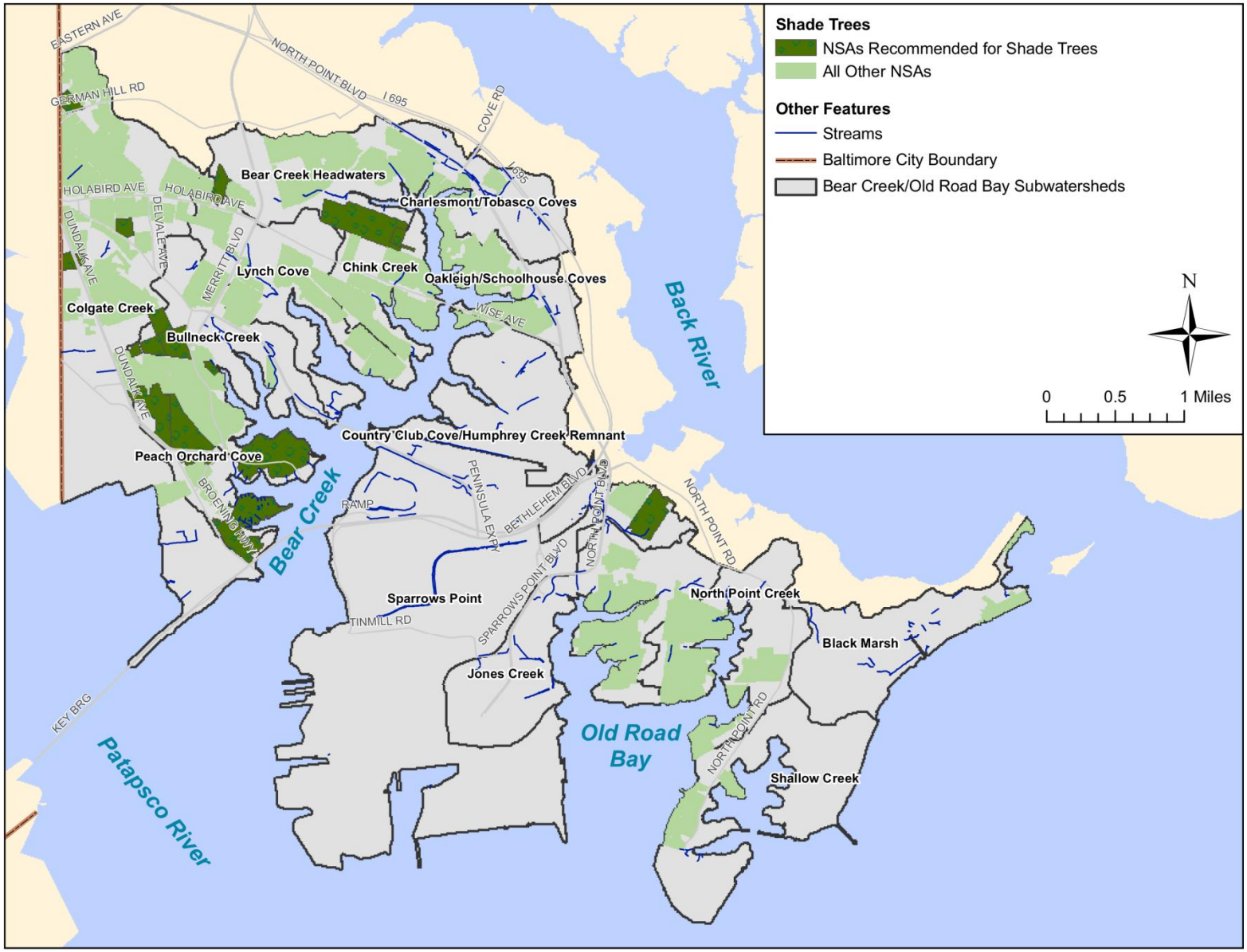

Figure 4-7: Neighborhoods Recommended for Shade Tree Planting

4.2.3.5 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 drains 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, the decay of an unbalanced amount of organic matter in a stream depletes the supply of dissolved oxygen, depriving 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% 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 by determining the miles of roads within each neighborhood recommended for street sweeping using Baltimore County's 2008 roads spatial data. For neighborhoods intersecting two or more subsheds, the miles addressed are only displayed for the subsheds where they are present.

Table 4-7: Miles Addressed by Street Sweeping

Subwatershed	# of NSAs Recommended for Street Sweeping*	Miles Addressed by Street Sweeping
Colgate Creek	2	3.2
Peach Orchard Cove	1	10.5
Bullneck Creek	1	6.4
Lynch Cove	0	0.0
Bear Creek Headwaters	1	8.1
Chink Creek	0	0.0
Charlesmont/Tobasco Coves	1	0.6
Oakleigh/Schoolhouse Coves	1	15.8
Country Club/Humphrey Creek Remnant	0	0.0
Jones Creek	0	0.0
Northpoint Creek	*0*	*0.0*
Shallow Creek	0	0.0
Black Marsh	0	0.0
Sparrows Point	0	0.0
Bear Creek/Old Road Bay Total	7	44.7

* If a neighborhood overlaps multiple subwatersheds, it is counted in "# of NSAs" for each subwatershed it encompasses. Miles of sweeping are counted only for the subsheds where they are proposed.

Figure 4-8 illustrates the location of neighborhoods recommended for street sweeping. Out of the 91 neighborhoods assessed, 5 (5%) met the criteria for street sweeping, 2 of which overlap multiple

subwatersheds. If initiated, this could address 45 miles of road within neighborhoods recommended in the watershed.

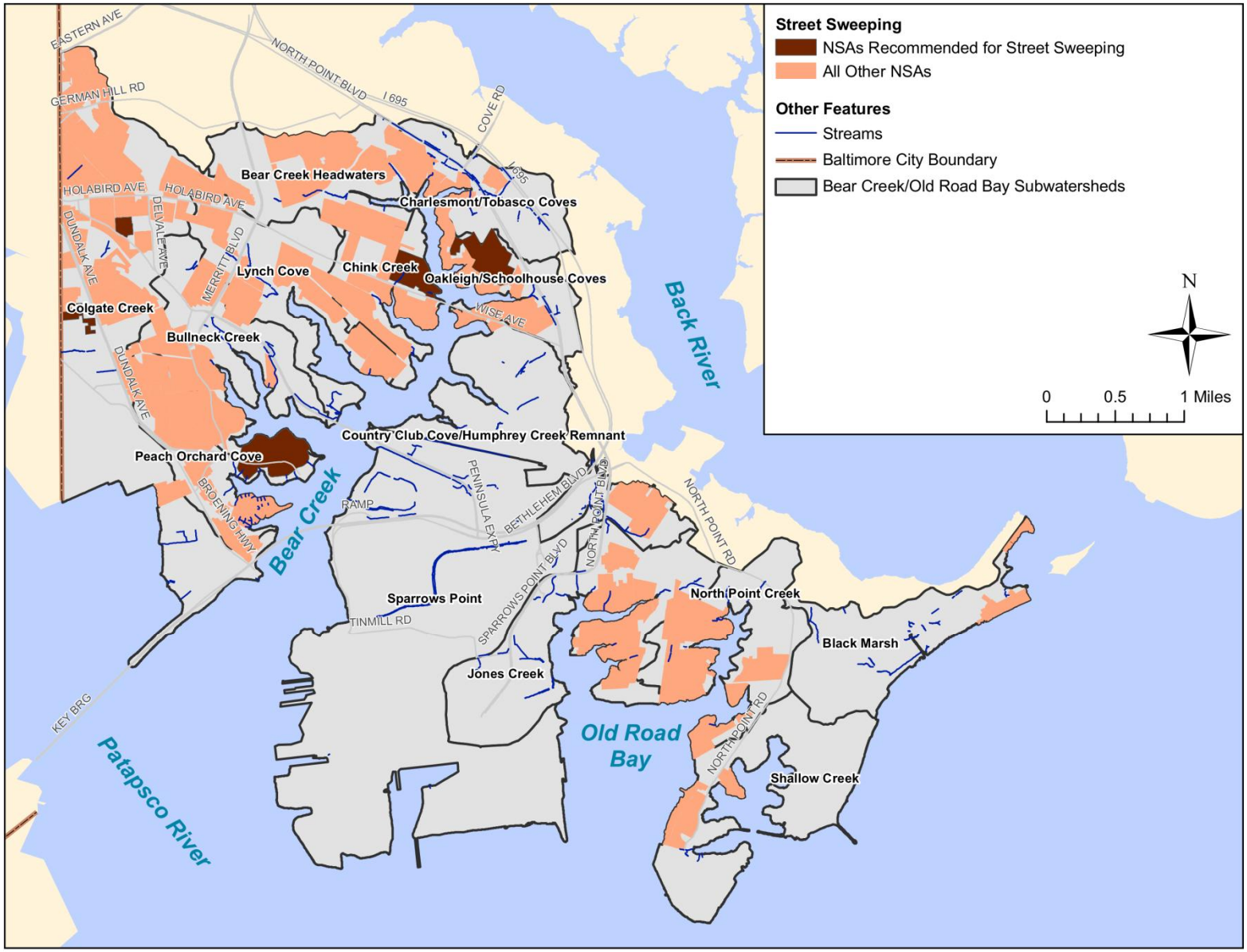

Figure 4-8: Neighborhoods Recommended for Street Sweeping

4.2.3.6 Neighborhood Trash Management

Trash can be a major pollutant of concern in neighborhoods. The uplands survey revealed that the study area 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.

In previous SWAP studies conducted by EPS, neighborhoods where junk or trash was observed in 25% or more of yards were recommended for trash management initiatives. Neighborhoods with less than 25% 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. For the Bear Creek/Old Road Bay planning area, the threshold for recommending trash management initiatives was altered to 15% due to overwhelming community concerns regarding trash and dumping in the watershed. 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
Colgate Creek	3	12.1	0.7%
Peach Orchard Cove	7	181.1	40.2%
Bullneck Creek	5	153.0	24.2%
Lynch Cove	8	219.0	33.8%
Bear Creek Headwaters	4	107.5	29.5%
Chink Creek	1	5.1	0.9%
Charlesmont/Tobasco Coves	0	0.0	0.0%
Oakleigh/Schoolhouse Coves	0	0.0	0.0%
Country Club/Humphrey Creek Remnant	0	0.0	0.0%
Jones Creek	1	2.0	0.2%
Northpoint Creek	0	0.0	0.0%
Shallow Creek	0	0.0	0.0%
Black Marsh	0	0.0	0.0%
Sparrows Point	0	0.0	0.0%
Bear Creek/Old Road Bay Total	18	679.7	6.0%

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

Figure 4-9 illustrates the location of neighborhoods recommended for trash management initiatives. Out of the 91 neighborhoods assessed, 18 (20%) were recommended for trash management. If initiated, this could address approximately 6% of the total Bear Creek/Old Road Bay planning area.

Trash management has the potential to address more developed and potential problem areas on the subwatershed scale; for example, targeting neighborhoods in the Peach Orchard Cove subwatershed could potentially address 40 percent of the subwatershed area.

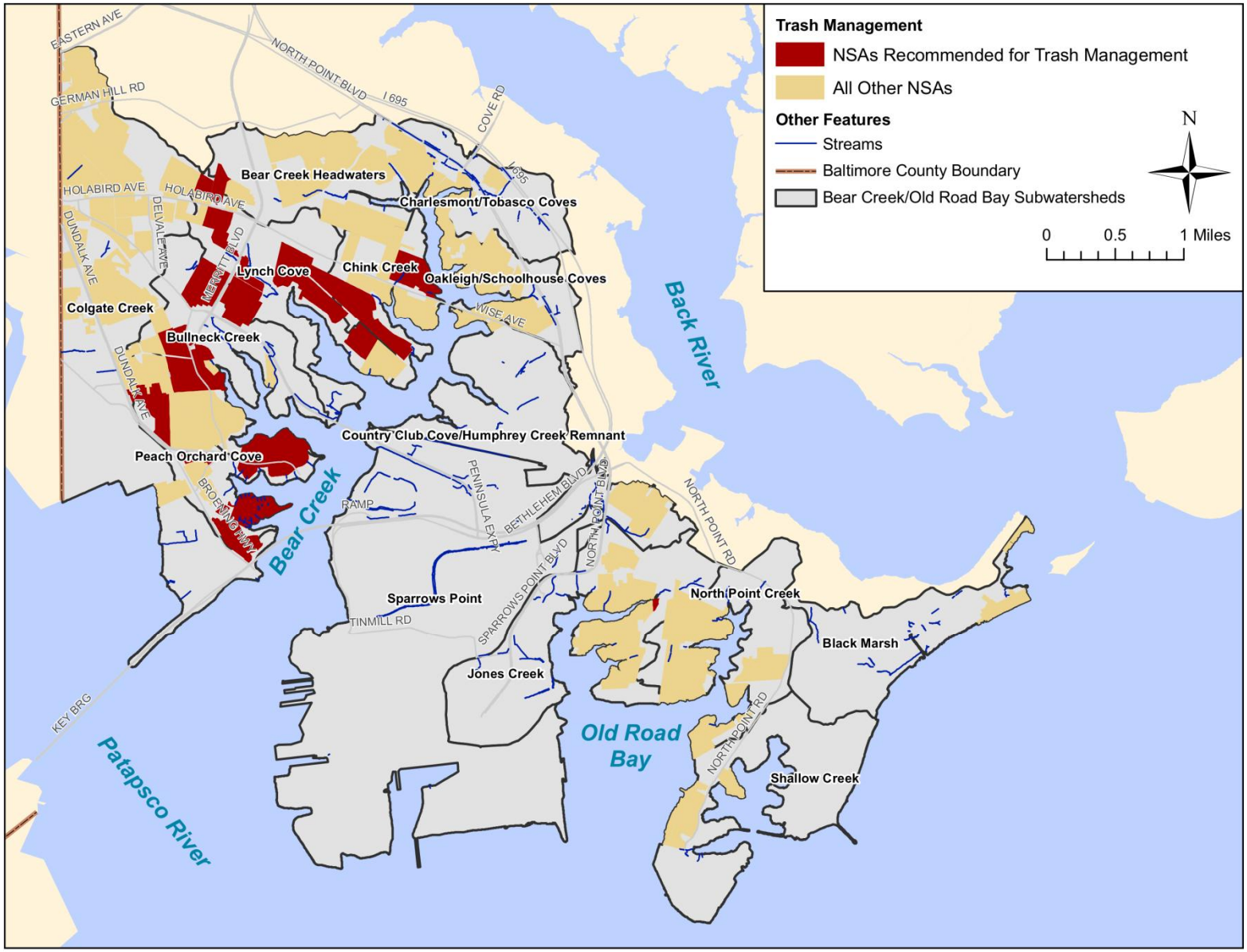

Figure 4-9: Neighborhoods Recommended for Trash Management

4.2.3.7 Parking Lot or Alley Retrofit

There are several apartment, townhouse, and condo complexes in the study area. Multi-family parking lots in these types of neighborhoods can be an opportunity for a stormwater retrofit to address stormwater runoff from impervious surfaces. In addition, neighborhoods with paved alleys 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 stormwater runoff from impervious parking lots and alleys while requiring minimal maintenance. In addition, many neighborhoods in the Bear Creek/Old Road Bay planning area have alleys behind or in front of residences. Baltimore County is investigating the feasibility of replacing existing paving on alleys with pervious concrete to provide infiltrative stormwater treatment. Blue Water Baltimore is conducting pilot studies on this type of retrofit which they term "blue alleys." With over 59 acres of alleys in the watershed, a pilot project for a "blue alley" could be conducted in the watershed to determine its feasibility on a larger scale.

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

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

Subwatershed	# of NSAs Recommended for Stormwater Retrofit*	Acres of Impervious Cover Addressed
Colgate Creek	1	0.9
Peach Orchard Cove	1	3.0
Bullneck Creek	1	0.7
Lynch Cove	0	0.0
Chink Creek	0	0.0
Bear Creek Headwaters	0	0.0
Charlesmont/Tobasco Coves	0	0.0
Oakleigh/Schoolhouse Coves	0	0.0
Country Club/Humphrey Creek Remnant	0	0.0
Jones Creek	0	0.0
Northpoint Creek	*0*	*0.0*
Shallow Creek	0	0.0
Black Marsh	0	0.0
Sparrows Point	0	0.0
Bear Creek/Old Road Bay Total	**3**	**4.7**

*If a neighborhood overlaps multiple subsheds, 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 91 neighborhoods assessed, 3 (3%) have sufficient green space

available for multi-family parking lot or alley stormwater retrofits. Note that the 4.7 acres of impervious cover addressed is an approximation based on potential sites identified in the field and area calculations using GIS and visual inspection of aerial images. Actual area addressed will depend on a closer inspection of site conditions conducive to a stormwater retrofit application (e.g., grading requirements, cost, etc.) In addition, Figure 4-10 also shows the NSAs where alleys are present that have the potential for conversion into a "blue alley" retrofit.

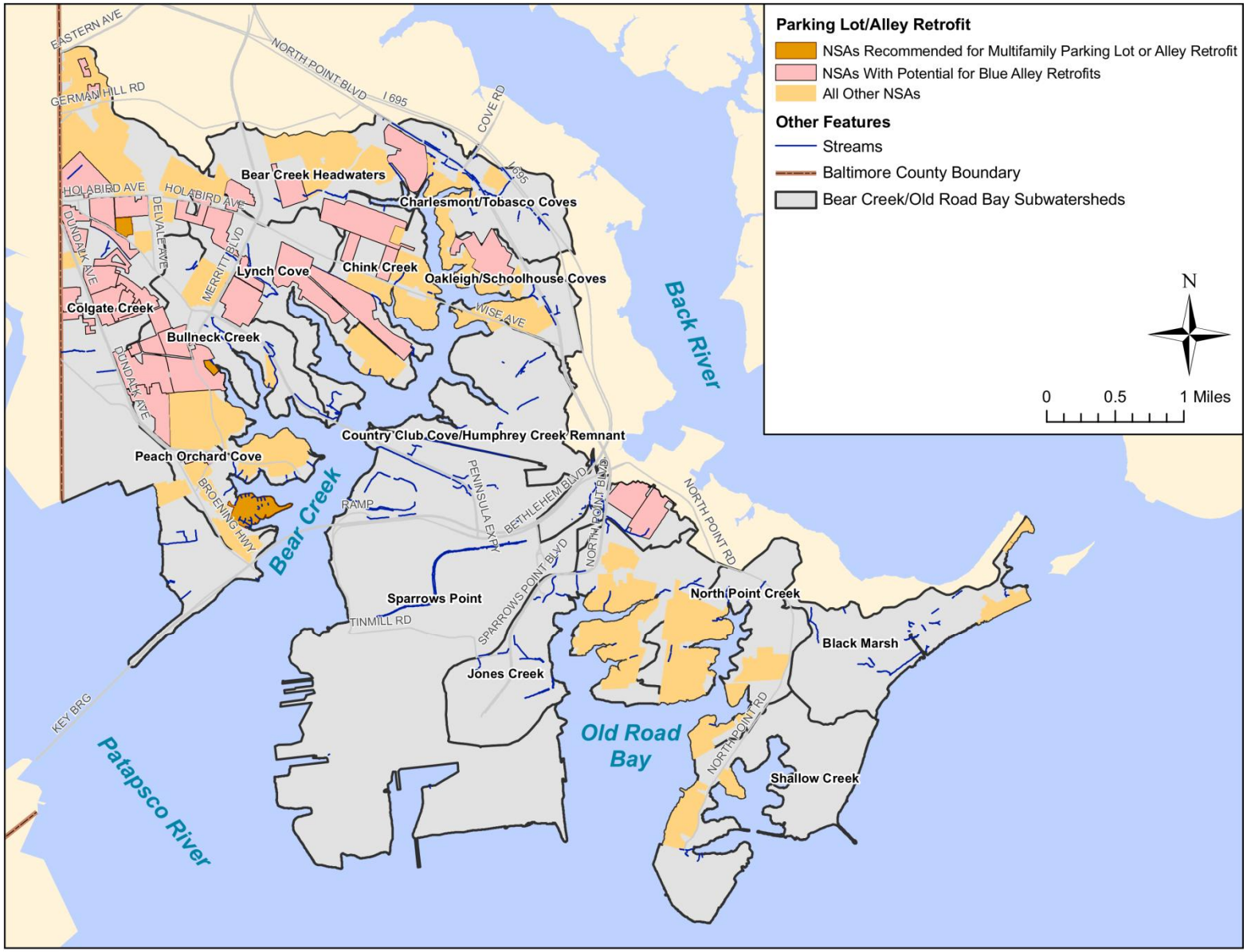

Figure 4-10: Neighborhoods Recommended for Parking Lot or Alley Stormwater Retrofit

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 Bear Creek/Old Road Bay watersheds. Note that marinas and NPDES-permitted industrial sites are addressed separately in Sections 4.6 and 4.7, respectively.

4.3.1 Assessment Protocol

Because there are numerous operations in the study area 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 hotspot operations and select sites to represent common types of hotspots found in the planning area. HSIs were also focused on unregulated hotspots since access to regulated hotspots is

often limited 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. Note, however, that since considerable portions of upland areas are occupied by specific industrial sites, these were addressed as a separate upland category (see Section 4.6). Marinas also typically hold NPDES permits and have a significant presence within the planning area. Consequently, these are also addressed as a separate upland category (see Section 4.7). Obvious sources of pollution observed during the upland assessment were revisited for hotspot potential. Problem areas identified by community members during the upland assessment were also scouted for hotspot potential.

Unique ID numbers were assigned to HSIs using the classification scheme "HSI_D_0100", where 'D' denotes the Bear Creek/Old Road Bay planning area and the first two numbers correspond to a specific subwatershed. Subwatersheds were assigned unique numbers summarized in Table 4-10 for the purposes of HSIs, ISIs, and PAAs.

Table 4-10: Subwatershed ID Numbers

ID	Subwatershed
1	Colgate Creek
2	Peach Orchard Cove
3	Bullneck Creek
4	Lynch Cove
5	Chink Creek
6	Bear Creek Headwaters
7	Charlesmont/Tobasco Coves
8	Oakleigh/Schoolhouse Coves
9	Country Club/Humphrey Creek Remnant
10	Jones Creek
11	Northpoint Creek
12	Shallow Creek
13	Black Marsh
14	Sparrows Point
15	Colgate Creek

Hotspot sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, HSIs in Lynch Cove would be identified as 0401, 0402, 0403, 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 surveyed 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 vehicle washing.

Outdoor Materials

Stormwater quality issues result 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 a 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 directly to 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 sources of nutrient, fertilizer, and pesticide pollution. 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% 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 and illicit connection potential. Storm drains with considerable amounts of sediment, organics, and/or trash were identified as potential pollution sources.

Recommended Actions

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. After surveying the entire property and evaluating hotspot operations, one or more of the follow-up actions listed below may be 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 17 hotspot candidates were investigated in the Bear Creek/Old Road Bay watershed. Most of the sites (10 out of 17) were commercial establishments. Five (5) industrial facilities and two (2) transport-related sites were also investigated. The hotspot candidates included as part of the uplands survey are listed in Table 4-11 including site ID, type, and subwatershed. Locations and initial hotspot status designations are shown in Figure 4-11.

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 4-11: Summary of Hotspot Sites Investigated in Bear Creek/Old Road Bay

Site ID	Subwatershed	Type
HSI_D_0701	Charlesmont/Tobasco	Industrial (Storage)
HSI_D_0702	Charlesmont/Tobasco	Industrial (Manufacturing)
HSI_D_0101	Colgate Creek	Commercial (Auto Repair)
HSI_D_0102	Colgate Creek	Transport (Containers)
HSI_D_0201	Peach Orchard Cove	Commercial (Shopping Center)
HSI_D_0301	Bullneck Creek/ Lynch Cove	Commercial (Construction)
HSI_D_0401	Lynch Cove	Commercial (Shopping Center)
HSI_D_0402	Lynch Cove/Bullneck Creek	Industrial (Recycling)
HSI_D_0601	Bear Creek Headwaters	Commercial (Shopping Center)
HSI_D_0602	Bear Creek Headwaters	Commercial (Car Wash)
HSI_D_0801	Oakleigh/ Schoolhouse Coves	Commercial (Gas Station)
HSI_D_0802	Oakleigh/ Schoolhouse Coves	Transport (Containers)
HSI_D_0901	Country Club Cove/ Humphrey Creek	Industrial (Equipment)
HSI_D_0501	Chink Creek	Commercial (Gas Station)
HSI_D_1001	Jones Creek/Sparrows Point	Industrial (Manufacturing)
HSI_D_1002	Jones Creek	Commercial (Retail)
HSI_D_1301	Black Marsh	Commercial (Restaurant)

Figure 4-11: HSI Locations in Bear Creek/Old Road Bay

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. Vehicle operations and waste management were the most common operations contributing to hotspot stormwater pollution among this sample of hotspot candidates. Outdoor materials storage, stormwater infrastructure (i.e., lack of stormwater management and/or condition of storm drains) and physical plant conditions (e.g., stained/breaking up parking lot, evidence of stains leading to storm drain) were also common pollutant sources at investigated hotspots. Turf/landscaping operations were identified as potential pollution sources for five (5) sites. 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 five categories based on characteristic operations and pollution sources: auto-related, shopping centers, construction, restaurant, and storage.

<u>Auto-related</u>

There are several auto-related commercial establishments throughout the Bear Creek/Old Road Bay planning area including auto repair shops, 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 or engine parts were being stored outdoors. If materials are uncovered or lack secondary containment for liquids 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). It is also common for impervious surfaces (parking lots) at these types 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 4-13). 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.

Figure 4-12: Examples of Potential Pollution Sources from Outdoor Material Storage at Auto-related Hotspots

Figure 4-13: Example of Potential Pollution Sources from Outdoor Vehicle Operations at Auto-related Hotspots

All commercial operations generate waste and auto-related enterprises have the potential to generate hazardous pollutants that can enter the stream or storm drain system. For example, a leaking dumpster and uncovered trash cans were observed at one site directly adjacent to a receiving stream (see Figure 4-14). This included an assortment of trash such as paper and tires. 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 or storm drain system.

Figure 4-14: Example of Potential Pollution Sources from Waste Management Operations at Auto-related Hotspots

Shopping Centers

There are multiple commercial shopping center areas within the planning area, each with unique operations and pollution sources. Common sources of pollutants from the commercial shopping centers assessed include those from waste management operations. 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 4-15).

Figure 4-15: Example of Potential Pollution Sources from Waste Management Operations at Commercial Hotspots

Commercial areas sometimes have outdoor shopping or stockpile 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 stockpile of salt that is stored on a shopping center parking lot. There is potential for the road salt to be washed away during a rainfall or snow event and enter into the storm drain system as the stockpile is only partially covered. De-icing salt contains constituents such as sodium chloride which can end up in storm drains or streams, leading to water quality and habitat degradation. There is also potential for the salt to spill over onto the adjacent landscaped areas, which can disrupt uptake of nutrients through plant and tree roots and inhibit long-

term growth. In addition, storage of solid supplies can lead to gross solids washing into surface waters and storm sewers in the vicinity of the hotspot.

Figure 4-16: Example of Potential Pollution Sources from Outdoor Material Storage at Commercial Hotspots

In 2 of the 3 shopping centers assessed in the Bear Creek/Old Road Bay planning area, the physical plant was noted as a potential pollution source, specifically the condition the parking surface. In shopping centers with multiple retail stores, large amounts of impervious surfaces are present to accommodate parking needs of these businesses. Impervious surfaces create increased runoff into storm systems and local surface waters, creating erosion problems and carrying nutrients and oil-based pollutants. When this impervious surface is breaking up, additional pollutants in the form of sediments are added to the runoff, further degrading downstream waters. Figure 4-17 shows examples of pollution sources from impervious surfaces at shopping center hotspots in the Bear Creek/Old Road Bay planning area.

Figure 4-17: Example of Potential Pollution Sources from Degraded Impervious Surfaces at Commercial Hotspots

Construction

One (1) construction site was also assessed in the Bear Creek/Old Road bay planning area. Earth disturbing activities at construction sites can create large areas of bare soil that have the potential to erode and wash sediment into local streams during rain events. In addition, construction sites can have large stockpiles of materials such as rock or sand that should be covered or contained to divert runoff to

approved sediment control devices. At the construction site assessed during the upland assessments, extreme erosion from the site was observed washing sediments into storm drains and wetlands adjacent to the site. It is recommended that Baltimore County continue to work with MDE to enforce regulations at these sites dictating proper erosion and sediment control practices.

Figure 4-18: Example of Erosion from Bare Areas at Construction Hotspots

Restaurant

Commercial restaurant sites generally consist of parking area outside the restaurant facility with waste management practices located on site. Like shopping centers, impervious cover at restaurants can become deteriorated or stained, leading to sediment or nutrient-laden runoff entering local storm drain systems. The primary concern for the restaurants observed in the Bear Creek/Old Road Bay planning area was how the waste from the site was handled, specifically used cooking grease and oils. At one restaurant located within a shopping center, a leaking grease bin was observed that drained directly to a storm drain in the parking lot (Figure 4-19). At another site, an uncovered, leaking dumpsters was seen on site that drained directly to an adjacent wetland area.

Figure 4-19: Example of Potential Pollution Sources from Waste Management Operations at Restaurant Hotspots

These sites are recommended for future education efforts related to waste management.

Storage

Several outdoor storage sites were observed within the planning area and one was assessed to represent this commercial hotspot subcategory. This particular site had operations related to boats and vehicles, outdoor materials, and waste management. Vehicle operations included operation of forklifts and storage of cars. At the site, vehicle operations were observed outdoors (uncovered) and lacking runoff diversion methods. Also outdoor storage areas lacked coverage and spilled liquids were seen on the site which drained to a storm drain inlet in the street. An assortment of materials was being stored in relation to metals recycling (see Figure 4-20). These materials were being stored immediately upstream from a storm drain with no diversion methods in place to prevent potential pollutants from being carried off-site via stormwater runoff.

Figure 4-20: Examples of Potential Pollution Sources from Storage-related Hotspots

Commercial storage sites are recommended for future education efforts related to proper vehicle operations and outdoor materials storage.

Commercial Hotspot Summary

Pollution potential from commercial hotspots including auto-related facilities, shopping centers, construction-related sites, restaurants, and storage facilities 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 or lack of runoff diversion methods for 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. These areas can be sources of potentially hazardous pollutants such as oil and grease from leaking vehicles and stained parking lot surfaces. Some can also be potential sources of trash/dumping and stormwater pollution from outdoor materials storage. These types of sites may be good candidates for future education efforts related to vehicle operations, outdoor materials storage, and waste management.

Two (2) transport-related sites were assessed in the Bear Creek/Old Road Bay planning area, both involving storage and shipping of containers. Because of the vicinity of large port operations in or near the planning area, container shipping is a major business market in the watershed. The major concern observed at these sites include large amounts of impervious area either breaking up or containing material stockpiles draining to storm drains with no diversions or treatment (see Figure 4-21).

Figure 4-21: Examples of Potential Pollution Sources from Transport-related Hotspots

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); uncovered or lack of runoff diversion methods for repair/fueling areas or outdoor materials storage

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

Industrial

Five (5) industrial operations were assessed within the planning area ranging from manufacturing facilities, to equipment storage areas and metals recycling. As discussed in Section 2.3.1, a third of the

Bear Creek/Old Road Bay watershed's land use is categorized as industrial so this category holds significant potential for the release of illicit pollutants into nearby storm sewers and surface waters.

Vehicle operations at industrial facilities include storing, fueling, washing, and maintaining vehicles on site including fleet vehicles, large 18-wheeled vehicles or industrial equipment. The vehicle operations that were observed were located outdoors without cover or runoff diversions and most were draining to a nearby storm drain or stream. Outdoor materials storage was also observed as a major concern at industrial operations. Materials including solids and liquids, were stored on impervious surfaces and draining to storm sewer systems. At one site in particular, an open oil barrel was located on site that could overflow in a storm event, leaking illicit liquids into surface waters. At another site, a multitude of barrels were stored on site which were uncovered and unlabeled. See Figure 4-22 for examples of outdoor materials storage observed at industrial hotspots.

Figure 4-22: Improper Outdoor Materials Storage at Industrial Hotspots

Industrial Hotspot Summary

Pollution potential from industrial hotspots including manufacturing facilities, metals recycling, and equipment storage 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 or lack of runoff diversion methods for repair/fueling areas or outdoor materials storage
- *Low pollution potential:* Proper disposal methods; good housekeeping (well maintained parking lot, waste management); stormwater management practices

4.4 Institutional Site Investigation (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 recently completed County watershed studies, 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 5 percent of the watershed area. The ISI method was first developed and implemented for the Upper Back River watershed study and was also used for the Tidal Back River and Middle River/Tidal Gunpowder watershed studies. Institutions surveyed as part of this study include the following types of community-based facilities: schools, faith-based facilities, community centers, fire and rescue stations, and care facilities (e.g., senior living). 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 field maps created for the upland assessments and on larger base maps showing the entire watershed. Institutions were surveyed as encountered in the field using these maps and a list of institutions as guidance. Unique ID numbers were assigned to ISIs using the classification scheme "ISI_D_100", where 'D' denotes the Bear Creek/Old Road Bay planning area watershed and the first number corresponds to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-10 for the purposes of HSIs, ISIs, and PAAs. Institutional sites were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, ISIs in Lynch Cove would be identified as 0401, 0402, 0403, 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 30-foot spacing between trees for narrow sites or based on an estimate of 135 trees per acre for larger areas. This density was taken from the *Baltimore County Policy and Guidelines for Community Tree Planting Projects* and assumes a survival density of 100 trees per acre after 25 years. 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 faith-based, care facilities and fire & rescue stations) did have fleet vehicles such as buses and trucks 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.

Recommended Actions

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:

- Tree planting
- Stormwater retrofit
- Downspout disconnection
- Impervious cover removal
- Trash management
- Storm drain marking
- Stream buffer improvement
- Education (e.g., lawn care, outdoor materials storage)

4.4.2 Summary of Sites Investigated

A total of 19 institutions were assessed throughout the Bear Creek/Old Road Bay watersheds. The number and type of institutions assessed within each subwatershed is summarized in Table 4-12. Note that several institutions overlapped two subwatersheds. For this analysis, it is counted toward the subwatershed in which the majority of the area falls within. For example, the Community College of Baltimore County-Dundalk encompasses portions of Bullneck Creek and Lynch Cove. Since the majority of the area falls within Bullneck Creek, it was counted toward this subwatershed for analysis purposes. Two (2) large institutions were assessed including the Community College of Baltimore County-Dundalk and the Fort Howard VA Hospital facility. Because of their size, specific recommendations at these locations are quantified in this section, but an in-depth discussion of these facilities can be found in Section 4.6.

Table 4-12: Types of Institutions Assessed

Subwatershed	Community Centers	Public Schools	Police, Fire & Rescue	Care Facilities	Faith-Based	Cemetery
Colgate Creek	1	1	-	1	-	1
Peach Orchard Cove	-	1	-	-	-	-
Bullneck Creek	-	2	-	-	-	-
Lynch Cove	1	1	1	-	1	-
Chink Creek	-	1	-	-	-	-
Bear Creek Headwaters	-	1	-	-	-	-
Charlesmont/Tobasco Coves	-	1	-	-	-	-
Oakleigh/Schoolhouse Coves	-	-	-	-	1	-
Country Club/Humphrey Creek Remnant	-	-	-	-	1	-
Jones Creek	-	-	-	1	-	-
Northpoint Creek	-	***1***	-	-	-	-
Shallow Creek	-	-	-	1	-	-
Black Marsh	-	-	-	-	-	-
Sparrows Point	-	-	-	-	-	-
Total	***2***	***9***	***1***	***3***	***3***	***1***

Figure 4-23 shows the distribution of the various types of institutions assessed throughout the planning area.

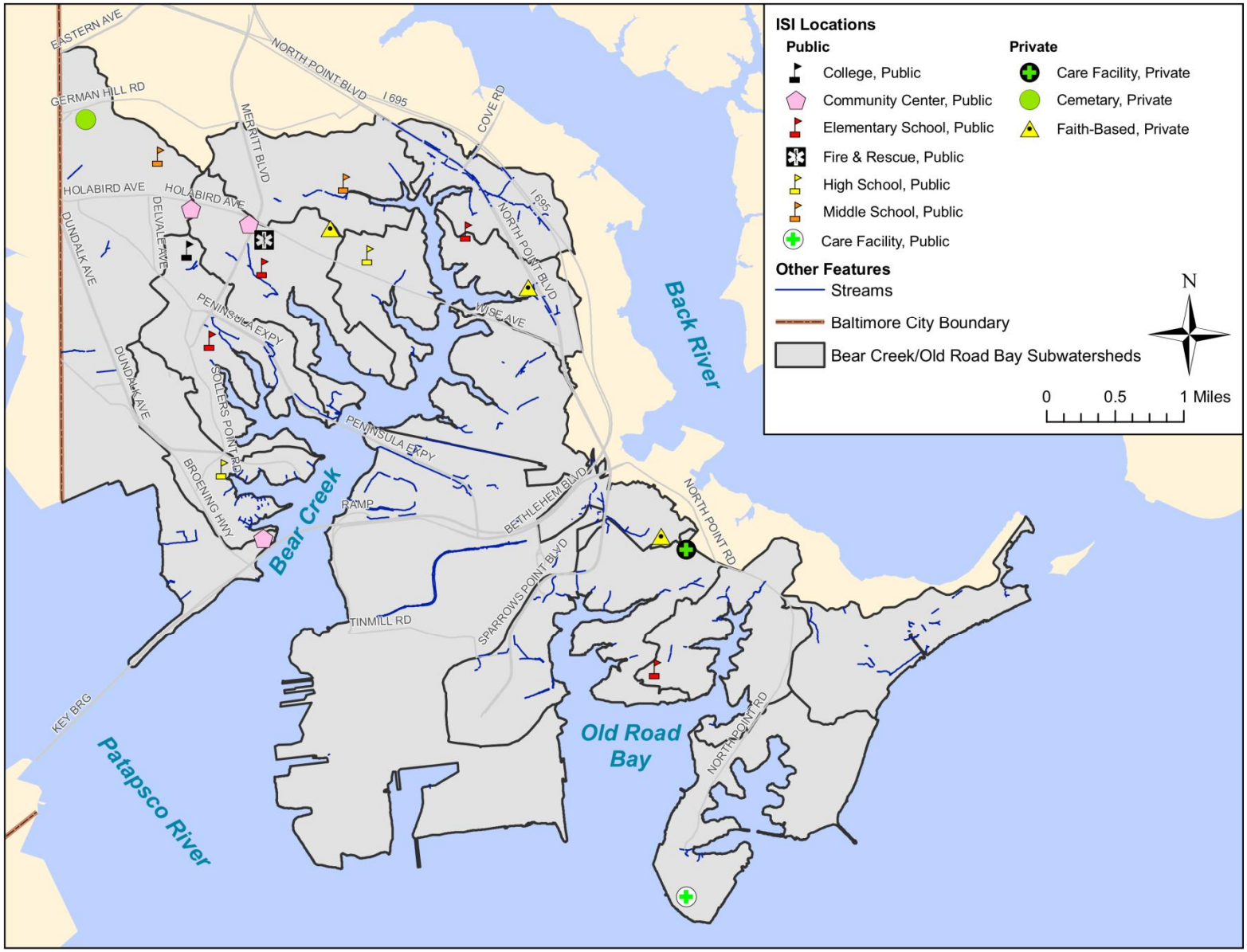

Figure 4-23: ISI Locations in Bear Creek/Old Road Bay

4.4.3 General Findings

The number of the different types of recommended actions for ISIs is summarized in Table 4-13 by subwatershed.

Table 4-13: ISI Recommended Actions by Subwatershed

Subwatershed	# of Trees	SW Retrofit	Downspout Disconnection	IC Removal	Trash Management	Storm Drain Marking	Buffer Improvement	Education
Colgate Creek	566	3	1	3	4	3	1	3
Peach Orchard Cove	18	1	0	0	1	1	0	1
Bullneck Creek	1,145	0	1	1	2	1	1	0
Lynch Cove	816	3	1	3	3	4	2	2
Chink Creek	180	1	0	0	1	1	0	1
Bear Creek Headwaters	161	1	0	1	1	1	1	1
Charlesmont/Tobasco Coves	285	0	0	1	1	1	0	0
Oakleigh/Schoolhouse Coves	53	1	0	0	1	1	1	1
Country Club/Humphrey Creek Remnant	27	0	0	0	1	1	0	1
Jones Creek	0	1	0	0	1	1	0	1
Northpoint Creek	34	0	0	0	1	1	0	1
Shallow Creek	0	0	0	0	0	1	1	0
Black Marsh	0	0	0	0	0	0	0	0
Sparrows Point	0	0	0	0	0	0	0	0
Total	***3,285***	***11***	***3***	***9***	***17***	***17***	***7***	***12***

4.4.3.1 Tree Planting

It was estimated that a total of 3,285 trees could be planted at institutions located within 10 of the 14 subwatersheds comprising the Bear Creek/Old Road Bay planning area. Trees were recommended for 16 out of the 18 institutions assessed. Tree planting sites were identified in the field and noted on field maps. The number of trees was estimated based on a planting density of 135 trees per acre. This density was taken from the *Baltimore County Policy and Guidelines for Community Tree Planting Projects* and assumes a survival density of 100 trees per acre after 25 years. . The table above 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 Table 4-13, stormwater retrofits were recommended at 11 sites. Storm drain marking was also a common recommendation (17 sites). Downspout disconnection was recommended for 2 public institutions and 1 private institution site (church) 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 Bear Creek/Old Road Bay and how their actions can impact or improve water quality.

Stormwater retrofits were recommended at 8 public institutions (5 schools, 2 community centers, 1 government facility) and 3 private facilities (2 faith-based, 1 care facility). Stormwater retrofit opportunities included treating runoff from parking lots, inlet retrofits, and conversion/inspection of existing SWM facilities. 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 stormwater infiltrates for pollutant removal prior to groundwater recharge or entering the stream system. Four examples of stormwater retrofit recommendations for parking lots are shown in Figure 4-24. The photos show sites which have large pervious areas available adjacent to impervious parking lot. This is a good opportunity to address runoff from the parking lots and potential ponding or sediment build-up issues, and also treat runoff before it enters any on-site inlets or streams.

At ISI_D_0102, runoff from a parking lot currently drains to an inlet that can be removed. Drainage here could enter a narrow bioretention area or vegetated swale in the planter strip to receive treatment. At ISI_D_0103, a large unused paved area in the rear of the property drains to a curbline which currently enters a drainage inlet. A large portion of this paved area could be removed to provide treatment to existing drainage here. In addition, downspouts on the side of the building could be disconnected and directed to a proposed treatment facility.

Two sites from the high EJ concern area discussed in Section 2.3.9 were also identified as potentially having stormwater retrofit opportunities. At ISI_D_0104, drainage from a parking lot that currently enters a drainage inlet could be directed to a bioretention area in the pervious area adjacent to and downhill from the parking lot. At ISI_D_0201, a large asphalt track currently drains through small curb openings to drainage inlets in the pervious interior of the track where bioretention areas could be constructed.

Figure 4-24: Parking Lot Retrofit Opportunities at ISI_D_0102 (top left), ISI_D_0103 (top right), ISI_D_0104 (bottom left) and ISI_D_0201 (bottom right)

At ISI_D_0403, the entrance road and parking area on the south of the property currently drain to existing drainage inlets. Runoff from these impervious areas could be directed to a large pervious area on the south side of the institution's property. This pervious area is significantly lower in elevation and a bioretention or swale facility could be constructed here to treat runoff prior to its entering Lynch Cove. At ISI_D_0501, drainage from a dilapidated paved area could be directed to a proposed bioretention area which could also treat rooftop runoff from a portable classroom on the site. At ISI_D_0601, an existing parking lot currently drains to an inlet which outfalls directly into an adjacent stream that shows evidence of incising and erosion. By removing the inlet, stormwater could be directed to a swale which could treat runoff for nutrients while also slowing the flow rate into the existing stream. ISI_D_0801 is a private, faith-based facility where runoff from the parking lot is currently directed to a turf grass lawn area where a swale or bioretention area can be constructed. In addition, pervious islands in the parking lot could be used to treat runoff.

Figure 4-25: Parking Lot Retrofit Opportunities at ISI_D_0403 (top left), ISI_D_0501 (top right), and ISI_D_0601 (bottom left), and ISI_D_0801 (bottom right)

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 watersheds' capacity for infiltrating and treating stormwater runoff.

Impervious cover removal was a recommended action for 9 out of the 18 institutions investigated. It was a recommended action for sites where a considerable impervious area appeared to be abandoned or underutilized such as parking lots 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.

The photos in Figure 4-26 show extraneous asphalt at ISI_D_0103 and ISI_D_0403 that could be removed. At ISI_D_0103, the rear of the building contains a large area of degraded asphalt surface which was not used for parking. A large portion of this area could be removed and either a small strip of asphalt could remain or a structural paver system could be installed to maintain vehicle access around

the area. This site was discussed in Section 4.4.3.2 as having potential for a stormwater retrofit installation. At ISI_D_0403, a large area of asphalt was located behind the school facility which was collecting sediment. This area is inaccessible to vehicles so its removal wouldn't remove parking spaces for the adjacent athletic fields.

Figure 4-26: Extraneous Asphalt Cover Removal Opportunities at ISI_D_0103 (left) and ISI_D_0403 (right)

Figure 4-27 shows two ISIs where dilapidated, athletic courts were found during the field assessments. The courts at ISI_D_0104 and ISI_D_0701 both showed signs of vegetation growing through cracks in the pavement and were directly adjacent two newer courts that had evidence of less wear and tear and more use. These areas provide an opportunity for the removal of worn pavement that could be replaced with a porous surface that would maintain the areas' use while providing for greater infiltration of stormwater.

Figure 4-27: Unused Athletic Court Removal Opportunities at ISI_D_0104 (left) and ISI_D_0701 (right)

Figure 4-28 shows an old impervious track pad at ISI_D_0102 that is no longer in used and is recommended for removal.

Figure 4-28: Impervious Cover Removal Opportunities at ISI_D_0102

4.4.3.4 Buffer Improvement

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 options, however, 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.

Buffer improvement was identified as a recommended action for 7 out of the 18 institutions assessed including a public community college, three (3) public schools, a government center, and one (1) private facility (faith-based). School properties typically represent a unique opportunity to combine restoration projects with education. The public schools recommended for buffer improvement are ISI_D_0403 and ISI_D_0601. In these locations, the streams run adjacent to the property line of the schools. As seen in Figure 4-29, there is ample room for extending the buffer in these areas. At ISI_D_0601, significant degradation of the adjacent stream was observed. Buffer planting could be performed at this site in conjunction with stream cleaning or restoration project. ISI_D_0402 is sited directly north of ISI_D_0403 and borders the same stream. Buffer improvements in this location could be extended to ISI_D_0402 which is a government complex used for police training.

Figure 4-29: Buffer Improvement Opportunity at ISI_D_0403 (left) and ISI_D_0601

ISI_D_0104 falls within the area indentified in Section 2.3.9 as potentially having EJ concerns. Split between the Peach Orchard Cove and Colgate Creek subwatersheds, this site is a public community center directly adjacent and draining to Bear Creek. As seen in Figure 4-30, the 50-foot strip adjacent to surface waters at the site is vegetated in some areas but has the potential for more plantings and possibly shoreline stabilization to prevent erosion of the existing beaches.

Figure 4-30: Buffer Improvement Opportunity at ISI_D_0104

4.4.3.5 Trash Management

Trash management is an area in need of improvement throughout various areas of the watersheds including institutions. A total of 17 institution sites (9 public, 6 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, at ISI_D_0501 and ISI_D_0701 there was evidence of leakage by stains on the ground. Dumpsters with evidence of leaking should be repaired or replaced. At both of these sites, staining from the dumpsters led to nearby storm drains. Runoff diversion methods should be used

to contain leaks and prevent potential pollutants from being carried by stormwater runoff into the storm drains. At some sites, dumpsters were noted as overflowing and with potential for trash to be carried off-site by wind and/or rain. In these cases, it should be determined whether additional dumpsters or increased pick-up frequency is necessary. Dumping was also noted at multiple institutional areas including both litter and bulk items. One trash dumping problem was observed at ISI_D_0901, where a shopping cart and other materials were observed in the woods at the rear of the property (see Figure 4-31). Other dumping and trash issues were observed along the edge of a property or in a nearby stream.

Figure 4-31: Trash Management Opportunity at ISI_D_0501 (left) and ISI_D_0901 (right)

4.5 Pervious Area Assessment (PAA)

PAAs were conducted to identify and evaluate sites within the Bear Creek/Old Road Bay 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 upland assessments and on larger base maps showing the entire planning area. 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 or large open spaces within an NSA. 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 are highly urbanized, sites greater than approximately 1 acre were considered. Unique ID numbers were assigned to PAAs using the classification scheme "PAA_D_0100", where 'D' denotes the Bear Creek/Old Road Bay planning area and the first two numbers correspond to a specific subwatershed. As previously described, subwatersheds were assigned the unique numbers summarized in Table 4-10 for the purposes of HSIs, ISIs, and PAAs. Pervious areas

were numbered sequentially in the order they were surveyed within a particular subwatershed. For example, PAAs in Colgate Creek would be identified as 0101, 0102, 0103, 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 another 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 it requires 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.

Recommended Actions

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 16 pervious areas were assessed within the Bear Creek/Old Road Bay planning area totaling approximately 296 acres. Parcel sizes ranged from 5 acres to over 40 acres. Most sites assessed (12 out of 16) were greater than 10 acres in size. All but two sites surveyed were considered as open pervious cover type with minimal site preparation required for restoration. Figure 4-32 shows the location and size of PAAs within the planning area.

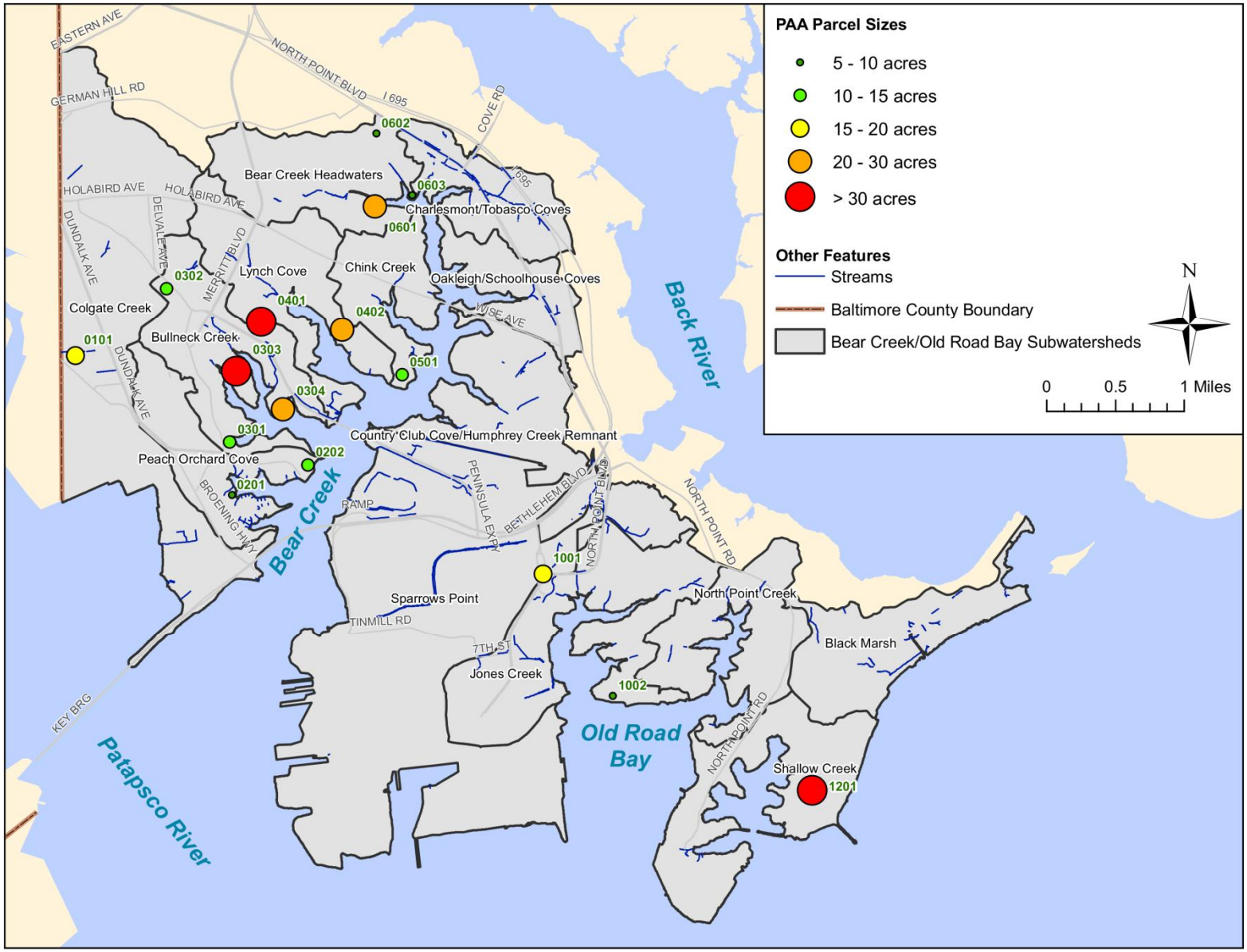

Figure 4-32: PAA Locations

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 4-14.

Table 4-14: Summary of PAA Results

Site ID	Acres	Ownership	Management	% Turf	Site Prep
PAA_D_0101	19.26	Public	Park	85	Minimal
PAA_D_0201	5.33	Public	Park	70	Minimal
PAA_D_0202	12.6	Public	Park	85	Minimal
PAA_D_0301	11.56	Public	Park	60	Minimal
PAA_D_0302	13.15	Public	Park	95	Minimal
PAA_D_0303	40.79	Public	Park	80	Extensive
PAA_D_0304	20.72	Public	Park	60	Minimal
PAA_D_0401	37.84	Public	Park	80	Minimal
PAA_D_0402	24.35	Public	Park	90	Minimal
PAA_D_0501	11.24	Private	Vacant Land	50	None
PAA_D_0601	22.49	Public	Park	60	Minimal
PAA_D_0602	8.86	Public	Park	65	Minimal
PAA_D_0603	5.83	Public	Park	90	Minimal
PAA_D_1001	17.05	Public	ROW	50	Minimal
PAA_D_1002	8.75	Private	Vacant Land	60	Minimal
PAA_D_1201	35.83	Public	Park	100	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 16 sites surveyed, 14 are under public ownership and all but one were considered to require minimal site preparation. The 14 public pervious area sites assessed are briefly described below.

PAA_D_0101: Saint Helena Park

PAA_D_0101 is located at the intersection of Willow Springs Road and Woodley Road in the Colgate Creek subwatershed. It is a 19.3-acre public park, maintained by Baltimore County Department of Recreation and Parks. It is mostly comprised of turf grass (85%) with approximately 10% forest cover, and 5% shrubbery. The majority of the site is comprised of athletic fields and courts, some of which appear to be unused. Of the two baseball fields on the site, one appears to be unused and located directly adjacent to a wetland stream buffer. It is recommended that the use of this site be investigated to determine if the field is a candidate for removal. If so, this site is recommended for reforestation with minimal site preparation to supplement and enhance the existing wetland and stream buffer. This site receives full sun exposure and is easily accessible by foot, vehicle, and heavy equipment. Tree planting could be a potential community project. The site is also recommended for impervious cover

removal as a tennis court surface on the site was found to be in disrepair. If the tennis court is still needed, the site could be a candidate for the use of porous pavement instead of a traditional impervious cover. In addition, dumping of construction materials was found on-site and appeared to have been there for a long period of time. Planning has occurred in the past for possible expansion and renovation of the park in which community input was solicited. Any input provided at public meetings should be taken into account prior to the implementation of restoration actions. Figure 4-33 shows potential wetland and stream buffer planting at PAA_D_0101 as well as the deteriorated tennis courts and dumping on the site.

Figure 4-33: Potential Stream Buffer Planting Area (top), Impervious Cover Removal (bottom left), and Dumping (bottom right) at PAA_D_0101

PAA_D_0201: Turner Station Park

PAA_D_0201 is located on Rayme Road in the Peach Orchard Cove subwatershed. It is a 5.3-acre public park, maintained by Baltimore County Department of Recreation and Parks. There is a large parking area on the site surrounded by pervious land mostly comprised of turf grass (70%) with approximately 25% forest cover, and 5% shrubbery. Young trees that had been recently planted were noted on the site so planting opportunities here are limited. Potential stormwater retrofits were noted here as the parking lot drains to turf islands that could be converted to small bioretention areas or rain gardens to

provide water quality treatment. See Figure 4-34 for examples of areas that could be retrofit with stormwater treatment areas at PAA_D_0201.

Figure 4-34: Potential Stormwater Retrofits at Parking Lot Islands at PAA_D_0201

PAA_D_0202: Watersedge Park

PAA_D_0202 is located on Bullneck Road in the Peach Orchard Cove subwatershed. It is a 12.6-acre public park, maintained by Baltimore County Department of Recreation and Parks. The park consists of multiple baseball diamonds as well as athletic courts and a public boat ramp and is partially located in the area of the study identified as having high EJ concerns. Localized reforestation, particularly along the shoreline is recommended for this PAA. The site would require minimal site preparation to supplement and enhance the shoreline buffer at the site. In addition, the boat launch at the site was noted as having significant erosion, delivering sediment directly into Bear Creek (see Figure 4-35). This area is recommended for resurfacing to stabilize the existing ramp and eliminate the erosion here.

Figure 4-35: Erosion at Boat Launch (left) and Shoreline Planting Potential (right) at PAA_D_0202

PAA_D_0301: Concrete Homes Park

PAA_D_0301 is located off Dundalk Avenue in the Bullneck Creek subwatershed. It is an 11.6-acre public park, maintained by Baltimore County Department of Recreation and Parks. The site is comprised mostly comprised of turf grass (60%) with approximately 25% forest cover, and 15% shrubbery. Located directly adjacent to the Bullneck Creek shoreline, the park provides a buffer between the residential area to its west and Bullneck Creek to the east. There is an opportunity for extensive planting along the shoreline with minimum site preparation needed and easy access for vehicles. Constraints at this site include a set of large transmission lines that bisect the site. Accounting for a 100-foot offset from the electric lines, there is still potential for almost two (2) acres of reforestation here, mostly in the southern half of the site. The other potential difficulty with reforestation at this site would be the elimination of scenic water views from much of the residential area.

Maintenance staff at this site is also recommended for education on proper landscaping techniques as mowing at the site left large amounts of grass clippings that could wash into Bullneck Creek, injecting additional and unnecessary nitrogen and phosphorous into the waterway. Figure 4-36 shows potential reforestation areas at PAA_D_0301 along with the transmission lines located on the site.

Figure 4-36: Reforestation Potential Limited by Overhead Transmission Lines at PAA_D_0301

PAA_D_0302: Dundalk Middle School Fields

PAA_D_0302 is located off Sollers Point Road across the street from the Community College of Baltimore County's Dundalk Campus. The 13.2 acre parked is divided down the middle with the northwestern portion under the control of Baltimore County Department of Recreation and Parks while the southeastern portion is under the ownership of the Board of Education of Baltimore according to GIS records. The area consists of four (4) baseball fields that appear to be used occasionally by Dundalk Middle School, which is located on the other side of a set of train tracks from the park. Smaller planting areas were identified on the periphery of the park and along Sollers Point Road as trees in these locations wouldn't affect the athletic fields. The field on the southeast end of the park was noted as seeming under-used and not maintained and could also be reforested. Minimal site preparation would be needed and the site is easily accessible by foot or vehicle.

Evidence of trash was found on the site that seemed to be carried by a concrete channel draining from Sollers Point Road. The 1,200-foot concrete channel traverses the exterior of the site where it eventually discharges to an inlet. This channel is recommended to be retrofit into a vegetated swale to treat runoff from Sollers Point Road.

Figure 4-37 shows reforestation potential at PAA_D_0302 along with an image of the concrete drainage channel recommended to be retrofit as a vegetated swale.

Figure 4-37: Reforestation Potential (left) and a Concrete Drainage Channel (right) at PAA_D_0302

PAA_D_0303: Merritt Point Park

PAA_D_0303 is located at the end of Dunmanway Road in the Bullneck Creek subwatershed. This 40.8 acre park sits on a peninsula protruding into Bullneck Creek and is maintained by Baltimore County Department of Recreation and Parks. Consequently, the park has a large amount of shoreline which was found to be mostly stabilized with rock. Emergent wetland species was sited along parts of the shoreline.

At the northern end of the site, demolition of a large building was noted which could be an area for potential reforestation depending on future plans at this location. It is recommended that this site be investigated to determine if reforestation is feasible. The other parts of the site include a driveway and parking area, two baseball diamonds, and a large pervious area with trees located sporadically throughout. The southern end of the site has large transmission lines running through it. Shade tree planting could be accomplished in some areas of the park that have open pervious area. In addition, the large parking surface on the site could be converted into a porous pavement system that would allow for more infiltration of rainfall. Planning has occurred in the past for possible expansion and renovation of the park in which community input was solicited. Any input provided at public meetings should be taken into account prior to the implementation of restoration actions.

Figure 4-38: Demolished Building Area (left) and Shade Tree Planting Potential (right) at PAA_D_0303

PAA_D_0304: Chesterwood Park

PAA_D_0304 is located on Chesterwood Road off the Peninsula Expressway in the Bullneck Creek subwatershed. Located on the shoreline, this 20.7 acre park is maintained by the Baltimore County Department of Recreation and Parks. The site consists of a large parking area and a soccer/football field, but the majority is natural forests and wetlands along the boundary of the site. "No-mow" buffer signs were seen along the perimeter of the site. Although reforestation here is limited, there is potential for shade tree plantings in the open pervious areas of the site. In addition, evidence of the dumping of bleachers, fencing, and other materials was seen on site.

Figure 4-39: Shade Tree Planting Potential (left) and Evidence of Dumping (right) at PAA_D_0304

PAA_D_0401: Stansbury Park

PAA_D_0401 is located on Stansbury Road in the Lynch Cove subwatershed. The 37.8 acre is maintained by the Baltimore County Department of Recreation and Parks site and consists of a driveway and parking area, large athletic fields, and an approximately 10 acre pond formed from an old quarry. The site is also bisected by a set of electric transmission lines. These transmission lines act as constraint to large-scale

planting on the site, but there is potential for street tree planting around the exterior as well as shade tree planting along the driveway.

Figure 4-40: Shade Tree Planting Potential (left) and Electric Transmission Lines (right) at PAA_D_0401

Contaimination from what appears to be Chrome Ore Process Resideue was identified at the park in 1986 along the entrance berm of the site, at the athletic fields, and in areas southeast of the pond. Several environmental investigations were conducted at the site by MDE and EPA to determine the extent and impact of contamination at the site. The investigations led to the conclusion that there was an increased potential risk of non-carcinogenic adverse effects to children as a result of exposure to on-site contamination in subsurface soils. To remediate this risk, the County has conducted soil removal in parts of the site as well as the installation of an impervious cap adjacent to the pond to prevent contaminant transport. To date, samplings taken at the site indicate that the levels of contaminants in the sediment adjacent to the shore remain at acceptable levels and no contaminants were detected in the samples collected at the pond bank (Facts About Stansbury Pond, 2008).

There is evidence of erosion on the slopes of the pond at the site, specifically the area that abuts Lynch Cove. Vegetation and plantings in this area are limited to prevent puncture of the cap. It is recommended that an investigation of this area be undertaken to what measures are necessary to stabilize the pond slopes from further erosion.

Figure 4-41: Evidence of Eroding Shoreline at the Pond at PAA_D_0401

In addition, potential stormwater retrofit opportunities were noted at the existing parking lot. Currently, drainage is directed towards a grassed strip adjacent to the parking lot which could be converted to a bioretention area or rain gardens to provide water quality treatment.

PAA_D_0402: Inverness Park

PAA_D_0402 is located on Inverton Road located mostly in the Lynch Cove subwatershed with a small portion in the Chink Creek subwatershed. At 24.4 acres, the park is maintained by the Baltimore County Department of Recreation and Parks and contains multiple playing fields, a recreation center and parking areas. Although much of the site consists of playing fields, there are opportunities for street tree planting along Lynch Road and reforestation in areas adjacent to the parking lot and recreation center. In addition, much of the site consists of shoreline along Lynch Cove. It is recommended that a "no-mow" buffer be instituted in these areas where it would not interfere with the existing playing fields on the site.

Figure 4-42: Potential for Shoreline Planting (left) and Reforestation (right) at PAA_D_0402

PAA_D_0601: Bear Creek Park

PAA_D_0601 is located on the north side of Park Haven Road and Gray Haven Road in the Bear Creek Headwaters subwatershed. The 22.5 acre park is maintained by the Baltimore County Department of Recreation and Parks and is linear in nature, stretching approximately 3,500-feet along Bear Creek Headwaters. Because of its location, this park possesses quite a bit of shoreline and in most areas, a 50-foot buffer is present between the mowed turf and surface waters. The area contains an athletic field and a playground, but the majority is open turf most likely used by the General John Stricker Middle School located across the stream. It is recommended that this sight be investigated to determine which areas are used by the school, and which areas may be reforested to provide additional stream and shoreline buffer while not interfering with the school's day-to-day activities. Figure 4-43 shows potential planting areas alongside existing shoreline buffer at PAA_D_0601.

Figure 4-43: Potential for Shoreline Planting (left) and Reforestation (right) at PAA_D_0601

PAA_D_0602: North Point Battlefield Monument

PAA_D_0602 is located at the intersection of North Point Road and Trappe Road, located in the Bear Creek Headwaters subwatershed. The 8.9 acre site is maintained by the State of Maryland's Department of Natural Resources (DNR) and commemorates the historic Battle of North Point that was fought in the area during the war of 1812. Currently, the site is comprised mostly of turf (65%) with 30% forest cover and the remaining areas shrubs (5%). With a turf height of 5-6 inches, this site is not mowed frequently. Its status as a historic preservation site might be an obstacle to reforestation but there is potential for small-scale shade tree planting in the area which would need minimal preparation.

Figure 4-44: Potential for Shade Tree Planting at PAA_D_0602

PAA_D_0603: Charlesmont Park

PAA_D_0603 is located off of Charlesmont Road located mostly in the Bear Creek Headwaters subwatershed while a sliver is in the Charlesmont/Tobasco Cove subwatershed. The 5.8 acre park is classified as County open space and is owned by Baltimore County EPS. A large portion of the site is unmaintained natural areas along the shoreline with emergent wetland vegetation and trees. At the southern point of the site, a smaller turf area was present, although the presence of underground and overhead utilities eliminated the possibilities of tree planting in this area. On the sides, there was evidence of residents from the adjacent neighborhood using the small turf areas on the sides of the park to park vehicles and boats. As part of the park property, this area could be used to expand the existing shoreline buffer if measures were enforced to prevent parking. In addition, during the assessment, a local resident identified the shoreline area has having significant trash problems because of the dumping of tires and other bulk materials. This site is recommended for inclusion as a candidate for a community trash cleanup.

Figure 4-45: Wetland Plants (left) and Open Pervious Area (right) at PAA_D_0603

PAA_D_1001: Sparrows Point Road Interchange

PAA_D_1001 is an open pervious area located within the interchange connecting Sparrows Point Boulevard and Wharf Road in the Jones Creek and Sparrows Point subwatersheds. At 17.0 acres in total, this site includes 6.6 acres of road while the remaining 10.4 acres is pervious area. Half of this area is covered by trees and shrubs, but the other half contains open pervious area that is a candidate for reforestation. Constraints to tree planting in the area including overhead electric lines that run over a portion of the site along with any sight-lines that would need to be maintained for roadway design standards. Figure 4-46 shows the potential for reforestation at PAA_D_1001.

Figure 4-46: Open Pervious Area at PAA_D_1001

PAA_D_1201: North Point Park

PAA_D_1201 is a collection of open pervious areas in the North Point State Park off of Bay Shore Road in the Shallow Creek subwatershed. Consisting entirely of turf grass, these areas total 35.8 acres and are maintained by DNR. These areas receive full sun exposure, would require minimal site preparation and are connected to a large forested area in North Point State Park. Possible constraints to reforesting here include potential agricultural use as DNR leases other parts of the park for agricultural use. Figure 4-47 provides an aerial view of the areas of North Point State Park that were identified as potential reforestation areas.

Figure 4-47: Open Pervious Area at PAA_D_1201

4.6 Marina Site Visits (MAR)

There are 15 marinas within the Bear Creek/Old Road Bay watershed. Marinas present a unique opportunity to promote environmental stewardship and reinforce the connection between water quality and recreational benefits. Marinas qualify as commercial hotspots since there is 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. In addition, stormwater runoff drains directly to tidal waters because of their location and need for access to waterways. Most marinas have individual NPDES permits, meaning discharges are already regulated and must abide by applicable state laws. A typical hotspot investigation was not conducted for marinas. Rather, site visits were conducted to gather information about typical marina operations and to identify potential restoration and partnership opportunities relevant to meeting watershed goals. The following subsections describe the methods used to evaluate a sample of marinas within the planning area.

4.6.1 Assessment Protocol

The County distributed a letter to all Baltimore County marina owners to solicit participation in a survey involving a tour of the marina property and typical operations. Some members of the Marine Trades Association of Baltimore County (MTABC) offered to give tours and helped identify other marina owners that would be willing to participate in the survey. Based on this information, the County arranged tours with 5 different marinas, representing various types of marinas distributed throughout the planning area. Unique ID numbers were assigned to marinas using the classification scheme “MAR_D_0401”, where ‘D’ denotes the Bear Creek/Old Road Bay planning area watershed and the first two numbers correspond to a specific subwatershed. As previously described, subwatersheds were assigned the

unique numbers summarized in Table 4-10 for the purposes of upland assessments. Marina sites were numbered sequentially in the ordered they were surveyed within a particular subwatershed. For example, marinas in Lynch Cove would be identified as 0401, 0402, etc.

A key strategy for including marinas in the SWAP process is to encourage all marinas to become a certified Maryland Clean Marina. The Maryland Clean Marina Initiative 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. A condensed and modified version of DNR's Clean Marina Checklist was used to gather key information related to existing pollution prevention practices and areas with improvement potential. More information on this program can be found here: http://www.dnr.state.md.us/boating/cleanmarina/

Marina owners typically gave a walking tour of the site and helped the field team answer a series of yes or no questions comprising the marina review checklist. Basic information was filled out first including type of marina, clean marina status, and contact information. Then, a series of yes/no questions was answered for each of the following operation categories:

- Vessel Maintenance & Repair
- Petroleum Control
- Sewage Handling
- Waste Management
- Marina Management
- Stormwater Management
- Turf/Landscaping Areas

For each of the above operation categories, a score (out of a maximum of 100) was calculated based on the number of yes responses divided by the number of applicable questions. Parameters evaluated within each operation category are described briefly below.

Vessel Maintenance & Repair

Vessels require many activities, such as cleaning, engine lubrication, and winterization, which have the potential for introducing pollutants into the environment. Vessel operations may include maintenance, repair, cleaning, and/or painting. The field team noted whether maintenance and repair activities took place in designated, covered work areas and whether runoff diversion methods were in place for these areas to limit stormwater pollution potential. Marina owners were asked whether and how environmental impacts from bottom coatings and paintings as well as cleaning are minimized. For example, some marinas use water-based paints and vacuum sanding or no sanding to minimize impacts from bottom coatings. Many marinas also use filter cloth and collect debris during boat washing as well as stock non-toxic washing products in their marina store.

Petroleum Control

Petroleum in or on the water can be harmful to aquatic and human health. Petroleum not only contains contaminants but can also reduce light penetration and the exchange of oxygen at the water's surface. For those marinas with fueling operations, it was noted whether fueling areas were covered and environmental controls, such as shut-off and vapor control nozzles and spill cleanup instructions, were in place at fueling pumps. Marina owners were also asked whether fueling areas were staffed by a trained employee and the field team checked whether oil absorbent pads were available.

Sewage Handling

Raw or poorly treated sewage is hazardous to human health. Waterborne diseases can be passed to people who come into contact with contaminated waters or by eating contaminated shellfish. Effluent discharged to waterways also reduces the amount of oxygen available for aquatic life. If applicable, marina owners were asked whether pump-out stations are well maintained. For example, regular inspections and an inspection log are indicators of well maintained pump-out systems. The field team also determined whether the pump-out station was easily accessible and if methods are in place to prevent spills. Marina owners were also asked whether clean, functioning restrooms are available 24 hours a day and if on a septic system, whether it is regularly maintained and functional.

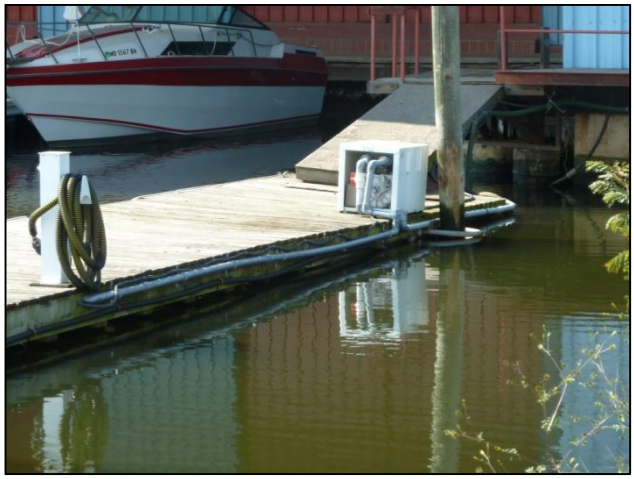

Figure 4-48: Example of Pump-Out with Spill Potential in Bear Creek/Old Road Bay

Waste Management

Every business generates waste as a result of daily operations, which can be potentially hazardous or a source of stormwater pollution depending on the type of waste and how it is stored. The field team noted whether hazardous wastes were stored, used and disposed of properly. For example, some proper liquid waste management techniques that were observed included using separate containers for storing oil, antifreeze and solvents, employing a certified waste hauler to dispose or recycle, surrounding tanks with impervious, secondary containment, and locking intake to oil and antifreeze recycling containers to prevent contamination. The field team checked whether non-hazardous dumpsters were covered, accessible, and in good condition (no leaking or overflow). Marina owners were also asked

whether solid waste recycling is provided on-site and if trash-pick up is conducted frequently to prevent litter from getting into waterways.

Marina Management

Maintaining and educating marina staff and clients about pollution prevention practices is important to routinely minimize pollution. This involves training staff, informing boaters about how their actions can affect water quality and letting the public know that the marina is doing its part to protect the environment. Marina owners were asked whether a spill prevention, control and countermeasures plan is in place and whether employees are trained for best management practices such as proper disposal techniques, spill prevention and control, and general good housekeeping. The field team also asked whether customers are educated about best management practices (BMPs) such as through signs, their rental slip contracts, or other information. For example, several of the certified Clean Marinas provide brochures with clean boating tips from DNR to their customers and others provide mailings or newsletters with similar information. Another marina provides annual safety training for boat owners.

Stormwater Management

Any marina that conducts boat maintenance activities or that has wastewater discharges must apply for coverage under a general permit for discharges from marinas. This authorizes and regulates the discharge of boat and equipment washing water, stormwater runoff from maintenance areas, treated bilge water, noncontact cooling water, and condensate discharges. Permit compliance requires a stormwater pollution prevention plan and BMPs to make sure that wastewater and stormwater leaving a marina will not impact water quality. Marina owners were asked whether they hold a current marina general permit and whether stormwater treatment practices are in place. The field team also determined whether paved areas were limited (which was often the case) and if runoff from paved areas was treated. If storm drains were on site, it was noted whether these were marked. In most cases storm drains were not present. Marina owners were also asked whether shoreline erosion control measures were in place if needed.

Turf/Landscaping Areas

Ground maintenance activities for turf/landscaped areas were also evaluated at marina sites. High turf management practices are potential pollution sources of nutrients, fertilizer, and pesticides. The field team asked marina owners whether toxic lawn/garden chemicals were minimized and determined whether landscaped areas accumulated on impervious surfaces. It was also noted whether runoff diversion methods were in place for landscaped areas. Most of the marinas had very little or no turf/landscaped areas.

Other Comments

After surveying the entire property and evaluating marina operations, notes were made about possible follow-up actions or partnership opportunities.

4.6.2 Summary of Sites Investigated

One-third of the marinas (5 out of 15) in the Bear Creek/Old Road Bay watershed were surveyed. The marinas that participated in the uplands survey are listed in Table 4-16 including site ID, subwatershed and Clean Marina status. Locations of marina site reviews are shown in Figure 4-46. As shown in Table 4-15, 2 out of 5 marinas assessed are certified Maryland Clean Marinas. While this is a sample assessment, the overall watershed strategy should also encompass all marina operations occurring in the watershed.

Table 4-15: Summary of Marina Sites Surveyed in Bear Creek/Old Road Bay

Site ID	Subwatershed	Clean Marina?
MAR_D_0401	LYNCH COVE	Y
MAR_D_0402	LYNCH COVE	N
MAR_D_1001	JONES CREEK	Y
MAR_D_1002	JONES CREEK	N
MAR_D_1301	BLACK MARSH	N

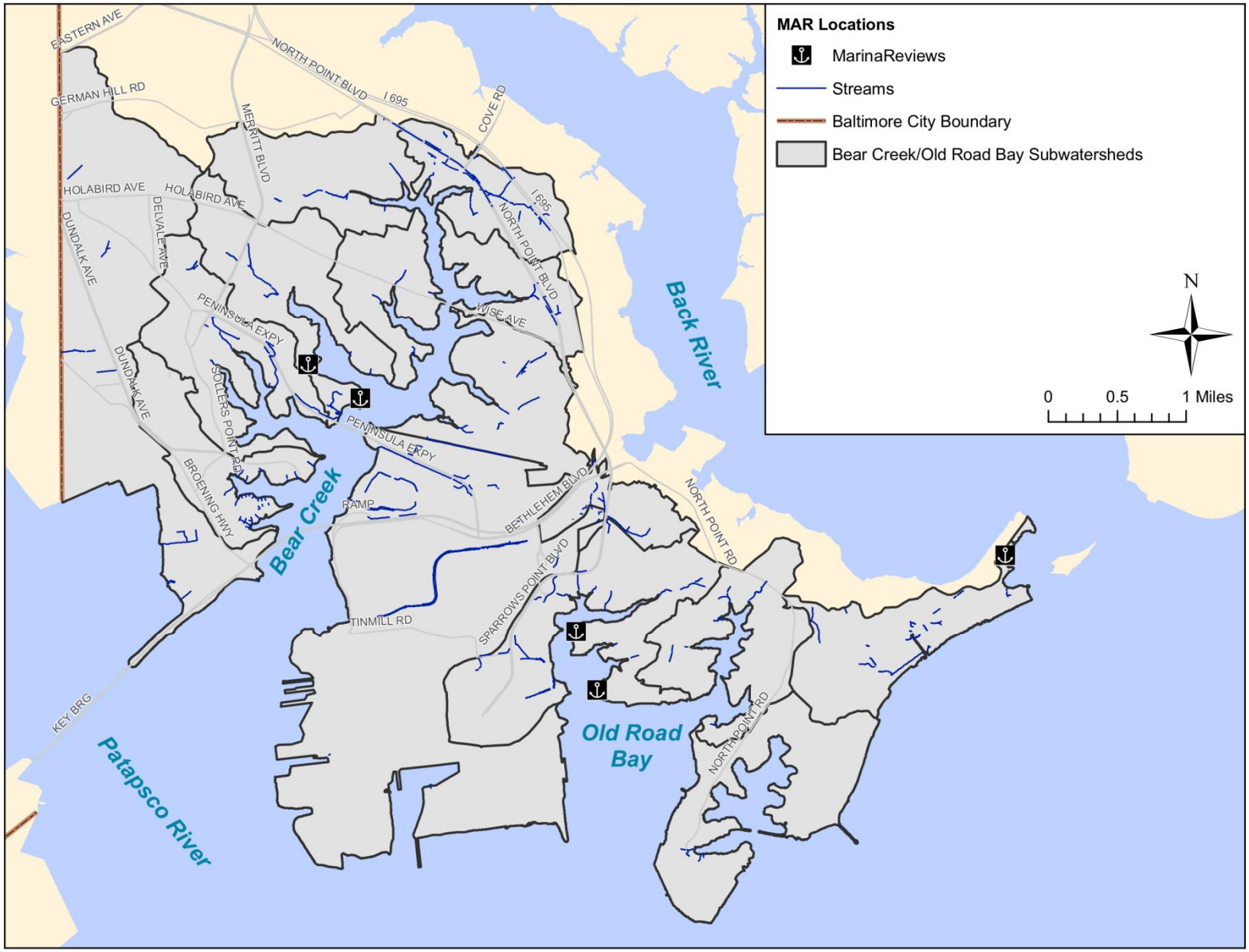

Figure 4-49: Marina Site Visit Locations

4.6.3 General Findings

A summary of marina survey results is presented in Table 4-16 including Clean Marina status and operation category scores. As previously described, for operation category assessed, a score (out of a maximum of 100) was calculated based on the number of yes responses divided by the number of applicable questions. If a category was not applicable, for example no fueling operations were present at a given marina, a score was not calculated. This is denoted by '-' in the table below. Further information including comments regarding observations is presented in Appendix C.

Table 4-16: Marinas Survey Results

Site ID	Clean Marina?	Maint/ Repair	Petroleum Control	Sewage Handling	Waste Mgmt	Marina Mgmt	SW Mgmt	Turf/ Scape
MAR_D_0401	Yes	80	75	75	60	100	83	0
MAR_D_0402	-	100	-	75	25	0	40	67
MAR_D_1001	Yes	0	-	100	60	67	40	100
MAR_D_1002	-	60	-	75	60	33	50	100
MAR_D_1301	-	-	-	100	0	100	20	100

In general, sewage handling and petroleum control operations are well managed at the marinas surveyed. Waste management and turf/landscaping operations were also well managed at most of the marinas surveyed. Vessel maintenance/repair, marina management, and stormwater management were the operation categories with the most room for improvement based on the marinas surveyed. A brief description of the operation categories with the most potential for pollution and general findings are provided below.

Vessel Maintenance & Repair

Marinas with higher scores (and lower pollution potential) for vessel maintenance and repair activities generally have designated and covered work areas with runoff diversion methods in place, such as berms, filter cloth or drip pans. Many of these marinas have eliminated sand blasting practices. Some use baking soda for blasting and others use vacuum sanders if sanding is still used to prevent particulate matter and potential chemicals from leaving the site. Many also use roller paint rather than spray painting. In addition, marinas with lower pollution potential in this category minimize environmental impacts from boat cleaning such as providing and encouraging the use of non-toxic cleaners, paints, and antifreeze products. Many also have debris collection systems in place during boat washing operations. Marinas with lower vessel maintenance and repair scores and higher pollution potential had no designated and/or uncovered work area, where some operations, such as engine repair or boat washing may take place adjacent to the water.

Figure 4-50: Covered Vessel Operations and Maintenance Areas

Waste Management

Most of the marinas surveyed exhibited opportunities for improvements in waste management practices in order to lower pollution potential for this category. In a couple of assessments, uncovered dumpsters were noted being located near surface waters with no runoff diversions. Most marina owners indicated that trash pick-up was conducted frequently along the shoreline and within the marina, which reduces the risk for trash and litter to leave the site and enter nearby waterways. Most marinas also appeared to abide by requirements related to hazardous waste storage, use, and disposal.

The main reason for waste management scores of less than 100 is that solid waste recycling is not provided for customers on-site at most of the marinas surveyed. There is potential to encourage both certified and non-certified Clean Marinas to incorporate recycling as part of their waste management operations. Several marinas mentioned issues with shrink wrap recycling.

Figure 4-51: Uncovered and Overflowing Dumpster at Marina Adjacent to Surface Waters

Marina Management

Keeping marina staff and clients informed about pollution prevention practices is important to routinely minimize pollution. Marinas with lower scores for this operation category and higher potential for pollution, tended to have no formal training for staff or education for customers about BMPs such as

spill prevention and control practices, trash management, and non-toxic boat maintenance practices and products. Some do have spill prevention, control, and countermeasures plans including spill kits and self report to MDE in case of a potentially hazardous spill. Several also have staff that have many years of experience with the same marina and are well trained about BMPs. The field team also noticed that brochures with clean boating tips from DNR were made available to customers, particularly certified Clean Marinas. Anchor Bay East was given a score of 100 for this operation category as they have a spill prevention plan, conduct routine staff training, and also educate customers about BMPs such as signs with fueling and spill control instructions and a winter contract which requires the use of non-toxic antifreeze for winterization. Some marinas have newsletters or mailings, which could be a potential opportunity to incorporate safety and clean boating tips to educate customers.

Figure 4-52: Example of Spill Response Communication to Customers at Clean Marina in Bear Creek/Old Road Bay

Stormwater Management

Stormwater management was a category with lower scores at the marinas assessed in the Bear Creek/Old Road Bay watershed, mostly due to a lack of stormwater treatment practices. Marinas with higher scores for stormwater management operations are those with limited impervious areas and shoreline erosion control measures in place. Marinas with higher pollution potential as a result of stormwater management operations are those with large impervious areas where runoff drains directly to surface water without treatment and/or where shoreline instability issues were observed. These sites may be opportunities to investigate natural shoreline stabilization alternatives and/or incorporation of stormwater management practices such as grass filter strips along marina bulkheads.

Recommended Actions

Based on the observations from the sample assessment, the following actions are recommended to minimize pollution potential from marina operations within the Bear Creek/Old Road Bay planning area:

- Encourage all marinas to become certified Maryland Clean Marinas and/or maintain Clean Marina status.
- Promote the Clean Boater Program including clean boating practices among marina customers.
- Develop and distribute a County-approved list of non-toxic, marina-related products (e.g., cleaners, antifreeze, etc.).
- Encourage solid waste recycling at area marinas.
- Work with marinas to properly recycle shrink wrap and address abandoned boats.
- Continue to enforce zoning laws related to marina use.

A list of the marinas within the Bear Creek/Old Road Bay planning area is included in Table 4-17, including marina name, address, and Clean Marina status. As shown, only two of the marinas are certified Maryland Clean Marinas. A key strategy is to encourage all marinas to enroll in the Clean Marina Initiative. This could involve working with the County, state and/or local community to become certified. In many cases, marinas are already adopting pollution prevention practices voluntarily and/or pursuant to NPDES permit requirements that could count toward the certification. Some of the marinas surveyed seemed willing to participate if educated about the process and cost efficient options. DNR launched an outgrowth of the Clean Marina Initiative in 2007, called the Clean Boater program, to help boaters join the effort to protect waterways. Many of the certified Maryland Clean Marinas included brochures about this program and also encourage customers. This involves signing a clean boater pledge and learning and adopting clean boating practices such as no littering, picking up litter, following sewage, chemical, and debris discharge laws, supporting Maryland Clean Marinas, and sharing clean, safe boating habits with others. This program and clean boating tips should be advertised at all marinas and encouraged among all recreational boaters within the planning area.

In addition to the potential restoration opportunities described in the previous sections, the presence of “bootleg” marinas where boats are kept at private residences or properties not zoned for marina use has the potential to cause harm to water quality. This was also noted as an issue in the 2009 Lower Back River Neck Community Action Plan. Marina operations present within the planning area should be overlaid with current zoning laws to determine whether marina uses are within the appropriate zoning classifications. Follow-up investigations should be conducted for those marina-related businesses that are not consistent with zoning laws and enforced as necessary.

Table 4-17: Marinas in Bear Creek/Old Road Bay

Marina Name	Address	Clean Marina?
Starr Marine	3307 Martini Avenue, Dundalk, Md	N
Anchor Bay East Marina & Yacht	8500 Cove Road, Dundalk, Md	Y
Meehan's Marina	2533 Schoolhouse Ln, Sparrow Point, Md	N
Youngs Boatyard	7201 Waldman Avenue, Edgemere, Md	Y
North Point Marina	2103 Creek Road, Sparrows Point, Md	N
Bill's Boats	9033 Cuckold Point Road, Sparrows Point, Md	N
Sheltered Harbor	8100 Stansbury Road, Baltimore, Md	N
Old Bay Marina	7200 Bay Front Road, Baltimore, Md 21219	N
Atlantis Marina	7201 Bucher Road, Sparrows Point, Md 21219	N
Layne's Marina	7767 North Point Creek Road, Edgemere, Md	N
Markel's Boat Yard	7745 North Point Creek Road, Edgemere, Md	N
Bay Marine Boating Center	8906 Avenue B, Sparrows Point, Md	N
North Point Yacht Club	1700 Wharf Road, Sparrows Point, Md 21219	N
Stoutens Bear Creek Marina	817 Wise Avenue, Dundalk, Md 21222	N
Roudebush Yacht & Engine Works/ Lynch Cove Marina	1917 Wills Road, Dundalk, Md 21222	N

4.7 Large Landowners

Several large parcels of land within the Bear Creek/Old Road Bay watershed were identified as having a single owner and being particularly importance to the health of the watershed. Because of the scope of operations on these sites or the shear land area they cover, this section is used to describe and track restoration potential and identify possible partnership opportunities at these sites.

The sites covered under the Large Landowners include large industrial sites and large institutional sites in the Bear Creek/Old Road Bay watershed. Industrial sites also qualify as hotspots since there is 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. In addition, stormwater runoff from many of these sites drains directly to tidal waters because of their location and need for access to waterways. The large industrial sites included in this assessment hold individual NPDES permits, meaning discharges are already regulated and must abide by applicable state laws. Therefore, a typical hotspot investigation was not conducted for large industrial sites. Rather, site visits were conducted when possible to gather information about operations concerning stormwater and to identify potential restoration and partnership opportunities relevant to meeting watershed goals. At sites where significant investigation has been completed in the past by MDE or EPS, a summary of the site is included. The following subsections describe the methods used to evaluate large industrial sites present within the planning area.

Institutions covered under the Large Landowner category were assessed in accordance with Section 4.4.1. Specific pollution reduction recommendations are quantified under Section 4.4.3, but descriptions of these recommendations are included in the following subsections.

4.7.1 Summary of Sites Investigated

A total of five (5) large, landowner sites were evaluated in the Bear Creek/Old Road Bay watershed. The participating sites are listed in Table 4-18 and the locations are shown in Figure 4-47.

Table 4-18: Summary of Industrial Sites Surveyed in Bear Creek/Old Road Bay

Name	Subwatershed	Acres
Dundalk Marine Terminal	Colgate Creek/Peach Orchard Cove	304
Sparrows Point Facility	Sparrows Point/Jones Creek	3098
Constellation Energy Riverside Generating Station	Colgate Creek/Peach Orchard Cove	179
Community College of Baltimore County - Dundalk Campus	Bullneck Creek/Lynch Cove/Colgate Creek	67
Fort Howard Veterans Administration Hospital	Shallow Creek	90

As shown in the table above, the five (5) sites comprise a considerable portion of the planning area, approximately 33%. It will be important to involve these landowners in the watershed plan and implementation process to help meet watershed goals. General findings from each site are described in the next section.

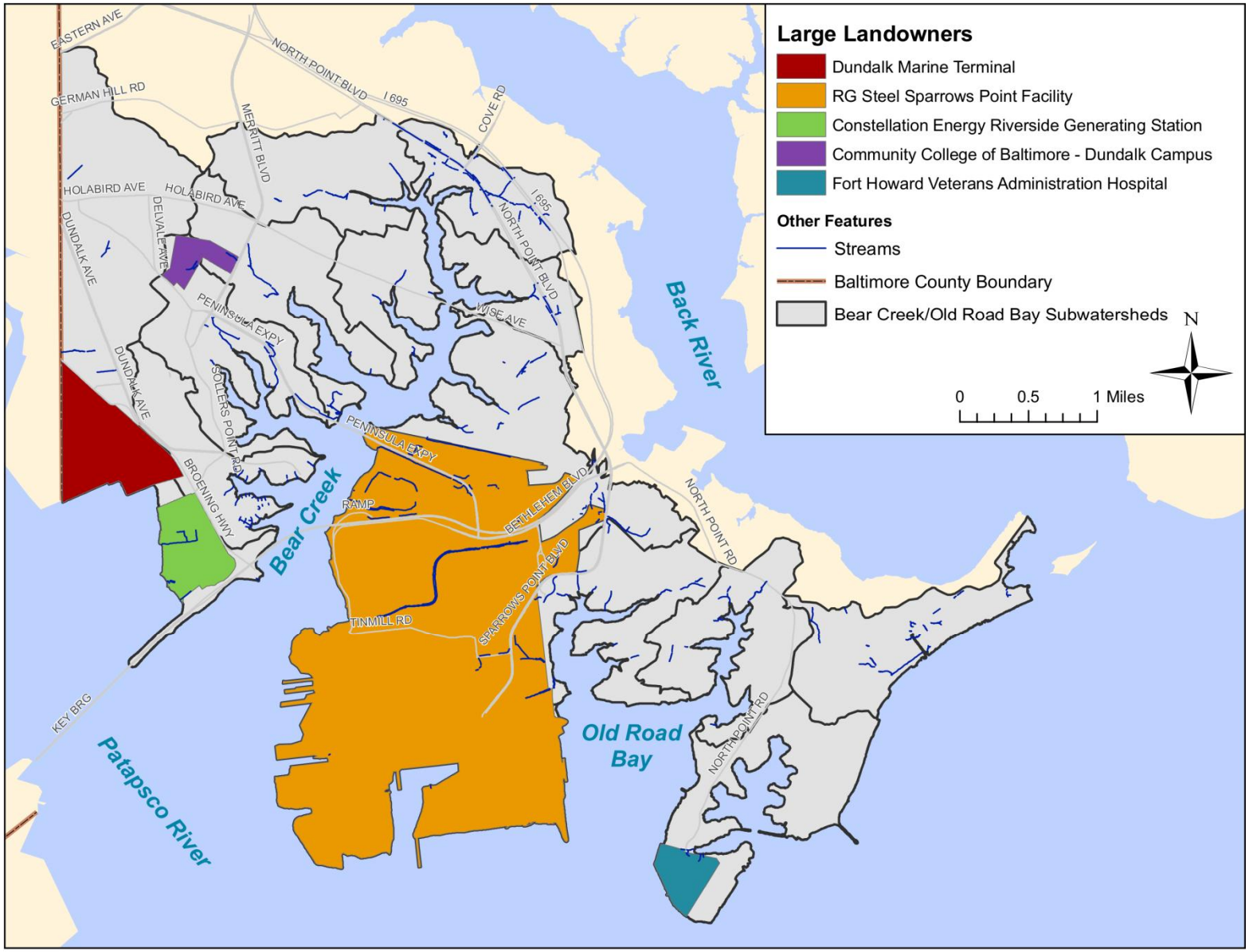

Figure 4-53: Large Landowner Sites in Bear Creek/Old Road Bay

Dundalk Marine Terminal

The Baltimore County portion of the Dundalk Marine Terminal occupies over 303 acres in the Colgate Creek and Peach Orchard Cove subwatersheds off of Broening Highway in the Bear Creek/Old Road Bay planning area. The port facility is split by the Baltimore County and Baltimore City jurisdiction line, totaling 570 acres altogether. The facility handles the import and export of "roll-on/roll-off" materials which includes cars, tractors, construction equipment, and other bulk commodities. In addition, the facility has a paper importing operation on the site. Owned by the Maryland Port Administration (MPA), the Dundalk Marine Terminal leases most of its property to private tenants for commercial shipping operations of import and export goods. The facility has four (4) cranes on the County side of the port that are owned by MPA and used to unload cargo containers and other imported and exported cargo. Equipment brought onto the site comes on an extensive train network or via truck trailer. See Figure 4-54 for an aerial map of the Dundalk Marine Terminal site.

The facility is owned by MPA, who is committed to environmental compliance and its obligation to comply with all applicable state regulations including having a NPDES permit, a Stormwater Pollution Prevention Plan (SWPPP), and BMPs for discharges from the site. In addition to meeting these required state mandates, MPA has taken the initiative to develop their own Stormwater Management Plan summarizing the existing stormwater facilities on the site. MPA holds semi-annual port users meetings with leases to go over environmental requirements pertaining to the NPDES permit including having a permit or a "No Exposure Certification."

The field team met and toured the site with the MPA Environmental Manager along with an environmental specialist representing Maryland Environmental Service (MES). Because of the nature of the operations at the facility, the site is almost entirely impervious. The site has a small storage area it uses for construction materials including sand and stone. These materials are kept isolated, and sediment and erosion control measures are in place around the materials and at stormwater drains to prevent sediment entering the storm sewer system. Any salt used at the facility is kept indoors when not in use. In addition, no uncontrolled bulk storage of construction materials is allowed with the individual tenants at the site. The site appeared to be mostly trash-free with no litter or noticeable trash on the grounds. Representatives with MPA stated that a concerted effort had been made to keep the site clean including collaborative efforts with the local labor force to conduct trash pickups as needed.

MPA has mapped the majority of the storm drain system on the site in GIS, including two (2) major storm sewer systems that enter the site from off the property. One of these systems drains about 30% of the drainage area of the terminal and has experienced flooding issues. The other system drains about 80 acres from the facility and 200-300 acres from off-site. This system was placed through an area identified as having legacy hazardous fill material. Currently, the facility treats baseflow in this system at an onsite industrial treatment plant. In addition, other areas of the site impacted by chromium in the subsurface strata are undergoing studies to prevent transport of the material.

Other measures MPA has taken include standards for vehicle washing and spill containment. Vehicle washing procedures are in place for all tenants including containment and dechlorination of wash water.

The facility has a formal spill response procedure in case of an accident at the site. There are no fueling areas within the portion of the site in Baltimore County.

The MPA is studying potential BMPs that can be used on the site to provide stormwater treatment. The facility has a few already, none of which are owned by tenants. Representatives from MPA did express interest in potentially partnering with Baltimore County on future, off-site projects that could assist the port with meeting TMDL requirements.

Summary of Potential Restoration Opportunities

The Dundalk Marine Terminal has proactively developed a number of pollution prevention measures on the site and maintains an NPDES permit. The main outcome is that the County will continue the dialogue with the environmental manager to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future offsite improvement measures. A summary of potential restoration opportunities at the Dundalk Marine Terminal are included below:

- Work with MPA to track illicit discharge eliminations
- Educate port users on proper hazardous and solid waste disposal
- Work with MPA and adjacent property holders to provide treatment of stormwater runoff from the two (2) storm sewers flowing onto the facility from off-site
- Work with MPA to identify and complete future off-site projects with the potential to meet TMDL reduction requirements imposed on the facility.

Figure 4-54: Dundalk Marine Terminal Site Map

Sparrows Point Facility

The Sparrows Point facility sits on 3,098 acres located almost entirely in the Sparrows Point subwatershed with a small portion extending into the Jones Creek subwatershed. Formerly owned by RG Steel Sparrows Point, LLC, the facility operated as a steel-making operation producing flat-rolled steel for construction, appliance, automotive and other markets (RG Steel, LLC). The site was first owned by the Pennsylavania Steel Company and has since been sold to Bethlehem Steel, Mittal Steel, Severstal, and now RG Steel Sparrows Point, LLC. In August of 2012, a U.S. Bankruptcy Court granted RG Steel approval to sell the property, and the facility was auctioned and purchased by Environmental Liability Transfer Inc., Commericial Development Co., and Hilco Trading Co (Bathon).

Because of the extensive work done by the US EPA and MDE regarding pollution prevention and remediation at Sparrows Point, a specific site visit to the facility was not conducted. This section summarizes a small portion of the information produced by EPA and MDE on the status of ongoing operations and remediation efforts at the site.

On October 8, 1997, the owners of the facility entered into a Consent Decree (Civil Action JFM-97-558, JFM-97-559) with the US EPA and MDE. The Consent Decree required ownership to comprehensively address pollution from historic and ongoing operations at the site. This included provisions for waste minimization/pollution prevention projects to reduce the amount of waste produced, and for recylcling of specific waste streams in the ongoing operations of the plant. The specific obligations listed under the Consent Decree from 1997 include:

1. *Complete a site wide investigation to investigate releases of hazardous constituents from the facility to learn the need for potential corrective action,*
2. *Use interim measures to address releases that require immediate action,*
3. *Apply compliance standards for two solid waste landfills (Greys Landfill and Coke Point Landfill),*
4. *Apply a compliance standard for visible emissions from the roof monitor at the Basic Oxygen Furnace,*
5. *Implement projects to minimize kish emissions,*
6. *Inspect and perform associated repairs of (a) all active sumps and associated trenches that are located in the Cold Sheet Mill and the Tin Mill that contain significant amounts of acid, caustic, plating, and coating solutions, and (b) all above ground storage tanks with capacity greater than 500 gallons that store hazardous substances, and*
7. *Implement projects to minimize waste production*

The Consent Decree designated 5 study areas to be analyzed by October of 2001 including the Tin Mill Canal/Finishing Mills, Greys Landfill, Coke Point Landfill, Coke Oven Areas, and Humphreys Impoundment. This work was completed in the fall of 2001 and a “Site Wide Groundwater Study

Report" was submitted to the EPA in December of 2001. In addition, several other reports have been submitted to EPA by owners of the facility detailing the extent of contaminant releases to groundwater and evaluation of human health factors.

"A broad range of contaminants were detected at the site associated with steel making process: antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, tin, zinc, ammonia, benzene, cyanide, ethyl benzene, ethylene glycol, hydrogen cyanide, hydrogen sulfide, naphthalene, PAHs, PCBs, pentachlorophenol, phenols, pyrene, sodium phenolate, styrene, sulfuric acid, toluene, trichloroethylene, xylene, coal tar, oils, lime sludge, waste alkaline rinses, mill scale, and ship yard wastes (EPA, 9)."

In the past, Severstal began implementation of contaminant recovery and groundwater treatment for subsurface plumes primarily consisting of benzene and napthalene found in subsurface layers. RG Steel Sparrows Point, LLC has continued this process and has assumed responsibility to complete the rest of the items under the Consent Decree. Ownership must provide a report on remediation activites by January 31 of each year.

The facility currently has two (2) landfills where they have or are implementing stormwater and erosion control practices to prevent polluted runoff from leaving the area. At the Greys Landfill, measurement of subsurface contaminants has been detected that would require further remediation in the future. A third landfill is currently being planned and is in the environmental permitting process with MDE.

Offshore investigations required by the Consent Decree are currently undergoing review as disputes have arisen regarding the responsibility of current ownership after the sale of the property. In July, 2011, a federal District Court judge ordered RG Steel, along with EPA, MDE, and the Chesapeake Bay Foundation (CBF) to continue to negotiate an acceptable scope of work for an offshore investigation. If unable to reach an agreement, the judge will determine what must be done to meet compliance of the Consent Decree and other applicable laws.

The MPA as expressed interest in purchasing the "southwest peninsular portion of the property covering the Coke Point Landfill and former Coke Oven Area. Based on the site-wide investigation, the former Coke Oven area is known to be the most contaminated land with product phase volatile and semi-volatile organic compounds present in groundwater" (EPA, 8). Covering about 300 acres, MPA has proposed using this site as a Dredged Material Containment Facility. Based on a fact sheet provided by the MPA, "if the MPA chooses to move forward and succeeds in acquiring Coke Point for the construction of a new DMCF, the MPA would remediate areas within the project footprint. Onshore areas would be remediated prior to project construction. Offshore areas would be remediated in conjunction with the construction of a dike. The remediation would address degraded land and groundwater conditions, as well as degraded sediment in the footprint of the project" (MPA, 4).

Summary of Potential Restoration Opportunities

Changes in ownership at the Sparrows Point facility have been frequent in the recent past. Although the future of steel production activites at the site is in jeopardy, environmental remediation and adherence

to the terms of the Consent Decree document will be required of any current and future owners of the property. The main outcome is that the County will continue the dialogue with MDE to track the pollutant removal efficiency of existing and future restoration practices as well as explore partnership options for future offsite improvement measures.

Figure 4-55: Sparrows Point Facility Site Map

Constellation Energy Riverside Generating Station

The Riverside Generating Station owned by Constellation Power Source Generation, Inc. occupies nearly 180 acres of land at the southern end of the Colgate Creek and Peach Orchards Cove subwatersheds. Located between the Dundalk Marine Terminal and the Francis Scott Key Memorial Bridge, the plant has one 78 megawatt (MW) stream-electric generating unit and one 85-MW natural gas burning unit. Discharges from the Constellation Energy facility must abide by regulations set forth in their individual NPDES permit. Upgrades to the natural gas burning unit, recently required an environmental review by DNR which was completed in January, 2009. The review included summaries of impacts and recommendations for improvements in the categories of air, water, and other resources. Because of the extent of this review, a site assessment was not conducted at this facility.

Constellation Energy has already implemented many stormwater pollution prevention related measures proactively. The main outcome is that the County will continue the dialogue with the plant and track the pollutant removal efficiency of existing and future restoration practices.

Figure 4-56: Constellation Energy Riverside Generating Station Site Map

Community College of Baltimore County – Dundalk Campus

The Community College of Baltimore County's Dundalk Campus is located off of Delvale Avenue and encompasses portions of the Bullneck Creek, Lynch Cove, and Colgate Creek subwatersheds. Sited on 67 acres, the site contains numerous education and operations buildings along with parking, athletic fields, and a significant amount of open space. The institution was assessed as an ISI in accordance with Section 4.4.1 of this report and given the site identification code ISI_D_0302. In addition, any recommendations for this site are accounted for in Section 4.4.3 but described here. The facility does operate under a NPDES General Stormwater Discharge Permit. Consequently, the facility has a Pollution Prevention Plan and an associated Spill Prevention and Control Plan.

Much of the site consists of paved parking for students and faculty draining directly to storm drains that are unstenciled. Converting parking areas into porous paving could significantly enhance the amount of rainfall infiltration on the site while reducing the runoff reaching the storm sewer systems. In addition, downspouts at the facility were connected directly into the storm drain system. Many of the downspouts had enough area for the construction of a large rain garden or bioretention area to treat rooftop runoff and promote infiltration as opposed to outletting directly to storm drains.

Waste management was also noted as an area of pollution potential. Waste generated at the site includes garbage, kitchen waste, and construction waste from miscellaneous projects occurring on campus. The facility has a strict Waste Management Plan including single-stream recycling and daily trash pickups on the campus.

The facility does have a vehicle operations component where fleet vehicles are maintained and fueled. Vehicle repairs are made indoors while fueling facilities were located outside. A large, impervious athletic court was being used for storage of materials outside, but all materials were appropriately wrapped or otherwise shielded from the weather.

The pervious areas of ISI_D_0302 are comprised mostly of turf (70%), while only 15% of the site was considered forested. It is recommended that the site be investigated to determine the feasibility of tree planting in various areas of the site. Currently, the facility replaces all dead or dying trees on the property, and recent tree plantings have been conducted at the site. Future development plans and existing athletic fields could limit reforestation in some of the larger open pervious areas on the south and east sides of the site. Street tree planting along Sollers Point Road and Merritt Boulevard did seem feasible along with at the edge of parking areas and driveways.

In conclusion, recommendations for the site include:

- Work with the Baltimore County Board of Education to determine feasibility of tree plantings
- Investigate the feasibility of converting parking areas from asphalt to a porous pavement
- Conduct volunteer activities to stencil storm drains located at the site
- Educate staff on proper waste management and vehicle operations procedures

Figure 4-57: Community College of Baltimore County – Dundalk Camp Site Map

Fort Howard Veterans Administration Hospital

Fort Howard Veterans Administration Hospital is located on 90 acres of land at the southern end of North Point Road in the Shallow Creek subwatershed. Located on the shoreline, the site is bordered by the Fort Howard State Park on the right and is owned by the United States federal government. Historically, the site housed a large hospital facility along with various administration and residential buildings on the property. Currently, the vast majority of the site is no longer in use and sits in a state of disrepair. One, outpatient facility still operates on the site utilizing one parking lot. The institution was assessed as an ISI in accordance with Section 4.4.1 of this report and given the site identification code ISI_D_1201. In addition, any recommendations for this site are accounted for in Section 4.4.3 but described here.

Figure 4-58: Abandoned Parking Lots and Buildings at ISI_D_1201

The site is currently being redeveloped so no specific reductions are being made in regards to elimination of impervious coverage or tree planting at the site. Instead, this site will be considered a redevelopment area, with appropriate pollution reduction credits taken based on redevelopment in accordance with the most recent stormwater requirements in Maryland. Because the site is located directly adjacent to surface waters, it is recommended that development at the site strongly consider enhancement of buffer areas adjacent to Shallow Creek.

Figure 4-59: Fort Howard Veterans Administration Hospital Site Map

CHAPTER 5: RESTORATION AND PRESERVATION OPTIONS

5.1 Introduction

This chapter presents an overview of the key management practice recommendations for the Bear Creek/Old Road Bay watershed based on the information collected during both the office/desktop analysis and field assessments. These practices are geared toward restoring degraded resources in urban/suburban watersheds. The chapter is divided into five sections: Municipal Capital Programs; Municipal Management Programs; Volunteer Restoration Programs; Neighborhood, Business and Institutional Initiatives; and Citizen Awareness Activities. The sections were delineated based on the entity controlling and performing the activities along with their funding and schedule requirements.

5.2 Municipal Capital Programs

Municipal capital programs are projects and purchases that the County can undertake in the short term to improve water quality in the Bear Creek/Old Road Bay watershed.

5.2.1 Stormwater Management Upgrades

The application of stormwater management practices varies according to various physical characteristics such as impervious cover and land use makeup of the site or subwatershed. The most efficient method to augment stormwater treatment is to convert existing dry detention ponds to a design with greater pollutant removal capability. This is referred to as a stormwater pond conversion. If enough land is available, the greatest benefit would be to construct a new facility, designed with current state of the art technology, to reduce pollutants to the maximum extent practicable. However, a developed subwatershed seldom has sufficient open space. Instead there are options available to put treatment systems directly in the storm drain system. Many packaged systems are available through the retail market and are explained further below. Additional sites in alleys and adjacent to parking lots can offer treatment of large amounts of impervious surface. Also, new research in porous concrete and asphalt may offer the potential for additional reductions in impervious cover on public and private properties.

Most of the Bear Creek/Old Road Bay planning area was developed prior to the passage of the Stormwater Act of 2007 in Maryland requiring more robust environmental site design. Stormwater retrofitting involves implementing stormwater 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 requirements, 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 Bear Creek/Old Road Bay watershed through municipal capital programs: conversion of existing detention ponds, storm drain inlet and outfall retrofits, and public parking lot retrofits. Each of these categories is described briefly in the sections below.

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. Six (6) out of the nine (9) existing detention ponds assessed during the SWM facility survey were determined to have potential for conversion to a wetland or extended detention facility. The facilities currently are vegetated with wetland vegetation, turf grass, or trees on the bottom with a riser structure or pipe acting as an outlet. Four (4) of the facilities had no fence at all, and one (1) needed repairs. 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.

Storm Drain Inlet and Outfall Retrofits

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.

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.

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.

Public Parking Lot 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 bioretention can be incorporated into the parking lot layout. Bioretention, 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. Many public facilities were identified as having sufficient open space for bioretention 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. Underground stormwater retrofits 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.

5.2.2 Stream Corridor Restoration

Stream corridor restoration practices are used to enhance the appearance, stability, and aquatic function of 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 Bear Creek/Old Road Bay stream corridors include buffer restoration, stream clean-ups, and stream repair.

Forest and Buffer Improvement

Forests are the best land use for the protection of water quality. The Bear Creek/Old Road Bay watershed is covered with over 20% forest. Much of the watershed is classified as open pervious and may provide opportunities for planting. Forested buffers are linear wooded areas along rivers, streams and shorelines which help stabilize banks, prevent erosion, filter pollutants such as sediment and nutrients, and provide wildlife habitat. Several portions of the Bear Creek/Old Road Bay 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 proposed for the Bear Creek/Old Road Bay watershed is to enhance forests and impacted stream and shoreline buffers. This can be accomplished by a variety of methods including:

- Planting on residential and open space properties with native vegetation – Institutions and residential communities should reduce the amount of mowed grass and plant additional native trees.

- Land Preservation – Forest protection is one reason for pursuing a property as part of the county's land preservation programs. Benefits to water quality are a part of the evaluation criteria in determining the most important parcels for protection. Smaller sites may be protected through NeighborSpace, a nonprofit organization that preserves small blocks of land within urban communities.

- Targeted education programs - Property owners, including private residences, businesses 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 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 phragmites or multiflora rose were identified in various locations within the watershed. Invasive species concerns can be addressed through public education, training of County grounds maintenance staff, and developing a volunteer group dedicated to controlling invasive species in the planning area.

- Community Reforestation Program (CRP) – established by EPS to plant, monitor, and maintain forest mitigation projects. The program is funded through fees-in-lieu of mitigation for forests removed as a result of public and private land development, as required by the implementation of the county's Forest Conservation Act and Chesapeake Bay Critical Area Regulations. The CRP includes a four-person reforestation crew that carries out year-round reforestation operations. By utilizing the existing CRP, the county can achieve targeted reforestation along well-suited river, stream, and shoreline buffers.

Stream Repair

Natural channel design techniques are 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.

Wetland Restoration

Wetlands are highly valuable lands in terms of their abilities to both improve water quality and as important habitat for many species. Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are often called swamps, marshes, or bogs. This strategy entails the creation or enhancement of existing wetlands that have been lost or impaired in the past. The County often undertakes wetland restoration on public lands where wetlands have been destroyed or impaired as well as partnering with businesses and institutions where wetland restoration is a viable option.

5.2.3 Tidal Waters and Shoreline Preservation/Enhancement

The Bear Creek/Old Road Bay 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:

- Navigation channels – Marking and maintaining navigation channels in the Bear Creek/Old Road Bay planning area will help keep a balance between encouraging recreational boat use and submerged aquatic vegetation (SAV) growth. As noted in Section 3.4.3, SAV is important for and a good indicator of water quality and habitat.
- Shoreline enhancement projects – potential shoreline enhancement projects include the following:
    - Concrete Homes Park – shoreline protection retrofit and ecological enhancement
    - Stansbury Park – habitat enhancement
    - West Inverness Park – shoreline protection expansion and ecological enhancement
    - Jones Creek – beneficial use of dredged material, marsh creation
    - Fort Howard Park – shoreline protection retrofit, ecological enhancement, and beneficial use of dredged material
    - North Point State Park – shoreline protection and ecological enhancement

5.2.4 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 is a high 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. Most of the pervious areas assessed were publicly owned.

5.3 Municipal Management Programs

Municipal management programs are longer-term or continuous actions that Baltimore County can take to improve water quality in the Bear Creek/Old Road Bay watershed.

5.3.1 Trash Management/Education

Dumping of bulk materials was noted as a problem in the watershed by field teams and residents. Ensuring the Department of Public Works provides a user-friendly and effective bulk trash pickup program would help prevent future 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.

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 Bear Creek/Old Road Bay watershed would improve water quality and aesthetics of the watershed.

5.3.2 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.

5.3.3 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

5.3.4 Baltimore Watershed Agreement

The Baltimore Watershed Agreement (BWA) formalizes the commitment of Baltimore City and Baltimore County to work together on the management and monitoring of shared watersheds. Rivers and streams don't fall neatly within city and county boundaries. The headwaters of the Gwynns Falls and Jones Falls, for example, are in Baltimore County but the streams flow to the harbor. Herring Run begins in the County, meanders through the City, and finally empties into the Back River in the County. First signed in 2002 and renewed in 2006, the agreement acknowledges that geographic boundaries of watersheds are more appropriate for managing these important natural resources than political boundaries. The 2006 agreement identifies five focus areas including: stormwater, community greening, redevelopment and development, public health and trash. An Action Plan was developed and continues to be implemented by staff and overseen by the BWA workgroup.

5.3.5 Inlet Cleaning

Over time, solids in stormwater runoff collect in storm drains and inlets. As solids accumulate in an inlet, they are susceptible to downstream transport during larger storm events, contributing to pollution in the Bear Creek/Old Road Bay watershed. A study conducted by the University of Maryland – Baltimore County (UMBC) and the Center for Watershed Protection as part of the U.S. EPA Chesapeake Bay Program concluded that annual or semi-annual cleaning of storm drain inlet can significantly increase solids removal rates (18-35%) while also contributing to nitrogen and phosphorus removal. The Department of Public Works employs three inlet cleaning trucks. Inlet cleaning at regular intervals

can reduce pollutant loads in the watershed, reduce flooding and help locate illicit discharges into the storm sewer system.

5.3.6 Erosion and Sediment Control

Construction activities in or near streams were observed during the uplands assessment of the watershed. In these cases, erosion and sediment controls are vital to prevent soil and other pollutants from entering the storm drain system or nearby streams. Follow-up inspections and improvements to substandard erosion and sediment control practices at construction sites are implemented and enforced by EPS to prevent sediment and other pollutant inputs from entering into the storm drain system and stream network.

5.3.7 Dry Weather Discharge Prevention

Baltimore County's illicit connection detection and elimination program 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 businesses' 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 more 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.

5.3.8 Land Preservation

Land preservation complements the implementation of BMP's by insuring that specific non-urban land uses remain intact over time on specific parcels. Land preservation includes areas such as parks and watershed protection zones where non-extractive uses predominate, as well as areas that are intensively managed for agriculture.

These parcels may be large, such as parks, or small, protecting a single farm. Land preservation reflects societal priorities and decisions to limit urban and residential development, and provides broad benefits. However, by themselves, they do not assure that certain environmental goals, such as good water quality, will be met.

"Protected land" includes any land with some form of long-term limitation on conversion to urban/developed land use. This protection may be in various forms: public ownership for natural resource or low impact recreational intent (i.e. park), private ownership where a third party acquired the development rights or otherwise acquired the right to limit use through the purchase of an easement (i.e. conservation easement), etc. The extent of "protection" varies greatly from one situation to the next. Therefore, for some protected land, it may be necessary to explore the details of land protection parcel-by-parcel through the local land records office to determine the true extent of protection.

For purposes of watershed management, an understanding of existing protected lands can provide a starting point in prioritizing potential protection and restoration activities. In some cases, protected lands may provide opportunities for restoration projects because owners of these lands may value natural resource protection or enhancement goals. A summary of current conservation easements is provided in Chapter 2.

Maryland and County Rural Legacy Program

Baltimore County 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 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. This planning area includes portions of the county's Coastal Rural Legacy Area. Efforts to increase participation in preservation programs are on going through EPS and the Gunpowder Valley Conservancy.

Maryland Environmental Trust and Local Land Trusts

Created by the Maryland General Assembly in 1967 to protect Maryland's natural environment, the Maryland Environmental Trust (MET) seeks donated easements on farms and forestlands, wildlife habitats, waterfront acreages, natural areas, historic sites, and other valuable and scenic features. In 1974, a landowner in Baltimore County was one of the first to protect their property through this program. Today, Baltimore County remains a leader in the state, with county landowners preserving over 12,000 acres through donations. Although both MET and local land trusts prefer to accept donations on lands greater than 50 acres, local land trusts are often willing to work with smaller property owners. Donations are accepted throughout the year. Landowners may qualify for a significant tax deduction and/or credit. MET also provides loans to qualified groups for the purchase of land for preservation.

5.4 Volunteer Restoration Programs

Volunteer restoration programs include activities or projects supported by the County but conducted by volunteers and volunteer organizations such as a watershed improvement group.

5.4.1 Stream Cleanups

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. Public outreach tools should be used to encourage and inform residents about organizing stream clean-ups and support available from the County.

5.4.2 Tree Planting

As noted previously, a number of open space and street tree planting opportunities are present in the Bear Creek/Old Road Bay watershed, offering 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 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 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.

5.4.3 Pet Waste Stations

Unmanaged pet waste is a major contributor to bacteria in streams, such as fecal coliform. Pet waste stations usually consist of a sign prompting pet owner's to discard of pet waste properly and a supply of convenient pet waste disposal bags for waste collection and disposal. Pet waste stations that are well-situated in parks or neighborhoods with high pet activity can help to reduce the bacteria flowing into streams along with maintaining an attractive area. Citizen volunteers can be asked to help install pet waste stations in high pet-traffic areas along with ensuring that stations are well-stocked with bags for collection and disposal.

5.4.4 Storm Drain Marking

Most of the developed areas in the Bear Creek/Old Road Bay 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 Bear Creek/Old Road Bay 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 Bear Creek, Old Road Bay, Shallow Creek and/or the Chesapeake Bay.

5.5 Business and Institutional Initiatives

Business and institutional initiatives include activities that are available for commercial businesses and institutions to undertake in order to improve water quality in the area. These activities can be supported by the County.

5.5.1 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 degraded stream systems and be significant contributors to water quality problems in the watershed than those that are less developed.

Unused or unmaintained impervious surfaces with the potential for removal were identified at several institutions. At sites where parking lots may be larger than necessary, portions of the impervious cover could be removed and converted to bioretention areas for treating stormwater runoff from the remaining impervious surfaces. 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 allow 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 incorporation of more permeable surfaces.

Channelized sections of stream corridors were identified during the uplands 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 stormwater discharge into receiving waters.

5.5.2 Potential Redevelopment of Urban Areas

Natural areas that are developed into impervious urban landscapes result in an increase in runoff and pollutant loading. Redeveloping these urban areas back into a more natural setting can provide nutrient load reductions. In the Water Resources Element of its Master Plan 2020, Baltimore County has analyzed redevelopment scenarios and identified potential land for redevelopment in each of its watersheds.

Urban watersheds developed prior to modern stormwater regulations have fewer stormwater management facilities to capture and treat stormwater runoff. As businesses and property owners choose to redevelop properties that already have high amounts of impervious cover, they must meet redevelopment regulations in Baltimore County requiring a 50% reduction in impervious surface or inclusion of equivalent stormwater quality management facilities.

5.5.3 Pervious Area Restoration

Several institutions assessed had extensive opportunities for reforestation which would also require less ground maintenance and improve energy efficiency. Parcels meeting these criteria are good candidates for follow-up investigations and landowner contact.

5.5.4 Stormwater Retrofits

The following represent stormwater retrofits that can be undertaken by private entities to positively affect water quality.

Parking Lot

A few institutions were identified as having sufficient open space for bioretention 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.

Downspout Disconnection

Downspouts directly connected to the storm drain system or draining to impervious surfaces such as parking lots, sidewalks, or the curb and gutter system increase the volume and flow rate of pollutant-laden runoff reaching streams. 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. Disconnecting downspouts in commercial corridors is an inexpensive way to improve water quality in the Bear Creek/Old Road Bay watershed.

5.5.5 Open Space Planting

Several opportunities for reforestation and buffer improvement were identified during the field assessments including open space shade tree plantings in various 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.

Tree-Mendous Maryland coordinates the free delivery of trees to citizens and community groups, and provides an inexpensive way to obtain trees and shrubs for planting on public lands and within community open spaces. 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.

5.5.6 Tidal Waters and Shoreline Preservation/Enhancement

As discussed in Section 5.2 on Municipal Capital Programs, shoreline enhancement is a very effective means of improving water quality in streams and rivers. Some of the businesses and institutions within

this planning area are adjacent to the shoreline. These properties may be candidates for shoreline enhancement either with stabilization or buffer planting projects.

5.5.7 Pollution Source Control

Hotspots 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.

5.6 Citizen Awareness Activities

Citizen awareness activities are actions that any resident or citizen in the Bear Creek/Old Road Bay watershed can take that would provide a benefit to water quality.

5.6.1 Pollution Prevention/Source Control Education

Residents engage in behaviors that can adversely impact water quality. Some of these behaviors observed during the assessment of neighborhoods 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 the occurrence of trash dumping in 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 can help influence these changes using pollution prevention education and outreach to teach citizens how to properly care for the watershed.

5.6.2 Trash and Recycling

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 Bear Creek/Old Road Bay 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 Bear Creek/Old Road Bay in their communities. Public education and awareness can also be accomplished through community clean-ups in neighborhoods or schools with observed trash management issues.

5.6.3 Environmental Awareness and Education

Community-based facilities 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 bioretention 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 activities also present an opportunity for combining community involvement and environmental education.

5.6.4 Bayscaping

A "Bayscape" is a landscape using native plants to provide habitat for local and migratory animals, improve water quality, and reduce the need for chemical pesticides and herbicides. Bayscaping plants, such as trees, shrubs and perennials, are able to make better use of rain water than typical lawn grasses, and so require less watering once established. They are also better at trapping and removing nitrogen and pollutants from rain water so that it is not released into nearby water bodies. A Bayscape is also valuable for the gardener or landowner because it offers greater visual interest than lawn, reduces the time and expense of mowing, watering, fertilizing and treating lawn and garden areas, and can address areas with problems such as erosion, poor soils, steep slopes or poor drainage.

5.6.5 MD Green School Awards Program

Baltimore County uses *The Maryland Green School Awards Program* to provide a framework for integrating environmental learning and community involvement in local schools. EPS supports workshops and site-based meetings for teachers and provides local and regional resources to enhance staff development opportunities and increase the environmental awareness and interest of local school principals, teachers, and facilities managers. A requirement of each Green School is to demonstrate Best Management Practices at their site. These may include: water conservation, energy conservation, solid waste reduction, and habitat restoration using the school grounds.

5.6.6 MD Clean Marina Program

The Maryland DNR Clean Marina Initiative recognizes marinas, boatyards, and yacht clubs that voluntarily undertake pollution prevention practices on site and meet the legal requirements of the designation. These practices deal with vessel maintenance and repair, petroleum control, emergency planning, sewage handling, waste containment and disposal, marina management, stormwater management, and marina design and maintenance. Facilities meeting the requirements for the Clean Marina Award are allowed to advertise themselves as a MD Clean Marina. In addition, boaters are encouraged by DNR to patronize Clean Marinas. Two (2) of the five (5) marinas assessed in this study

were certified as Clean Marinas. By providing educational assistance for other marinas to obtain a Clean Marina certification, pollutant sources in close proximity to waterways can be eliminated while also providing education to the boating public on clean boating practices.

5.6.7 MD Clean Boater Program

The Maryland Clean Boater Program is an outgrowth of the Maryland Clean Marina Initiative, and seeks to involve boaters in protecting Maryland's waterways. The purpose of the program is to educate boaters on sustainable boating practices including proper waste disposal, fueling methods, cleaning, and maintenance. In addition, MD Clean Boaters are encouraged to utilize Clean Marinas. Providing boaters with education on the MD Clean Boater Program can decrease and prevent pollution to local streams and waterways from improper boating practices.

5.6.8 Downspout Disconnection

Most of the neighborhoods assessed in the Bear Creek/Old Road Bay watershed were recommended for downspout disconnection. This is because most downspouts were 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 as well as individual homeowners.

CHAPTER 6: REFERENCES

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APPENDIX A:

SWM FACILITY ASSESSMENT DATA

Bear Creek/Old Road Bay SWM Facility Assessment Data

Site ID	Subwatershed	Structure Name	Location	Ownership	Drainage Area (acres)	Riser	Embankment	Vegetation	Fence Condition	Gate Condition	Water Quality Potential	Access	Flow Path	Horizontal Expansion Potential	Vertical Expansion Potential	WQ Notes
234	COUNTRY CLUB COVE/ HUMPHREY CREEK	Greif Brothers	2500 Grays Road	Private	7.1	None	No Problems	Wetland Veg.	None	None	X	Easy	Long	X		FOREBAYS;POTENTIAL EXPANSION TOWARD BUILDING;INCREASE DETENTION WITH WEIR/BERM
290	COUNTRY CLUB COVE/ HUMPHREY CREEK	Amtrol Inc.	2440 Grays Road	Private	8.9	None Found	Invasive Veg.	Invasives	None	None	X	Moderate	Unobserved			DUE TO EXCESSIVE VEGETATION PREVENTED INSPECTION CONVERSION POTENTIAL IS QUESITIONABLE
326	CHARLESMONT/ TOBASCO COVE	Benhoff Property - East Facility Pond 1	4216 North Point Road	Private	1.4	Good	Trees	Turf	Good	Locked	X	Easy	Long			POTENTIAL CONVERSION TO SANDFILTER OR BIORETENTION
463	BULLNECK CREEK	Dundalk Community College	7200 Sollers Point Road	Public	42.5	Good	Trees	Turf	None	None	X	Easy	Long	X	X	FOREBAYS;POTENTIAL EXPANSION ON SOUTH SIDE;LOWER BOTTOM FOR WETLAND/MIRCOPOOL;WETLAND VEGATATION;POTENTIAL ENGINEERED RISER
722	CHARLESMONT/ TOBASCO COVE	National Wire Product	8203 Fischer Road	Private	12.4	Good	Holes	Turf	Good	Locked	X	Easy	Short	X	X	IMPROVE INFLOW;POTENTIAL EXPANSION INTO UNUSED PARKING LOT;LOWER BOTTOM FOR WETLAND/MICROPOOL;WETLAND VEGATATION; DECREASE LOWFLOW ORIFICE
726	LYNCH COVE	North Point Government Center	7735 Wise Avenue	Public	7.3	Good	Trees	Turf	None	None	X	Easy	Long	X	X	FOREBAYS;POTENTIAL EXPANSION INTO PARK;TRASH RACK;LOWER BOTTOM FOR WETLAND/MICROPOOL;WETLAND VEGATATION
926	BEAR CREEK HEADWATERS	Towne Center Shopping Center South Basin	1576 Merritt Boulevard	Private	40.0	Good	No Problems	Wetland Veg.	Good	Unlocked		Easy	Long			CONFINED DUE TO ADJACENT ROADS, PARKING LOT, AND PROPERTY LINE;POND IS CONNECTED TO POND NO 927
927	BEAR CREEK HEADWATERS	Towne Center Shopping Center North Basin	1576 Merritt Boulevard	Private	28.1	Good	No Problems	Wetland Veg.	Good	Unlocked		Easy	Long			CONFINED DUE TO ADJACENT ROADS AND PARKING LOT; POND IS CONNECTED TO POND NO 926
1420	COLGATE CREEK	Boston Courts Pond 1	Villager Circle	Public	78.9	Good	Trees	Wetland Veg.	Repairs Needed	Locked		Difficult	Long			CONFINED DUE TO ADJACENT ROADS AND HOUSES; ALREADY HAS A MICROPOOL

APPENDIX B:

UPLANDS SURVEY DATA

Bear Creek/Old Road Bay Uplands Survey:
NSA Data

Neighborhood Information and Recommended Actions																								
Nbrhd_ID	Subwatershed	Neighborhoood Name	Acres	PSI	ROI	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	Bay Scape	Lot Canopy Improve-ment	Fertilizer Reduction	Percent Lawns High	Pet Waste	Trash Manage-ment	Buffer Impact	Street Trees	Open Space Shade Trees	Park Creation	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other_Actions	Lot Size (Acres)
NSA_D_39	COLGATE CREEK	BOSTON COURTS	10.51	Moderate	Moderate	N	N	N	Y	N	Y	N	0	N	N	N	3	10	N	N	N	0.00	Pond maintenance	<1/8
NSA_D_38	COLGATE CREEK	DEL RAY PARK ROWHOMES	10.57	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	150	0	N	N	N	0.00	N/A	<1/8
NSA_D_35	COLGATE CREEK	DEL RAY PARK SD	18.15	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	140	0	N	N	N	0.00	N/A	<1/4
NSA_D_34	COLGATE CREEK	GRACELAND PARK	12.63	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	92	0	N	N	N	0.00	N/A	<1/4
NSA_D_36	COLGATE CREEK	DELVALE	11.86	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	22	0	N	N	N	0.00	N/A	<1/4
NSA_D_37	COLGATE CREEK	MILLER PLAT &OTHER PROPERTIES	23.54	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	80	0	N	N	N	0.00	N/A	1/4
NSA_D_33	COLGATE CREEK	NORWOOD PARK/ BROOKVIEW/ HOLABIRD PARK	69.88	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	580	0	N	N	N	0.00	N/A	<1/4
NSA_D_49	BULLNECK CREEK / LYNCH COVE	DUNDALK FARMS	49.20	Moderate	High	Y	Y	Y	Y	Y	Y	N	5	N	Y	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_32	COLGATE CREEK	FAIRLAWN	49.83	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	Y	0	0	N	N	Y	0.00	BLUE ALLEY, EMPTY LOT - CHECK WITH OWNER FOR POSSIBLE TREE PLANTING, IMPERVIOUS COVER REMOVAL NEXT TO STREAM	<1/4
NSA_D_43	COLGATE CREEK / LYNCH COVE	KIMBERLY FARMS	38.33	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	TWO EMPTY LOTS AT BAYARD AND SCHOOL LANE AND STENGEL ALING; POTENTIAL SWM RETROFIT OR TREE PLANTING	<1/4
NSA_D_48	LYNCH COVE	EASTFIELD	44.04	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	Y	N	330	0	N	N	Y	0.00	BLUE ALLEYS, GOOD STREET TREE PLANTING OPPURTUNITY	<1/8
NSA_D_27	COLGATE CREEK	WILLOW SPRING PARK	14.93	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEY	<1/8
NSA_D_31	COLGATE CREEK	MARTELL PLAT	22.38	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEY, EMPTY LOT CAN BE A PLANTING OPPURTUNITY	1/4
NSA_D_29	COLGATE CREEK	DUNSHIRE TOWNHOUSES	9.67	Moderate	Moderate	N	Y	N	Y	N	Y	N	0	N	N	N	0	12	N	Y	N	1.13	REPAVE PARKING LOT- VERY OLD AND BREAKING UP, RETROFIT OPEN SPACES ADJACENT TO PARKING LOTS TO TREAT RUNOFF	<1/8
NSA_D_42	COLGATE CREEK	TALBOT PARK	16.31	Moderate	Moderate	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_44	LYNCH COVE / COLGATE CREEK	MOUNTAIN FARMS	22.59	Moderate	Low	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	POTENTIAL BLUE ALLEY OPPURTUNITY	1/8
NSA_D_47	BEAR CREEK HEADWATERS / LYNCH COVE	MERRITT HOMES	20.36	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	300	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_08	PEACH ORCHARD COVE	WATERSEDGE	82.21	High	High	Y	Y	N	Y	Y	Y	N	15	N	Y	Y	100	15	N	N	N	16.89	BOAT STORAGE	1/4

Bear Creek/Old Road Bay Uplands Survey:
NSA Data

Neighborhood Information and Recommended Actions																								
Nbrhd_ID	Subwatershed	Neighborhoood Name	Acres	PSI	ROI	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	Bay Scape	Lot Canopy Improve-ment	Fertilizer Reduction	Percent Lawns High	Pet Waste	Trash Manage-ment	Buffer Impact	Street Trees	Open Space Shade Trees	Park Creation	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other_Actions	Lot Size (Acres)
NSA_D_50	LYNCH COVE / BULLNECK CREEK	STANBROOK	47.78	Moderate	Moderate	Y	Y	N	N	N	Y	N	1	N	Y	N	240	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_64	BEAR CREEK HEADWATERS	GRAY MANOR	96.79	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_66	BEAR CREEK HEADWATERS / CHARLESMONT/TOBASCO	CHARLESMONT	57.20	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	600	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_26	COLGATE CREEK	NEW PITTSBURG/ DUNDALK	27.35	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEY	<1/4
NSA_D_30	COLGATE CREEK	LORRAINE PARK	21.19	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS ON PAVED ALLEYS, POTENTIAL WATER LEAK AT 6902 HOMEWAY	<1/8
NSA_D_53	CHINK CREEK / LYNCH COVE	WEST INVERNESS	77.65	Moderate	High	N	Y	N	Y	N	Y	N	0	N	Y	N	970	0	N	N	Y	0.00	BLUE ALLEYS (LYNCH RD)	<1/8
NSA_D_54	LYNCH COVE / CHINK CREEK	SOUTHFIELD	22.48	Moderate	High	N	Y	N	Y	N	Y	N	0	N	Y	N	296	0	N	N	N	0.00	N/A	<1/8
NSA_D_55	LYNCH COVE / CHINK CREEK	KEY LANDING APARTMENTS	34.75	Moderate	High	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	SMALL BIORETENTION PONDS AT END OF PARKING LOT	<1/8
NSA_D_56	CHINK CREEK	INVERNESS	64.77	Moderate	Moderate	Y	Y	Y	N	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	CLEAN OUT STORM DRAINS NEAR CHINK CREEK	1/8
NSA_D_28	COLGATE CREEK	WILLOW TERRACE	11.19	Moderate	Moderate	Y	Y	N	Y	N	N	N	0	N	N	N	8	0	N	N	N	0.00	N/A	<1/4
NSA_D_02	PEACH ORCHARD COVE	DAY VILLAGE	38.66	Moderate	Moderate	N	Y	Y	Y	N	Y	N	0	N	Y	N	0	30	N	Y	N	0.00	N/A	<1/8
NSA_D_01	PEACH ORCHARD COVE / COLGATE CREEK	LYON HOMES	34.20	High	High	Y	Y	Y	Y	N	Y	N	0	N	Y	N	0	140	N	N	N	0.00	N/A	<1/8
NSA_D_03	PEACH ORCHARD COVE	CARVER MANOR	4.07	Moderate	Moderate	N	Y	N	Y	N	Y	N	0	N	Y	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_05	COLGATE CREEK / PEACH ORCHARD COVE	CARNEGIE	21.40	Moderate	Moderate	Y	Y	N	N	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_62	BEAR CREEK HEADWATERS	SOUTHBROOK	27.52	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	370	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_63	BEAR CREEK HEADWATERS	LYNBROOK	21.06	Moderate	Moderate	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_60	BEAR CREEK HEADWATERS / CHINK CREEK / LYNCH COVE	GRAY HAVEN	75.72	Moderate	Moderate	Y	Y	N	Y	N	N	N	0	N	N	N	800	35	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_61	CHINK CREEK	HOLIDAY GATE APTS	6.03	Moderate	High	Y	Y	Y	Y	N	Y	N	0	N	N	N	112	54	N	N	N	0.00	N/A	<1/8
NSA_D_59	CHINK CREEK	ROSEWALD BEACH	43.55	High	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	Y	Y	0	0	N	N	N	8.14	N/A	1/3
NSA_D_57	CHINK CREEK	EASTEREST WEST	11.73	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_52	LYNCH COVE / CHINK CREEK	EASTFIELD	72.04	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	Y	N	300	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_07	PEACH ORCHARD COVE	TURNER STATION APTS	1.95	Moderate	Moderate	N	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/8
NSA_D_04	PEACH ORCHARD COVE	SUMMER	25.04	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_06	PEACH ORCHARD COVE	TURNER	10.58	Moderate	Moderate	N	Y	N	Y	N	Y	N	0	N	Y	N	0	40	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_11	BULLNECK CREEK / PEACH ORCHARD	DUNDALK SFD	79.96	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4

Bear Creek/Old Road Bay Uplands Survey:
NSA Data

Neighborhood Information and Recommended Actions																								
Nbrhd_ID	Subwatershed	Neighborhoood Name	Acres	PSI	ROI	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	Bay Scape	Lot Canopy Improve-ment	Fertilizer Reduction	Percent Lawns High	Pet Waste	Trash Manage-ment	Buffer Impact	Street Trees	Open Space Shade Trees	Park Creation	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other_Actions	Lot Size (Acres)
NSA_D_09	PEACH ORCHARD COVE / COLGATE CREEK	DUNDALK VILLAGE	41.38	Moderate	Low	Y	Y	N	N	N	Y	N	0	N	Y	N	0	50	Y	N	Y	0.00	BLUE ALLEYS, POTENTIAL PAVEMENT REMOVAL AT INTERSECTION OF DUNHAVEN AND DUNRANRDS	<1/8
NSA_D_65	BEAR CREEK HEAD WATERS	CHARLESMONT APARTMENTS	35.56	Moderate	High	Y	Y	Y	Y	N	Y	N	0	N	N	N	216	0	N	N	N	0.00	N/A	<1/8
NSA_D_40	COLGATE CREEK	HARBOR VIEW SFD	53.26	Moderate	Moderate	Y	Y	N	Y	N	Y	N	5	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_41	COLGATE CREEK	HARBOR VIEW RANCH HOMES	9.89	Moderate	Moderate	N	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_71	OAKLEIGH/SCHOOLHOUSE COVES / CHARLESMONT/TOBASCO COVES	NORTH POINT VILLAGE	59.75	Moderate	Moderate	N	Y	N	Y	N	Y	N	5	N	N	N	364	0	N	N	Y	16.44	BLUE ALLEYS	<1/8
NSA_D_20	COLGATE CREEK	DUNDALK ROWHOMES - BAYSHIP	35.59	Moderate	Moderate	Y	Y	N	N	N	Y	N	0	N	N	N	0	0	Y	N	Y	0.00	BLUE ALLEYS, SEDIMENT IN GUTTERS APPEARS TO BE FROM SEVERAL AREAS WITH BARE SOIL	<1/8
NSA_D_72	OAKLEIGH/SCHOOLHOUSE COVES / COUNTRY CLUB COVE/HUMPHREY REMNANT	OAKLEIGH BEACH	34.99	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_73	COUNTRY CLUB COVE/HUMPHREY REMNANT / OAKLEIGH/SCHOOLHOUSE COVES	PERRY POINT	13.60	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_51	BULLNECK CREEK	DUNDALK MOBILE HOME	10.09	Moderate	Moderate	Y	Y	N	N	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/8
NSA_D_19	COLGATE CREEK	DUNDALK DUPLEX	26.07	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS; CARS PARKING ON GRASS CAUSING LOSS OF VEGETATION AND SEDIMENT	<1/8
NSA_D_16	BULLNECK CREEK / COLGATE CREEK / PEACH ORCHARD COVE	THREE GARDEN VILLAGE	24.94	None	Moderate	N	Y	Y	Y	N	Y	N	0	N	N	N	0	250	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_17	BULLNECK CREEK	DUNDALK ROWHOMES	24.01	Moderate	High	Y	Y	N	Y	N	Y	N	0	N	Y	N	0	46	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_14	BULLNECK CREEK	MERRITT GARDEN APTS	4.08	Moderate	Moderate	Y	Y	Y	N	N	Y	N	0	N	N	N	0	60	N	Y	N	0.00	N/A	<1/8
NSA_D_15	PEACH ORCHARD COVE / COLGATE CREEK	DUNMANNAY APTS.	3.70	Moderate	High	Y	Y	Y	N	N	Y	N	0	N	N	N	0	16	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_58	CHINK CREEK	EASTEREST WEST	14.88	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	184	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_70	OAKLEIGH/SCHOOLHOUSE COVES / CHARLESMONT/TOBASCO COVES	BATTLE GROVE	83.25	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	Y	0	0	N	N	N	0.00	N/A	1/4

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NSA Data

Neighborhood Information and Recommended Actions																								
Nbrhd_ID	Subwatershed	Neighborhoood Name	Acres	PSI	ROI	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	Bay Scape	Lot Canopy Improve-ment	Fertilizer Reduction	Percent Lawns High	Pet Waste	Trash Manage-ment	Buffer Impact	Street Trees	Open Space Shade Trees	Park Creation	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other_Actions	Lot Size (Acres)
NSA_D_74	OAKLEIGH/SCHOOLHOUSE COVES / COUNTRY CLUB COVE/HUMPHREY REMNANT	EDGEPOINT	25.76	Moderate	Moderate	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/4
NSA_D_21	COLGATE CREEK		11.80	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/8
NSA_D_25	COLGATE CREEK	WILLOW SPRING APTS	2.94	Moderate	Moderate	Y	Y	Y	N	N	Y	N	0	N	N	N	0	40	N	N	N	0.00	BETTER TRASH MANAGEMENT - MULTIPLE DUMPSTERS IN COMMON AREA WITHOUT LIDS AND	<1/8
NSA_D_24	COLGATE CREEK	PARTSIDE APTS	6.92	Moderate	Moderate	Y	Y	Y	N	N	Y	N	0	N	N	N	0	10	N	N	N	0.00	N/A	<1/8
NSA_D_23	COLGATE CREEK	COLGATE PARK	12.17	Moderate	Low	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/4
NSA_D_22	COLGATE CREEK	ST. HELENA ROWHOMES	12.94	Moderate	Moderate	Y	Y	N	N	N	Y	N	0	N	N	N	48	0	N	N	Y	2.11	BLUE ALLEYS	<1/8
NSA_D_67	CHARLESMONT/TOBASCO COVES	CARPENTERS TRAILER COURT	9.56	Moderate	Moderate	N	Y	N	N	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/8
NSA_D_75	COUNTRY CLUB COVE/ HUMPHREYS REMNANT	CEDAR CREST	33.85	Moderate	Moderate	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/4
NSA_D_76	COUNTRY CLUB COVE/ HUMPHREYS REMNANT	BATTLE PARK	38.42	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	10	N	N	Y	0.00	BLUE ALLEYS; SHADE TREE PLANTING OPPURTUNITY AT CIRCLE AREA ON	1/4
NSA_D_77	JONES CREEK	SPARROWS POINT MANOR	25.51	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_80	JONES CREEK / NORTH POINT CREEK	CHESAPEAKE TERRACE	116.30	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	Y	0	0	N	N	N	0.00	DECALS ON STORM DRAINS	1/4
NSA_D_81	NORTH POINT CREEK / JONES CREEK	LODGE FOREST - NORTH COVE	97.50	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	Y	0	0	N	N	N	0.00	N/A	1/4
NSA_D_84	NORTH POINT CREEK	BAYWOOD MOBILE HOME PARK	11.76	None	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	<1/8
NSA_D_87	SHALLOW CREEK	NORTH POINT TERRACE	35.62	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	BLANK AVE. COULD USE SOME TRASH CLENA UP	1/4
NSA_D_88	SHALLOW CREEK	TODD PLANTATION	16.46	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_86	SHALLOW CREEK	OLEARY PLANTATION	14.54	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_79	JONES CREEK	KRAKOW	14.37	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_83	NORTH POINT CREEK	PENWOOD TERRACE & OTHER PROP	43.38	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_68	CHARLESMONT/TOBASCO COVES	ANNADALE/TOBASCO COVES	18.43	Moderate	Moderate	Y	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_46	LYNCH COVE / BEAR CREEK HEAD WATERS	HOLABIRD EAST APARTMENTS	15.27	High	High	N	Y	Y	Y	N	Y	N	0	N	Y	Y	32	100	N	N	N	0.00	UNCOVERED DUMPSTERS SHOULD BE COVERED	<1/8
NSA_D_45	LYNCH COVE / COLGATE CREEK	FAIRLAWN/ KIMBERLY FARMS	8.73	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	Y	N	5	0	N	N	N	0.00	N/A	<1/8

Bear Creek/Old Road Bay Uplands Survey:
NSA Data

Neighborhood Information and Recommended Actions																							
Nbrhd_ID	Subwatershed	Neighborhoood Name	Acres	PSI	ROI	Downspout Redirect	Rain Barrel	Rain Garden	Stencil	Bay Scape	Lot Canopy Improve-ment	Fertilizer Reduction	Percent Lawns High	Pet Waste	Trash Manage-ment	Buffer Impact	Street Trees	Open Space Shade Trees	Park Creation	Parking Lot Retrofit	Alley Retrofit	Street Sweeping	Other_Actions	Lot Size (Acres)
NSA_D_18	COLGATE CREEK	DUNDALK SFD SUNSHIP	33.09	Moderate	Moderate	Y	Y	N	Y	N	Y	N	0	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS, cars parking in grass strip, damaging vegetation, a potential pollutant source	<1/4
NSA_D_89	BLACK MARSH	SWAN PT./BAYLIGHT BEACH	25.10	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_69	CHARLESMONT/TOBASCO COVES	ROSE MANOR/ MONUMENTAL TERRACE	13.54	Moderate	Moderate	Y	Y	Y	N	N	Y	N	0	N	N	N	0	0	N	N	N	0.00	POSSIBLY PAVE RAYMOND AVE.	<1/4
NSA_D_85	NORTH POINT CREEK / SHALLOW CREEK	BROWN/ TODD PLANTATIONS	36.20	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_78	JONES CREEK	WATERVIEW & OTHER PROP.	47.62	Moderate	Moderate	N	Y	Y	N	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_13	BULLNECK CREEK / PEACH ORCHARD	DUNDALK SFD - BAYBRIAR	61.89	Moderate	High	Y	Y	N	Y	N	Y	N	5	N	Y	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/4
NSA_D_10	PEACH ORCHARD COVE	DUNDALK SFD	43.38	Moderate	Moderate	Y	Y	Y	Y	N	Y	N	0	N	N	N	0	40	N	N	N	0.00	N/A	<1/4
NSA_D_12	PEACH ORCHARD COVE / COLGATE CREEK / BULLNECK	DUNDALK SFD	55.78	Moderate	High	Y	Y	Y	Y	N	Y	N	5	N	N	N	0	0	N	N	Y	0.00	BLUE ALLEYS	<1/4
NSA_D_82	NORTH POINT CREEK	LODGE FOREST - NORTH POINT CREEK	79.25	Moderate	Moderate	Y	Y	Y	Y	Y	Y	N	0	N	N	N	0	0	N	N	N	0.00	N/A	1/4
NSA_D_90	JONES CREEK	CHESAPEAKE TERRACE MOBILE HOMES	1.97	Moderate	Low	N	N	N	N	N	N	N	25	Y	Y	Y	0	0	N	Y	N	0.00		<1/8
NSA_D_91	BLACK MARSH	CUCKOLD POINT	8.79	High	Moderate	Y	Y	Y	N	Y	Y	Y	0	N	N	N	0	0	N	N	N	0.00		1/3

Bear Creek/Old Road Bay Uplands Survey:
ISI Data

Institution Information and Recommended Actions													
Site ID	Subwatershed	Name	Type	Public/ Private	Nutrient Manage-ment	# Trees for Planting	Stormwater Retrofit	Downspout Disconnection	Impervious Cover Removal	Trash Manage-ment	Storm Drain Marking	Buffer Improve-ment	Notes
ISI_D_0101	COLGATE CREEK	THE WORKMEN'S CIRCLE CEMETERY	Cemetary	Private		0				X			NO ROOM FOR PLANTINGS/TRASH DUMPED ON SITE
ISI_D_0102	COLGATE CREEK	HOLABIRD MIDDLE SCHOOL	Middle School	Public		349	X		X	X	X		PLANTING,ROADSIDE SWALE FOR PARKING
ISI_D_0103	COLGATE CREEK / LYNCH COVE	ATEAZE SENIOR CENTER	Community Center	Public		39	X	X	X	X	X		SHADE PLANTS WEST; CURB RETROFIT TO SWALE
ISI_D_0104	COLGATE CREEK / PEACH ORCHARD COVE	FLEMING COMMUNITY CENTER	Community Center	Public		450	X		X	X	X	X	3 PLANTINGS; SWALE NEXT TO COURT, REMOVE COURT
ISI_D_0201	PEACH ORCHARD COVE	SOLLERS POINT TECHNICAL HIGH SCHOOL	High School	Public		26	X			X	X		RETROFIT TRACK INLETS, TREE PLANTING, LOOSE TRASH
ISI_D_0301	BULLNECK CREEK	LOGAN ELEMENTARY SCHOOL	Elementary School	Public		176				X			STREET TREE AND SHADE TREE PLANTING
ISI_D_0302	BULLNECK CREEK / LYNCH COVE	COMMUNITY COLLEGE OF BALTIMORE COUNTY DUNDALK	College	Public	X	1520		X	X	X	X	X	LOTS OF PARKING/REFORESTATION POTENTIAL/PERV PARK
ISI_D_0401	LYNCH COVE	NORTH POINT LIBRARY	Community Center	Public		5				X	X		RECENTLY PLANTED WITH TREES. SPACE FOR FEW MORE
ISI_D_0402	LYNCH COVE	NORTH POINT GOVERNMENT CENTER	Fire & Rescue	Public	X	237	X		X	X	X	X	RETROFIT EXISTING POND WITH LOW FLOW PLANTING
ISI_D_0403	LYNCH COVE	GRANGE ELEM SCHOOL	Elementary School	Public		508	X		X	X	X	X	STREAM EROSION/RETROFIT SWALE FOR FRONT CIRCLE
ISI_D_0404	LYNCH COVE / CHINK CREEK / BEAR CREEK HEADWATERS	OUR LADY OF HOPE CATHOLIC CHURCH	Faith-Based	Private	X	459	X	X	X		X		POTENTIAL PARKING LOT RETROFIT IN ISLANDS
ISI_D_0501	CHINK CREEK	PATAPSCO HIGH SCHOOL	High School	Public		267	X			X	X		STREET TREES/BIORETENTION PARKING/SWALE COURTS
ISI_D_0601	BEAR CREEK HEADWATERS	GEN JOHN STRICKLER MIDDLE SCHOOL	Middle School	Public		239	X		X	X	X	X	STREAM EROSION/BUFFER/SWALE RETROFITS/BIORETENTION
ISI_D_0701	CHARLESMONT/TOBASCO COVES	BATTLE GROVE ELEM SCHOOL	Elementary School	Public		422			X	X	X		PLNTNG NE, S OF SCHOOL; RETROFIT INLT, NE PRKG LOT
ISI_D_0801	OAKLEIGH/SCHOOLHOUSE COVES	NORTH POINT BAPTIST CHURCH	Faith-Based	Private	X	78	X		X	X	X	X	SWALE/BIORETENTION RETROFIT/REMOVE UNUSED PAD
ISI_D_0901	COUNTRY CLUB COVE/HUMPHREY	SHILOH BAPTIST CHURCH	Faith-Based	Private		40				X	X		POND HANDLES 65% OF IMPERVIOUS/STREET TREES ON SPR
ISI_D_1001	JONES CREEK	ST LUKE'S ASSISTED LIVING CENTER	Care Facility	Private	X	0	X			X	X		RETROFIT SWALE AT ROOF DRAIN OUTLETS
ISI_D_1101	NORTH POINT CREEK / JONES CREEK	CHESAPEAKE TERRACE ELEMENTARY SCHOOL	Elementary School	Public		50				X	X		STREET TREES ON LODGE FARM & HEADLAND
ISI_D_1201	SHALLOW CREEK	VA HOSPITAL	Care Facility	Public		0					X	X	AREA SLATED FOR REDEVELOPMENT CREDITS

Bear Creek/Old Road Bay Uplands Survey:
ISI Data

Subwatershed	Site_ID	Hot Spot Status	Refer for Enforce-ment	Follow Up Inspection	Test for IDDE	Education	Check NDPES Permit	On Site Retrofit	PAA	Review SW PPP	Business Type	Category	Vehicle Operations	Outdoor Materials	Waste Manage-ment	Physical Plant	Turf/ Land-scaping	Storm Water	Comments
COLGATE CREEK	HSI_D_0101	Confirmed Hot Spot	N	Y	Y	Y	Y	N	N	Y	COMMERCIAL-AUTO REPAIR	Commercial	Y	Y	Y	N	N	N	PARKING LOT STAINS, DILAPIDATED VEHICLES, DRUMS
COLGATE CREEK	HSI_D_0102	Potential Hot Spot	N	N	N	Y	Y	Y	N	Y	TRANSPORT-CONTAINERS	Transport-Related	Y	Y	N	Y	Y	Y	STREAM BISECTING SITE COLLECTING RUNOFF FROM STORAGE AREA
PEACH ORCHARD COVE	HSI_D_0201	Confirmed Hot Spot	N	N	N	Y	Y	Y	N	Y	COMMERCIAL-SHOPPING CENTER	Commercial	Y	Y	Y	N	N	N	REAR PAVEMENT BREAKING/DOWNSPOUTS/DUMPSTER DRAIN TO ALLEY INLET
BULLNECK CREEK/ LYNCH COVE	HSI_D_0301	Confirmed Hot Spot	Y	Y	N	Y	Y	N	N	Y	COMMERCIAL-CONSTRUCTION	Commercial	Y	Y	Y	N	Y	Y	SEVERE EROSION FROM SITE TO ADJACENT VEGETATED AREAS
LYNCH COVE	HSI_D_0401	Confirmed Hot Spot	N	Y	N	Y	Y	N	N	Y	COMMERCIAL-SHOPPING CENTER	Commercial	Y	Y	Y	Y	N	Y	SEDIMENT IN LOT/POOR WASTE PRACTICE/GAS,CARWASH,TIRES
LYNCH COVE/BULLNECK CREEK	HSI_D_0402	Confirmed Hot Spot	N	Y	Y	Y	Y	N	N	Y	INDUSTRIAL-METALS RECYCLING	Industrial	Y	Y	N	Y	N	N	METALS RECYCLING DROP-OFF;STAINS AND LIQUID EXITING SITE
CHINK CREEK	HSI_D_0501	Potential Hot Spot		N	Y	N	N	N	N	N	COMMERCIAL - GAS STATION	Commercial	Y	N	Y	Y	N	Y	WATER LEAKING TO STREET FROM CAR WASH
BEAR CREEK HEADWATERS	HSI_D_0601	Confirmed Hot Spot	N	N	Y	Y	Y	N	N	Y	COMMERCIAL-SHOPPING CENTER	Commercial	Y	N	Y	Y	Y	Y	RESTAURANT AND CAR FACILITY PRIMARY POLLUTION SOURCES
BEAR CREEK HEADWATERS	HSI_D_0602	Confirmed Hot Spot	N	N	Y	Y	Y	N	N	N	COMMERCIAL-CAR WASH	Commercial	Y	N	Y	Y	Y	Y	OBSERVED WASHWATER DRAINING TO STREET AND SITE INLET
CHARLESMONT/ TOBASCO	HSI_D_0701	Severe Hot Spot	Y	Y	N	N	Y	N	N	N	INDUSTRIAL-STORAGE	Industrial	Y	Y	Y	Y	N	N	OPEN WASTE OIL CONTAINER; SEDIMENT & DEBRIS
CHARLESMONT/ TOBASCO	HSI_D_0702	Potential Hot Spot	N	Y	N	Y	Y	N	N	N	INDUSTRIAL-MANUFACTURING	Industrial	N	N	N	N	N	N	SIGNIFICANT # OF DRUMS
OAKLEIGH/ SCHOOLHOUSE COVES	HSI_D_0801	Confirmed Hot Spot	N	N	Y	Y	Y	N	N	N	COMMERICAL-GAS STATION	Commercial	Y	N	Y	Y	N	N	STAINS FROM REPAIR BAYS INTO LOT/LOT CRACKING
OAKLEIGH/ SCHOOLHOUSE COVES	HSI_D_0802	Confirmed Hot Spot	N	Y	N	Y	Y	N	N	Y	TRANSPORT-CONTAINERS	Transport-Related	Y	Y	Y	Y	Y	Y	STOCKPILES/SEDIMENT ISSUES; LOT CRACKING; WET POND
COUNTRY CLUB COVE/ HUMPHREY CREEK REMNANT	HSI_D_0901	Confirmed Hot Spot	N	Y	N	Y	Y	Y	N	Y	INDUSTRIAL-EQUIPMENT	Industrial	Y	Y	Y	Y	N	Y	POTENTIAL RETROFIT TO EXISTING STREAM (OFFSITE POND)
JONES CREEK/ SPARROWS POINT	HSI_D_1001	Potential Hot Spot	N	N	N	Y	Y	N	N	N	INDUSTRIAL-MANUFACTURING	Industrial	Y	Y	Y	Y	N	Y	OUTDOOR MATERIALS STORED WITH NO COVER TO DRAIN
JONES CREEK	HSI_D_1002	Confirmed Hot Spot	Y	Y	N	Y	N	N	N	N	COMMERCIAL-STORAGE	Commercial	N	Y	Y	Y	N	Y	OBSERVED SPILT PAINT/UNCOVERED METALS
BLACK MARSH	HSI_D_1301	Potential Hot Spot	N	N	N	Y	N	N	N	N	COMMERCIAL-RESTAURANT	Commercial	N	N	Y	Y	N	Y	GRAVEL LOT ADJACENT TO WETLANDS

APPENDIX C:

SUPPORTING CALCULATIONS FOR NSA ANALYSIS

Supporting Calculations for NSA Analysis

Downspout Disconnection

Table 4-2 in the Bear Creek/Old Road Bay 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.

<u>Rooftop Acres Addressed</u>

Only NSAs recommended for downspout redirection contribute to this analysis. Rooftop acres addressed by redirecting downspouts in a recommended neighborhood were calculated as follows:

Acres of Buildings x %Connected Downspouts

For example, NSA_D_01 was recommended for downspout redirect and has a total of 5.59 acres of buildings (i.e., rooftop) based on Baltimore County's GIS buildings layer. During the uplands survey, it was estimated that 25% of the downspouts in NSA_D_01 were connected. Therefore, the total rooftop acres addressed by redirecting downspouts in this neighborhood would be 5.59 acres x 0.25 = 1.40 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_D_01, for example, overlaps Colgate Creek and Peach Orchard Cove where 31.5% of its area is within Colgate Creek and 68.5% is within Peach Orchard Cove. The rooftop acres addressed by redirecting downspouts in NSA_D_01 in Colgate Creek were calculated as 1.40 acres x 0.315 = 0.44 acres. The rooftop acres addressed through redirecting downspouts in Sue Creek would be 1.40 acres x 0.685 = 0.96 acres.

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

For a given subwatershed, the % of subwatershed rooftop area addressed by downspout redirection 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.

Bayscaping

Table 4-3 in the Bear Creek/Old Road Bay 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.

Acres of Land Addressed

Only NSAs recommended for bayscaping contributed 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 fraction of existing landscaping of a 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_D_08 was recommended for bayscaping and has a total area of 82.21 acres. Based on Baltimore County's GIS roads layer, there are approximately 15.91 acres of roads in this NSA. This means NSA_ D_08 consists of approximately 82.21 – 15.91 = 66.30 acres of total lots. During the uplands survey, it was estimated that the average lot in NSA_ D_08 already consisted of 10% landscaping which means 25% – 10% = 15% would be recommended for additional bayscaping. This equates to 66.30 acres x 0.15 = 9.94 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_ D_08, for example, overlaps Peach Orchard Cove and Bullneck Creek where 62.0% of its area is within Hawk Cove and 38.0% is within Sue Creek. The acres of land addressed by bayscaping in NSA_ D_08 in Peach Orchard Cove were calculated as 9.94 acres x 0.62 = 6.17 acres. The acres of land addressed through bayscaping in Bullneck Creek would be 9.94 acres x 0.38 = 3.78 acres.

% of Subwatershed Area Addressed

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

Σ Individual NSA Land Acres Addressed / Total Subwatershed Acres

Storm Drain Marking

Table 4-4 in the Bear Creek/Old Road Bay Watershed Characterization Report summarizes the number of inlets and % of subwatershed inlets addressed by storm drain marking for the recommended neighborhoods. The method in which these two columns were calculated is described below.

Approximate No. of Inlets Addressed

Only NSAs recommended for storm drain marking contributed to this analysis. The approximate number of inlets addressed in a neighborhood recommended for storm drain marking was calculated as follows:

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

The approximate number of inlets was determined for all 14 subwatersheds in Bear Creek/Old Road Bay 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 Section 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_D_11 was recommended for storm drain marking and has a total area of 79.96 acres or 0.125 square miles. NSA_ D_11 overlaps Peach Orchard Cove and Bullneck Creek where 17.8% of its area is within Peach Orchard Cove and 82.2% is within Bullneck Creek. The number of inlets addressed by storm drain marking for this NSA in Peach Orchard Cove would be 0.125 sq miles x 29.9 inlets/sq mile in Peach Orchard Cove x 0.178 = 0.7 inlets (~ 1 inlet). The number of inlets addressed by storm drain marking for this NSA in Bullneck Creek would be 0.125 sq miles x 68.8 inlets/sq mile in Bullneck Creek x 0.822 = 7.1 inlets (~7 inlets). 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 for storm drain marking was calculated as:

Σ Individual NSA Inlets Addressed / Total Subwatershed Inlets

Street Trees and Shade Trees

Table 4-5 in the Bear Creek/Old Road Bay Watershed Characterization Report summarizes the number of street trees that could be planted in each subwatershed if this action were addressed for the recommended neighborhoods. Similarly, Table 4-6 of the report summarizes the number of open space shade trees that could be planted if this action were addressed for the recommended neighborhoods. The number of street trees recommended for each neighborhood was estimated during the uplands survey based on available space as described in Section 4.2.3.5.

For NSAs encompassing more than one subwatershed, the total number of recommended street trees was multiplied by the proportion of the NSA area within each subwatershed. NSA_D_66, for example, overlaps Bear Creek Headwaters and Charlesmont/Tobasco Coves where 59.2% of its area is within Bear Creek Headwaters and 40.8% is within Charlesmont/Tobasco Coves. The total number of street trees recommended for NSA_ D_66 was 600. The number of street trees recommended for NSA_ D_66 in Bear Creek Headwaters was calculated as 600 x 0.592 = 355 trees. The number of street trees recommended for NSA_D_66 in Charlesmont/Tobasco Coves would be 600 x 0.408 = 245 trees.

A similar example can be made for the calculation of shade trees in NSA_D_01, which overlaps Colgate Creek by 31.5% and Peach Orchard Cove by 68.5%. A total of 140 shade trees were recommended for this neighborhood during the uplands survey. The number of shade trees recommended for NSA_ D_01 in Colgate Creek was calculated as 140 x 0.315 = 44 trees. The number of shade trees recommended for NSA_ D_01 in Peach Orchard Cove would be 140 x 0.685 = 96 trees.

Street Sweeping

Table 4-7 in the Bear Creek/Old Road Bay Watershed Characterization Report summarizes the miles of road recommended for street sweeping in each subwatershed. If a neighborhood was

recommended for street sweeping, all roads in the neighborhood counted toward the total miles that would be addressed by this action. Miles of road in each neighborhood were determined based on Baltimore County's GIS roads layer. For NSAs encompassing more than one subwatershed, the total miles addressed by street sweeping was multiplied by the proportion of the NSA area within each subwatershed. NSA_D_08, for example, overlaps Peach Orchard Cove and Bullneck Creek where 62.0% of its area is within Peach Orchard Cove and 38.0% is within Bullneck Creek. The total length of road in NSA_ D_08 is 16.89 miles. The miles of street sweeping recommended for NSA_D_08 in Peach Orchard Cove was calculated as 16.89 miles x 0.62 = 10.5 miles. The number of miles of street sweeping recommended for NSA_D_08 in Bullneck Creek would be 16.89 miles x 0.38 = 6.4 miles.

Trash Management

Table 4-8 in the Bear Creek/Old Road Bay Watershed Characterization Report summarizes the acres of land and % of subwatershed area addressed by trash management for the recommended neighborhoods. The method in which these two columns were calculated is described below.

<u>Acres of Land Addressed</u>

Neighborhoods were recommended for trash management during the uplands survey if 15% or more of homes in the neighborhood contained trash or other indications of trash. Acres of land addressed by trash management in a recommended neighborhood were simply taken as the total area of the NSA. Only NSAs recommended for trash management contributed to the total acres of land addressed by this action in each subwatershed.

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 in the NSA multiplied by the proportion of the NSA area within that subwatershed. NSA_D_08, for example, overlaps Peach Orchard Cove and Bullneck Creek where 62.0% of its area is within Peach Orchard Cove and 38.0% is within Bullneck Creek. The total number of acres addressed by trash management in NSA_D_08 is 82.21 acres. The acres addressed for NSA_D_08 in Peach Orchard Cove was calculated as 82.21 acres x 0.62 = 51.0 acres. The number of acres addressed for NSA_D_08 in Bullneck Creek would be 82.21 acres x 0.38 = 31.2 acres.

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

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

$$\Sigma \text{ Individual NSA Acres Addressed} / \text{Total Subwatershed Acres}$$

APPENDIX F:

Chesapeake Bay TMDL Executive Summary

CHESAPEAKE BAY TMDL EXECUTIVE SUMMARY

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) has established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet" with rigorous accountability measures to initiate sweeping actions to restore clean water in the Chesapeake Bay and the region's streams, creeks and rivers.

Despite extensive restoration efforts during the past 25 years, the TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries. The TMDL is required under the federal Clean Water Act and responds to consent decrees in Virginia and the District of Columbia from the late 1990s. It is also a keystone commitment of a federal strategy to meet President Barack Obama's Executive Order to restore and protect the Bay.

The TMDL – the largest ever developed by EPA – identifies the necessary pollution reductions of nitrogen, phosphorus and sediment across Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia and sets pollution limits necessary to meet applicable water quality standards in the Bay and its tidal rivers and embayments. Specifically, the TMDL sets Bay watershed limits of 185.9 million pounds of nitrogen, 12.5 million pounds of phosphorus and 6.45 billion pounds of sediment per year – a 25 percent reduction in nitrogen, 24 percent reduction in phosphorus and 20 percent reduction in sediment. These pollution limits are further divided by jurisdiction and major river basin based on state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and close interaction with jurisdiction partners.

The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017. The TMDL is supported by rigorous accountability measures to ensure cleanup commitments are met, including short-and long-term benchmarks, a tracking and accountability system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress.

Watershed Implementation Plans (WIPs), which detail how and when the six Bay states and the District of Columbia will meet pollution allocations, played a central role in shaping the TMDL. Most of the draft WIPs submitted by the jurisdictions in September 2010 did not sufficiently identify programs needed to reduce pollution or provide assurance the programs could be implemented. As a result, the draft TMDL issued September 24, 2010 contained moderate- to high-level backstop measures to tighten controls on federally permitted point sources of pollution.

A 45-day public comment period on the draft TMDL was held from September 24 to November 8, 2010. During that time, EPA held 18 public meetings in all seven Bay watershed jurisdictions, which were attended by about 2,500 citizens. EPA received more than 14,000 public comments and, where appropriate, incorporated responses to those comments in developing the final TMDL.

After states submitted the draft WIPs, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Regulated point sources and non-regulated nonpoint sources of nitrogen, phosphorus, and sediment are fully considered and evaluated separately in terms of their relative contributions to water quality impairment of the Chesapeake Bay's tidal waters.
- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress. As a result, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution, which was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now the focus shifts to the jurisdictions' implementation of the WIP policies and programs that will reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA is committed to take appropriate contingency actions including targeted compliance and enforcement activities, expansion of requirements to obtain NPDES permit coverage for currently unregulated sources, revision of the TMDL allocations and additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems.

In 2011, while the jurisdictions continue to implement their WIPs, they will begin development of Phase II WIPs, designed to engage local governments, watershed organizations, conservation districts, citizens and other key stakeholders in reducing water pollution.

TMDL BACKGROUND

The Clean Water Act (CWA) sets an overarching environmental goal that all waters of the United States be "fishable" and "swimmable." More specifically it requires states and the District of Columbia to establish appropriate uses for their waters and adopt water quality standards that are protective of those uses. The CWA also requires that every two years jurisdictions develop – with EPA approval – a list of waterways that are impaired by pollutants and do not meet water

quality standards. For those waterways identified on the impaired list, a TMDL must be developed. A TMDL is essentially a "pollution diet" that identifies the maximum amount of a pollutant the waterway can receive and still meet water quality standards.

Most of the Chesapeake Bay and its tidal waters are listed as impaired because of excess nitrogen, phosphorus and sediment. These pollutants cause algae blooms that consume oxygen and create "dead zones" where fish and shellfish cannot survive, block sunlight that is needed for underwater Bay grasses, and smother aquatic life on the bottom. The high levels of nitrogen, phosphorus and sediment enter the water from agricultural operations, urban and suburban stormwater runoff, wastewater facilities, air pollution and other sources, including onsite septic systems. Despite some reductions in pollution during the past 25 years of restoration due to efforts by federal, state and local governments; non-governmental organizations; and stakeholders in the agriculture, urban/suburban stormwater, and wastewater sectors, there has been insufficient progress toward meeting the water quality goals for the Chesapeake Bay and its tidal waters.

More than 40,000 TMDLs have been completed across the United States, but the Chesapeake Bay TMDL will be the largest and most complex thus far – it is designed to achieve significant reductions in nitrogen, phosphorus and sediment pollution throughout a 64,000-square-mile watershed that includes the District of Columbia and large sections of six states. The TMDL is actually a combination of 92 smaller TMDLs for individual Chesapeake Bay tidal segments and includes pollution limits that are sufficient to meet state water quality standards for dissolved oxygen, water clarity, underwater Bay grasses and chlorophyll-*a*, an indicator of algae levels (Figure ES-1). It is important to note that the pollution controls employed to meet the TMDL will also have significant benefits for water quality in tens of thousands of streams, creeks, lakes and rivers throughout the region.

Since 2000, the seven jurisdictions in the Chesapeake Bay watershed (Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), EPA and the Chesapeake Bay Commission, which are partners in the Chesapeake Bay Program, have been planning for a Chesapeake Bay TMDL.

Since September 2005, the seven jurisdictions have been actively involved in decision-making to develop the TMDL. During the October 2007 meeting of the Chesapeake Bay Program's Principals' Staff Committee, the Bay watershed jurisdictions and EPA agreed that EPA would establish the multi-state TMDL. Since 2008, EPA has sent official letters to the jurisdictions detailing all facets of the TMDL, including: nitrogen, phosphorus and sediment allocations; schedules for developing the TMDL and pollution reduction plans; EPA's expectations and evaluation criteria for jurisdiction plans to meet the TMDL pollution limits; reasonable assurance for controlling nonpoint source pollution; and backstop actions that EPA could take to ensure progress.

The TMDL also resolves commitments made in a number of consent decrees, Memos of Understanding, the Chesapeake Bay Foundation settlement agreement of 2010, and settlement agreements dating back to the late 1990s that address certain tidal waters identified as impaired in the District of Columbia, Delaware, Maryland and Virginia.

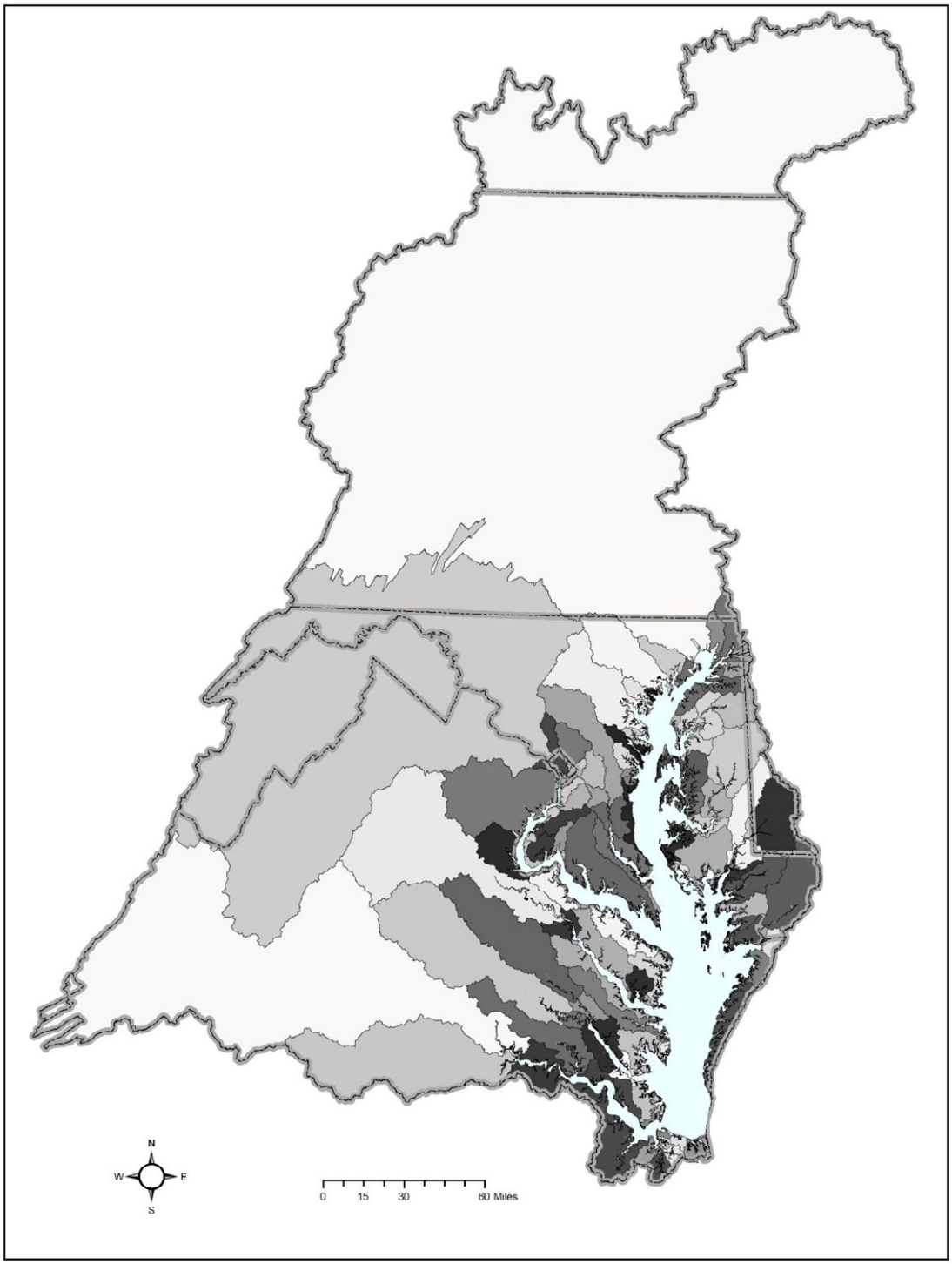

Figure ES-1. A nitrogen, phosphorus and sediment TMDL has been developed for each of the 92 Chesapeake Bay segment watersheds.

Additionally, President Obama issued Executive Order 13508 on May 12, 2009, which directed the federal government to lead a renewed effort to restore and protect the Chesapeake Bay and its watershed. The Chesapeake Bay TMDL is a keystone commitment in the strategy developed by 11 federal agencies to meet the President's Executive Order.

DEVELOPING THE CHESAPEAKE BAY TMDL

Development of the Chesapeake Bay TMDL required extensive knowledge of the stream flow characteristics of the watershed, sources of pollution, distribution and acreage of the various land uses, appropriate best management practices, the transport and fate of pollutants, precipitation data and many other factors. The TMDL is informed by a series of models, calibrated to decades of water quality and other data, and refined based on input from dozens of Chesapeake Bay scientists. Modeling is an approach that uses observed and simulated data to replicate what is occurring in the environment to make future predictions, and was a critical and valuable tool to develop the Chesapeake Bay TMDL.

The development of the TMDL consisted of several steps:

1. EPA provided the jurisdictions with loading allocations for nitrogen, phosphorus and sediment for the major river basins by jurisdiction.
2. Jurisdictions developed draft Phase I WIPs to achieve those basin-jurisdiction allocations. In those draft WIPs, jurisdictions made decisions on how to further sub-allocate the basin-jurisdiction loadings to various individual point sources and a number of point and nonpoint source pollution sectors.
3. EPA evaluated the draft WIPs and, where deficiencies existed, EPA provided backstop allocations in the draft TMDL that consisted of a hybrid of the jurisdiction WIP allocations modified by EPA allocations for some source sectors to fill gaps in the WIPs.
4. The draft TMDL was published for a 45-day public comment period and EPA held 18 public meetings in all six states and the District of Columbia. Public comments were received, reviewed and considered for the final TMDL.
5. Jurisdictions, working closely with EPA, revised and strengthened Phase I WIPs and submitted final versions to EPA.
6. EPA evaluated the final WIPs and used them along with public comments to develop the final TMDL.

Since nitrogen and phosphorus loadings from all parts of the Bay watershed have an impact on the impaired tidal segments of the Bay and its rivers, it was necessary for EPA to allocate the nitrogen and phosphorus loadings in an equitable manner to the states and basins. EPA used three basic guides to divide these loads.

- Allocated loads should protect living resources of the Bay and its tidal tributaries and should result in all segments of the Bay mainstem, tidal tributaries and embayments meeting water quality standards for dissolved oxygen, chlorophyll *a*, water clarity and underwater Bay grasses.
- Tributary basins that contribute the most to the Bay water quality problems must do the most to resolve those problems (on a pound-per-pound basis) (Figure ES-2).
- All tracked and reported reductions in nitrogen, phosphorus and sediment loads are credited toward achieving final assigned loads.

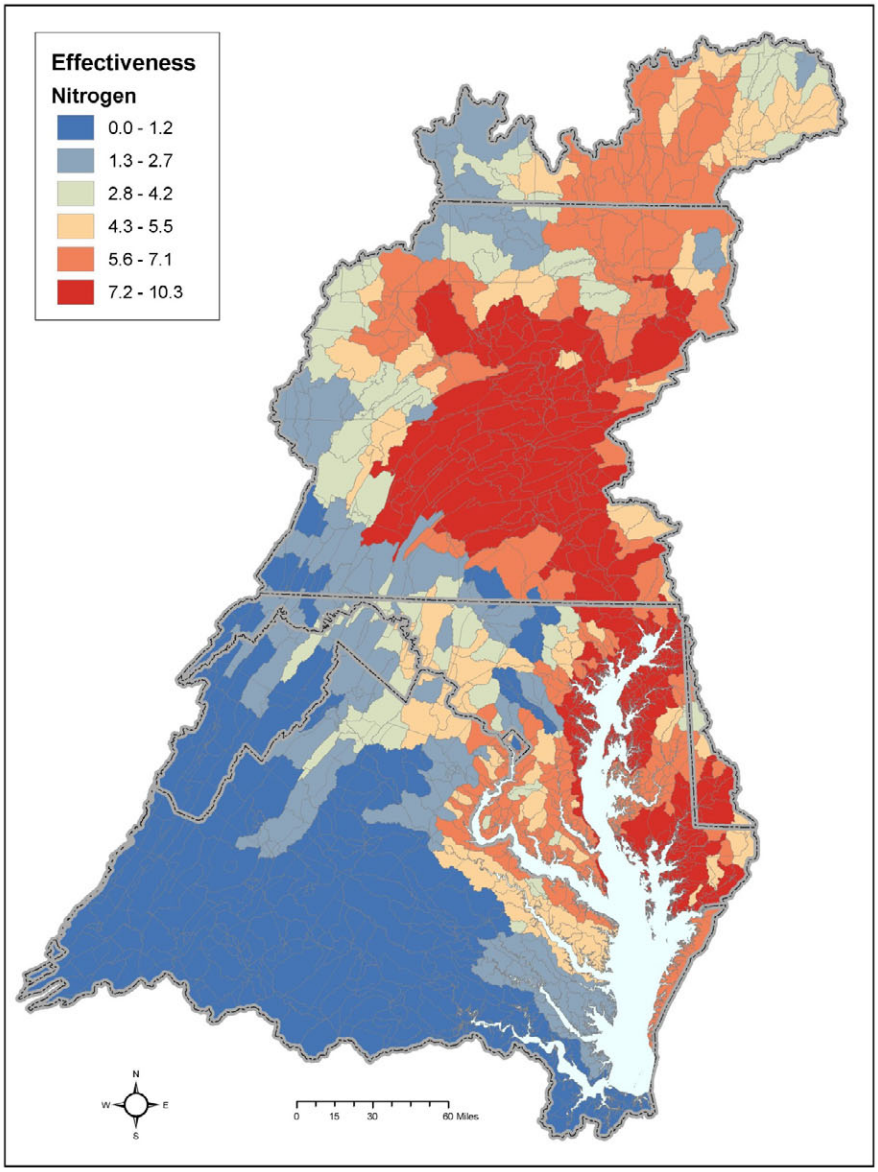

Figure ES-2. Sub-basins across the Chesapeake Bay watershed with the highest (red) to lowest (blue) pound for pound nitrogen pollutant loading effect on Chesapeake Bay water quality.

In addition, EPA has committed to reducing air deposition of nitrogen to the tidal waters of the Chesapeake Bay from 17.9 to 15.7 million pounds per year. The reductions will be achieved through implementation of federal air regulations during the coming years.

To ensure that these pollutant loadings will attain and maintain applicable water quality standards, the TMDL calculations were developed to account for critical environmental conditions a waterway would face and seasonal variation. An implicit margin of safety for nitrogen and phosphorus, and an explicit margin of safety for sediment, also are included in the TMDL.

Ultimately, the TMDL is designed to ensure that by 2025 all practices necessary to fully restore the Bay and its tidal waters are in place, with at least 60 percent of the actions taken by 2017.

The TMDL loadings to the basin-jurisdictions are provided in Table ES-1. These loadings were determined using the best peer-reviewed science and through extensive collaboration with the jurisdictions and are informed by the jurisdictions' Phase I WIPs.

Table ES-1. Chesapeake Bay TMDL watershed nitrogen, phosphorus and sediment final allocations by jurisdiction and by major river basin.

Jurisdiction	Basin	Nitrogen allocations (million lbs/year)	Phosphorus allocations (million lbs/year)	Sediment allocations (million lbs/year)
Pennsylvania	Susquehanna	68.90	2.49	1,741.17
	Potomac	4.72	0.42	221.11
	Eastern Shore	0.28	0.01	21.14
	Western Shore	0.02	0.00	0.37
	PA Total	**73.93**	**2.93**	**1,983.78**
Maryland	Susquehanna	1.09	0.05	62.84
	Eastern Shore	9.71	1.02	168.85
	Western Shore	9.04	0.51	199.82
	Patuxent	2.86	0.24	106.30
	Potomac	16.38	0.90	680.29
	MD Total	**39.09**	**2.72**	**1,218.10**
Virginia	Eastern Shore	1.31	0.14	11.31
	Potomac	17.77	1.41	829.53
	Rappahannock	5.84	0.90	700.04
	York	5.41	0.54	117.80
	James	23.09	2.37	920.23
	VA Total	**53.42**	**5.36**	**2,578.90**
District of Columbia	Potomac	2.32	0.12	11.16
	DC Total	**2.32**	**0.12**	**11.16**
New York	Susquehanna	8.77	0.57	292.96
	NY Total	**8.77**	**0.57**	**292.96**
Delaware	Eastern Shore	2.95	0.26	57.82
	DE Total	**2.95**	**0.26**	**57.82**
West Virginia	Potomac	5.43	0.58	294.24
	James	0.02	0.01	16.65
	WV Total	**5.45**	**0.59**	**310.88**
Total Basin/Jurisdiction Draft Allocation		**185.93**	**12.54**	**6,453.61**
Atmospheric Deposition Draft Allocationa		**15.7**	**N/A**	**N/A**
Total Basinwide Draft Allocation		**201.63**	**12.54**	**6,453.61**

[a] Cap on atmospheric deposition loads direct to Chesapeake Bay and tidal tributary surface waters to be achieved by federal air regulations through 2020.

ACCOUNTABILITY AND GOALS

The Chesapeake Bay TMDL is unique because of the extensive measures EPA and the jurisdictions have adopted to ensure accountability for reducing pollution and meeting deadlines for progress. The TMDL will be implemented using an accountability framework that includes WIPs, two-year milestones, EPA's tracking and assessment of restoration progress and, as necessary, specific federal contingency actions if the jurisdictions do not meet their commitments. This accountability framework is being established in part to provide demonstration of the reasonable assurance provisions of the Chesapeake Bay TMDL pursuant to both the Clean Water Act (CWA) and the Chesapeake Bay Executive Order, but is not part of the TMDL itself.

When EPA establishes or approves a TMDL that allocates pollutant loads to both point and nonpoint sources, it determines whether there is a "reasonable assurance" that the point and nonpoint source loadings will be achieved and applicable water quality standards will be attained. Reasonable assurance for the Chesapeake Bay TMDL is provided by the numerous federal, state and local regulatory and non-regulatory programs identified in the accountability framework that EPA believes will result in the necessary point and nonpoint source controls and pollutant reduction programs. The most prominent program is the CWA's National Pollutant Discharge Elimination System (NPDES) permit program that regulates point sources throughout the nation. Many nonpoint sources are not covered by a similar federal permit program; as a result, financial incentives, other voluntary programs and state-specific regulatory programs are used to achieve nonpoint source reductions. These federal tools are supplemented by a variety of state and local regulatory and voluntary programs and other commitments of the federal government set forth in the Executive Order strategy and identified in the accountability framework.

Beginning in 2012, jurisdictions (including the federal government) are expected to follow two-year milestones to track progress toward reaching the TMDL's goals. In addition, the milestones will demonstrate the effectiveness of the jurisdictions' WIPs by identifying specific near-term pollutant reduction controls and a schedule for implementation (see next section for further description of WIPs). EPA will review these two-year milestones and evaluate whether they are sufficient to achieve necessary pollution reductions and, through the use of a Bay TMDL Tracking and Accountability System, determine if milestones are met.

If a jurisdiction's plans are inadequate or its progress is insufficient, EPA is committed to take the appropriate contingency actions to ensure pollution reductions. These include expanding coverage of NPDES permits to sources that are currently unregulated, increasing oversight of state-issued NPDES permits, requiring additional pollution reductions from point sources such as wastewater treatment plants, increasing federal enforcement and compliance in the watershed, prohibiting new or expanded pollution discharges, redirecting EPA grants, and revising water quality standards to better protect local and downstream waters.

Watershed Implementation Plans

The cornerstone of the accountability framework is the jurisdictions' development of WIPs, which serve as roadmaps for how and when a jurisdiction plans to meet its pollutant allocations under the TMDL. In their Phase I WIPs, the jurisdictions were expected to subdivide the Bay TMDL allocations among pollutant sources; evaluate their current legal, regulatory,

programmatic and financial tools available to implement the allocations; identify and rectify potential shortfalls in attaining the allocations; describe mechanisms to track and report implementation activities; provide alternative approaches; and outline a schedule for implementation.

EPA provided the jurisdictions with detailed expectations for WIPs in November 2009 and evaluation criteria in April 2010. To assist with WIP preparation, EPA provided considerable technical and financial assistance. EPA worked with the jurisdictions to evaluate various "what if" scenarios – combinations of practices and programs that could achieve their pollution allocations.

The two most important criteria for a WIP is that it achieves the basin-jurisdiction pollution allocations and meets EPA's expectations for providing reasonable assurance that reductions will be achieved and maintained, particularly for non-permitted sources like runoff from agricultural lands and currently unregulated stormwater from urban and suburban lands.

After the draft Phase I WIP submittals in September 2010, a team of EPA sector experts conducted an intense evaluation process, comparing the submissions with EPA expectations. The EPA evaluation concluded that the pollution controls identified in two of the seven jurisdictions' draft WIPs could meet nitrogen and phosphorus allocations and five of the seven jurisdictions' draft WIPs could meet sediment allocations. The EPA evaluation also concluded that none of the seven draft Phase I WIPs provided sufficient reasonable assurance that pollution controls identified could actually be implemented to achieve the nitrogen, phosphorus and sediment reduction targets by 2017 or 2025.

In response to its findings, EPA developed a draft TMDL that established allocations based on using the adequate portions of the jurisdictions' draft WIP allocations along with varying degrees of federal backstop allocations in all seven jurisdictions. Backstop allocations focused on areas where EPA has the federal authority to control pollution allocations through NPDES permits, including wastewater treatment plants, stormwater permits, and animal feeding operations.

Public Participation

The draft Chesapeake Bay TMDL was developed through a highly transparent and engaging process during the past two years. The outreach effort included hundreds of meetings with interested groups; two rounds of public meetings, stakeholder sessions and media interviews in all six states and the District of Columbia in fall of 2009 and 2010; a dedicated EPA website; a series of monthly interactive webinars; notices published in the Federal Register; and a close working relationship with Chesapeake Bay Program committees representing citizens, local governments and the scientific community.

The release of the draft Chesapeake Bay TMDL on September 24, 2010 began a 45-day public comment period that concluded on November 8, 2010. During the comment period EPA conducted 18 public meetings in all six states and the District of Columbia. More than 2,500 people participated in the public meetings. Seven of these meetings were also broadcast live online. During the six weeks that EPA officials traveled around the watershed, they also held dozens of meetings with stakeholders, including local governments, agriculture groups, homebuilder and developer associations, wastewater industry representatives and environmental

organizations. EPA received more than 14,000 comments – most of which supported the TMDL – and the Agency's response to those comments is included as an appendix to the TMDL.

Final Watershed Implementation Plans and TMDL

Since submittal of the draft WIPs and release of the draft TMDL in September 2010, EPA worked closely with each jurisdiction to revise and strengthen its plan. Because of this cooperative work and state leadership, the final WIPs were significantly improved. Examples of specific improvements include:

- Committing to more stringent nitrogen and phosphorus limits at wastewater treatment plants, including on the James River in Virginia. (Virginia, New York, Delaware)
- Pursuing state legislation to fund wastewater treatment plant upgrades, urban stormwater management and agricultural programs. (Maryland, Virginia, West Virginia)
- Implementing a progressive stormwater permit to reduce pollution. (District of Columbia)
- Dramatically increasing enforcement and compliance of state requirements for agriculture. (Pennsylvania)
- Committing state funding to develop and implement state-of-the-art-technologies for converting animal manure to energy for farms. (Pennsylvania)
- Considering implementation of mandatory programs for agriculture by 2013 if pollution reductions fall behind schedule. (Delaware, Maryland, Virginia)

These improvements enabled EPA to reduce and remove most federal backstops, leaving a few targeted backstops and a plan for enhanced oversight and contingency actions to ensure progress.

Backstop Allocations, Adjustments, and Actions

Despite the significant improvement in the final WIPs, one of the jurisdictions did not meet all of its target allocations and two of the jurisdictions did not fully meet EPA's expectations for reasonable assurance for specific pollution sectors. To address these few remaining issues, EPA included in the final TMDL several targeted backstop allocations, adjustments and actions. As a result of the jurisdictions' significant improvements combined with EPA's backstops, EPA believes the jurisdictions are in a position to implement their WIPs and achieve the needed pollution reductions. This approach endorses jurisdictions' pollution reduction commitments, gives them the flexibility to do it their way first, and signals EPA's commitment to fully use its authorities as necessary to reduce pollution.

New York Wastewater – Backstop Allocation

- EPA closed the numeric gap between New York's WIP and its modified allocations by establishing a backstop that further reduces New York's wasteload allocation for wastewater. EPA is establishing an aggregate wasteload allocation for wastewater treatment plants.
- EPA calculated this backstop WLA using the nitrogen and phosphorus performance levels that New York committed to, but assumes that significant wastewater treatment plants (WWTPs) are at current flow rather than design flow.

- EPA understands that New York plans to renew and/or modify WWTP permits upon completion of its Phase II WIP, consistent with the applicable TMDL allocations at that time. New York is reviewing engineering reports from WWTPs and, in its Phase II WIP, will provide information to support individual WLAs for these plants.

Pennsylvania Urban Stormwater – Backstop Adjustment

- EPA transferred 50 percent of the stormwater load that is not currently subject to NPDES permits from the load allocation to the wasteload allocation. The TMDL allocation adjustment increases reasonable assurance that pollution allocations from urban stormwater discharges will be achieved and maintained by signaling that EPA is prepared to designate any of these discharges as requiring NPDES permits. Urban areas would only be subject to NPDES permit conditions protective of water quality as issued by Pennsylvania upon designation. EPA will consider this step if Pennsylvania does not demonstrate progress toward reductions in urban loads identified in the WIP. EPA may also pursue designation activities based on considerations other than TMDL and WIP implementation.
- EPA will maintain close oversight of general permits for the Pennsylvania stormwater sector (PAG-13 and PAG-2) and may object if permits are not protective of water quality standards and regulations. Upon review of Pennsylvania's Phase II WIP, EPA will revisit the wasteload allocations for wastewater treatment plants, including more stringent phosphorus limits, in the event that Pennsylvania does not reissue PAG-13 and PAG-2 general permits for Phase II MS4s and construction that are protective of water quality by achieving the load reductions called for in Pennsylvania's Phase I WIP.

West Virginia Agriculture – Backstop Adjustment

- EPA shifted 75 percent of West Virginia's animal feeding operation (AFO) load into the wasteload allocation and assumed full implementation of barnyard runoff control, waste management and mortality composting practices required under a CAFO permit on these AFOs. The shift signals that any of these operations could potentially be subject to state or federal permits as necessary to protect water quality. AFOs would only be subject to NPDES permit conditions as issued by West Virginia upon designation. EPA will consider this step if West Virginia does not achieve reductions in agricultural loads as identified in the WIP. EPA may also pursue designation activities based upon considerations other than TMDL and WIP implementation.
- Based upon West Virginia's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including CAFO Program authorization and permit applications and issuance, EPA will assess in the Phase II WIP whether additional federal actions, such as establishing more stringent wasteload allocations for wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

Enhanced Oversight and Contingencies

While final WIPs were significantly improved and the jurisdictions deserve credit for the efforts, EPA also has minor concerns with the assurance that pollution reductions can be achieved in certain pollution sectors in Pennsylvania, Virginia and West Virginia. EPA has informed these jurisdictions that it will consider future backstops if specific near-term progress is not demonstrated in the Phase II WIP.

Pennsylvania Agriculture

- Based on Pennsylvania's ability to demonstrate near-term progress implementing the agricultural section of its WIP, including EPA approval for its CAFO program and enhanced compliance assurance with state regulatory programs, EPA will assess in the Phase II WIP whether additional federal actions, such as shifting AFO loads from the load allocation to the wasteload allocation or establishing more stringent wasteload allocations for WWTPs, are necessary to ensure that TMDL allocations are achieved.

Pennsylvania Wastewater

- EPA established individual wasteload allocations for wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of the TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.
- EPA will assess Pennsylvania’s near-term urban stormwater and agriculture program progress and determine whether EPA should modify TMDL allocations to assume additional reductions from wastewater treatment plants.

Virginia Urban Stormwater

- If the statewide rule and/or the Phase II WIP do not provide additional assurance regarding how stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment reductions proposed in the final Phase I WIP and assumed within the TMDL allocations, EPA may shift a greater portion of Virginia’s urban stormwater load from the load allocation to the wasteload allocation. This shift would signal that substantially more stormwater could potentially be subject to NPDES permits issued by the Commonwealth as necessary to protect water quality.

West Virginia Urban Stormwater

- If stormwater rules and/or the Phase II WIP do not provide additional assurance regarding how urban stormwater discharges outside of MS4 jurisdictions will achieve nitrogen, phosphorus, and sediment allocations proposed in the final Phase I WIP and assumed within the TMDL load allocations, EPA may shift a greater portion of West Virginia’s urban stormwater load from the load allocation to the wasteload allocation. The shift would signal that substantially more urban stormwater could potentially be subject to state permit coverage and/or federal Clean Water Act permit coverage as necessary to protect water quality.

West Virginia Wastewater

- EPA established individual wasteload allocations for significant wastewater treatment plants in the TMDL to ensure that sufficient detail is provided to inform individual permits for sources within the wastewater wasteload allocation. Individual allocations do not commit wastewater plants to greater reductions than what the state has proposed in its WIP. Provisions of this TMDL allow, under certain circumstances, for modifications of allocations within a basin to support offsets and trading opportunities.

- EPA will assess West Virginia's near-term agriculture program progress and determine whether additional federal actions consistent with EPA's December 29, 2009 letter, such as modifying TMDL allocations to assume additional reductions from wastewater treatment plants, are necessary to ensure that TMDL allocations are achieved.

Ongoing oversight of Chesapeake Bay jurisdictions

EPA will carefully review programs and permits in all jurisdictions. EPA's goal is for jurisdictions to successfully implement their WIPs, but EPA is prepared to take necessary actions in all jurisdictions for insufficient WIP implementation or pollution reductions. Federal actions can be taken at any time, although EPA will engage particularly during two-year milestones and refining the TMDL in 2012 and 2017. Actions include:

- Expanding coverage of NPDES permits to sources that are currently unregulated
- Increasing oversight of state-issued NPDES permits
- Requiring additional pollution reductions from federally regulated sources
- Increasing federal enforcement and compliance
- Prohibiting new or expanded pollution discharges
- Conditioning or redirecting EPA grants
- Revising water quality standards to better protect local and downstream waters
- Discounting nutrient and sediment reduction progress if jurisdiction cannot verify proper installation and management of controls

FINAL TMDL

As a result of the significantly improved WIPs and the removal and reduction of federal backstops, the final TMDL is shaped in large part by the jurisdictions' plans to reduce pollution. Jurisdiction-based solutions for reducing pollution was a long-standing priority for EPA and why the agency always provided the jurisdictions with flexibility to determine how to reduce pollution in the most efficient, cost-effective and acceptable manner.

Now, the focus shifts to jurisdictions' implementation of the WIP policies and programs designed to reduce pollution on-the-ground and in-the-water. EPA will conduct oversight of WIP implementation and jurisdictions' progress toward meeting two-year milestones. If progress is insufficient, EPA will utilize contingencies to place additional controls on federally permitted sources of pollution, such as wastewater treatment plants, large animal agriculture operations and municipal stormwater systems, as well as target compliance and enforcement activities.

Federal agencies will greatly contribute to restoration of the Chesapeake Bay watershed, particularly through implementation of the new federal strategy created under President Obama's Executive Order. Eleven federal agencies have committed to a comprehensive suite of actions and pursuit of critical environmental goals on the same 2025 timeline as the TMDL. Additionally, federal agencies will be establishing and meeting two-year milestones, with the specific charge of taking actions that directly support the jurisdictions in reducing pollution and restoring water quality.

The jurisdictions are expected to submit Phase II WIPs that provide local area pollution targets for implementation on a smaller scale; the timeframe for these Phase II WIPs will be determined in early 2011. Phase III WIPs in 2017 are expected to be designed to provide additional detail of restoration actions beyond 2017 and ensure that the 2025 goals are met.

APPENDIX G:

Total Maximum Daily Load (TMDL) Documentation for Chlordane in Baltimore Harbor

Total Maximum Daily Load (TMDL) Documentation for Chlordane in Baltimore Harbor

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TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR CHLORDANE IN BALTIMORE HARBOR
Basin Code: 02-13-09-03

PREFACE

Section 303(d) of the federal Clean Water Act (CWA) directs states to identify and list waters, known as water quality limited segments (WQLSs), where 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 waterbody can receive without violating water quality standards.

On the basis of fish tissue data associated with portions of the Baltimore Harbor, the entire waterbody was identified on the 1998 additions to Maryland's 303(d) list of WQLSs as being impaired by the pesticide chlordane. This report documents the establishment of a proposed chlordane TMDL for Baltimore Harbor.

Once approved by the U.S. Environmental Protection Agency (USEPA), the TMDL will be documented according to procedures described in the State's Continuing Planning Process. In the future, the established TMDL will support monitoring activities required to track restoration of the impaired resource with the eventual goal of lifting the associated fish consumption advisory.

EXECUTIVE SUMMARY

Chlordane, a pesticide no longer authorized for use in the United States, has been detected in certain Baltimore Harbor fish tissues at levels requiring issuance of a fish consumption advisory. This advisory has been in place since February 5, 1986 (Attachment 1). As a consequence of impairment by chlordane, the Baltimore Harbor was identified as a WQLS on the 1998 additions to Maryland's 303(d) list.

The Maryland Department of the Environment (MDE), thereby, proposes a TMDL of 0.00059 µg/L in the water column based on an earlier, more conservative USEPA water quality criterion for chlordane. In the absence of any defined currently active sources of chlordane, other than sporadic low-level inputs from urban runoff, there is no opportunity to allocate loadings among point and non-point sources other than bottom sediments. The State intends to periodically monitor contaminant levels in fish tissues from Baltimore Harbor to track expected gradual declines in chlordane concentrations. The goal of the monitoring program will be to identify fish tissue levels that would allow for the withdrawal of the fish consumption advisory.

1.0 INTRODUCTION

The Clean Water Act (CWA), 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 303(d) list. A TMDL reflects the maximum amount of the impairing substance a waterbody can receive and still meet water quality standards. A TMDL can be expressed in mass per unit 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 1998 additions to the 303(d) list, submitted to the U.S. Environmental Protection Agency (USEPA) by the Maryland Department of the Environment (MDE), identify Baltimore Harbor as impaired by the pesticide chlordane. Historical fish tissue data and an associated fish consumption advisory (Attachment 1), based on monitoring of the fish resources during the 1980s, prompted the 1998 listing.

Chlordane has been identified as a pollutant of concern because it is a bioaccumulative pesticide that is carcinogenic and can cause both acute and chronic toxic effects. Since its introduction in the 1940s, chlordane had been used as a broad-spectrum pesticide for agricultural, home, and commercial control of insects until it was withdrawn from the market in 1988. Its polycyclic chlorinated organic structure produces deleterious biological effects similar to those of DDT, polychlorinated biphenyls (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 USEPA 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. The USEPA 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 program, which has been an element of the State's water quality monitoring efforts since the 1970s. Water quality impairments in the Baltimore Harbor estuary were initially suggested as a result of fish tissue samples taken by the State of Maryland in 1981 from waters of the tidal portion of the basin. Chlordane levels were of sufficient magnitude to justify issuance of a fish consumption advisory for Channel catfish (*Ictalurus punctatus*) and American eel (*Anguilla rostrata*). All readily available data indicate that the only current source of chlordane in fish tissues is the historical accumulation of chlordane in sediments of the tidal reaches of the Baltimore Harbor estuary.

The estuary's designation as a WQLS is based upon violations of the use designation for the waterbody and the narrative standard for toxic substances in the State's regulations. Specifically, Baltimore Harbor is designated as a Use I water. The Code of Maryland Regulations (COMAR) Title 26.08.02.01 B (2) (a), requires that all Use I "waters of this State shall be protected for the basic uses of water contact recreation, fish, other aquatic life, wildlife, and water supply." In 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 estuary does not comply with the Use I designation and is considered to be impaired.

2.0 SETTING AND SOURCE ASSESSMENT

2.1 General Setting

Baltimore Harbor is a tidal estuary located on the western shore of the Chesapeake Bay, just south of Back River (see Attachment 2). Baltimore Harbor lies in the Patapsco watershed (Maryland Department of Natural Resources basin code 12-13-09-03) and it is estimated that 60 percent of the total freshwater entering Baltimore Harbor comes from the Patapsco River (Quirk, Lawler and Matusky Engineers, QLME, 1973). With an area of roughly 623 square miles, the Patapsco watershed straddles both the Piedmont Plateau and Coastal Plain Province geological formations, and includes all of Baltimore City, as well as portions of Anne Arundel, Baltimore, Carroll and Howard Counties (MDE 1996). Smaller tributaries feeding the Harbor are the Gwynns Falls (upper Middle Branch of the Harbor), Jones Falls (Northwest Branch of Baltimore Harbor), Bear Creek, and Curtis Creek.

The Harbor estuary is highly developed with a mix of urban residential, commercial, and industrial/manufacturing uses, which include; food and related products, chemical and allied products, electrical/electronic equipment, and primary metals' industries (MDE 1996). Land use in the large Harbor tributaries shifts from industrial/commercial to high/low density residential and eventually rural/agricultural in the uppermost reaches of some of these drainages.

The largest wastewater discharge to the Baltimore Harbor is from the Patapsco Wastewater Treatment Plant, operated by the City of Baltimore. It discharges approximately 60 million gallons per day of treated municipal and pretreated industrial wastewater to the middle tidal reaches of the estuary.

2.2 Source Assessment

This analysis divides sources into two components, external sources and internal sources (primarily bottom sediments). Based on limited available information, this analysis suggests that internal sources dominate impacts on the water quality, and that, external sources are not significant, and thus no attempt is made to quantify them. This is reasonable considering that any minute external loads eventually become internal sources as they bind strongly to the bottom sediments, and are thus accounted for as part of the internal sources (Agency for Toxic Substances and Disease Registry. 1989).

All readily available data point to *in-situ* Harbor sediments as the sole remaining source of chlordane to the estuary. Estuaries are sinks for contaminants and Harbor sediments integrate loadings from the tributaries. Due to their adsorption capacity, sediments are the most comprehensive indicators of historical and present day contamination (Agency for

Toxic Substances and Disease Registry. 1989). Equilibrium partitioning equations used in section 6.0 predict current Harbor water column concentrations below the 0.00059 µg/L benchmark adopted for this TMDL. These low concentrations predicted in the water column suggest that natural processes are converging to reduce chlordane levels in the Harbor. Future fish analyses are predicted to show decreased tissue burdens and will further confirm adherence to the proposed TMDL.

External Sources: The majority of chlordane loadings were expected 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. Based on the limited nonpoint source and point source data, presented below, there do not appear to be any significant external sources of chlordane to control or regulate at this time.

External Nonpoint Sources: Water quality information on chlordane concentrations in surface waters draining to the Harbor is limited. However, studies of urban and agricultural runoff report minute amounts of chlordane being detected in tributaries to the Harbor. These infrequent occurrences, however, do not allow for the identification of quantifiable sources.

Data from an unpublished 1994 urban runoff study by MDE (MDE draft August 1997) suggest that the occurrence of chlordane is unpredictable in spatial and temporal scope. Twelve of the fifteen samples taken from the Baltimore Harbor watershed stations (ZDE0009, ZGW0001 and GWN0015) 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 µg/L or parts per billion - ppb) and two were at 0.03 µg/L (Table 1).

Table 1: Pesticides in Baltimore Harbor Tributaries – 1994 (units are in mg/L)

Tributary	Station	Watershed	Winter	Spring	Summer-1	Summer-2	Fall
Unnamed Trib.	ZDE0009	Stony Run	0.03	ND	ND	0.02	ND
Unnamed Trib.	ZGW0001	Gwynns Falls	<0.02[T]	ND	ND	0.03	ND
Gwynns Falls	GWN0015	Middle Branch	ND	ND	ND	ND	ND

[T]Trace – the pesticide was detected in at least one sample at a level below the quantification limits.
ND – Not detected

Another report published by MDE in 1997 (MDE 1997) analyzed stormwater discharge data for the National Pollutant Discharge Elimination System (NPDES, 1987 CWA) permit application process. Baltimore City and Anne Arundel, Baltimore, Harford, Howard, Montgomery and Prince George's counties were required to participate in the NPDES program. Monitoring sites were organized into residential, commercial and industrial categories to analyze specific landuse runoff characteristics.

Sampling was conducted at each site during three discrete storm events which had to produce at least 0.1 inches of rainfall and occur at least 72 hours after the previous rain event. Samples were collected every 20 minutes for the first 3 hours of the storm and each outfall could not be sampled more than once per month. A total 107 storm events were sampled during the NPDES study, 21 of which were in tributaries to Baltimore Harbor. Chlordane detection levels were 0.014 µg/L using USEPA method 608. No chlordane was detected during this study.

Point Sources: Chlordane is not an expected substance in point source discharges. If it were to occur in municipal discharges, it would be from intermittent, illicit, and generally untraceable sources. If such sources exist, they are not generally considered controllable by waste water treatment plants.

Chlordane has not been detected in discharges from the Patapsco River wastewater treatment plant (personal communication – John Martin, Baltimore City DPW). For meaningful reference, however, the nearby Back River wastewater treatment plant produced no detectable chlordane during pesticide surveys in 1989 or 1998. The detection levels in 1998 were 0.086 µg/L (personal communication – John Martin, Baltimore City DPW).

Internal Sources: The only significant internal source of chlordane in the Baltimore Harbor is the bottom sediments, which are considered to be a nonpoint source from the perspective of load allocations. Computations provided within this report indicate that current sediment concentrations should not lead to the elevation of chlordane in fish tissue; however, older fish may have elevated levels due to past exposure. MDE continues to monitor fish tissue to verify these expectations.

Harbor sediments are the most probable continuing source of chlordane. The most recent sediment data collected in the estuary are from the "Spatial Mapping of Sedimentary Contaminants from the Baltimore Harbor/Patapsco River/Back River System" (Baker *et al.* 1997). The mean concentration of chlordane detected in this study was 5.62 ng/g dry weight. An earlier study conducted by Eskin *et al.* (1996) in the Harbor found mean chlordane sediment concentrations of 2.56 ng/g dry weight. Instead of averaging the values from these two studies, the higher chlordane concentration of 5.62 ng/g from the Baker study is assumed for the calculations in this study. This adds a margin of safety to the analysis by using the highest mean sediment concentrations currently available for calculating associated chlordane in the water column.

3.0 WATER QUALITY IMPAIRMENT

Fish tissue samples collected since 1976 as part of a statewide fish tissue monitoring program serve as the sole source of data used to justify placement of the Baltimore Harbor on Maryland's 303(d) list of water quality limited segments for chlordane. Under this state program two or more fish species, representing bottom feeders and higher trophic level predators, are targeted for collection at each monitoring location. Species having a wide range of occurrence are targeted to allow for regional comparisons in addition to the temporal trends at each monitoring station. Chlordane has been identified in almost every fish tissue

sample collected from all basins under the State's fish tissue monitoring program. 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 in areas of concern.

Statewide, most fish tissue chlordane levels have been well below the 0.3 mg/kg action level established by U.S. Food and Drug Administration (USFDA) guidelines. 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), Back River, and Lake Roland (an impoundment on Jones Falls and a tributary to the Patapsco River). In these water bodies, the levels of chlordane in selected fish tissues frequently exceeded the USFDA action levels.

Following the initial surveys of the 1970s, where results indicated a potential for problems in selected urban areas, additional monitoring efforts were focused on the areas of greatest concern, including Baltimore Harbor. The monitoring conducted in Baltimore Harbor in 1981 substantiated contamination concerns and resulted in additional, more comprehensive monitoring in subsequent years. Because chlordane was detected in a number of fish tissue samples above the 0.3 mg/kg level, the waterbody was considered to be impaired. Results of the monitoring in the Baltimore Harbor watershed are summarized in Table 2.

Table 2: Chlordane Levels in Fish Tissue Collected in Baltimore Harbor (1976-1987)

Year	Station	Basin	Species	Tissue Analyzed	Weight (g)	Concentration (ppm)
1976	PAT0195	Patapsco River	Yellow Perch	Fillet	N/A	0.05
	XHF9502	Rock Creek	White Perch	Fillet	N/A	**0.37**
	PAT0195	Patapsco River	Bluegill	Edible Portion	419	ND
	XIE2885	Patapsco River	White Perch	Edible Portion	315	0.05
	XIE2885	Patapsco River	Spot	Edible Portion	440	0.02
	XIE2885	Patapsco River	White Perch	Edible Portion	N/A	0.11
	XIE2885	Patapsco River	White Perch	Edible Portion	343	0.07
	XIE2885	Patapsco River	American Eel	No skin, head, visc.	372	0.17
1982	XIE2885	Patapsco River	White Perch	Edible Portion	290	0.10
	XIE2885	Patapsco River	Spot	Edible Portion	540	0.10
	CUR0007	Curtis Creek	Spot	Fillet	N/A	0.07
1983	XIE2885	Patapsco River	Spot	Fillet	95.5	**0.31**
	XIE2885	Patapsco River	Spot	Fillet	86.6	**0.49**
	XIE2885	Patapsco River	Spot	Fillet	86.1	0.11
	XIE2885	Patapsco River	Spot	Fillet	108.3	0.20
	XIE2885	Patapsco River	Spot	Fillet	86.1	**0.73**
	XIE2885	Patapsco River	Spot	Fillet	76.3	0.27
	XIE2885	Patapsco River	Spot	Fillet	80	0.11
	XIE2885	Patapsco River	Spot	Fillet	95.3	**0.45**
	XIE2885	Patapsco River	Spot	Fillet	86.9	0.18
	XIE2885	Patapsco River	Spot	Fillet	89.3	**0.30**
	XIE2885	Patapsco River	Spot	Fillet	96.5	0.16
	XIE2885	Patapsco River	Spot	Fillet	83.8	**0.75**
	XIE2885	Patapsco River	Spot	Fillet	92.5	0.22
	XIE2885	Patapsco River	Spot	Fillet	91.6	0.20
1985	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	260	**0.67**
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	360	0.18
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	180	**0.40**
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	220	**0.34**
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	226	**0.60**
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	208	**0.67**
	XIE6254	Northwest Branch	American Eel	No skin, head, visc.	170	**0.57**
	XIE2590	Patapsco River	American Eel	No skin, head, visc.	194	0.26
	XIE2590	Patapsco River	Channel Catfish	Fillet	813	**0.46**
	XIE2590	Patapsco River	American Eel	No skin, head, visc.	128	**0.42**
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	191	0.16
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	398	0.24
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	251	0.26
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	461	0.08
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	189	0.21
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	177	0.17
	XHF9502	Rock Creek	American Eel	No skin, head, visc.	134	0.19

Table 2: Continued

	XIF1629	Patapsco River	White Catfish	Fillet	305	**0.36**
	XIF1629	Patapsco River	Brown Bullhead Catfish	Fillet	195	**0.53**
	XIF1629	Patapsco River	Brown Bullhead Catfish	Fillet	127	0.02
	XIF1629	Patapsco River	Channel Catfish	Fillet	402	0.19
	XIF1629	Patapsco River	Channel Catfish	Fillet	475	**0.31**
	XIF1629	Patapsco River	Channel Catfish	Fillet	672.4	**0.86**
	XIF1629	Patapsco River	White Perch	Fillet	148	0.07
	XIF1629	Patapsco River	White Perch	Fillet	149	0.06
	XIF1629	Patapsco River	White Perch	Fillet	110	0.11
	XIF1629	Patapsco River	White Perch	Fillet	167	0.06
	XIF1629	Patapsco River	White Perch	Fillet	152	0.09
	XIF1629	Patapsco River	White Perch	Fillet	101	0.04
	XIF1629	Patapsco River	White Perch	Fillet	142	0.05
	XIF1629	Patapsco River	White Perch	Fillet	192	0.06
	XIF1629	Patapsco River	White Perch	Fillet	129	0.16
	XIF1629	Patapsco River	White Perch	Fillet	90	0.11
	XIF1629	Patapsco River	White Perch	Fillet	192	0.04
	XIF1629	Patapsco River	White Perch	Fillet	128	0.08
	XIF1629	Patapsco River	White Perch	Fillet	128	0.08
	XIF1629	Patapsco River	White Perch	Fillet	93	ND
	XIF1629	Patapsco River	White Perch	Fillet	100	0.15
	XIF1629	Patapsco River	White Perch	Fillet	83	0.05
	XIF1629	Patapsco River	White Perch	Fillet	113	0.08
	XIF1629	Patapsco River	White Perch	Fillet	89	0.08
	XIF1629	Patapsco River	White Perch	Fillet	89	**0.75**
	XIF1629	Patapsco River	White Perch	Fillet	1082	0.16
	XHE9541	Patapsco River	White Perch	Fillet	182	0.11
	XHE9541	Patapsco River	White Perch	Fillet	282	**0.61**
	XHE9541	Patapsco River	White Perch	Fillet	319	0.22
	XHE9541	Patapsco River	White Perch	Fillet	270	0.15
	XHE9541	Patapsco River	Carp	Fillet	1467	**0.33**
	XHE9541	Patapsco River	Brown Bullhead Catfish	Fillet	206	0.16
	XHE9541	Patapsco River	Brown Bullhead Catfish	Fillet	185	0.08
	XHE9541	Patapsco River	White Perch	Fillet	237	0.11
	XHE9541	Patapsco River	White Perch	Fillet	173	0.11
	XHE9541	Patapsco River	White Perch	Fillet	162	0.10
	XHE9541	Patapsco River	White Perch	Fillet	152	0.09
	XHE9541	Patapsco River	White Perch	Fillet	N/A	**0.53**
	XHE9541	Patapsco River	White Perch	Fillet	214	0.04

Table 2: Continued

	XHE9541	Patapsco River	White Perch	Fillet	179	0.18
	XHE9541	Patapsco River	Carp	Fillet	2533	**0.67**
	XHE9541	Patapsco River	Brown Bullhead Catfish	Fillet	185	0.17
	XHE9541	Patapsco River	Brown Bullhead Catfish	Fillet	162	0.11
	XHE9541	Patapsco River	Brown Bullhead Catfish	Fillet	187	0.21
1986	CUR0007	Curtis Creek	White Perch	Fillet	170.1	0.17
	CUR0007	Curtis Creek	White Perch	Fillet	170.1	0.17
	CUR0007	Curtis Creek	White Perch	Fillet	155.9	-0.02
	CUR0007	Curtis Creek	White Perch	Fillet	184.3	ND
	CUR0007	Curtis Creek	White Perch	Fillet	141.8	ND
	CUR0007	Curtis Creek	White Perch	Fillet	198.4	ND
	CUR0007	Curtis Creek	White Perch	Fillet	192.8	ND
	CUR0007	Curtis Creek	White Perch	Fillet	170.1	ND
	CUR0007	Curtis Creek	White Perch	Fillet	184.3	ND
	CUR0007	Curtis Creek	White Perch	Fillet	175.8	ND
	CUR0007	Curtis Creek	White Perch	Fillet	184.3	ND
	CUR0007	Curtis Creek	White Perch	Fillet	221.1	**0.49**
	CUR0007	Curtis Creek	White Perch	Fillet	155.9	0.11
	CUR0007	Curtis Creek	White Perch	Fillet	170.1	**0.33**
	CUR0007	Curtis Creek	White Perch	Fillet	192.8	0.02
1987	XIF2929	Old Road Bay	Brown Bullhead Catfish	Fillet	680	0.02

N/A – Information not available
ND – Not detected
Concentrations in bold exceed the USFDA guidance level of 0.3 mg/kg

4.0 TARGETED WATER QUALITY GOALS

Although the State has not adopted a numeric water quality criterion for chlordane, it does take action on environmental contaminants that significantly increase the risk to public health. The level of significance generally used by the State in these analyses for carcinogenic endpoints is the level that produces an increased risk greater than one in 100,000 of the population. This is often expressed as a risk greater than 1.0×10^{-5}. Assuming that the public has a risk of cancer from all causes of at least 25%, or 25,000 in 100,000, the threshold of concern for a single substance would increase the risk to 25,001 in 100,000.

The USFDA has established specific guidance levels for fish tissue in the commercial market (0.3 mg/kg). This level was employed in the setting of the original fish consumption advisory for Baltimore Harbor. The USEPA currently supports a purely risk based approach for developing fish consumption advisories. Using USEPA default assumptions: CSF_o (0.35/mg/kg/d), the average adult daily consumption of fish (6.5 grams/day), the average body weight of an adult (70 kg) and a risk factor of 10^{-5}, yields a fish tissue concentration of 0.3 mg/kg. This means that a fish tissue concentration of 0.3 mg/kg approximates a 10^{-5} risk level. Since both USEPA and USFDA support the same fish tissue concentration, this weight-of-evidence leads Maryland to conclude that an average fish tissue level of 0.3 mg/kg is reasonable for the purpose of deciding whether a fish consumption advisory may be warranted. The current USEPA ambient water quality criteria for the protection of human health from the consumption of contaminated fish is calculated similarly, but is conservatively based on a 10^{-6} risk level instead of 10^{-5}. This adds a factor of 10 safety margin to the most current USEPA water quality criteria of 0.0022 µg/L. Therefore, the endpoint for the control or mitigation of chlordane as it affects the edibility of fish taken from Baltimore Harbor would be linked to achieving a reduction of chlordane in the targeted fish tissues to a level of 0.3 mg/kg or less.

Because chlordane was banned nearly 15 years ago, chlordane loadings from sources other than existing bottom sediments are believed to be negligible; consequently, the bottom sediments are assumed to be the dominant present day source of chlordane in Baltimore Harbor water and fish tissue[1]. Therefore, the rate of reduction of chlordane concentrations in the biologically active sediment layer will ultimately control water column and fish tissue concentrations. Chlordane concentrations in sediments are reduced by a number of processes, including:

- Burial/dilution of contaminated sediments;
- Dissolution into, followed by vaporization from, the water column;
- Uptake by biota living in the sediment;

[1] This expectation is also supported by the well-established propensity of chlordane to adsorb to sediments (Agency for Toxic Substances and Disease Registry, 1989). Based on calculations provided in section 5.0 Technical Methods, current sediment concentrations of chlordane in Baltimore Harbor have declined below levels that are expected to result in elevated fish tissue concentrations (See also Section 2.2 Source Assessment).

- Chemical degradation;
- Biological degradation; and
- Hydrologic transport from the system.

The dominant processes are likely burial and/or dissolution followed by volatilization from the water body. 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.

Water quality criteria for chlordane have been developed by USEPA (USEPA 1999) to protect marine aquatic life from toxic effects (0.004 µg/L) and to protect humans from the consumption of contaminated aquatic organisms (0.0022 µg/L). These superceded the earlier water quality criteria developed by USEPA; 0.0043 µg/L (toxicity to marine aquatic life) and 0.00059 µg/L (human health) (EPA 1999). As a conservative assumption of the TMDL analysis, the earlier and more strict ambient water quality criteria for the protection of human health was employed, which includes an additional built-in margin of safety.

5.0 TECHNICAL METHODS

Following the steps provided below, an equilibrium approach, using the USEPA 1993 sediment criteria development methodology, was employed to provide an upper estimate of the dissolved water column concentration based on recent sediment concentrations.

First, the log K_{oc} is estimated from the log K_{ow} using 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 (L/kg)

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 of chlordane in water in equilibrium with the sediment can be estimated by the equation provided below. It should be emphasized that this equation represents the pore water concentration or the concentration in the water present between bottom sediment particles. The overlying water column is expected to be subject to a much greater degree of

dilution, resulting in even lower chlordane concentrations. Using this methodology provides an additional margin of safety by estimating the maximum concentration of chlordane potentially present in the overlying water column.

$$C_w = C_s / (f_{oc} \times K_{oc})$$

where:

C_w = concentration in water (µg/L)
C_s = concentration in sediment (g/kg)
f_{oc} = fraction organic carbon (unitless)
K_{oc} = organic carbon/water equilibrium partition coefficient (L/kg)

Recent measurements of Baltimore Harbor sediments (Baker *et al.* 1997) indicate an average concentration of 5.62 ng/g (dry weight) for chlordane and 4.36% total carbon. Applying these values in the following equation yields a predicted water column concentration of 0.000462 µg/L (4.62 x 10^{-4} µg/L)., lower than the more conservative water quality criteria (0.00059 µg/L) being used in this TMDL analysis.

$$C_w = C_s / (f_{oc} \times K_{oc})$$

$$C_w = 5.62\ \mu g/kg / (0.0436\ g/g \times 279{,}000\ L/kg)$$

$$C_w = 0.000462\ \mu g/L = 4.62 \times 10^{-4}$$

The multiple margins of safety used in the above calculations ensure that the predicted water column concentration (4.62 x 10^{-4} µg/L) of chlordane in Baltimore Harbor represents the maximum concentration possible based upon available data. These calculations predict that the current concentration of chlordane in the water column (4.62 x 10^{-4} µg/L) is still approximately twenty five percent lower than the most conservative (5.9 x 10^{-4} or 0.00059µg/L) USEPA water quality criteria adopted for the Baltimore Harbor TMDL. In addition, since there are no discernible continuing sources of chlordane to the Harbor, continued fish monitoring and the expected gradual declines in tissue burdens below the 0.3 mg/kg level will strongly suggest that water column concentrations fall below the 0.00059 µg/L water quality standard adopted for the Harbor TMDL.

6.0 TOTAL MAXIMUM DAILY LOADS AND LOAD ALLOCATIONS

Chlordane is a persistent substance, which has a high affinity for fine sediments and generally settles to the bottom with the sediment in the estuary. Water column concentrations are thus generally extremely low and difficult to measure in a manner that would allow adequate characterization of a large estuarine system. Sediment analyses are costly and provide information only on the precise location where sampling occurred. Fish tissue accumulates and integrates bioaccumulative contaminants, such as chlordane, and is, therefore, the logical endpoint for assessing environmental contamination.

6.1 Water Quality Endpoint

The water quality endpoint for this TMDL is expressed in terms of achieving the specific criterion for which Baltimore Harbor was identified on the 303(d) list. The current USFDA guidance level for fish tissue concentrations of 0.3 mg/kg was used to determine the need to list Baltimore Harbor as being impaired by chlordane. A water quality endpoint equivalent to the most conservative of the USEPA's water quality criteria for chlordane (0. 00059 µg/L) should, therefore, be sufficient to attain fish tissue concentrations below the guidance level.

6.2 Total Maximum Daily Load

The computations provided above establish a linkage between the fish tissue endpoint of 0.3 mg/kg and a water column concentration of 0.00059 µg/L (USEPA 1980) that includes a factor of 30 margin of safety (see Margin of Safety section). Thus, MDE is establishing a concentration of 0.00059 µg/L as the appropriate measure for the Baltimore Harbor chlordane TMDL.

6.3 Seasonal Variations and Critical Conditions

The TMDL is represented as a concentration level that is protective against 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, the TMDL is founded upon human health standards which account for 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 levels 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.

6.4 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 non-point sources, are too insignificant to support the quantification of meaningful allocations to these sources. Furthermore, the bottom sediments integrate other sources. All readily available data indicate that chlordane present 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 Baltimore Harbor estuary.

6.5 Margin of Safety

The USEPA's TMDL guidance requires each TMDL to include a margin of safety (MOS) that accounts for uncertainty in a manner that is conservative with respect to environmental protection. 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 USEPA ambient water quality standard for the protection of humans from the ingestion of contaminated aquatic organisms (0.00059 µg/L) serves as the basis of the TMDL. This is more conservative than the current USEPA ambient water quality criterion (0.0022 µg/L) and was employed to add a margin of safety of a factor of 3. Additionally, the current USEPA water quality criterion of 0.0022 µg/L was calculated at a 10^{-6} risk level, whereas Maryland typically uses a 10^{-5} risk level for water quality criteria for the protection of human health due to fish ingestion. This adds an additional margin of safety by a factor of 10. When combined, these two margins of safety amount to a protection factor of 30.

The equation used in section 6.0 to predict water column concentrations of chlordane based upon current Inner Harbor sediment concentrations also has a built-in margin of safety. It predicts concentrations expected in the sediment pore water rather than the water column overlying the sediments. When considering sediments as the sole source of contamination, the pore water between sediment particles frequently has higher contaminant concentrations than the overlying water column, which is subject to mixing and dilution.

As a third margin of safety, the maximum mean chlordane concentration among the most recent sediment analyses was used to calculate the existing water column concentration.

6.6 TMDL Summary

Based on the previous discussion, the TMDL for chlordane may be summarized as follows:

TMDL	=	WLA	+	LA	+	MOS
0.00059	**=**	**0**	**+**	**0.00059**	**+**	**built-in**

(µg/l – at all times). No future allocation is provided.

Where, WLA is Waste Load Allocation (Nonpoint Sources)
LA is Load Allocation (Point Sources), and
MOS is Margin of Safety

7.0 ASSUREDNESS OF IMPLEMENTATION

The State of Maryland is committed to protecting the State's rivers, streams, lakes, wetlands, and estuaries. Chlordane concentrations in Baltimore Harbor sediments are expected to decline over time due to natural recovery of the estuary, through gradual biodegradation, dispersal, and natural burial by sedimentation. The computations provided in Section 6.0 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.

Chlordane has not been commercially available since the late 1980s. It is, therefore, an intermittent contaminant the source of which is most likely stormwater or illegal disposal. Local governments are promoting efforts to enhance source reductions by offering "household hazardous chemical disposal days." These efforts 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.

Aside from the processes of natural recovery, physical removal of the bottom sediments from this estuary would be the only other means of removing the chlordane-contaminated sediments. Environmental concerns, coupled with the high costs associated with dredging and dredged material disposal, place chlordane impairment in Baltimore Harbor in the category of "Extremely Difficult Problems" as defined in Chapter 6 of the Report of the Federal Advisory Committee on the TMDL Program (USEPA 1998a).

Biologically available chlordane levels in Baltimore Harbor sediments are expected to decline over time due to natural processes including biodegradation, redistribution, and natural burial by sedimentation. Maryland has a fish tissue monitoring program in place that collects and analyzes samples for contamination in Baltimore Harbor on a regular basis. Maryland is proposing triennial monitoring of the fish and surficial sediments in the Harbor to track the natural attenuation of chlordane. An evaluation of the required sampling frequency will be considered each year as information from the statewide monitoring network is developed. As contamination levels decline and appear low enough to protect human health and the environment, these data and results from additional samples will be evaluated to determine if the consumption advisory should be modified or withdrawn.

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NEWS RELEASE

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February 5, 1986

DHMH ISSUES HEALTH ADVISORY

Adele Wilzack, R.N., M.S., Secretary of the Department of Health and Mental Hygiene, today issued a health advisory concerning recreational fishing and the consumption of black crappie, carp, channel catfish and american eels from certain waters in the urban Baltimore area.

"This advisory is limited in nature," Ms. Wilzack said. "No health risk exists with the general consumption of oysters, crabs or finfish from Maryland waters, and commercial fisheries are not affected."

A recently concluded intensive investigation in Lake Roland, the Baltimore Harbor and Back River found that average chlordane concentrations in certain fish exceeded the FDA action level of 0.3 ppm.

Chlordane is an insecticide whose use in Maryland is now limited to subterraneous application to protect homes from termites. However, in the past, chlordane was also used as an insecticide in agriculture and was sprayed in homes and gardens. Chlordane remains for long periods of time in the environment and can become concentrated in fish. It has a relatively low acute toxicity, compared to other insecticides, but because it is a suspected carcinogen, continuing long-term exposure is considered a risk.

MORE

DHMH ISSUES HEALTH ADVISORY

"Individuals are advised to limit their consumption of carp and black crappie from Lake Roland," Ms. Wilzack said. "We are also advising residents to limit their consumption of channel catfish and american eels from both the Baltimore Harbor and Back River."

These fish should not be used as a substantial part of the daily diet and should be avoided by women of childbearing age, infants or children. To further reduce health risks, Secretary Wilzack recommends removal of the belly flap, skin and dark meat, because chlordane is most likely to be concentrated in fatty protions of fish. Secretary Wilzack indicated that other fish were tested in each body of water, but that the average chlordane levels in them were not found to exceed the FDA action level for chlordane.

To protect the consumer, the Food and Drug Administration has established a chlordane "action level" of 0.3 parts per million for fish. The possible lifetime cancer rish associated with consumption of over 100 lbs. of fish containing chlordane levels of 0.3 ppm. over a person's lifetime has been estimated at 1 in 100,000 for the average individual.

To give this value some perspective, it can be compared to the lifetime cancer risk for a person sharing an office with a smoker, which is 70 in 100,000 or the lifetime cancer risk from cosmic radiation associated with taking one transcontinental airplane flight annually, which is 3.5 in 100,000. To illustrate this another way, a person is at a 3.5 times greater risk from taking one such flight annually than from eating 100 lbs. of fish containing 0.3 ppm chlordane over a lifetime.

MORE

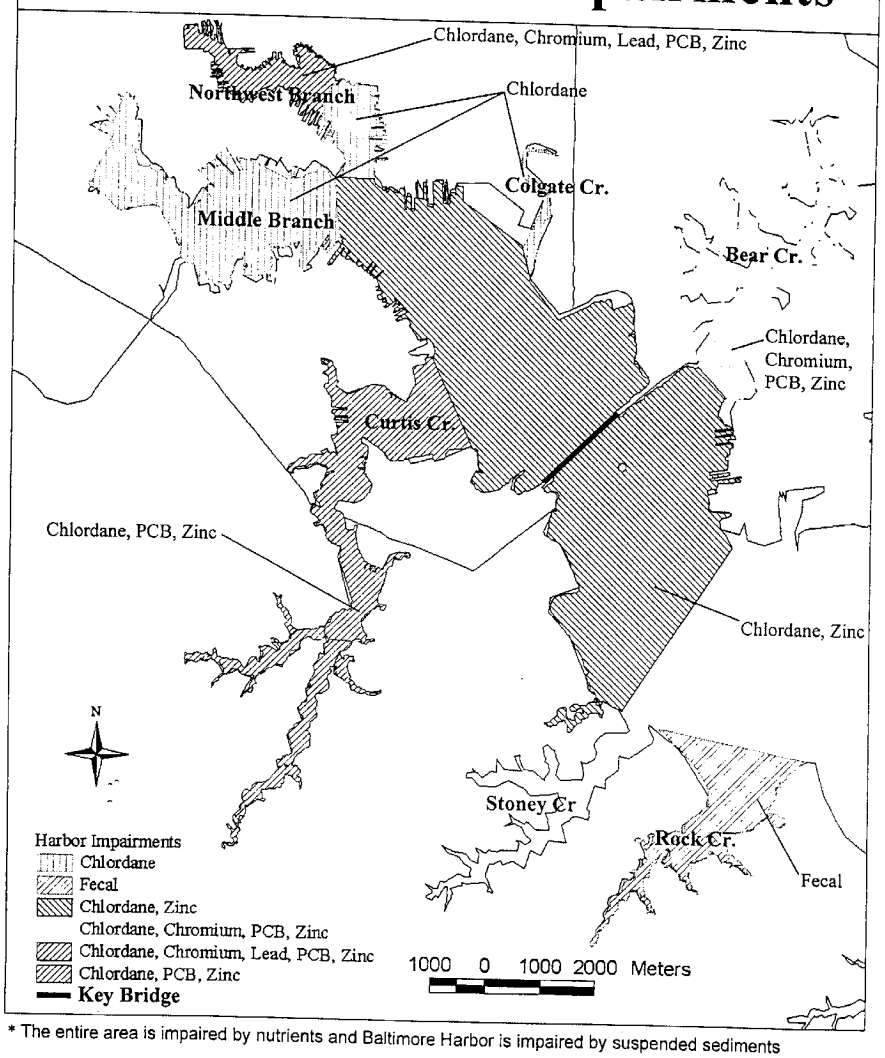
DHMH ISSUES HEALTH ADVISORY

"Similar advisories concerning chlordane have been issued in New York, New Jersey, Mississippi, Missouri, Illinois and Wisconsin," said Ms. Wilzack, who again emphasized that continual surveillance of Maryland fish, crabs and shellfish indicates there is no health risk associated with the general consumption of oysters, crabs and finfish from Maryland waters.

Indiviuaals desiring further information may contact Dr. Katherine Farrell, M.D., M.P.H. at (301) 225-5753.

# # #

Baltimore Harbor Impairments



* The entire area is impaired by nutrients and Baltimore Harbor is impaired by suspended sediments

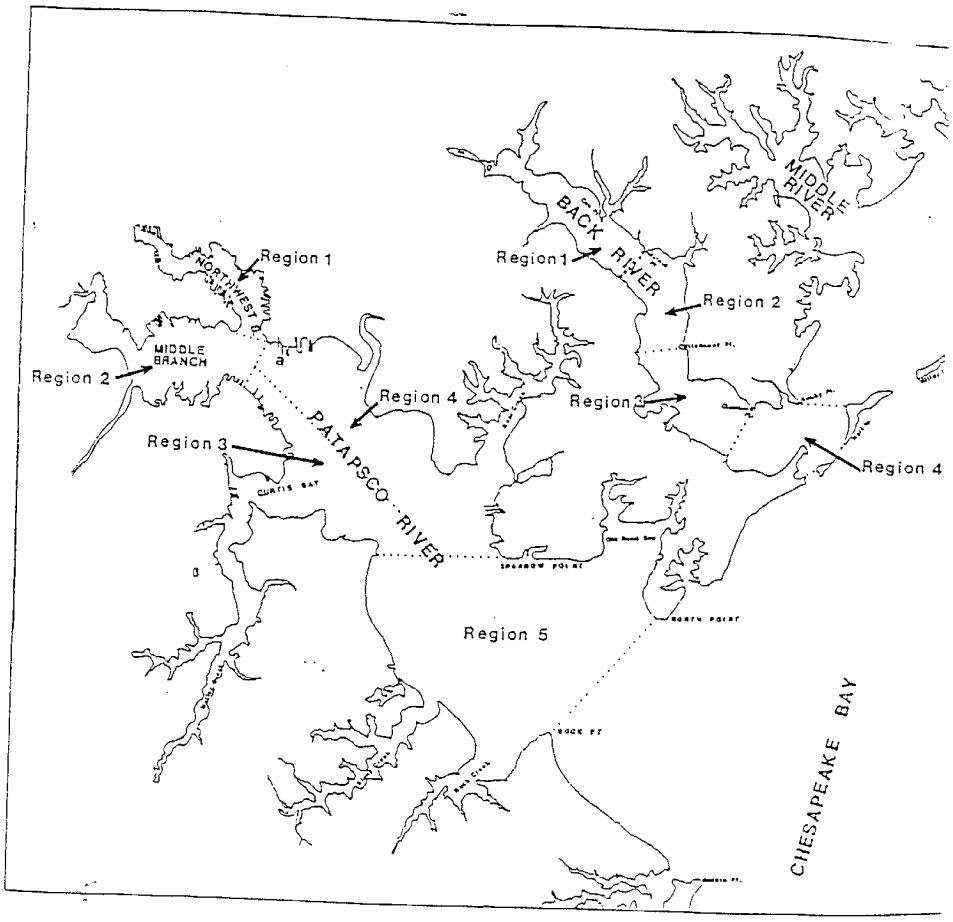


Figure 1. Finfish sampling regions in the Patapsco and Back River Estuaries.

MDE *Facts About . . .*

Maryland Department of the Environment

CONTAMINANTS AND TOXICITY

BACKGROUND

In describing the estuarine and marine environment, the terms "contaminant" and "toxic" are widely used and often misunderstood. The detection or presence of contaminants or toxic substances does not mean a threat exists to either human health or the health of the water body.

- All substances have the potential to be contaminants and to cause toxicity.
- Even substances considered relatively harmless or even beneficial, such as water and vitamin C, may be harmful if consumed in very large quantities or on a too frequent basis. Alcohol is another example; one drink per week is considered harmless, while several drinks per day can cause liver disease.
- Whether or not a substance exerts toxicity depends on both the concentration (dose) and duration of exposure. For example, because of the difference in alcohol content (dose), consumption of a shot glass of whiskey each day is more harmful than consumption of a shot glass of beer each day. Similarly, consumption of a shot glass of whiskey each day is more harmful than drinking same amount each week.
- In assessing the health of Maryland surface waters, substances which are evaluated include metals, such as lead and cadmium, and organic substances, such as pesticides and PCBs. These substances are frequently not present or only present in natural waters at very low concentrations, often below analytical detection levels. Therefore, water sampling is not cost effective and is seldom performed. Since these substances may accumulate in fish and shellfish tissue or sediment, tissue or sediment are the media of choice for sample collection and analysis. Sediment data are used to determine historical discharges or environmental trends, but are not appropriate for evaluating human health risk.

SWIMMING

The presence of toxic substances is generally not important in evaluating the health risk associated with swimming. Exceptions are the rare situation when there may be excessive discharges of acids or alkalis or the presence of marine toxin producing algal blooms. These situations do not occur in Maryland. During swimming, the potential for exposure to heavy metals at concentrations and frequencies sufficient to cause a problem is negligible, when compared to other daily sources such as ingesting food or drinking water.

Although a swimmer might accidentally swallow water during swimming, the amount of a chemical that would be ingested in this manner would be much too small to pose a health risk. Therefore, there is no significant health risk from exposure to chemical contaminants during recreational swimming. Skin contact, during swimming is of no consequence either, since metals are not readily absorbed through the skin.

CONSUMING FISH

Fish have the potential to accumulate heavy metals or organic chemicals in their tissue, even when these materials cannot be measured in the water column. This makes fish good indicators of environmental pollution in a body of water. For this reason, MDE monitors chemical contaminants in fish tissue. Monitoring fish tissue also allows the Maryland Department of Environment to determine if contaminant levels in fish are within limits established as safe for human consumption.

MDE has monitored contaminant levels in fish from Maryland waters since the 1960s and 1970s. Analysis of these data has identified only three water bodies in Maryland where contaminants in certain fish species pose a health concern to humans consuming them. These three water bodies are Lake Roland (black crappie and carp) and the Baltimore Harbor and Back River (american eel and channel catfish).

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MDE *Facts About . . .*

Maryland Department of the Environment

MONITORING CONTAMINANT LEVELS IN FISH, SHELLFISH AND CRABS

Fish and shellfish have the potential to accumulate heavy metals or organic chemicals in their tissue even when these materials cannot be measured in the water column. This makes fish good indicators of environmental pollution in a body of water. This is one of the reasons MDE monitors chemical contaminants in fish tissue. Monitoring fish tissue also allows the Maryland Department of Environment to determine if contaminant levels in fish are within limits established as safe for human consumption. In order to make this determination, MDE evaluates all relevant data and utilizes our professional knowledge and experience.

The relevant data include not only contaminant data on fish and shellfish from the area, but also information on which compounds are likely to bioaccumulate in tissue, their sources and their potential to be present in the aquatic environment at sufficient levels for bioaccumulation to levels of concern. Additional important information considered includes the seasonal variations in fish lipid levels which governs levels of many contaminants. MDE also gives careful consideration to which fish species are those likely to accumulate the highest levels of bioaccumulative contaminants; and thus pose the highest potential risk to human consumers.

FISH

Since the early 1970s, the Maryland Department of the Environment (MDE) has been monitoring chemical contaminant levels in fish found in Maryland waters. Currently, Maryland's monitoring program divides state waters into three groups: 1) Western Maryland watersheds, 2) Chesapeake Bay watersheds, and 3) Baltimore/Washington urban watersheds. Fish from within each of these areas are sampled each 3 years. Collections consist of 2 samples of accumulator species and one sample of game species. Of the accumulator samples, one includes whole fish, while the second includes only fillet tissue. Of the game species, only the fillet portion is analyzed. This allows water-quality managers to evaluate the relative levels of contaminants of concern accumulating in state waters, and contaminant levels in the fish to determine safety for human consumption.

APPENDIX H:

Water Quality Analyses of Chromium in the Inner Harbor/Northwest Branch and Bear Creek Portions of Baltimore Harbor in Baltimore City and Baltimore County, Maryland

Final

Water Quality Analyses of Chromium in the Inner Harbor/Northwest Branch and Bear Creek Portions of Baltimore Harbor in Baltimore City and Baltimore County, Maryland

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List of Abbreviations

ANOVA	Analysis of Variance
AVS-SEM	Acid Volatile Sulfide – Simultaneously Extracted Metals
BOD	Biological Oxygen Demand
BSM	Baltimore Harbor Sediment Mapping Study
CBL	Chesapeake Biological Laboratory
Cd	Cadmium
cm	Centimeter
COMAR	Code of Maryland Regulations
Cr	Chromium
Cr III	Trivalent Chromium
Cr VI	Hexavalent Chromium
Cu	Copper
CWA	Clean Water Act
EPA	Environmental Protection Agency
ERM	Effects Range Median
ERM-Q	Effects Range Median Quotient
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/Kg DW	Milligram per Kilogram on a Dry Weight Basis
Pb	Lead
PCBs	Polychlorinated Biphenyls
ppm	Parts per Million
TMDL	Total Maximum Daily Load
µg/L	Micrograms per Liter
WQA	Water Quality Analysis
WQLS	Water Quality Limited Segment
Zn	Zinc

EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the 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. For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

The Baltimore Harbor, with its watershed located in Baltimore City and parts of Baltimore, Howard, Anne Arundel, and Carroll Counties was identified on the 1996 303(d) list as impaired by toxic substances, nutrients, and suspended sediments. In 1998, the impairment listings were refined to include specific impairing substances and increased spatial resolution. As a result, the Inner Harbor/Northwest Branch (basin code 02-13-09-03) was listed for fecal coliform, chromium (Cr), zinc (Zn), lead (Pb), and polychlorinated biphenyls (PCBs). In 2002 it was listed for biological community impacts. Bear Creek, a tributary to Baltimore Harbor (basin code 02-13-09-03) located in Baltimore County, was included in the 1996 303(d) listing for the Baltimore Harbor. However, in 1998 the increased spatial resolution led to Bear Creek being identified as impaired specifically for the substances Cr, Zn, and PCBs.

This report provides analyses of the data used to determine the Inner Harbor/Northwest Branch and Bear Creek Cr impairment listings. It also includes recently collected data that indicates that although sediment toxicity is present in the Inner Harbor/Northwest Branch and Bear Creek, the source of the toxicity cannot be attributed to Cr. As a result, the analyses support the conclusion that TMDLs for Cr are not currently necessary. However, the segments will remain listed as impaired for biological community impacts due to sediment toxicity.

Barring the receipt of any contradictory data, this report will be used to support the removal of total Cr as an impairing substance in the Inner Harbor/Northwest Branch and Bear Creek on Maryland's list of WQLSs when MDE proposes the revision of Maryland's 303(d) list for public review in the future. The nutrients, Zn, and Pb impairments are currently being addressed under separate analyses; the suspended sediments, biological, and PCB impairments will be addressed at a future date.

Although the waters of the Inner Harbor/Northwest Branch and Bear Creek do not currently display signs of toxicity due to Cr, the State reserves the right to reassess the impact(s) of all Cr species on the environment due to future changes in Baltimore Harbor water quality, including, but not limited to the improvement of dissolved oxygen levels due to a reduction in nutrients. Furthermore, the State reserves the right to require additional pollutant controls in the Inner Harbor/Northwest Branch and Bear Creek if evidence suggests that Cr from either basin is contributing to water quality problems within Baltimore Harbor.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and 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 currently 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 must establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are met.

A segment identified as a WQLS may not require the development 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 the criteria; 3) refinements to water quality criteria, or the interpretation of those standards, which result in criteria being met; or 4) correction to errors made in the initial listing.

The Baltimore Harbor, with its watershed located in Baltimore City and parts of Baltimore, Howard, Anne Arundel, and Carroll Counties was identified on the 1996 303(d) list as impaired by toxic substances, nutrients, and suspended sediments. In 1998, the impairment listings were refined to include specific impairing substances and increased spatial resolution. As a result, the Inner Harbor/Northwest Branch (basin code 02-13-09-03) was listed for fecal coliform, chromium (Cr), zinc (Zn), lead (Pb), and polychlorinated biphenyls (PCBs). In 2002 it was listed for biological community impacts. Bear Creek, a tributary to Baltimore Harbor, (basin code 02-13-09-03) located in Baltimore County, was included in the 1996 303(d) listing for the Baltimore Harbor. However, in 1998 the increased spatial resolution led to Bear Creek being identified as impaired specifically for the substances Cr, Zn, and PCBs.

The 1998 listings for Cr were based on the bulk sediment concentration of total Cr, acute sediment toxicity, and benthic integrity data generated during the Baltimore Harbor Sediment Mapping Study (BSM). The data collected during the BSM revealed high levels of toxic metals (including total Cr), and organic compounds in both the Inner Harbor/Northwest Branch and Bear Creek. Additionally, the BSM toxicity test results indicated elevated levels of toxicity associated with the sediments in these regions. Since toxicity to aquatic life (*Leptocheirus plumulosus*) was evident and no water quality criteria for toxic contaminants in sediment were available, the sediment concentrations were evaluated against the Effects Range Median (ERM) concentration; a commonly used sediment quality benchmark (Long *et al.*, 1995; MacDonald *et al.*, 1996). The ERM guidelines are based on data from 89 reports that contain simultaneous measures of sediment toxicity and chemistry. The ERM designates the sediment contaminant level at which half [50th percentile] of the studies reported harmful effects. As a result of these analyses, the Maryland Department of the Environment (MDE) concluded that total Cr in the Inner Harbor/Northwest Branch and Bear Creek was to be considered an impairing substance due to the frequency and magnitude of the exceedance of the ERM, as well as the observed sediment toxicity.

However, during discussions with the Baltimore Harbor TMDL Stakeholder Advisory Group, stakeholders raised questions regarding the justification of the Cr impairment and the MDE - developed water quality endpoint. The questions regarding the impairment listings focused on the use of total Cr sediment concentrations, given that Cr exists in two major valence states, trivalent (Cr III) or hexavalent (Cr VI), depending upon the presence of oxygen in the sediment and overlying water column. The distinction between the two major valence states is significant due to the toxicity associated with each species; Cr III is relatively non-toxic, and Cr VI is highly toxic. The current science indicates that reduction/oxidation conditions present within the water column and sediment govern the chemistry of Cr. Within Baltimore Harbor, the presence of low dissolved oxygen in the water column for significant time periods and high levels of biologically oxygen demanding (BOD) substances within the sediment facilitate the conversion of Cr VI to Cr III. Additionally, the relatively insoluble Cr III is also subject to reactions that create stable oxides and hydroxides that are unavailable for partitioning into porewater (Baker, Personnel Communication 2004).

The questions regarding the MDE - developed endpoint were focused on the appropriateness of the ERM - based endpoint because ERM values are screening values and the authors explicitly warned that they should not be used for regulatory purposes. The justification for the development of this endpoint was the lack of EPA promulgated water quality criteria for toxic substances present in the sediment. The MDE - developed endpoint was based on sediment concentrations of total Cr at an ERM-Quotient (ERM-Q) value of 0.5. The ERM-Q is an evaluation method used to develop a spatial average of a specific contaminant within a given region based on several sample sites and data points (MDE, 2002).

Based on the issues raised by stakeholders, the initial listing for Cr was brought into question because: 1) the original listing was based on the total Cr concentration in sediment evaluated against the ERM guideline value; 2) current aquatic life water quality criteria exist for Cr III and Cr VI in the dissolved state; and 3) water quality data evaluated did not contain data on Cr III and Cr VI.

The water quality analyses (WQA) for total Cr in the Inner Harbor/Northwest Branch and Bear Creek was conducted using recently collected water column, pore water, and sediment concentration data. The data collected includes Cr III and Cr VI for the water column and pore water matrices. The results indicate that the pore water concentrations of Cr VI do not exceed the water column saltwater aquatic life criterion (chronic) of 50μg/L for Cr VI in Bear Creek and the water column fresh water aquatic life criterion (chronic) of 11μg/L for Cr VI in the Inner Harbor/Northwest Branch (Code of Maryland Regulations (COMAR) 26.08.02.03-2G) and there is therefore is no basis for concluding that Cr is an impairing substance. The nutrients, Zn, and Pb impairments are currently being addressed under separate analyses whereas the suspended sediments, biological, and PCB impairments will be addressed at a future date.

Barring contradictory data, this report will be used to support the removal of total Cr as an impairing substance in the Inner Harbor/Northwest Branch and Bear Creek on Maryland's list of WQLSs when MDE proposes the revision of Maryland's 303(d) list for public review in the future. However, the segments will remain listed as impaired for biological impacts due to sediment toxicity. In addition, MDE is funding a "stressor identification" study to determine

which substances, including some not previously analyzed, may be causing the sediment toxicity. The remainder of this report lays out the general setting of the waterbody and presents a discussion and conclusions relative to the water quality characterization process.

2.0 GENERAL SETTING

The Inner Harbor/Northwest Branch and the Bear Creek watersheds are located in the Patapsco/Back River region of the Chesapeake Bay watershed within Maryland (See Figure 1). The Inner Harbor/Northwest Branch watershed is within Baltimore City; the Bear Creek watershed is within Baltimore County. The Inner Harbor/Northwest Branch has a drainage area of 42,000 acres, which consists of the Jones Falls watershed and two subwatersheds that drain directly into the Inner Harbor/Northwest Branch. The land use profile in these areas include forest and other vegatation (6,648 acres or 16%), mixed agriculture (3,400 acres or 8%), and urban (31,561 acres or 76%). The water surface area of Inner Harbor/Northwest Branch is 164 acres (<1%). Table 1 shows the land use of the Inner Harbor/Northwest Branch watershed.

Bear Creek, a highly urbanized tidal creek in the Baltimore Harbor, drains a watershed area of approximately 5,900 acres. The land use in this watershed consists of forest and other herbaceous cover (400 acres or 7%), and urban (5300 acres or 91%). The water surface area of Bear Creek is 100 acres (2%). Table 1 shows the land use of the Bear Creek watershed.

Table 1: Land Use Composition of Inner Harbor/Northwest Branch and Bear Creek

Region	Forest/Herbaceous	Mixed Agriculture	Urban	Water
Inner Harbor/Northwest Branch	16%	8%	76%	<1%
Bear Creek	7%	0%	91%	2%

The Baltimore Harbor watershed, including the Inner Harbor/Northwest Branch and Bear Creek, lies within the Piedmont and Coastal Plain provinces of Central Maryland. The surficial geology of the Piedmont has been formed from the decomposition of various sedimentary, metamorphic, and igneous rocks. The underlying rock formations consist of schist, limestone, marble, and gneiss. The stream valleys along the fall line between the Piedmont and the Coastal Plain are typified by exposed igneous rocks such as gneiss and Baltimore gabro. 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 southeast and eventually extend beneath the sediments of the Coastal Plain. The fall line represents the transition between the Coastal Plain and the Piedmont. The Coastal Plain surficial geology is characterized by thick, unconsolidated marine and riverine sediments deposited over the crystalline rock of the piedmont (Coastal Environmental Services, 1995).

A summary of land use for the Inner Harbor/Northwest Branch and Bear Creek watersheds are given in Figures 2 and 3, respectively. Based on the 1997 land use assessment developed by the

Maryland Department of Planning (MDP), MDE aggregated the 22 land uses identified in the Baltimore Harbor watershed down to four general categories: urban; water; mixed agriculture; and forest/vegetation. Urban land-use categories represent 76% of the Inner Harbor/Northwest Branch and 91% of the Bear Creek watershed, respectively.

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 the designated use may differ and are dependent upon the specific designated use(s) of a waterbody. Maryland's water quality standards presently include numeric criteria for Cr III and Cr VI in the water column based on the need to protect aquatic life, wildlife and human health. An interpretation of the narrative water quality standards exists for toxic substances to address sediment quality and ensure the surficial bottom sediments of a waterbody are capable of supporting aquatic life, thus protecting the designated uses.

The Maryland Surface Water Use Designation COMAR 26.08.02.08J for the Baltimore Harbor and its tributaries (including the Inner Harbor/Northwest Branch and Bear Creek) is Use I – water contact recreation, fishing, and protection of aquatic life and wildlife. The applicable water quality criterion, based on chronic toxicity, for Cr VI in saltwater is 50μg/L and freshwater is 11μg/L (COMAR 26.08.02.03-2G). The Inner Harbor/Northwest Branch segment is defined in COMAR 26.08.02.03-1B as freshwater. Of the two chromium species of concern, Cr III and Cr VI, Cr VI is highly toxic and therefore has a numeric criterion that is more stringent (i.e., at a lower concentration). Therefore, the Cr VI data will be evaluated against the Cr VI water quality standard to determine if there is a water quality impairment in either the Inner Harbor/Northwest Branch or Bear Creek.

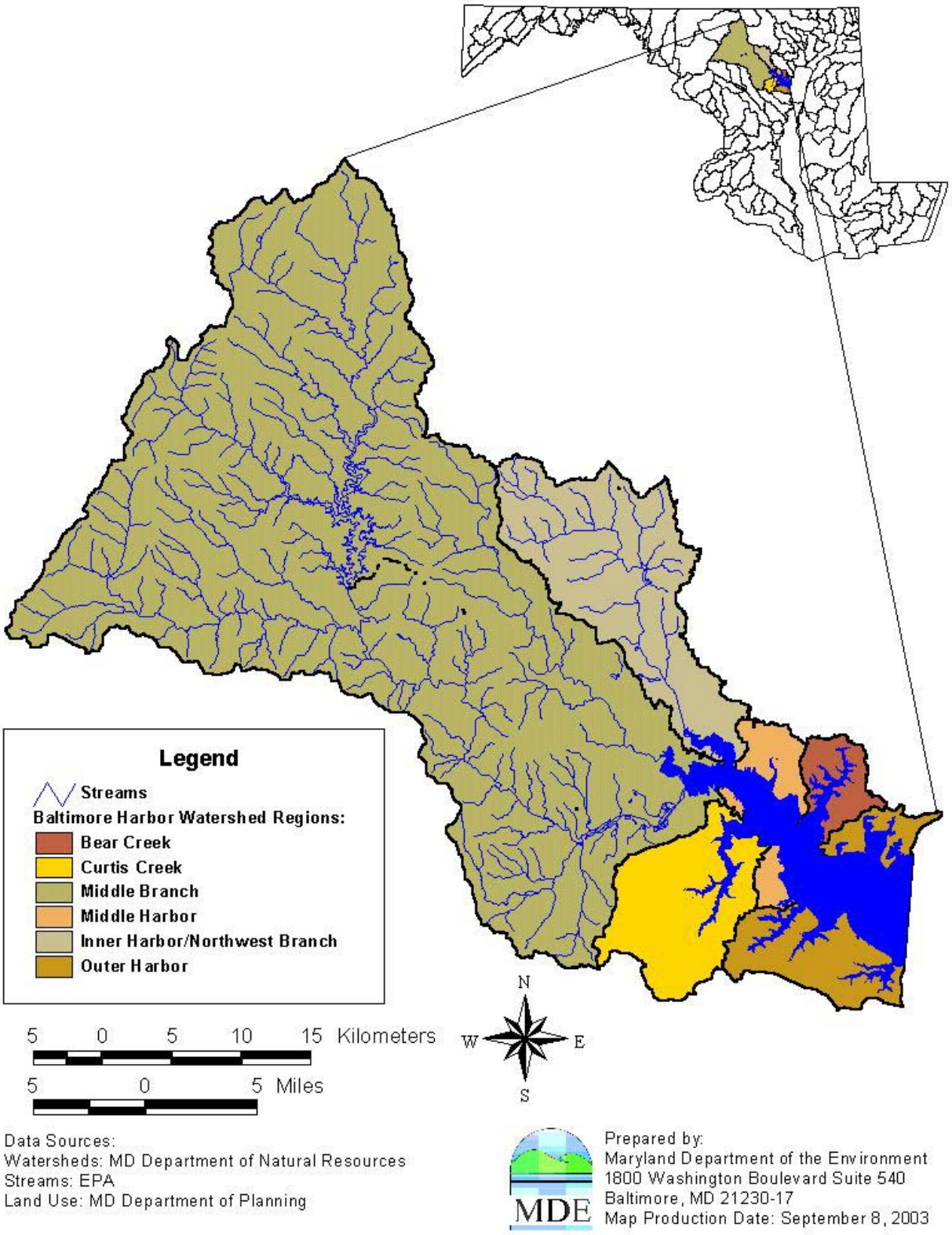

Figure 1: Watershed Map of the Baltimore Harbor Watershed

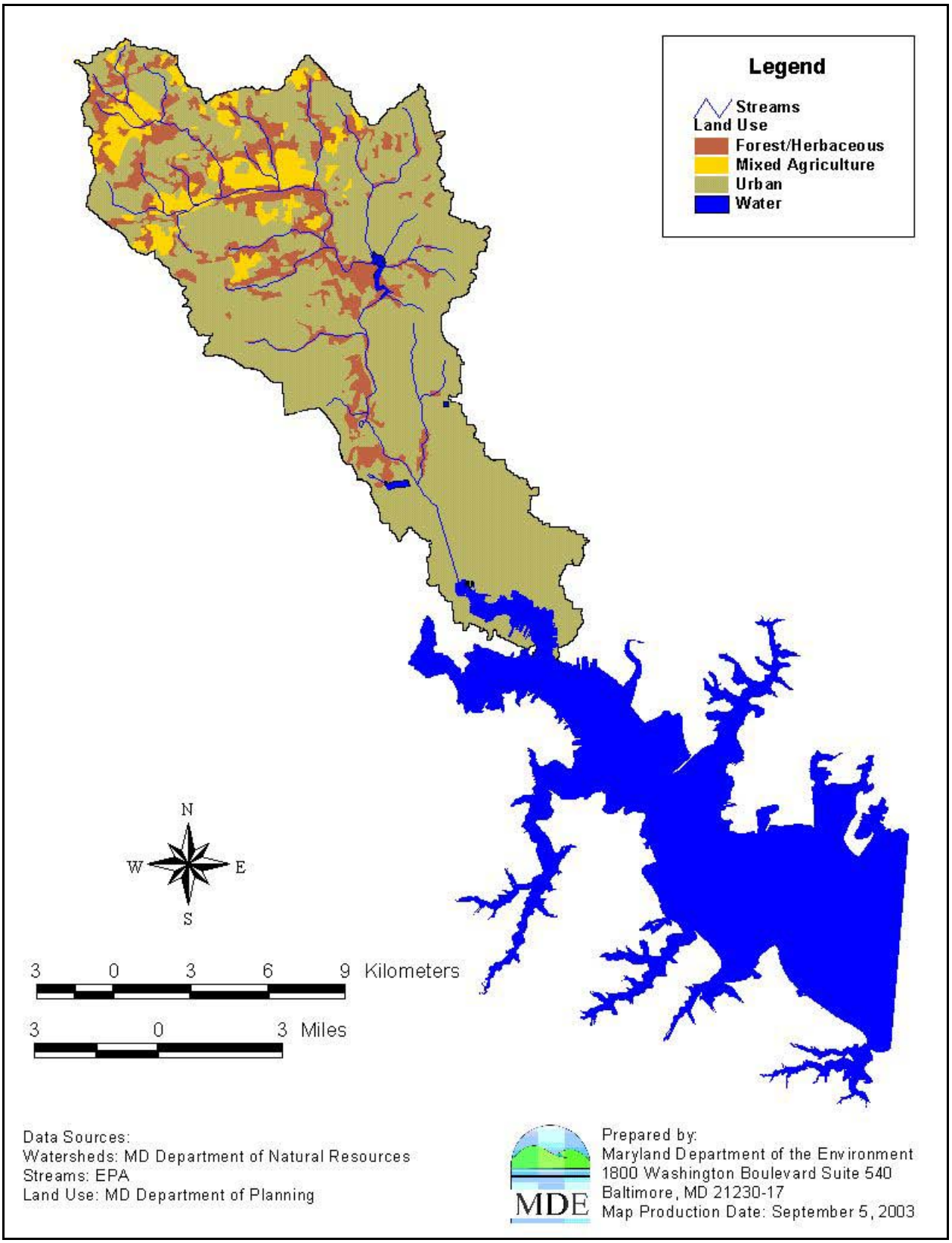

Figure 2: Land Use Map of the Inner Harbor/Northwest Branch Watershed

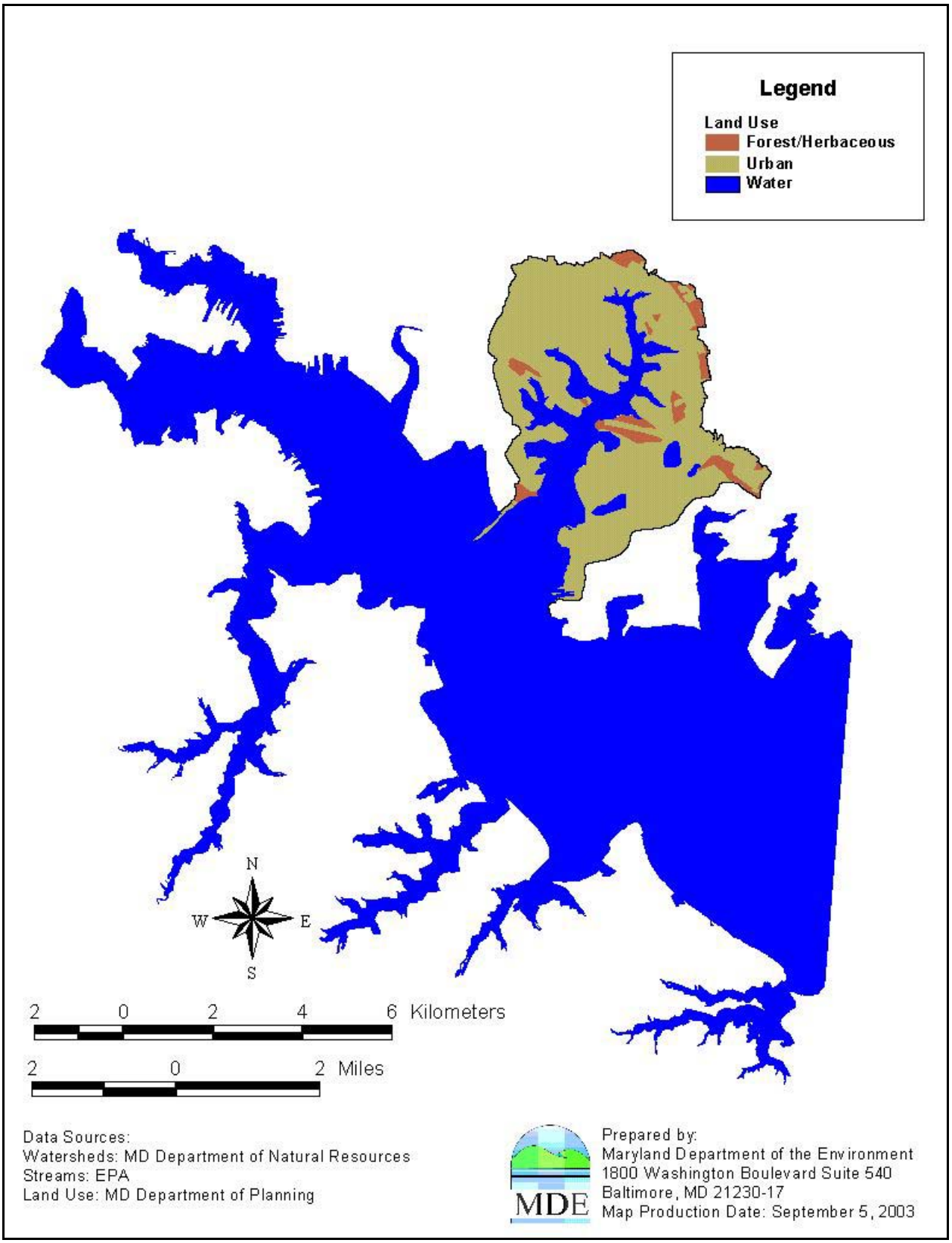

Figure 3: Land Use Map of the Bear Creek Watershed

A water column and sediment survey was conducted at stations 68, 69, 70, 71, and 73 in the Inner Harbor/Northwest Branch and stations 28, 29, 30, 31, 32 in Bear Creek during August 2003 (See Figure 4 and Tables 2 and 3). The data from this sampling effort is used to support this WQA. For each sample, concentrations were determined for: 1) dissolved Cr in the water column (1 meter from the bottom), and the surficial sediment pore water; 2) Cr III and Cr VI in the water column (1 meter from the bottom), and the surficial sediment pore water; 3) total Cr, Acid Volatile Sulfide – Simultaneously Extracted Metals (AVS-SEM), and sulfides in surficial (< 2cm in depth) sediment; and 4) chronic toxicity bioassays (28-day *L. plumulosus*) on surficial sediment. The water column and surficial sediment porewater data presented in Section 3.1, Table 5 and Table 6, indicates that concentrations of Cr VI do not exceed the water quality criteria for Cr VI in either the water column or the surficial sediment pore water.

The sediment data presented in Section 3.2, Table 7 and Table 8, indicates that high concentrations of total Cr remain present in the surficial sediments. However, using a molar-based analysis to account for the varying molecular weights of the compounds, the data indicates that the amount of sulfides present in the sediments is well above the amount necessary to reduce all the Cr present in the sediment from Cr VI to Cr III.

The ambient sediment bioassay data presented in Section 3.3, Tables 9 and 10 indicate that toxicity occurs at 9 of the 10 Inner Harbor/Northwest Branch and Bear Creek stations sampled (Fisher, 2004). However, due to the presence of many chemical contaminants at elevated levels in the sediment and pore water concentrations of Cr VI that indicate that this metal does not exceed the applicable water quality standard, MDE is unable to assign the cause of the toxicity to Cr VI.

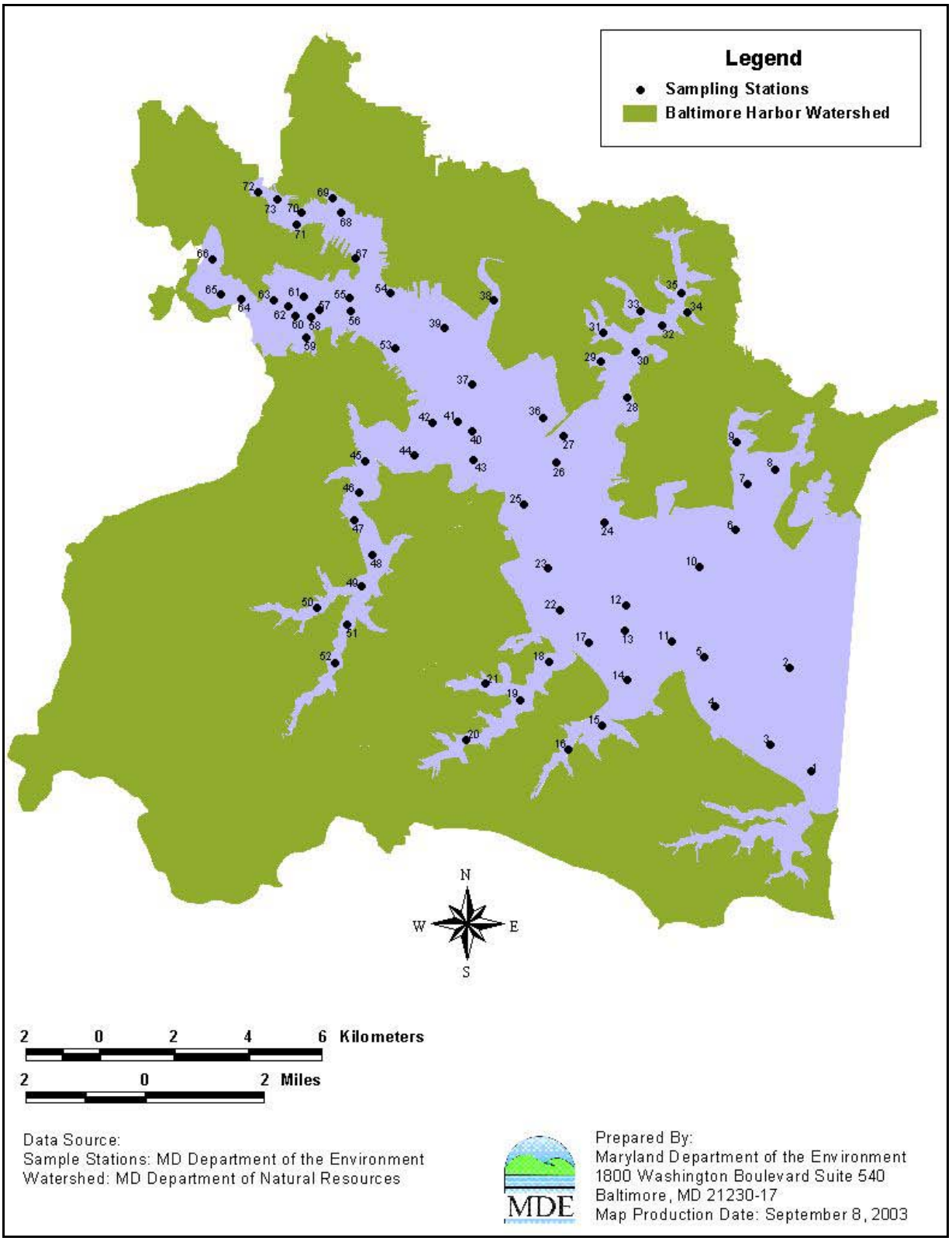

Figure 4. Baltimore Harbor Sediment Mapping Study Sampling Locations

3.1 WATER COLUMN EVALUATION

To evaluate the water quality of the Inner Harbor/Northwest Branch and Bear Creek, MDE evaluated the pore water concentrations of Cr VI against the freshwater and saltwater aquatic life chronic criteria for Cr VI in the water column. The samples collected for these analyses were taken from stations established during the 1996 BSM. Table 2 and Table 3 contain the station identifications, geographical coordinates, and descriptive locations of the stations in the Inner Harbor/Northwest Branch and Bear Creek, respectively.

Table 2: Water Quality Analysis Stations for the Inner Harbor/Northwest Branch

Station ID	GPS Coordinates	Station Description
BSM 68	39.278 76.583	Southeast of Fells Pt.
BSM 69	39.282 76.586	Southeast of Fells Pt.
BSM 70	39.278 76.596	South of former chromium refinery
BSM 71	39.275 76.598	Across channel from former chromium refinery
BSM73	39.283 76.609	Head of Inner Harbor

Table 3: Water Quality Analysis Stations for Bear Creek

Station ID	GPS Coordinates	Station Description
BSM 28	39.233 76.495	Mouth of Bear Creek near International Steel
BSM 29	39.242 76.503	Cove Northwest of Route 695 bridge
BSM 30	39.244 76.492	Mid Creek adjacent to railroad bridge
BSM 31	39.248 76.502	Head of small tributary entering Creek at railroad bridge
BSM32	39.250 76.484	Head of Bear Creek/South of Wise Ave. bridge

Water column and porewater samples were collected in August 2003 by the University of Maryland Chesapeake Biological Laboratory (CBL) and shipped to Frontier Geosciences in Seattle, WA for extraction and analysis. The collection of porewater was conducted in an anoxic environment to maintain the appropriate sediment chemistry. The porewater was separated from the surficial sediments by centrifugation, filtered to remove particulate matter, and split for separate analysis. One half of the filtrate was analyzed for the free ionic species of Cr III and Cr VI using an ion chromatography method to separate Cr III and Cr VI ions from the remaining

matrix. Following the chromatographic separation step the sample was analyzed using Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) to determine the concentrations of Cr III and Cr VI (Gurleyk).

The second half of the filtrate was analyzed for total Cr in the dissolved phase using a standard metals ICP-MS analysis. The values generated from both analyses were then assessed against the water quality criteria to determine if a violation of the water quality standard occurred. The Cr III, Cr VI, and Total Cr data from the water column and porewater are presented in Table 5 and Table 6. The detection limits for metals analysis are displayed in Table 4.

Table 4: Chromium Analysis Detection Limits

Analyte	Detection Limit
Cr III Water Column	0.017 µg/L
Cr VI Water Column	0.022 µg/L
Total Cr Sediment	0.50 mg/Kg DW

Table 5: Inner Harbor/Northwest Branch Water Column and Porewater Data

Station	Water Column		Pore Water	
	Cr (III)	Cr (VI)	Cr (III)	Cr (VI)
	µg/L		µg/L	
BSM68	0.222	0.279	0.07	ND
BSM69	0.129	0.163	0.31	ND
BSM70	0.125	0.262	0.50	ND
BSM71	0.109	0.131	0.50	ND
BSM73	0.070	0.178	0.36	ND

Cr VI Chronic WQ Criteria for Freshwater = 11 µg/L
ND = Non Detect

Table 6: Bear Creek Water Column and Porewater Data

Station	Water Column		Pore Water	
	Cr (III)	Cr (VI)	Cr (III)	Cr (VI)
	µg/L		µg/L	
BSM28	0.263	0.176	0.05	ND
BSM29*	0.171	0.175	0.12	ND
BSM30	0.355	0.143	0.09	ND
BSM31	0.138	0.168	0.12	ND
BSM32*	0.132	0.148	0.17	ND

*Value is average of duplicate samples
Cr VI Chronic WQ Criteria for Saltwater = 50 µg/L
ND = Non Detect

3.2 SEDIMENT CHEMISTRY EVALUATION

To evaluate the sediment conditions, surficial (top 2 cm) sediment samples were collected by CBL in Inner Harbor/Northwest Branch and Bear Creek using a petite ponar dredge. The sediment stations correspond to the monitoring stations sampled in the BSM and the water column survey described in the above sections. Refer to Table 1 and Table 2 for station locations. The samples collected were analyzed for total Cr, AVS-SEM, and sulfides. The results of the analysis are presented in Table 7 and Table 8.

Table 7: Inner Harbor/Northwest Branch Sediment Data*

Station	Total Cr	AVS/SEM Cr	AVS/SEM Divalent Metals Cu, Cd, Zn, Pb	AVS	Excess Sulfides
	mg/Kg DW**	µmole/g	µmole/g	µmole/g	µmole/g
BSM68	443	1.60	7.46	78.75	69.69
BSM69	480	2.11	7.91	369.38	359.36
BSM70	1,068	4.66	7.59	173.44	161.19
BSM71	1,286	6.60	10.78	196.88	179.50
BSM73	500	2.01	7.13	236.25	227.11

*The analysis is presented on a molar basis to account for the various molecular weights of the analytes.
**DW = Dry Weight

Table 8: Bear Creek Sediment Data*

Station	Total Cr	AVS/SEM Cr	AVS/SEM Divalent Metals Cu, Cd, Zn, Pb	AVS	Excess Sulfides
	mg/Kg DW**	µmole/g	µmole/g	µmole/g	µmole/g
BSM28	705	6.92	19.42	144.06	117.72
BSM29***	724	6.20	21.29	304.06	276.58
BSM30	827	10.80	31.58	340.63	298.25
BSM31	847	4.73	19.14	500.00	476.13
BSM32	601	6.00	19.78	375.00	349.22

*The analysis is presented on a molar basis to account for the various molecular weights of the analytes.
**DW = Dry Weight
***Value is average of duplicate samples

Baltimore Harbor sediments are acted upon by chemical reactions that result in Cr being sequestered into non-reactive forms. The presence of a low dissolved oxygen environment with high levels of sulfides produces a reduction-based conversion of Cr VI to Cr III and the formation of Cr oxides and hydroxides. The sediment data presented above indicates that there are sulfides present in the sediment in concentrations well in excess of what would be required to reduce all chromium in the sediment from Cr VI to Cr III. As a result of the conversion to Cr III the porewater concentrations are below water quality criteria even though the bulk sediment concentrations are in excess of ERM levels (Boothman et al., 2000 and Berry et al., 2002).

3.3 SEDIMENT TOXICITY EVALUATION

To complete the WQA, sediment toxicity in the Inner Harbor/Northwest Branch and Bear Creek was evaluated using a 28-day chronic growth and survival whole sediment test with the marine amphipod *L. plumulosus.* 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 estuarine or marine sediments (EPA, 2001). Surficial (top 2 cm) sediment samples were collected by CBL in Inner Harbor/Northwest Branch and Bear Creek using a petite ponar dredge. The sediment stations correspond to the monitoring stations sampled in the BSM and the water column survey described in the above sections. Refer to Table 1 and Table 2 for station locations. Sediment toxicity test results are presented in Table 9 and Table 10.

Table 9: Inner Harbor/Northwest Branch Sediment Toxicity Data

Station	Percent Survival	Growth mg/ind/d[1]	Reproduction (Neonates/survivor)
Control	88	0.065	4.94
BSM68*	61	0.039	0.47
BSM69*	35	0.044	0.18
BSM70*	9.4	0.032	0.00
BSM71*	3.0	0.021	0.30
BSM73*	55	0.054	0.94

[1]Growth rate equals milligram dry weight/individual/day
*Significant observed toxicity

Table 10: Bear Creek Sediment Toxicity Data

Station	Percent Survival	Growth mg/ind/d[1]	Reproduction (Neonates/survivor)
Control	87	0.068	4.34
BSM28*	0	0	0.00
BSM29*	72	0.063	3.26
BSM30*	2	0.014	0.00
BSM31	80	0.049	1.45
BSM32*	61	0.050	1.90

[1]Growth rate equals milligram dry weight/individual/day
*Significant observed toxicity

The endpoints for the test were survival, growth rate (mg dry weight/individual/day) and reproduction (neonates/survivor). Data were analyzed in accordance with procedures outlined in the EPA 2001 method (EPA, 2001). Survival data were arcsine square-root transformed prior to analysis. The survival data were then assessed for normality and homogeneity of variance using the Chi-Square Test and Bartlett's Test, respectively ($\alpha = 0.05$). All transformed survival data were normal and homogeneous. The survival data were then analyzed via Analysis of Variance (ANOVA) followed by comparisons between test sediment amphipod survival and the control amphipod survival using a Dunnett's Test ($\alpha = 0.05$).

All of the sites showed a significant reduction in survival except for BSM 31 (Table 10). Statistical analyses of sublethal endpoints were conducted only on treatments not exhibiting significant effects on survival after 28 days. Since only one site, BSM 31, did not have a reduction in survival, a two-sample t-Test ($\alpha = 0.05$) was used to compare growth rate and reproduction at BSM 31 with the control endpoints for that suite of sample sites. Although there was not a reduction in growth rate at this site, there was a reduction in reproduction (Table 10).

All of the sediments from the tested sites showed significant reductions in test endpoints. BSM sites 28, 29, 30, 32, 68, 69, 70, 71, and 73 showed reduced survival of *L. plumulosus*. The most significant effects were seen at BSM 28 (0% survival), BSM 30 (2% survival), BSM 70 (9.4% survival), and BSM 71 (3.0% survival). The only station not having significant survival effects on the amphipod was BSM 31. Amphipods from this station showed a significant reduction in reproduction (1.45 neonates per survivor versus 4.34 neonates per survivor in the control).

4.0 CONCLUSION

The data presented in support of the WQA indicates that the pore water and water column data collected for Cr VI does not exceed the water quality standard in the water column. The toxicity data indicates mortality in Inner Harbor/Northwest Branch and Bear Creek sediments. However, sediment data collected for AVS-SEM metals plus sulfides indicate that in situ environmental conditions (i.e., low dissolved oxygen, high BOD) has produced sulfide concentrations within the sediments that are at levels well in excess of what would be needed to convert the Cr present in the Northwest Branch/Inner Harbor and Bear Creek sediments from Cr VI to Cr III and render

it unavailable to partition into the pore water in quantities that would exceed water quality standards. As a result, the sediment chemistry present in the Northwest Branch/Inner Harbor and Bear Creek creates an environment where Cr cannot be determined as the specific cause of the observed toxicity.

Therefore, barring any contradictory data, this information provides sufficient justification to remove Cr from Maryland's 303(d) list as an impairing substance in the Inner Harbor/Northwest Branch and Bear Creek. The segments will continue to be listed for biological impacts due to sediment toxicity based on the data collected in the WQA effort. To address the toxicity impairment, MDE will begin the process of developing a field study to identify the substance or substances that are causing the sediment toxicity observed in these segments and to address the potential that sediment ingestion could be a route of exposure not fully accounted for by these procedures.

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APPENDIX I:

Water Quality Analyses for Lead in the Inner Harbor/Northwest Branch and Zinc in the Inner Harbor/Northwest Branch and Bear Creek Portions of Baltimore Harbor in Baltimore City and Baltimore County, Maryland

Final

Water Quality Analyses for Lead in the Inner Harbor/Northwest Branch and Zinc in the Inner Harbor/Northwest Branch and Bear Creek Portions of Baltimore Harbor in Baltimore City and Baltimore County, Maryland

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List of Abbreviations

ANOVA	Analysis of Variance
AVS	Acid Volatile Sulfides
AVS-SEM	Acid Volatile Sulfides – Simultaneously Extracted Metals
BSM	Baltimore Sediment Mapping Study
CBL	Chesapeake Biological Laboratory
COMAR	Code of Maryland Regulations
Cr	Chromium
CWA	Clean Water Act
EPA	Environmental Protection Agency
ERM	Effects Range Median
ERM-Q	Effects Range Median Quotient
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
mg/kg DW	Milligram/kilogram Dry Weight Basis
Pb	Lead
PCB	Polychlorinated Biphenyls
TMDL	Total Maximum Daily Load
µg/L	Micrograms per Liter
µmole/g	Micromoles per gram
WQA	Water Quality Analysis
WQLS	Water Quality Limited Segment
Zn	Zinc

EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the 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. For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

The Baltimore Harbor, with its watershed located in Baltimore City and parts of Baltimore, Howard, Anne Arundel, and Carroll Counties was identified on the 1996 303(d) list as impaired by toxic substances, nutrients, and suspended sediments. In 1998, the impairment listings were refined to include specific impairing substances and increased spatial resolution based on an analysis of bulk sediment contaminant concentrations compared to non-regulatory screening values. As a result, the Inner Harbor/Northwest Branch (basin code 02-13-09-03) was listed for fecal coliform, chromium (Cr), zinc (Zn), lead (Pb), and polychlorinated biphenyls (PCBs). In 2002 it was listed for biological community impacts. Bear Creek, a tributary to Baltimore Harbor (basin code 02-13-09-03) located in Baltimore County, was included in the 1996 303(d) listing for the Baltimore Harbor. However, in 1998 the increased spatial resolution led to Bear Creek being identified as impaired specifically for the substances Cr, Zn, and PCBs.

This report provides analyses of the data used to determine the Inner Harbor/Northwest Branch and Bear Creek Zn impairment listings and Inner Harbor/Northwest Branch Pb impairment listing. It also includes recently collected data that indicates that although sediment toxicity is present in the Inner Harbor/Northwest Branch and Bear Creek, the source of the toxicity cannot be attributed to Zn and Pb. As a result, the analyses support the conclusion that TMDLs for Zn and Pb are not currently necessary. However, the segments will remain listed as impaired for biological community impacts due to sediment toxicity pending a field study scheduled to begin in September 2004 and be completed by December 2005. The goal of the study is to identify the substance or substances that are causing the sediment toxicity observed in these segments and to address the potential that sediment ingestion could be a route of exposure not fully accounted for by these procedures.

Barring the receipt of any contradictory data, this report will be used to support the removal of Zn and Pb as impairing substances in the Inner Harbor/Northwest Branch and Bear Creek on Maryland's list of WQLSs when the Maryland Department of the Environment (MDE) proposes the revision of Maryland's 303(d) list for public review in the future. The nutrients and Cr impairments are currently being addressed under separate analyses; the suspended sediments, biological community, fecal coliform, and PCB impairments will be addressed at a future date.

Although the waters of the Inner Harbor/Northwest Branch and Bear Creek do not currently display signs of toxicity due to Zn and Pb, the State reserves the right to reassess the impact(s) of Zn and Pb on the environment due to future changes in Baltimore Harbor water quality, including, but not limited to the improvement of dissolved oxygen levels due to a reduction in

nutrients. Furthermore, the State reserves the right to require additional pollutant controls in the Inner Harbor/Northwest Branch and Bear Creek if evidence suggests that Zn or Pb from either basin is contributing to water quality problems within Baltimore Harbor.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and 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. 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) of 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 the criteria; 3) refinements to water quality criteria, or the interpretation of those standards, which result in criteria being met; or 4) correction to errors made in the initial listing.

The Baltimore Harbor, with its watershed located in Baltimore City and parts of Baltimore, Howard, Anne Arundel, and Carroll Counties was identified on the 1996 303(d) list as impaired by toxic substances, nutrients, and suspended sediments. In 1998, the impairment listings were refined to include specific impairing substances and increased spatial resolution. As a result, the Inner Harbor/Northwest Branch (basin code 02-13-09-03) was listed for fecal coliform, chromium (Cr), zinc (Zn), lead (Pb), and polychlorinated biphenyls (PCBs). In 2002 it was listed for biological community impacts. Bear Creek, a tributary to Baltimore Harbor, (basin code 02-13-09-03) located in Baltimore County, was included in the 1996 303(d) listing for the Baltimore Harbor. However, in 1998 the increased spatial resolution led to Bear Creek being identified as impaired specifically for the substances Cr, Zn, and PCBs.

The 1998 impairment listings for Zn and Pb were based on the bulk sediment concentrations of Zn and Pb, acute sediment toxicity, and benthic integrity data generated during the Baltimore Harbor Sediment Mapping Study (BSM). The data collected during the BSM revealed high levels of toxic metals (including Zn and Pb), and organic compounds in both the Inner Harbor/Northwest Branch and Bear Creek. Additionally, the BSM toxicity test results indicated elevated levels of toxicity associated with the sediments in these regions. Since toxicity to aquatic life (*Leptocheirus plumulosus*) was evident, and no water quality criteria for toxic contaminants in sediment were available, the sediment concentrations were evaluated against the Effects Range Median (ERM) concentration; a commonly used sediment quality benchmark (Long *et al.*, 1995; MacDonald *et al.*, 1996). The ERM guidelines are based on data from 89 reports that contain simultaneous measures of sediment toxicity and chemistry. The ERM designates the sediment contaminant level at which half [50th percentile] of the studies reported harmful effects. As a result of these analyses, the Maryland Department of the Environment (MDE) concluded that Zn in the Inner Harbor/Northwest Branch and Bear Creek and Pb in the

Inner Harbor/Northwest Branch were to be considered impairing substances due to the frequency and magnitude of the exceedance of the ERM, as well as the observed sediment toxicity.

However, during discussions with the Baltimore Harbor TMDL Stakeholder Advisory Group stakeholders raised questions regarding the MDE's water quality endpoints. The questions were focused on the appropriateness of an ERM based endpoint because ERM values are screening values and the authors of the ERM endpoints explicitly warned that they should not be used for regulatory purposes. The justification for the development of this endpoint was the lack of EPA promulgated water quality criteria for toxics present in sediment. The MDE's endpoints were based on sediment concentrations of Zn and Pb; the endpoint for each constituent was set at an ERM-Quotient (ERM-Q) value of 0.5. The ERM-Q is an evaluation method used to develop a spatial average of a specific contaminant within a given region based on several sample sites and data points (MDE, 2002).

Based on the issues raised by stakeholders, the initial listings for Zn and Pb were brought into question because; 1) the original listings were based on Zn and Pb sediment concentrations evaluated against the ERM guideline value, 2) the current aquatic life water quality criteria for Zn and Pb are based on dissolved water column concentrations, and 3) the ERMs do not account for mitigating factors such as acid volatile sulfides (AVS) that precipitates metals into compounds that render them biologically unavailable. AVS is very high in Inner Harbor/Northwest Branch and Bear Creek sediments.

The water quality analyses (WQA) for Zn in the Inner Harbor/Northwest Branch and Bear Creek and Pb in the Inner Harbor/Northwest Branch was conducted using more recent water column, porewater, and sediment concentration data. The data collected includes dissolved Zn and Pb concentrations in the water column and porewater matrices. The results indicate that the porewater concentrations of Zn do not exceed the water column saltwater aquatic life criterion (chronic) of 81μg/L in Bear Creek and the water column freshwater aquatic life criterion (chronic) of 120μg/L in the Inner Harbor/Northwest Branch (Code of Maryland Regulations (COMAR) 26.08.02.03-2G) (See Table 5 and 6). The results also indicate that porewater concentrations of Pb do not exceed the water column chronic freshwater aquatic life criterion of 2.5μg/L in the Inner Harbor/Northwest Branch (COMAR 26.08.02.03-2G) (See Table 5). The nutrients and Cr impairments are currently being addressed under separate analyses whereas, the suspended sediments, biological community, fecal coliform, and PCB impairments will be addressed at a future date.

Barring contradictory data, this report will be used to support the removal of Zn as an impairing substance in the Inner Harbor/Northwest Branch and Bear Creek and Pb as an impairing substance in the Inner Harbor/Northwest Branch on Maryland's list of WQLSs when MDE proposes the revision of Maryland's 303(d) list for public review in the future. However, the segments will remain listed as impaired for biological community impacts due to sediment toxicity. In addition, MDE is funding a "stressor identification" study to determine which substances, including some not previously analyzed, may be causing the sediment toxicity. The remainder of this report presents the general setting of the waterbody and presents a discussion and conclusions relative to the water quality characterization process.

2.0 GENERAL SETTING

The Inner Harbor/Northwest Branch and the Bear Creek watersheds are located in the Patapsco/Back River region of the Chesapeake Bay watershed within Maryland (see Figure 1). The Inner Harbor/Northwest Branch watershed is within Baltimore City and has a drainage area of 42,000 acres consisting of the Jones Falls watershed and two subwatersheds that drain directly into the Inner Harbor/Northwest Branch. The land use profile in this watershed include forest and other herbaceous (6,648 acres or 16%), mixed agriculture (3,400 acres or 8%), and urban (31,561 acres or 76%). The water surface area is 164 acres (<1%). Table 1 highlights the land use within the Inner Harbor/Northwest Branch watershed.

Bear Creek, located within Baltimore County, is a highly urbanized tidal creek in the Baltimore Harbor watershed that drains an area of approximately 5,900 acres. The land use in this watershed consists of forest and other vegetation (400 acres or 7%), and urban (5,300 acres or 91%). The water surface area is 100 acres (2%). Table 1 highlights the land use within the Bear Creek watershed.

Table 1: Land Use Composition of the Inner Harbor/Northwest Branch and Bear Creek

Region	Forest/Herbaceous	Mixed Agriculture	Urban	Water
Inner Harbor/Northwest Branch	16%	8%	76%	<1%
Bear Creek	7%	0%	91%	2%

The Baltimore Harbor watershed, including the Inner Harbor/Northwest Branch and Bear Creek, lies within the Piedmont and Coastal Plain of Central Maryland. The surficial rocks of the Piedmont have formed from the decomposition of various sedimentary, metamorphic, and igneous parent materials. Underlying parent material consists of schist, limestone, marble and gneiss. Exposed igneous rocks such as gneiss and Baltimore gabro typify the stream valleys along the fall line between the Piedmont and Coastal Plain. 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 southeast and eventually extend beneath the younger sediments of the Coastal Plain. The fall line represents the transition between the Coastal Plain and the Piedmont. The Coastal Plain surficial geology is characterized by unconsolidated marine and riverine sediments deposited over the crystalline rock of the piedmont (Coastal Environmental Services, 1995).

A summary of land use for the Inner Harbor/Northwest Branch and Bear Creek watersheds are given in Figures 2 and 3, respectively. Based on the 1997 land use assessment developed by the Maryland Department of Planning (MDP), MDE aggregated the 22 land uses identified in the Baltimore Harbor watershed down to 10 land uses for modeling purposes. Using these 10 land use categories MDE classified the land uses Commercial/Industrial, High, Medium and Low Density Residential as urban land uses. These urban categories represent 76 % of the Inner Harbor/Northwest Branch and 91% of the Bear Creek watershed, respectively.

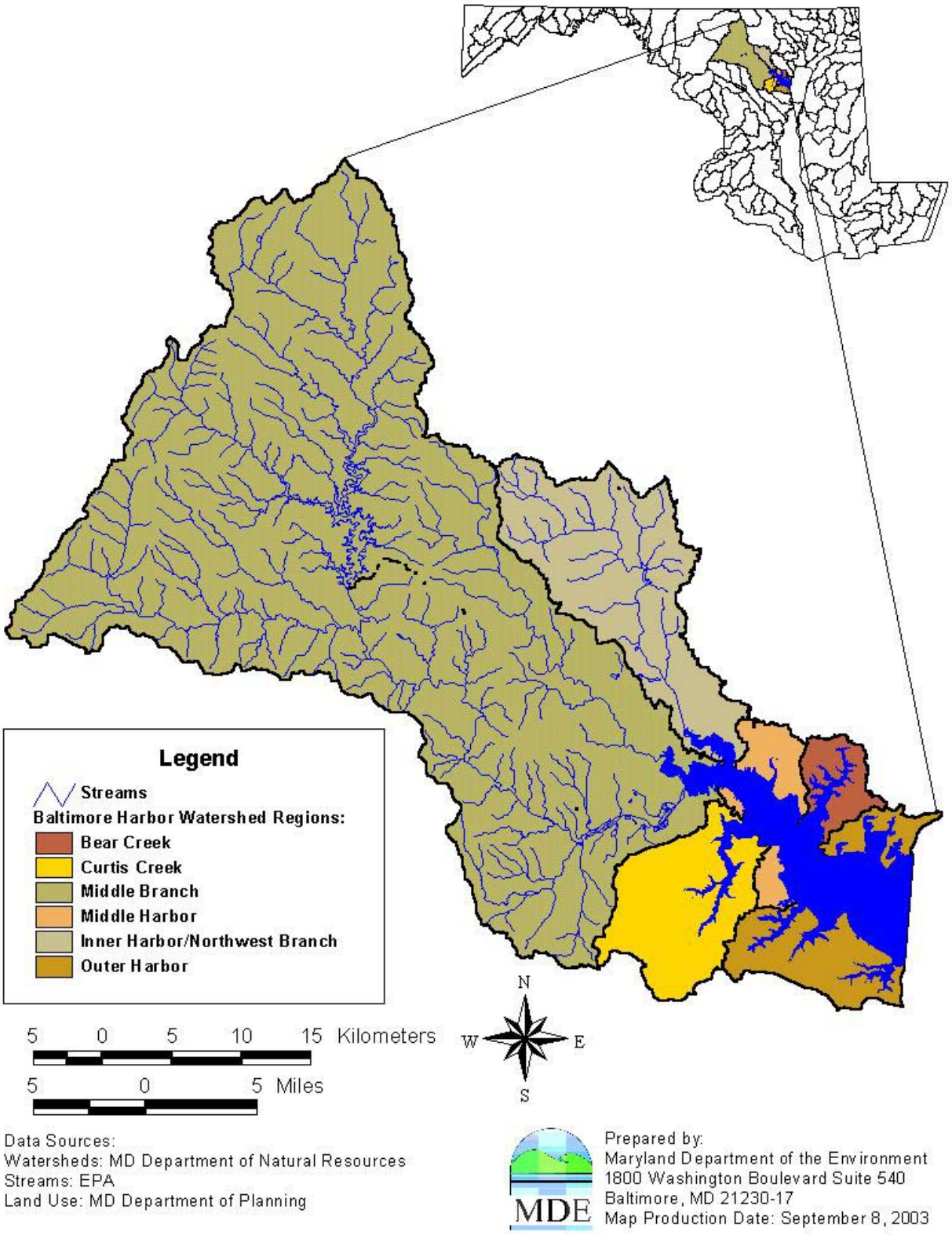

Figure 1: Watershed Map of the Baltimore Harbor

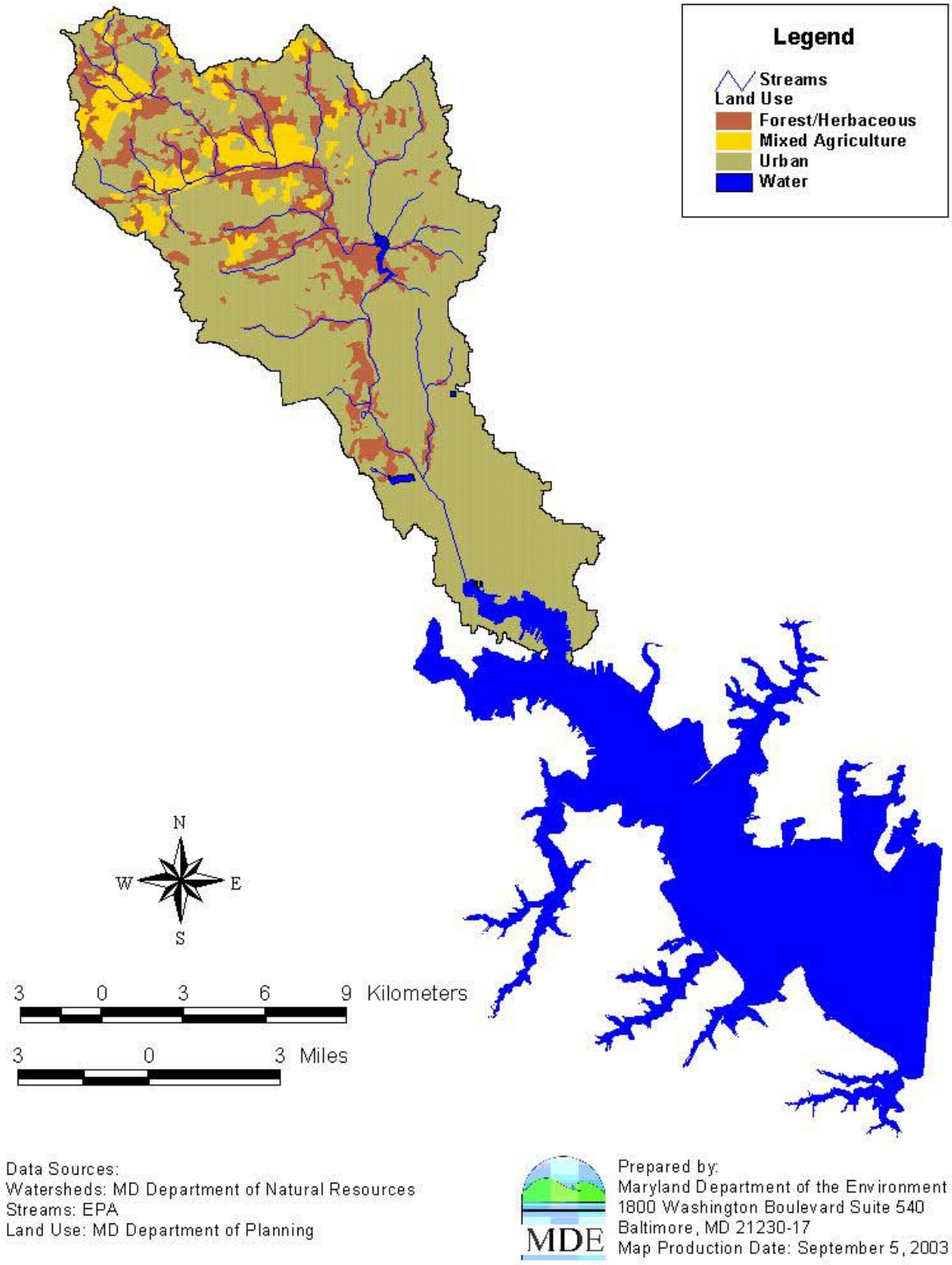

Figure 2: Land Use Map of the Inner Harbor/Northwest Branch Watershed

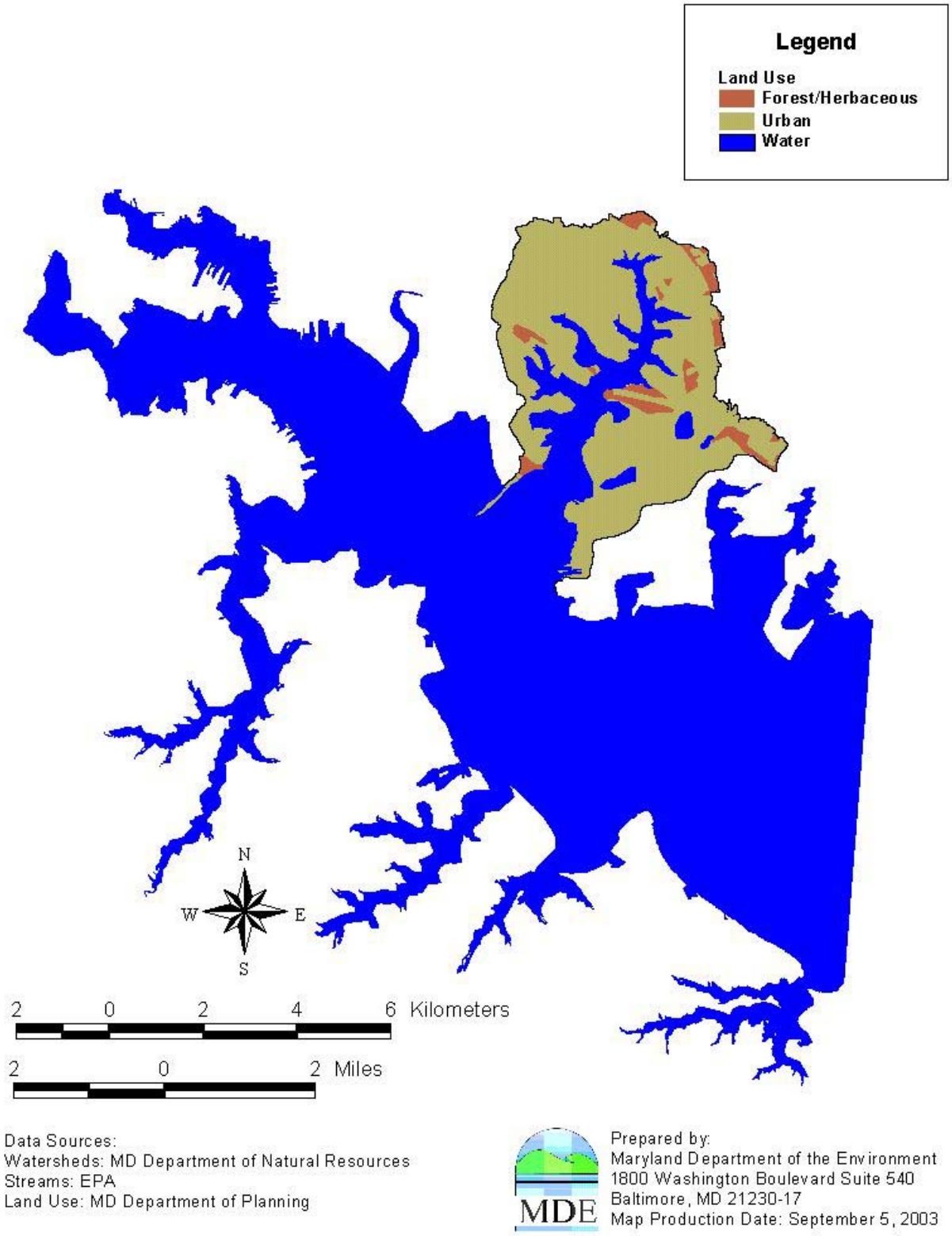

Figure 3: Land Use Map of the Bear Creek Watershed

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 the designated use may differ and are dependent upon the specific designated use(s) of a waterbody. Maryland's water quality standards presently include numeric criteria for Zn and Pb in the water column based on the need to protect aquatic life, wildlife and human health. An interpretation of the narrative water quality standards exists for toxic substances to address sediment quality and ensure the surficial bottom sediments of a waterbody are capable of supporting aquatic life, thus protecting the designated uses.

The Maryland Surface Water Use Designation COMAR 26.08.02.08J for the Baltimore Harbor and its tributaries (including the Inner Harbor/Northwest Branch and Bear Creek) is Use I – water contact recreation, fishing, and protection of aquatic life and wildlife. The applicable numeric water quality criteria, based on chronic toxicity, for Zn is 81μg/L in saltwater and 120μg/L in freshwater. The applicable numeric water quality criteria, based on chronic toxicity, for Pb is 2.5μg/L in freshwater (COMAR 26.08.02.03-2G). The Inner Harbor/Northwest Branch segment is defined in COMAR 26.08.02.03-1B as freshwater. To assess if the segments are impaired the porewater data will be evaluated against the water column water quality criterion.

A water column and sediment survey was conducted at stations 68, 69, 70,71, and 73 in the Inner Harbor/Northwest Branch and stations 28, 29, 30, 31, 32 in Bear Creek in August 2003 (see Figure 4 and Tables 2 and 3). The data from this sampling effort will support this WQA. For each sample, concentrations were determined for: 1) dissolved Zn and Pb in the water column (1 meter from the bottom); 2) dissolved Zn and Pb in the surficial sediment porewater; 3) Zn and Pb chemistry, acid volatile sulfide – simultaneously extracted metals (AVS-SEM), and sulfides in surficial (< 2cm in depth) sediment; and 4) chronic toxicity bioassays (28-day L. plumulosus) on surficial sediment. The water column and surficial sediment porewater data presented in Section 3.1, Table 5 and Table 6, indicates that concentrations of Zn and Pb do not exceed quality criteria in either the water column or the surficial sediment porewater.

The sediment data is presented in Section 3.2, Tables 7 – 9, indicate that high sediment concentrations of Zn and Pb remain present in the surface sediments. However, utilized a molar-based analysis of the metals to account for the varying molecular weights of the compounds, the data indicates that the amount of sulfides present in the sediments is well above the amount necessary to reduce all divalent metals, including the Zn and Pb, into metallic sulfide compounds that render them non-bioavailable.

The ambient sediment bioassay data is presented in Section 3.3, Tables 10 and 11, indicate that toxicity occurs at 9 of the 10 Inner Harbor/Northwest Branch and Bear Creek stations sampled (Fisher, 2004). However, due to the presence of many contaminants at elevated levels in the sediment and porewater concentrations of Zn and Pb that do not exceed the applicable water quality standard, MDE is unable to assign the cause of toxicity to either metal.

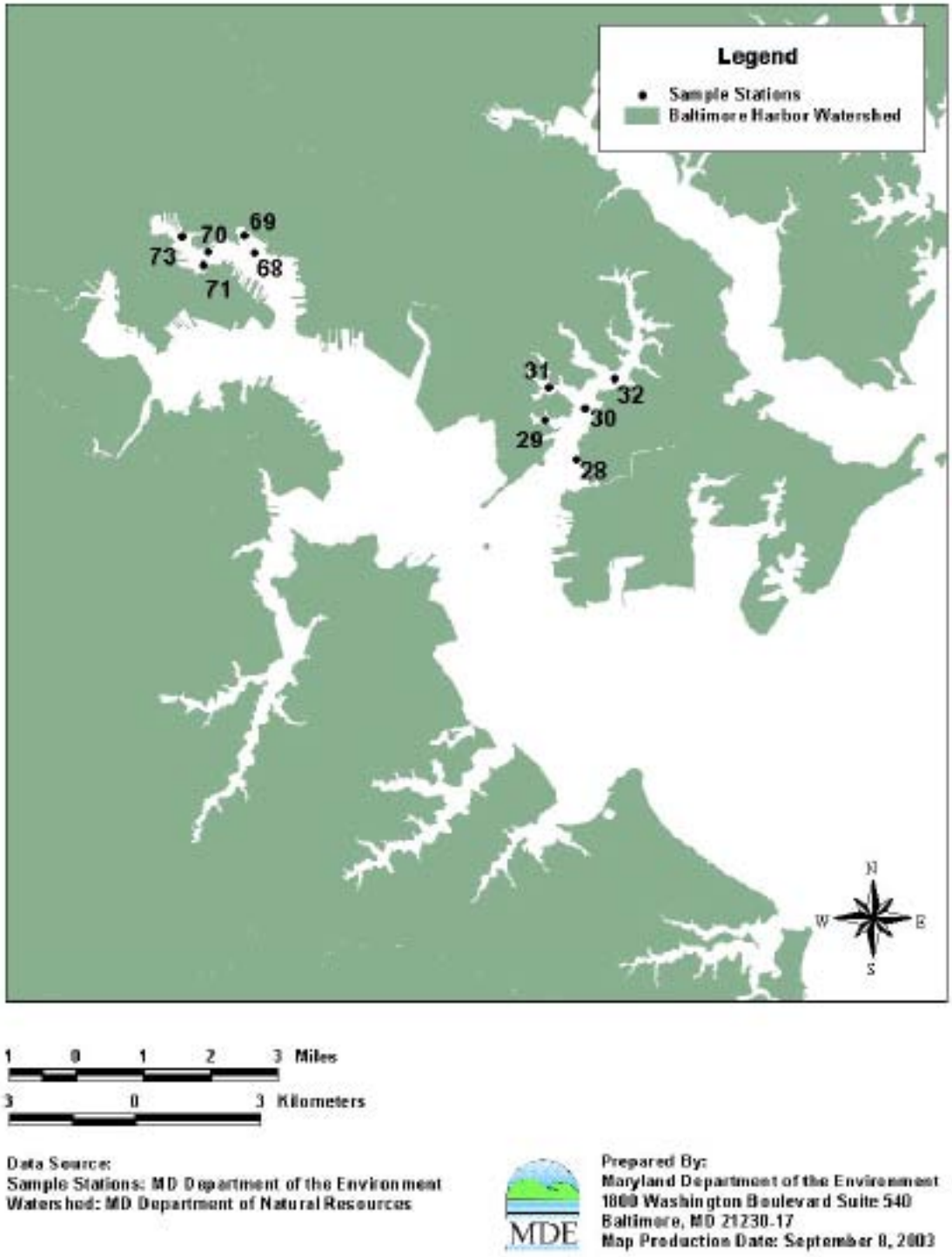

Figure 4: Northwest Branch/Inner Harbor and Bear Creek Sampling Locations

3.1 WATER COLUMN EVALUATION

To evaluate the water quality of the Inner Harbor/Northwest Branch and Bear Creek, MDE evaluated the porewater concentrations of Zn and Pb against the aquatic life chronic criteria for each contaminant in the water column. The samples collected for these analyses were taken from stations established during the 1996 BSM. Table 2 and Table 3 contain the station identifications, geographical coordinates, and descriptive locations of the stations in the Inner Harbor/Northwest Branch and Bear Creek, respectively.

Table 2: Water Quality Analysis Stations for the Inner Harbor/Northwest Branch

Station ID	GPS Coordinates	Station Description
BSM 68	39.278 76.583	Southeast of Fells Pt.
BSM 69	39.282 76.586	Southeast of Fells Pt.
BSM 70	39.278 76.596	South of former chromium refinery
BSM 71	39.275 76.598	Across channel from former chromium refinery
BSM73	39.283 76.609	Head of Inner Harbor

Table 3: Water Quality Analysis Stations for Bear Creek

Station ID	GPS Coordinates	Station Description
BSM 28	39.233 76.495	Mouth of Bear Creek near International Steel
BSM 29	39.242 76.503	Cove Northwest of Route 695 bridge
BSM 30	39.244 76.492	Mid Creek adjacent to railroad bridge
BSM 31	39.248 76.502	Head of small tributary entering Creek at railroad bridge
BSM32	39.250 76.484	Head of Bear Creek/South of Wise Ave. bridge

Water column and porewater samples were collected in August 2003 by the University of Maryland, Chesapeake Biological Laboratory (CBL) and shipped to Frontier Geosciences in Seattle, WA for extraction and analysis. The porewater was separated from the surficial sediments by centrifugation, filtered to remove particulate matter and analyzed. The filtrate was analyzed for Zn and Pb in the dissolved phase using a standard metals analysis. The values were assessed against the water quality criteria to determine if a violation of the water quality standard

occurred. The Zn and Pb data from the water column and porewater analysis are presented in Table 5 and Table 6. The detection limits for the Zn and Pb analysis are displayed in Table 4.

Table 4: Zinc and Pb Analysis Detection Limits

Analyte	Detection Limit
Zn Water Column	0.08 µg/L
Zn Sediment	1.0 mg/kg
Pb Water Column	0.05 µg/L
Pb Sediment	0.30 mg/kg

Table 5: Inner Harbor/Northwest Branch Dissolved Zn and Pb Water Column and Porewater Data

Station	**Water Column**		**Porewater**	
	Zn	**Pb**	**Zn**	**Pb**
	µg/L		**µg/L**	
BSM68	20.8	0.05	1.9	0.80
BSM69	24.0	0.13	4.9	1.18
BSM70	23.6	<0.05	2.1	1.58
BSM71	29.7	0.11	1.9	1.47
BSM73	20.0	<0.05	3.7	0.99

Chronic water quality criteria for freshwater for Zn is = 120µg/L and Pb is 2.5µg/L

Table 6: Bear Creek Dissolved Zn Water Column and Porewater Data

Station	**Water Column**	**Porewater**
	Zn	
	µg/L	
BSM28	2.25	1.77
BSM29	5.89	1.20*
BSM30	11.90	1.56
BSM31	8.63	1.54
BSM32	8.69*	1.10

Chronic water quality criteria for saltwater for Zn is = 81µg/L
*Value is average of duplicate samples

3.2 SEDIMENT CHEMISTRY EVALUATION

To evaluate the sediment conditions, bulk surficial (top 2 cm) sediment samples were collected by CBL in the Inner Harbor/Northwest Branch and Bear Creek using a petite ponar dredge. The sediment stations correspond to the monitoring stations sampled in the BSM and the water column survey described in the above sections. Refer to Table 1 and Table 2 for station locations. The samples collected were analyzed for Zn and Pb, AVS/SEM, and sulfides. The results of the analysis are presented in Tables 7, 8, and 9.

Table 7: Inner Harbor/Northwest Branch Sediment Data*

Station	Total Zn	AVS/SEM Zn	AVS/SEM Divalent Metals Cu, Cd, Zn, Pb	AVS	Excess Sulfides
	mg/kg DW**	µmole/g	µmole/g	µmole/g	µmole/g
BSM68	661	6.41	7.46	78.75	71.29
BSM69	704	6.64	7.91	359.38	351.47
BSM70	790	6.46	7.59	173.44	165.85
BSM71	970	9.10	10.78	196.88	186.10
BSM73	618	5.95	7.13	236.25	229.12

*The analysis is presented on a molar basis to account for the various molecular weights of the analytes.
**DW = Dry Weight

Table 8: Inner Harbor/Northwest Branch Sediment Data*

Station	Total Pb	AVS/SEM Pb	AVS/SEM Divalent Metals Cu, Cd, Zn, Pb	AVS	Excess Sulfides
	mg/kg DW**	µmole/g	µmole/g	µmole/g	µmole/g
BSM68	298	1.01	7.46	78.75	71.29
BSM69	352	1.22	7.91	359.38	351.47
BSM70	394	1.10	7.59	173.44	165.85
BSM71	470	1.63	10.78	196.88	186.10
BSM73	312	1.14	7.13	236.25	229.12

*The analysis is presented on a molar basis to account for the various molecular weights of the analytes.
**DW = Dry Weight

Table 9: Bear Creek Sediment Data*

Station	Zn	AVS/SEM Zn	AVS/SEM Divalent Metals Cu, Cd, Zn, Pb	AVS	Excess Sulfides
	mg/kg DW**	μmole/g	μmole/g	μmole/g	μmole/g
BSM28	1,530	17.13	19.42	144.06	124.64
BSM29***	1,930	16.16	21.29	304.06	282.77
BSM30	1,870	27.82	31.58	340.63	309.05
BSM31	2,230	17.89	19.14	500.00	480.86
BSM32	1,490	17.74	19.78	375.00	355.22

*The analysis is presented on a molar basis to account for the various molecular weights of the analytes.
**DW = Dry Weight
***Results are an average of duplicate samples

Baltimore Harbor sediments are acted upon by chemical reactions that result in the Zn and Pb being sequestered into non-reactive forms. In the low dissolved oxygen environment found in the Harbor high levels of sulfides have accumulated in the sediments. Recent EPA studies indicate that sulfide compound reactions dominate the sediment chemistry reactions of cationic metals such as Zn and Pb (Boothman et. al., 2000 and Berry et. al., 2002). Based on this information, the data presented in Tables 7-9 were assessed using a molar analysis to determine the molecular balance of compounds found within the sediments. The data presented indicate that the levels of AVS present within the sediment are well above those needed to fully react with Zn, Pb, and other divalent metals. As a result, the high concentrations of total Zn and Pb found within the sediments do not correspond to the reactive amounts available to partition to the water column or that may be biologically available.

3.3 SEDIMENT TOXICITY EVALUATION

To complete the WQA, sediment quality in the Inner Harbor/Northwest Branch and Bear Creek was evaluated using a 28-day chronic growth and survival whole sediment test with the marine amphipod *L. plumulosus.* 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 estuarine or marine sediments (EPA, 2001). Surficial (top 2 cm) sediment samples were collected by CBL in the Inner Harbor/Northwest Branch and Bear Creek using a petite ponar dredge. The sediment stations correspond to the monitoring stations sampled in the BSM and the water column survey described in the above sections. Refer to Table 1 and Table 2 for station locations. Sediment toxicity test results are presented in Table 10 and Table 11.

Table 10: Inner Harbor/Northwest Branch Sediment Toxicity Data

Station	Percent Survival	Growth mg/ind/d[1]	Reproduction Neonates/Individual
Control	88	0.065	4.94
BSM68*	61	0.039	0.47
BSM69*	35	0.044	0.18
BSM70*	9.4	0.032	0.00
BSM71*	3	0.021	0.30
BSM73*	55	0.054	0.94

[1]Growth rate equals milligram/individual/day
*Significant observed toxicity

Table 11: Bear Creek Sediment Toxicity Data

Station	Percent Survival	Growth mg/ind/d[1]	Reproduction Neonates/Individual
Control	87	0.068	4.34
BSM28*	0	0	0.00
BSM29*	72	0.063	3.26
BSM30*	2	0.014	0.00
BSM31	80	0.049	1.45
BSM32*	61	0.050	1.90

[1]Growth rate equals milligram/individual/day
*Significant observed toxicity

The endpoints for the 28-day test were survival, growth rate (mg dry weight/individual/day) and reproduction (neonates/survivor). Data were analyzed in accordance with procedures outlined in the EPA 2001 method (EPA, 2001). Survival data were arcsine square-root transformed prior to analysis. The survival data were then assessed for normality and homogeneity of variance using the Chi-Square Test and Bartlett's Test, respectively ($\alpha = 0.05$). All transformed survival data were normal and homogeneous. The survival data were then analyzed via Analysis of Variance (ANOVA) followed by comparisons between test sediment amphipod survival and the control amphipod survival using a Dunnett's Test ($\alpha = 0.05$).

All of the sediments from the sites tested showed significant reductions in test endpoints. BSM sites 28, 29, 30, 32, 68, 69, 70, 71, and 73 showed reduced survival of *L. plumulosus* (Tables 10 and 11). The most significant effects were seen at BSM 28 (0% survival), BSM 30 (2% survival), BSM 70 (9.4% survival), and BSM 71 (3.0% survival). Statistical analyses of sublethal endpoints were conducted only on treatments not exhibiting significant effects on survival after 28 days. Since only one site, BSM 31, did not have a reduction in survival, a two-sample t-Test ($\alpha = 0.05$) was used to compare growth rate and reproduction at BSM 31 with the control endpoints for that suite of sample sites. Although there was not a reduction in growth

rate at this site, amphipods from this station showed a significant reduction in reproduction (1.45 neonates per survivor versus 4.34 neonates per survivor in the control).

4.0 CONCLUSION

The data presented in support of the WQA indicate that porewater and water column concentrations of Zn in the Inner Harbor/Northwest Branch and Bear Creek, and Pb in the Inner Harbor/Northwest Branch do not exceed water quality standards. The toxicity data indicates mortality was found in the Inner Harbor/Northwest Branch and Bear Creek sediments. However, sediment data collected for AVS/SEM metals plus sulfides indicate that in situ environmental conditions (i.e., low dissolved oxygen, high BOD) have produced high sulfide concentrations within the sediments. The sulfide levels are well in excess of what is needed to sequester Zn and Pb into metallic sulfide compounds that render them unavailable to partition into the porewater in quantities that violate water quality standards. This relationship indicates the probability that neither Zn nor Pb are bioavailable for sediment dwelling organisms and cannot be determined as the specific cause of the observed toxicity.

Therefore, barring any contradictory data, this information provides sufficient justification to remove Zn and Pb from Maryland's 303(d) list as impairing substances in the Inner Harbor/Northwest Branch and Bear Creek. The segments will continue to be listed for toxicity based on the data collected in the WQA effort. To address the sediment toxicity impairment, MDE is conducting a field study scheduled to begin in September 2004 and be completed by December 2005. The goal of the study is to identify the substance or substances that are causing the sediment toxicity observed in these segments and to address the potential that sediment ingestion could be a route of exposure not fully accounted for by these procedures. Information on the study can be attained from MDE upon request by contacting the TMDL outreach staff at 410-537-3902. Once the study is completed MDE will utilize the information to begin developing TMDLs for the compound or compounds identified as causes of toxicity.

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