Water Resources Element
Worcester County, MD

Prepared by the Worcester County Department of Development Review and Permitting
and reviewed by the Worcester County Planning Commission

Approved by the Worcester County Commissioners on October 4, 2011

RESOLUTION NO. 11 - 26

RESOLUTION AMENDING THE COMPREHENSIVE PLAN FOR WORCESTER COUNTY, MARYLAND TO INCLUDE A WATER RESOURCES ELEMENT

WHEREAS, the County Commissioners of Worcester County, Maryland adopted a Comprehensive Plan for the County on March 7, 2006; and

WHEREAS, the Comprehensive Plan was subsequently amended to add a Priority Preservation Areas Element by Resolution No. 10-1 adopted on January 5, 2010; and

WHEREAS, recent changes to State law require local jurisdictions exercising planning and zoning authority to include a Water Resources Element in their comprehensive plan; and

WHEREAS, the County's staff has prepared and the Worcester County Planning Commission has favorably reviewed the draft Water Resources Element; and

WHEREAS, the Planning Commission, after holding a duly advertised public hearing on July 7, 2011 in accordance with the requirements of Article 66B of the Annotated Code of Maryland, unanimously recommended adoption of the draft Water Resources Element; and

WHEREAS, the County Commissioners have considered the recommendation of the Planning Commission, have reviewed the document and have found that the adoption of the Water Resources Element is desirable and necessary to comply with the requirements of State law.

NOW, THEREFORE, BE IT RESOLVED by the County Commissioners of Worcester County, Maryland that the Water Resources Element attached hereto is hereby adopted as an amendment to the 2006 Worcester County Comprehensive Plan.

AND, BE IT FURTHER RESOLVED that this Resolution shall take effect upon its passage.

PASSED AND ADOPTED this 4th day of October, 2011.

ATTEST:

Gerald T. Mason
Chief Administrative Officer

WORCESTER COUNTY COMMISSIONERS

James C. Church, President

James L. Purnell, Jr., Vice President

Judith O. Boggs

Madison J. Bunting, Jr.

Louise L. Gulyas

Merrill W. Lockfaw, Jr.

Virgil L. Shockley

Blank page

Table of Contents

List of Tables

List of Figures

Blank page

Section 1 Introduction

1.1 Purpose

During the 2006 legislative session the Maryland General Assembly passed House Bill 1141 which requires that Maryland jurisdictions with zoning authority prepare a Water Resources Element (WRE)-and adopt their WRE in the County's *Comprehensive Plan*. This WRE must identify the following:

1. Water and other water resources that will be adequate for the needs of existing and future development proposed in the land use element of the *Comprehensive Plan.*
2. Suitable receiving waters and land areas to meet storm water management and wastewater treatment and disposal needs of existing and future development proposed in the land use element of the *Comprehensive Plan.*
3. Water quality impact on water resources, if any, by meeting these needs.

This document is Worcester County's Water Resources Element. It was adopted by the Worcester County Commissioners by Resolution No. 11-26 on October 4, 2011. By this action the Water Resources Element became an addendum to the *Comprehensive Plan Worcester County, Maryland,* originally adopted by the County Commissioners on March 7, 2006. This latter document is referred to as the *Comprehensive Plan* throughout the rest of this Water Resources Element.

In General

The WRE of the *Comprehensive Plan* creates a policy framework for sustaining public drinking water supplies and protecting the County's waterways and riparian ecosystems by effectively managing point and nonpoint source water pollution.

The WRE identifies opportunities to manage existing water supplies, wastewater effluent, and stormwater runoff, in a way that balances the needs of the natural environment with the County's projected growth, including the growth projected for the County's municipalities. In this way, this WRE helps to protect the local and regional ecosystem while ensuring clean and adequate drinking water for future generations of Worcester County residents.

1.2 Interjurisdictional Coordination

There are four incorporated municipalities in Worcester County: Berlin, Pocomoke, Ocean City, and Snow Hill. Residents and businesses of these communities receive public water and sewer service. These municipalities own and operate their water and wastewater treatment plants, as well as the distribution and collection systems. Each municipality developed a WRE and Municipal Growth Element (MGE) specific to their jurisdiction. They can be viewed online through the Maryland Department of Planning's (MDP) website at http://www.mdp.state.md.us/OurWork/CompPlans/ViewPlans.shtml (accessed September 13, 2010). To the extent possible, the County's WRE includes up-to-date data about each municipality in order to coordinate water resources, growth, and land-use planning.

1.3 Goal and Objectives

The *Comprehensive Plan* contains the following goal and objectives that directly relate to the WRE:

Goal:

This plan's goal is to maintain and improve the County's rural and coastal character, protect its natural resources and ecological functions, accommodate a planned amount of growth served by adequate public facilities, improve development's compatibility and aesthetics, continue the County's prosperous economy, and provide for residents' safety and health.

Objectives:

1. *Provide adequate public health, safety, social, recreation, and waste disposal services.*
2. *Protect drinking water supplies.*
3. *Preserve and protect natural resources and their ecological functions.*
4. *Accommodate planned future growth through designated "growth areas" with development standards designed to minimize environmental and habitat disruption.*
5. *Provide for adequate public services to facilitate the desired amount and pattern of growth.*

The WREs goal is to:

Maintain and protect the County's current water resources for their ecological and water supply benefits and to understand and mitigate to the extent possible the adverse affects of future growth on these resources. The WRE provides a strategy and implementation approach to meet water quality needs and legal requirements.

1.4 Land Use Plan Analysis and Growth Projection

The Land Use Element contained in Chapter Two of the *Comprehensive Plan* provides a watershed by watershed review of demand for, compatibility with, and amount of planned growth. During the development of the *Comprehensive Plan* and several watershed restoration action strategies (WRAS), the County undertook extensive land use analysis using GIS, or geographic information systems, which considered land, water, and wastewater service characteristics. This review considered many alternative approaches to growth and involved the public. For these reasons the *Comprehensive Plan's* land use map is used as the basis for designating land uses in Scenario A of the nonpoint source assessment which is discussed in section four of this WRE.

The *Comprehensive Plan* anticipates growth of about 18,000 persons and 7,700 new homes over the twenty year planning period. The *Comprehensive Plan* distributes this growth by infilling existing population centers and placing new development in the *Comprehensive Plan's* designated growth areas. Table 1-1 provides an estimated number of additional potential persons and dwelling units distributed among the growth areas. These locations were carefully selected to reduce environmental effects and to make them easy to provide with public services. Three of the four County growth areas will be tied to service expansion and municipal growth aspirations of

Table 1-1. Projected Population and Dwelling Growth

Subarea	Acres	RUT*	Potential Additional Population
Town of Berlin	1,326	2,910	6,781
Town of Pocomoke City	495	1,606	3,742
Showell	360	1,000	2,330
Town of Snow Hill	680	2,207	5,143
Totals	**2,861**	**7,723**	**17,996**

*Residential unit target; Source: Adapted from the *County Comprehensive Plan*, Worcester County Government.

the County's three inland towns. For planning purposes, these estimates are conservative as a small portion of this growth will occur in the more rural areas of the County. Rural development will occur on individual well and septic systems while growth area development will rely on public sanitary services. During the *Comprehensive Plan's* development, each municipality participated in the decision making process regarding its growth area sizing and location. Infill growth within each town's boundaries was addressed in their individual MGE and WRE. This approach eschews sprawl and standard automobile dominated subdivision development.

For more detailed land use and public infrastructure goals, objectives, recommendations as well as population, household and dwelling unit projection analysis methods refer to "Chapter Two: Land Use" and "Chapter Six: Public Infrastructure" in the *Comprehensive Plan*. For the detailed natural resources goal, objectives, and recommendations, refer to "Chapter Three: Natural Resources." These goals and objectives will be used to assess this WRE's recommendations for consistency with the *Comprehensive Plan*.

The County is committed to continuing its concentrated development pattern and developing in low hazard and less environmentally sensitive areas while reserving agricultural and other significant lands for natural resource reasons. This commitment was implemented by the adoption of new zoning maps and an updated Zoning and Subdivision Control Article on November 3, 2009. Since its adoption, the County has required that most forms of land use development employ environmental site design (refer to page 4-58 for more details). Likewise, the zoning maps limit higher density development to those areas having public services while retaining agricultural and resource protection zoning throughout most of the County.

1.5 Future Population and Household Growth

Worcester County's population growth has increased over the past four decades (Figure 1-1). The County's population grew steadily from 1970 to 1980. Afterward, population growth began to experience a slight decline until the 1990s when population growth began increasing rapidly.

Both the MDP and the County agree that population growth will continue to increase in the future despite MDP's projected slower growth rate (Figure 1-2). Recent economic and development conditions reached low ebb and impacted the County's growth rate. Figure 1-1 shows how growth leveled off between 2000-2010. During this time period, the County's overall population increased by just 4,911 persons while the previous decade attracted more than 11,000 persons into the County (Table 1-2). As shown in Table 1-2, most of the new residents

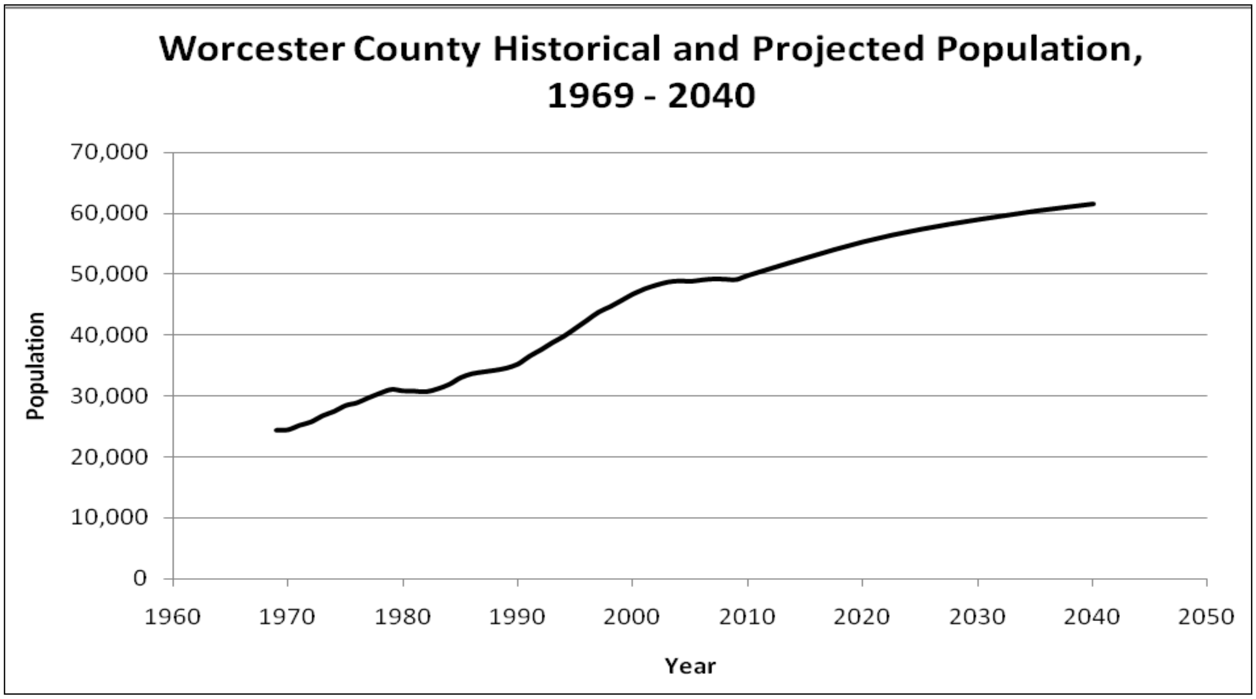


Figure 1-1. 1969 – 2009 data extracts prepared by the Maryland Department of Planning, Planning Data Services, from the U.S. Census Bureau and U.S. BEA, March 2010. 2010 – 2040 data extracts prepared by the Maryland Department of Planning, Historical and Projected Total Population for Maryland's Jurisdictions, September 2010.

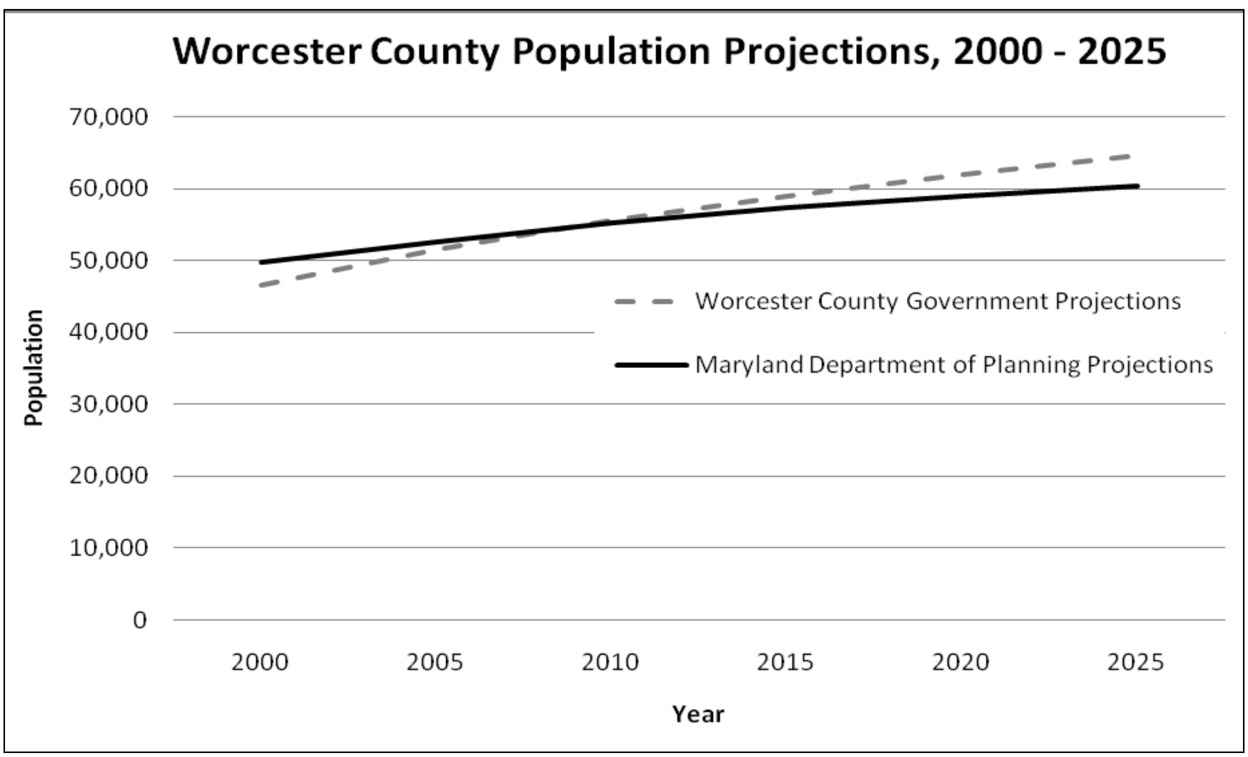


Figure1-2. Projections from the Maryland Department of Planning and Worcester County Government consistently show that population will continue to increase during the planning period.

moved outside of incorporated areas (4,208 persons) although the Town of Berlin experienced a 28% population increase and Pocomoke City experienced a 2% increase in population. Population growth decreased in the Town of Ocean City (-71 persons) and the Town of Snow Hill (-306 persons) from 2000 to 2010.

Table 1-3 shows the *Comprehensive Plan's* growth projections which were developed during the historical market boom time period. Subsequent to the adoption of the *Comprehensive Plan* and these projections, the real estate market slowed dramatically, resulting in flattened growth trends in recent years. However, given that real estate trends tend to be cyclical, particularly in a resort area such as Worcester County, the County concludes that the projections will remain valid for long term planning. The population and household projections shown in Table 1-3 serve as the basis for this WRE's assessments.

Table 1-2. Population for Incorporated Places in Worcester County, 1990 to 2010

Place Name	1990	2000	2010	Change (1999 - 2000)	Change (2000 - 2010)
Worcester County	**35,028**	**46,543**	**51,454**	**11,515**	**4,911**
Total Municipal Population	13,901	17,171	17,874	3,270	703
Percent of County	40%	37%	35%		
Balance of Worcester County	21,127	29,372	33,580	8,245	4,208
Percent of County	60%	63%	65%		
Town of Berlin	2,616	3,491	4,485	875	994
Town of Ocean City	5,146	7,173	7,102	2,207	-71
Town of Pocomoke City	3,922	4,098	4,184	176	86
Town of Snow Hill	2,217	2,409	2,103	192	-306

Source: U.S. Census Bureau.

Table 1-3. Projected Population and Projected Household Change

	5-year period					
	2000	2005	2010	2015	2020	2025
Population	46,543	51,543	55,543	59,043	62,043	64,543
Estimated Annual Change		1,000	800	700	600	500
Cumulative Population Change		5,000	9,000	12,500	15,500	18,000
Annual Household Change*		435	348	304	261	217
Cumulative Household Change		2,146	3,863	5,365	6,652	7,725

*Household size is assumed to be of 2.33 persons per household (Census 2000); Source: *County Comprehensive Plan*, Worcester County Government.

1.6 Pollution Assessment Considerations

To assess water quality in Worcester County, the following discusses the County's water quality impairments, total maximum daily loads, and Maryland's antidegradation policy which are considered throughout this WRE document. This document seeks to achieve the WRE and *Comprehensive Plan* goals while reducing nutrient contributions from nonpoint and point sources to a healthy and safe level for aquatic life and human contact and use.

Water Quality Impairments

Water bodies are classified as "impaired" when they are too polluted or otherwise degraded to support their designated and existing uses. Currently, the majority of the County's watersheds do not meet their designated use due to nutrient, sediment, biological, and/or bacteria impairments (Table 1-4). The Pocomoke River and Coastal Bays are designated as Use II[1] while the remaining waterways in the County are designated as Use I[2]. The Maryland Department of the Environment (MDE) defines a designated use for a water body as a description of an appropriate intended use like recreational swimming, fishing, and seashell harvesting by humans and/or aquatic life. Impaired water bodies that do not meet these uses are not suited to receive additional nutrient loads.

Table 1-4. Watershed impairments*

Watershed Name	Impairments			
	Nutrients	Sediment	Biological	Bacteria
Coastal Bays Watershed				
Assawoman Bay	Y			
Chincoteague Bay	Y	Y		
Isle of Wight Bay	Y			
Newport Bay	Y			
Sinepuxent Bay	Y			
Chesapeake Bay Watershed				
Dividing Creek				Y
Lower Pocomoke River	Y		Y	
Nassawango Creek				
Upper Pocomoke River		Y	Y	
Wicomico Creek				

*Source: Maryland Department of the Environment

---

[1] Use II: support of estuarine and marine aquatic life and shellfish harvesting. Please note that water bodies designated as Use I do not necessarily support the shellfish harvesting use as some waters may be tidal but too fresh to support viable populations of shellfish. Retrieved July 27, 2010 http://www.mde.maryland.gov/researchcenter/data/waterqualitystandards/index.asp.
[2] Use I: Water contact recreation, and protection of nontidal warm-water aquatic life. Retrieved July 27, 2010 http://www.mde.maryland.gov/researchcenter/data/waterqualitystandards/index.asp.

Total Maximum Daily Loads

Impaired waterways receive TMDLs, or a prescribed "diet", for specific pollutant types such as nitrogen, phosphorus, and sediment. A TMDL is also referred to as a Total Maximum Daily Load and identifies the maximum amount of a pollutant a waterway can receive without impairing water quality. A TMDL can be further subdivided into pollution limits for regulated sources such as wastewater treatment plants (WWTPs) and unregulated sources including stormwater and agricultural runoff. By knowing how much pollution can come from different sources like WWTPs and stormwater and agricultural runoff, for example, then all stakeholders can have a better understanding of the pollution reduction necessary to attain designated uses and help improve water quality.

Table 1-5 summarizes TMDLs in the Coastal Bays Watershed approved by the U.S. Environmental Protection Agency (EPA) in 2001 and 2002. However, new TMDLs for the Coastal Bays Watershed are currently in development and are not planned for release until late summer or fall of 2011. Nutrient TMDLs for the Chesapeake Bay Watershed are in development as well with final quantitative figures planned for release by the summer of 2011. It is likely that the County's first WRE will be complete before the new TMDL figures for both watersheds are released. Thus, the County will consider the new TMDL impacts to assessments conducted for this WRE and revise strategies and implementation measures as needed during the 6-year review period for the *Comprehensive Plan*. To the extent possible, historical TMDL figures for the Coastal Bays Watershed and draft TMDL figures for the Chesapeake Bay Watershed are considered in the nonpoint source assessment described in section four of this document.

Antidegradation

Maryland's antidegradation policy significantly limits new discharge permits and expansions of existing permits that would degrade water quality in Tier II (high quality) waters, as defined by the EPA (MDE 2008). In these areas, new nutrient discharges can be permitted as long as they do not degrade existing water quality. Designated Tier II waters are protected more stringently due to water quality that is better than the minimum specified for that designated use. There are four Tier II waters in the County: Nassawango Creek 2, Nassawango Creek 3, Dividing Creek 1, and Little Mill Creek 1(Figure 1-3). These tributaries have very little existing development on their borders and there are no future growth areas affecting Tier II waters. None of the County's public WWTPs discharge to Tier II waters.

1.7 Conclusion

The WRE provides the County with an assessment of its groundwater and surface water resources and how future growth will affect them. This helps the County plan for coming needs and avoids unnecessary future costs. The *Comprehensive Plan* distributes approximately 18,000 new residents and development by infilling existing population centers and in the *Comprehensive Plan's* designated growth areas. The remainder of the WRE assesses the County's water supply, wastewater services and disposal and nonpoint sources. Each assessment identifies future service demand, associated issues, and a strategy to address them.

Table 1-5. Coastal Bays Watershed TMDL Summary, 2001-2002

	TMDL[1]						
Sub-Watershed	**Nitrogen (lb/yr)**			**Phosphorus (lb/yr)**	**Sediment (m^3/yr)**	**Biological Oxygen Demand (lbs/month)**	
St. Martin River System[2]			222,110	41,133	none		none
Bishopville Prong			64,946	9,471	none		none
Shingle Landing Prong			104,700	12,926	none		none
Herring Creek			9,547	1,235	none		none
Turville Creek			26,272	3,928	none		none
	June 1 – Oct. 31	**April 1 – May 31**	**Nov. 1 – March 31**				
Ayer Creek (lbs/month)	215	1,824	2,085	none	none		none
Newport Creek (lbs/month)	280	2,194	2,886	none	none		none
Newport Bay (lbs/month)	4,491	17,202	32,270	none	none		none
						June 1 – Oct. 31	**April 1 – May 31**
Kitts Branch (lbs/month)			none	none	none	1,369	6,132
Big Millpond			none	880	931.9		none

Sources:

Maryland Department of the Environment. *Total Maximum Daily Loads of Nitrogen and Phosphorus for Five Tidal Tributaries in the Northern Coastal Bays System, Worcester County, MD.* Baltimore. December 31, 2001.

_______. *Total Maximum Daily Loads of Phosphorus and Sediment to Big Millpond, Worcester County, MD.* Baltimore. January 31, 2002.

_______. *Total Maximum Daily Loads of Nitrogen for Three Tidal Tributaries and Total Maximum Daily Load of Biochemical Oxygen Demand for One Tributary in the Newport Bay System, Worcester County, MD.* Baltimore. December 27, 2002.

[1] TMDL=Point source + Nonpoint source + Margin of Safety (5% of nonpoint source loads)
[2] Includes Bishopville Prong, Shingle Landing Prong and St. Martin direct

Figure 1-3. Tier II Waters in Worcester County, Maryland.

Section 2 Water Supply

2.1 Introduction

Worcester County's water supply relies entirely on local groundwater resources to support household, industrial, and commercial uses. This includes washing clothes, cars, and boats as well as irrigating golf courses, residential yards, and farmland. Typical household uses include bathing, drinking, and cooking. Critical factors in this WRE assessment are the sufficiency of water distribution systems and level of treatment for public and larger private systems. Additionally, the current and future quantity and quality of our groundwater resources are assessed. In the following section current groundwater resource conditions, water availability, and water supply recommendations are provided.

2.2 Current Conditions

In order to assess future water availability, this section discusses groundwater resources availability, general hydrology in Worcester County, groundwater protection, and water supply infrastructure. To begin, the following section provides information about our current understanding of available groundwater resources in the County.

Available Groundwater Resources

According to the State of Maryland, Department of Geology, *Mines and Water Resources Bulletin 16*, 1955, "The quantity of groundwater in the sedimentary deposits of Somerset, Wicomico, and Worcester Counties is estimated at 600,000 billion gallons." Much of this water cannot be recovered because it exists in clay formations or at depths down to 8,000 feet and much is highly mineralized, which limits its uses.

As *Bulletin 16* states, "Of greater importance than the quantity of water stored in the sediments is the quantity of groundwater recharge by infiltration from rainfall and from bodies of surface water." The importance of aquifer recharge is obvious when wells are impacted by drought or salt water intrusion due to over-pumping. Reclaiming, reusing, and returning groundwater to the aquifer source is the best way to protect and preserve the water resources locally.

As noted above, in the past, studies and reports by the United States Geological Survey (USGS) and Maryland Geological Survey (MGS) have indicated adequate groundwater sources in Worcester County. However, there has been no comprehensive evaluation of water use in the Coastal Plain Aquifer System for several years. In response to the lack of current information about local groundwater resources, the USGS will conduct a regional assessment of the Coastal Plain System in Maryland. This USGS study is projected to be complete by 2015.When completed this assessment will identify the amount, location, and character of groundwater supply sources to help Coastal Plain counties facilitate sound management of these sources. Until this study is completed, assessing the resource potential of the aquifer systems cannot be adequately performed.

Based on previous studies indicating that there are adequate groundwater sources in Worcester County, this WRE recommends continuing future planning efforts as recommended in the *Comprehensive Plan*. When the USGS regional groundwater assessment is completed, the

County will be able to apply the updated information and data to determine whether water resources will be available and adequate for long-term planning purposes. Following is a brief overview of general hydrology in the County.

General Hydrology

Worcester County lies within the Atlantic Coastal Plain Physiographic Province. This province includes roughly the area east of Interstate 95 in Maryland. It is underlain by unconsolidated elastic sediments of Lower Cretaceous to recent age, which thicken to the southeast so that they appear wedge-shaped. The thickness of these sediments is greater than 8,500 feet beneath the Atlantic shore. There are five small community water systems that pump water from the Quaternary sediments, an unconfined aquifer. This aquifer has been studied considerably and hydrologic, lithologic, and geochemical data is available in several MGS reports (1955, 1972, 1974, 1982, and 1993).

The County has four main sand and gravel aquifers that yield substantial quantities of generally good quality groundwater. The four aquifers used in Worcester County, in order of increasing depth, are the Pleistocene, Pocomoke, Ocean City, and Manokin Aquifers. Figure 2-1 shows a cross section of these aquifers in northern Worcester County. Figure 2-2 shows the areas of the County where the principal aquifers, Pleistocene, Pocomoke, and Manokin Aquifers, are used and Table 2-1 lists the aquifer nomenclature-depths, thickness, and soil characteristics. A brief explanation of each aquifer follows.

The Pleistocene Aquifer

In many areas of the County, adequate quantities of groundwater can be obtained within the upper 100 feet of land surface from the Pleistocene Aquifer. The aquifer is very productive and is the most commonly used; however, the deeper confined aquifers are becoming more utilized now. The Town of Berlin and the Ocean Pines community both utilize this aquifer, along with many smaller public water systems and hundreds of private wells. Agricultural wells are usually limited to this aquifer as well. This aquifer is generally considered to be unconfined, although in many areas it is partially confined by shallow silty clay layers. It receives recharge by local precipitation and is vulnerable to surface contamination and salt water intrusion.

This aquifer is also referred to as the Columbia Aquifer or Quaternary Aquifer in MGS reports. The Quaternary sediments are mostly surficial, of fluvial and estuarine origin and are composed predominantly of sand and gravel with some layers of silty clay and clay. The aquifer functions as a water-table aquifer. Its thickness ranges from a few feet to 220 feet, with the thickest layers located in the northeast and southeast parts of the County. In general, the regional movement of groundwater is from areas with a high water table, corresponding to topographic highs, towards streams and the Chesapeake Bay and the Atlantic Ocean. In areas with high water tables, there may be hydraulic connections with underlying aquifers, and water may move downward to recharge these underlying aquifers. Aquifer tests conducted on Quaternary sediments indicate that transmissivity ranges from 100 to 50,000 ft^2/day.

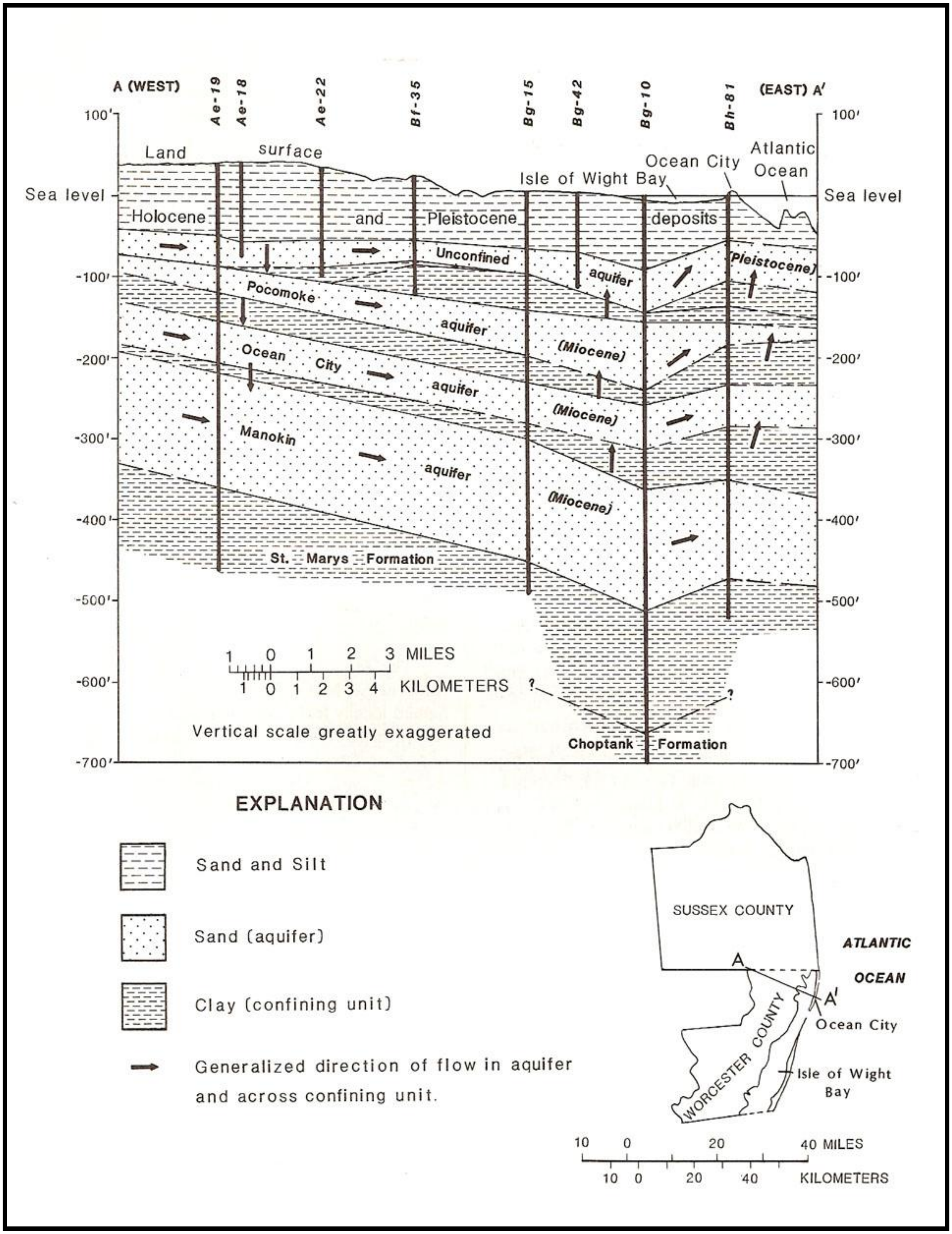


Figure 2-1. Cross Section of Aquifers in Northern Worcester County, Maryland.

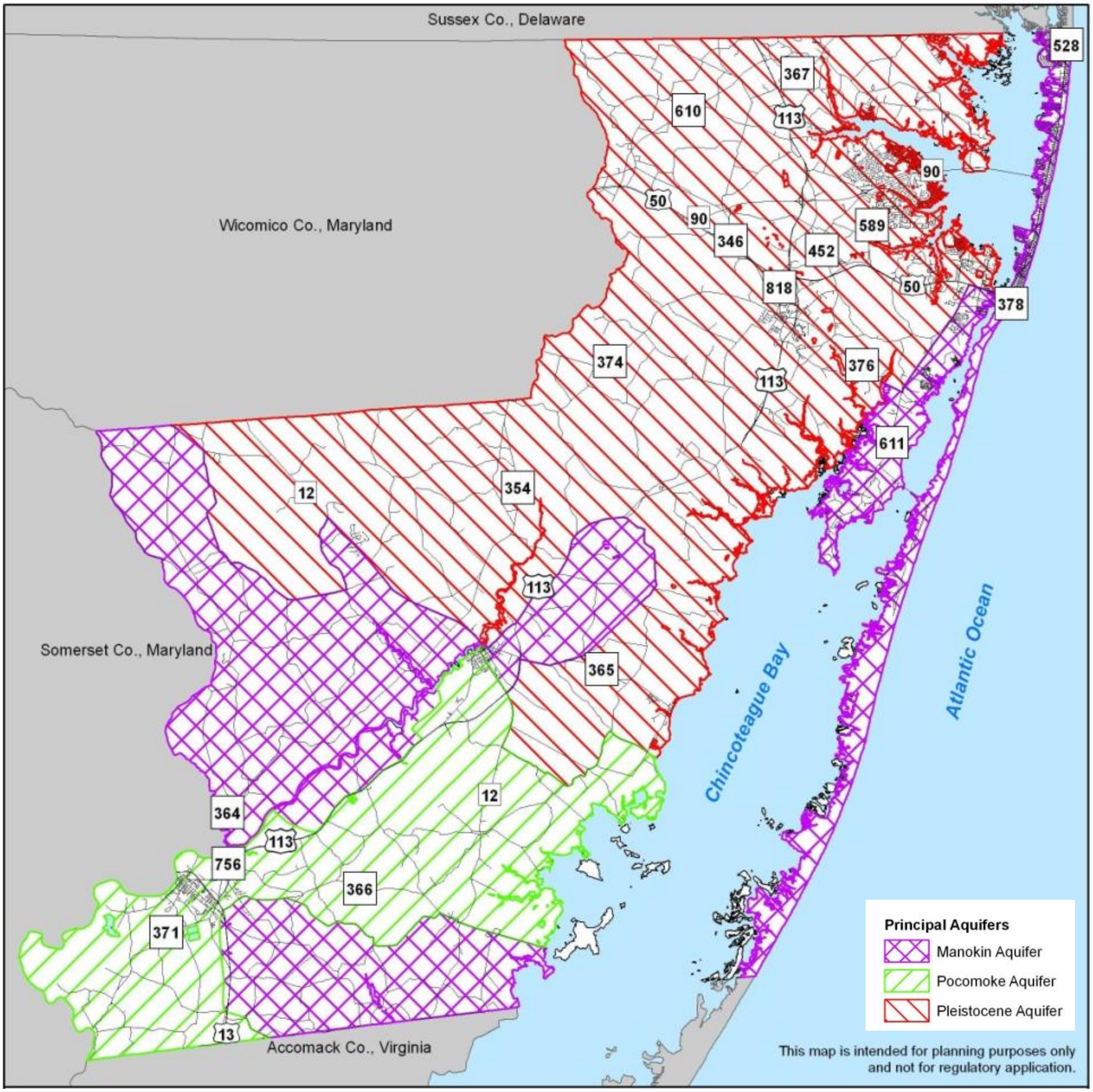


Figure 2-2. Principal Aquifers in Worcester County, Maryland.

Table 2-1. Coastal Plain Stratigraphic Nomenclature and Aquifers of the Eastern Shore of Maryland

System	Series (Group)	Geologic Unit	Thickness (feet)	Hydrogeologic Unit(s)	Dominant Lithologic Character
Quaternary & Tertiary	Holocene	Holocene deposits	0 – 40	-----	Soil, alluvial sand and silt, dune sand, and peat. Disconformable base.
	Pleistocene & Pliocene (Columbia Group)	Shoreline complex	0 – 230	Columbia Aquifer	Lenticular deposits of sand, silt, clay, and peat. Some beds of coarse sand and fine gravel. Tan; some gray and blue clay.
		Salisbury Formation: Beaverdam Fm. and Pensaukan Fm. of Owens and Denny (1979)			Beaverdam Sand: Light gray to light tan, fine to coarse grained, moderately sorted, feldspathic sand. Pensauken Formation: Light tan to orange tan, medium to coarse grained, moderately to poorly sorted, pebbly feldspathic sand.
Tertiary	Miocene (Chesapeake Group)	Upper Miocene Aquifer Complex [Yorktown and Cohansey Formations of Rasmussen and Slaugheter (1955)]	0 – 50	Upper confining bed	Lenticular silts, clays, and fine sands. Green-blue silt and fine gray sand most common, but occasionally includes blue-green pebbly clay.
			0 – 80	Pocomoke Aquifer	Sand, gray or tan-gray; coarse and pebbly generally, but locally fine.
			0 – 85	Lover confining bed	Blue and gray clayey silt and sand; some peat. Some beds of shell and calcite and/or limestone.
				Ocean City Aquifer	Coarse gray sand, fine gravel.
			0 – 240	Manokin Aquifer	Fine to very coarse gray sand, and some lignite or peat. Some silty sand and clay. Occasional beds of shell and/or "rock".
		St. Marys Formation	0 – 190	Confining layer	Gray fossiliferous clay, silt, fine sand, and silty and sandy clay.
		Choptank Formation	0 – 240	Frederica Aquifer and confining layer	Gray fine sand. Thin Beds of shell and calcite. Green or brown clay and fine sand. Thin beds of shell and calcite or limestone.

The Pocomoke Aquifer

The top of the Pocomoke Aquifer ranges from about 50 feet below sea level in the northwestern portions of the County to about 150 feet below sea level in the southeastern portions of the County. The aquifer rises to the northwest, at the rate of 5 to 6 feet per mile and directly underlies the Pleistocene and Pliocene in relatively thin and permeable deposits in an intake belt (subcrop area), the nearest of which is about 5 miles northwest of Pocomoke City. The aquifer is overlain by the upper confining bed which consists of lenticular bodies of silt, clay, and fine sand. It consists predominantly of gray medium to fine-grained sand. In places, it has stringers of coarse sand and small gravel and thin lenses of brown or blue clay. The cumulative sand thickness of the aquifer ranges from 20 to 65 feet. Transmissivity values for the aquifer range from 2,000 to 8,000 ft^2/day and the direction of groundwater flow is towards the southeast.

The Ocean City Aquifer

The top of the Ocean City Aquifer ranges from about 125 feet below sea level to 250 feet below sea level. This aquifer is restricted to northeastern Worcester County and appears to pinch out and updips near Willards in Wicomico County. The general direction of groundwater flow is from northwest to southeast with a gradient of about one foot per mile. The aquifer consists of fine to coarse orange tan sands, greenish-gray glauconite bearing clayey silts, and fine sands.

The Manokin Aquifer

The top of the Manokin Aquifer ranges from about 150 feet below sea level to 350 feet below sea level and dips to the southeast. The aquifer has an intake belt beneath the sands and gravels of the Pleistocene and Pliocene series from which it receives recharge directly. The belt is located in Wicomico County and is 2.5 to 6 miles in width and crosses the northwestern corner of the area from Nanticoke through Hebron to Delmar. The regional groundwater flow direction in the aquifer is mainly towards the east. The Manokin Aquifer is a gray medium to fine-grained sand. It is coarser in the lower portion, containing some coarse sand, granules, and small lenses of fine gravel. The upper portion is fine to very fine sand, becoming silt in places. Shell fragments are present in a few of the sand layers. The aquifer is overlain by the lower confining bed which consists of blue and gray clay, silt, and fine sand.

As described above, the County’s sole source of potable water is withdrawn from four aquifers. The Pleistocene Aquifer is the most commonly used; however, the deeper confined Manokin and Pocomoke Aquifers, as shown in Figure 2-2, supply potable water to the southern and far eastern and central western parts of the County. The deeper aquifers are confined (artesian) aquifers, except for the Pocomoke Aquifer in a small area of Bishopville. The recharge areas for these aquifers may be several miles away. These aquifers are less susceptible to surface contamination but more impacted by over-pumpage. Ocean City, Snow Hill, and Pocomoke utilize these aquifers, along with many smaller public systems and private wells. Combined, these aquifers have supplied and are likely to continue to supply an adequate amount of water to users in the County. In the following discussion, the *Groundwater Protection Report* is summarized.

Groundwater Protection Report

The County's *Groundwater Protection Report* (1988), or GPR, is a management plan designed to protect the County's groundwater resources, especially the surficial aquifer in areas with seasonally high water tables. The GPR outlines three management areas within the County which are identified based on soil characteristics, water table, and other features. The GPR also describes the type of septic system as well as specific construction techniques that is permitted in each of the three management areas. Recommendations about minimum well depths, well construction techniques, and other factors to further reduce the possibility of contamination of the valuable surficial aquifer are also provided in the report.

The GPR is adopted by reference into the County's *Master Water and Sewer Plan*. MDE has also prepared source water assessments for all public water systems, including community systems, non-transient non-community and transient non-community water supply systems in Worcester County. The County should work with those users, its municipalities and with its own water system operators to investigate and implement action items identified in those assessments.

Well Head Protection Plans

Both the Town of Berlin and Ocean Pines water service systems have well head protection plans delineated for their well fields. This plan identifies water supplies relying on unconfined aquifers. These may be subject to contamination from land use activities. The Town of Berlin and the Ocean Pines Water Planning Area utilize the Pleistocene Aquifer, which is unconfined at those locations and more susceptible to contamination.

Water Supply Infrastructure

In Worcester County, groundwater is the sole source of potable water. There are 19 community water systems: four municipalities, six County-owned systems, six mobile home parks, and three systems serving apartment complexes. There are 41 non-transient non-community water systems that serve a variety of large non-residential uses. Table 2-2 lists the number of non-transient systems by use. In addition, there are 120 transient non-community water systems that serve a variety of commercial, government, office, and seasonal residential uses.

Depending on their location, these water systems may use the shallow Pleistocene Aquifer or the deeper confined aquifers. Many of these water systems have multiple wells. The largest water supplier in the County is the Ocean City municipal system, which has 16 wells in the Ocean City Aquifer and 8 wells in

Table 2-2. Non-transient Water Systems by Use

Use	Number of systems
Mobile Home Parks	1
Golf Courses	0
Commercial Centers	17
Hotel/Motel	3
Racetracks	1
Campgrounds	2
Industrial	3
Daycare/schools	11
Offices	3
TOTAL	**41**

Source: Worcester County Department of Development Review and Permitting, Division of Environmental Programs. January 2011.

the Manokin Aquifer. The expanded Mystic Harbour Water Service Area currently has several hundred domestic and commercial wells at varying depths. These wells serve a variety of uses including existing residences. If these wells fail, user(s) must connect to a public water distribution network if it is readily accessible to the property.

Water Planning Areas

Water planning areas are generally adjacent to existing population centers and municipalities (Figure 2-3). A water planning area is an area designated as planned to receive public water service from a town or the County. The estimated time for receiving service is represented by one of the following designations: Present to 2 years (W1), future service 3-5 years (W2), or future service 6-10 years (W3). The areas served by private community systems can be designated W1 but are not planning areas.

Creating or amending a planning area requires an amendment to the *Water and Sewer Plan*. However, the inclusion of any water system in the *Water and Sewer Plan* does not legally obligate the County or any of its political subdivisions to take any action to implement such projects or to enforce the implementation of such projects.

The *Comprehensive Plan* has designated growth areas near existing population centers and attempted to continue the County's compact development pattern. Figure 2-3 shows the water system planning areas overlain on areas zoned for development and planned for growth at urban densities. This approach will assist in the containment of water service costs.

Most of the existing water systems serve communities or uses with limited expected growth. Growth in such areas will generally be infill or modest service area expansion over the next ten years. Some of the water service areas will expand in accordance with the County's planned growth strategy. An amendment to the *County Water and Sewer Plan* is necessary for expansion of a service area. Compliance with this plan is a prerequisite for state approval of both groundwater discharge and groundwater appropriation permits.

Water Management Strategy Area

MDE has designated the Ocean Pines Water Service Area a Water Management Strategy Area. Figure 2-4 shows the general boundary line for the strategy area. This designation means that MDE has identified a specific water resource problem (possible salt water intrusion) and have adopted specific criteria for permit approval to protect the water resource and existing users.

Conservation Measures

Since 1993, water conservation measures with financial disincentives have been implemented in the County's water service areas. These measures mandate water conservation and discourage wasteful usage by creating a rate structure for residential and commercial customers. This approach makes every user more accountable for their water usage by requiring each user to pay more for every 1,000 gallons of water actually used instead of the more conventional tiered systems where the cost per gallon of water gets cheaper the more you use. Overall, the County's water conservation measures have reduced water demands.

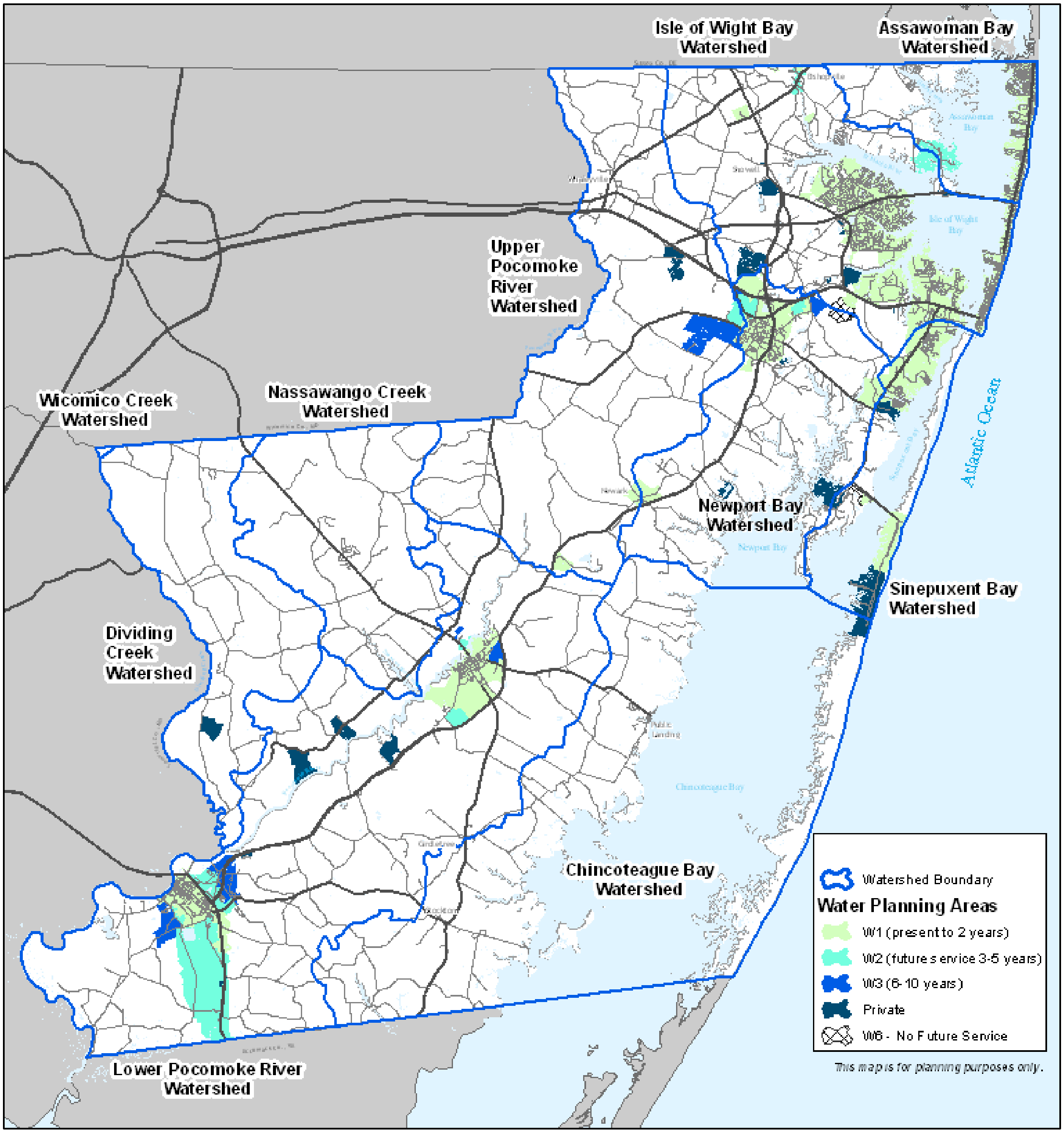


Figure 2-3. Water Planning Areas. Generalized boundaries for W1, W2, W3, W6 or Private water service designations are shown above.

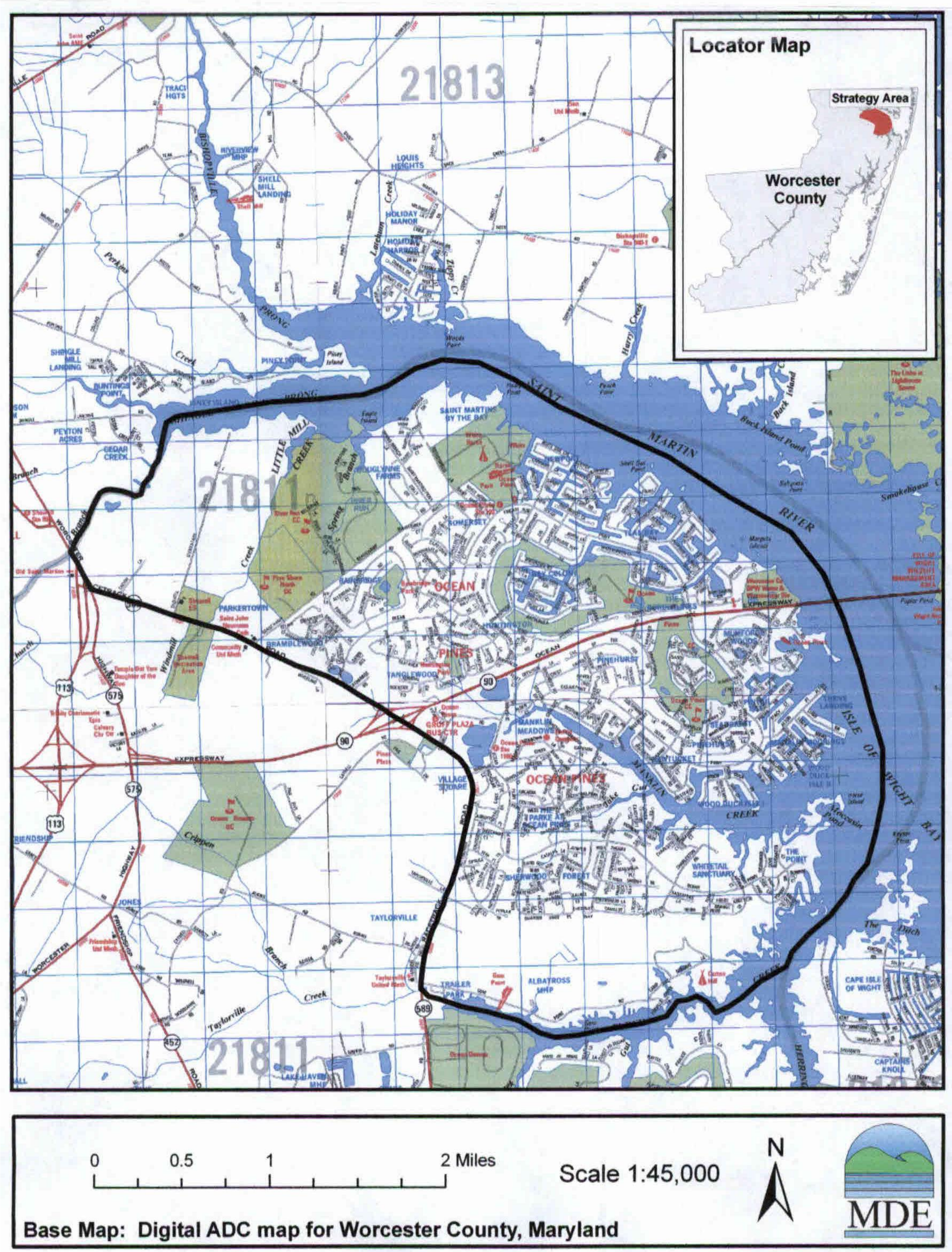


Figure 2-4. Ocean Pines Water Management Strategy Area

Additional State regulations address unaccounted water for capacity development for new systems, water appropriations, and water conservation plumbing fixtures. The Code of Maryland Regulations (COMAR) 26.04.01.36.G (b) requires tracking to keep systems informed about how much water is leaking in distribution systems.

The MDE also issues water withdrawal permits for beneficial appropriations or use (COMAR 26.17.06.05A). This regulation assists local jurisdictions by adding further scrutiny to the permitting process; for example, during the permit review process applicants are required by the State to determine unaccounted water in their permit application. Applicants must also certify that they will install water conserving fixtures that will conform with the State Plumbing Code. For instance, COMAR 09.20.01.02 H (1) requires low flow toilets to be installed for all new facilities. Furthermore, COMAR 09.20.01.02.J (9) and 12-605 to 12-607 in the Annotated Code of Maryland prohibits the installation or sale of a plumbing fixture which is not an approved plumbing fixture. Thus, no high flow plumbing fixtures can be legally sold or installed in buildings in the County. The County's *Water and Sewer Plan*, according to COMAR 26.03.01.07, must conform with Maryland's Water Conservation Plumbing Fixtures Act as well.

2.3 Water Supply Assessment

For this WRE, Worcester County estimated the amount of groundwater resources withdrawn. This was followed by two assessments quantifying the amount of groundwater required to meet future projected population growth. Assessments are based on today's planning assumptions for both population and water usage per EDU.

Groundwater Withdrawals

Maximum daily groundwater withdrawals in Worcester County are estimated at ~31 million gallons per day, or GPD (Table 2-3). In the future, withdrawals are projected to increase to ~37 million gallons per day. This reflects a 17% increase in withdrawals from all uses. Three fourths of the withdrawal will be in municipal water systems. Public water systems including major community water and municipal water serving residential and commercial areas as well as major industry have the potential to withdraw up to 19.5 million GPD of groundwater. Maximum withdrawal by public water systems is projected to increase by approximately 5.6 million gallons per day. There are a few industrial users on individual wells which withdraw up to 90,000 GPD of groundwater. The maximum daily withdrawal for private residential wells is ~2.1 million GPD which includes ~8,400 residential users, mobile home parks, and small community wells.

Agriculture withdraws an average of 9.3 million gallons of water daily accounting for nearly one third of the potential water usage in the County. This is common for most of Maryland's Eastern Shore where farmers use groundwater for crop irrigation and livestock (primarily poultry) watering. Agriculture's groundwater withdrawal may increase by nearly 1 million GPD in the future.

Table 2-3. Existing and Future Maximum Daily Groundwater Withdrawals (GPD)

Use	Existing Use	Future Use
Major Community Water System	3,995,000	4,623,500
Municipal Water System	15,564,000	20,570,000
Industrial	90,000	90,000
Agriculture water use*	9,352,500	10,194,225
Private residential well	2,100,000	2,306,250
Total Groundwater useage	31,101,500	37,783,975
Natural groundwater available[1]	Adequate	Adequate
Recharge rate	Adequate	Adequate
Groundwater remaining	Adequate	Adequate

Source: Department of Development Review and Permitting.
*Agricultural water use is based on daily average amount not to exceed annual withdrawal permits.

Rural Water Supply

Worcester County is still largely a rural County, with agriculture as the main industry. Poultry production and agricultural crop production are the largest consumers of water in rural areas. While groundwater is the main source of water for farm irrigation, there is some surface water also used for irrigation in the southern areas of the County. Farm irrigation wells are restricted to the Pleistocene Aquifer but many poultry house wells utilize the deeper aquifers. Sufficient groundwater resources currently exist to supply the requirements of domestic wells in rural areas of the County and for the future, based on projected growth rates in those areas.

One area of concern is southwestern Worcester County, including the area surrounding Pocomoke City. This area utilizes the Pocomoke Aquifer only. The transmissivity of this aquifer has been decreasing over the years. Below the Pocomoke Aquifer, the groundwater is high in chlorides. Over-withdrawal of the Pocomoke Aquifer, causing decreased pressure in the aquifer and a large cone of depression, could causes chloride problems in the future. Monitoring water use in this region, including withdrawals from neighboring Somerset County, should be undertaken to ensure supplies are adequate for future growth in the area.

[1] USGS "Sustainability of the Ground-Water Resources in the Atlantic Coastal Plain of Maryland" study pending funding. USGS Fact Sheet FS 2006-3009, 2006.

Projected Water Demand

Two assessments were conducted to estimate potential water supply demand. The first assessment considered the municipalities' WRE analyses. Combined with the County's *Comprehensive Plan*'s growth projection for the Village of Showell growth area, an additional demand of 911,750 gallons per day (GPD) of water is needed to accommodate 8,031 additional persons (Table 2-4).

The second assessment is based on the County's *Comprehensive Plan.* The county-wide assessment required consideration of all persons living within municipal boundaries and in the County regardless of whether a private or public water supply is provided. The *Comprehensive Plan's* growth projections estimate 10,000 more persons and approximately 1.1 million more gallons per day of water than projected in the first assessment. Table 2-5 shows the *Comprehensive Plan's* allocation of population growth among the designated growth areas and

Table 2-4. Municipal Projections: Additional Water Demand Projected for Growth Area

	Predicted Population Increase	EDUs Generated	GPD/EDU	Additional Demand Projected (GPD)
Berlin	1,768	759	250	189,750
Pocomoke	2,286	981	250	245,250
Village of Showell	2,330	1,000	300	300,000
Snow Hill	1,647	707	250	176,750
Total	**8,031**			**911,750**

Sources: This table was prepared with EDU and GPD/EDU data provided in each municipality's WREs and the *Comprehensive Plan* provided the Village of Showell data. Assume 2.33 persons per EDU.

Table 2-5. County Projections: Additional Water Demand Projected for Growth Area

Growth Area	Population Increase	EDUs Generated	GPD/EDU	Additional Demand Projected (GPD)
Berlin	6,781	2,910	250	727,500
Pocomoke	3,742	1,606	250	401,500
Village of Village of Showell	2,330	1,000	300	300,000
Snow Hill	5,143	2,207	250	551,750
Totals	**17,996**			**1,980,750**

Sources: This table was prepared with GPD/EDU data provided in each municipality's WREs. The 2006 *Comprehensive Plan* provided the Village of Showell GPD/EDU data and the population increase figures which were obtained from the Residential Unit Target (RUTs). Assume 2.33 persons per EDU.

identifies the additional water supply that will be needed to meet this demand. Approximately 1.9 million GPD of water will be needed to accommodate the projected population growth increase of nearly 18,000.

The results of the population projection analyses differ by 10,000 persons and approximately 1.1 million gallons per day of water due to the fact that the County's population projections took place under different economic conditions than when the municipalities conducted their projections for their respective WREs.

As stated in Section 1 of this document, the County and municipalities worked together to develop growth areas adjacent to their respective municipality during the County Comprehensive Planning process. During this process, population projections were also developed. Since the adoption of the County's *Comprehensive Plan*, changes in municipal leadership and the housing market have influenced the development of the municipal WREs. Although the County concluded that the *Comprehensive Plan* projections will remain valid for long term planning, the County will consider potential impacts to the population growth projections during their 6-year review of the *Comprehensive Plan* scheduled to begin in 2012. The County and municipalities will continue to work together, as demonstrated during the Comprehensive Planning process, to resolve any issues.

Water System Capacity for Future Projected Growth

Table 2-6 lists the County and municipal public water systems and pertinent system facts. With the exception of four water systems, Briddletown, Newark, Pocomoke, and the Village of Showell, the majority of the water systems in the County have more than enough planned capacity to supply water to the projected population under either the municipality or County assessment. The difference between the planned capacity and current capacity is the capacity for growth. Beyond this, additional users can be hooked up to existing water distribution systems while considering improvements needed for infrastructure distribution as well as the location of potential users relative to nearest water distribution system.

New Development Water Supply Policy

The County's policy regarding providing potable water to new development within a public water service area is that the developer(s) and/or property owner(s) associated with the growth area or the service area's expansion shall bear the responsibility for all costs associated with the water system's expansion. This includes costs that accommodate the proposed development, including infrastructure and treatment system costs. Treatment facilities and public infrastructure for new and expanded public water areas are built by the developer(s) and turned over to the County for operation and management of the systems.

Table 2-6. County and Municipal Water Systems

Water System	No. of Wells	Source Aquifer	Current Capacity (GPD)[1]	Planned Capacity (GPD)[2]
Assateague Pointe	2	Ocean City	35,000	64,000
Berlin	**3**	**Pleistocene**	**490,000**	**1,000,000**
Briddletown	1	Pleistocene	12,000	12,000
The Landings	2	Ocean City	115,000	200,000
Mystic Harbour	3	Ocean City (1) Pocomoke (2)	512,500	1,000,000
Newark	2	Manokin (1) Pocomoke (1)	142,500	142,500
Ocean City	21	OC/Manokin	16,600,000	18,100,000
Ocean Pines	5	Pleistocene	1,500,000	2,000,000
Pocomoke	**4**	**Pocomoke**	**860,000**	**860,000**
Riddle Farms	2	Manokin	205,000	228,000
Village of Showell	**n/a**	**n/a**	**n/a**	**n/a**
Snow Hill	**3**	**Manokin**	**320,000**	**1,094,000**

Notes: Bold text indicates growth areas.

1. The current capacity for water means that the figure shown is the maximum treatment capacity of the water treatment system in conjunction with the average withdrawal limit under the water appropriation permit for the system.

2. The planned capacity is a number that was planned for the system and either has been achieved or will be achieved by infrastructure improvements and/or increases in water appropriation permits in the future. Planned capacity should be the increased capacity level needed to meet projected growth.

3. Water demand projections outside the County Growth Areas include: private residential wells which are expected to increase by 9% and the major community water systems which are projected to increase by 14% by 2025.

2.4 Water System Conclusion and Recommendations

An adequate water supply is necessary for growth and development within the County. Equally important is water system infrastructure, which may be the limiting factor for expansion of any water service area. While the quantity of groundwater in the County may be adequate, the quality of the water may make use of the water economically unfeasible, due to treatment costs.

Protection of the groundwater in areas that use the shallow Pleistocene Aquifer is highly recommended. Well head protection ordinances should be considered for these systems. If they are approved, they should be adopted and implemented for each of the water systems that utilize this aquifer. While the deeper aquifers are not susceptible to surface contaminants, in Ocean City and Pocomoke, caution should be exercised so that increased withdrawals do not lead to salt water intrusion either from lateral salt water movement or upwelling from salty formations below.

To meet future demand for water supply, Pocomoke City's water system will require capacity increases since it currently is at its planned capacity (Table 2-6). The Village of Showell is a designated growth area and will require a new system be constructed in the future. Additional future planned capacity needed at Showell is approximately 300,000 to 450,000 gallons per day.

Specific recommendations for water system improvements to address both quantity and quality as well as system maintenance needs are as follows.

1. In advance of demand materializing, increase the Berlin and Snow Hill water systems to meet anticipated demand of the County's adjacent growth areas.
2. Encourage USGS to undertake the Coastal Plain groundwater study to determine the adequacy of Worcester County's groundwater supply. Work within the Maryland Association of Counties to ensure the funding requirements of this study are met by the State. Until this study is completed, all indications are that sufficient groundwater exists to meet anticipated demand.
3. Carefully monitor regional water withdrawals in southwestern Worcester County and Somerset County to ensure sufficient supplies in this area. This would also include tracking progress of large residential developments or proposed industrial facilities for the Route 13 corridor.
4. Review the source water protection reports' recommendations for each system and determine what is feasible for implementation on a local level. Where applicable, request MDE's involvement for areas that they are responsible for providing assistance.
5. Institute watershed planning strategies.
6. Include in the County's annual planning report:
    a. A list of EDUs in service by service area.
    b. An assessment of new and "pipeline" EDUs by location and development type to automatically track existing and potential consumption of water supply capacity as development moves through the review and construction phases. This system should be coordinated with the municipal tracking systems to give a County-wide assessment.
    c. An assessment of summer peak, peak day and annual water consumption by service area and a determination of remaining capacity for each system.
7. Consider planning system expansions when summer three-month average daily consumption reaches 80 percent of permitted capacity.

8. For maintenance and emergency continuity, interconnect water systems to the maximum extent feasible. An example of this is the Riddle Farms/Ocean Pines water inter-connection.
9. Examine the feasibility of creating a sanitary service to support development of the Village of Showell growth area. This system would be able to provide service to 1,000 to 1,500 EDUs. This equates to 300,000 to 450,000 GPD with sufficient additional capacity for fire protection.
10. The County could periodically review the Ocean Pines Well Head Protection Plan to ensure potential source code contamination are being avoided as well as monitoring water quality in the supply wells as necessary.
11. Worcester County's conservation rate structure should be maintained. If needed, the County may consider exploring increases in the rate structure or new programs to mandate water conservation and reduce demands.

Section 3 Wastewater Services

3.1 Introduction

Wastewater services and especially wastewater treatment drive the amount and location of municipal and suburban development in Worcester County. A number of factors, including the limited availability of wastewater treatment, past growth policies, strong agricultural zoning, and the fact that more than 75 percent of the County's soils are poorly drained, have resulted in compact development patterns and, thus, smart growth in the County. The current *Comprehensive Plan* reinforces this concentrated development pattern through its policies and land use designations. Further discussion about the County's current wastewater services follows. The remaining parts of this section addresses point source pollution impacts, provides an assessment of future wastewater demand, discusses results from the point source pollution analysis, describes alternative wastewater disposal options, and proposes recommended policies and projects.

3.2 Current Wastewater Services

The County adopted a policy in the 1980's that all wastewater services serving more than one lot or processing more than 5,000 gallons per day (GPD) must be owned and operated by the County or a municipality. This policy resulted from health and management issues with private systems in the County. It has recently been amended to permit certain larger systems up to 50,000 GPD that serve or plan to serve a shopping center, planned commercial development, unified development or cooperative campgrounds and mobile home parks to be privately owned. Provisions for County oversight and other safeguards have been provided. For areas outside of public service areas, development relies on on-site septic waste disposal systems. In the following discussion, the County's current wastewater planning areas and facilities, policy regarding new development and the current and future state of septic systems in the County are discussed.

Sewer Planning Areas

Sewer planning areas are generally adjacent to existing population centers and municipalities. A sewer planning area is an area designated as planned to receive public sewer service from a municipality or the County. The estimated time for receiving service is represented by one of the following designations: Present to 2 years (S1), future service 3-5 years (S2), or future service 6-10 years (S3). The areas served by private community systems can be designated S1 but are not planning areas. Creating or amending a planning area requires an amendment to the *Water and Sewer Plan*. However, the inclusion of any sewer system in the *Water and Sewer Plan* does not legally obligate the County or any of its political subdivisions to take any action to implement such projects or to enforce the implementation of such projects. Generalized sewer planning areas are shown in Figure 3-1 along with the general location of existing wastewater treatment plants (WWTP). Using Table 3-1 each WWTP can be named and described by its facility and discharge type.

As shown in Figure 3-1 and Table 3-1, there are 13 WWTPs located in the Coastal Bays Watershed: nine are owned and operated by the Worcester County Government while the

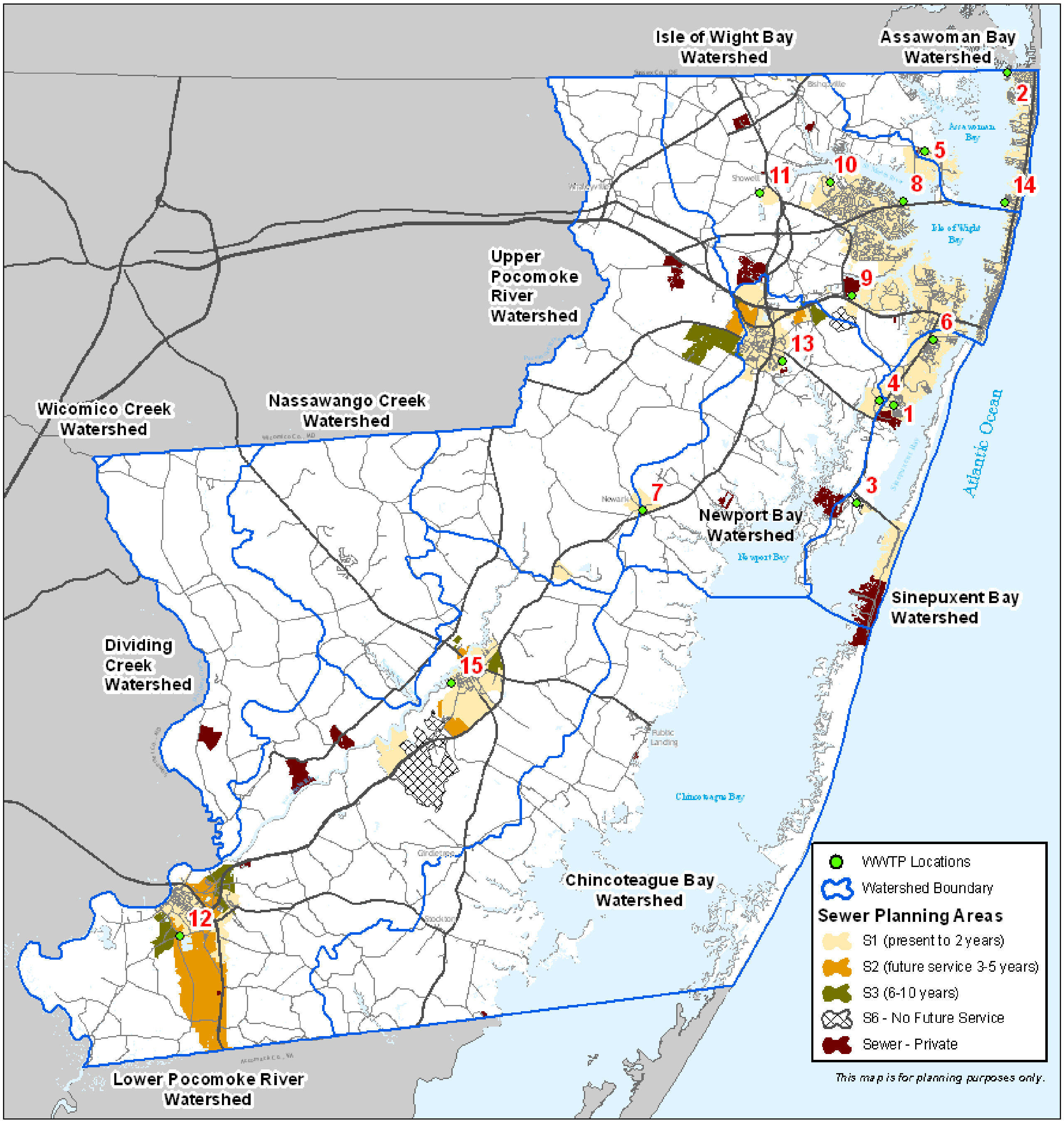


Figure 3-1. Sewer Planning Areas. Generalized boundaries for S1, S2, S3, S6 or Private sewer service designations are shown above. The general location of wastewater facilities are also shown relative to its watershed and sewer service area. Use Table 3-1 to identify facility descriptions.

Table 3-1. Wastewater Treatment Plant Description

ID No.	Watershed Name	Facility Type	Facility Name	Discharge Type
1.	Sinepuxent Bay	Major Community	Assateague Pointe	Spray
2.	Isle of Wight Bay	Major Community	Edgewater (Sussex County, DE)	Ocean outfall (DE)
3.	Sinepuxent Bay	Owned and operated by National Park Service	Federal Assateague Park	Overland flow *Spray in the future
4.	Newport Bay	Major Community	The Landings	Injection wells
5.	Assawoman Bay	Major Community	Lighthouse Sound	Spray
6.	Sinepuxent Bay	Major Community	Mystic Harbor	Injection wells
7.	Newport Bay	Major Community	Newark	Surface *Spray in the future
8.	Isle of Wight Bay	Major Community	Ocean Pines	Surface
9.	Isle of Wight Bay	Major Community	Riddle Farm	Spray
10.	Isle of Wight Bay	Major Community	River Run	Spray
11.	Isle of Wight Bay	Industrial *Planned for residential in the future	Village of Showell	Surface (Industry permit) *Spray in the future if permitted for residential use
12.	Lower Pocomoke River	Municipal	The City of Pocomoke	Surface
13.	Newport Bay	Municipal	Town of Berlin	½ Surface, ½ Spray *100% Spray in the future
14.	Isle of Wight Bay	Municipal	Town of Ocean City	Ocean outfall
15.	Lower Pocomoke River	Municipal	Town of Snow Hill	Surface

Note: Overland flow treatment directs effluent into a wetland where three processes occur: transpiration, infiltration, and evaporation.

National Park Service, Town of Berlin, and Ocean City each own and operate WWTPs in the watershed. Currently, four of the County-owned and operated WWTPs utilize spray irrigation and two discharge treated effluent via injection wells; thus, eliminating nutrient point sources from the Coastal Bays Watershed. There are four WWTPs in the watershed that discharge directly to surface waters. Three of these WWTPs are planning to convert to spray irrigation in the future, eliminating the nutrient point sources from the watershed. The Ocean Pines WWTP will continue to discharge to the Isle of Wight Bay. This plant uses best available technology and exceeds ENR standards. In turn, this plant will serve to accept effluent from households previously on septic systems, lowering overall nonpoint source nutrient contributions to the Isle of Wight Bay.

There are two plants whose discharge type is ocean outfall, Edgewater and Ocean City. The County sends wastewater from West Ocean City to the Town of Ocean City WWTP where treated effluent is discharged to the Atlantic Ocean. The Town of Snow Hill and the City of Pocomoke's WWTP are located along the Pocomoke River in the Chesapeake Bay Watershed and discharge directly to the river. Each municipality intends to upgrade their WWTP and will continue to surface discharge whereas the Town of Berlin plans to spray irrigate 100% of its treated effluent in the near future. Continued management of these wastewater services will help to reduce nutrient loads overall, is vital to the continuation of the County's concentrated development pattern, and the Comprehensive Plan's implementation.

Current Facility Parameters

Specific parameters for existing WWTPs owned and operated by either the County or a municipality are shown in Table 3-2. The average current flow estimates the average daily wastewater flow by gallons from current users. To determine the current committed capacity, the designated number of gallons per day per equivalent dwelling unit (GPD/EDU) is multiplied by the total number of users. The sum equals the current committed capacity and shall not exceed the permitted capacity. The difference between the permitted and committed capacity is the remaining capacity, implying that additional users may utilize wastewater services. In some cases, WWTPs have the capacity to serve expansions of growth, while others are very limited, having committed most of their capacity to undeveloped or developed properties within their service areas. However, to determine a WWTPs remaining capacity the factors below must also be considered.

- Disposal Capacity: A WWTP utilizing spray irrigation is limited by the ability of the service area to locate suitable land area for the purpose of spraying treated effluent.
- Discharge Limits: Increasing volume of treated effluent that is sprayed may exceed the land's ability to absorb and process the treated effluent per design standards.
- Treatment Capacity: Each WWTP must meet total nitrogen and total phosphorus standards measured on a pounds per year basis. Increasing the volume of treated effluent will increase nutrient loads. WWTPs cannot exceed nutrient caps and/or permit limits, whichever is more restrictive.
- Physical Constraints: The infrastructure may not function properly if permitted design limitations for the disposal method are exceeded or volume increases.

Despite having a small remaining capacity, these plants do have committed capacity that will be available to support new growth whether from undeveloped land or the intensification of uses on previously developed lands. Each municipality is currently upgrading or planning to upgrade their WWTP to conform with State treatment standards while accommodating new growth.

Table 3-2. Current Facility Parameters

Facility Name	Average Current Flow (GPD)	Current Committed Capacity (GPD)	Current Permitted Capacity (GPD)	Estimated Remaining Capacity (GPD)	Percent Remaining Capacity
Assateague Pointe	24,250	37,640	41,930	4,290	10
Edgewater (Sussex County, DE)	21,000	54,750	57,500	2,750	5
The Landings West	32,000[1]	27,750	100,000	72,250	72
Lighthouse Sound	17,805	34,350	37,950	3,600	9
Mystic Harbor	153,000	200,000[2]	250,000	50,000	20
Newark	45,500	53,000	56,000	3,000	5
Ocean Pines	1,010,000	2,125,000[3]	2,500,000	375,000	15
Riddle Farm	54,000	89,375	200,000	110,625	55
River Run	16,900	47,000	100,000	53,000	53
Village of Showell[4]	**0**	**0**	**0**	**0**	**0**
The City of Pocomoke	**555,000**	**555,000**	**1,470,000**	**915,000**	**62**
Town of Berlin	**413,000**	**557,500**	**600,000**	**42,500**	**7**
Town of Ocean City	12,100,000	12,152,000	15,000,000	2,848,000	n/a
Town of Ocean City	11,200,000	11,200,000	14,000,000	2,800,000	20
West Ocean City[5]	900,000	952,000	1,000,000	48,000	5
Town of Snow Hill[6]	**302,300**	**487,750**	**500,000**	**12,250**	**2**

Note: bold text highlights proposed growth areas.

[1] Current average flow higher due to Assateague Pointe treatment.

[2] Mystic Harbor has 800 active sewer accounts today. There are 200 left for committed capacity to current undeveloped or underdeveloped properties.

[3] Capacity is totally committed for Ocean Pines community lots and Greater Ocean Pines Service Area. This number reflects current accounts connected.

[4] The Village of Showell has a permit for industrial surface discharge and operates at minimal levels since the closing of the Perdue Chicken Plant. The *Comprehensive Plan* anticipates that the new residential growth area would require the existing industrial permit to be converted to a residential discharge permit.

[5] All sewer taps are committed to either residential or commercial properties. Unfilled capacity is very minimal and flow average is average flow.

[6] Snow Hill has 1,951 committed EDU's of which 1,322 are currently in use.

New Development Wastewater Services Policy

The existing WWTPs shown in Table 3-2 have limited, but still significant, capacity to connect significant amounts of new development because these plants were designed and built to meet an approved project's wastewater service needs. For example, the Riddle Farm WWTP has a permitted capacity of 200,000 GPD, enough to meet the approved number of residential and commercial buildings within the Riddle Farm development project. At this time, 89,375 GPD are currently committed to already built residential or commercial units. The remaining capacity, 110,635 GPD, is reserved for the remaining Riddle Farm lots not yet developed. Potentially expanding this plant for new development must be paid for by the developer and/or property owner(s) associated with the new proposed growth.

The County's policy regarding providing sanitary services to new development within a public wastewater service area is that the developer(s) and/or property owner(s) associated with the growth area or the service area's expansion shall bear the responsibility for all costs associated with the wastewater system's expansion to accommodate the proposed development, including infrastructure and treatment system costs.

Treatment facilities and public infrastructure for new and expanded public wastewater areas are built by the developer(s) and turned over to the County for operation and management of the systems. Furthermore, the County assigns capacity based on planning figures, not average flow. As a result, capacity safety factors are already built into the treatment facilities.

Septic System Assessment

For areas outside sewer service areas, development relies on waste disposal systems located on-site, commonly known as "septic systems". Currently, there are approximately 7,184 septic systems in Worcester County as shown in Figure 3-2. There are approximately 4,154 septic systems located in the Coastal Bays Watershed, 1,429 are located in the Critical Area (Table 3-3). The Isle of Wight Bay Watershed has the highest number of septic systems followed by the Newport Bay Watershed, 1,762 and 1,102 respectively. By 2025, the County anticipates an overall reduction of 229 septic systems in the Coastal Bays Watershed. There are approximately 3,030 septic systems in the Chesapeake Bay Watershed (Table 3-4). Of this amount, 1,613 septic systems are located in the Lower Pocomoke River Watershed. There are currently only 168 septic systems in the Chesapeake Bay Critical Area. By 2025, the County anticipates 37 less septic systems in the Chesapeake Bay Watershed.

A total of 273 septic systems in the Coastal Bays Watershed were taken offline and connected to public WWTP prior to 2011 (Table 3-5). By 2025, it is anticipated that an additional 683 septic systems will be taken offline in the Coastal Bays watershed and 123 septic systems taken offline in the Chesapeake Bay Watershed, for a net reduction of 266 fewer septic systems in the County. Equations 3.1 and 3.2 are used to demonstrate how this net reduction was determined.

To estimate the number of septic systems by 2025, the County estimated the number of septic systems that may be connected to a public WWTP and estimated the number of new septic systems in the County. Table 3-6 shows that the County anticipates connecting septic systems that are located inside the Critical Area in the Isle of Wight Bay, Sinepuxent Bay, Lower Pocomoke River, and Nassawango Creek Watersheds. All watersheds in the Coastal Bays will most likely have additional septic systems installed inside the Critical Area. It is likely that the Lower Pocomoke River and Nassawango Creek Watersheds will also have additional septic systems installed inside the Critical Area. Areas outside the Critical Areas will also see their fair share of septic system connections and installations (Table 3-7). On a County-wide basis, approximately 341 new septic systems may be installed by 2025. The County anticipates connecting 364 septic systems to public WWTPs by 2025 as well.

Development near the water with septic systems is discouraged by the *Comprehensive Plan* and is expected to be very limited. Inland sites are also very limited and will be widely dispersed. This will result in negligible water quality impacts, if standards requiring best available technology are applied. As a result, the remainder of this section focuses on the few existing wastewater service areas where limited increases in capacity are planned and the facilities needed to address the designated growth areas.

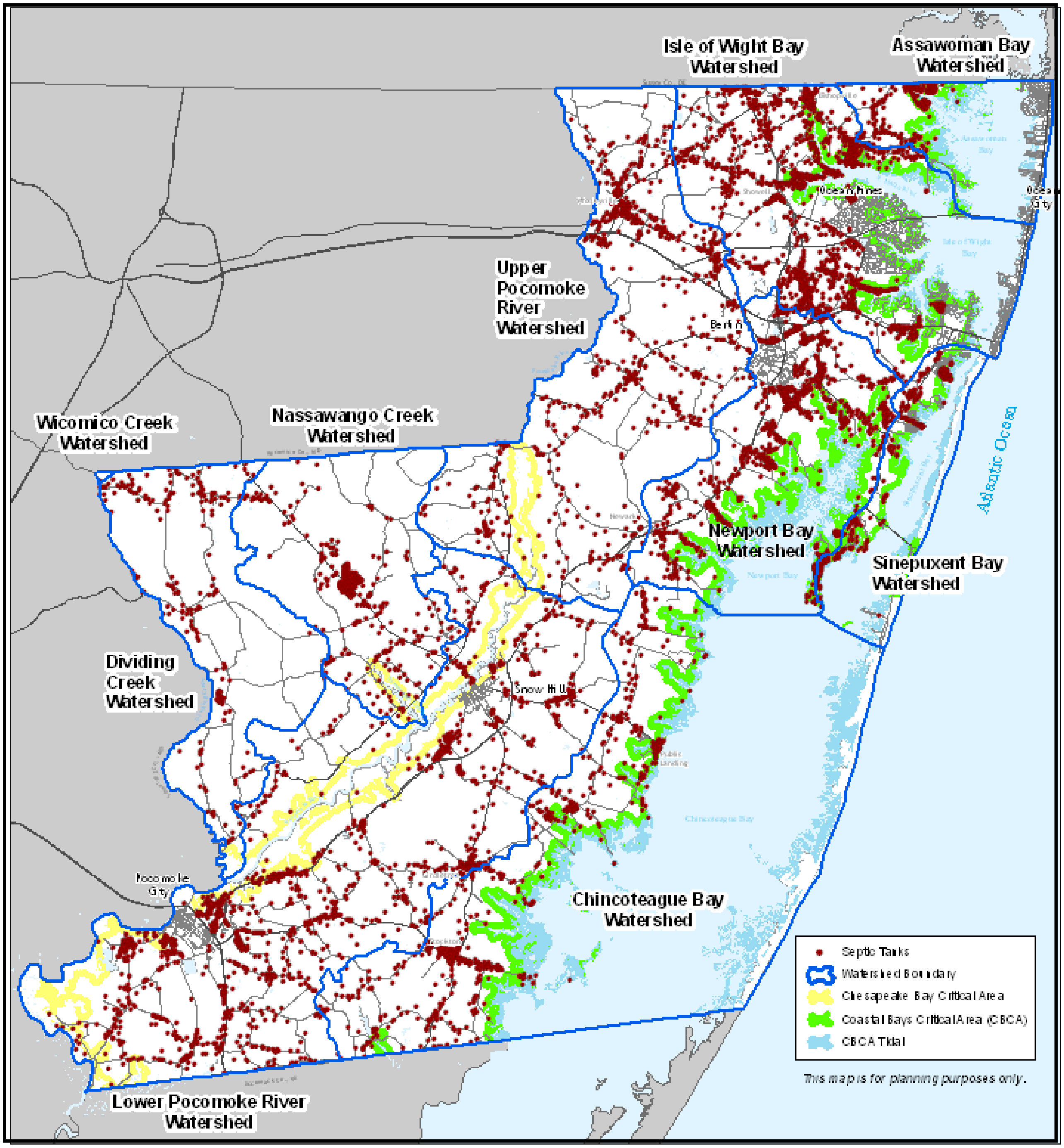


Figure 3-2. Worcester County Septic System Locations

Table 3-3. Septic Systems in the Coastal Bays Watershed

Watershed Name	No. Septic (1960-2010)	No. Septic (2011-2025)	Change in no. of septic systems
Assawoman Bay	**304**	**349**	**45**
Inside Critical Area	207	237	30
Outside Critical Area	97	112	15
Chincoteague Bay	**709**	**814**	**105**
Inside Critical Area	157	172	15
Outside Critical Area	552	642	90
Isle of Wight Bay	**1,762**	**1,548**	**-214**
Inside Critical Area	596	315	-281
Outside Critical Area	1,166	1,233	67
Newport Bay	**1,102**	**1,062**	**-40**
Inside Critical Area	291	336	45
Outside Critical Area	811	726	-85
Sinepuxent Bay	**277**	**152**	**-125**
Inside Critical Area	178	108	-70
Outside Critical Area	99	44	-55
Total Inside CA	**1,429**	**1,168**	**-261**
Total Outside CA	**2,725**	**2,757**	**32**
Grand Total	**4,154**	**3,925**	**-229**

Table 3-4. Septic Systems in the Chesapeake Bay Watershed

Watershed Name	No. Septic (1960-2010)	No. Septic (2011-2025)	Change in no. of septic systems
Dividing Creek	**224**	**226**	**2**
Inside Critical Area	0	0	0
Outside Critical Area	224	226	2
Lower Pocomoke River	**1,613**	**1,580**	**-33**
Inside Critical Area	152	167	15
Outside Critical Area	1,461	1,413	-48
Nassawango Creek	**413**	**420**	**7**
Inside Critical Area	12	15	3
Outside Critical Area	401	405	4
Upper Pocomoke River	**778**	**764**	**-14**
Inside Critical Area	4	4	0
Outside Critical Area	774	760	-14
Wicomico Creek	**2**	**3**	**1**
Inside Critical Area	0	0	0
Outside Critical Area	2	3	1
Total Inside CA	**168**	**186**	**18**
Total Outside CA	**2,862**	**2,807**	**-55**
Grand total	**3,030**	**2,993**	**-37**

Table 3-5. Septic Tank Connections to Public WWTP

Watershed Name	2006-2010		2011-2025	
	Outside Critical Area	Inside Critical Area	Outside Critical Area	Inside Critical Area
Coastal Bays Watershed				
Assawoman Bay	0	0	0	0
Chincoteague Bay	0	0	0	0
Isle of Wight Bay	0	35	113	300
Newport Bay	1	0	100	0
Sinepuxent Bay	0	238	70	100
Grand Total	**1**	**273**	**283**	**400**
Chesapeake Bay Watershed				
Dividing Creek	0	0	0	0
Lower Pocomoke River	0	0	60	30
Nassawango Creek	0	0	0	12
Upper Pocomoke River	0	0	21	0
Wicomico Creek	0	0	0	0
Grand Total	**0**	**0**	**81**	**42**

Equation 3.1, refer to Tables 3-6 and 3-7

$S_i - C = S_c$, the remaining number of septic systems from 1960-2010

Where,

S: the number of septic systems, 1960 - 2010

C: the predicted number of connections to a public WWTP between 2011 and 2025

Equation 3.2, refer to Tables 3-6 and 3-7

$S_c + S_n = S_f$, the total number of septic systems by the end of 2025

Where,

S_c: the remaining number of septic systems, 1960-2010

S_n: the predicted number of new septic systems, 2011 and 2025

Table 3-6. Total Number of Septic Systems Inside the Critical Area

Watershed Name	Number of septic systems, 1960 - 2010	Predicted no. of connections, 2011 - 2025	Remaining septic systems 1960 – 2010	Predicted no. of new septic systems by 2025	Total septic systems by end of 2025
See equations 3.1 & 3.2	S_i	C	S_c	S_n	S_f
Coastal Bays Watershed					
Assawoman Bay	207	0	207	30	237
Chincoteague Bay	157	0	157	15	172
Isle of Wight Bay	596	300	296	19	315
Newport Bay	291	0	291	45	336
Sinepuxent Bay	178	100	78	30	108
Chesapeake Bay Watershed					
Dividing Creek	0	0	0	0	0
Lower Pocomoke River	152	30	122	45	167
Nassawango Creek	12	12	0	15	15
Upper Pocomoke River	4	0	4	0	4
Wicomico Creek	0	0	0	0	0
Total	**1,597**	**442**	**1,155**	**199**	**1,354**

Table 3-7. Total Number of Septic Systems Outside of the Critical Area

Watershed Name	Number of septic systems, 1960 - 2010	Predicted no. of connections, 2011 - 2025	Remaining septic systems 1960 – 2010	Predicted no. of new septic systems by 2025	Total septic systems by end of 2025
See equations 3.1 & 3.2	S_i	C	S_c	S_n	S_f
Coastal Bays Watershed					
Assawoman Bay	97	0	97	15	112
Chincoteague Bay	552	0	552	90	642
Isle of Wight Bay	1,166	113	1,053	180	1,233
Newport Bay	811	100	711	15	726
Sinepuxent Bay	99	70	29	15	44
Chesapeake Bay Watershed					
Dividing Creek	224	0	224	2	226
Lower Pocomoke River	1,461	60	1,401	12	1,413
Nassawango Creek	401	0	401	4	405
Upper Pocomoke River	774	21	753	7	760
Wicomico Creek	2	0	2	1	3
Total	**5,587**	**364**	**5,223**	**341**	**5,564**

Note: While MDP forecasts an additional 1,516 septic tanks from 2011-2025, Worcester County Environmental Programs remains confident that County-level historical data supports the 540 septic tank estimates listed in Tables 3-6 and 3-7.

3.3 Pollution Impacts

Total nitrogen and total phosphorus (more generally referred to as ―"nutrients") from WWTPs contribute to degraded water quality in the Chesapeake and Coastal Bays and their tributaries. As a result of Maryland's participation in the *Chesapeake Bay 2000 Agreement* and resulting State policies designed to help restore the Bay, water and sewer planning must take into account the "assimilative capacity" of a receiving body of water—the mass of nutrients that the stream can receive while still maintaining acceptable water quality. This section describes the key limits on assimilative capacity as they apply to the County's WWTPs.

The County has the benefit of a no-new point discharge requirement in the *Water and Sewer Plan*. This is why all new plants in the County utilize spray irrigation. Some nutrient increases will result from meeting future growth via existing WWTPs but only in those that have a significant amount of capacity left of new development. Snow Hill and Pocomoke City's WWTPs will be limited by the Chesapeake Bay Tributary Strategy point source caps. Action on the Chesapeake Bay TMDL could possibly lower those caps in the future and therefore lower their nutrient contributions to the Bay.

Most of the new growth in point source inputs will be mitigated by the elimination of point source discharges (Berlin) and transition to spray irrigation or other alternative discharges (Assateague – Federal Park, Landings, and Mystic Harbor).

TMDLs

Another measure of assimilative capacity is the Total Maximum Daily Load (TMDL), the maximum amount of pollutant that a water body, such as a river or a lake, can receive without impairing water quality. When the Coastal Bays and Chesapeake Bay TMDLs are released in the summer of 2011, the County will be able to determine what actions are required to meet TMDLs. Until then, the County intends to take every action possible to reduce nutrient pollution levels from point sources. For instance, Newport Bay is the receiving body for the Berlin WWTP. Action is being taken now to remove the Berlin WWTP point source from the Newport Bay Watershed. This WWTP effluent will be applied to land approximately five miles west of the Town of Berlin. The Town of Snow Hill and Pocomoke City are working to lower nutrient pollution with enhanced nutrient removal (ENR) upgrades to their WWTPs. Both WWTPs currently discharge to the Lower Pocomoke River.

Point Source Caps

To address nutrient loads from point sources such as WWTPs, the State has established Chesapeake Bay Tributary Strategy point source caps. These caps are numerical limits on the amount of nitrogen and phosphorus that WWTPs can discharge to the Bay and their tributaries (expressed as pounds per year of nitrogen and phosphorus). Point source caps have been established for the Pocomoke and Snow Hill WWTPs and are reflected in their permits.

This WRE assumes that by 2025 ENR upgrades will be complete at the Pocomoke and Snow Hill WWTPs. Given these assumptions, as well as assumptions about the nitrogen and phosphorus concentrations in future discharges, the Pocomoke and Snow Hill WWTPs will not exceed their nutrient caps under the 2025 growth scenario.

3.4 Future Wastewater Services

This section discusses future upgrades to existing wastewater service areas within the County as well as those growth areas designated in the *Comprehensive Plan*. In general, if an area is not associated with a growth area the existing service areas will rely on infill development of similar character to the existing community. For those existing service areas not designated for growth by the *Comprehensive Plan*, expansion of the service areas is not planned. To begin this discussion, the following highlights upgrades planned in the sewer service areas.

County Sewer Service Area Upgrades

The Ocean Pines, Riddle Farm, and Mystic Harbor sewerage systems are planned for expansion to serve limited areas in their vicinities. Such expansions are designed to reduce reliance on either small inefficient and difficult to maintain treatment plants or to take on-site septic systems in sensitive areas off-line. These expansions would help implement the *Comprehensive Plan* and reduce water pollution while mainly serving infill development. The potential for expansion of each system is discussed in the following subsection.

Ocean Pines

The Ocean Pines sanitary service area is located in the Isle of Wight Bay Watershed and discharges to the Saint Martin's River[7], which is a tributary to the Isle of Wight Bay. Tributaries of the Isle of Wight Bay are impaired by the nutrients nitrogen and phosphorus[8], which cause algae blooms and low dissolved oxygen. Such conditions severely limit biological productivity. By the summer of 2011, a Coastal Bays TMDL will be completed and may provide additional insight about nutrient TMDLs for the Isle of Wight Bay.

The Ocean Pines system has operated for over 30 years. It was recently upgraded from 1.5 millions of gallons per day (MGD) to 2.5 MGD. This expansion was necessary to serve the community's remaining vacant lots and to address existing problems along and to the east of the MD 589 corridor. These areas have failing or outdated individual treatment systems and on-site septic systems. This expansion of the service area will consequently improve water quality and correct several potential health problems. The system is planned to accommodate 611 equivalent dwelling units (EDUs) outside the original service area.

The Ocean Pines system uses best available technology and exceeds ENR standards. This service area therefore qualified for exclusion from the Chesapeake and Coastal Bay Restoration Fund fee. It was the first public plant in the State to meet this high and sustained performance standard.

Pennington Commons, a new residential subdivision and commercial area just west of Ocean Pines, sends its wastewater to the Ocean Pines system on a contract basis. This community contains land dedicated for future land disposal of treated effluent. This area may be used in the future as part of a larger land disposal strategy for the Ocean Pines system.

---

[7] Maryland Department of the Environment, *Total Maximum Daily Loads of Nitrogen and Phosphorus for Five Tidal Tributaries in the Northern Coastal Bays System, Worcester County, Maryland*, Baltimore, Maryland, 2001, page 25.

[8] Ibid.

This service area's total capacity will be consumed by infilling and final build out of Ocean Pines and serving of the Greater Ocean Pines Service area. At this time, the County has no plans for additional expansion of the WWTP or the service area other than serving the Greater Ocean Pines Service Area.

Riddle Farm

Owned by the County, this community system serves Riddle Farm, which at build out will use the system's 716 EDUs. The Riddle Farm project is located immediately adjacent to Turville Creek, a tributary of the Isle of Wight Bay. A TMDL (2002) has been established by the State for Turville Creek. The treatment system is best available technology, specifically a Xenon membrane system. The treated effluent is disposed of by means of spray irrigation on the community's two golf courses. With this method of disposal nutrient contribution to the Isle of Wight Watershed is minimal.

Future expansion may be possible to serve existing and future commercial development across US 50 to the south. Such expansions would also use best available technology and spray irrigation; therefore the system's nutrient inputs would continue to be limited. The treatment facility can be upgraded and land for additional spray irrigation sites exists in the area. Any expanded development opportunities would be very limited and prevent the placement of on-site septic systems.

Given the type of treatment and disposal utilized at Riddle Farm and the fact that it does not discharge to surface waters, this system does not now, nor in the future if properly expanded, adversely impact the 2002 Turville Creek TMDL. This assessment will also be compared to the new Coastal Bays TMDL once it is completed and released to the public.

Mystic Harbor

The Mystic Harbor system located along the Sinepuxent Bay serves only the community of Mystic Harbor's 1,000 EDUs. This system uses wetland polishing and groundwater injection wells for effluent disposal. The WWTP is at the end of its service life and must be upgraded.

The County prepared an amendment to its *Water and Sewer Plan* to begin the upgrade process. The County seeks an additional 666 EDU treatment capacity to meet infill demand from the West Ocean City service area to the immediate north. Originally, the West Ocean City demand was planned to be transferred to the Ocean City Wastewater System. However, the most cost effective approach to meeting this demand would be additional capacity in the Mystic Harbor system.

From a nutrient management perspective, this additional effluent would be land applied, so potentially the entire system flow could be spray irrigated for an even greater water quality benefit. The final disposition of the effluent is under study at this time.

Given the County's strong growth management program, the following assessment of the *Comprehensive Plan's* designated growth areas relies on the *Comprehensive Plan's* land use policies.

Growth Area Wastewater Service

The *Comprehensive Plan* designates four growth areas, which are located adjacent to the Village of Showell, the Town of Berlin, the Town of Snow Hill, and The City of Pocomoke. Each of these growth areas was designated to link an existing community with lands that can be readily served by urban services while having the least negative effect on the land, water, and air. Listed in Table 3-8 is the maximum number of residential units projected for each growth area, referred to as residential unit targets, or RUTs. The *Comprehensive Plan* distributes this growth by infilling existing population centers and placing new development in the *Comprehensive Plan's* designated growth areas. New commercial development within RUTs was not considered because there is currently sufficient commercial zoning throughout the County to support the projected population increase of approximately 18,000 persons.

The number of potential RUTs serves as a rough equivalent for the future demand for new EDUs as shown in Table 3-9. If the County's population projection is realized then an additional wastewater service demand of nearly 2 million GPD is expected. Due to recent market conditions, this anticipated demand is unlikely to occur by 2025 but may still be suitable for long-range planning purposes.

A review of each municipality's anticipated wastewater demand revealed a reduction in the estimated number of EDUs needed for their expected future growth (Table 3-10). Since the County's *Comprehensive Plan* was adopted, each municipality reduced the amount of EDUs needed to accommodate their projected growth in response to recent market conditions. As a result, approximately 8,033 persons instead of 18,000 persons may be anticipated in the future and would need wastewater services. By incorporating the municipalities EDUs and GPD/EDU data, the total amount of wastewater services demand is less than 1 million GPD if the municipality projections are realized.

There is a considerable difference in the population estimates between Tables 3-8, 3-10 and 3-11. The RUT analysis has certainly been impacted by the nation's economic crisis and the crash in the local housing market. The slow pace of growth indicated in Table 3-11 more accurately reflects the impact of the down economy on the municipalities. The County anticipates that future wastewater services may be able to support 9,690 additional persons county-wide, 5,126 persons inside the designated growth areas with the Village of Showell and The City of Pocomoke absorbing the majority of the growth. Both Berlin and Snow Hill are upgrading their plants; however, their capacity remains unchanged. The additional demand projected is shown in Table 3-12 as the future realized flow and is considered in the future realized committed capacity. As shown in Table 3-13, by 2025 several WWTPs in the County will still have remaining capacity. Should population growth exceed anticipated wastewater service demands and projected population figures shown in Table 3-11, the remaining wastewater service capacity can support up to 34,253 persons county-wide, 6,242 are located in The City of Pocomoke growth area. Through these estimates, the County was able to better reflect how the current market conditions and economy has impacted anticipated population growth. The RUT growth estimates will be addressed as County staff and Planning Commission review the *County Comprehensive Plan* in our 2012 review.

The following subsections are assessments of each growth area's facility needs and their potential impacts to water quality.

Table 3-8. Growth Area Residential Unit Targets (RUT)

Growth Area	Acres	RUT	Population Increase
Town of Berlin	1,326	2,910	6,781
The City of Pocomoke	495	1,606	3,742
Village of Showell	360	1,000	2,330
Town of Snow Hill	680	2,207	5,143
Total	**2,861**	**7,723**	**17,996**

Sources: *Comprehensive Plan*

Table 3-9. County Projections: Additional Wastewater Service Demand Projected for Growth Area

	Predicted Population Increase	EDUs Generated	GPD/EDU	Additional Demand Projected (GPD)
Town of Berlin	6,781	2,910	250	727,500
The City of Pocomoke	3,742	1,606	250	401,500
Village of Showell*	2,330	1,000	300	300,000
Town of Snow Hill	5,143	2,207	250	551,750
Total	17,996			1,980,750

Sources: This table was prepared with EDU and GPD/EDU data provided in each municipality's WREs and the County's *Comprehensive Plan* provided Village of Showell data. Assume 2.33 persons per EDU.

Table 3-10. Municipality Projections: Additional Wastewater Service Demand Projected for Growth Area

	Predicted Population Increase	EDUs Generated	GPD/EDU	Additional Demand Projected (GPD)
Town of Berlin	1,768	759	250	189,750
The City of Pocomoke	2,286	981	250	245,250
Village of Showell*	2,330	1,000	300	300,000
Town of Snow Hill	1,647	707	250	176,750
Total	**8,031**			**911,750**

Sources: This table was prepared with EDU and GPD/EDU data provided in each municipality's WREs and the County's *Comprehensive Plan* provided Village of Showell data. Assume 2.33 persons per EDU.

Table 3-11. County Projections: Anticipated Wastewater Service Demand and Projected Population

Facility Name	EDUs Generated	GPD/EDU	Additional Demand Projected (GPD)	Projected Population (2.33 persons per household x EDU)
Assateague Pointe	17	250	4,290	40
Edgewater (Sussex County, DE)	11	250	2,750	26
The Landings West	60	300	18,000	140
Lighthouse Sound	14	250	3,600	33
Mystic Harbor	200	250	50,000	466
Newark	12	250	3,000	28
Ocean Pines	300	250	75,000	699
Riddle Farm	300	275	82,500	699
River Run	150	250	37,500	350
Village of Showell[9]	**1,000**	**300**	**300,000**	**2,330**
The City of Pocomoke	**981**	**250**	**245,160**	**2,286**
Town of Berlin	**170**	**250**	**42,500**	**396**
Town of Ocean City	n/a	n/a	228,840	n/a
Town of Ocean City	723	250	180,840	1,685
West Ocean City	171	280	48,000	398
Town of Snow Hill	**49**	**250**	**12,250**	**114**
Total (County-wide)			**1,105,390**	**9,690**
Total (Growth Area)			**599,910**	**5,126**

Note: bold text highlights proposed growth areas.

[9] The County assumes that the Showell sanitary service area will be established and the WWTP will be built by 2025. The flow projections serve the projected population increase.

Table 3-12. Future Facility Parameters

Facility Name	Future Realized Flow (GPD)	Future Realized Committed capacity (GPD)	Future Permitted Capacity (GPD)	Future Remaining Capacity (GPD)	Percent Wastewater Remaining / Permitted	Nonresidential Uses Percentage*
Assateague Pointe	4,290	41,930	41,930	0	0	0
Edgewater (Sussex County, DE)	2,750	57,500	57,500	0	0	0
The Landings West	18,000	45,750	100,000	54,250	54	10
Lighthouse Sound	3,600	37,950	37,950	0	0	0
Mystic Harbor	50,000	250,000	250,000	0	0	40
Newark	3,000	56,000	56,000	0	0	0
Ocean Pines	75,000	2,200,000	2,500,000	300,000	12	40
Riddle Farm	82,500	171,875	200,000	28,125	14	0
River Run	37,500	84,500	100,000	15,500	16	0
Village of Showell[10]	**300,000**	**300,000**	**300,000**	**0**	**0**	**20**
The City of Pocomoke	**245,160**	**800,160**	**1,470,000**	**669,840**	**46**	**40**
Town of Berlin	**42,500**	**600,000**	**600,000**	**0**	**0**	**40**
Town of Ocean City	228,840	12,380,840	15,000,000	2,619,160	n/a	40
Town of Ocean City	180,840	11,380,840	14,000,000	2,619,160	19	40
West Ocean City	48,000	1,000,000	1,000,000	0	0	40
Town of Snow Hill	**12,250**	**500,000**	**500,000**	**0**	**0**	**0**

Note: bold text highlights proposed growth areas.

***Percentage is based on figures provided in column, "Future Realized Flow (GPD)". Nonresidential uses include commercial, industrial and institutional).**

[10] The County assumes that the Showell sanitary service area will be established and the WWTP will be built by 2025. The flow projections serve the projected population increase.

Table 3-13. County Projections: Future Remaining Capacity and Projected Population

Facility Name	EDUs Generated	GPD/EDU	Future Remaining Capacity (GPD)	Projected Population (2.33 persons per household x EDU)
Assateague Pointe	0	250	0	0
Edgewater (Sussex County, DE)	0	250	0	0
The Landings West	181	300	54,250	422
Lighthouse Sound	0	250	0	0
Mystic Harbor	0	250	0	0
Newark	0	250	0	0
Ocean Pines	1,200	250	300,000	2,796
Riddle Farm	102	275	28,125	238
River Run	62	250	15,500	144
Village of Showell[11]	**0**	**300**	**0**	**0**
The City of Pocomoke	**2,679**	**250**	**669,840**	**6,242**
Town of Berlin	**0**	**250**	**0**	**0**
Town of Ocean City	10,477	n/a	2,619,160	24,411
Town of Ocean City	10,477	250	2,619,160	24,411
West Ocean City	0	280	0	0
Town of Snow Hill	**0**	**250**	**0**	**0**
Total (County-wide)				**34,253**
Total (Growth Area)				**6,242**

Note: bold text highlights proposed growth areas.

[11] The County assumes that the Showell sanitary service area will be established and the WWTP will be built by 2025. The flow projections serve the projected population increase.

Village of Showell Growth Area

This growth area includes an existing, idled 1,000,000 gallon per day WWTP, previously used for a poultry processing plant. Prior to the plant's idling, treated wastewater effluent was discharged to Middle Branch, a tributary of the Saint Martins River. The Saint Martins River has an established nutrient TMDL limit dating back to 2002 that would necessitate that the system achieves total land application to help meet water quality standards. A Coastal Bays TMDL will become available by the end of summer 2011. At that time the County will revisit this assessment.

Reactivation of the existing Showell WWTP for processing purposes or its adaption to other uses is unknown at this time. Its ability to serve residential uses is indeterminate. This plant could possibly be adapted to serve residential uses if properly modified and provided with a redundant treatment train.

The City of Pocomoke Growth Area

Pocomoke City expanded and upgraded its WWTP system to ENR treatment in 1996. MDE rated the system's design capacity at 1,470,000 gallons per day. The latest three year average flows for the system were 647,000 gallons per day. The system discharges into the Lower Pocomoke River.

The most recent available data indicates 1,750 EDUs were served in 2004 and the town projects a total of 2,100 EDUs by the year 2011. The system has sufficient reserve flow to meet the additional 1,606 EDUs planned as the residential unit target for the Pocomoke growth area by the County *Comprehensive Plan*. The flow and method of effluent disposal should be revisited once a Chesapeake Bay TMDL is established.

The Town of Berlin Growth Area

Berlin's sewerage system has a permitted flow of 600,000 GPD. The treatment quality and volume must be upgraded to meet water quality standards and to provide sufficient capacity for infill development within the existing town boundaries. Furthermore, the County's designated growth area adjacent to Berlin calls for an additional 2,910 EDUs, which will also need sanitary services.

The town's consultants are designing a new treatment/collection system to initially treat 750,000 GPD at ENR levels. Spray irrigation will dispose of the system's effluent. With this system design, pollution contribution to the Newport Bay Watershed will be negligible. This approach to wastewater treatment will eliminate one industrial point source and move the town's discharge to 100 percent spray irrigation.

With proper phasing Berlin's WWTP can meet the anticipated growth and if best available technology and land effluent disposal are implemented the nutrient contribution from the Town and County growth area's wastewater could be reduced. The nutrient reduction will come from wastewater treatment to ENR standards, the removal of the former Tyson Chicken Processing Plant's point discharge and land application of all future additional effluent.

The Town of Snow Hill Growth Area

The Snow Hill WWTP, like Berlin's, requires upgrades in quality and volume. The WWTP has a current permitted flow of 500,000 gallons per day. Three year average flow was 391,000 gallons per day.

The town linked the WWTP's upgrade to the proposed 2,000 plus unit Summerfield development. The new treatment would be to ENR standards and some land application of effluent was planned when, and if, the plants flow was expanded over the Chesapeake Bay load caps imposed on this major plant. This current system will discharge to the Lower Pocomoke River subwatershed. Until the Chesapeake Bay TMDL is available, the WWTP's final design must follow the State's nutrient caps for large treatment plants. Due to market conditions, the Summerfield development appears to be on hold for the foreseeable future.

For the Snow Hill growth area's residential unit target to be achieved, the Snow Hill system must be upgraded and expanded. The County's residential unit target for the Snow Hill growth area is an additional 2,207 EDUs. Water quality standards will be revised once the Chesapeake Bay TMDL is available. It appears that any expansion will require land treatment of effluent to meet established nutrient caps or the TMDL standards. There are no plans to expand at this time. Plant construction is limited to the 0.5 MGD ENR upgrade.

The following section summarizes pollution contribution from point sources in Worcester County.

3.5 Point Source Pollution Assessment

Point sources in Worcester County are comprised of the WWTPs that discharge directly to surface waters. In the Coastal Bays Watershed, point sources are found in the Isle of Wight Bay, Newport Bay, and Sinepuxent Bay Watersheds. There are two point sources located in the Chesapeake Bay; both are located in the Lower Pocomoke River drainage basin.

Overall, total nitrogen (TN) may decrease in the future in the Coastal Bays Watershed. However, a closer look at the overall reduction shows that the Ocean Pines WWTP and Mystic Harbor WWTP may increase their TN contribution to their respective watersheds. On the other hand, by removing the surface discharge from the Newark and Berlin WWTPs, a reduction of 17,216 pounds per year (lbs/yr) of TN by 2025 may occur in the Newport Bay Watershed (Table 3-14). In the Chesapeake Bay Watershed, TN may increase in the future by 2,517 lbs largely because of Pocomoke's WWTP.

Total phosphorus (TP) contributions from point sources in the Lower Pocomoke River Watershed may decrease by 4,649 lbs/yr by 2025 (Table 3-15). Pocomoke's WWTP is expected to reduce its contribution by 3,726 lbs/yr while Snow Hill's WWTP is expected to reduce its contribution by 923 lbs/yr. In the Coastal Bays Watershed, TP may increase by 2,257 lbs/yr. Although point source TP loads in the Newport Bay Watershed decrease by 570 lbs/yr, Mystic Harbor and Ocean Pines WWTPs both increase TP loads, 1,477 lbs/yr and 1,361 lbs/yr respectively.

Table 3-14. Total Nitrogen Point Source Contribution (lbs/yr)

Watershed Name	1960-2010	2011-2025	Change
Coastal Bays Watershed			
Assawoman Bay	0	0	0
Chincoteague Bay	0	0	0
Isle of Wight Bay	9,223	22,830	13,607
Ocean Pines WWTP	9,223	22,830	13,607
Newport Bay	20,260	3,044	-17,216
The Landings WWTP	974	3,044	2,070
Newark WWTP	2,493	0	-2,493
Berlin WWTP	16,793	0	-16,793
Sinepuxent Bay	1,506	2,283	777
Assateague Federal ParkWWTP	109	0	-190
Mystic Harbor WWTP	1,397	2,283	886
Grand Total	**30,989**	**28,157**	**-2,832**
Chesapeake Bay Watershed			
Dividing Creek	0	0	0
Lower Pocomoke River	19,951	22,468	2,517
Snow Hill WWTP	6,436	4,569	-1,867
Pocomoke WWTP	13,515	17,899	4,384
Nassawango Creek	0	0	0
Upper Pocomoke River	0	0	0
Wicomico Creek	0	0	0
Grand Total	**19,951**	**22,468**	**2,517**

Table 3-15. Total Phosphorus Point Source Contribution (lbs/yr)

Watershed Name	1960-2010	2011-2025	Change
Coastal Bays Watershed			
Assawoman Bay	0	0	0
Chincoteague Bay	0	0	0
Isle of Wight Bay	922	2,283	1,361
Ocean Pines WWTP	922	2,283	1,361
Newport Bay	2,092	1,522	-570
The Landings WWTP	487	1,522	1,035
Newark WWTP	692	0	-692
Berlin WWTP	913	0	-913
Sinepuxent Bay	2,339	3,805	1,466
Assateague Federal Park WWTP	11	0	-11
Mystic Harbor WWTP	2,328	3,805	1,477
Grand Total	**5,353**	**7,610**	**2,257**
Chesapeake Bay Watershed			
Dividing Creek	0	0	0
Lower Pocomoke River	6,333	1,684	-4,649
Snow Hill WWTP	1,265	342	-923
Pocomoke WWTP	5,068	1,342	-3,726
Nassawango Creek	0	0	0
Upper Pocomoke River	0	0	0
Wicomico Creek	0	0	0
Grand Total	**6,333**	**1,684**	**-4,649**

3.6 Alternative Wastewater Disposal Options

A number of other opportunities exist to protect and improve water quality while still accommodating projected growth and development. This section summarizes key concepts that the County and its municipalities may wish to consider or have already embarked on projects to complete.

Continue System Repairs

Partial capacity is taken up by inflow/infiltration (I/I) in the Snow Hill collection system. Repairing these problems (which is not reflected in the data in the Worcester County WRE) will give the system additional capacity. Other municipalities should continue to test their sewer systems for I/I and address problems as they arise.

Land Application of Treated Wastewater

The *Comprehensive Plan* states that land application of effluent is the preferred disposal method. Land application of highly treated wastewater allows the soil to remove nearly all nutrients, thus virtually eliminating nutrient pollution to the bays and groundwater.

Applying treated wastewater effluent directly to the soil can allow pollutants to be absorbed before the effluent reaches receiving streams. Spray irrigation is the most common form of land application, although other options (such as drip irrigation or subsurface discharge) can also be considered. The high cost of land and difficulty in obtaining consent to utilize properties for land application coupled with property limitations due to the presence of wetlands or seasonal high water tables limits the role that land application can play in meeting the County's wastewater needs. This does not eliminate it from consideration to meet future growth. Factors such as slope, soil depth and texture, water table behavior, and buffers from streams and developed areas are important in determining true suitability for spray irrigation.

Other important considerations for land application include storage and seasonal restrictions. Land application systems typically require large storage lagoons capable of holding several months' worth of effluent. Land application may not be permitted during winter months, when frozen soil cannot accept effluent, or during other months when water tables rise. Any future land application system would likely be paired with the nearby surface discharge to maximize system capacity without exceeding nutrient caps or TMDLs.

Those noted limitations notwithstanding, there does appear to be an opportunity for public/private wastewater systems to utilize land application as an alternative or enhancement to surface water discharge. Much of the potentially suitable land is within a reasonable distance of the existing plants and growth areas.

Tertiary Treatment Wetlands

In this wastewater treatment system, effluent is treated at BNR or ENR standards and then discharged into a series of constructed, vegetated (typically, forested) wetlands[12]. These wetlands purify the effluent to the point where the eventual discharge is essentially free of nutrients and other pollutants.

---

[12] BNR = biological nutrient removal; ENR = enhanced nutrient removal

Small applications of tertiary treatment wetlands can be found throughout Maryland. These facilities are typically used at schools and other institutional uses. Implementation of such a facility would depend heavily on soil characteristics and other conditions.

The WWTP for the Federal Park at Assateague Island National Seashore will take advantage of a constructed wetland for just this purpose and eliminate their discharge in the process. While theirs is more of an overland-flow-type system, the use of constructed wetlands for final treatment will result in a nutrient reduction for the Sinepuxent Bay Watershed.

Nutrient Trading

Under the State's *Policy for Nutrient Cap Management and Trading*, one of the County's WWTPs could agree to forego a certain amount of development in exchange for payment, and then send or "trade" that excess treatment capacity to another WWTP on the Eastern Shore in need of capacity. The receiving WWTP would then be allowed to expand beyond its current permitted capacity, provided that such expansion does not exacerbate existing water quality impairments or violate TMDL requirements.

With a compliment of large, existing/expanding plants having projected capacity surplus in the future, the point source dischargers may explore taking advantage of this system. The County may explore working with the municipalities and its own County-run systems to ensure that any such nutrient trading approaches fall within the County's overall land use and growth management approach.

WWTPs with ENR technology may also be able to expand their facilities by connecting septic systems to public sewer systems. There are a number of rural communities where failing septic systems threaten water quality in older, shallow wells.

In addition, MDE and the Maryland Department of Agriculture (MDA) have developed guidelines that would allow trades between nonpoint sources (such as agriculture) and point sources. The County may work with the municipalities to identify and prioritize areas of failing septic systems and other nonpoint source pollution "hot spots" for potential inclusion in any trading system.

3.7 Wastewater Policies and Projects

Below are recommendations for wastewater policies and projects.

1. Investigate and, if feasible, develop a long term strategy to convert existing point source discharges to land disposal or another minimally polluting disposal method.
2. Investigate a comprehensive water conservation program for all land uses.
3. Ensure that the Berlin and Snow Hill sewerage systems can accommodate the *Comprehensive Plan*'*s* residential unit targets for the municipalities' associated growth areas using best available technology. These upgrades should come online appropriately phased in advance of demand but not so early as to prematurely burden rate payers.
4. If a development proposal for the Village of Showell is submitted and approved, create a sanitary service area and the infrastructure required to accommodate the growth planned for Showell. This service area should include the existing village as well as the designated growth area and treat to ENR standards with land application of treated effluent.

5. Support a water reuse program with appropriate zoning regulations and policies.
6. Maintain collection and treatment systems to prolong their longevity and to maximize their effectiveness.
7. Cooperate with Berlin, Ocean City, Ocean Pines, Snow Hill, and Pocomoke City to create an inter-jurisdictional communication and coordination mechanism to maximize the use and efficiency of existing facilities.
8. Implement the best available technologies for wastewater treatment and disposal facilities County-wide.
9. Continue to use all available funding to retrofit nutrient reduction technology for on-site septic systems.
10. Undertake feasibility studies, where necessary, to determine best operational or maintenance practices to meet both community needs and nutrient caps.

Section 4 Stormwater Management and Nonpoint Source Assessments

4.1 Introduction

This section provides an assessment of (1) programmatic aspects of effective stormwater management, (2) how nonpoint source pollution could impact water quality and wildlife habitat, and (3) the total potential nutrient impact based on nonpoint and point sources.

4.2 Stormwater Management Assessment

Stormwater runoff is generated when the ground's natural ability to infiltrate and hold rainwater is exceeded. This is primarily caused by impervious surfaces that do not allow the rainwater to infiltrate into the ground. Development activities can affect the ability of the ground to absorb the rainfall by compaction, removal of vegetation and the installation of impervious surfaces, such as roads, parking lots, buildings, and houses. When rainwater's ability to infiltrate is lessened, stormwater runoff is directed to the nearest rivers, streams, and bays. This increased runoff also contributes to the erosion of stream banks, more rapid introduction of pollutants to the water bodies, and reduced infiltration, which results in decreases in groundwater recharge.

Research conducted by the Center for Watershed Protection has shown that stream degradation occurs when its watershed is at least 10 % impervious. Imperviousness is one of the few variables that can be explicitly quantified, managed, and controlled at each stage of land development. It is also a management practice that can be remedied by the homeowner simply by choosing to install pervious products to create driveways or sidewalks, maintaining more forests rather than lawns, and creating more gardens that allow stormwater to soak into the ground. Redirecting runoff from impervious surfaces towards areas that can absorb stormwater also reduces the amount of polluted runoff flowing into our storm drains that ultimately empty into our local waterways.

The Assawoman Bay and Isle of Wight Bay Watersheds have the highest percentage of impervious surfaces in the County, roughly 9% and 6% respectively[1], mainly due to the Town of Ocean City (Table 4-1). Streets alone occupy 25% of the town's land area. The Town of Ocean City anticipates that efforts to require more open space, increased pervious land coverage, and improved stormwater management (SWM), together with the Coastal Bays Critical Areas Program restrictions on future redevelopment projects, will reduce nutrient loading in the future. Thus, the County does not expect the percentage of imperviousness to increase in the planning period. The remaining watersheds in the County have less than 3% impervious surfaces[2].

Stormwater runoff can carry a whole host of pollutants, including sediments, heavy metals, phosphorus, and nitrogen. If left untreated, these pollutants have a serious impact on the receiving water bodies, leading to diminished water quality and less than desirable habitat. Since 1982, the State of Maryland has had a SWM program in effect. Initially this program was

---

[1] A GIS-based landcover file, digitized based on the 2004 aerial imagery, was used to calculate the acreage amount of buildings, paved and unpaved roads, paved and unpaved driveways, parking lots, sidewalks, trails, tennis courts, and dirt roads.

[2] To calculate impervious surfaces in the Chesapeake Bay watershed, GIS was used to estimate the acreage amount of building footprints and street centerlines (assumed 30 feet total road width).

Table 4-1. Impervious Surfaces by Watershed, 2004

Watershed Name	Watershed Area (acres)	Impervious Area (acres)	Percentage
Coastal Bays Watershed			
Assawoman Bay	12,802	1,195	9.33
Chincoteague Bay	89,293	300	0.34
Isle of Wight Bay	41,121	2,369	5.76
Newport Bay	32,492	813	2.50
Sinepuxent Bay	13,710	409	2.98
Chesapeake Bay Watershed			
Dividing Creek	26,320	208	0.79
Lower Pocomoke River	81,443	1,723	2.12
Nassawango Creek	25,997	259	1.00
Upper Pocomoke River	51,204	687	1.34
Wicomico Creek	70	1	1.43
Grand Total	**374,452**	**7,964**	

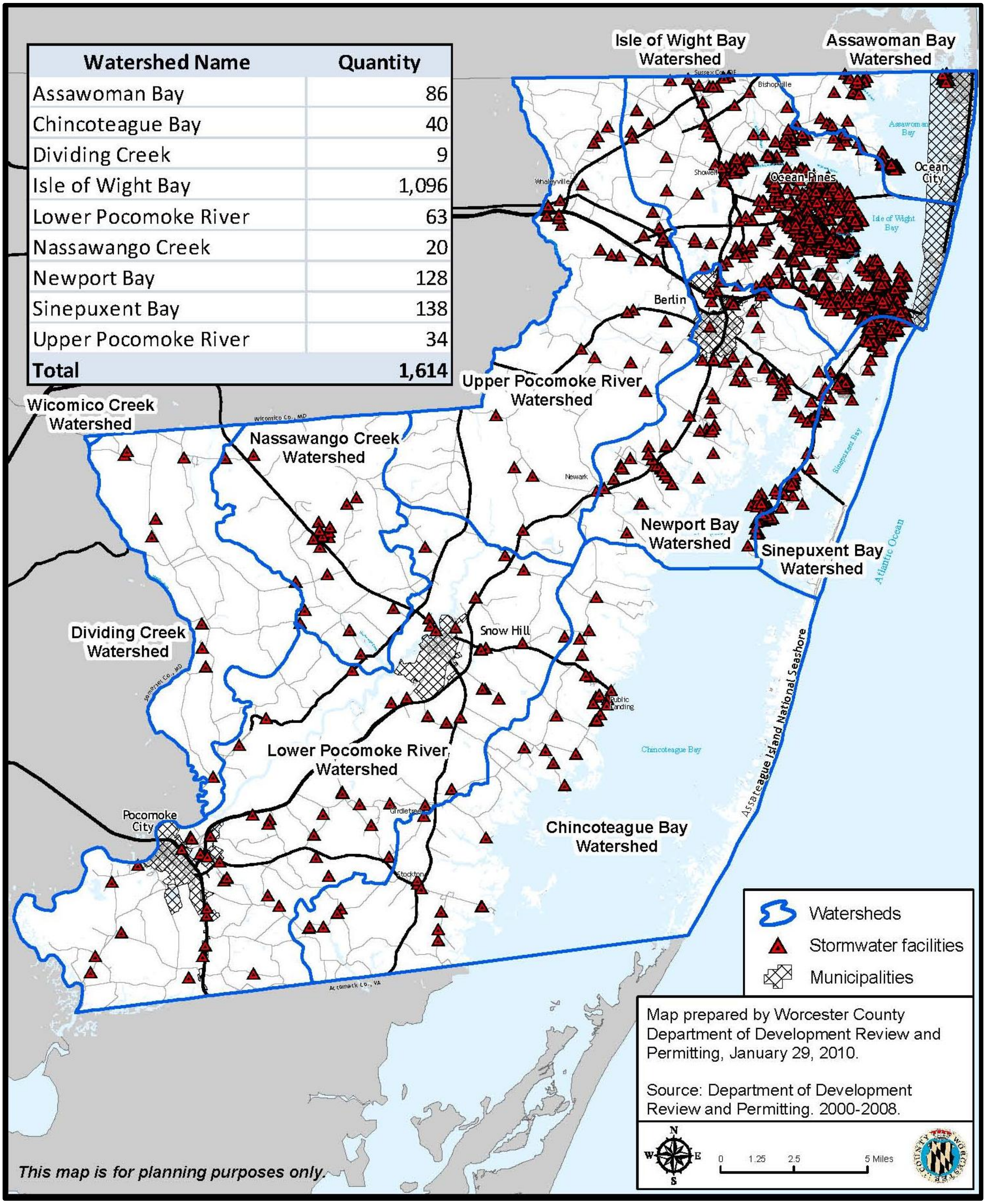
Source: 2004 Aerial Imagery, GIS-based building footprints and streets layer.

primarily intended to provide abatement to flooding issues by capturing and storing stormwater. However, although not particularly planned for at the onset, regulators noticed a water quality benefit from capturing and storing stormwater before ultimate discharge to local rivers, streams and bays.

The County's current SWM requirements, adopted in 2000, incorporate changes mandated by the State and referenced in the *2000 Maryland Stormwater Design Manual*. One of the significant changes outlined in this manual is a menu of non-structural best management practices (BMPs) that allowed for a more environmentally sensitive approach to site development. Unlike other areas of the State, Worcester County has little to no relief in its topography, thus allowing for easier and more successful use of non-structural BMPs. These practices incorporate existing site conditions along with vegetative filtering practices to provide water quality on sites. Once approved and implemented they provide a profound impact on water quality. The relatively flat topography lengthens the amount of time stormwater runoff takes to reach receiving waters, thus allowing for more natural nutrient uptake from existing vegetation.

Currently, Worcester County has over 1,600 permitted and approved SWM facilities as shown in Figure 4-1. After final approval and associated inspections, these facilities are inspected once every three years to ensure the functionality of the sites. Of the approved stormwater management facilities, almost 85% incorporate non-structural BMPs.

Enforcement procedures in place in the local ordinance require developers and subsequent property owners to enter into inspection and maintenance agreements which bind properties to perpetual compliance with the approved stormwater management plan. This, along with strong oversight during construction, ensures the continued functionality of onsite SWM facilities.



Watershed Name	Quantity
Assawoman Bay	86
Chincoteague Bay	40
Dividing Creek	9
Isle of Wight Bay	1,096
Lower Pocomoke River	63
Nassawango Creek	20
Newport Bay	128
Sinepuxent Bay	138
Upper Pocomoke River	34
Total	**1,614**

Figure 4-1. Stormwater Facilities in Worcester County, MD

The State’s previous stormwater management law was amended by the passage of the Stormwater Management Act of 2007 by the Maryland General Assembly. The primary focus of the Act is to require environmental site design to the maximum extent practicable. This change requires a more environmentally sensitive site development plan to be submitted as part of the regulatory review. As part of that review, three plans must be submitted. The first, the concept plan, focuses on protecting existing natural resources on the site and limiting the amount of created impervious surfaces. The second plan, known as the site development plan, ties the site design parameters from the concept phase into more workable construction document~~s~~. The third and final plan is the approved construction plan~~s~~. Worcester County amended its stormwater management regulations to bring them into compliance with the 2007 Act on May 18, 2010.

In the next discussion, nutrient pollutant loads from urban stormwater and other nonpoint sources including agricultural and forests designated areas are assessed to determine its potential water quality impact.

<u>4.3 Nonpoint Source Assessment</u>

This assessment focused on two sources of nonpoint pollution: land use activities and septic systems. To examine pollution impacts from land uses, the County compared two different land use scenarios. To understand the potential impact of septic systems, the County projected the future number of septic systems while considering their location, possibility of connecting systems to nearby WWTPs, and potential for upgrading systems to denitrification technologies.

Through this nonpoint source (NPS) assessment, the County quantified the potential nutrient load, specifically total nitrogen (TN) and total phosphorus (TP), each land use scenario and septic system could contribute at a watershed scale. By examining different land use scenarios while considering the nutrient impact of septic systems, the County can identify which land use scenario has the least impact on water quality and wildlife habitat. This initial NPS assessment could supplement existing planning decision-making tools that help to identify appropriate places for future growth and development while protecting our natural resources.

This NPS assessment’s methodology is based on nutrient loading rates provided by the Chesapeake Bay Program as well as land use acreages and the number of septic systems in the County (Table 4-2). These three variables are applied in the equations shown in Table 4-3. Based on this methodology and generalizations of the land use scenarios, the County recognizes that the results described in this WRE NPS assessment do not reflect the *actual* amount of nutrients in the watershed. These “what if” scenarios demonstrate how different land use activities, given its size, location and nutrient loading potential, could impact a watershed’s water quality and

Table 4-2. Nutrient Loading Rates (lbs/ac/yr)

					Septic System (lbs/system/yr)	
Nutrient loading rate	**Forest**	**Agriculture**	**Urban**	**Air Deposition**	**Outside Critical Area**	**Inside Critical Area**
Total Nitrogen Load	1.2	11.7	5.2	7.9	6.0	12.0
Total Phosphorus Load	0.0	1.0	0.6	0.0	0.0	0.0

Source: Chesapeake Bay Program Watershed Model Output database Phase 4.3, Watershed segment 430, Maryland Tributary Strategy 06 scenario, April 2004.

wildlife habitat. Additionally, for the purposes of this WRE, the County does not provide additional recommendations regarding air deposition but recognizes that it can contribute nutrients to water resources. EPA has committed to reducing air deposition of nitrogen to the tidal waters of the Chesapeake Bay and these reductions will be achieved through implementation of the Clean Air Act during the coming years (TMDL Implementation Letter dated 11-4-09, p. 34). The County will continue to work with federal and state agencies and assist where needed to comply with regulations. Following is a discussion focused on the land use scenarios. Then a quantitative assessment of septic systems is provided.

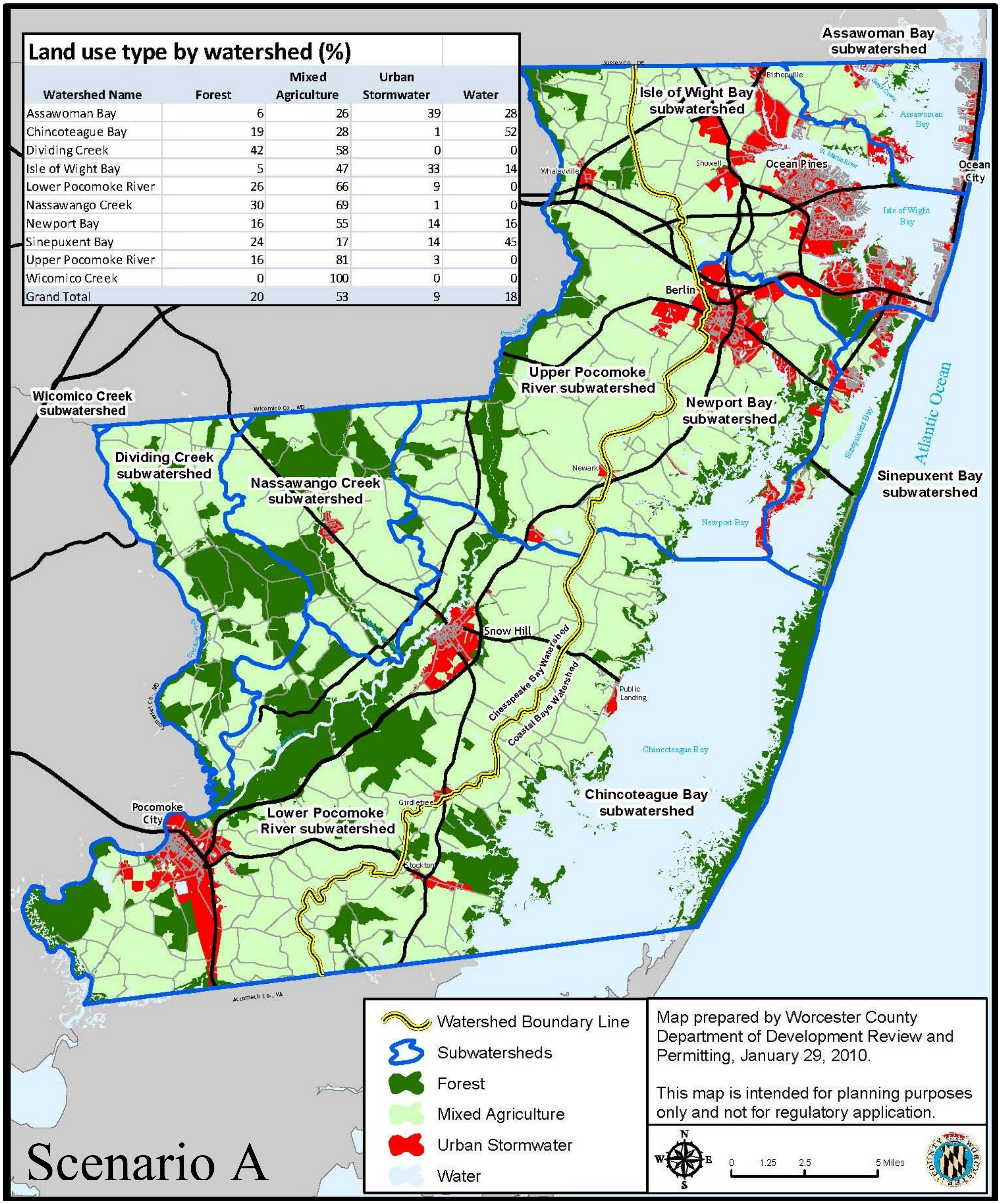
Land Use Scenarios

For this NPS assessment two different land use scenarios were developed and compared to each other on the basis of their nutrient contribution within a watershed. Although this assessment was conducted at a county-level and not a site-level, this broad-based planning exercise gave the County insight on how land use changes impact the environment. For this WRE, this assessment level is deemed appropriate. These lessons can translate into improving the implementation of environmental site design standards, assisting others with voluntary approaches that can help reduce nutrient loads, and informing the land use element of the *Comprehensive Plan*.

The two land use scenarios used in this NPS assessment, Scenario A and Scenario B, are shown in Figure 4-2 and Figure 4-3. Each land use scenario was based on land use maps from the 1989 and 2006 *Comprehensive Plan*. A land use map generally shows where the County anticipates growth and development, identifies the natural resources that should be protected, and the preservation of agricultural landscapes. Its purpose is to help guide over-arching planning principles. For the purposes of this NPS assessment, the scenario which contributes the least amount of nutrients should be used for guidance when designating land uses while minimizing impacts to the environment. A summary of land use acreages derived from Scenario A and Scenario B is provided in Table 4-4 and Table 4-5. Following is a discussion about how land use changes affected nutrient loads in each watershed.

Table 4-3. Nonpoint Source Assessment Equations

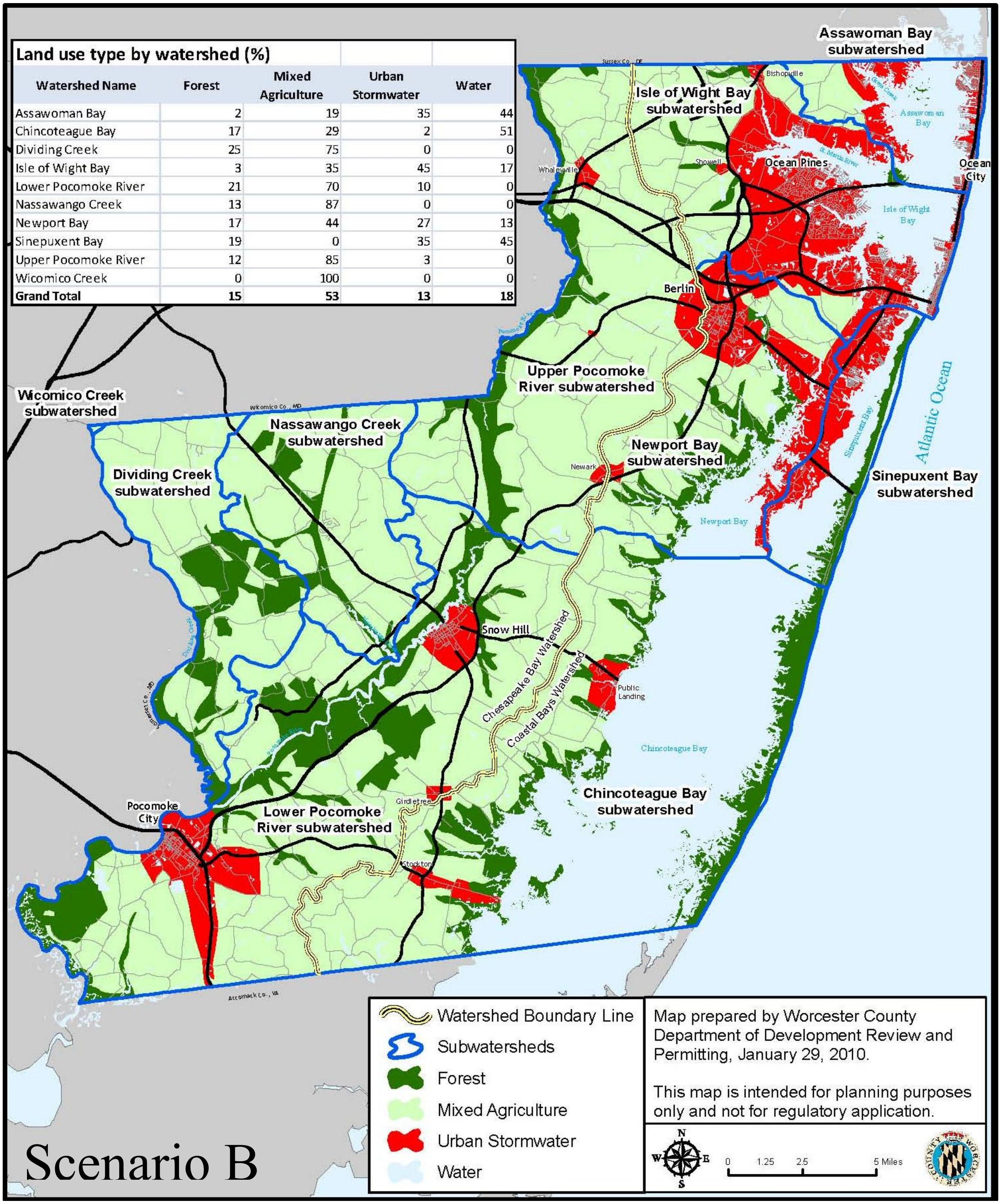
Equation ID	Result	Equation	Variable	Definition	Units
Eq. 1	Total nitrogen load	$TN = LR_n * LU$	TN	Total nitrogen load	lbs/yr
			LR_n	Nitrogen loading rate	lbs/ac/yr
			LU	Land use	acres
Eq. 2	Total phosphorus load	$TP = LR_p * LU$	TP	Total phosphorus load	lbs/yr
			LR_p	Phosphorus loading rate	lbs/ac/yr
			LU	Land use	acres
Eq. 3	Septic nitrogen load	$S_n = LR_{sn} * S_a$	S_n	Septic nitrogen load	lbs/yr
			LR_{sn}	Septic nitrogen load per system	lbs/sys/yr
			S_a	Number of septic systems	n/a
Eq. 4	Total nitrogen NPS load	$TNPS_n = S + TN$ or	$TNPS_n$	Total Nitrogen nonpoint source load	lbs/yr
Eq. 5	Total pollution load	$TPL_n = TNPS_n + TPS_n$ $TPL_p = TP + TPS_p$	TPL_x	Total N or P pollution load	lbs/yr
			TPS_x	Total N or P point source load	lbs/yr



Land use type by watershed (%)

Watershed Name	Forest	Mixed Agriculture	Urban Stormwater	Water
Assawoman Bay	6	26	39	28
Chincoteague Bay	19	28	1	52
Dividing Creek	42	58	0	0
Isle of Wight Bay	5	47	33	14
Lower Pocomoke River	26	66	9	0
Nassawango Creek	30	69	1	0
Newport Bay	16	55	14	16
Sinepuxent Bay	24	17	14	45
Upper Pocomoke River	16	81	3	0
Wicomico Creek	0	100	0	0
Grand Total	20	53	9	18

Figure 4-2. Land Use Scenario A, shown above, consumes 9% of the County for growth and urban development. This approach seeks to preserve more mixed agriculture and forest by designating growth and development within or adjacent to existing population centers including Berlin, Snow Hill and Pocomoke City. By creating a more compact development pattern, much of the County's sensitive shoreline is protected.



Land use type by watershed (%)				
Watershed Name	Forest	Mixed Agriculture	Urban Stormwater	Water
Assawoman Bay	2	19	35	44
Chincoteague Bay	17	29	2	51
Dividing Creek	25	75	0	0
Isle of Wight Bay	3	35	45	17
Lower Pocomoke River	21	70	10	0
Nassawango Creek	13	87	0	0
Newport Bay	17	44	27	13
Sinepuxent Bay	19	0	35	45
Upper Pocomoke River	12	85	3	0
Wicomico Creek	0	100	0	0
Grand Total	**15**	**53**	**13**	**18**

Figure 4-3. Land Use Scenario B, shown above, depicts a generalized land use plan for growth and development in the County. Much of the urban development surrounds existing population centers and is designated along the shoreline in the northern part of the County. This land use plan would consume 13% of the County for growth and urban development.

Table 4-4. Scenario A: NPS Assessment Land Use Type by Watershed (acres)

Watershed Name	Forest	Mixed Agriculture	Urban	Water	Grand Total
Coastal Bays Watershed					
Assawoman Bay	713	3,329	2,560	6,200	12,802
Chincoteague Bay	15,726	25,257	695	47,615	89,293
Isle of Wight Bay	1,889	19,223	11,922	8,087	41,121
Newport Bay	4,601	17,641	4,407	5,843	32,492
Sinepuxent Bay	3,203	2,209	1,833	6,465	13,710
Chesapeake Bay Watershed					
Dividing Creek	10,716	15,496	0	108	26,320
Lower Pocomoke River	19,707	53,098	6,828	1,810	81,443
Nassawango Creek	7,654	17,960	224	159	25,997
Upper Pocomoke River	7,992	41,290	1,576	346	51,204
Wicomico Creek	0	68	0	2	70
Grand Total	**72,201**	**195,571**	**30,045**	**76,635**	**374,452**

*Note: change in water is due to the change in shorelines for different GIS files.

Table 4-5. Scenario B: NPS Assessment Land Use Type by Watershed (acres)

Watershed Name	Forest	Mixed Agriculture	Urban	Water	Grand Total
Coastal Bays Watershed					
Assawoman Bay	170	2,392	3,833	6,407	12,802
Chincoteague Bay	13,341	25,730	1,965	48,257	89,293
Isle of Wight Bay	982	14,371	17,390	8,378	41,121
Newport Bay	4,553	13,914	8,056	5,969	32,492
Sinepuxent Bay	2,218	0	4,607	6,885	13,710
Chesapeake Bay Watershed					
Dividing Creek	6,659	19,566	0	95	26,320
Lower Pocomoke River	15,711	56,218	7,727	1,787	81,443
Nassawango Creek	3,212	22,652	0	133	25,997
Upper Pocomoke River	5,883	43,409	1,656	256	51,204
Wicomico Creek	0	67	0	3	70
Grand Total	**52,729**	**198,319**	**45,234**	**78,170**	**374,452**

*Note: change in water is due to the change in shorelines for different GIS files.

Assawoman Bay

As shown in Scenario B, urban areas in the Assawoman Bay Watershed were concentrated along the mainland's coastline and on Fenwick Island. Through the process of developing the *Comprehensive Plan*, new land use goals were established and included preserving the County's sensitive coastal areas, forests, and agriculture heritage. This meant that new growth should be located adjacent to existing population centers and infrastructure. Scenario A reflects these goals by recognizing existing developed areas and designating undisturbed urban areas as either forest or agriculture (Figure 4-2). This resulted in an overall nutrient increase, however. As shown in Table 4-6, approximately 3,300 pounds (lbs) of TN and ~170 lbs of TP were added to the bay system largely due to the increase in designated agricultural areas.

A conflict arises in this watershed where the goals of the *Comprehensive Plan*, to protect our natural resources and sensitive areas and to preserve our agricultural heritage, reflected in Scenario A, may hinder the goal to reduce nutrients in the bay. The County seeks to maintain growth and development in existing developed areas or adjacent to those areas. Extending development to areas shown in Scenario B could cause irreparable damage not only to our natural resources, sensitive areas, and agricultural heritage but to wildlife habitat and water quality. Unfortunately, this WRE's NPS assessment is not designed to consider complex interactions between the land, water, and anthropogenic sources. Further detailed analysis should be performed to understand the full urban impact to the natural environment.

Table 4-6. Assawoman Bay NPS Assessment

Assawoman Bay Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	856	38,949	13,312	48,983	102,100
Scenario B	204	27,986	19,932	50,619	98,741
Change in Total Nitrogen	**652**	**10,963**	**-6,620**	**-1,635**	**3,360**
Scenario A	0	3,329	1,536	0	4,865
Scenario B	0	2,392	2,300	0	4,692
Change in Total Phosphorus	**0**	**937**	**-764**	**0**	**173**

Chincoteague Bay

Chincoteague Bay is the largest watershed in the Coastal Bays Watershed and is dominated by agriculture and forest land uses. A comparison between agricultural land use in Scenario A (Table 4-4) and Scenario B (Table 4-5) reveals that Scenario A has 473 acres less than Scenario B. As a result, TN declined by ~5,500 lbs and TP declined by ~470 lbs (Table 4-7). Urban areas decreased by ~1,300 acres in Scenario A as well. This resulted in a reduction of ~6,600 lbs of TN and ~760 lbs of TP when compared to Scenario B. By changing urban and agricultural land use designations to a forest land use designation the amount of land area designated as forest in Scenario A increased by ~2,400 acres. The combined effect of these land use changes resulted in an overall decrease of ~14,000 lbs of TN and a decrease of ~1,200 lbs of TP in Scenario A when compared to Scenario B.

Table 4-7. Chincoteague Bay NPS Assessment

Chincoteague Bay Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	18,871	295,507	3,614	376,159	694,151
Scenario B	16,009	301,041	10,218	381,230	708,499
Change in Total Nitrogen	**2,862**	**-5,534**	**-6,604**	**-5,072**	**-14,348**
Scenario A	0	25,257	417	0	25,674
Scenario B	0	25,730	1,179	0	26,909
Change in Total Phosphorus	**0**	**-473**	**-762**	**0**	**-1,235**

Dividing Creek

Agriculture is a major nonpoint source contributor of nutrients in the Dividing Creek Watershed. However, the nutrient impact decreases by changing ~4,000 acres of land designated as agriculture to forest (Tables 4-4 & 4-5). This change is reflected in Scenario A (Figure 4-2). Although this change increased the forest TN load contribution, the reduction in TN loads from agriculture was significant (~48,000 lbs). Overall, by implementing the goals of the *Comprehensive Plan* in Scenario A, ~ 43,000 lbs of nitrogen and ~4,000 lbs of TP were removed from the system (Table 4-8).

Table 4-8. Dividing Creek NPS Assessment

Dividing Creek Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	12,859	181,303	0	853	195,016
Scenario B	7,991	228,922	0	751	237,664
Change in Total Nitrogen	**4,868**	**-47,619**	**0**	**103**	**-42,648**
Scenario A	0	15,496	0	0	15,496
Scenario B	0	19,566	0	0	19,566
Change in Total Phosphorus	**0**	**-4,070**	**0**	**0**	**-4,070**

Isle of Wight Bay

The Isle of Wight Bay Watershed is located in the northern Coastal Bays Watershed which is the most urbanized region of the County. Scenario B designated the entire shoreline for urban development (Figure 4-3). Scenario A scaled back the amount of new growth directed into the watershed by changing much of the urban area to agriculture (Figure 4-2). Given these changes in land use designations, agriculture remained the major single nonpoint source contributor of TN and TP. Over 56,000 lbs of TN and ~4,800 lbs of TP were added to the bay system as a result of the change in land use designation (Table 14-9). Approximately 28,000 lbs of TN and ~3,000 lbs of TP were removed from the system due to less urban areas. Sensitive areas along the shoreline undisturbed by new development were changed to forest. Overall, an additional ~27,000 lbs of TN and ~1,600 lbs of TP were added to the entire bay system.

A conflict arises in this watershed where the goals of the *Comprehensive Plan* to protect our natural resources and sensitive areas and to preserve our agricultural heritage, reflected in Scenario A, may hinder the goal to reduce nutrients in the bay. The County seeks to maintain growth and development in existing developed areas or adjacent to those areas. Extending development to areas shown in Scenario B could cause irreparable damage not only to our natural resources, sensitive areas, and agricultural heritage but to wildlife habitat and water quality. Unfortunately, this WRE's NPS assessment is not designed to consider complex interactions between the land, water, and anthropogenic sources. Further detailed analysis should be performed to understand the full urban impact to the natural environment.

Table 4-9. Isle of Wight Bay NPS Assessment

Isle of Wight Bay Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	2,267	224,909	61,994	63,887	353,058
Scenario B	1,178	168,141	90,428	66,186	325,933
Change in Total Nitrogen	**1,088**	**56,768**	**-28,434**	**-2,299**	**27,124**
Scenario A	0	19,223	7,153	0	26,376
Scenario B	0	14,371	10,434	0	24,805
Change in Total Phosphorus	**0**	**4,852**	**-3,281**	**0**	**1,571**

Lower Pocomoke River

The Lower Pocomoke River Watershed is located in the Chesapeake Bay drainage basin and is the largest watershed in the County. Dominated by an agricultural land use in both land use scenarios, it comes as no surprise that this land use designation contributed nearly 90% of the TN load (Table 4-10). To meet the *Comprehensive Plan* goals, areas designated as urban in Scenario B were changed to agriculture in Scenario A thus preserving the County's agricultural heritage. To protect our sensitive areas from intensive land uses, nearly 4,000 acres designated as agriculture in Scenario B were designated as forest in Scenario A. Developed areas including the Town of Snow Hill and Pocomoke City contribute approximately 5% of the TN load and 7% of the TP load in either scenario. Overall, TN loads are approximately 36,000 lbs less in Scenario A than Scenario B. Similarly, TP loads in Scenario A are less than the TP loads in Scenario B.

The NPS assessment conducted by the Town of Snow Hill suggested that "the town's future development plans will greatly decrease the amount of nitrogen entering the Lower Pocomoke [River];" however, TP loads may increase slightly (Snow Hill WRE, pg. 80). Decreasing the amount of agricultural land for both scenarios contributed to TN removal. For both of the Town's scenarios potential future development showed that impervious surfaces would increase and therefore increase stormwater runoff. The Town of Snow Hill's WRE recommended requiring pervious pavers or increasing required open space for future development to help decrease impervious areas. The Town of Snow Hill and County will continue to work together to implement stormwater management practices from new development (Snow Hill WRE, pg. 81).

Results of Pocomoke City's NPS assessment indicated that by implementing BMPs, "the City will make a significant contribution toward achieving nutrient reduction goals for the [Lower

Pocomoke River Watershed]" (Pocomoke City WRE, 11-24-09, pg.18). Pocomoke City's future development scenario proposed infill and redevelopment; thus, no expansion of the city's limits will occur in the future planning period. A reduction in TN and TP can be attributed to a decrease in agriculture and forest and an increase in development. Estimated nutrient loading from point and nonpoint sources amounted to a decrease in TN and TP, ~27,000 lbs and ~9,000 lbs, respectively (Pocomoke City WRE, 11-24-09, pg. 19).

Table 4-10. Lower Pocomoke River NPS Assessment

Lower Pocomoke River Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	23,648	621,247	35,506	14,299	694,700
Scenario B	18,853	657,751	40,180	14,117	730,902
Change in Total Nitrogen	**4,795**	**-36,504**	**-4,675**	**182**	**-36,202**
Scenario A	0	53,098	4,097	0	57,195
Scenario B	0	56,218	4,636	0	60,854
Change in Total Phosphorus	**0**	**-3,120**	**-539**	**0**	**-3,659**

Nassawango Creek

Comparing Scenario A to Scenario B reveals the amount of forested areas more than doubled in Scenario A, thus reducing the amount of agriculturally designated areas by ~4,700 acres. The impact on nutrient loads is significant. Approximately 48,000 lbs of TN and 4,600 lbs of TP were removed from the system by designating areas that were once agriculture to forest (Table 4-11). There are two Tier II waterways located in this watershed, Nassawango Creek 2 and Nassawango Creek 3, which will not be threatened by growth as no new growth areas are proposed in this watershed. The community of Nassawango Estates is located south of the Tier II waterways but should not pose a threat to its high water quality.

Table 4-11. Nassawango Creek NPS Assessment

Nassawango Creek Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	9,185	210,132	1,165	1,256	221,738
Scenario B	3,854	265,028	0	1,051	269,934
Change in Total Nitrogen	**5,330**	**-54,896**	**1,165**	**205**	**-48,196**
Scenario A	0	17,960	134	0	18,094
Scenario B	0	22,652	0	0	22,652
Change in Total Phosphorus	**0**	**-4,692**	**134**	**0**	**-4,558**

Newport Bay

The amount of agriculturally designated land uses shown in Scenario A in the Newport Bay Watershed increased by reducing the amount of urban areas shown in Scenario B. These new designations resulted in a TN increase of ~ 24,000 lbs and TP loads increased by 1,500 lbs (Table 4-12). The Town of Berlin's contribution towards the TN and TP loads is less than 20,000 lbs of TN and less than 2,000 lbs of TP according to the Town's Nonpoint Source Loading Scenario 1-Existing Town Boundaries Assessment (Town of Berlin WRE). Their results are fairly consistent with the results shown from Scenario A below. As the Town continues to develop and expand its municipal boundaries their NPS assessment indicated that nitrogen loads would decrease while TP loads would see relatively no change.

A conflict arises in this watershed where the goals of the *Comprehensive Plan* to protect our natural resources and sensitive areas and to preserve our agricultural heritage, reflected in Scenario A, may hinder the goal to reduce nutrients in the bay. The County seeks to maintain growth and development in existing developed areas or adjacent to those areas. Extending development to areas shown in Scenario B could cause irreparable damage not only to our natural resources, sensitive areas, and agricultural heritage but to wildlife habitat and water quality. Unfortunately, this WRE's NPS assessment is not designed to consider complex interactions between the land, water, and anthropogenic sources. Further detailed analysis should be performed to understand the full urban impact to the natural environment.

Table 4-12. Newport Bay NPS Assessment

Newport Bay Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	5,521	206,400	22,916	46,160	280,997
Scenario B	5,464	162,794	41,891	47,155	257,304
Change in Total Nitrogen	**58**	**43,606**	**-18,975**	**-995**	**23,693**
Scenario A	0	17,641	2,644	0	20,285
Scenario B	0	13,914	4,834	0	18,748
Change in Total Phosphorus	**0**	**3,727**	**-2,189**	**0**	**1,538**

Sinepuxent Bay

Overall, TN and TP loads increased by ~9,000 lbs and ~500 lbs, respectively, in the Sinepuxent Bay Watershed due to the conversion between urban and agriculturally designated areas (Table 4-13). Scenario B designated the entire mainland portion of the watershed as an area where new urban growth should occur (Figure 4-3). When compared to Figure 4-2, the amount of land targeted for development was replaced by designating those areas to agriculture. This change reflected the *Comprehensive Plan's* goal to maintain the County's rural and coastal character by preserving the integrity of its agricultural heritage and sensitive coastal areas.

A conflict arises in this watershed where the goals of the *Comprehensive Plan* to protect our natural resources and sensitive areas and to preserve our agricultural heritage, reflected in Scenario A, may hinder the goal to reduce nutrients in the bay. The County seeks to maintain growth and development in existing developed areas or adjacent to those areas. Extending development to areas shown in Scenario B could cause irreparable damage not only to our natural resources, sensitive areas, and agricultural heritage but to wildlife habitat and water quality. Unfortunately, this WRE's nonpoint assessment is not designed to consider complex interactions between the land, water, and anthropogenic sources. Further detailed analysis should be performed to understand the full urban impact to the natural environment.

Table 4-13. Sinepuxent Bay NPS Assessment

Sinepuxent Bay Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	3,844	25,845	9,532	51,074	90,294
Scenario B	2,662	0	23,956	54,392	81,010
Change in Total Nitrogen	**1,182**	**25,845**	**-14,425**	**-3,318**	**9,285**
Scenario A	0	2,209	1,100	0	3,309
Scenario B	0	0	2,764	0	2,764
Change in Total Phosphorus	**0**	**2,209**	**-1,664**	**0**	**545**

Upper Pocomoke River

The Upper Pocomoke River Watershed is dominated by an agricultural landscape. Thus, both scenarios reflect similar land use patterns. For both scenarios, TN and TP loads from agriculture make up ~96% and ~98%, respectively, of the nonpoint source load from land uses. However, by increasing the amount of forested acres by ~2,000 acres and decreasing agricultural areas by the same amount in Scenario A, TN and TP loads decreased by ~22,000 lbs/yr and ~2,000 lbs/yr, respectively (Table 4-14).

Table 4-14. Upper Pocomoke River NPS Assessment

Upper Pocomoke River Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	9,590	483,093	8,195	2,733	503,612
Scenario B	7,060	507,885	8,611	2,022	525,579
Change in Total Nitrogen	**2,531**	**-24,792**	**-416**	**711**	**-21,967**
Scenario A	0	41,290	946	0	42,236
Scenario B	0	43,409	994	0	44,403
Change in Total Phosphorus	**0**	**-2,119**	**-48**	**0**	**-2,167**

Wicomico Creek

The Wicomico Creek Watershed is the smallest Watershed in the County and is located where Worcester County meets the boundaries of Wicomico and Somerset Counties. Its impact to the County's Chesapeake Bay Watershed portion is minimal due to its size, 70 acres. However, this watershed is designated as agriculture and could contribute ~800 lbs of TN and ~65 lbs of TP.

Table 4-15. Wicomico Creek NPS Assessment

Wicomico Creek Nutrient Loads (lbs/yr)	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A	0	796	0	16	811
Scenario B	0	784	0	24	808
Change in Total Nitrogen	**0**	**12**	**0**	**-8**	**4**
Scenario A	0	68	0	0	68
Scenario B	0	67	0	0	67
Change in Total Phosphorus	**0**	**1**	**0**	**0**	**1**

Land Use Scenario Summary

Overall, Scenario A contributes less TN and TP than Scenario B. The NPS assessment resulted in a decrease in TN and TP by a total of ~100,000 lbs and ~12,000 lbs, respectively, by changing land use designations in Scenario B to those land uses reflected in Scenario A. The largest reduction in TN loads, ~79,000 lbs, came from reducing the amount of land targeted for new urban growth and development. A reduction of agricultural areas resulted in a reduction of ~32,000 lbs of TN (Table 4-16). As agricultural and urban acres decreased, forested areas increased by ~17,000 acres. This land use increase resulted in more than ~23,000 lbs of TN from forested areas. Approximately 9,000 lbs of TP from urban areas and ~2,700 lbs of TP from agricultural areas could be removed from the system by implementing Scenario A instead of Scenario B (Table 4-17).

A closer look at the Chesapeake Bay and Coastal Bays Watersheds indicate that Scenario A favors nutrient reduction in the Chesapeake Bay Watershed whereas Scenario B appears to favor nutrient reduction in the Coastal Bays Watershed. As you recall, much of the northern Coastal Bays Watershed was designated as urban land use in Scenario B. In Scenario A much of this urban land use was changed to agriculture. For this broad-based NPS assessment, an acre of agriculture contributes more nutrients than an acre of urban area which results in an increase of nutrients should the amount of agriculture exceed the amount of urban land use. Unfortunately, this type of NPS assessment is not designed to consider complex interactions between the land, water, and anthropogenic sources; thus, making it difficult to assess the full impact of urban development as shown in Scenarios A and B.

In general, agriculture was the leading cause in TN increases to waterways. Given that over half of the County is designated as agriculture and that its TN loading rate is roughly 10-25 pounds per acre, depending on the level of BMP implementation, it comes as no surprise that agriculture is the primary source of excessive nutrients to the bays. One of the goals of the *Comprehensive*

Plan is to consume less land for new development and growth in order to preserve our agricultural heritage and sensitive coastal areas. To be consistent with the *Comprehensive Plan*, Scenario A preserves the County's agricultural heritage, its sensitive shoreline, and natural resources. Scenario B clearly works against the goals of the *Comprehensive Plan* since urban land uses dominate the northern Coastal Bays Watershed. In turn, the County continues to support agricultural BMP implementation efforts that can help minimize TN and TP loads from agricultural areas. Table 4-18 shows the change in nutrients per watershed from changing land uses designated in Scenario B to Scenario A. A positive sign (+) indicates an increase in nutrients whereas a negative sign (-) indicates a decrease in nutrients.

Table 4-16. County-wide Total Nitrogen (TN) Assessment Results

Worcester County Scenarios	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A TN Load (lbs/yr)	**86,641**	**2,288,181**	**156,234**	**605,420**	**3,136,476**
Coastal Bays Watershed	31,358	791,610	111,368	586,262	1,520,600
Chesapeake Bay Watershed	55,283	1,496,570	44,866	19,158	1,615,876
Scenario B TN Load (lbs/yr)	**63,275**	**2,320,332**	**235,217**	**617,546**	**3,236,370**
Coastal Bays Watershed	25,517	659,962	186,425	599,582	1,471,486
Chesapeake Bay Watershed	37,758	1,660,370	48,792	17,965	1,764,885
Change in TN	**23,366**	**-32,152**	**-78,983**	**-12,127**	**-99,895**

Table 4-17. County-wide Total Phosphorus (TP) Assessment Results

Worcester County Scenarios	Forest	Agriculture	Urban	Air Deposition	Total
Scenario A TP Load (lbs/yr)	**0**	**195,571**	**18,027**	**0**	**213,598**
Coastal Bays Watershed	0	67,659	12,850	0	80,509
Chesapeake Bay Watershed	0	127,912	5,177	0	133,089
Scenario B TP Load (lbs/yr)	**0**	**198,319**	**27,140**	**0**	**225,459**
Coastal Bays Watershed	0	56,407	21,511	0	77,918
Chesapeake Bay Watershed	0	141,912	5,630	0	147,542
Change in TP	**0**	**-2,748**	**-9,113**	**0**	**-11,861**

Table 4-18. Change in TN and TP from Scenario B to Scenario A

	Watershed Name	TN	TP
Coastal Bays Watershed	Assawoman Bay	+	+
	Chincoteague Bay	-	-
	Isle of Wight Bay	+	+
	Newport Bay	+	+
	Sinepuxent Bay	+	+
Chesapeake Bay Watershed	Dividing Creek	-	-
	Lower Pocomoke River	-	-
	Nassawango Creek	-	-
	Upper Pocomoke River	-	-
	Wicomico Creek	+	+

Notes: A positive sign (+) indicates an increase in nutrients whereas a negative sign (-) indicates a decrease in nutrients.

Septic System Contribution

This assessment examines the contribution from septic systems during the planning period 1960 through 2010 as well as the future septic nitrogen load for the planning period 2011-2025.

Location and technology choices are regulated by State and local requirements. Some older septic systems, especially when located near the water, pose significant water quality problems. They contribute nutrients and pathogens to the nearby surface waters and groundwater. In the Critical Area, current standards require best available technology for new development and certain specific cases. State grants are now useful in converting existing outdated on-site septic systems to less damaging nutrient reduction technologies but the continued availability of such funding is questionable.

Depending on the location of septic systems, each system may contribute 6 or12 lbs of TN annually. There are no significant amounts of phosphorus leaching from septic systems. In Worcester County, septic systems within the Critical Area contribute 12 lbs/sys/yr of TN whereas septic systems outside of the Critical Area contribute 6 lbs/sys/yr of TN. Less nitrogen will enter the bays because of the distance traveled by groundwater which allows nitrogen removal processes to occur. Recently installed systems and existing systems upgraded to denitrification standards leach 6 lbs of TN annually instead of 12 lbs of TN regardless of their location in or outside of the Critical Area. As shown in table 4-19, 109 septic systems inside the Critical Areas were upgraded prior to 2011. By the end of 2025, we anticipate upgrading 185 septic systems inside the Coastal Bays Critical Area and 26 septic systems in the Chesapeake Bay Critical Area. Upgraded septic systems outside of the Critical Area were upgraded to enhance overall performance, not for denitrification. The following section quantifies the amount of nitrogen potentially leaching from septic systems in the Coastal Bays Watershed.

Table 4-19. Septic System Upgrades

Watershed Name	2006-2010		2011-2025	
	Outside Critical Area	Inside Critical Area	Outside Critical Area	Inside Critical Area
Coastal Bays Watershed				
Assawoman Bay	0	3	5	30
Chincoteague Bay	0	13	10	25
Isle of Wight Bay	25	53	25	60
Newport Bay	0	11	15	40
Sinepuxent Bay	0	11	4	30
Grand Total	**25**	**91**	**59**	**185**
Chesapeake Bay Watershed				
Dividing Creek	0	0	4	0
Lower Pocomoke River	2	18	25	25
Nassawango Creek	0	0	2	0
Upper Pocomoke River	0	0	15	1
Wicomico Creek	0	0	0	0
Grand Total	**2**	**18**	**46**	**26**

Coastal Bays Watershed Septic System Assessment

Nearly 60% of all existing septic systems in the County are located in the Coastal Bays Watershed. By the end of 2025, 229 less septic systems are anticipated to be located in the watershed (Table 4-20). Approximately 34% of the total number of septic systems in the Coastal Bays Watershed is currently located in the Critical Area. By the end of 2025, about 30% of all septic systems in the watershed may be located in the Critical Area. The Isle of Wight Bay and Newport Bay Watersheds have the highest combined number of septic systems currently and will continue to have the highest amount in the future (Table 4-20). There are more septic systems located outside of the Critical Area in the Isle of Wight Bay Watershed than any other watershed.

Approximately 32,820 lbs/yr of TN from septic systems currently enter the Coastal Bays. By the end of 2025, the County expects a reduction of approximately 4,884 pounds of TN to occur in the Coastal Bays Watershed. The Isle of Wight Watershed contributes the highest amount of TN from septic systems followed by the TN contributions from the Newport Bay Watershed. The greatest amount of TN reduction, 5,364 lbs, may occur in the Northern Coastal Bays Watershed region. The largest amount of TN loss may occur inside the Critical Area, 5,076 lbs, by the end of 2025. The Assawoman Bay and Chincoteague Bay Watersheds show slight increases in TN relative to the other three watersheds.

Much of the TN load from septic systems occurs in the Coastal Bays Watershed, particularly the Northern Coastal Bays region where most of the development and growth is concentrated. Action is being taken to reduce the number of septic systems in the region by connecting existing septic systems to public wastewater treatment plants. New septic systems installed have denitrification technology that will contribute the least amount of TN annually.

Table 4-20. Number of Septic Systems and Total Nitrogen Load in the Coastal Bays Watershed

Watershed Name	No. Septic (1960-2010)	No. Septic (2011-2025)	Change in No. of Septic Systems	1960-2010 TN Load (lbs/yr)	2011-2025 TN Load (lbs/yr)	Change in Nitrogen Loads
Assawoman Bay	**304**	**349**	**45**	**3,036**	**3,126**	**90**
Inside Critical Area	207	237	30	2,454	2,454	0
Outside Critical Area	97	112	15	582	672	90
Chincoteague Bay	**709**	**814**	**105**	**5,106**	**5,586**	**480**
Inside Critical Area	157	172	15	1,794	1,734	-60
Outside Critical Area	552	642	90	3,312	3,852	540
Isle of Wight Bay	**1,762**	**1,548**	**-214**	**13,770**	**10,326**	**-3,444**
Inside Critical Area	596	315	-281	6,774	2,928	-3,846
Outside Critical Area	1,166	1,233	67	6,996	7,398	402
Newport Bay	**1,102**	**1,062**	**-40**	**8,268**	**7,788**	**-480**
Inside Critical Area	291	336	45	3,402	3,432	-30
Outside Critical Area	811	726	-85	4,866	4,356	-510
Sinepuxent Bay	**277**	**152**	**-125**	**2,640**	**1,110**	**-1,530**
Inside Critical Area	178	108	-70	2,046	846	-1,200
Outside Critical Area	99	44	-55	594	264	-330
Total Inside CA	**1,429**	**1,168**	**-261**	**16,470**	**11,394**	**-5,076**
Total Outside CA	**2,725**	**2,757**	**32**	**16,350**	**16,542**	**192**
Grand Total	**4,154**	**3,925**	**-229**	**32,820**	**27,936**	**-4,884**

Chesapeake Bay Watershed Septic System Assessment

Nearly 40% of all existing septic systems are located in the Chesapeake Bay Watershed. By the end of 2025, we anticipate 37 fewer septic systems in this watershed (Table 4-21). Approximately 5% of the total number of septic systems in the Chesapeake Bay Watershed is currently located in the Critical Area. By the end of 2025, about 6% of all septic systems in the watershed may be located in the Critical Area. The Lower Pocomoke River Watershed has the highest number of septic systems currently and will continue to have the highest number in the future. There are more septic systems located outside of the Critical Area in the Lower Pocomoke River Watershed than all other individual watersheds.

Approximately 19,050 lbs/yr of TN from septic systems currently enter the Chesapeake Bay via the Pocomoke River (table 4-21). By the end of 2025, the County expects a reduction of approximately 630 pounds of TN to occur in the Chesapeake Bay Watershed portion of the County. The Lower Pocomoke River Watershed contributes the highest amount of TN from septic systems followed by the combined TN contributions from the Upper Pocomoke River and Nassawango Creek Watersheds. The greatest amount of TN reduction, 528 lbs, may occur in the Lower Pocomoke River Watershed by 2025. The Dividing Creek and Wicomico Creek Watersheds show slight increases in TN relative to the Upper and Lower

Table 4-21. Number of Septic Systems and Total Nitrogen Load in the Chesapeake Bay Watershed

Watershed Name	No. Septic (1960-2010)	No. Septic (2011-2025)	Change in No. of Septic Systems	1960-2010 TN Load (lbs/yr)	2011-2025 TN Load (lbs/yr)	Change in Nitrogen Loads
Dividing Creek	**224**	**226**	**2**	**1,344**	**1,356**	**12**
Inside Critical Area	0	0	0	0	0	0
Outside Critical Area	224	226	2	1,344	1,356	12
Lower Pocomoke River	**1,613**	**1,580**	**-33**	**10,452**	**9,924**	**-528**
Inside Critical Area	152	167	15	1,686	1,446	-240
Outside Critical Area	1,461	1,413	-48	8,766	8,478	-288
Nassawango Creek	**413**	**420**	**7**	**2,550**	**2,520**	**-30**
Inside Critical Area	12	15	3	144	90	-54
Outside Critical Area	401	405	4	2,406	2,430	24
Upper Pocomoke River	**778**	**764**	**-14**	**4,692**	**4,602**	**-90**
Inside Critical Area	4	4	0	48	42	-6
Outside Critical Area	774	760	-14	4,644	4,560	-84
Wicomico Creek	**2**	**3**	**1**	**12**	**18**	**6**
Inside Critical Area	0	0	0	0	0	0
Outside Critical Area	2	3	1	12	18	6
Total Inside CA	**168**	**186**	**18**	**1,872**	**1,578**	**-300**
Total Outside CA	**2,862**	**2,807**	**-55**	**17,172**	**16,842**	**-330**
Grand total	**3,030**	**2,993**	**-37**	**19,050**	**18,420**	**-630**

Pocomoke River Watersheds and Nassawango Creek Watersheds. In general, TN contribution from the Chesapeake Bay Watershed portion of the County remains relatively stable by the end of the 2025.

The following section discusses the combined impact of nonpoint sources from land uses and septic systems.

Septic System Contribution Summary

Prior to 2011, there were 7,184 septic systems in the County. The County anticipates a reduction of 266 septic systems by 2025 or 6,918 septic systems. This leads to a reduction of 5,514 lbs of TN originating from septic systems or ~46,356 lbs of TN entering waterways via septic systems in 2025.

In the following section, a nutrient assessment based on nonpoint sources that include projected septic systems and land uses from Scenario A is described.

4.4 Total Nonpoint Source Pollution Assessment: Scenario A and Septic Systems

This section discusses the cumulative amount of total nitrogen and total phosphorus entering local waterways from nonpoint sources if future growth patterns mirrored land use designations depicted in Scenario A and projected contributions from septic systems were realized. To begin, this section first addresses total nitrogen (TN) followed by a discussion on total phosphorus (TP).

Total Nitrogen

In the Coastal Bays Watershed, more TN could be released from the Chincoteague Bay Watershed than any other watershed because it is the largest in size and because half of the watershed is made up of water (Table 4-22). Air deposition on water could be significant source of TN in this watershed. The Northern Coastal Bays region which is comprised of the Assawoman Bay, Isle of Wight Bay, Newport Bay, and Sinepuxent Bay Watersheds contribute more TN to the Coastal Bays than the Chincoteague Bay Watershed.

The Lower Pocomoke River Watershed within the Chesapeake Bay drainage basin is the largest in land area and contributes the highest amount of TN to any water body in the County. This watershed can be largely characterized as either forest or agriculture with just a few acres devoted to urban. County-wide, septic systems could contribute over 46,000 lbs of TN annually. In the Coastal Bays alone, septic systems may contribute nearly 28,000 lbs of TN.

In general, the Lower and Upper Pocomoke River Watersheds and the Chincoteague Bay Watershed, contribute more than half of the total TN loads entering local watersheds from land uses designated in Scenario A and projected septic systems (Table 4-22).

Table 4-22. Projected Total Nonpoint Source Contribution: Scenario A and Septic Systems

Watershed Name	Total Nitrogen			Total Phosphorus		
	Scenario A Land Use TN Load	**Projected Septic TN Load**	**Total NPS TN Load**	**Scenario A Land Use TP Load**	**Projected Septic TP Load**	**Total NPS TP Load**
Coastal Bays Watershed						
Assawoman Bay	102,100	3,126	105,226	4,865	0	4,865
Chincoteague Bay	694,151	5,586	699,737	25,674	0	25,674
Isle of Wight Bay	353,058	10,326	363,384	26,376	0	26,376
Newport Bay	280,997	7,788	288,785	20,285	0	20,285
Sinepuxent Bay	90,294	1,110	91,404	3,309	0	3,309
Grand Total	**1,520,600**	**27,936**	**1,548,536**	**80,509**	**0**	**80,509**
Chesapeake Bay Watershed						
Dividing Creek	195,016	1,356	196,372	15,496	0	15,496
Lower Pocomoke River	694,700	9,924	704,624	57,195	0	57,195
Nassawango Creek	221,738	2,520	224,258	18,094	0	18,094
Upper Pocomoke River	503,612	4,602	508,214	42,236	0	42,236
Wicomico Creek	811	18	829	68	0	68
Grand Total	**1,615,877**	**18,420**	**1,634,297**	**133,089**	**0**	**133,089**

Total Phosphorus

For the purposes of this NPS assessment, the only sources of TP are urban (0.6 lbs/acre) and agricultural (1.0 lbs/acre) land uses. In the Coastal Bays drainage basin, land uses in the Chincoteague Bay, Isle of Wight Bay, and Newport Bay Watersheds contribute a significant amount of TP to the bays. However, the TP impact is not as great when compared to the Chesapeake Bay Watershed. Water bodies are a significant feature in the Coastal Bays Watershed and are not considered a contributor of TP in this assessment. The Chesapeake Bay Watershed portion of the County is largely comprised of designated agricultural land areas as shown in Scenario A. Thus, agriculturally designated land uses in the Upper and Lower Pocomoke River Watersheds have a significant TP impact on tributaries of the Chesapeake Bay (Table 4-22). The Lower and Upper Pocomoke River Watersheds could contribute nearly 75% of the TP load to the Pocomoke River given the scenarios set forth in this NPS assessment.

The following section discusses the cumulative impact of nonpoint source and point source pollution.

4.5 Total Nonpoint and Point Source Pollution Assessment

Waters in the Coastal Bays and Chesapeake Bay Watersheds are impaired. It is likely that in the future nutrient loads will increase due to nutrient contributions from point sources and nonpoint sources including septic systems. Should Scenario A serve as the guidance map for land use planning in the future, potentially 1.5 million pounds of TN could enter the Coastal Bays Watershed and 1.6 million pounds of TN could flow into the Chesapeake Bay (Table 4-23).

The NPS assessment conducted for this WRE to project future nutrient loads require additional scrutiny, however. The County recognizes that interactions between land use activities and the natural environment are much more complicated than what the NPS assessment considered. Additional detailed information about nutrient load contributions from specific types of land uses, understanding how effective BMPs are at removing or reducing nutrients, and realizing the impacts of continued development and growth should be considered in future NPS assessments. This level of detailed analysis is beyond the scope of this WRE document. For WRE purposes, understanding the broad implications of how land uses in general could impact local water quality can help inform long-range planning decisions and future BMP implementation efforts.

Based on the point source assessment, projected point sources in the Northern Coastal Bays region are expected to increase TN and TP loads in 2025. The Ocean Pines WWTP in the Isle of Wight Bay Watershed is expected to contribute 22,830 lbs of TN annually (Table 4-23). Point sources in the Newport Bay and Sinepuxent Bay Watersheds are projected to contribute over 5,000 lbs of TN annually. The combined TP load projected from the northern region of the Coastal Bays Watershed is in excess of 7,000 lbs per year by 2025. The Chesapeake Bay Watershed has two point sources located in the Lower Pocomoke River Watershed that are expected to increase TN and TP loads. Given the current unhealthy state of water quality in the Chesapeake Bay and Coastal Bays Watersheds, additional nutrient loads from future point sources will make achieving a healthy water quality difficult.

TMDLs for the Coastal Bays and Chesapeake Bay are underdevelopment and will help to define the nutrient reduction load needed to achieve a healthy water body. This WRE's NPS assessment demonstrates, however, that additional BMP implementation is needed to improve water quality.

Table 4-23. Projected Total Nutrient Contribution: Nonpoint Source Assessment and Estimated Future Point Source Loads (lbs/yr)

	Total Nitrogen			Total Phosphorus		
Watershed Name	**Total NPS Contribution**	**Estimated Future PS**	**Total**	**Total NPS Contribution**	**Estimated Future PS**	**Total**
Coastal Bays Watershed						
Assawoman Bay	105,226	0	105,226	4,865	0	4,865
Chincoteague Bay	699,737	0	699,737	25,674	0	25,674
Isle of Wight Bay	363,384	22,830	386,214	26,376	2,283	28,659
Newport Bay	288,785	3,044	291,829	20,285	1,522	21,807
Sinepuxent Bay	91,404	2,283	93,687	3,309	3,805	7,114
Grand Total	**1,548,536**	**28,157**	**1,576,693**	**80,509**	**7,610**	**88,119**
Chesapeake Bay Watershed						
Dividing Creek	196,372	0	196,372	15,496	0	15,496
Lower Pocomoke River	704,624	22,468	727,092	57,195	1,684	58,879
Nassawango Creek	224,258	0	224,258	18,094	0	18,094
Upper Pocomoke River	508,214	0	508,214	42,236	0	42,236
Wicomico Creek	829	0	829	68	0	68
Grand Total	**1,634,297**	**22,468**	**1,656,765**	**133,089**	**1,684**	**134,773**

In Worcester County, agriculture is the dominant land use designation shown in Scenario A and Scenario B. Thus, the rural sector will most likely shoulder much of the burden to lower nutrient contributions to the Chesapeake Bay and Coastal Bays Watersheds. Continued BMP implementation efforts should be increased for both agricultural and urban areas, specifically, in the Northern Coastal Bays region where urban development is concentrated. Population centers like The Town of Ocean City, The Town of Berlin, The Town of Snow Hill and Pocomoke City have already or are currently working towards implementing the best nutrient reduction technologies available for their wastewater treatment plants. Meanwhile, agricultural BMP implementation levels in Worcester County are highest in the State distributing $1,723,142 in 2010 and $1,312,457 in 2009 for MDA cost-share capital projects which include waste sheds and composters. In 2008-2009, $801,839 was spent planting 16,904 acres in winter cover crop (*MACS 2009 Annual Report*).

Maintaining a high level of BMP implementation on an annual basis and installing the highest quality nutrient reduction technologies is the challenge, however. Overcoming this challenge by providing the necessary staffing, technical and funding support will likely help to maintain ongoing BMP implementation efforts and create new opportunities for implementation. More recommendations regarding stormwater and nonpoint sources are provided in the next, and final, discussion.

4.6 Stormwater and Nonpoint Source Recommendations

As the NPS assessment has shown, there are cases in which preserving our agricultural heritage and sensitive coastal areas increased nutrient loads to waterways. However, the generalized land use designations reflected in Scenario A achieve the State's Smart Growth goals and the *County Comprehensive Plan* goals. These goals are also reflected in the County's 2006 land use plan map shown in Figure 2.3 of the *Comprehensive Plan*. The State's Smart Growth goals are to:

- Support existing communities by targeting resources to support development in areas where infrastructure exists;
- Save our most valuable natural resources before they are forever lost;
- Save taxpayers from the high cost of building infrastructure to serve development that has spread far from our traditional population centers; and
- Provide Marylanders with a high quality of life, whether they choose to live in a rural community, suburb, small town, or city.

As shown in the *Comprehensive Plan's* land use map, the County's rural and coastal character is maintained by preserving the integrity of its agricultural and forested areas and concentrating new growth away from the coastline and near existing population centers where infrastructure already exists. To achieve this success, the following growth area criteria were considered:

- Limit environmental damage;
- Reduce land consumption outside existing communities;
- Minimize negative impacts to natural, economic, and social resources;
- Efficiently provide adequate public facilities and services; and
- Minimize adverse impacts on existing communities and foster a cooperative approach to land use planning and development.

To work towards improving our local waterways in the Chesapeake and Coastal Bays Watersheds while still maintaining the County's agricultural heritage and sensitive coastal environment, the following recommendations should be explored for further consideration.

1. Continue implementing the Zoning and Subdivision Control Article (adopted November 3, 2009) to provide the following:
    a. Compact development patterns
    b. Minimum impervious surfaces
    c. Environmental site design standards that preserves the natural hydrology and floodplains
2. Increase tree and shrub canopy cover in developed and developing areas.
3. Seek funding to preserve agricultural land, implement urban BMPs, and install retrofits.
4. Assist and inform farmers to secure the funding for agricultural BMPs.
5. Educate the public to modify their stormwater inducing behaviors, e.g. move downspout outlets from paved areas to grassed areas.
6. Work with the Maryland Coastal Bays Program to continue and upgrade as necessary water quality monitoring efforts.
7. Track progress toward meeting TMDL standards.
8. Develop and implement Watershed Implementation Plans (WIPs).
9. Revisit the NPS assessment when the new Coastal Bays and Chesapeake Bay TMDLs become available.

-end-

-end-