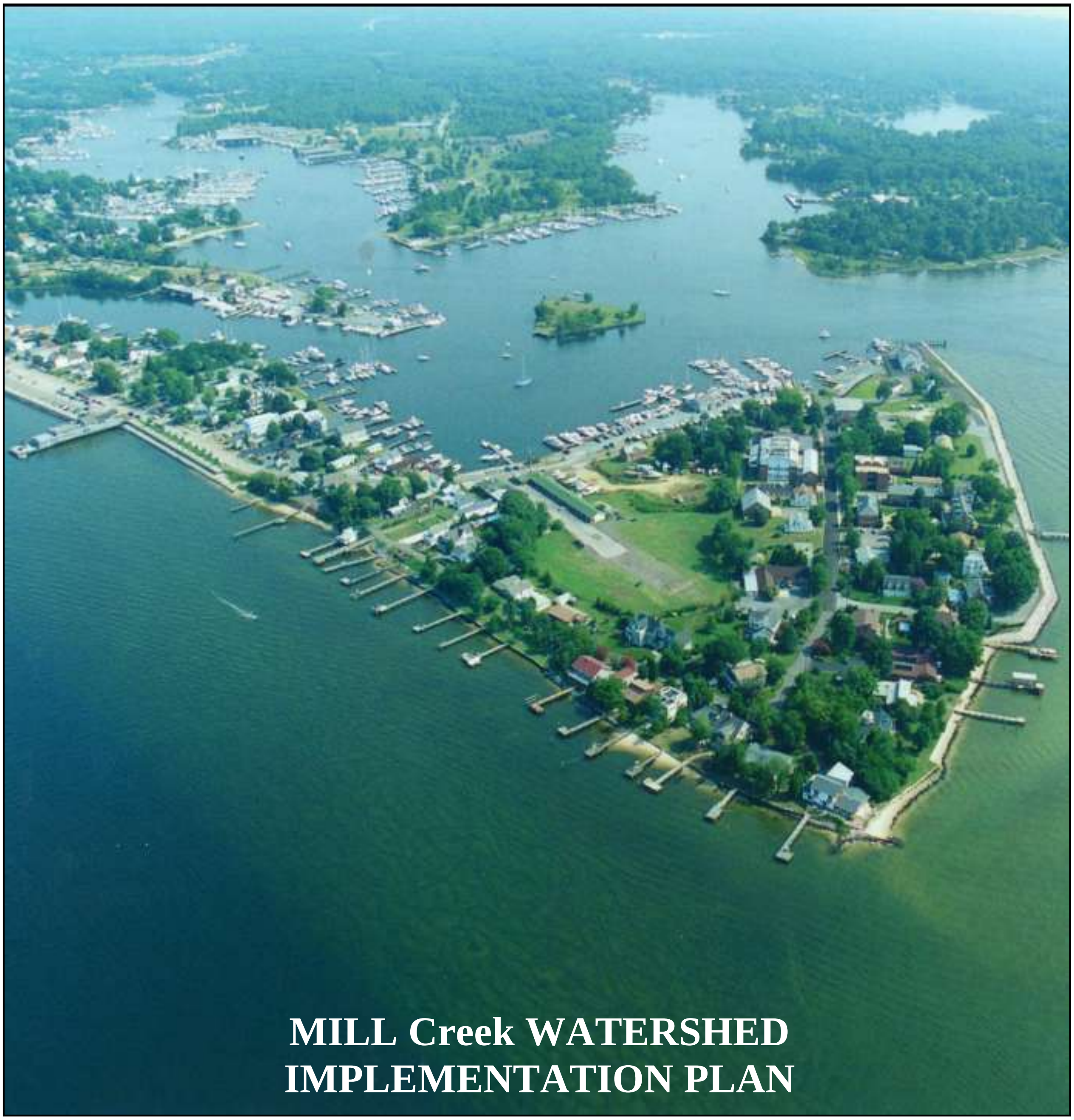

MILL Creek WATERSHED IMPLEMENTATION PLAN

Draft Plan May 2011

Calvert County Department of Planning & Zoning
County Services Plaza
150 Main Street
Prince Frederick, MD 20678

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List of Acronyms

To be completed for final draft.

1 Introduction

The Mill Creek watershed, while highly developed and urban, remains a scenic system of waterways that serves as an integral part of both the ecosystem and the community. Streams, creeks, and marshes provide both habitat for wildlife and recreational and commercial opportunities for the neighborhoods of Dowell, Drum Point, Lusby, Olivet and Solomons. The availability of rich natural resources is a central part of what makes this southern portion of Calvert County an attractive place to live and visit.

The population in the area has grown rapidly during the past few decades, as have the pressures the community has placed upon the watershed. Absent management of these pressures, the watershed may not remain capable of supporting either wildlife or human needs. The watershed must be managed to safeguard its vitality for future generations.

Preventing further degradation and restoring damaged resources will require effective environmental education, environmentally sound development, and environmental protections of sensitive areas. Central to success is the development of strategies and working plans to achieve water resource goals. Such watershed planning provides numerous benefits to the community. Table 1.1, from the Maryland Department of Natural Resources (DNR) *A User's Guide to Watershed Planning in Maryland*, outlines some of these benefits.

By analyzing the Mill Creek watershed's natural resources, measuring impacts upon water quality, and coordinating with citizens, local organizations, and governmental agencies, this Plan will serve to guide the management and protection of the natural resources in the watershed. The remainder of this section outlines the relation of the Watershed Implementation Plan (WIP) to the Calvert County Comprehensive Plan and the process through which the Plan was developed.

Table 1.1 Benefits of Watershed Planning

Local Government Benefits	*Administrative Benefits*
• Enables analyses that are most meaningful at a watershed or subwatershed scale (e.g. nutrient loadings, impervious cover estimate, etc.) • Enables management at a scale necessary to ensure consistency with TMDLs • Provides a framework for prioritizing resources (staff, conservation dollars, etc.) • Provides opportunities for citizens to understand how natural resources management interacts with existing and future development • Gives citizens an active voice in protecting and restoring important community natural resources	• Provides a structure for communities to target geographic areas for land conservation and development to maximize the efficiency of community planning efforts • Enables more efficient management of permitting programs • Focuses data collection and analysis for environmental assessments • Provides benchmarks for measuring the success of management efforts
Environmental Benefits	*Financial Benefits*
• Improves quality of water for drinking and recreational use • Enhances water supply • Protects wildlife habitat and improves natural resources • Controls flooding by restoring riparian and wetland areas	• Avoids development in sensitive areas and can help minimize compliance and mitigation costs • Improves water supply protection to reduce the need for costly drinking water treatment • Provides a framework and rationale to pursue various funding opportunities • Avoids costly restoration projects through prevention and planning.

Source: DNR, 2005

1.1 The Calvert County Comprehensive Plan

The Calvert County Comprehensive Plan (CCCP) is the County's official policy document. In 2010, the Calvert County Board of Commissioners amended the CCCP. Among the amendments was the addition of a Water Resources Element (WRE), required in all state jurisdictions with the passage of HB 1141 (Chapter 381) by the Maryland General Assembly in 2006 (Department of Legislative Services, 2006). The elements are to include provisions on potable water, wastewater, and stormwater, with a primary purpose of addressing the decline of water quality in the Chesapeake Bay watershed.

The CCCP Water Resources Element establishes the following objectives with concern to water resources:

- Encourage preservation, protection, and conservation of natural resources.
- Establish a comprehensive approach to environmental planning with special emphasis on watershed planning.
- Protect environmental features that will help ensure continuance of a healthy and pleasant place to live for current residents and future generations.
- Protect environmentally sensitive areas (wetlands, floodplains, wetland and water way buffers, steep slopes) from development impacts to provide:
    - Sufficient habitat to maintain our current diversity of fauna and flora
    - Protection of habitat and individuals of rare, threatened, or endangered species
    - Nutrient removal
    - Flood control.
- Preserve stream valleys to maintain their important natural functions and to provide greenways throughout the County.
- Practice community planning and site design that conserves energy, protects natural resources, and minimizes impacts on the landscape.
- Encourage restoration of lost and/or damaged natural environmental features.
- Foster greater public awareness, education, and support of environmental concerns.
- Develop an implementation plan to accommodate growth in Priority Funding Areas while reducing nutrient loads in waterways to targeted levels.
- Ensure sufficient water supply and water/sewer treatment capacity to serve future growth in Calvert County.
- Protect the quality and quantity of groundwater aquifers.

The Element details actions to fulfill these objectives. Action I-133 calls for the preparation of watershed plans for all 22 subwatersheds, "including the actions and capital improvements necessary to implement the plans". This Plan fulfills the requirement for the Mill Creek Watershed and will serve to guide the County in management and protection of the natural resources in the watershed.

1.2 Plan Process

In March 2008, the United States Environmental Protection Agency released the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* as a guide for organizations developing and implementing watershed management plans. The planning process for this WIP was organized around the following steps as recommended in the Handbook.

A. Build partnerships

The County has identified a team of stakeholders and scheduled a first watershed planning meeting. Letters were sent out to over 150 property owners, business owners, and local organizations. Twenty-eight attended the kickoff meeting.

B. Characterize the watershed to identify problems.

The County has used extensive data sources and GIS mapping to characterize the watershed. Data has been collected from stormwater management plans, recorded plots, aerial photography and topography, electronic soil maps, permit data, and water testing data.

C. Set goals and identify solutions

Goals and solutions will be developed after soliciting comments from stakeholders.

D. Design an implementation program

To be completed after goals and solutions are drafted.

E. Implement the watershed plan

The County has a variety of tools it can use to implement a plan including applying for grants, implementing capital projects, amending regulations, negotiating development agreements, monitoring conditions, and enforcing violations. The proper implementation strategies will be identified toward complementation of the Plan.

F. Measure progress and make adjustments.

The Watershed Implementation Plan (WIP) Team, consisting of representatives from local and state agencies, will monitor stream test results and land use data tracked with the County's Geographic Information System (GIS). The revised WIP and recommendations will be presented each year to the Board of County Commissioners with a request for direction.

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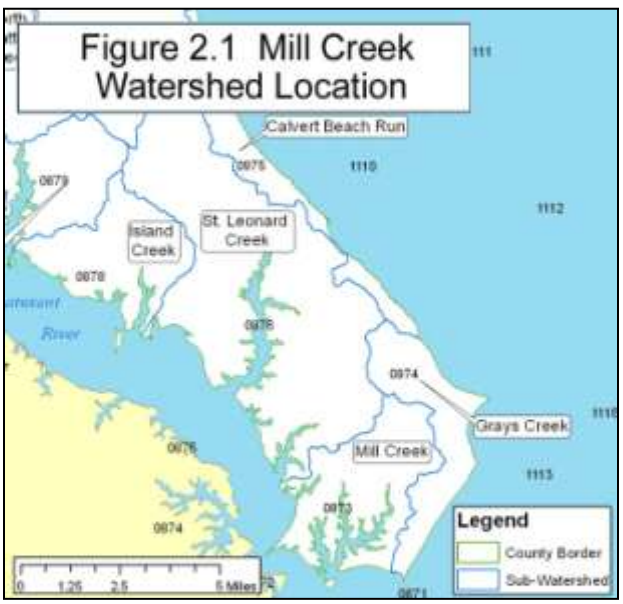
2 Watershed Characterization

The Mill Creek watershed is located in the southern portion of Calvert County, encompassing roughly 6,204 acres of land. The watershed extends from its tidal mouth on the Patuxent River to the west side of Little Cove Point Road and to the south side of Cove Point Road (MD 497) and includes Mill Creek, Back Creek, Hungerford Creek, St. Johns Creek, the Narrows and Solomons Harbor. For the purposes of this Plan, the watershed has been divided into five subwatersheds: Back Creek, Lower Mill Creek, Upper Mill Creek, Hungerford Creek, and St. Johns Creek. Figure 2.1 outlines the location of the Mill Creek watershed and adjacent watersheds and Figure 2.2 shows the zoning within the Mill Creek watershed in addition to delineating the five subwatersheds.



Compared to most watersheds in Calvert County, the Mill Creek watershed is quite urban, containing both the Solomons Town Center and a large portion of the Lusby Town Center.

Solomons is one of the four Major Town Centers recognized in the County's Comprehensive Plan and Lusby is included in the Plan as a minor Town Center. These Town Centers are expected to be centers of residential and commercial growth.

This section of the plan details the characteristics of the Mill Creek watershed significant to planning and analysis including topography, land use, and natural resources.

2.1 Topography and Soils

Topographic and soil information is an essential feature of watershed planning, as it can help identify parts of the watershed that may be more prone to erosion. The topography or slope of the land, in an area governs the flow of water. A soil type's characteristics determine retention and stability. In 2011, the United States Department of Agriculture (USDA) Natural Resources Conservation Service updated its 1971 soils survey, analyzing current soils and topography in the United States and provided their results in detailed soils maps. This section details the findings from that survey for the Mill Creek watershed.

Table 2.1 details the features of soils found in the watershed and **Figure 2.3** shows watershed topography.

INSERT ANALYSIS ONCE DATA RECEIVED

2.2 Land Use

Land use evaluation is a key step to the watershed planning process, as land use type relates to the activities within a watershed. Different land use categories serve as an indicator for particular pollutant sources and have been used to model expected pollutant loadings. Implementation of mitigation efforts can also be added to the model to estimate pollutant loading reductions.

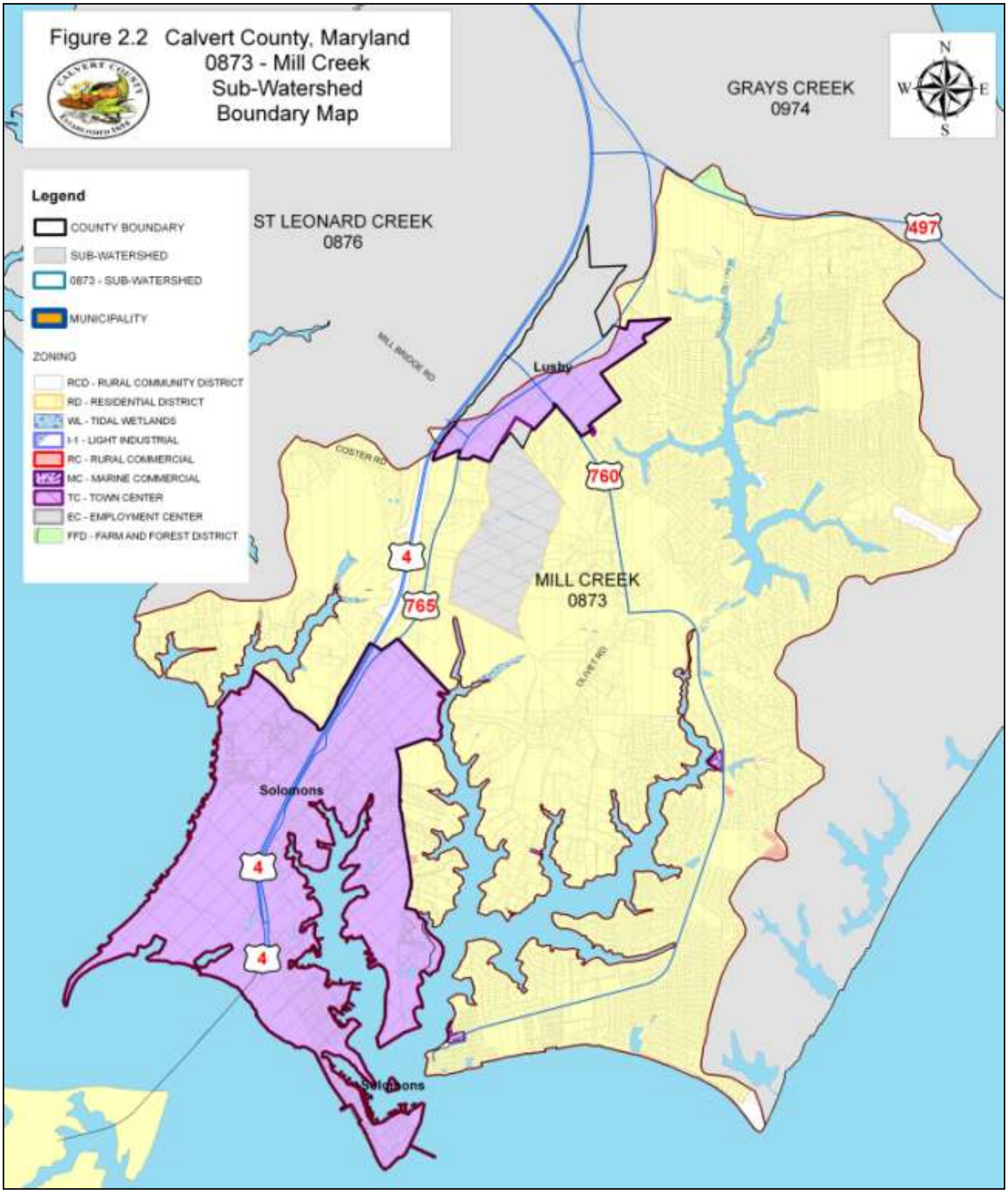


Figure 2.2 Calvert County, Maryland
0873 - Mill Creek
Sub-Watershed
Boundary Map
Legend
COUNTY BOUNDARY
SUB-WATERSHED
0873 - SUB-WATERSHED
MUNICIPALITY
ZONING
RCD - RURAL COMMUNITY DISTRICT
RD - RESIDENTIAL DISTRICT
WL - TIDAL WETLANDS
I-1 - LIGHT INDUSTRIAL
RC - RURAL COMMERCIAL
MC - MARINE COMMERCIAL
TC - TOWN CENTER
EC - EMPLOYMENT CENTER
FFD - FARM AND FOREST DISTRICT
ST LEONARD CREEK
0876
GRAYS CREEK
0974
MILL CREEK
0873
Lusby
Solomons
Solomons
N
S
E
W
497
760
765
4
4
4

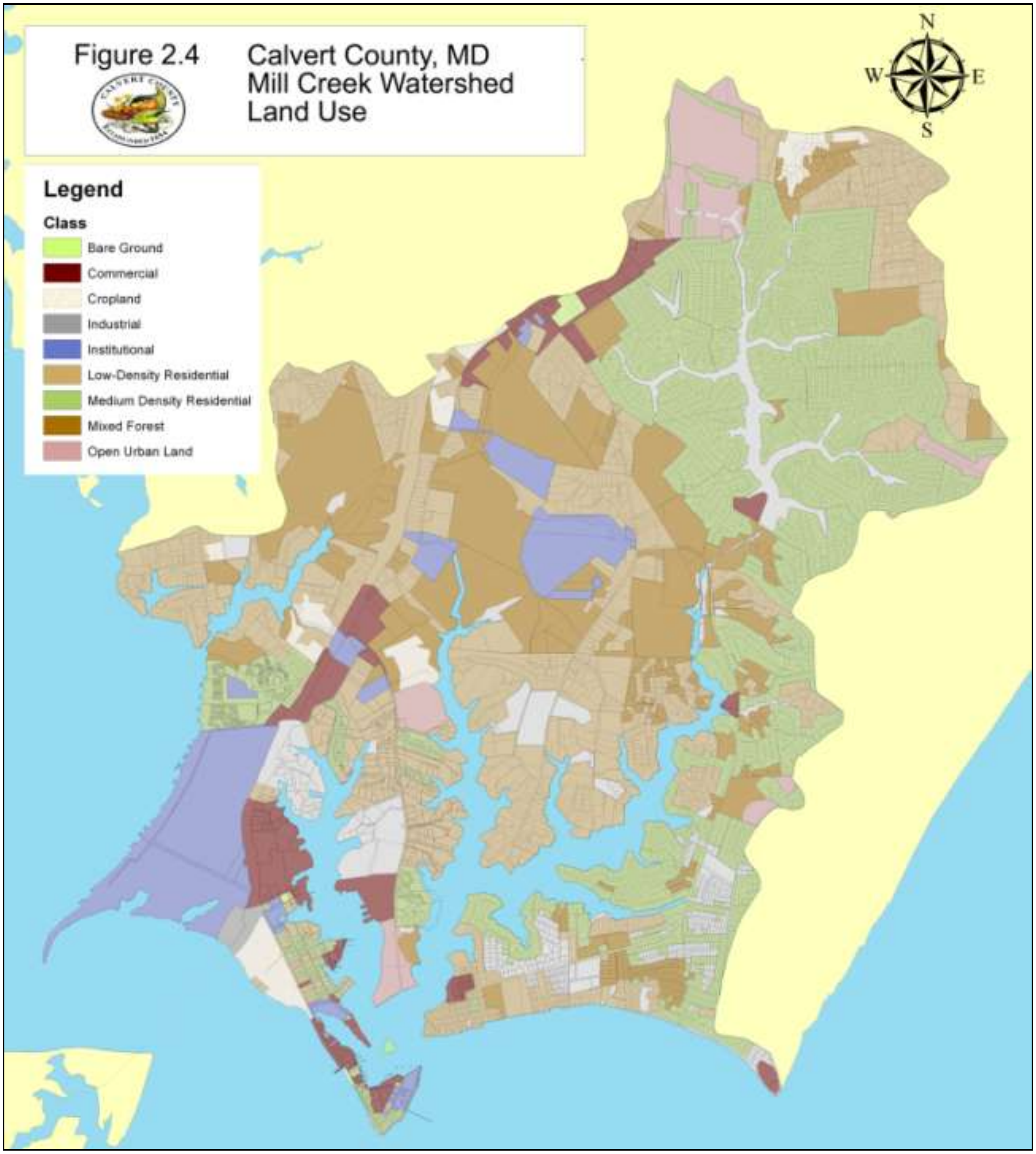


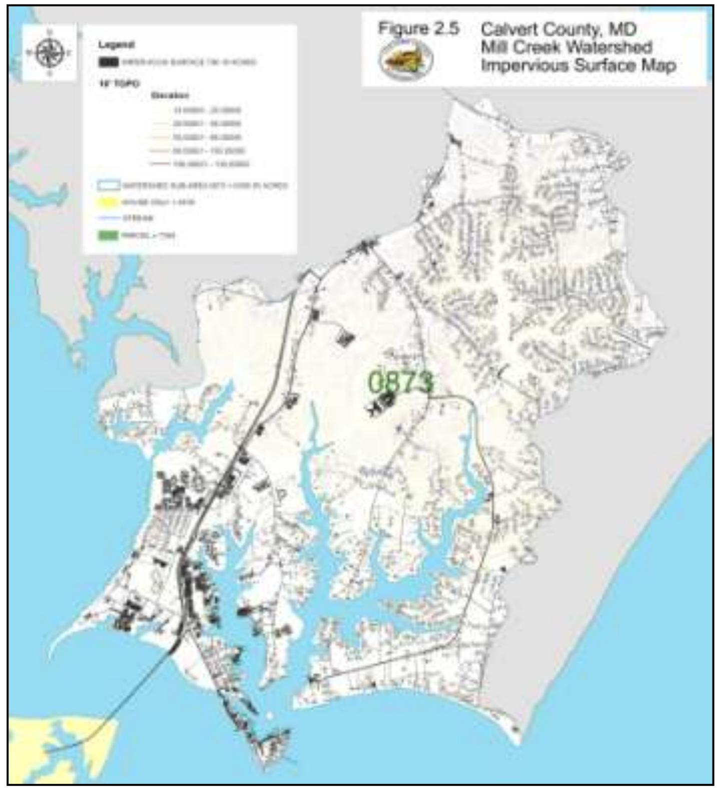
Figure 2.4
Calvert County, MD
Mill Creek Watershed
Land Use
N
W
E
S
Legend
Class
Bare Ground
Commercial
Cropland
Industrial
Institutional
Low-Density Residential
Medium Density Residential
Mixed Forest
Open Urban Land

Current land use, as of 2007, for the Mill Creek Watershed is depicted in Figure 2.4. A majority of the watershed (approximately 62%) has been developed either for residential or commercial uses.

The Back Creek subwatershed, which contains most of the Solomons Town Center, consists predominantly of institutional (35.6%), commercial (17.7%), and residential land uses (32.3%), with some cropland and forest. The Lower Mill Creek subwatershed contains portions of both the Solomons and Lusby Town Centers. Its land uses are mainly a mix of residential (55.3%) and forest (32.4%).

The remainder of Lusby in the Plan area is located in the Upper Mill Creek subwatershed. This subwatershed contains mostly medium-density residential uses (56.9%), with some forest, low-density residential, and commercial (primarily in the Town Center). The uses in the Hungerford Creek subwatershed are largely forest (46.5%) and low-density residential (43%). Finally, the St. Johns Creek subwatershed is almost entirely (91.3%) low-density residential.

The CCCP describes two useful factors that determine water quality: percentages of impervious surfaces and forest cover. Forest cover, currently at 47 percent in the watershed, is discussed below in section 2.3.5. As to impervious surfaces, the Center for Watershed Protection (CWP) has set less than ten percent as a benchmark for good water quality. Higher percentages are considered “urban.” In Calvert County, a majority of watersheds have less than five percent but Mill Creek has approximately ten percent coverage. Figure 2.5 shows where impervious surfaces are located within the watershed.



2.3 Natural Resources Identification

Natural resources are those actual and potential forms of wealth supplied by nature, providing both valuable products and immeasurable value in the services they supply. These include waterways, floodplains, water supply, wildlife habitat and habitat for rare, threatened, and endangered species, and wetlands.

2.3.1 Waterways

The waterways of the Mill Creek watershed are a priceless resource, serving as habitat for wildlife and providing economic and recreational benefits to the surrounding community. Tourism is a crucial industry for the Solomons area, and access to scenic waterways is a large part of the area’s appeal. Maritime industry has existed in the watershed, particularly Solomons Harbor, since the early 18th century (Solomons Master Plan, 2009).

Following World War II, extensive marina development was begun in the area, until today

9 separate marinas offer a total of 1,561 boat slips for transient and long-term dockage. With additional slips at restaurants, bars, government properties, and private residences, it is estimated that there are over 2,000 slips in Solomons Harbor (Solomons Master Plan, 2009). Residents and visitors reap inestimable benefits from the watershed through activities including fishing, boating, canoeing, swimming, waterfront dining, etc.

Solomons Island forms a deep protected harbor which has served the maritime industry since the early 18th century.

2.3.2 Floodplains

Floodplains are low-lying areas that have a one percent chance of flooding any given year (100-yr floodplain) either due to high seas and sea level and/or excessive amounts of rainwater runoff. Floodplain areas are also often wetlands and serve valuable functions as natural stormwater management devices, habitats for species diversity, and often are the habitat of rare, threatened or endangered species. These areas are usually heavily vegetated with forests, scrub-shrub plant associations, or emergent plant species; and the soils are often hydric. Due to the presence of the hydric soils and vegetation, natural floodplains are often excellent nutrient and pollutant removal systems that reduce pollutants entering our waterways.

The CCCP discourages development in floodplains to preserve their ecological value and to reduce the costs to life and property due to severe flooding resulting from storm events (hurricanes and heavy rainstorms). The Zoning Ordinance and Subdivision Regulations regulate development in the 100-year floodplain (area where a flood is likely to occur on the average of once every l00 years). In Calvert County, the 100-year floodplain is defined by (1) those areas so depicted on the Calvert County Flood Insurance Rate Maps (FIRM) and (2) areas adjacent to floodplains where the elevation is less than that of the 100-year flood. There is some development in the Mill Creek watershed 100-year floodplain

2.3.3 Water Supply

Calvert County is situated over a favorable geological formation of groundwater resources. Five major aquifers (the Piney Point, Nanjemoy, Aquia, Magothy, and Patapsco) supply nearly all of the County's potable water. In the region around the Mill Creek watershed, these aquifers reside 150-300 (Piney Point), 150-250 (Nanjemoy), 400-500 (Aquia), 650-700 (Magothy), and 600-1,400 (Patapsco) feet below sea level.

2.3.4 Wildlife Habitat

The CCCP encourages the preservation and conservation of wildlife habitats. The Critical Area Program (applies to all lands within 1,000 ft. of tidal waters and tidal waters and tidal wetlands) has specific requirements for activities in Habitat Protection Areas. Outside the Critical Area, mandatory clustering regulations and the Forest Conservation Program identify areas of important habitat value for rare, threatened, and endangered species as a priority area for retention.

An important function of watersheds is the provision of habitat for a variety of species. The Mill Creek watershed has been identified

by DNR as a potentially significant spawning area for white perch. The same survey identified leastbrook lampreys, American eels, eastern mudminnows, yellow and brown bullheads, pumpkinseed, and bluegill in the watershed.
Historic oyster bars are located at the mouth of the watershed (DNR, 2003). Oysters play vital roles in the ecosystem, including the provision of underwater habitat, food and filtering of nutrients, sediments, and other contaminants from the water (Chesapeake Bay Program, 2011). In addition, the oyster industry in Maryland contributes millions of dollars annually to the economy and is part of the region's rich history and cultural heritage.

Today, oyster populations in the Chesapeake Bay are a small fraction (1%) of historic populations (DNR, 2010a). The population declined due to a combination of disease, overfishing, water quality decline, and habitat loss from sedimentation. The bars at the mouth of Mill Creek are legally-defined, maintained by DNR, and protected by state regulations. The tidal waters within the watershed are restricted from shellfish harvesting due to potential contamination from boating activities and adjacent land uses.

The Southern Maryland Oyster Cultivation Society (SMOCS) grows oyster spat in floats at docks in the watershed and has created an oyster bar in Mill Creek using these spat.

2.3.5 Forest Cover

The CCCP emphasizes how vital forest cover is as a natural resource. Forests play a critical role in reducing runoff, removing the nutrient pollutants in runoff, inducing groundwater recharge, minimizing flooding, reducing erosion and sedimentation, and providing shelter and food for numerous species of wildlife. Forests are also important in removing air pollution and as a renewable resource. According to an analysis report using CITYgreen provided by American Forests, the County's tree canopy provides total stormwater savings of over $1.5 billion and removed over 9 million pounds of air pollutants in 2006 (CCCP, 2010).

Forest cover plays a key role in the ecosystem of the Mill Creek watershed.

As stated above, the higher the percentage of forest canopy, the better the opportunity for good water quality. Scientists have suggested that 60 percent forest canopy is a good benchmark. In Calvert County about 58 percent of the land is under forest canopy, though the percentage does vary widely by watershed.

In the Mill Creek watershed approximately 47 percent is forested. Figure 2.6 displays the tree coverage of the Plan area by subwatershed. Most of the coverage is located in the Lower Mill Creek and Hungerford Creek subwatersheds.

The Calvert County Critical Area Program, Calvert County Forest Conservation Program, and mandatory cluster provision of the Calvert County Zoning Ordinance all recognize the importance of large blocks of contiguous forests and riparian forests (forests along waterways). These areas are very essential for wildlife and are potential FID bird habitat, defined as riparian forest 300 feet in width or greater and continuous blocks of 50 or more acres that include at least 10 acres of forest interior (forest at least 300 ft from a forest edge). In the Mill Creek watershed, 46 percent of the forested area qualifies as potential, forest-interior dwelling, bird habitat.

2.3.6 *Wetlands*

Wetlands are lands where water is the dominant factor determining the nature of soil development and the types of plant and animal communities. They tend to be low lands covered with shallow water and provide flood and water storage, pollution control, wildlife habitat, and a major food supply for aquatic organisms, migratory waterfowl, and other wildlife. Maryland has lost approximately one-half of its wetlands over time, resulting in the State setting a goal of "no net loss" of wetlands going forward. The CCCP includes County actions to ensure the preservation of wetlands.

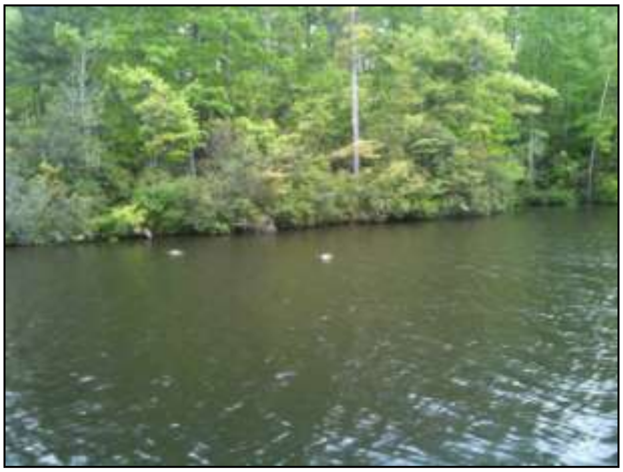
The primary watershed functions wetlands provide include:

- Groundwater recharge and discharge, replenishing groundwater when needed and augmenting base flows during periods of drought.
- Flood flow alteration, potential storage of floodwater by wetlands which moderates the effects of flooding.
- Shoreline anchoring and dissipation of erosive forces.
- Sediment/toxicant retention, sedimentation, absorption, and plant uptake protecting downstream surface waters from pollutants.
- Removal/transformation of the nutrients nitrogen and phosphorus.
- Production and export of organic matter from the wetland to downstream waters which replenishes the food chain.
- Aquatic diversity/abundance.
- Wildlife diversity/abundance for breeding.
- Ecological integrity.
- Educational potential, providing educational access to a variety of species and habitats.
- Recreation and uniqueness/heritage, addressing the ability of wetlands to provide recreation activities such as bird watching, hunting, hiking, etc. and non-recreation activities such as nature study, scientific research, etc.
- Historical site potential, as wetlands have the potential to contain historical artifacts.

Based on land use maps, the wetlands within the Mill Creek watershed comprise 44 acres. This represents 0.7% of the watershed.

2.3.7 *Lake Lariat*

Lake Lariat is an 86 acre, 10-12 foot deep, man-made lake created in 1965 by damming Mill Creek (MDE, 2002). It is located within the Chesapeake Ranch Estates Community and drains approximately 1,800 acres of surrounding lands.



Lake Lariat is habitat for freshwater species and provides recreational opportunities for the surrounding community.

3 Cumulative Impact Statement

An understanding of pollutants being introduced into a watershed, the sources of those pollutants, and the effects of those pollutants is essential to a watershed plan. A variety of nonpoint sources of pollution that exist in the Mill Creek watershed have the potential to affect water quality and wetland functions. Section 3.1 examines the sources of pollution in the watershed. Section 3.2 analyzes concentrations of certain indicator pollutants in the watershed and Section 3.3 discusses the effect these pollutant loads have upon the functions of the watershed.

3.1 Sources

Various point and nonpoint sources deliver pollutants into the Mill Creek watershed. While data quantifying the pollutant contribution of specific sources is unavailable, this section serves to highlight probable pollutant contributors to guide mitigation efforts.

3.1.1 Point Sources

Point sources discharge directly into waterways. Due to their direct negative impact upon water quality, point source discharges are regulated through National Pollutant Discharge Elimination System (NPDES) permits. There are currently eleven sources requiring NPDES permits in the Mill Creek watershed.

Marinas are required to obtain a NPDES permit as a result of activities that might discharge pollutants into waterways such as fueling, engine or boat maintenance/repair, boat washing, sanding, blasting, welding, or metal fabrication, or pressure washing (MDE, 2011). Marinas in the watershed with an NPDES permit include Back Creek Boat Yard, Harbor Island Marina, Inc., Spring Cove Marina, Town Center Marina, Washburn's Boat Yard, Inc., and Zahniser's Yachting Center (DNR, 2003).

Periodic maintenance is necessary for public water supply systems, including "flushing" finished water from the systems. This flushing can discharge chlorinated water into waterways, requiring a NPDES permit. In the Plan area, the Chesapeake Ranch Water Company and the Solomon's Island Water Distributional System have MDE water supply discharge permits.

The Solomons U.S. Navy Recreation Complex has a NPDES permit under the category of "other" and the University of Maryland Chesapeake Biological Lab has an industrial surface water NPDES permit.

The Solomons Island Wastewater Treatment Plant (WWTP), located on Sweetwater Lane in Lusby, was built in 1986 (Comprehensive Water & Sewerage Plan, 2008). The facility serves the Solomons Island Sanitary District, including the Solomons Island Town Center, areas around Back Creek, the Lusby Town Center, and the Patuxent Business Park. The WWTP has a groundwater sewage effluent NPDES permit and is a rapid infiltration plant with a design capacity of 700,000 gallons per day. Rapid infiltration is an innovative type of treatment which uses large infiltration basins to grow bacteria for nitrogen removal. It is a two-step process resulting in an effluent which is of groundwater quality (Comprehensive Water & Sewerage Plan, 2008).

None of the point sources in the watershed have been determined to be a significant contributor to water quality impairment (DNR, 2003).

3.1.2 Nonpoint Sources

Nonpoint pollution comes from many sources and drains into the watershed, either through ground water or carried by surface water runoff caused by rainfall or snowmelt. The predominant forms of nonpoint pollution in the Mill Creek watershed come from urban land uses including septic systems, agricultural land use, and wildlife sources.

Urban nonpoint sources of pollution result from impervious land cover, stormwater runoff, excess lawn fertilization, and septic systems. Impervious surfaces cause runoff by preventing rainfall and snowmelt from filtering into the ground and concentrating flow. With a relatively high percentage of impervious surfaces (>12%), the coverage in the watershed may result in negative impacts to water quality. In addition, urban areas typically have unique pollutant sources such as high concentrations of residential units, pet wastes, lawn fertilizers, a large percentage of impervious surface, etc. As such, the Town Centers and the large amount of development in the Plan area have the potential to contribute significant pollutant loads to the watershed.

All conventional septic systems can contribute significant amounts of nitrogen to groundwater, which can eventually be transported to surface waters. Malfunctioning septic systems can also contribute significant amounts of nutrients as well as bacteria and other pathogens to nearby water bodies. In 2007, there were approximately 3,969 residential septic tanks and 100 acres of non-residential septic systems in the area. The number of malfunctioning septic systems in the watershed is unknown but is about 1.1% county-wide (CC Environmental Health Department, based on 2010 data). Septic systems represent a major nonpoint source of nutrient emissions into the Mill Creek watershed, with estimates based on the Chesapeake Bay Model ranging from 55.3% to 62.7% of total nitrogen emissions.

Agricultural sources of nonpoint pollution include runoff from livestock grazing, livestock holding areas, and cropland. Livestock can be a significant source of nutrients and overgrazing can increase erosion in an area. However, the United States Department of Agriculture (USDA) 2007 Census of Agriculture did not find significant numbers of livestock in the watershed, indicating that livestock nonpoint source pollution is not a large burden on Mill Creek.

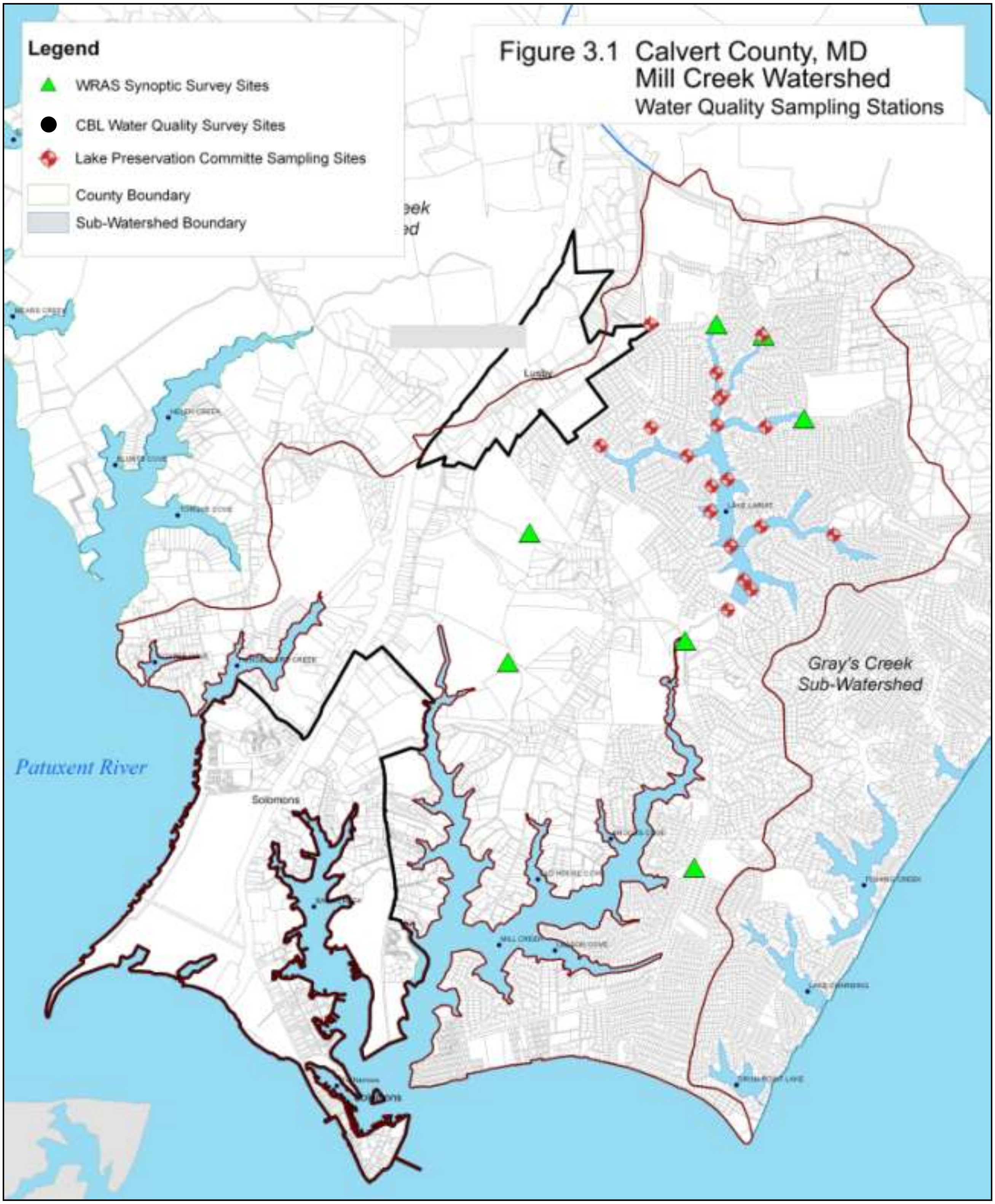
In addition to livestock, croplands are a potentially significant nonpoint source of nutrients, sediment, and pesticides when not managed properly. Sediment loads can result from failure to counter erosion. Fertilizers and pesticides can be delivered to the watershed through surface runoff and groundwater transport. As of 2007, 132 acres in the watershed are used for cropland. Without proper management these crops have the potential to unload pollutants into nearby water bodies.

Finally, wildlife in a watershed input nutrients and bacteria into a watershed, though these sources are part of the natural background level in a system.

3.2 Pollutants and Water Quality Data

Since 1987, the Calvert County Board of County Commissioners has provided the University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory (CBL) with funding to monitor tidal water quality in the Mill Creek watershed. Each year, CBL has measured chlorophyll-a, temperature, water column clarity, dissolved oxygen concentrations, and salinity at 10 locations in the watershed.

Figure 3.1 shows the locations of the CBL sampling stations. Four stations, numbers 3, 4, 6, and 7, were located along Mill Creek; stations 8 and 9 were on St. John's Creek; stations 15 and 17 were on the main waters of



Legend
WRAS Synoptic Survey Sites
CBL Water Quality Survey Sites
Lake Preservation Committe Sampling Sites
County Boundary
Sub-Watershed Boundary
Figure 3.1 Calvert County, MD
Mill Creek Watershed
Water Quality Sampling Stations
Lusby
Gray's Creek
Sub-Watershed
Patuxent River
Solomons

Back Creek; station 11 was in The Narrows; and station 2 was at the mouth of Mill Creek. Each station is sampled once in May and September and twice a month in June, July, and August. At each site, measurements were made on the surface (0.5 meters down) and bottom (0.5 meters above the sediment surface).

In 2003, Maryland DNR and Calvert County began the process of developing a Watershed Restoration Action Strategy (WRAS) for the Calvert Portion of the Lower Patuxent Watershed. The purpose was to guide restoration efforts in the area, concentrating on the subwatersheds of Hall Creek, Island Creek, Back Creek and Mill Creek. These Creeks were emphasized due to interest in the impacts of land development on Hall Creek, boating impacts on Island Creek, and septic impacts on Back and Mill Creeks (DNR, 2004). The first step was a water characterization report in 2003, followed by a Synoptic Survey for nutrients, a Stream River Corridor Assessment Survey, and a final WRAS published in 2004.

While most of the information in the reports pertains to the entire Lower Patuxent Watershed, the Synoptic Survey measured nitrogen and phosphorus concentrations at seven freshwater locations in the Mill Creek watershed in April 2003 (locations shown on Figure 3.1). Section 3.2.8 below discusses other significant findings from the WRAS relative to Mill Creek.

In 2010, Calvert County Planning and Zoning employees and volunteers began a new regime of water quality sampling throughout County watersheds, including a freshwater location in the Mill Creek watershed (shown on Figure 3.1). To estimate watershed pollutant concentration and loads, this plan relies on CBL tidal data, freshwater data from the WRAS and County measurements, and load calculations based on land use as per the Chesapeake Bay model. What follows is an analysis of water quality in the watershed using available data.

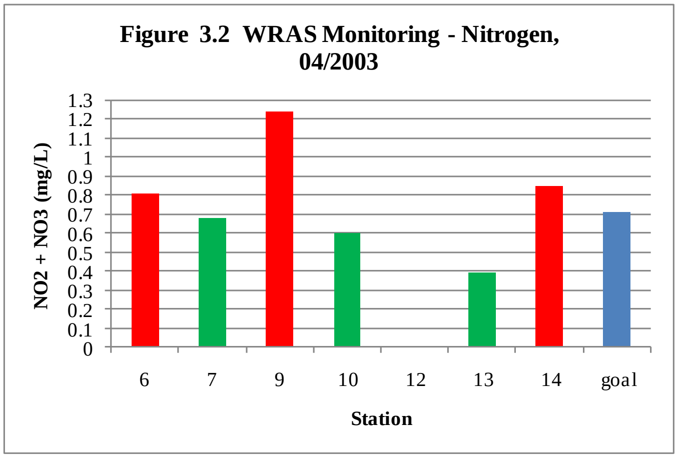
The data for Lake Lariat and its tributaries collected by the Property Owners' Association of the Chesapeake Ranch Estates' (POACRE) Lake Preservation Committee follows in Section 3.2.9 (sampling stations in Figure 3.1).

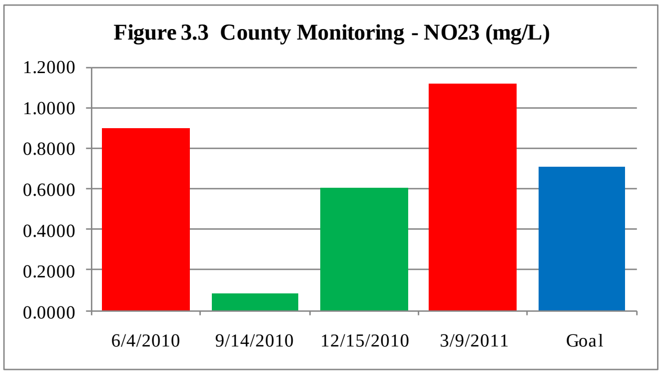
3.2.1 Nitrogen

Nitrogen is a form of nutrient, delivered into the watershed from fossil fuel power plant and automobile emissions (atmospheric deposition), agricultural and urban fertilizers, wastewater, septic systems, erosion, and wildlife waste. The nutrient is needed for plant growth but excessive levels can lead to massive algae growth in aquatic systems. Nitrogen is often the limiting nutrient in tidal waters. The algae blooms block sunlight from reaching submerged aquatic vegetation. When the blooms die and sink to the bottom of the waterway, their decomposition reduces the amount of oxygen available to other species. To guide evaluations of water quality in Calvert County, the CCCP sets a threshold for County fresh waters at less than 0.71 milligrams of nitrogen per liter (mg/L).

Nutrients in tidal areas of the watershed are very temporally variable due to the phytoplankton populations that use these nutrients. A large pulse of nutrients can result in an algal bloom. Nutrient values measured near the end of the bloom may be very low as they have been used up by the algae. Therefore, CBL has not consistently sampled nitrogen (or phosphorus) levels in the tidal portions of Mill Creek. However, freshwater nitrogen level data is available for 2003, 2010, and March 2011, shown in Figures 3.2 and 3.3.

In April 2003, three out of the seven monitored sites exceeded County thresholds for nitrogen





levels. While concentrations were below the CCCP threshold for September and December in 2010, they exceeded the threshold in June 2010 and March 2011. The excess of nitrogen for 2003 may be partially explained by rainfall in March, which tends to be high, and the above-average precipitation rates for that year (CBL, 2010). However, it is unlikely that rain alone explains high levels in June 2010. Rainfall in 2010 was below average in April and May, prior to elevated nitrogen levels in June and greater later in the summer before low nitrogen levels in September. The high levels in June may instead have to do with higher rates of fertilizer and other nutrients applied to land during early summer months.

Table 3.1 shows subwatershed nutrient loads for nitrogen in 2007, estimated by staff utilizing the Chesapeake Bay Model formulas provided by the Maryland Department of the Environment. The first column represents the nutrient loads based upon 2007 land uses (LU) assuming 2002 "best management practices" (BMPs). The second represents 2007 estimated nutrient loads assuming 2007 BMPs based upon the Tributary Strategies for restoring the Chesapeake Bay. A majority of nitrogen loads come from Lower and Upper Mill Creek, representing 84 to 85.5 percent of all nitrogen in the watershed. While the load from St. Johns Creek is only 2 percent of all nitrogen in the watershed, its load measured in pounds per acre exceeds that of Lower Mill Creek and is almost as high as that in Upper Mill Creek.

Table 3.1 Nitrogen Load Estimates Based on 2007 Watershed Land Use

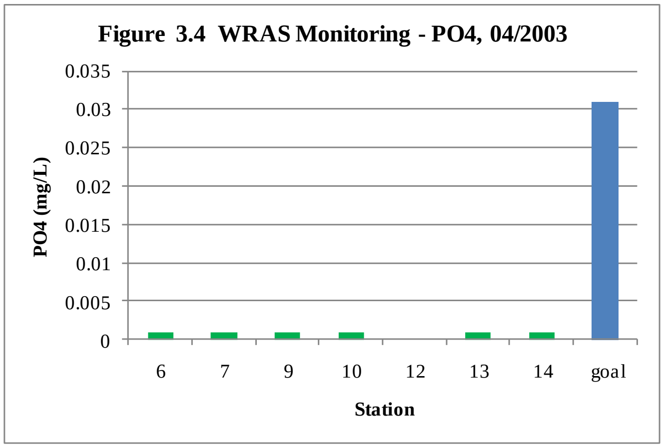
	2002 BMPs	2007 BMPs
Back Creek		
Lbs/Year	7,169	5,383
Lbs/Acre	7.73	5.81
Lower Mill Creek		
Lbs/Year	30,424	26,753
Lbs/Acre	11.44	10.06
Upper Mill Creek		
Lbs/Year	38,150	34,763
Lbs/Acre	19.42	17.7
Hungerford Creek		
Lbs/Year	4,318	3,627
Lbs/Acre	7.7	6.47
St. Johns Creek		
Lbs/Year	1,574	1,392
Lbs/Acre	17.11	15.13
Total		
Lbs/Year	81,635	71,918
Lbs/Acre	13.16	11.59

Source: Calvert Planning and Zoning Staff, 2010

3.2.2 Phosphorus

Phosphorus (PO4), another nutrient, is also needed for plant growth and can lead to algae growth when too much enters a watershed. Phosphorous is often the limiting nutrient in freshwater environments. Sources of phosphorus include agricultural and urban fertilizers, manure, wastewater, erosion and wildlife waste. Phosphorous attaches strongly to soils but is released when sediment is washed into a waterway. Erosion, including stream bank erosion, can be a large contributor of phosphorous. The CCCP has set a threshold for phosphorus concentrations at 0.031 milligrams of phosphorus per liter (mg/L) in County fresh water.

Figures 3.4 and 3.5 show freshwater phosphorus concentrations for 2003 and 2010. Based on the samples, phosphorus levels were well below the CCCP threshold in 2003 and 2010 through March 2011.



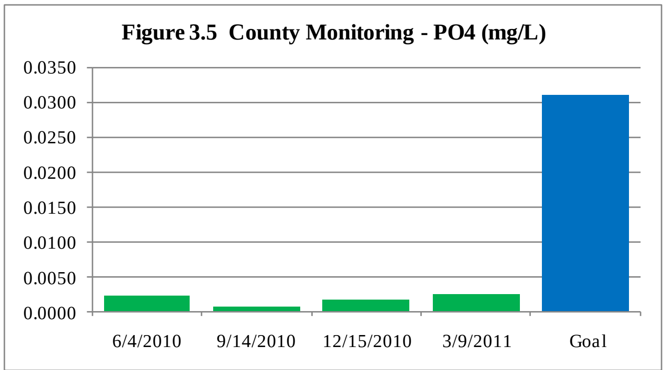


Table 3.2 shows subwatershed nutrient loads for phosphorus for 2007, estimated by staff utilizing the Chesapeake Bay Model formulas. As with nitrogen, phosphorus loads are the greatest in Lower and Upper Mill Creek, which represent 73 percent of all phosphorus in the watershed. However, the phosphorus load measured in pounds per acre for both Back Creek and St. Johns Creek exceed the load of either section of Mill Creek.

Table 3.2 Phosphorus Load Estimates Based on 2007 Watershed Land Use

	2002 BMPs	2007 BMPs
Back Creek		
Lbs/Year	496	358
Lbs/Acre	0.54	0.39
Lower Mill Creek		
Lbs/Year	1,047	723
Lbs/Acre	0.39	0.27
Upper Mill Creek		
Lbs/Year	980	681
Lbs/Acre	0.50	0.35
Hungerford Creek		
Lbs/Year	183	126
Lbs/Acre	0.33	0.22
St. Johns Creek		
Lbs/Year	51	35
Lbs/Acre	0.55	0.38
Total		
Lbs/Year	2,757	1,923
Lbs/Acre	0.44	0.31

Source: Calvert Planning and Zoning Staff, 2010

3.2.3 Water Column Clarity, Light Penetration, and TSS

Water column clarity and resulting light penetration are very significant factors to water quality. Without sufficient levels of light, submerged aquatic vegetation (SAV) growth is stunted or prevented. SAVs play a vital role in the aquatic ecosystem, providing habitat, food, oxygen, and preventing erosion. Due to the importance of SAVs in the Chesapeake Bay, the Maryland Department of Natural Resources set a goal to restore 110,000 acres of aquatic vegetation in the Bay by 2010. As of 2009, only 41 percent of the goal had been reached (DNR, 2010).

A Secchi disk has been used since 1987 to measure water column clarity at 10 locations in the Mill Creek watershed. Higher Secchi disk readings, measured in meters, indicate greater water clarity. Figure 3.6 shows the average, maximum and minimum clarity depth for all the sites during the past decade. Water clarity has remained relatively constant, absent natural seasonal fluctuations. The spike in clarity during 2002 is most likely due to that year being dry compared to other years in the decade (CBL, 2011).

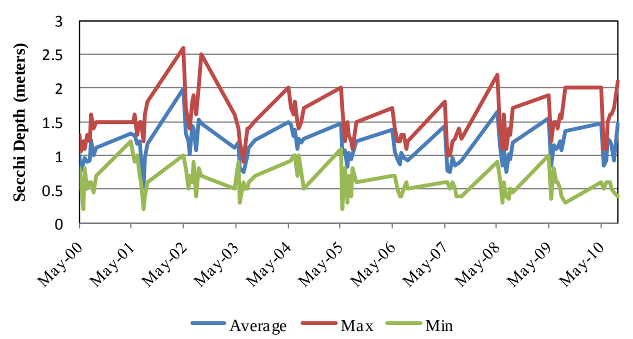


Figure 3.6 CBL Monitoring - Secchi Depth Averages

Table 3.3 highlights average, maximum and minimum water quality depth for each site during the decade. For a majority of the sites, the maximum Secchi disk measurements were in May 2002, a reflection of the peaks found in Figure 3.5 at that time. The sites with the lowest Secchi measurements over time were stations 7 and 9, both with an average of 0.7 meters.

The light attenuation coefficient (Kd) is calculated based on the Secchi disk depth (the equation is Kd = 1.45/ Secchi). The resulting number is an indication of the depth that adequate light penetrates the water to promote growth of both SAVs and algae. SAVs require 30 percent of surface light/radiation. Algae, requires 1 percent of surface light/radiation.

CBL analysis found that in 2010 the average Secchi disk depth of 1 meter allowed light sufficient for algal growth to penetrate an average of 2.71 meters, indicating that enough light was present for algal growth. This is a continuation of the trend from previous years. However, light sufficient for SAV growth only penetrated an average of 0.71 meters. The average depth in the watershed was 1.2 meters, indicating that there was not enough light for SAV growth throughout much of the watershed in 2010.

Table 3.3 Secchi Depth (meters) for Each Sampling Station between 2000 and 2010

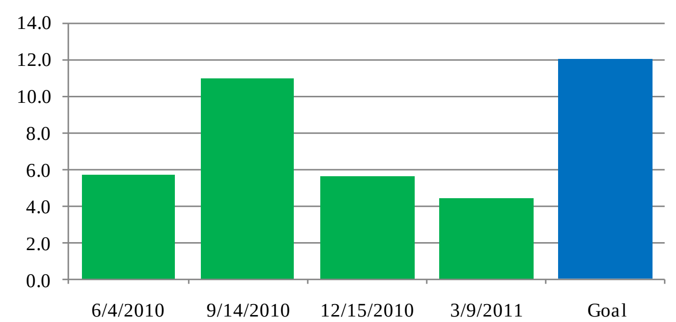
Station Name	Station #	Average Water Depth	Secchi Depth				
			Average	Maximum		Minimum	
				Depth	Year(s)	Depth	Year(s)
Boat Shop	2	5.9	1.4	2.4	2002	0.7	2010
Bow Cove	3	4.6	1.2	2.3	2002	0.6	2001
Pancake Point	4	4.6	1.2	2.3	2002	0.2	2002
Cole's Creek	6	2.3	1.0	1.7	2004, 2010	0.3	2002
Ranch Club	7	1.4	0.7	1.3	2001	0.3	2005
Hutchin's Cove	8	2.8	1.1	2.2	2002	0.3	2001
Lore's Creek	9	1.0	0.7	1.4	2001, 2008	0.2	2000, 2005
Pilot Transfer Station	11	3.5	1.3	2.6	2002	0.8	2000, 2001, 2003, 2006
Calvert Marina	15	3.7	1.3	2.3	2002	0.6	2000, 2001
Solomon's Landing	17	3.0	1.1	2.0	2002	0.3	2004

Source: CBL, 2010.

Total suspended solids (TSS), the weight of materials that can be retained on a membrane filter, including silt, clay, plankton, and organic and inorganic waste, is another indication of water clarity. High levels of TSS, or sedimentation, can be very destructive to a watershed, clogging fish gills, covering oyster shells and limiting the ability of light to penetrate water. No formal limits exist for TSS, but levels between 40 and 80 mg/L appear cloudy to the eye and levels above 80 mg/L can be damaging to an ecosystem. County staff uses a goal of 12 mg/L or under for TSS in its quarterly stream tests.

County staff and volunteers measured TSS levels at one sample location in the Mill Creek watershed during 2010. Figure 3.7 shows the resulting TSS levels, which remained below staff goals from June 2010 through March 2011.

Figure 3.7 County Monitoring - TSS (mg/L)



3.2.4 Chlorophyll-A

Chlorophyll-a (CHL-A) measurements are used by scientists as an indicator for the amount of algae in an aquatic ecosystem, and thus the magnitude of nutrient loading. The CCCP sets a threshold of 10 ug/L for CHL-A during the months April through October. The Mill Creek Study considers any CHL-A reading at 25 ug/L or greater as a bloom condition.

Figure 3.8 and Figure 3.9 show CHL-A surface and bottom levels in the Mill Creek watershed as measured by CBL staff from 2000 to 2010. Every site's CHL-A levels exceeded 25 ug/L on more than one occasion at both the bottom and the surface. In fact, stations 7 and 9 averaged over 25 ug/L at the bottom during that time period, and stations 7, 9, and 17 averaged over 25 ug/L at the surface. The peak shown on Figure 3.9 is station 17 at Solomon's Landing, which reached 443 ug/L in June 2003.

Figure 3.8 CBL Monitoring - Surface CHL-A

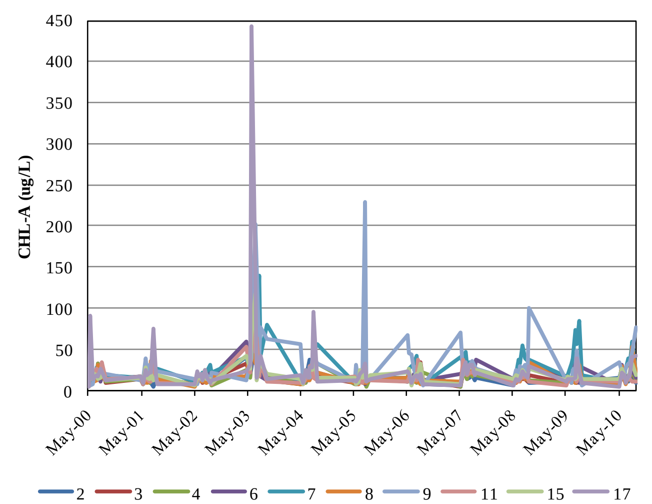
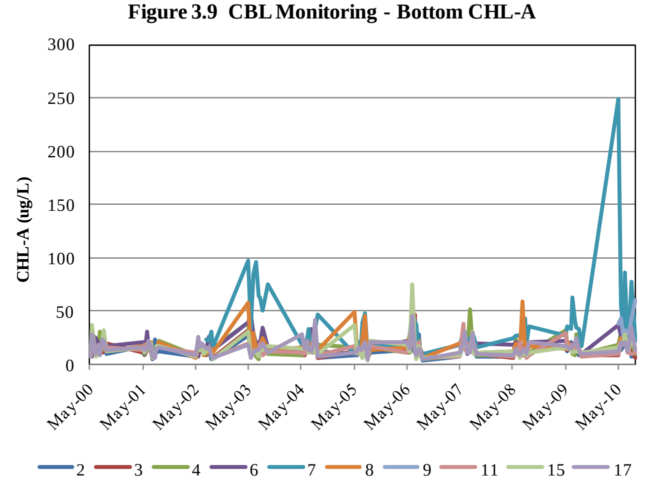


Figure 3.9 CBL Monitoring - Bottom CHL-A



3.2.5 Dissolved Oxygen

Water dissolved oxygen (DO) levels are a key measurement to ascertain the health of an aquatic ecosystem. Without adequate concentrations of oxygen, water can no longer sustain fisheries and other forms of life. A major cause of low DO levels are algae blooms resulting from excessive nutrients. When an algae bloom dies its decomposition consumes oxygen in the water. DO concentrations below 5 mg/L begin to stress organisms and below 2 mg/L massive mortality occurs (DNR, 2004b). Due to algae sinking to the bottom when they die, DO concentrations are often lower in bottom waters.

Figure 3.10 CBL Monitoring - Surface Dissolved Oxygen

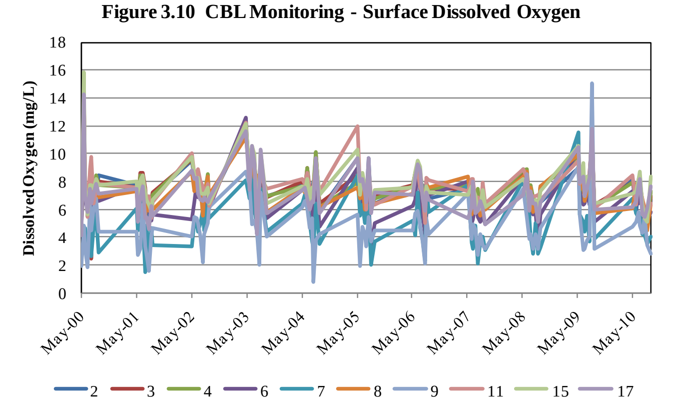
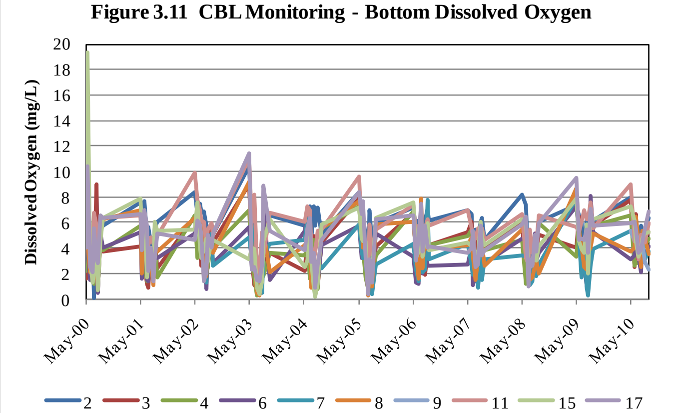


Figure 3.11 CBL Monitoring - Bottom Dissolved Oxygen



CBL data on DO surface and bottom concentrations in the Mill Creek watershed is shown in Figure 3.10 and Figure 3.11. Concentrations on the surface have remained above 5 mg/L for the most part, though stations 7 and 9 have gone below that level numerous times and have even sunk below 2 mg/L. In fact, station 9 averaged at 4.6 mg/L and station 7 only averaged at 5 mg/L.

DO levels on the bottom are well below those at the surface at all of the sampled stations. Figure 3.12 shows that every station has gone below 5 mg/L on numerous occasions and all of the stations except 2 and 11 averaged below that level. In addition, every station except for station 9 (this station's bottom levels were only measured started in 2010) went below 2 mg/L more than once. CBL analysis has found that levels below 2 mg/L are more likely in wetter years than drier yeas.

3.2.6 Salinity and Stratification

Salinity is a measure of the quantity of dissolved salts in water. Salinity on the surface and bottom of the 10 CBL measuring stations is shown in Figures 12 and 13.

Figure 3.12 CBL Monitoring - Surface Salinity

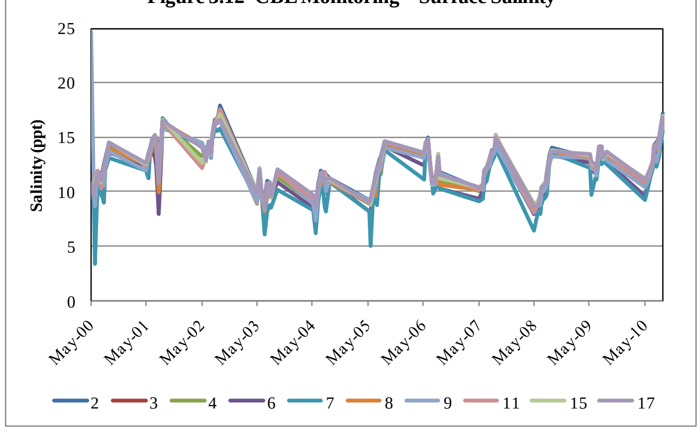
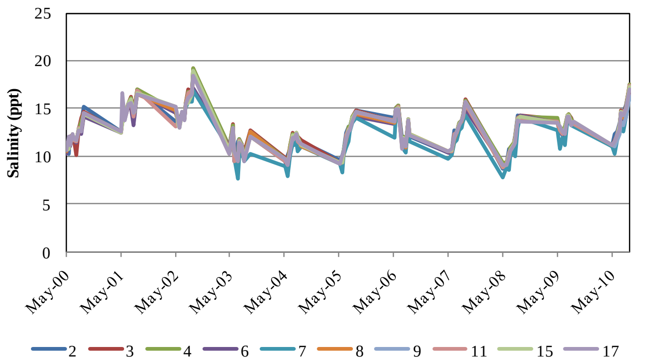


Figure 3.13 CBL Monitoring - Bottom Salinity



At the surface, salinity levels at all stations remained mostly between 5 and 18 parts per thousand (ppt). This is well within the normal range for brackish tidal water (between 5 and 30 ppt). Ranges at the bottom were slightly higher, between 7 and 19 ppt, but also within brackish concentrations.

3.2.7 Fecal Coliform

Fecal coliform bacteria are found in the intestines of humans and other animals. When they are discovered in waterways they indicate that that waterway is contaminated with fecal material, either from humans or wildlife. In a watershed, certain concentrations are naturally produced by wildlife in the ecosystem. High levels, potentially caused by wastewater, manure, and failing septic systems, would indicate human health risks from exposure to pathogenic bacteria and viruses.

U.S. EPA regulations state that waters used for Class 1 primary contact (including such activities as swimming, rafting, and kayaking) shall not have fecal coliform counts above 200 most probable number per 100 mL (MPN/100 mL) (EPA, 2003). Water quality standards for shellfish harvesting require that levels be less than or equal to 70 MPN/100 mL. To read a layman's discussion of factors affecting fecal coliform, please refer to the following web site: *http://bcn.boulder.co.us/basin/data/BACT/info/FColi.html*.

While the CBL monitoring program does not include measurement of fecal coliform concentrations, the Maryland Department of the Environment has three stations in the Plan area for the analysis of shellfish waters. Their sites are Station 015A, near CBL station 2 (Boat Shop); Station 109A, at the mouth of Saint John's Creek near CBL station 4 (Pancake Point); and station 104 in Back Creek, near CBL station 15 (Calvert Marina).

Table 3.4 Average Fecal Coliform Levels at MDE Stations 2007-2010 (MPN/100 mL)

Station	2007	2008	2009	2010
015A	8.1	44.8	5.4	20.1
109A	10.7	11.7	4.2	130.8
104	27.4	36.5	44.4	32.9

Table 3.4 shows average fecal coliform levels since 2007 for the three MDE Mill Creek stations. Levels in 2010 at 015A and 104 both exceeded shellfish standards at one point, as did the annual average for station 109A. However, these numbers were skewed by a major rain event in October 2010 which led to concentrations of 93 MPN/100 mL /100 mL at station 015A, 150 MPN/100 mL /100 mL at station 104, and 1,100 MPN/100 mL /100 mL at station 109A. What is not known is whether the bacteria found in the samples originate from wildlife or humans.

3.2.8 Additional Information from WRAS

The Stream Corridor Survey of the WRAS process included an analysis of problems in area freshwater streams, such as erosion, inadequate buffers, and trash dumping (DNR, 2004a). Each problem was given a severity rating from minor to severe. A minor rating was for problems not appearing to significantly impact the stream or aquatic life. A moderate rating indicates problems having some environmental impacts that are limited in severity and length. Severe problems have wide reaching, direct impacts on the stream and aquatic life.

Erosion is a natural process, but too much can destabilize stream banks and result in sedimentation of waterways. Problem sites identified in the 2004 survey were stream banks that were nearly vertical and had no available roots to stabilize them. Five sites were documented in Back and Mill Creeks, all which received minor to moderate severity rankings. In size, they ranged from 50 to 700 feet and from 2 to 3 feet in height. They were spread evenly throughout the creeks and were mostly found in forested areas.

Forested buffers are vital for the maintenance of healthy streams, providing such services as bank stabilization, nutrient and sediment filtering from runoff, and habitat for wildlife. For the survey, a buffer was considered inadequate if it was less than 50 feet wide. There were seven sites in Back and Mill Creeks with inadequate buffers, with six listed as minor and one as moderate.

The surveying team documented locations where large amounts of trash had either been dumped or accumulated over time. Types of trash found included residential, floatables, and vehicles. Three sites were discovered in Back and Mill Creeks, one rated as minor, one moderate, and one as severe. This last site on Mill Creek had an estimated seven dump truck loads of trash, including cars, appliances, and glass. It was unknown whether the vehicles were leaking hazardous substances.

3.2.9 Lake Lariat Sampling

Figures 3.14 and 3.15 show nitrogen and phosphorus levels at sampling stations in Lake Lariat during 2010. Nitrogen levels remained above the County threshold (0.71 mg/L) at all stations March through July, and were above the threshold at stations LT4 (Concho Cove), LT7 (Big Bear Creek), and LT8 (Running Fox Cove) at all sampling times. Phosphorus levels remained well below the County threshold (0.031 mg/L) throughout 2010. CHL-A was also measured, though a graph is not displayed since sampling was done more sporadically. Algal bloom conditions were only detected once, at station C9 (Hickok Pond) in September 2010 with a measurement of 56.5 ug/L.

Figure 3.14 Lake Lariat NO23 Levels in 2010

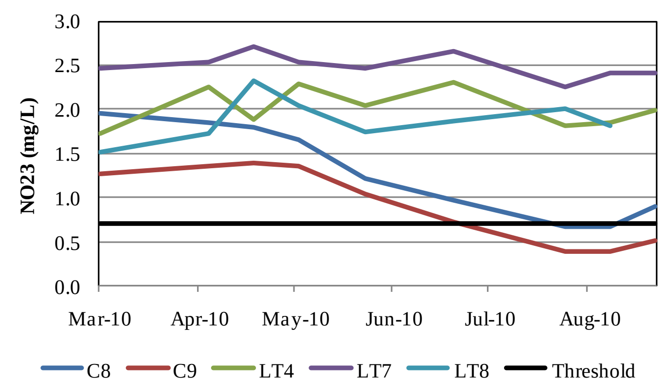
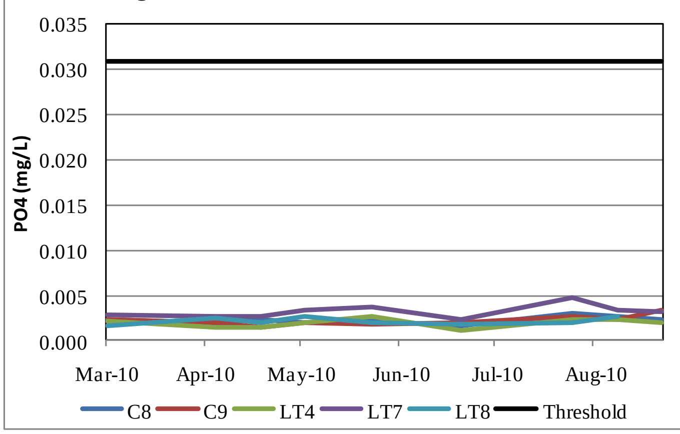


Figure 3.15 Lake Lariat PO4 Levels in 2010



3.2.10 Water Quality Analysis Summary

Concentrations of TSS appear to be below the County goal. While extensive sampling data for phosphorus levels is not available, the two rounds of monitoring in 2003 and 2010 indicate that phosphorus is not an issue in the watershed. These lower levels are not surprising, as a majority of nutrient loads come from septic systems, which are not a significant source of phosphorus.

However, concentrations of nitrogen, CHL-A, and fecal coliform have often exceeded optimal levels during the past ten years. Even though extensive sampling data is not available on nitrogen levels, freshwater data indicates that such concentrations may be of concern. In addition, the effects of high nitrogen loads can be observed through CHL-A levels, which have exceeded bloom conditions numerous times at all tidal sampling locations in the watershed. This is an indication of high nutrient levels, resulting in algal blooms. CBL regression analyses through the years indicate that there is a significantly correlated upward trend in CHL-A levels throughout the years. In fact, the average CHL-A concentration during 2010 was almost equal to 25 ug/L (bloom level).

High CHL-A levels are likely linked to low dissolved oxygen (DO) levels in the watershed. These concentrations have been quite low in the bottom waters of the tidal waterways. Levels have often remained low enough to stress aquatic species (below 5 mg/L) and have even declined below life sustaining amounts on many occasions.

CBL light penetration analyses indicate that water clarity is of concern in the watershed. While light sufficient to sustain algae has been present over time, much of the watershed lacks levels sufficient to sustain SAV growth. Finally, while fecal coliform levels at the three MDE Mill Creek stations have remained below EPA levels for Class 1 primary contact, they have gone above shellfish standards on several occasions since 2007.

All areas of concern have been linked through CBL analysis to precipitation rates. In general, water quality (lower nitrogen, CHL-A, and fecal coliform levels and higher DO concentrations and water clarity) is better in dryer years than in wet years due to the increased runoff during wet years. Even so, the pattern of CHL-A concentrations increasing over time in drought years indicates a trend of decreasing water quality in the Mill Creek watershed.

In all of the factors measured watershed-wide, the worst water quality was consistently found in the upper tidal reaches of Mill and St. John's Creeks (stations 7 and 9). These two locations had the highest CHL-A level averages from 2000 to 2010 (37 and 37.5 respectively). They also had the lowest surface levels of oxygen (bottom levels were not measured for station 9 until 2010), averaging at 5.0 and 4.6 mg/l over the past decade, and the lowest Secchi depth readings (averaging at 0.7 meters). This may be due to the fact that both areas receive runoff from principally residential development where sewage treatment is provided via septic systems. In addition, the runoff from several schools drains into the headwaters of St. John's Creek.

3.3 Effects on Natural Resources

3.3.1 Waterways and Wetlands

Wetland and waterway functions can be affected by pollutants in various ways. The pollutant effects on wetland function are summarized in Table 3.5 (PCWWA, 1995). As the table indicates, large amounts nutrients such as nitrogen and phosphorus can negatively affect the watershed-specific functions of sediment/toxicant retention, nutrient removal, and diversity. Excess pollutants affect the watershed-specific function of pollution retention.

Forest buffers play a key role in stabilizing stream banks and preventing runoff from entering a watershed. As of 1998, about 10

Table 3.5 Pollutant Effects on Wetland Functions

Function	Nutrient Effects	Sediment Effects	Toxicant Inputs
Groundwater recharge and discharge	Probably minimal effect.	Fine sediments could interfere with groundwater exchange.	Little effect on function, but could contaminate groundwater.
Flood flow alteration	Probably minimal effect.	Large amounts of sediment could result in loss of water storage capacity.	Probably little effect.
Sediment stabilization	Probably minimal effect.	Large sediment inputs could kill vegetation, resulting in loss of substrate binding root systems.	Probably little effect.
Sediment/toxicant retention	Nutrient levels resulting in algal growth could shade and thus reduce vegetative growth, reducing sediment filtering.	Massive sediment inputs could reduce the long-term capabilities of the wetland.	Massive inputs could reduce the long-term capabilities of the wetland.
Nutrient removal/ transformation	Overload of nutrients could minimize effectiveness.	Massive sediment inputs could reduce the vegetative uptake capabilities of wetland by killing vegetation.	Probably little effect.
Production export	Possible positive impact, since vegetation growth would be enhanced.	High levels could reduce vegetation, and production export.	Probably little effect.
Aquatic diversity/abundance	Nutrient levels resulting in algal growth could shade and thus reduce vegetative growth, reducing habitat and food availability.	Sediment inputs can reduce bottom heterogeneity, thereby decreasing benthic habitat; also, sediment inputs can smother eggs and larval stages of aquatic organisms and inhibit feeding.	Average levels have little effect, but above average levels could decrease aquatic diversity and abundance.
Wildlife diversity/ abundance for breeding	Little effect for non-aquatic habitats.	Low levels of sediment could enhance plant growth, but excessive amounts could block light and reduce vegetation and food sources	Probably little effect.
Recreation and uniqueness/heritage	High nutrient inputs could result in eutrophication and loss of sport fishing.	Sediment inputs can reduce bottom heterogeneity, thereby decreasing benthic habitat; also, sediment inputs can smother eggs and larval stages of aquatic organisms. These impacts could reduce sport fishing.	Probably little effect unless the wetland became toxic to fish or people.

Source: PCWWS, 1995.

percent of streams in watersheds in the Lower Patuxent area were not buffered with trees (DNR, 2003). This number is high compared to similar Maryland watersheds.

3.3.2 Floodplains

The 2011Calvert County Flood Mitigation Plan indicates that areas within the Mill Creek watershed, particularly Solomons Island, are susceptible to flood events. Solomons has been impacted by damaging tides from several major weather events during the past century. The Plan highlights the importance of protecting critical facilities in or near the 100-year floodplain, including Our Lady Star of the Sea School in Solomons and Solomons's Police Station.

Recent draft digital Flood Insurance Rate Maps (D-FIRMs) can be viewed at: *www.mdfloodmaps.com*.

3.3.3 Water Supply

Ground water is Calvert County's sole potable water source and is readily obtainable in sufficient quantities to supply current private and commercial requirements. Aquifer studies by the Maryland Geological Survey (MGS) indicate that despite significant decreases in the Aquia aquifer in the Solomons/Lusby area, sufficient groundwater is available for county needs beyond the year 2030 (MGS, 2008).

The Maryland Department of the Environment (MDE) does not permit increased usage of groundwater from a particular aquifer if the aquifer is at or below its management level, set at 80% of aquifer capacity. The MGS 2008 report examined three scenarios and the effect of water usage on aquifer water levels from 2003 to 2030. Based on the scenarios, the projected water levels in the aquifers for the Solomons area in 2030 are above the management level for all three scenarios.

3.3.4 Wildlife Habitat

As is stated in Table 3.3, both nutrients and other pollutants can have a negative impact on wildlife in a watershed, including species essential to the maritime industry. For example, water quality decline and habitat loss from sedimentation are listed among the primary factors that have led to the decline of the oyster population in the Chesapeake Bay.

In addition, indicators of SAV abundance show that only 10 percent or less of potential SAV habitat in the area is covered with SAVs (DNR, 2003). This low level of coverage is of concern throughout the state of Maryland, where the maximum observed coverage is 20 percent.

3.3.5 Forest Cover

Forest cover in the Plan area is currently at 47 percent in the watershed. **Table 3.6** shows a breakdown of forest cover percentages by subwatershed. INSERT ANALYSIS

Coverage in the watershed is especially low in the Solomons Town Center (21 percent). In order to improve coverage, and reduce runoff, the 2009 Solomons Town Center Master Plan established a forest canopy goal of 40 percent.

3.3.6 Lake Lariat

In 2002, Lake Lariat was identified on Maryland's list of Water Quality Limited Segments due to mercury contamination. Fish in the lake were found by the Food and Drug Administration (FDA) containing over twice the amount of safe mercury concentrations for consumers (MDE, 2002). As a result, MDE has placed the lake under a fish consumption advisory since that year, warning those who fish to eat limited amounts of their catch. The advisory recommends that children avoid eating all bass from the lake and adults consume no more than 12 meals of the fish in a year. However, mercury concentrations in Lake Lariat water are well below the threshold of concern for drinking water (MDE, 2002). MDE has created a Total Maximum Daily Load (TMDL) for mercury in fish in Lake Lariat.

Lake mercury impairment is mostly a product of atmospheric deposition of mercury. The EPA has concluded coal-fired power plants to be the largest source of mercury emissions to the atmosphere, though atmospheric levels effecting Lake Lariat cannot be connected to a single source. In fact, many source plants are located outside of the State or even the region.

In addition to high mercury levels, Lake Lariat water quality is also impaired by algae blooms.

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4 Existing Protective Measures

Before recommending new management efforts, it is important to identify programs, management strategies, and ordinances already implemented in a watershed. This chapter highlights federal, state, county, and community regulations and programs in place that seek to protect watershed resources.

4.1 Waterways and Wetlands

4.1.1 Buffers

In 1984, the Critical Area Act passed and established the Chesapeake Bay Critical Area (all area within 1,000 ft of tidal waters and tidal wetlands) and regulations for activities within this area. Within the Critical Area, a 100-foot buffer is required from the mean high water line (County Zoning Ordinance). For contiguous slopes 15% or greater, the buffer is expanded four feet for every one percent of slope, or to the top of the slope, whichever is greater. The buffer is also expanded to include sensitive areas such as hydric soils and highly erodible soils. Nontidal wetlands either inside or outside of the Critical Area require 50-foot buffers.

A buffer consists of native species and serves as an important barrier between human activity and sensitive water resources. It provides functional habitat for wildlife and filters nutrients, sediment, and other pollutants from runoff. Within the buffer, disturbances such as construction of new structures and the removal of natural vegetation are prohibited. Some activities, determined to be water dependent (such as water access or a boat ramp) are allowed within the buffer with appropriate permits.

As part of the Chesapeake Bay Program, Maryland has been working since 1996 to restore riparian forest buffers along streams and rivers in the Bay watershed. This project has resulted in more than 7.1 acres of planted buffers in the Mill Creek watershed (DNR, 2003a).

4.1.2 Restrictions on the Filling of Wetlands

Any filling of wetlands in Calvert County requires the attainment of appropriate county, federal, and state permits (County Zoning Ordinance). Subdivision of land in a manner that requires filling of wetlands is prohibited for all activities except road crossing and stormwater management. In addition, filling of wetlands in the 100-year floodplain is not allowed except for road crossings and stormwater management. Fill of wetlands for development of single family residences is also prohibited.

4.1.3 Septic Systems

Standard septic systems discharge about 8 lbs of nitrogen per person per year (CCCP, 2010) into groundwater. In 2007 there were 3,969 residential septic tanks and 100 acres of non-residential systems in the Mill Creek watershed. 94% of residential systems are located around Mill Creek (either in the Upper or Lower Mill Creek subwatersheds). Septic systems represent a majority of nitrogen releases into the Mill Creek watershed, with estimates based on the Chesapeake Bay Model ranging from 55.3% to 62.7% of total nitrogen loadings.

In 2008, the County Commissioners updated the County's Comprehensive Water and Sewerage Plan, which provides a framework for County water supply and sewerage disposal. The Plan requires that all on-site septic disposal systems (85% of County residents have such systems) must have one primary and two secondary septage recovery areas in order to receive Health Department approval to construct a home. If and when

these chambered tanks fail, the septage backs up into the house rather than spilling into the drain field and eventually overland to waterways.
In 2009, the Maryland State Legislature passed the Chesapeake Bay Nitrogen Reduction Act (Chapter 280). The law requires all new or replacement septic systems in the Critical Area to utilize the best available nitrogen removal technology (DLS, 2009). Homeowners in the Critical Area can receive financial assistance either in the form of a subtraction modification against the personal income tax or from the Bay Restoration Fund (BRF) (DLS, 2009). The BRF was established in 2004 as a dedicated fund, financed by wastewater treatment plants and onsite disposal system users, to upgrade municipal and residential treatment systems in Maryland.

The County Water and Sewerage Plan encourages all new lots not served by community, multi-use, or shared facility sewerage systems to be served by nitrogen removing systems. 43 (1%) of the residential septic systems in the Mill Creek watershed had denitrification technology in 2007. Nitrogen removing septic systems generally remove 50-70% of nitrogen, while some, more expensive systems can remove over 90% of the nitrogen.

4.1.4 Stormwater Management

Stormwater management (SWM) requirements protect waterways and wetlands from the impacts of runoff from impervious surfaces. This is particularly important in the town centers and in higher density subdivisions where impervious surfaces are greater. Proper management of stormwater runoff will minimize damage to public and private property, reduce the effects of development on land and stream channel erosion, assist in the attainment and maintenance of water quality standards, reduce local flooding, and maintain after development, as nearly as possible, the pre-development runoff characteristics. SWM controls the quantity and quality of runoff by a system of vegetative and/or structural measures.

The new Calvert County Stormwater Management Ordinance became effective May 4, 2010. The purpose of the Ordinance is to "protect, maintain and enhance the public health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff" (Stormwater Management Ordinance, 2010, p. 1). In the Ordinance, minimal environmental site design (ESD) requirements are established to attain water quality goals.

The Ordinance sets a groundwater recharge goal to mimic predevelopment groundwater recharge rates to maintain hydrology of existing streams. Also, owners are required to control for 2-year and 10-year storm events. All redevelopment projects must reduce existing site impervious areas by at least 50%. If impervious area reduction has been maximized, the owner can use alternative measures such as stream restoration, an on-site structural BMP, or fees-in-lieu. Under the Ordinance, exemptions exist for agricultural land management activities, developments disturbing 5,000 square feet or less of land area (only allowed once per property in its lifetime), or modification/addition to existing single family detached residential structures that disturb 5,000 square feet or less of land area (only allowed once per property in its lifetime).

4.1.5 Other Mitigation Efforts

Collaborative efforts with the community have reduced loads from certain sources of pollution in the watershed. Agricultural programs, including the Maryland Agricultural Cost-Share program (MACS), the Conservation Reserve Program (CRP and CREP) and the

Environmental Quality Incentive Program (EQIP), help farmers to afford nutrient management practices. Such practices to control runoff, erosion, and animal waste include grassed waterways, forested buffers, cover crops, and grade stabilization structures.

To control discharge of sewage from boats, the Clean Marinas Program enables marinas to become certified and gain public recognition for taking steps to reduce and manage waste in the facility. Requirements for certification include the provision of ample pump-out facilities, which many marinas provide outside of the Program, and design and operation actions to contain petroleum and other noxious material releases from boat maintenance. By state law, any new or expanded marinas with over 10 slips are required to provide a sewage pump-out station.

In 2004, the Calvert County Department of Planning and Zoning completed the report "Onsite Sewage Disposal System (OSDS) in Calvert County, Management Implementation Strategy, Problem Identification and Monitoring". It included recommendations for actions which have reduced nutrient loads into all County watersheds, including Mill Creek. These actions include regulations concerning septic systems, ensuring that low nitrogen fertilizers are available and promoted in Calvert County, providing citizen education and outreach, etc.

4.2 Floodplains

Regulations governing development in and adjacent to the 100-year floodplains are designed to protect the floodplain values described above as well as property and lives of residents. Activities in the floodplain are regulated via the Calvert County Zoning Ordinance, Calvert County Flood Management Ordinance, and the Calvert County Subdivision Regulations. The main issues relative to floodplains are loss of wetland floodplains and loss of life and property during flood events. The County has established a successful flood management program which directs most new growth out of the floodplain and, where allowed, requires appropriate construction techniques.

The Solomons Town Center, which is particularly susceptible to floods and sea level rise, is currently taking the following steps with regards to floodplain management: (1) increased flood elevation requirements (freeboard) by two feet (Solomons Town Center Zoning Ordinance), (2) reviewing the MD Climate Change Commission's report and considering ways to implement the Commission's recommendations, (3) working with the Chesapeake Biological Laboratory to monitor sea level rise in Calvert County, and (4) using geographic information systems technology to analyze the areas of the Town Center vulnerable to sea level rise (Solomons Master Plan, 2009).

4.3 Wildlife Habitat

Maryland has designated Habitat Protection Areas (HPA), which encompass areas and plant and animal species that merit special protection. They include (1) threatened, and endangered species and species in need of conservation; (2) plant and habitat overlays including Natural Heritage Areas, State-listed Species Sites, Locally Significant Habitats, waterfowl staging and concentration areas, habitats for colonial nesting water birds and forest interior dwelling (FID) birds; and (3) anadromous fish propagation waters (County Zoning Ordinance).

In the Critical Area, all development activities, redevelopment, or maintenance in HPAs require Habitat Protection Plans (HPP) approved by the State. A HPP includes protective measures where appropriate, including buffer areas, minimization of the removal of vegetation, reduction of runoff, and reforestation.

In addition, impacts to FID habitat must be mitigated using site design guidelines prescribed in “A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area” prepared by and available from the Critical Area Commission.

4.3.1 Oysters

In 2010, new Maryland regulations were enacted as part of the state’s Oyster Restoration and Aquaculture Development Plan, with a goal of restoring the oyster population in the Bay. The regulations expand oyster sanctuaries, quality habitat for oysters in which wild oyster harvesting is prohibited, from 9% to 25% of available habitat (DNR, 2010a). To enforce the protections in the Plan, DNR requires monthly oyster reports of watermen, has implemented radar and camera vessel monitoring technology, continues traditional natural police boat patrols, and has updated the penalty system for fishery law violations. All of Back Creek, St. John’s Creek, and Mill Creek have been designated as oyster sanctuaries under the Plan.

In addition to habitat protection, a broad coalition of state and federal agencies, community organizations, and citizens have been striving to restore oyster populations in the Bay and its tributaries for nearly three decades through aquaculture, oyster plantings, and habitat construction. One of the most recent projects in the Mill Creek watershed has been undertaken by the Southern Maryland Oyster Cultivation Society (SMOCS). In 2009, SMOCS placed approximately 150,000 oysters on a sanctuary reef in Mill Creek near Solomons (SMOCS, 2008).

4.4 Forest Cover

In the Critical Area, the Critical Area Program regulates forest conservation and provides the most stringent restrictions on clearing and requirements for reforestation. Within the Critical Area portion of the Mill Creek watershed, clearing relative to development is restricted to a maximum of 30% of the lot or parcel area and at least 100% replacement is required.

Outside of the Critical Area, the Forest Conservation Program (FCP) regulates forest removal and retention. Based on zoning, certain retention thresholds are set. Replacement of forest is required based on the amount of clearing in relation to the retention threshold. Priorities for forest retention are set forth in the FCP and include forested wetlands and wetland buffers, floodplains, steep slopes, large contiguous forest areas, endangered species habitat, etc.

The cluster provisions of the Zoning Ordinance direct development away from buffer areas and large contiguous tracts of forest.

Forest conservation regulations set thresholds for zoning districts, requiring the reforestation of a certain ratio of the trees lost in an area due to development. Almost the entire Mill Creek watershed is zoned as either residential, town center, or employment center districts. The conservation thresholds for these districts are 20 percent for the residential district and 15 percent for the town center and employment center districts. Above this threshold, one-quarter acre of forest must be planted for each acre removed. Below the threshold, the ratio changes to two acres planted for each acre removed.

4.5 Lake Lariat

In order to reduce mercury concentrations, the Maryland Department of the Environment (MDE) has established a Total Maximum Daily Load (TMDL) for Lake Lariat (MDE, 2002). A TMDL sets a limit on the maximum load of pollutants a body of water can receive while meeting water quality standards. MDE has set a TMDL at 1.21 grams per year (0.0033 grams per day). The TMDL is expected to be met through regulations, such as the Clean Air Act, which place limits on the sources of mercury emissions including power plants and incinerators.

In addition to high mercury levels, Lake Lariat water quality is also impaired by algae blooms including serious blue-green algal blooms in 2008 and 2009. Efforts to improve lake water quality include the Lake Preservation Committees creation and emplacement of three floating islands to remove nutrients.

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5 Goals

To be completed

6 Recommendations

To be completed.

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