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Approved

Water Resources Functional Master Plan

September 2010

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September 2010

The Maryland-National Capital
Park and Planning Commission
Prince George's County Planning Department
www.mncppc.org/pgco

ABSTRACT

Title:	Approved Water Resources Functional Master Plan
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Abstract:	This report contains the text of the Approved Water Resources Functional Master Plan (Water Resources Plan). It amends Prince George's County's 2002 General Plan. The Water Resources Plan provides information relating to county water and sewer service capacity relative to planned growth to 2030, summarizes and provides a technical model to estimate the nutrient loadings on watersheds from existing and future conditions, and identifies the policies and strategies to amend the General Plan that are needed to maintain adequate drinking water supply and wastewater treatment capacity to 2030 and to meet water quality regulatory requirements as the county continues to grow. It satisfies the requirements of MD House Bill 1141.

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Water Resources Functional Master Plan

September 2010

The Maryland-National Capital Park and Planning Commission
Prince George's County Planning Department
14741 Governor Oden Bowie Drive
Upper Marlboro, Maryland 20772

www.mncppc.org/pgco

THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

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The Maryland-National Capital Park and Planning Commission is a bicounty agency, created by the General Assembly of Maryland in 1927. The Commission's geographic authority extends to the great majority of Montgomery and Prince George's Counties: the Maryland-Washington Regional District (M-NCPPC planning jurisdiction) comprises 1,001 square miles, while the Metropolitan District (parks) comprises 919 square miles, in the two counties.

The Commission has three major functions:

- The preparation, adoption, and, from time to time, amendment or extension of the General Plan for the physical development of the Maryland-Washington Regional District;
- The acquisition, development, operation, and maintenance of a public park system; and
- In Prince George's County only, the operation of the entire county public recreation program.

The Commission operates in each county through a Planning Board appointed by and responsible to the county government. All local plans, recommendations on zoning amendments, administration of subdivision regulations, and general administration of parks are responsibilities of the Planning Boards.

The Prince George's County Department of Planning (M-NCPPC):

- Our mission is to help preserve, protect and manage the county's resources by providing the highest quality planning services and growth management guidance and by facilitating effective intergovernmental and citizen involvement through education and technical assistance.
- Our vision is to be a model planning department of responsive and respected staff who provide superior planning and technical services and work cooperatively with decision-makers, citizens and other agencies to continuously improve development quality and the environment and act as a catalyst for positive change.

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The County Council has three main responsibilities in the planning process: (1) setting policy, (2) plan approval, and (3) plan implementation. Applicable policies are incorporated into area plans, functional plans, and the general plan. The Council, after holding a hearing on the plan adopted by the Planning Board, may approve the plan as adopted, approve the plan with amendments based on the public record, or disapprove the plan and return it to the Planning Board for revision. Implementation is primarily through adoption of the annual Capital Improvement Program, the annual Budget, the water and sewer plan, and adoption of zoning map amendments.

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PRINCE GEORGE'S COUNTY

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FOREWORD

The Prince George's County Planning Board is pleased to make available the *Approved Water Resources Functional Master Plan* for Prince George's County.

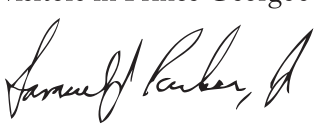
This plan fulfills the provisions of the Water Resources Element, one of several state planning requirements signed into law in Maryland on May 2, 2006, and mandated in HB 1141, Section 1.03 (iii) of Article 66B of the Annotated Code of Maryland. The Water Resources Plan shows how drinking water supplies, wastewater effluents, and stormwater runoff can be anticipated and managed to support existing and planned growth.

Policy guidance for this plan came from the 2002 *Prince George's County Approved General Plan.*

It contains recommendations for growth policies; land use; environmental conservation and preservation; water resource protection and restoration; water resource conservation and efficiency; interagency and intergovernmental communication and coordination; outreach and education; community engagement; regulatory revision; and data and systems management. This plan organizes an approach to water resource sustainability that clarifies the county's intent to prioritize water resource protection; identifies issues and regulations critical to water resource preservation and restoration; and provides a framework for establishing the criteria necessary to achieve and evaluate our success toward meeting these objectives. This effort is supported and reinforced countywide through the ***Envision Prince George's*** initiative to engage a broad cross section of stakeholders in developing a shared vision for the county's future direction and growth. We invite you to visit the ***Envision Prince George's*** web site at www.mncppc.org/Envision to learn more about how to participate in this exciting initiative.

On February 23, 2010, the Prince George's County Planning Board and the District Council held a joint public hearing on the preliminary functional master plan. The Planning Board adopted the plan in May 2010 with modifications as contained in PGCPB Resolution No. 10-44. The District Council approved the plan in June 2010 with additional modifications stipulated in CR-59-2010.

The Planning Board and District Council appreciate the contributions of the community members and stakeholders throughout the plan development phase and at the public hearing. We look forward to this plan providing the foundation for water quality protection, conservation, and enhancement that will benefit the residents, citizens, and visitors in Prince George's County for years to come.



Samuel J. Parker, Jr., AICP
Chairman
Prince George's County Planning Board

I. EXECUTIVE SUMMARY

"The world's water resources are our lifeline for survival and for sustainable development in the twenty-first century."

Kofi Annan,
former Secretary General
United Nations
March 22, 2005

Virtually everything that society does, and has done, on the surface of the land has impacted our water resources. Water and community are linked and interdependent elements that combined have shaped the landscape of Prince George's County. Historically, the natural waters of the county have stimulated growth and economic development and have influenced the evolution of our communities and neighborhoods. Similarly, the advancement and expansion of society has impacted and affected natural waters in numerous respects. Today it is attainable and necessary to maintain the growth and vitality of our county, while sustaining the integrity of the natural water resources that support our existence.

The natural environment of Prince George's County is rich in diversity and provides economic and social, as well as environmental, resources. The county has large and small rivers; streams and tributaries; mature woods; farmland; floodplains; tidal and nontidal wetlands; habitats of rare, threatened, and endangered species; and steep and gentle slopes that make up its physical form. This natural landscape sustains the hydrologic system that provides drinking water, absorbs waste, and manages stormwater consumed and produced by our land uses. Preservation of the natural, environmental, and water resources of Prince George's County is a necessary priority in order to sustain existing development, allow for growth and change, and adapt to future conditions.

This Water Resources Functional Master Plan (Water Resources Plan) has been prepared in conformance with state requirements and guidelines as an amendment to the 2002 *Prince George's County Approved General Plan*. The Water Resources Plan is a policy document that is formally adopted by the Planning Board and approved by the County Council. This plan makes recommendations and establishes goals, policies, and

> **"Sustainable communities can improve the quality of life for their citizens and at the same time take responsibility to protect common goods and natural resources. Good governance toward sustainable development requires permanent, cyclic management mechanisms and instruments (e.g., systems and tools) in municipal management aimed at effective target setting, monitoring, reporting, and continual improvement. The aim is to anchor sustainability principles within all municipal decision-making."**
>
> **—ICLEI Local Governments for Sustainability[1]**

[1] ICLEI—Local Governments for Sustainability. http://www.iclei.org/index.php?id=global-about-iclei

strategies to assist the county, state, and federal agencies, communities, citizens, and others in making informed decisions about growth and development, land preservation, environmental and water resource protection, and the infrastructure needed to support sound land use.

The Water Resources Plan strives to support contemporary water resource protection policies and strategies, incorporate natural resource and land preservation programs, enumerate coordination and communication opportunities, and maintain supportive planning processes. The plan was assembled to provide an assessment of the impacts of existing and future land use on county water resources, including drinking water and wastewater supply and demand capacities, and point source and nonpoint source impacts to streams and local tributaries. Multiple resources were consulted including studies, research, and reports produced by federal, state, local, and nonprofit agencies that address water resource protection as policy, planning, programs, and partnerships.

The task of creating sustainable communities is daunting but achievable. This plan organizes an approach to water resource sustainability that clarifies the county's intent to prioritize water resource protection, identifies issues and regulations critical to water resource preservation and restoration, and provide a framework for establishing the criteria necessary to achieve and evaluate our success toward meeting this objective.

Community engagement reflected the draft proposed goals, concepts, and guidelines and the public participation program established at the initiation of the Water Resources Functional Master Plan by the County Planning Board and County Council in September and October 2008. The public outreach process began with a countywide public forum on November 20, 2008, and culminated in a final public presentation on March 18, 2009. Comments on, and inputs to, the draft plan recommendations were also received through focus groups, telephone surveys, and web page e-mails and surveys. Public comment was summarized in writing and evaluated by staff to establish priority goals and plan recommendations.

The Water Resources Plan has incorporated differing growth and development directives into modeling scenarios to determine water quality impacts associated with development patterns. An ideal growth pattern was based on state smart growth policies, the county priority funding areas and proposed priority preservation areas. The modeling decisions for the ideal growth pattern regarding land preservation, conservation, and growth boundaries reflect the policies of the *Approved Countywide Green Infrastructure Plan* and the 2008 *Water and Sewer Plan*. The Water Resources Plan is intended to help inform planners, plan reviewers, permitting and implementation agencies, the county citizenry, and the development community to achieve and maintain healthy water resources for the current and future citizens of Prince George's County. It is the intent of this plan to advocate for smart growth strategies, to establish development capacities, to incorporate environmental site design, and preservation, conservation, and restoration programs into countywide growth policies in the interest of maintaining healthy and sufficient water resources for the county and its municipalities. The Water Resources Plan broadly supports the General Plan, and its core policies and recommendations for the county to guide decisions about growth and development.

The Water Resources Plan promotes source and receiving water protection and use and demand management of water resources. Through conservation and efficiency recommendations, this plan establishes achievable sustainability goals for water resources in Prince George's County. Public drinking water availability has been evaluated per the Interstate Commission on the Potomac River Basin's Water Supply Reliability Forecast for Washington Metropolitan Area, Year 2025 study that indicates current water resources are able to meet demand forecast for the region, including the area of Prince George's County served by the Washington Suburban Sanitary Commission, to the year 2025, and as projected to 2045. WSSC develops wastewater flow projections based on population and employment forecasts compiled by Prince George's County and developed for the Metropolitan Washington Council of Governments. These show existing and projected demands, and capacity limits at their wastewater treatment plants. WSSC forecasts indicate that current public wastewater treatment capacity for Prince George's County is sufficient through the year 2030. The protection of receiving waters and establishment of waste load capacities for county streams and watersheds are examined and considered in this plan. Many waters in Prince George's County are currently impaired and strategies to mitigate impacts and restore biological and physical health have been addressed particularly through growth policies, land development standards, and preservation strategies.

During the planning process and in conversation with citizens, environmental groups, builders, and developers, the necessity of productive coordination among jurisdictions, agencies, communities, organizations, and citizens responsible for water resource protection and management was clear. This plan confirms that it is imperative to reach across traditional land use planning boundaries to partner with leaders in diverse fields including: policy-makers, public and private funders, landowners, appraisers, economists, engineers, environmentalists, and educators. In order to achieve meaningful goals developed with measurable criteria, we need to galvanize a cooperative directive and share responsibility with our multiple county agencies and environmental nonprofits, neighboring jurisdictions, and local, state, and federal agencies that together oversee, manage, and protect our water resources. Water by nature does not respond to jurisdictional boundaries and a comprehensive management and protection program cannot either.

The Water Resources Plan is structured on major themes of why, what, who, and how and has been organized to read sequentially as well as specifically. Water resources have been addressed holistically but with special emphasis given to the preservation, conservation, and protection of these resources through land use planning. This plan acknowledges that water is a naturally renewing resource, but alterations to natural hydrology and ecological processes may impact water's ability to be replenished and renewed. It is our responsibility to forestall and reverse this trend to ensure the continued health, safety, and welfare of our county and its residents.

II. PLAN PURPOSE AND BENEFITS

Ensure that the Water Resources Functional Master Plan, as a Water Resources Element of the 2002 Prince George's County Approved General Plan, achieves the mandated requirements of HB 1141 and keeps the county in conformance with all federal and state planning requirements and responsibilities.

HB 1141 STATUTORY REQUIREMENTS

The Water Resources Element (WRE) is one of several state planning requirements signed into law on May 2, 2006, as HB 1141. Mandated in HB 1141, Section 1.03 (iii) of Article 66B of the Annotated Code of Maryland, all Maryland counties and municipalities that exercise planning and zoning authority must prepare and adopt a WRE in their comprehensive plans by October 2009 (or October 2010 with extensions). This Water Resources Functional Master Plan (Water Resources Plan) fulfills the requirements of the WRE.

PLAN PURPOSE

The purpose of the Water Resources Plan is to evaluate existing growth and anticipated future development and consider any impacts to, and demands on, water resources, drinking water, wastewater, and stormwater. The Water Resources Plan provides growth guidance expressed as goals, policies, and strategies to address water quality impacts associated with land use in the county. The creation of this Water Resources Plan will assure that the Prince George's County's General Plan fully integrates water resource issues and planning solutions into its overall mission and addresses the relationship between planned growth and the area's water resource demands and capacities.

This Water Resources Plan shows how drinking water supplies, wastewater effluents, and stormwater runoff can be anticipated and managed to support planned and existing growth. Water resource limitations include finite source water supplies and thresholds on wastewater and stormwater discharge based on the assimilative capacity of the receiving watersheds. The identification of limitations and/or opportunities in the planning process ensures that the Water Resources Plan is realistic and environmentally sustainable. The Water Resources Plan provides a sound foundation and support for smart growth principles and the establishment of sustainable development capacities in Prince George's County based on water resources.

The purpose of the Water Resources Plan is to:

- Ensure a safe and ample supply of drinking water from both surface and groundwater sources and adequate treatment of wastewater.
- Minimize the nutrient loading impacts to our groundwater, streams, rivers, and the Chesapeake Bay from the uses we employ on our land.
- Improve data collection and promote a watershed planning process to achieve a desirable balance of sustainable growth and preservation of the Chesapeake Bay.
- Provide water resources data that can be transparently interpreted to establish growth area boundaries, inform land-use recommendations, and target preservation/conservation/restoration areas.

The goals, policies, and strategies in this Water Resources Plan are based on a scientific understanding of the hydrology and water quality conditions in Prince George's County. Water behaves in response to established principles, and solutions for management, preservation, and restoration of these resources should be developed in concert with a clear understanding of the hydrologic system and water processes. The Water Resources Plan specifically addresses:

Drinking Water Supply—Production capacity of drinking water supply facilities; protection of source waters, headwaters, aquifers, and the quality and quantity of receiving waters; water appropriation permit limits; and drinking water resource availability during drought.

Wastewater Treatment—Treatment and allowable discharge capacity of wastewater systems; wastewater management through alternate distribution technologies; inspection and maintenance of existing and proposed public and private wastewater systems; location and implementation of advanced wastewater treatment septic systems; expansion or restriction of public sewer systems; and prevention of public sewer overflows and wastewater treatment system failures.

Stormwater Management—Current and proposed stormwater management systems and practices; water quality protection in receiving waters, headwaters, wetlands, aquifers and groundwater; stream morphology, ecosystems, woodlands and tree canopy preservation and restoration; policy support and implementation strategies for environmental site design; support for conservation, preservation, and restoration programs; and community engagement and education to maintain and/or improve water quality.

PUBLIC PARTICIPATION

The Planning Board is required by the Prince George's County Zoning Ordinance to prepare a program for public participation in the preparation of any plan. The public participation program encourages a balance of participation by area residents and businesses affected by the plan. Stakeholders for this planning effort include property owners, civic associations, environmental groups, the agriculture and forestry community, local business groups, the development and building community, government agencies, and all municipalities and jurisdictions within or adjacent to the county.

The public participation program utilized various outreach techniques to facilitate committed public involvement in the preparation of the plan including: Public meetings, PowerPoint presentations, round table focus groups, telephone surveys, online surveys, and question and comment opportunities. The presentation materials included a timetable for the Water Resources Plan preparation and the points at which public briefings would be held and public input would be addressed. The criteria for the public participation program included:

- A timeline and plan to engage and encourage public participation.
- A compilation of interested individuals, community groups, stakeholders, agencies, and commissions and a method to engage them in the plan process.
- Preparation and administration of the public participation process including staffing, presentations, informational boards, and hand-outs for public meetings.
- Standards for the acknowledgment and evaluation of public input.
- Reports and PowerPoint presentations summarizing the public's comments and recommendations.

INTERJURISDICTIONAL AND INTERAGENCY COORDINATION AND COMMUNICATION

The Water Resources Plan planning area encompasses approximately 300,000 land acres located in Prince George's County, Maryland. The physical and geographic nature of all water resources made it essential that the water plan include interjurisdictional and interagency coordination. Because watersheds, water supply areas, and water quality issues often overlap political boundaries and agency agendas, a successful water resources plan requires coordinated efforts among adjacent jurisdictions and state and county agencies sharing watershed land area or water resource responsibilities.

Key departments and agencies involved in creating this Water Resources Plan and their responsibilities are summarized below.

The Maryland-National Capital Park and Planning Commission (M-NCPPC)—The mission of M-NCPPC is to manage physical growth and plan communities, protect and steward natural, cultural, and historic resources; and provide leisure and recreational experiences. M-NCPPC is responsible for preparing and administering the General Plan and managing the regional system of parks for Prince George's and Montgomery Counties.

The Prince George's County Department of Environmental Resources (DER)—The mission of DER is to protect and enhance the natural and built environments of Prince George's County by enforcing federal, state, and county laws to create a healthy, safe, and aesthetically pleasing environment for all residents and businesses of the county. DER is responsible for water and sewer services, sanitation services, and several stormwater-related programs including Municipal Separate Storm Sewer System (MS4) permit compliance and floodplain management.

The Livable Communities Initiative is an exciting strategic plan that will guide, support, and assist government, residents, and businesses in the creation and implementation of principles that will result in a healthy, safe, litter-free environment and promote more livable communities in Prince George's County, one community at a time.

The Prince George's County Department of Public Works and Transportation (DPW&T)—The mission of the Department of Public Works and Transportation (DPW&T) includes maintenance, improvements, and beautification by professionals who use innovative technologies to stimulate "livable communities" through development. DPW&T is responsible for various county programs including maintenance of stormwater facilities; roadway and public right-of-way maintenance; stormwater management, erosion, and sedimentation control inspections; the Livable Communities Initiative; and the enforcement of woodland conservation and critical area laws.

The Prince George's County Health Department—The mission of the Health Department is to protect public health, assure availability of and access to quality health care services, and promote individual and community responsibility for the prevention of disease, injury and disability. The Health Department issues permits and conducts inspections for septic systems, private residential wells, and food services. The Health Department also works with the Washington Suburban Sanitary Commission (WSSC) to reduce the amount of fats, oils, and grease getting into its wastewater management systems. The Health Department's Environmental Engineering Program investigates complaints of overflowing sewers into streams.

Prince George's Soil Conservation District (SCD)—The SCD protects and promotes the health, safety, and general welfare of the county's citizens and residents by conserving soil, water, and related resources through various measures designed to protect public land. Services provided include, but are not limited to: reviewing and approving grading and sediment control plans for all construction projects that disturb 5,000 square feet of land area; working with state and federal agencies on agricultural issues that include erosion control, nutrient management, and land strategies that help improve water quality in the Chesapeake Bay and its tributaries; developing education and outreach programs that help protect and discourage the abuse of land, water, and related natural resources; approving ponds for dams safety in lieu of a state permit; and administering the county's Agricultural Land Preservation Program providing information for the farming community regarding governmental programs affecting agriculture.

Washington Suburban Sanitary Commission (WSSC)—WSSC is the bicounty water and wastewater utility that is "entrusted by our community to provide safe and reliable drinking water, life's most precious resource, and return clean water to our environment, all in an ethically and financially responsible manner" (WSSC mission statement).

The plan has examined land use and land use planning in the City of Laurel, the Town of Bowie, Prince George's County's municipalities, Montgomery County, Charles County, Anne Arundel County, and Calvert County. Tributary teams, regional councils of government, and watershed-based organizations also helped inform the planning process and participated in the ongoing development of recommendations to establish shared and unified goals. The state's Departments of Planning, Environment, and Natural Resources, as well as the Prince George's County Planning Department and multiple county agencies, participated in providing plan recommendations that include strategies to maintain continued communication and coordination beyond the preparation of this plan.

PLAN METHODOLOGY

The Water Resources Plan reexamines the planning process and how growth policies drive and direct land use. The state has recently initiated many regulatory changes regarding local environmental responsibilities and the county is called upon to examine and address the impacts our land uses and behaviors have on natural systems and water resources. The Water Resources Plan addresses capacity issues associated with growth and land use policies and practices and provides an analysis of existing and future growth scenarios; the drinking water quality and demand associated with existing conditions and future growth, the wastewater demands and treatment capacities necessary for current and future conditions, and impacts to our surface and ground water from point and nonpoint source pollutants. This plan acknowledges that current growth patterns and development standards have resulted in environmental imbalances and unsustainable land uses.

One of the express goals of this Water Resources Plan is to integrate land use planning with sustainable water supply and water quality goals. It is necessary to gauge the carrying capacity of the county watersheds and to direct future development accordingly. Efforts at the site level require the support of a broader planning framework to protect and preserve water quality. The Water Resources Plan recommends that existing zoning codes, legislation, environmental regulations, and plan review standards and process in the county be evaluated to achieve water resource protection through coordinated Planning Department and interagency efforts. The recommendations in this Water Resources Plan are presented in terms of overarching goals and policies with supporting strategies. The strategies are intended to outline a greater level of detail and specific future actions recommended to support the stated policies and achieve the goals.

A wide range of stressors are contributing to the deterioration of the county's land and water resources. Consequently, an increasing myriad of environmental regulations and citizen concerns must be addressed to manage the county's water resources in a comprehensive and egalitarian manner. Federal and state regulatory requirements are often complex, costly, and confusing to implement. This plan advocates for a coordinated watershed-based approach as the preferred method to address these mandates and concerns.

One of the key tasks of the Prince George's County Water Resources Element (WRE) plan is an evaluation of nutrient loads to each of the county's Potomac and Patuxent watersheds from stormwater runoff based on various land use scenarios. In order to produce a tool that supports dynamic water resource planning for and beyond the evaluations assessed for this plan, the planning team evaluated several existing modeling options to estimate land use-based watershed pollutant loads. The evaluation included the project needs, which are guided by Maryland Department of Planning's Models & Guidelines 26, The Water Resources Element: Planning for Water Supply and Wastewater and Stormwater Management (MDP MG26, 2007), in addition to the scale of analysis appropriate for the county assuming future evaluations will continue for increasingly smaller-scale watersheds.

A summary of the nonpoint source modeling conducted for the county's land area is provided in this plan which describes the impacts of land use and land management on nutrient loads in the Potomac and Patuxent watersheds. Technical Appendix I provides a more detailed overview of the watershed pollutant load models that were evaluated and a description of the Pollutant Load Analysis Model (PLAM) developed for use in the Water Resources Plan. Descriptions and results of the various nonpoint source loading model runs conducted for the plan are also provided in Technical Appendix I, followed by a summary of findings from the modeling effort as well as a discussion of the future use of PLAM.

III. PLANNING CONTEXT

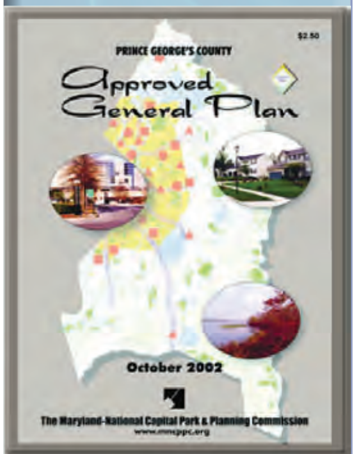
Support the goal, policy, and strategy recommendations of relevant federal, state, county, and other plans and programs to protect, preserve, and enhance water quality in the watersheds of Prince George's County.

There are several important existing county plans and a number of federal, state, and regional regulations and programs that were considered during the development of this Water Resources Plan. Current county plans served as a baseline. This chapter provides a brief overview of the existing planning and regulatory environment for water resources, recognizing that Prince George's County must comply with the details of these regulations and any applicable permits associated with federal, state, and local regulations.

The current overarching comprehensive plan is the 2002 *Prince George's County Approved General Plan*. The General Plan puts forth broad planning policies for the county in order to guide growth and set goals and benchmarks for additional planning efforts. Functional master plans, subregion plans, master plans, and sector plan, are prepared to support the county's vision, goals, and policies of the General Plan or to amend it as necessary to achieve new or additionally defined goals. The recommendations made in county planning documents address existing conditions and issues, change zoning to support desired land use patterns, and provide regulatory guidance during the review and implementation of development plans and projects.

The county prepares functional master plans to establish countywide goals, policies, and strategies for specific planning considerations such as: transportation, green infrastructure, historic sites and districts, and adequate public facilities. Functional master plans inform subregion, master, and sector plans regarding specific functional planning recommendations. The Water Resources Plan has been developed as a functional master plan to address the specific planning considerations for countywide water resources.

Additionally, other county and state agencies produce plans that either inform the policies of the General Plan, as in the case of the 1992 State of Maryland's Smart Growth Act, or provide technical support to implement policies defined by functional master plans, as in the 2008 Water and Sewer Plan developed by the Prince George's County Department of Environmental Resources. An overarching intent of this Water Resources Plan is to integrate its goals, policies, and strategies with all relevant county and state plans in a consistent and transparent manner.



COUNTY PLANNING

Prince George's County General Plan—The 2002 *Prince George's County Approved General Plan* contains goals, policies and strategies to guide future growth, development, preservation, and restoration. The General Plan establishes three growth policy tiers in the county— Developed, Developing, and Rural. Within these Tiers, a policy overlay for centers and corridors focuses on specific areas where more intense development is encouraged to take advantage of public infrastructure investments in transportation and other public facilities. The Water Resources Plan evaluates these growth areas for consistency with water resources capacity and demand. The development pattern as espoused in the county General Plan is:

> The **Developed Tier** is most densely developed along the Washington, D.C., border and east to the Capital Beltway. Environmental goals for this area are to preserve existing, and restore degraded, sensitive environmental features and provide open space. Since this area is highly urbanized, environmental features will often include innovative designs, technologies, and management techniques.
>
> The **Developing Tier**, within the middle section of the county, is where much of the county's future development is currently focused. This area contains many valuable environmental features, such as forests, streams, floodplains, and wetlands. Numerous passive and active recreational opportunities and agricultural lands exist throughout the Developing Tier. Environmental preservation and enhancement is an important policy in this tier.
>
> The **Rural Tier,** in the eastern and southern portions of the county, should remain rural including portions of the Patuxent River, Potomac River, Piscataway Creek, and Mattawoman Creek watersheds. Preservation and enhancement of the remaining environmentally significant areas, including the large amounts of woodland, wildlife habitat, and recreational areas, should be a high priority. Agricultural preservation, rural character, and scenic value are also important here. Public funds should not encourage future development in the Rural Tier:
>
> - Prohibit extension of water and sewer services into the Rural Tier unless necessary to address existing health problems or if found to be consistent with other county growth policies.
> - Designate water and sewer line extension into the Rural Tier as controlled access only.

The countywide goals of the General Plan describe the importance of preserving rural, agricultural, and scenic areas, and protecting environmentally sensitive lands through planning.

The General Plan makes the following specific environmental recommendations:

- Protect and enhance/restore areas within the green infrastructure network.
- Protect/restore ecological functions (including aquatic living resources).
- Protect and enhance water quality within each watershed.
- Meet or exceed forest/tree cover goals (26 percent Developed Tier, 38 percent Developing Tier, 60 percent Rural Tier; 44 percent countywide), reduce forest fragmentation, and preserve mature forests.
- Encourage environmental awareness through outreach and education.
- Continue property acquisition or easements along key stream valleys.
- Control flooding and reduce flood-related property damage.

The General Plan makes the following specific water-related strategy recommendations:

- Preserve, protect, and enhance surface and ground water features and restore lost ecological functions.
- Prepare and implement major watershed management plans to address the preservation and restoration of ecological functions within watersheds, with an emphasis on the restoration and maintenance of water quality, protection of the aquatic living resources, and the control of water quality with consideration of the development pattern of the General Plan.
- Periodically employ a water-quality model that evaluates existing water quality and use the results to determine where additional efforts are needed.
- Evaluate the effectiveness of current ordinances and regulations regarding stream and wetland buffer widths. Consider revising the current regulations to provide varying buffer widths.
- Augment current forest conservation and sediment and erosion control enforcement efforts.
- Continue parkland acquisition in key steam valleys and seek additional funding sources for acquisition and conservation easements.
- Continue implementation of available federal and state programs to control flooding and losses due to flooding without impairing water quality. Seek additional funding sources to augment current efforts.
- Implement through existing ordinances the use of systems and processes for treating stormwater runoff that preserve and/or reestablish natural resources and systems, such as reducing natural vegetation removal, reducing impervious surfaces, and increasing infiltration.
- Evaluate current regulations that result in the construction of mandated impervious surfaces. Encourage the use of innovative design that reduces the amount of impervious surfaces.
- Treat stormwater on site to the fullest extent possible to maximize infiltration, restore the natural hydrologic system, improve water quality, and minimize run-off.
- Evaluate opportunities for coordination of watershed protection policies and programs with adjoining jurisdictions.

Infiltration or Percolation:
The penetration and movement of water downward and radially through the ground surface into subsurface soil layers, usually continuing downward to ground water; can also entail upward movement of water through capillary action.

Hydrologic Cycle:
The natural pathway water follows as it changes between liquid, solid, and gaseous states; biogeochemical cycle that moves and recycles water in various forms through the ecosphere. Also called the water cycle.

Run-Off:
That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface-water. It can carry pollutants from the air and land into receiving waters.

The General Plan notes that the implementation of comprehensive plans involves making choices concerning future development patterns considering the cost of infrastructure and the need for environmental protection. Prince George's County is required to remain current in its conformance with state smart growth principles, which offer a range of policy choices for implementing development controls and ensuring a sustainable quality of life, including:

- Intergovernmental cooperation and public participation.
- Additional and ongoing planning activities.
- Regulatory review and revision.
- Biennial Growth Policy Updates.

The Countywide Green Infrastructure Plan—The 2005 *Approved Countywide Green Infrastructure Plan* has identified a contiguous network of environmentally sensitive areas and sets forth goals, policies, strategies, and objectives to preserve, protect, and enhance these areas by 2025. In this plan, the identified countywide green infrastructure network encompasses the most significant natural resource lands, including streams, wetlands, buffers, 100-year floodplains, severe slopes, interior forest, colonial waterbird nesting sites, and unique habitats, as well as critical wooded uplands that provide network connectivity. This system of resources currently comprises approximately 168,000 acres, or 54 percent of the county. Of this, 33 percent is publicly owned and 67 percent is privately owned.[1] Within this plan, the green infrastructure network classifies land into three categories:

Regulated Areas include environmentally sensitive features, such as streams, wetlands, 100-year floodplains, and severe slopes and their associated buffers that are protected during the land development process. These areas comprise approximately 32 percent of the mapped green infrastructure network.

Evaluation Areas include features such as interior forests, colonial waterbird nesting sites, and unique habitats that are not protected during the land development process. These areas comprise approximately 52 percent of the mapped green infrastructure network.

Network Gaps include areas that are critical to the connection of regulated and evaluation areas. These areas are suggested for evaluation of restoration opportunities to enhance ecological functioning of the network. They comprise approximately 16 percent of the mapped green infrastructure network.

The plan also identifies special conservation areas, which should be carefully considered when land development proposals are reviewed in their vicinity to ensure that the unique and sensitive ecological functions are protected or restored.

The goals for these areas outlined in the Green Infrastructure Plan include:

- Preserving, enhancing, and restoring these environmentally sensitive features.
- Implementing desired development pattern throughout the county while protecting these sensitive areas.

1 http://www.pgplanning.org/Projects/Ongoing_Plans_and_Projects/Environmental/Green_Infrastructure/Countywide_Green_Infrastructure_Functional_Master_Plan_on_Publication.htm

- Restoring and enhancing water quality in areas that have been degraded by a high percentage of impervious surfaces and preserving water quality in areas not degraded.
- Preserving some portions of the county from future development.

Ten-Year Water and Sewerage Plan—Since 1970, the county has been required to prepare and annually update a ten-year plan and program for the extension of water and sewer service. The Ten-Year Water and Sewerage Plan is the central county policy statement as to where, when, and at what rate growth can be expected to occur. The plan has been used as a major guide to master plan staging and is considered in zoning decisions and the granting of subdivision approvals. The plan is also the major guide to the programming of other public facilities in the Capital Improvement Program, particularly with respect to providing services to new development.[2]

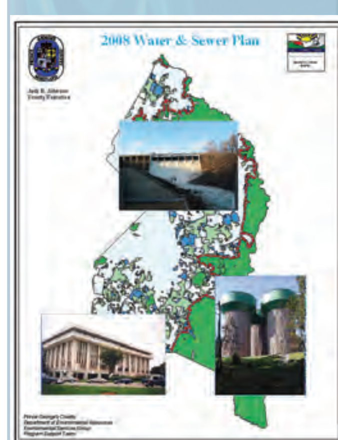
A water and sewer service network is important in managing and directing development in the county. Urban development requires community or multiuse water and sewer service; urban growth is directly dependent on expansion of this service. On the other hand, individual water supply and septic systems, as well as shared facilities, can only support relatively low-density development. Water and sewer management that provides for adequate water supplies, healthy drinking water, and appropriate sewage disposal methods promotes public health and environmental quality.[3]

The Water and Sewer Plan for Prince George's County acts as a statement of policy and as a working document. As a policy statement, the plan defines the land use and development policies set by the county through its designation of geographic boundaries where public water and sewer must be used. As a working document, it guides the county planning and development processes by setting out the criteria under which both public and private water and sewer services can be provided.[4]

The Prince George's County Ten-Year Comprehensive Water Supply and Sewerage Systems Plan establishes a water and sewer service area category for each property within the county as follows:

- Category 1 for properties approved for and generally with access to public service.
- Category 3 for properties planned, approved, and with the highest priority for public service.
- Categories 4 or 5 for properties planned for future public service, but which need to use private, on-site systems (usually wells and septic systems) in the interim.
- Category 6 for properties that will use private, on-site systems, where public service is not planned.

The 2008 *Water and Sewer Plan*, the current plan, was prepared by the Prince George's County Department of Environmental Resources. The 2008 *Water and Sewer Plan* is required by state law to be consistent with the 2002 General Plan and approved master and sector plans. To ensure the long-term maintenance and restoration of water quality in our streams and rivers, the 2008 *Water and Sewer Plan* makes strategic planning



[2] http://www.princegeorgescountymd.gov/Government/LegislativeBranch/CouncilAdministration/plan_develop.asp?nivel=subfoldmenu(0,4,0)

[3] http://www.co.pg.md.us/government/agencyindex/der/PDFs/Adopted%202008%20Water%20and%20Sewer%20Plan.pdf

[4] http://www.co.pg.md.us/Government/AgencyIndex/DER/PDFs/chap1.pdf

Biosolids: is also referred to as treated sludge and is a term used by the wastewater industry to indicate the byproduct of domestic and commercial sewage and treated wastewater.

—Wikipedia

recommendations for sewage treatment and transmission capacity. The 2008 *Water and Sewer Plan* notes:

- Wastewater treatment plants serving the county are approaching capacity, and the sanitary sewer transmission system is suffering from overflows during storm events.
- Marlboro Meadows' wastewater treatment plant initially addressed the subdivision's community wastewater but WSSC has since acquired the facility.
- Regional water quality initiatives in the Chesapeake Bay watershed incorporates the Bay Restoration Fund Law, the enhanced nutrient removal requirements, and the bay restoration fee that is being collected from all residents (commenced in January 2005) from public utility customers and October 2005 from private septic system owners.
- Sanitary sewer overflows require a description of the cause and effect of the overflows, enforcement actions by the Environmental Protection Agency (EPA), and improvements implemented by the Washington Suburban Sanitary Commission (WSSC) on its collection and transport systems.
- Regulatory requirements for permits associated with the application and storage of biosolids is regulated by the Maryland Department of the Environment (MDE). One biosolids lagoon is located in Cedarville in Prince George's County.

The 2008 *Water and Sewer Plan* documents existing water resources and wastewater treatment capacities and identifies mechanisms needed to meet future demand. Land use in relation to public water and sewer service, as well as individual wells and septic systems in the county, are also governed by this plan

FEDERAL AGENCIES, PROGRAMS, AND REGULATIONS

In many instances, federal agencies' regulations and programs establish the platform for state- and county-implemented regulations and permits. The federal agencies, programs, and regulations outlined in this plan include the Clean Water Act, Safe Drinking Water Act, regulations to address flood damage and loss, and programs that support partnerships and establish environmental policies.

The Clean Water Act (CWA) provides the basis for most federal and state regulations governing water pollution. The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. In the 1970s and early 1980s, the focus was on regulating discharges from traditional "point source" facilities, such as municipal sewage plants and industrial facilities, with little attention paid to runoff from streets, construction sites, farms, and other "wet-weather" sources. In the late 1980s, the focus expanded to include nonpoint source pollution from stormwater runoff. For "nonpoint" runoff, voluntary programs, including cost-sharing with landowners, are the key tool. For "wet-weather point sources" like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Additionally, the CWA has trended toward looking at a more holistic watershed- based approach versus looking at each regulated entity individually.[5] Over the past 15 years the emphasis has shifted from a programmatic approach to a watershed approach.

5 http://www.epa.gov/watertrain/cwa/

Under the watershed approach equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. There are several components of the CWA that are of interest for the Water Resources Plan.

Nonpoint Source Management Program (Section 319)—Congress amended the CWA in 1987 to establish the Section 319 Nonpoint Source Management Program because it recognized the need for greater federal leadership to help focus state and local nonpoint source pollution control efforts. Under Section 319, the state may receive grant money to support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

Water Quality Standards—The CWA authorizes states to establish water quality standards that include setting the designated use for water bodies and then establishing appropriate allowable concentration limits for various parameters of concern. Biennially, states develop a list of water bodies that do not meet state standards according to monitoring activities. These water bodies are known as the 303(d) list of impaired waters. In Maryland, water quality standards and the 303(d) list are developed by MDE.

National Pollutant Discharge Elimination System (NPDES)—Under the NPDES program, any discharge of pollutants to waters of the United States must be permitted. In Maryland, these permit programs are managed by MDE in accordance with federal provisions. There are two types of permits under the NPDES program, individual permits and general permits. Individual permits are specific to a facility, whereas general permits have standardized conditions.

Total Maximum Daily Loads (TMDLs)—A TMDL is the maximum amount of a pollutant that a waterbody can assimilate and still meet water quality standards (see Code of Maryland Regulations 26.08.02). Maryland's Report of Integrated Surface Water Quality[6] lists the water bodies that do not meet state standards and either have or will have TMDLs developed. TMDLs have been developed for a number of water bodies, including several in Prince George's County. Currently, MDE is working with EPA on a TMDL for the entire Chesapeake Bay watershed that is expected to be completed by December 2011.

The Safe Drinking Water Act is intended to protect public health and public drinking water supplies from groundwater or surface water sources. The requirements include treatment to primary health-related standards and the 1996 amendments require a detailed risk assessment for drinking water sources and protection of groundwater sources.

The National Flood Insurance Protection (NFIP) Act allows property owners in participating communities to purchase flood insurance in exchange for the community adopting a floodplain management ordinance and program to reduce the risk of floods. Communities are given a score through the community rating system that guides insurance premiums. The insurance program was created to mitigate the need for disaster relief due to floods. As part of this program, the Federal Emergency Management

Designated uses are human uses and ecological conditions that are officially recognized and protected. States must designate one or more uses for each water body.

—Maryland Department of the Environment (MDE) Water Quality Standards

6 http://www.mde.state.md.us/programs/waterprograms/tmdl/maryland%20303%20dlist/index.asp

Agency maps the 100-year floodplain as an area requiring protection to prevent against flood losses.

Watershed Plan Guidance Elements[7]—Beginning in fiscal year 2003, EPA requires all watershed restoration projects funded under Section 319 of the CWA to be supported by a watershed plan. The watershed plans must ensure:

- The causes and sources of impairment are identified;
- The management practices are identified to help address the causes and sources of impairment; and
- There is a monitoring component for the project to demonstrate progress toward meeting water quality standards.

U.S. Geological Survey (USGS)[8]—The USGS mission is to make available relevant information by providing extensive data, maps, publications, and applications software. USGS has developed the Water Resources Discipline (WRD) to provide reliable, impartial, timely information that is needed to understand the nation's water resources. WRD actively endorses the use of this data and information by decision makers to:

- Minimize loss of life and property as a result of water-related natural hazards, such as floods, droughts, and land movement.
- Effectively manage ground-water and surface-water resources for domestic, agricultural, commercial, industrial, recreational, and ecological uses.
- Protect and enhance water resources for human health, aquatic health, and environmental quality.
- Contribute to wise physical and economic development of the nation's resources for the benefit of present and future generations.

USGS collects most of the water data in the nation, but official forecasts are made by other agencies. In most cases, USGS partners with federal, regional, state, and local, agencies to provide reliable current and historical water data that are essential for sound planning and accurate forecasts. The Water Resources Plan incorpated data regarding aquifer drawdown and stream base flows to understand existing conditions in the county.

The U.S. Army Corps of Engineers (ACE) has reaffirmed its commitment to the environment by formalizing a set of environmental operating principles applicable to all its decision-making and programs: These principles are:

- Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse and sustainable condition is necessary to support life.
- Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of ACE programs and act accordingly in all appropriate circumstances.
- Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

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7 http://www.epa.gov/nps/tribal/pdf/r5c.pdf

8 http://water.usgs.gov/

- Continue to accept corporate responsibility and accountability under the law for activities and decisions under ACE control that impact human health and welfare and the continued viability of natural systems.
- Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
- Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of ACE work.
- Respect the views of individuals and groups interested in ACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems that also protect and enhance the environment.[9]

In July 2002, the EPA and ACE announced the selection of the Anacostia River as one of eight urban river restoration pilot projects. These projects are part of the Urban Rivers Restoration Initiative, designed to promote urban river cleanup and restoration nationwide through the collaborative efforts of these two federal agencies. This project was selected through a competitive process for its plans to restore wetlands, expand forest coverage, redevelop underused brownfields properties, and expand private and public stakeholder involvement. In partnership with state and local governments, tribal authorities and private organizations, this project focuses on water quality improvement, cleanup of contaminated sediments, and human and animal habitat restoration. This project strives to demonstrate how coordinated government and private sector efforts can not only restore contaminated rivers, but also revitalize urban environments. A memorandum of understanding aims to better coordinate hazardous waste cleanup, water quality improvements, and environmental restoration activities under the CWA, Superfund, the Resource Conservation and Recovery Act and the various Water Resources Development Act authorities.[10]

U.S. Department of Agriculture (USDA)—Conservation of environmental resources that are an integral part of farming is a major goal of USDA. USDA administers programs to support wetland and riparian buffer protection and creation; nutrient management planning; soil productivity; and conservation planning and technical assistance. USDA administers the National Water Management System, which gives direct assistance, information, and technology on water-related issues for the purpose of conserving natural resources. Its functions also include water resource planning; watershed plan development and review; watershed assessments; and water policy implementation.[11] The USDA Comprehensive Nutrient Management Plans (CNMPs)[12] are conservation plans that are unique to livestock and poultry operations. These plans document the practices and strategies adopted by the landowner or operator to address the natural resource concerns related to soil erosion, water quality, utilization of manure, and disposal of organic by-products.

The National Resource Conservation Service (NRCS) is a technical agency of the U.S. Department of Agriculture. The Agency was established in 1935 as the Soil

9 http://www.usace.army.mil/Environment/Pages/eop.aspx

10 http://enviro.blr.com/news.aspx?id=36166

11 http://wmc.ar.nrcs.usda.gov/

12 http://www.md.nrcs.usda.gov/technical/agronomy/cnmp.html

Conservation Service (SCS) to promote soil and water conservation. In 1994, NRCS was organized to combine the authorities of the former SCS as well as additional programs that provide financial assistance for natural resource conservation. NRCS works with farmers providing technical assistance and education and also manages several grant programs. The Maryland NRCS has a policy statement supporting "clean and abundant water to protect human health, support a healthy environment, encourage a productive landscape, and ensure an abundant and reliable supply."[1] Action items for the Maryland NRCS include reducing the potential delivery of sediment and nutrients from agricultural producers by 70 million tons and conserving eight million acre-feet of water. The Soil and Water Resources Conservation Act of 1977, as amended, provides broad strategic assessment and planning authority for the conservation, protection, and enhancement of soil, water, and related natural resources, including:

- Appraisal of the status and trends of soil, water, and related resources on non-federal land and assessment of their capability to meet present and future demands;
- Evaluation of current and needed programs, policies, and authorities; and development of a national soil and water conservation program to give direction to USDA soil and water conservation activities.

The U.S. Department of Transportation issues policy guidance on coordinating highway and water resource development projects. The Federal Highway Administration cooperates with federal and state agencies in identifying existing or planned highway segments that may need to be modified to accommodate water resource development projects and to equitably share the costs of infrastructure projects using public funds.

STATE AGENCIES, PROGRAMS, AND REGULATIONS

There are a number of State of Maryland regulations and programs that complement and support the recommendations in this Water Resources Plan. The plan acknowledges that the state has taken a significant role in the protection, preservation, and restoration of the Chesapeake Bay watershed.

Maryland's Planning Act and Smart Growth Initiatives—The Maryland Department of Planning Economic Growth, Resource Protection and Planning Act of 1992 (the Planning Act) was enacted to organize and direct comprehensive planning, regulations, and funding by state, county, and municipal governments. The Planning Act is organized around statutory vision statements that must be pursued in county and municipal comprehensive plans, where priorities for land use, economic growth, and resource protection are established. The vision statements must also be followed and supported by the state in its various programs and public projects. The Planning Act also established an Economic Growth, Resource Protection, and Planning Commission to oversee, study, and report on progress toward implementation of the vision statements. State and local funding decisions on public construction projects must also adhere to the vision statements.

Maryland's Planning Act and Smart Growth Initiatives recently updated these vision statements in HB294-2009. The newly established 12 visions for all Maryland jurisdictions to follow as they plan for the future are:

1 http://www.nrcs.usda.gov/technical/rca/

1. *Quality of life and sustainability:* A high quality of life is achieved through universal stewardship of the land, water, and air resulting in sustainable communities and protection of the environment.
2. *Public participation:* Citizens are active partners in the planning and implementation of community initiatives and are sensitive to their responsibilities in achieving community goals.
3. *Growth areas:* Growth is concentrated in existing population and business centers, growth areas adjacent to these centers, or strategically selected new centers.
4. *Community design:* Compact, mixed–use, walkable design consistent with existing community character and located near available or planned transit options is encouraged to ensure efficient use of land and transportation resources and preservation and enhancement of natural systems, open spaces, recreational areas, and historical, cultural, and archeological resources.
5. *Infrastructure:* Growth areas have the water resources and infrastructure to accommodate population and business expansion in an orderly, efficient, and environmentally sustainable manner.
6. *Transportation:* A well-maintained, multimodal transportation system facilitates the safe, convenient, affordable, and efficient movement of people, goods, and services within and between population and business centers.
7. *Housing:* A range of housing densities, types, and sizes provides residential options for citizens of all ages and incomes.
8. *Economic development:* Economic development and natural resource-based businesses that promote employment opportunities for all income levels within the capacity of the state's natural resources, public services, and public facilities are encouraged.
9. *Environmental protection:* Land and water resources, including the Chesapeake and coastal bays, are carefully managed to restore and maintain healthy air and water, natural systems, and living resources.
10. *Resource conservation:* Waterways, forests, agricultural areas, open space, natural systems, and scenic areas are conserved.
11. *Stewardship:* Government, business entities, and residents are responsible for the creation of sustainable communities by collaborating to balance efficient growth with resource protection.
12. *Implementation:* Strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation are integrated across the local, regional, state, and interstate levels to achieve these visions.[2]

Maryland Department of the Environment (MDE) implements a diversity of regulatory and planning programs to reduce the input of pollutants to surface and ground waters of the state. Reduction of nutrients from both point and nonpoint sources is the focus of the permit requirements, along with control of bacterial pollution from sewage treatment plants and toxic materials from any source.[3]

[2] http://mlis.state.md.us/2009rs/chapters_noln/Ch_177_hb0294E.pdf

[3] http://www.mde.state.md.us/Water/water_programs/index.asp.

Threatened, Endangered, and Rare Habitats and Species—In 1995, Maryland's Rare and Endangered Species List contained about 500 plant and 125 animal species. These species are protected by law under the Non-Game and Endangered Species Conservation Act of 1975. At least 185 of these species no longer exist in Maryland.

—Maryland Department of Natural Resources

Maryland Department of Natural Resources (DNR) is responsible for the Maryland Biological Stream Survey (MBSS). The MBSS was first developed in 1993 as a small pilot study in three watersheds. The MBSS was Maryland's first probability-based or random design stream sampling program intended to provide unbiased estimates of stream conditions with known precision at various spatial scales ranging from large 6-digit river basins and medium-sized 8-digit watersheds to the entire state. The Maryland DNR supports the Watershed Restoration Action Strategy (WRAS) Program and has coordinated the steady development of five new WRASs each year along with others prepared by local governments. DNR is also the coordinating agency for the Chesapeake Bay Tributary Teams.

Stormwater Management Act—Originally passed in 1984, the act required that each county and municipality adopt ordinances to implement a stormwater management program with a focus on mitigating post-construction stormwater runoff. The Stormwater Management Act of 2007, which became effective on October 1, 2007, requires environmental site design (ESD) through the use of nonstructural best management practices and other better site design techniques be implemented to the maximum extent practicable. The act was approved by the state in May 2009 and Prince George's County is required to update the stormwater ordinance to be in compliance with the requirements of the act by May 2010. MDE has published the 2009 Model Standard Stormwater Management Plan. While it may vary among counties because of specific local development ordinances, MDE will use this document as a template to ensure effective implementation of standard plans.[4] MDE has proposed emergency regulation and they have a new guidance document, Stormwater Management Regulations Guidance for Implementation of Local Stormwater Management Programs (March 2010), that defines grandfathering as well as other local planning issues.[5] Prior to this act, ESD was encouraged through a series of credits found in Maryland's Stormwater Design Manual. The specific requirements for ESD are outlined in greater detail in Chapter VII: Stormwater.

Wetlands and Waterways Program—This MDE-housed program regulates activities in tidal wetlands as well as activities in waterways and floodplains. Authorizations are required for filling, dredging, grading, altering water levels, and destroying or removing vegetation. Applicants must demonstrate that there is no practicable alternative to conducting and activity in a wetland, unless the activity is water dependent, and must attempt to avoid or minimize impacts. Compensatory mitigation is required for wetlands lost through regulated activities. In addition, the Wetlands and Waterways Program produces educational materials and technical and planning guidance on various aspects of wetland management and monitors the status of wetlands and trends in wetland conservation in Maryland.

Maryland Geological Survey Coastal Plain Aquifer and Groundwater Study—The U.S. Geological Survey and the Maryland Geological Survey have undertaken several studies on the groundwater resources in the Atlantic Coastal Plain of Maryland. One such study focused on the sustainability of groundwater resources to determine the ability of the aquifer system to meet future water demands, the patterns of water quality, and how to enhance hydrologic monitoring networks and management tools for groundwater allocation. The study highlighted the declining groundwater level in Southern Maryland.[6]

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[4] http://www.mde.state.md.us/Programs/WaterPrograms/SedimentStormwater/swm2007.asp

[5] http://www.mde.state.md.us/assets/document/Stormwater%20Guidance%20Document.pdf.

[6] http://www.nemw.org/cbbriefing-shedlock.pdf

The Chesapeake Bay Critical Area Commission—In 1984, to safeguard the bay from the negative impacts of intense development, the Maryland General Assembly enacted the Chesapeake Bay Critical Area Protection Program, a far-reaching effort to control future land use development in the Chesapeake's watershed. The ribbon of land within 1,000 feet of the tidal influence of the bay was determined to be crucial because development in this critical area has direct and immediate effects on the health of the bay.

The Chesapeake Bay Critical Area Commission was charged with devising a set of criteria that would minimize the adverse effects of human activities on water quality and natural habitats and would foster consistent, uniform, and more sensitive development activity within the critical area. In cooperation with the Critical Area Commission, Prince George's County critical area management programs are administered by the Planning Department and the Department of Public Works and Transportation for the areas of the county within the critical area.

The Critical Area Law requires that Prince George's County identify and provide for the establishment, preservation, and maintenance of habitat protection areas. These areas include: a naturally vegetated 100-foot buffer; nontidal wetlands; the habitats of threatened and endangered species, species in need of conservation, and their habitat; significant plant and wildlife habitat; and anadromous fish-spawning areas.[7]

The Maryland Department of Transportation (MDOT) has an environmental policy that integrates environmental protection and stewardship into the everyday business activities of all modes of transportation, including the prevention of pollution through reduced water usage and sound stormwater management practices.[8] By planning to protect natural ecosystems, MDOT strives to avoid, minimize, or lastly, mitigate impacts of transportation facilities on the state's natural resources. Provisions of the Intermodal Surface Transportation Efficiency Act of 1991 requires that transportation planners, highway officials, and transit interests recognize environmental values and incorporate environmental protection and enhancement measures into programs to develop and improve the nation's surface transportation system. An important element of the process is the consideration of various environment and quality of life planning factors.[9]

Maryland Department of Transportation

The Maryland State Highway Administration asked the Land and Water Conservation Fund to coordinate a Natural Resources Work Group with the Maryland Department of Natural Resources and the U.S. Fish and Wildlife Service. The work group is utilizing a green infrastructure approach to identify and evaluate environmental stewardship opportunities and to strategically prioritize conservation and restoration projects that provide environmental benefits to the communities affected by a planned road improvement in the vicinity of the US 301 Waldorf Transportation Improvements Project in Charles and Prince George's Counties, Maryland.

The Maryland Department of Agriculture's Office of Resource Conservation (RC) works closely with Maryland farmers and soil conservation districts to plan and implement conservation practices and programs that balance crop and livestock production with the need to protect natural resources. RC provides a range of

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7 http://www.dnr.state.md.us/criticalarea/section2.html

8 http://www.mdot.state.md.us/Enviromental%20Compliance/index.html

9 Maryland's Transportation Agencies: Committed to Protecting Maryland's Waters, MDOT, 2004

educational, financial, technical assistance, and regulatory programs to support Maryland agriculture and to protect natural resources for future generations. The office works with a number of local, state, and federal agencies, while implementing policies established by the State Soil Conservation Committee. Four key areas—Program Planning and Development, Conservation Grants, the Nutrient Management Program, and Conservation Operations—comprise the Office of Resource Conservation.

REGIONAL PARTNERSHIPS, PROGRAMS, AND REGULATIONS

In response to the importance of preserving and protecting the Chesapeake Bay, there are a number of regional partnerships, programs, and regulations that provide for additional water quality protection.

Chesapeake Bay Program is a regional partnership that has coordinated and conducted the restoration of the Chesapeake Bay and its watershed since 1983. Partners include the U.S. Environmental Protection Agency, representing the federal government; the U.S. Department of Agriculture; the states of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; and advisory groups of citizens, scientists, and local government officials. The Chesapeake Bay signatories committed to work with local governments, community groups, and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the bay watershed by 2010. These plans are developed to protect, conserve, and restore stream corridors, riparian forest buffers, and wetlands to improve habitat and water quality.

Chesapeake Bay Program
A Watershed Partnership

Since the 1980s several agreements have been signed that advance the protection of the bay. In addition to these agreements, each year the Chesapeake Executive Council meets to reaffirm its commitment to bay restoration and the policy agenda is set for the year ahead. The state's plans for actions through 2011 were released in May 2009 and describe a number of programs and commitments including increased control of runoff from agriculture and urban/suburban lands through best management practices. Some of the agreements and policy documents are outlined below.

Chesapeake 2000 Bay Agreement (C2K)—In June 2000, Chesapeake Bay Program partners adopted C2K, a strategic plan to achieve a vision for the future of the Chesapeake Bay. The agreement details nearly 100 commitments important to bay restoration, organized into five strategic focus areas:

- Engaging individuals and local communities.
- Improving water quality.
- Managing lands soundly.
- Protecting and restoring vital habitat.
- Protecting and restoring living resources.[10]

Chesapeake Bay Tributary Strategy[11]—The C2K agreement called for water quality goals based scientifically on the conditions required to restore the living resources in the bay. Maryland's nutrient loading goals are 37.3 million pounds per year for nitrogen and 2.9 million pounds per year for phosphorus. These goals are also caps, meaning once Maryland and the other states in the bay watershed achieve the necessary reductions, they must maintain that level in order to achieve and sustain improved water quality in the bay. The statewide tributary strategy was developed to achieve Maryland's nutrient reduction goals and includes actions in agricultural fields, urban and suburban development, waste water treatment plants, and atmospheric deposition.

"By 2010, work with local governments, community groups, and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the bay watershed covered by this Agreement. These plans would address the protection, conservation, and restoration of stream corridors, riparian forest buffers and wetlands for the purposes of improving habitat and water quality, with collateral benefits for optimizing stream flow and water supply."
—Chesapeake Bay Program

The tributary strategy is structured to identify the level of effort needed to achieve measurable reductions in nutrients entering local waterways feeding to the bay through the implementation of specific management practices. Maryland's ten tributary teams have the primary charge of facilitating the implementation of management practices and policy changes needed at the state and local levels to meet the nutrient reduction goals. The teams comprise citizens, farmers, local government representatives, watershed groups, and business leaders, and are appointed by the Secretary of Natural Resources on behalf of the governor.[12]

BayStat Chesapeake—The governor's Chesapeake Bay Cabinet is a subcabinet council for interagency coordination and integration of Chesapeake Bay-related activities. Governor Martin O'Malley has, through this council, initiated BayStat Chesapeake[13] to assure that bay management and restoration programs are reaching their maximum efficiency and that together they complement each other to assure maximum overall efficiency and effectiveness.

The Patuxent River Commission (PRC) is an interjurisdictional group created by state legislation in 1980 to provide guidance on land use and governmental policies in the Patuxent watershed with the aim of promoting the protection and restoration of

[10] CHESAPEAKE 2000, Chesapeake Bay Program A Watershed Partnership

[11] http://www.chesapeakebay.net/tributarystrategies.aspx?menuitem=19917

[12] Maryland's Chesapeake Bay Tributary Strategy Statewide Implementation Plan, 1/24/2008

[13] http://www.baystat.maryland.gov/

the river. The Patuxent River Policy Plan,[14] a land management strategy to protect the river and its watershed, was originally prepared in 1984 by representatives from the state and seven counties in the watershed. PRC is charged with the implementation of the Patuxent River Policy Plan and in 1995 expanded to 34 members and assumed the additional role of the Patuxent River Tributary Team. The focus of the Patuxent River Policy Plan is to address programmatic and land management issues while the Patuxent River Tributary Team seeks to reduce nutrient and sediment pollution. The PRC's membership represents a cross-section of the watershed's interest groups and serves as an interjurisdictional forum for the protection and restoration of the river's economic, recreational, and environmental resources. Membership includes businesses, developers, state and local governments (including Prince George's County) and its agencies, M-NCPPC, federal facilities, and environmental, academic, agricultural, and watermen interests.

Middle Potomac Tributary Team—Maryland DNR coordinates tributary teams for each of the state's ten Chesapeake Bay tributary basins. The teams comprise local citizens, farmers, business leaders and government officials appointed by the governor. Members of the Middle Potomac Tributary Team include representatives from the Interstate Commission on the Potomac River Basin, Metropolitan Washington Council of Governments, M-NCPPC, WSSC, Prince George's and Montgomery Counties, federal and state agencies, and environmental, academic, agricultural, and community representatives. The teams' mission is to reduce nutrient and sediment inputs and to restore habitat through community participation. The primary focus of the team in 2004 was the revision of the state tributary strategy, particularly wastewater, urban stormwater, agriculture, and outreach and education aspects. Since that time, the team continues to work closely with state and local governments to spur discussion and actions to address the complex water quality issues that dominate the very urban nature of the Middle Potomac Basin. These issues include multijurisdictional management of Potomac Basin waterways, issues related to the Blue Plains Advanced Wastewater Treatment Plant, urban stormwater retrofits, and the highly impervious watersheds that characterize the Rock Creek and Anacostia Rivers.

Anacostia Watershed Restoration Partnership (AWRP)[15]—The Anacostia Watershed Restoration Partnership[16] is a coalition focused on the clean-up and restoration of the Anacostia watershed. Housed in the Metropolitan Washington Council of Governments, the partnership grew out of an agreement to restore the watershed that dates from 1987. The partnership includes government agencies, environmental advocates, and business leaders, including the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration, the State of Maryland (represented by the Maryland Department of the Environment and the Maryland Department of Natural Resources), the District of Columbia, Montgomery County, Prince George's County, and the University of Maryland. Recently, the partnership has stepped up its efforts to restore the watershed, adding additional staff and undertaking some important initiatives, including working with the U.S. Army Corps of Engineers to development a comprehensive plan to restore the watershed. The partnership is advised by a group of

Physiographic Province **is an area delineated according to similar terrain that has been shaped by a common geologic history.**

Headwaters **is a descriptive rather than a scientific word. Generally it describes the upper parts of a watershed that contribute flow to a specific river or storage reservoir.**

—American Groundwater Trust, Glossary of Terms

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[14] www.mdp.state.md.us/info/patxattach/PPP-Update-xComplete.pdf

[15] http://www.epa.gov/reg3wapd/anacostia.htm

[16] http://www.anacostia.net/restoration.html

citizens who are active in watershed restoration, the Anacostia Watershed Citizens Advisory Committee, comprising representatives of ten active subwatershed citizen stewardship groups.

The Potomac Watershed Partnership (PWP) works to restore the Potomac River which drains a nine-million-acre area including the District of Columbia, Maryland, Virginia, West Virginia, and Pennsylvania. The Potomac River is the second-largest tributary of the Chesapeake Bay and crosses five physiographic provinces representing a diversity of eastern forest ecosystems and is affected by nearly five million residents.

Almost four centuries of intense land use have threatened the health of the Potomac River watershed. Many of the river's tributaries have been altered and degraded. Acid mine drainage has polluted its headwaters, while farming has overloaded the waterway with sediments and nutrients. Rapidly expanding urban populations and urban sprawl have created a host of problems, from urban stormwater runoff and altered streams to fragmentation of the forest and destruction of critical fish and wildlife habitat.

PWP is not the only restoration effort in the Potomac River watershed, but it is one of the first large-scale collaborative efforts to focus on the region's land use and water quality. PWP work with private landowners, community organizations, businesses, and governments to undertake a variety of efforts to improve water quality; enhance forest, wetland, and aquatic habitats; restore threatened and endangered species; reduce erosion; and conserve open space. The following six goals guide PWP efforts:

- Increase and spread knowledge through assessment, monitoring, and education
- Accelerate riparian and wetland restoration
- Promote land protection and stewardship
- Enhance forest stewardship and reduce wildfire risk
- Create more livable communities
- Sustain and expand partnerships[17]

Metropolitan Washington Council of Governments (MWCOG)—The Chesapeake Bay and Water Resources Policy Committee (CBPC) was established by the MWCOG Board of Directors in 1998 as the Chesapeake Bay Policy Committee; CBPC tracks developments under the federal/state Chesapeake Bay Program for implications to local governments and recommends bay-related policies to the board. Board action in 2005 added "Water Resources" to the committee's title and expanded its mandate to include other regional water quality issues in addition to those associated with the bay. The committee's membership comprises elected officials and staff from MWCOG's 20-member governments. Upon the recommendation of CBPC, the MWCOG Board has endorsed four water quality principles to guide regional policy regarding the bay restoration effort and other water quality goals. These principles, which were developed originally in 1997 and recently revised by CBPC are:

> "**Holistic Requirements—**Programs and policies to restore and protect the Chesapeake Bay and its tributaries, whether regulatory or not, shall reflect a holistic, multi-sector analysis of environmental benefits and costs as well as technical feasibility, before being established.

[17] http://www.potomacwatershed.org/pwp_about.html

"**Equitable Responsibility—**Chesapeake Bay and its tributaries shall strive for equity and cost-effectiveness in allocating responsibilities among regions, counties, and municipalities and among the different sources of pollution.

"**Sound Science—**Programs and policies to restore and protect the Chesapeake Bay and its tributaries shall rely on a sound scientific foundation and shall be revised as needed, reflecting advances in that foundation.

"**Communication and Voice—**Programs and policies to restore and protect the Chesapeake Bay and its tributaries, whether regulatory or not, should be developed through a cooperative process among stakeholders including local governments and wastewater utilities. Given their implementation responsibilities, local governments and wastewater utilities shall be engaged at the earliest stages of these development processes."

MWCOG also supports an urban forestry program that seeks to enhance and preserve forestry resources in the region through public outreach and education. The Community Forestry Network (CFN) was officially organized at the MWCOG in 1991. One of the goals of the CFN is to provide a framework for discussions and activities for MWCOG member governments and other interested parties to develop solutions for urban and community forestry problems in the Washington metropolitan area. Water resource protection is inherently linked to tree canopy and forest resources.[18]

[18] http://www.mwcog.org/

Adopt land use policies and practices that will manage and monitor growth in a manner that is sustainable, reflects watershed goals and targets, and is protective of environmentally sensitive resources.

IV: GROWTH POLICIES AND LAND USE PLANNING

Prince George's County is situated at the approximate geographic center of the Chesapeake Bay watershed and encompasses a gross area of roughly 300,000 acres. Although the county represents only 0.7 percent land area of the overall bay watershed, it is a significant part of the growing urban core around the District of Columbia and has influenced the quality and health of the entire bay watershed.

Population growth and associated development require water. The type of development, where it takes place, and how it is managed impacts the environment and influences the delivery cost of water service. Conventional growth, with characteristics of large lots, low density, and sprawling development, increases the amount of infrastructure required and therefore the cost of delivering water services. Smart growth principles, on the other hand, help direct growth to areas with existing infrastructure, promote mixed land uses, and encourage walkable places and the use of transit. Such principles can help reduce the quantity of water needed, reduce infrastructure costs, and positively contribute to improving water quality through better site design, preservation of open space, and application of best management practices.

The amount of land in Maryland converted to development is statistically outpacing population growth. It has been estimated that between 1970 and 1980 developed acreage increased, as a percentage, more than twice as fast as the population. A 7.5 percent population increase was accompanied by a 16.5 percent increase in developed acreage during this time period. Between 1982 and 1997, the Chesapeake Bay watershed lost over 750,000 acres of forestland to development—a rate of about 100 acres per day and a total size equal to 20 District of Columbias. At least 36 percent of all forestland

Map 1: Chesapeake Bay watershed and surrounding area. Source: USGS

in the bay watershed is at high risk for development over the next five to ten years.[1] Development has been the largest cause of forest loss over the past 15 to 20 years. Forests act as an effective nutrient sponge and the Chesapeake Bay Program estimates that if the entire watershed were forested, only 60 million pounds of nitrogen per year would reach the bay.[2]

LAND USE AND LAND COVER

It is important to understand the distinction between land use and land cover and how they influence water quality. Land use is the employed activity occurring on a defined piece of land whereas land cover is the actual type of surface feature on the ground. Land use is tied to a parcel boundary, whereas land cover is independent of parcels. The county real estate classification system identifies properties according to their primary use. For example, a large parcel containing an industrial building would be classified as

1 http://www.dnr.state.md.us/criticalarea/section2.html

2 http://www.bayjournal.com/article.cfm?article=2898

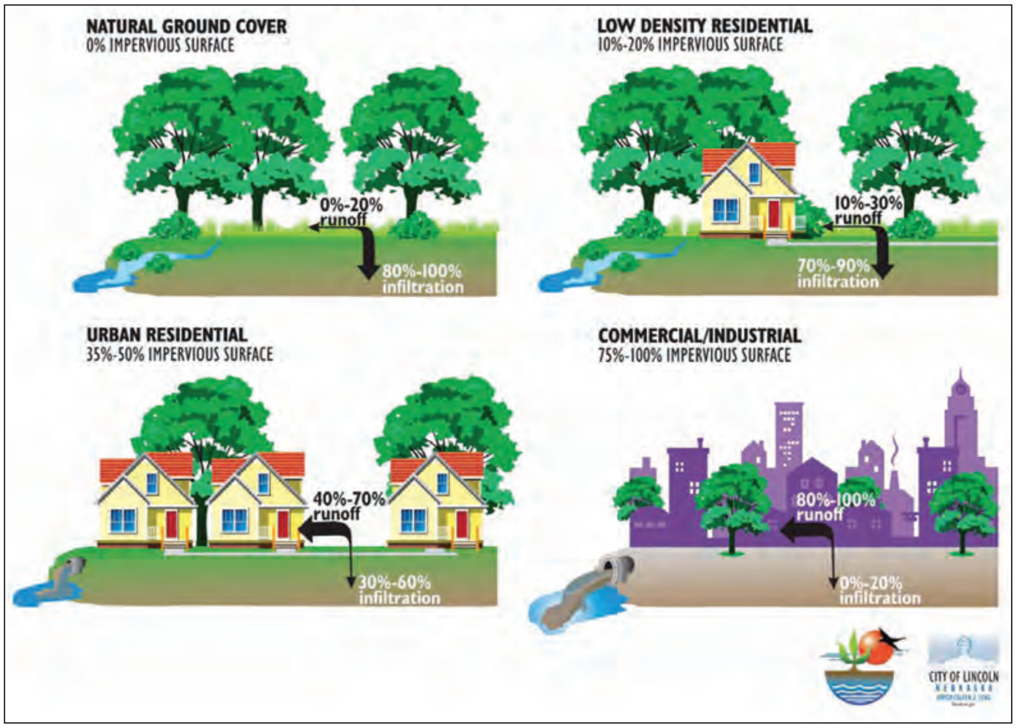


Figure 1: Increase in stormwater runoff with urbanization.

an industrial land use. However, the site may include a building, a parking lot, and forested land covers. An agriculturally zoned property often has associated woodlands and wetlands and only a percentage of the property is actively farmed or used as pasture for livestock.

Each land cover influences water quality differently. Land development has implied land cover necessary to support its use. For instance, multifamily residential land use requires parking at a prescribed number of spaces per living unit. Consequently, the land cover associated with this land use will include a prescribed amount of paved surfaces to accommodate the land use.

For water resource analysis purposes, land cover data is more suitable than land use data in capturing the true water quality signature of an area, but the implications of land use were analyzed to determine land cover as build-out scenarios in this plan. For purposes of the Water Resources Element (WRE) model, the Maryland Department of Planning 2007 Draft Land Use Land Cover data provided the basis for the analysis of existing conditions and was applied to projections of future impacts.

As land cover changes, the amount of rainfall absorbed into the ground or that runs off as stormwater changes too. Water quality is largely dependent on a number of key factors—the nature and type of land development and the corresponding pollutants and the type and condition of channels, drainage and management systems that carry water and associated pollutants. The former is the direct result of the land use in an area while the latter is dependent on the topography, soils, land cover, and any existing drainage features in an area and how these natural conditions are managed and incorporated to support development.

GENERAL PLAN FRAMEWORK

The 2002 Prince George's County Approved General Plan provides a framework to guide future growth within the county. The plan strives to reconcile growth and conservation goals through a thoughtful countywide approach. The General Plan designates three growth policy tiers to describe and guide growth within the county: the Developed Tier, the Developing Tier, and the Rural Tier. As shown within the Developed and Developing Tiers, an overlay of centers and corridors represents areas where the plan encourages a concentration of new development to take advantage of existing infrastructure. Included among these centers and corridors are the Metrorail stations, which provide the most prominent opportunities for high density and mixed-use development. The General Plan also outlines specific objectives for housing growth within the county. These objectives have relevance to water resources since growth in population requires water and sewer service and development of land to accommodate the growth.

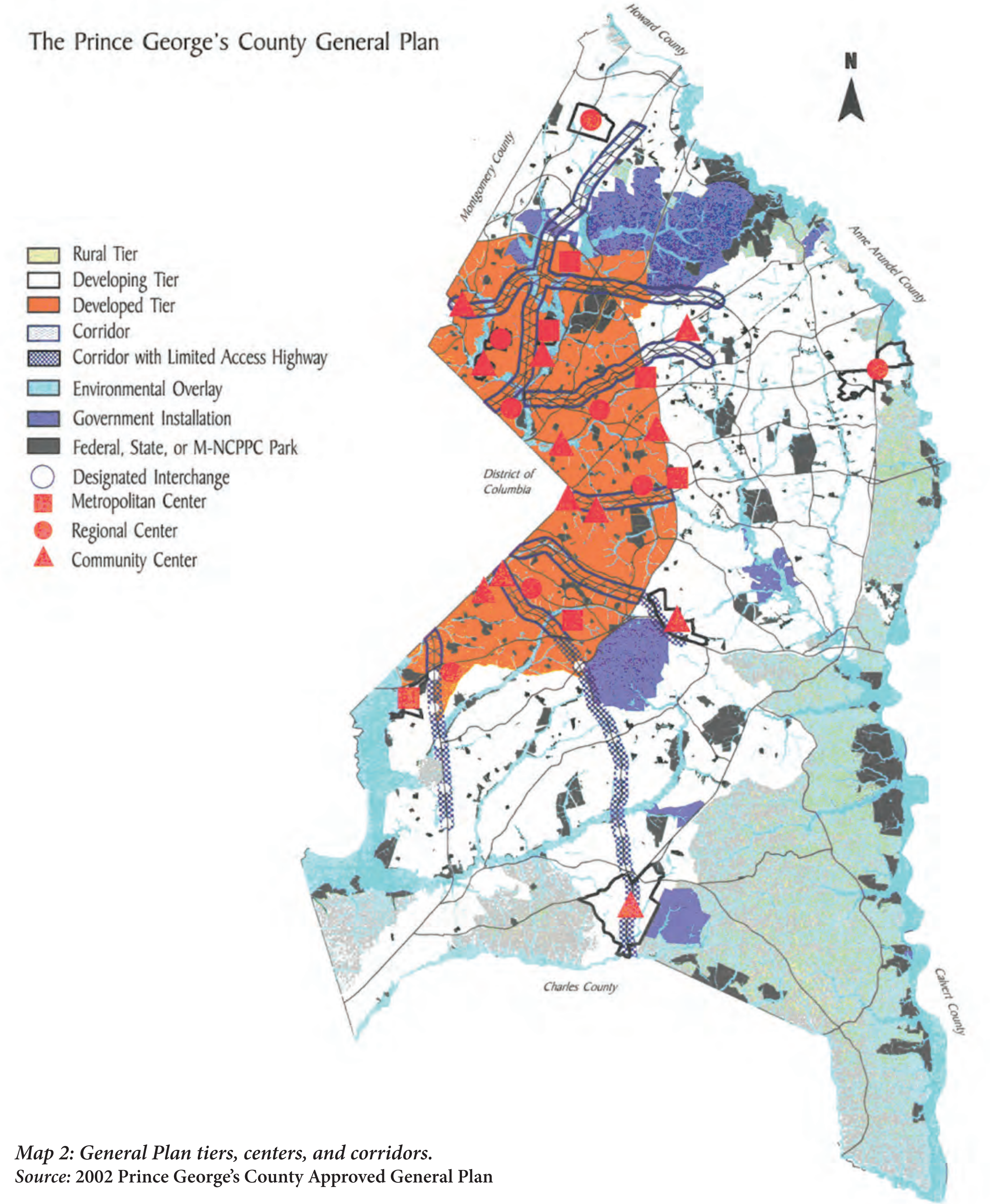
		Developed Tier	**Developing Tier**	**Rural Tier**
General Plan Objectives	Capture a designated percentage of the county's dwelling unit growth by 2025	>33%	<66%	<1%
	Capture a designated percentage of each tier's housing growth by 2025 in centers and corridors	>50%	>20%	

Table 1: General Plan growth objectives by tier.
***Source: 2*002 Prince George's County Approved General Plan**

Directing new growth to previously developed areas holds the potential to prevent unnecessary land consumption and conserve valuable natural areas. Infill and redevelopment opportunities inside the Beltway and within transit centers are plentiful and represent powerful tools to protect water resources. Redevelopment of land within the Developed and Developing Tiers protects greenfield areas and provides opportunities to improve water quality, reduce impervious surfaces, and provide infiltration opportunities at the site level. Infill and redevelopment also tie growth to existing water and sewer infrastructure and avoid construction of expanded infrastructure or additional septic systems where public service is unavailable. Sustainable benefits include reduction of infrastructure costs, reduced vehicle trips, and revitalization of existing neighborhoods.

COUNTY LAND USE AND DEVELOPMENT PATTERNS

Prince George's County experienced dramatic growth during the decades following World War II due to its proximity to the District of Columbia. As a result, the land area east of the District became the focus of a great deal of residential development, largely low- to medium-density single-family neighborhoods, inside what would later become known as the Capital Beltway corridor. According to a 2007 study on Maryland growth patterns, urbanization, or the rate of land conversion, Prince George's County has averaged around 1.65 percent land conversion per year, about three-quarters of the state



Map 2: General Plan tiers, centers, and corridors.
Source: **2002 Prince George's County Approved General Plan**

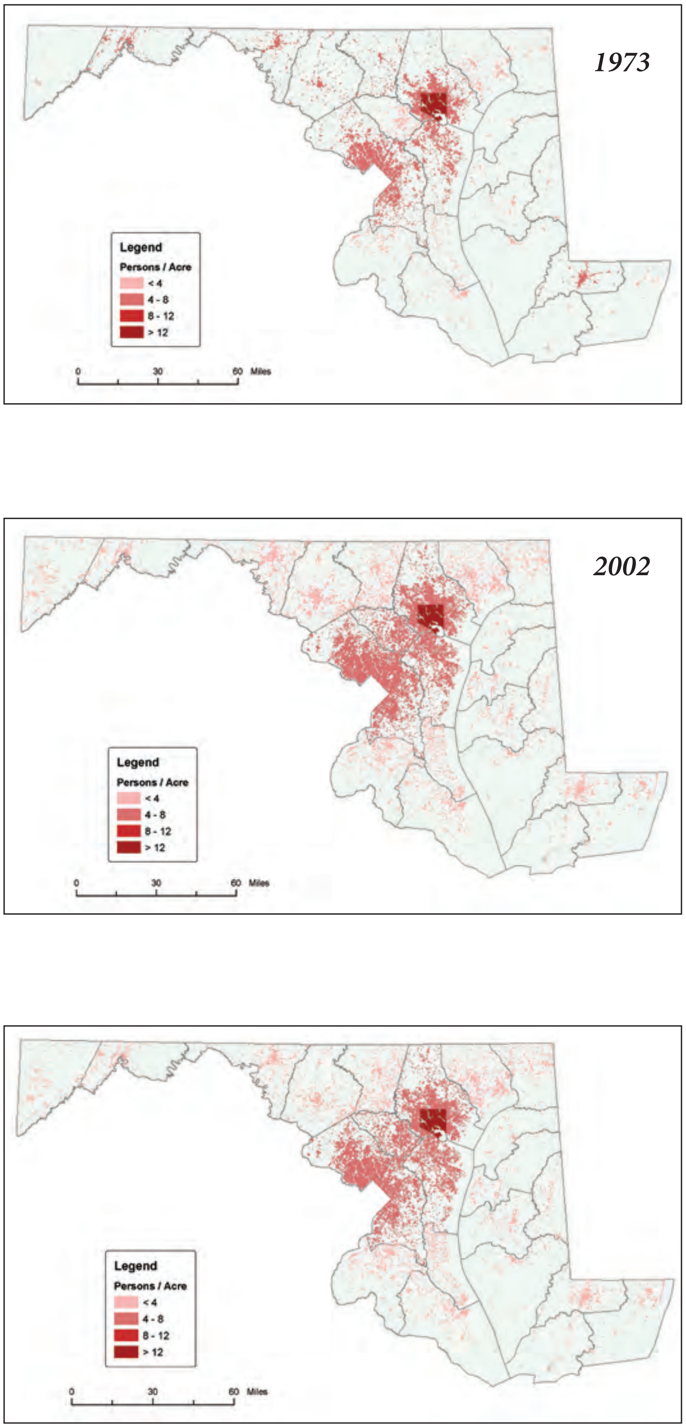
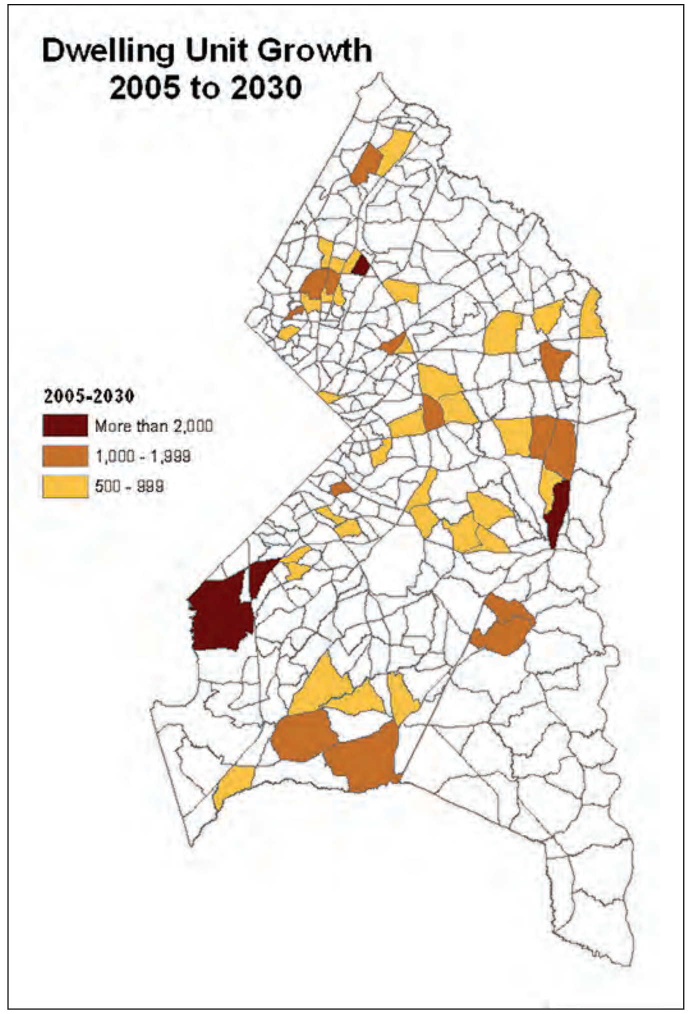


Figure 2: Urban growth pattern in Maryland.
Source (1973–2002 maps): Shen, Qing et al, "Changing Urban Growth Patterns in a Pro-Smart Growth State: The Case of Maryland, 1973-2002", Research Paper, April 2007; 2007 map based on 2007 LULC Data provided by USGS.



Map 3: Round 7.1 projected dwelling unit growth in Prince George's County.
Source: M-NCPPC

average of 2.65 percent.[3] The same study also concluded that the county has a sprawl index comparable to that of adjacent Montgomery County and lower (less sprawl) than the state average or a majority of the other counties in Maryland. The study also rated the growth pattern as moderately compact and less fragmented than adjacent counties, although it also indicated a trend toward more fragmented development.

A notable trend in recent decades is a significant shift in the percentage of population living inside versus outside the Beltway. This dispersal in population has resulted in additional lower density residential development mainly to the east and north and within the county's Developing Tier. More than 80 percent of new housing units built from 1970 to 2000, and nearly all population growth during that time, occurred outside the Beltway.[4] Figure 2 provides a historical perspective of development patterns in the Washington, D.C., metropolitan region during the last three decades of the twentieth century.

The Metropolitan Washington Council of Governments, in cooperation with the county, has generated projections of population, employment, and dwelling unit growth to 2030. This effort, termed the Cooperative Forecasting Program, serves to reconcile a regional growth model with projections at the local level providing forecasts in five-year increments for each locality. Projections indicate steady growth in the county through 2030 with respect to both population and employment. How the county manages the pattern, type, and location of new growth will influence the success of its water resource initiatives.

Table 2: Round 7.1 Cooperative Forecast for Prince George's County

Round 7.1	2005	2010	2015	2020	2025	2030
Dwellings	318,966	341,187	359,324	373,290	384,216	392,490
Households	307,319	328,636	345,989	359,376	369,865	377,820
Population	852,875	900,831	936,843	961,598	979,836	992,868
Employment	347,886	365,386	389,136	420,386	461,886	518,386

Source: M-NCPPC

LAND USE IMPACT FACTORS

Urban development is often considered the primary cause of water quality degradation in developed watersheds. Although land development does directly affect watershed functions, the pattern and management of development at both a regional and site level can help mitigate or reduce impacts over time. Where new development is located and how water relative to that development is managed is ultimately responsible for the impact on water quality in the rivers, streams, and lakes within the watershed.

3 Urban Growth Pattern in Maryland. Source (1973–2002 maps): Shen, Qing et al, "Changing Urban Growth Patterns in a Pro-Smart Growth State: The Case of Maryland, 1973-2002", Research Paper, April 2007

4 Emerging Trends: The Many Faces Of Prince George's County, September 2004, Volume 1, Issue 1

Greenfield:
A piece of usually rural or semirural property that is undeveloped except for agricultural use, especially one considered as a site for expanding urban development.

In most urban developments, the largest source of water pollution is not point source or from a pipe, such as a sewage treatment plant. Instead, the largest amount of pollution is attributed to surface water runoff known as nonpoint source pollution. Nonpoint source pollution is a direct result of land use, land cover, the extent of imperviousness, and the quality of stormwater management facilities within the watershed. Surface water runoff is conveyed across varying land covers and land uses and requires a watershed-based approach to evaluate, analyze, and plan to control and effectively manage the impacts of nonpoint source pollution.

Four major factors must be considered when assessing the impacts to the health of a watershed from a land use perspective:

- Amount of development
- Location of development
- Intensity of development
- Pattern and type of development

Amount of Development—As the population grows, more and more natural land—such as forests, brush and grasslands, and water recharge areas—are converted into developed land to accommodate the new growth. These natural lands play a critical role in protecting water resources by allowing precipitation to infiltrate into the ground. In forested riparian corridors that flank county streams and tributaries, the vegetation and soils help improve water quality by processing nutrients, filtering contaminants, absorbing flood waters, recharging groundwater systems, supporting ecosystems, and maintaining stream flows.

Accommodating new growth does not have to result in highly consumptive land use practices. Growth can be accommodated with intelligent policies and practices that are more considerate and protective of natural systems. Policies adopted in the 2002 General Plan have sought to direct and manage the amount and location of development by encouraging growth into specified centers and corridors within hierarchal tiers of development. According to the September 2008 General Plan Growth Policy Update, "The county has made very limited progress toward achieving the General Plan objectives for the development pattern. Since 2002 dwelling unit growth in the Developed, Developing, and Rural Tiers has not been on target toward achieving these objectives. The share of residential growth within centers and corridors in both the Developed and Developing Tiers has been lower than the General Plan objectives. The county is moving in the right direction in incorporating transit-oriented and/or transit-supporting design features in new development within centers and corridors. In terms of protecting sensitive lands, although considerable land is preserved each year, this amount is much less than the General Plan objective."[5]

General Plan policies were assessed in the General Plan Growth Policy Update (2008)[6] and showed that, between 2002 and 2007, development in the Rural Tier was within the planned objectives, and development in the Developed Tier was approximately 18 percent, much less than the 38 percent benchmark. The Developing Tier absorbed roughly 79

5 http://www.pgplanning.org/Projects/Completed_Projects/Recently_Completed_Studies/Growth_Policy_Update.htm

6 http://www.pgplanning.org/Resources/Publications/General_Plan_Growth_Policy_Update__Prince_George_s_County.htm

percent of the new growth, which was much higher than the 66 percent benchmark. This trend suggests that infill and redevelopment are less desirable to developers than greenfield development and county policies and incentives and disincentives would need to be strengthened to encourage more development in the Developed Tier. The county's next General Plan Growth Policy Update will provide an opportunity to reassess planned development objectives relative to water resource protection.

Year	Developed Tier	Developing Tier	Rural Tier
2002	527	2,597	97
2003	351	1,721	76
2004	344	1,855	104
2005	550	2,488	114
2006	803	2,543	116
2007	412	2,063	61
Total	2,987	13,267	568
Percentage	18	79	3

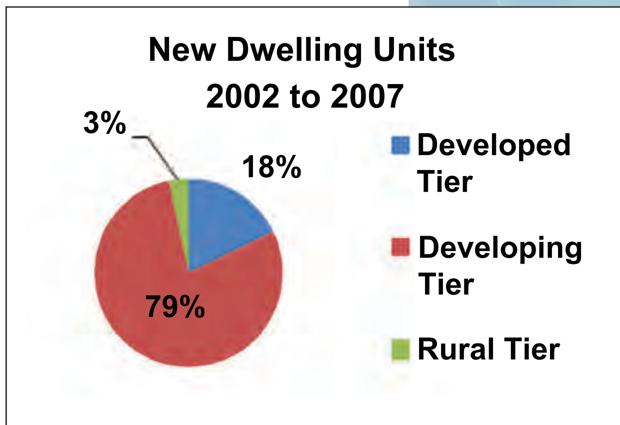


Table 3 and Figure 3: General Plan Policy Update (2008). *Source: M-NCPPC*

Location of Development—It is difficult to establish the impacts of land use alone on water quality due to the dynamic nature of non point source pollution and cumulative impairments in a watershed that build up over time. However, certain types of practices are known to exacerbate water quality conditions. Much of the growth between 1970 and 1980 in the entire Chesapeake Bay watershed occurred directly within 1,000 feet of the Chesapeake Bay—identified as the Chesapeake Bay critical area. Past land protection strategies to protect riparian areas along streams and rivers oftentimes neglected to include smaller tributaries, wetlands, or other natural features that provide natural, cost effective water resource management benefits. Site constraints or previous development practices may consequently make riparian corridor preservation difficult for infill or redevelopment sites. However, these types of sites should not be exempt from providing site management practices that can achieve similar benefits in managing stormwater impacts. Currently, Subtitle 24 of the County Code requires preservation of areas directly around streams, tributaries, and wetlands to ensure an adequate buffer exists between development and the water resource.

Significant natural features can similarly be protected through conservation and land preservation efforts that strongly regulate development or prevent it entirely. Large contiguous amounts of open space and forests help control and reduce run off, absorb nutrients, and provide flood control benefits. Other benefits from open space and forests include provision of habitat for animals and plants, community recreation, air quality benefits, reduced temperatures, and contribution to community character and overall quality of life.

Intensity of Development—The intensity of a development, as it affects stormwater runoff, can be measured by calculating the level of imperviousness within a watershed. Rooftops, driveways, pavement, and roadways are examples of features that contribute to imperviousness levels. Impervious surfaces collect pollutants deposited from the atmosphere and other sources and increase the volume and intensity of runoff, resulting in increased levels of erosion and associated sediment, and nutrient and pollutant loads to nearby streams. Low density development does not necessarily correlate to reduced impervious levels. Lawns and residential landscape features may function in the same way as degraded natural areas due to wholesale grading and disturbance, removal of topsoil, and soil compaction.

The U.S. Environmental Protection Agency uses a threshold of ten percent imperviousness in a watershed as an indicator that water resources might be impaired. Based on the analyses conducted as part of the Water Resources Plan, the Potomac watershed maintains an average impervious rate of 18 percent and the Patuxent watershed maintains an average impervious rate of 12 percent. Redevelopment of areas that already contain impervious cover into mixed use, higher density communities can help reduce land consumption, reduce overall watershed impervious levels, provide opportunities to retrofit stormwater facilities that are ineffective or unsustainable, and provide facilities where none exist. Overall, impervious cover for a watershed decreases as site density increases because more development is accommodated with less land, thereby preserving greenspace.

Pattern of Development—The intensity of development is not necessarily the primary factor contributing to water pollution but must be considered in concert with the location and type of stormwater management practices. The pattern or arrangement of land use and activities within a watershed plays a critical role in affecting the water quality. At the watershed level, the same population accommodated in a higher density, smaller, more compact pattern at strategic locations typically has many water quality advantages over sprawling low density development. By placing polluting activities away from natural drainage and groundwater recharge areas and allowing stormwater to travel across vegetated areas to filter out pollutants before runoff flows enter the streams and ponds, even high intensity uses may be accommodated without adverse impact.

UNDERSTANDING RELATIONSHIPS BETWEEN LAND USE, DEVELOPMENT PATTERN, AND WATER QUALITY

In order to compare and understand the impact of land use patterns on water quality, an empirical study was conducted using the model developed for the Water Resources Plan and various prototypical land use configurations on a fixed 200-acre site. A version of the Water Resources Plan model developed by MDE was customized for Prince George's County's Water Plan as described in more detail in Technical Appendix I. The model calculates estimated nitrogen and phosphorus loads from various land use/land cover categories based on average loading rates provided by the Maryland Department of the Environment (MDE). Application of the model to the prototypical 200-acre land use/land cover configurations shown in Figure 4 provides a simplistic comparison between the relative water quality impacts of each of these types of development. It should be noted that the Water Resources Plan model does not include functionality to represent specific precipitation events or watershed characteristics and, therefore, cannot be used to evaluate impacts of many development aspects discussed above (e.g., improvements in site drainage or stormwater management through redevelopment). Rather, the results for the various configurations reflect only the differences in the loads calculated from the acreages of each land use/land cover within the parcels illustrated in Figure 4.

For modeling purposes the Water Resources Plan has utilized state designated land use/land cover definitions in Technical Appendix I.

	Land Use Pattern		Impervious %	INDICATORS: WRE Baseline Results – Nitrogen	Phosphorous	Overall Water Quality	INDICATORS: Results with Enhanced BMP Implementation – Nitrogen	Phosphorous	Overall Water Quality
1	**All Forest:** Predevelopment Pattern with nearly 100% of land area in watershed under forest cover		0.0%	1.0	1.0	2.0	1.0	1.0	2.0
2	**All Brushland:** Predevelopment Pattern with nearly 100% of land area in watershed under small shrubs and grasslands		0.0%	1.0	1.0	2.0	1.0	1.0	2.0
3	**All Active Agricultural:** Early Settlement Development Pattern with nearly 90% of the watershed under cropland, 5% under animal farms and 5% under hedgerows		2.2%	7.0	13.8	20.8	6.2	13.1	19.3
4	**Typical Large Lot Rural:** Development pattern with large lots and very low density as typically allowed under zoning		8.2%	4.2	12.5	16.7	3.7	11.9	15.6
5	**Conservation Development:** Conservation Development Pattern accomodating same density but with more land under forest and open spaces		8.8%	3.0	8.3	11.4	2.9	7.9	10.9
6	**Typical Sprawl:** 90% of watershed developed with low to moderate intensity development.		43.3%	4.4	12.3	16.7	4.2	11.7	15.9
7	**Smart Growth:** Development concentrated to 60% of area accomodating green buffers, open spaces and high density mix use areas		33.8%	3.8	10.2	14.0	3.6	9.7	13.3

Results with Enhanced BMP Implementation

Notes:
Nitrogen and Phospohrous Levels are relative to Scenario 1 (N = 229 lb/day; P = 3 lb/day)

Figure 4: Prototypical land use configuration.
Source: M-NCPPC

The configurations chosen for Figure 4 represent a range of intensities and patterns of development. A predevelopment condition of the site completely covered by forest was considered a baseline in which to compare other results. Three key indicators of water quality—composite imperviousness, terrestrial nitrogen levels, and terrestrial phosphorus levels—were compared. The results of other configurations were normalized by the results of the forested baseline, which yielded 338 pounds of nitrogen per year and nine pounds of phosphorus per year from the 200-acre parcel. Other configuration results shown in Table 4 indicate the magnitude of pollution levels compared to the forested baseline.

Details of land use acreages applied for each configuration and a summary of model results are shown on Figure 4. The prototypical land use configurations were first evaluated with the model by applying data provided by MDE that represent loading rates reflective of 2002 land management practices (2002 best management practices [BMP] implementation loading rates). The land use configurations were then reevaluated by applying average nutrient reductions resulting from moderate enhancements in best BMPs, as measured by the model during the work conducted for the Water Resources Plan and summarized in Appendix I. These results are shown in the improved water quality scores in the Enhanced BMP Implementation columns of Figure 4. This modeling work supports the implementation of improved land management practices as a strategy for achieving water quality improvements, and the modest nutrient reductions shown in Table 4 could be increased by modeling a more aggressive BMP strategy than the one illustrated.

The model runs described herein were developed to provide an illustration of the impacts that development, land use, and land management decisions can have on water quality. The 200-acre land use parcels and the suite of BMPs applied to provide results of enhanced management techniques were purely hypothetical and were not intended to provide quantitative estimates of any specific county land use or watershed management strategy. The model developed for the Water Resources Plan can be used by the county to evaluate the impacts of more specific development and land management policy decisions as they are developed in the future.

Although the results of this hypothetical analysis are limited by the sensitivity of the Water Resources Plan model, the study confirms that land use pattern and intensity have an impact on water quality with some interesting observations:

- Forest cover and brush land are equivalent in terms of nitrogen and phosphorus loads, based on the data provided by MDP and MDE, and each of these land use configurations reflect "baseline" loads representative of natural, undeveloped conditions.
- Nutrient loads from actively farmed agricultural lands are significant under MDE's 2002 BMP implementation scenario. Implementation of additional BMPs can significantly reduce runoff and help mitigate nutrient loads from agricultural land use. The state's strategies for effective agricultural land management are continuing to evolve along with improved BMP effectiveness data, and future strategies should be applied in subsequent analyses in order to develop quantitative estimates of agriculture's water quality impacts within the county. Within the developed residential land use configurations, the conservation development pattern provided the lowest modeled nutrient loads, with estimated annual nitrogen and phosphorus loads that were approximately 45 percent lower than loads generated from typical sprawl and large lot rural development. As previously described, these model results

Land Use Configurations—Model Result Comparison

PROTOTYPICAL LAND USE CONFIGURATIONS			1	2	3	4	5	6	7
	LAND USE	Imperviousness Factor	All Forest	All Brushland	All Agricultural	Typical Large Lot Rural	Conservation Development	Typical Sprawl	Smart Growth
Acres of Land	Forest	0.00	190	30	15		52		32
	Brushland	0.00		160		10	22		4
	Parks	0.09					39	10	20
	Roads	0.95			4	10	4	30	20
	Cropland	0.00			167				
	Industrial	0.53						20	
	Rural Residential	0.04				170			
	Low Density Res	0.14			4		73	40	
	Medium Density Res	0.28						50	40
	High Density Res	0.41							40
	Commercial	0.72						35	20
	Institutional	0.34						5	14
	Water	0.00	10	10	10	10	10	10	10
	Total		**200**	**200**	**200**	**200**	**200**	**200**	**200**
	Composite Imperviousness		0.00%	0.00%	2.18%	8.15%	8.77%	43.25%	33.78%
RESULTS with 2002BMP Rates	Nitrogen (total lb/year)		338	338	2,362	1,404	1,028	1,492	1,272
	Phosphorus (total lb/year)		9	9	124	113	75	111	92
	Nitrogen (Forest Equivalent)		1	1	7.0	4.2	3.0	4.4	3.8
	Phosphorus (Forest Equivalent)		1	1	13.8	12.5	8.3	12.3	10.2
	Overall Water Quality*		**2.0**	**2.0**	**20.8**	**16.7**	**11.4**	**16.7**	**14.0**
RESULTS with Enhanced BMPs	Nitrogen (total lb/year)		338	338	2,097	1,263	984	1,422	1,216
	Phosphorus (total lb/year)		9	9	118	107	72	105	87
	Nitrogen (Forest Equivalent)		1.0	1.0	6.2	3.7	2.9	4.2	3.6
	Phosphorus (Forest Equivalent)		1.0	1.0	13.1	11.9	7.9	11.7	9.7
	Overall Water Quality*		**2.0**	**2.0**	**19.3**	**15.6**	**10.9**	**15.9**	**13.3**

* Nitrogen and phosphorus forest equivalent

Table 4: Model results.
Source: M-NCPPC.

reflect only the differences in nutrient estimates generated by a different mix of land use acreages, so this example illustrates the significant benefits of providing or conserving more green infrastructure within the development parcel. Agricultural land use/land cover in the county often includes forests, riparian buffers, and wetlands, and the model representation of agriculture only considers active farming—land in crops or utilized for livestock grazing. Agriculture as a land use is valued, and its preservation is encouraged due to the associated water quality protection land covers, such as forest, that typically make up the total farm environment. This model does not have the ability to estimate additional benefits of environmental site design such as reduced erosion, improvements in stream channel stability, enhanced riparian habitat, and other significant water quality benefits that would result from this pattern of development. However, the conservation development pattern does illustrate the benefits of enhanced land management practices (such as reductions in fertilizer applications) that were modeled and illustrated in the Enhanced BMP column of Figure 4. These results were generated from modeling a very moderate suite of BMPs described in Technical Appendix I, and reductions could be greater through more aggressive implementation of BMPs within all hypothetical development patterns.

- A compact, denser development pattern that incorporates the right mix of open space and green infrastructure as shown in the smart growth land use configuration reduces water quality impacts compared to the same size parcel of typical sprawl or even rural large lot development. The model results estimated that nitrogen and phosphorus loads from the smart growth parcel were approximately 10 to 20 percent lower than the loads from the typical sprawl and large lot rural development parcels. As with the previous descriptions, additional improvements were shown by applying the nutrient reductions estimated from modeling a moderate degree of enhanced BMP implementation, and more significant improvements are expected from more aggressive BMP implementation.

IMPLICATIONS FROM THEORETICAL MODEL OBSERVATIONS

The empirical land use prototype study supports the conclusion that careful and smart land use planning protects water quality and that preservation or restoration of green infrastructure is a component part of water resource protection. Based on the modeling results produced from application of MDE's load rate data, the study results suggest that density of development is not the primary factor contributing to pollution, but the location of development and mix of land covers strongly influence the degree of nitrogen and phosphorus loads from terrestrial sources. As previously discussed, the Water Resources Plan model does not have the ability to fully estimate the benefits of better site design, including reductions in watershedwide impervious rates that can be achieved through increased development densities. Improvement in site infiltration, reduced volume and intensity of runoff, and the resulting reductions in sediment and nutrient loads can be more accurately estimated by more detailed modeling with local watershed data. However, the model does indicate that significant water quality improvements can be provided through a combination of careful land use decisions, such as those illustrated by the smart growth and conservation development examples, and improved land management practices, such as those included in the moderate suite of BMPs used for this example. The model developed for the Water Resources Plan provides a tool for the county to use with local watershed data to generate quantitative predictions of specific land use and watershed management decisions that will be developed as part of countywide and community-level planning efforts in the future.

The county has current strategies to promote smart growth by encouraging development in Developed Tier centers and corridors and through adoption of the Green Infrastructure Plan. However, despite such policies, the cumulative impacts of countywide development trends indicate that most growth is occurring in the Developing Tier; therefore, stronger policies are needed to better guide and manage growth in a way that is more considerate of watershed and water resource impacts, especially in light of new and more stringent federal, state, and local regulatory requirements. As additional data become available the ensuing water resources plans should continue to update and refine NPS analysis appropriately.

CURRENT LAND COVER WITHIN THE COUNTY

The Maryland State Land Use Land Cover (LULC) data for 2007 uses 12 developed land use classifications and 13 undeveloped land cover classifications to describe the county.

Table 5 summarizes this data at the county level. Based on this information, the most common type of developed land is medium density residential development followed by low density residential development. Maryland's commitment to smart growth echoes the understanding of impacts associated with low density, highly dispersed uses correlating with a decrease in water quality. Low density single-family development is associated with increased roadway and driveway impervious surfaces, as well as compacted lawns that lack the filtration benefits of natural green spaces ("Protecting Water Resources with Smart Growth").[7] Based upon the state data, the predominant developed land use type in the county is medium density residential, followed by low density residential—two land use types that are traditionally considered more consumptive of land. Nearly 34 percent of the county land area is categorized as residential, and the additional amount of land devoted to housing has increased by approximately 11 percent since 2002. Commercial and industrial uses account for only around three percent each of the total county land area. These uses typically have characteristics of large building lots, large buildings, and expansive parking—uses associated with higher levels of impervious surfaces and, therefore, increased stormwater runoff. Industrial uses are also linked with point source pollutant loadings, although these are highly regulated and managed. Finally, institutional uses account for approximately five percent of the county's land, associated largely with Joint Base Andrews Naval Air Facility Washington. Institutional uses, while often possessing large buildings and parking lots associated with industrial and commercial uses, typically have a higher level of tree cover that can help mitigate some of the effects of impervious surfaces.

Some parts of the county have not been developed and remain in a natural state or are used for production purposes. Within the undeveloped land use category, nearly 31 percent of the county is categorized as forest cover, followed by nearly 11 percent classified as agriculturally related (cropland, pasture, etc.) uses. In general, a greater percentage of forested and agricultural lands are located in the Patuxent watershed in the eastern half of the county, although acreage of each can also be found in the Potomac watershed.

[7] http://www.epa.gov/dced/pdf/waterresources_with_sg.pdf

LU CODE	Land Use Description	County	
		Existing Acres	Percentage
101	Rural (Agriculture)	2,121	0.69
102	Rural (Forest)	8,821	2.85
11	Residential Low	29,774	9.62
12	Residential Medium	52,504	16.97
13	Residential High	13,542	4.38
14	Commercial	9,516	3.08
15	Industrial	8,333	2.69
16	Institutional	14,537	4.70
18	Parks & Open Space	7,946	2.57
21	Cropland	23,616	7.63
22	Pasture	8,867	2.87
24	Agriculture Facilities	198	0.06
25	Row and Garden Crops	260	0.08
41	Deciduous Forest	77,416	25.03
42	Evergreen Forest	3,545	1.15
43	Mixed Forest	29,628	9.58
44	Brush	3,135	1.01
50	Water	1,401	0.45
60	Wetlands	2,693	0.87
73	Bare ground	6,175	2.00
71	Beaches	58	0.02
17	Mining	1,695	0.55
80	Transportation	3,573	1.16
Total		309,355	100.00
Overall Land Use/Land Cover			
Developed		49%	
Undeveloped		51%	
Urban		45%	
Rural		55%	

Table 5: The Maryland State Land Use Land Cover (LULC) data for 2007.

SUBWATERSHED LAND COVER

A subwatershed level of analysis can provide a finer grain of detail and a deeper understanding of land use patterns in the county. The predominant existing land uses vary substantially across the county, as do factors affecting the potential for future growth.

The county is almost evenly divided into two subwatersheds at the state's 6-digit classification and nine subwatersheds at the 8-digit classification. Map 4 shows the locations of these subwatersheds and Table 6 shows the land area they encompass. Table 7 shows the variation in developed and undeveloped land area percentages across the different subwatersheds.

Although the 6-digit Potomac and Patuxent watersheds are approximately equal in size, the patterns of development vary. The Potomac watershed is more developed (55 percent) than the Patuxent (43 percent), which is consistent with overall countywide policies inherent in the General Plan. The Western Branch and Anacostia watersheds have the largest land areas in the 8-digit category and are more than 50 percent developed. Although it appears some growth is occurring in the Developed Tier in centers and along corridors, a high rate of development is occurring in the Developing Tier. For example, almost 90 percent of the Piscataway subwatershed is located in the Developing Tier, and almost half of it is currently developed. Similarly, 57 percent of the Upper Patuxent subwatershed is in the Developing Tier and 43 percent is in the Rural Tier, yet almost half of the entire watershed is already considered developed.

Reviews of land use statistics such as these are helpful in assessing the impact the current policies have on growth and whether they align with intended results. Based on these land use figures, half of the county is already considered developed, and five of the nine subwatersheds assessed are more than 50 percent developed. Development trends and consumption of land is pushing eastward, and eventually the subwatersheds in the rural tier will see a slow reduction in undeveloped land as forest and agriculture uses are exchanged for housing or other types of development without stronger policies and regulations.

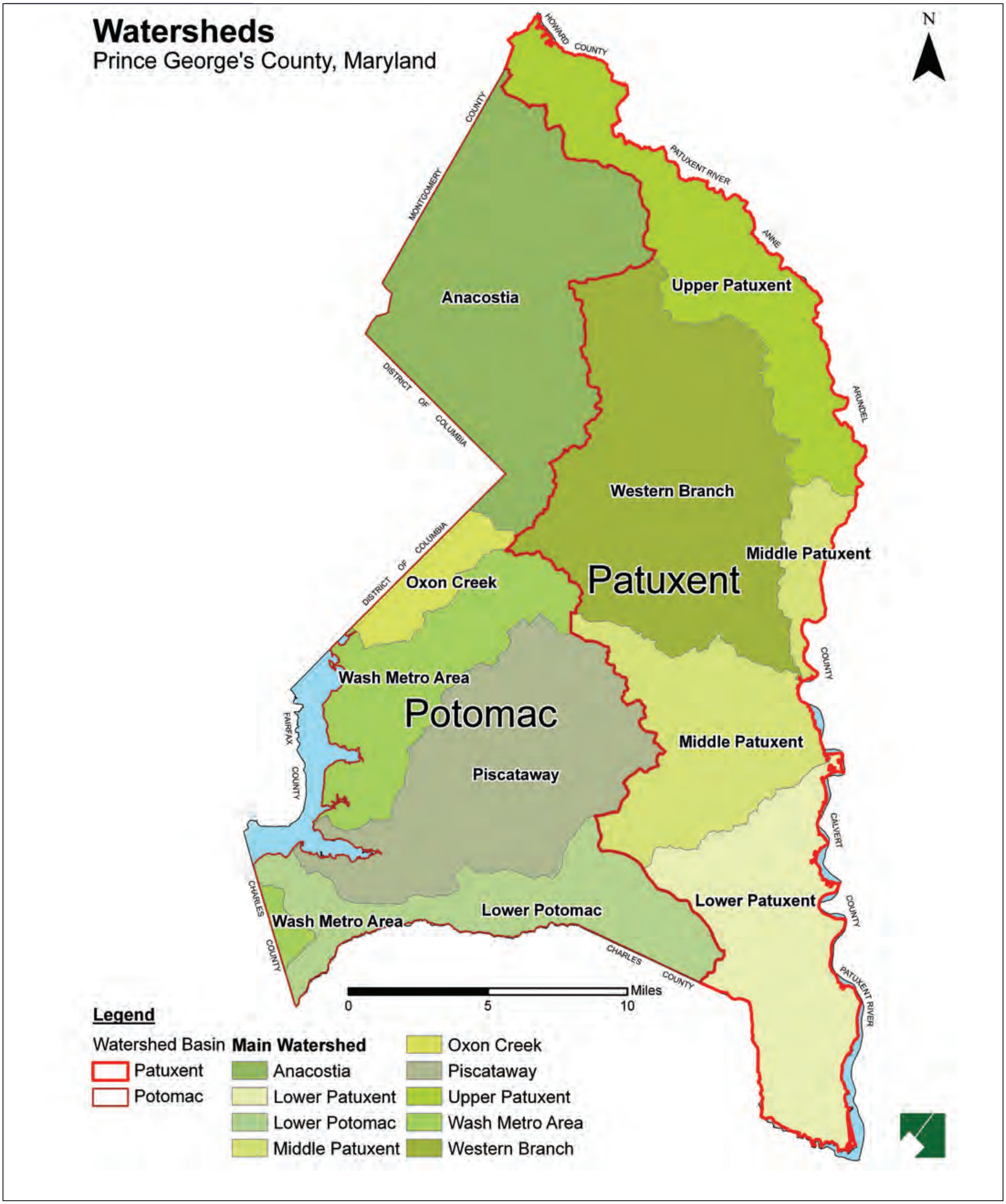
Subwatershed	Acres	Percent of County
Anacostia	54,396	18
Lower Patuxent	32,420	10
Lower Potomac	23,108	7
Middle Patuxent	33,454	11
Oxon Creek	6,509	2
Piscataway	42,933	14
Upper Patuxent	32,585	11
Wash Metro Area	24,674	8
Western Branch	59,302	19
Potomac	151,621	51
Patuxent	157,761	49
County	309,382	100

Table 6: Acres and percent of county land by watershed.
Source: 2007 MD State LULC Data and 2005 General Plan Update

Percentages shown relative to total land area of county.

Subwatershed	Developed Tier	Developing Tier	Rural Tier
Anacostia	62	22	16
Lower Patuxent	0	0	100
Lower Potomac	0	31	69
Middle Patuxent	0	28	72
Oxon Creek	100	0	0
Piscataway	1	90	10
Upper Patuxent	0	57	43
Wash Metro Area	36	57	7
Western Branch	9	85	6
Potomac	33	47	20
Patuxent	3	50	47
County	18	49	34

Table 7: Percentage of 8-digit subwatersheds per General Plan tiers.



Map 4: Watershed classifications within Prince George's County.

Because over half of the county is developed, a major focus must be placed on restoration of existing urbanized areas with a goal of reducing nonpoint source pollution. Opportunities exist to retrofit sites that were developed prior to the establishment of stormwater management regulations. Areas with high concentrations of development can become targets for restoration and for promoting sustainable infill and redevelopment projects. Subwatersheds with a high percentage of undeveloped land, on the other hand, hold significant potential for protecting and preserving existing natural systems so they can continue to serve their intended function, particularly where development is imminent.

Natural forest cover is good for the health of a watershed because of its inherent abilities to intercept rainwater, remove pollutants, promote surface water infiltration and groundwater recharge, and provide wildlife habitat. The Lower Potomac has the highest percentage (57 percent) of natural forested land, while the Lower Patuxent has the highest percentage of agricultural land in the county. Research and studies indicate that sustainable practices in timbering, agriculture, and mining can have positive impacts on water quality and reduce demands for water supply.

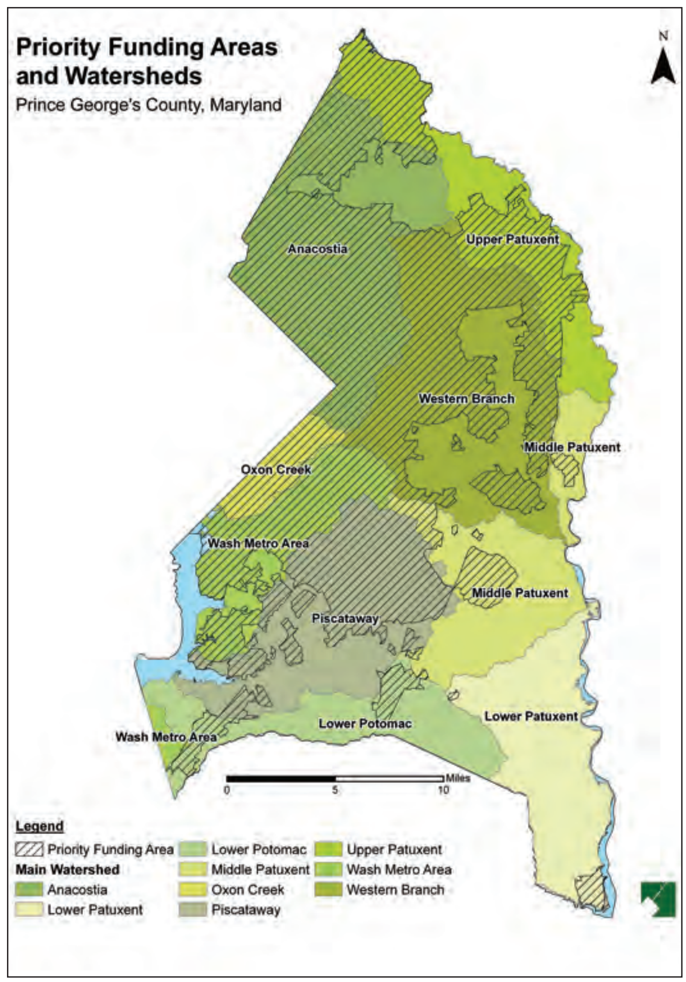
Forestry, agriculture, and mining are land and impact intensive uses that often have significant influences on ground and surface water. Combined, these uses account for more than 130,000 acres in the county. The benefits and challenges associated with production-related lands can vary tremendously depending upon the level of resources needed and the types of BMPs in place.

Recent growth trends in Prince George's County suggest a more aggressive management approach is needed to direct growth in a way that is truly protective of water resources. Designation of a countywide priority preservation area (PPA) is a promising step in the protection of areas that have countywide significance and contribute positively to protecting water resources. Development that recognizes the benefits and adheres to the principles for the preservation of a green infrastructure network, as identified in the Green Infrastructure Plan, is also a critical part of the solution suite that must be incorporated in order to meet the goals of the Water Resources Plan.

CONSERVATION PRIORITIES

Conservation strategies form a key element in the sustained success of any water resource protection policy. Providing adequate quantities of open and natural lands necessary to perform the ecological services that sustain the health and functionality of healthy environmental, social, and economic systems is the responsibility of Prince George's County's Planning Department, Planning Board, county agencies, and elected officials. Several regulatory requirements required by the state are in place to support this goal.

Priority Funding Areas—The state and county have designated priority funding areas (PFA) (Map 5), that consist of existing communities, municipalities, and places where local governments want state investment to support



Map 5: Priority funding areas per watershed.

future growth. The PFA boundaries were established before the county adopted the three tiers in the General Plan.

SB-276, passed in the 2009 Maryland legislative session, sets a statewide land use goal of increasing the current percentage of growth in Priority Funding Areas (PFAs) and decreasing the current percentage of growth outside of PFAs. SB-276 also requires local governments to develop a percentage goal toward achieving the statewide goal. The new annual report requirements under SB-276 will not be filed until July 1, 2011. Prince George's County should estimate its percentage of growth to be served by public water and sewer and if it will be sufficient to contribute to the achievement of the statewide land use goal. Statewide in Maryland, the current (as of 2006) percentage of growth in PFAs is 68 percent.[8]

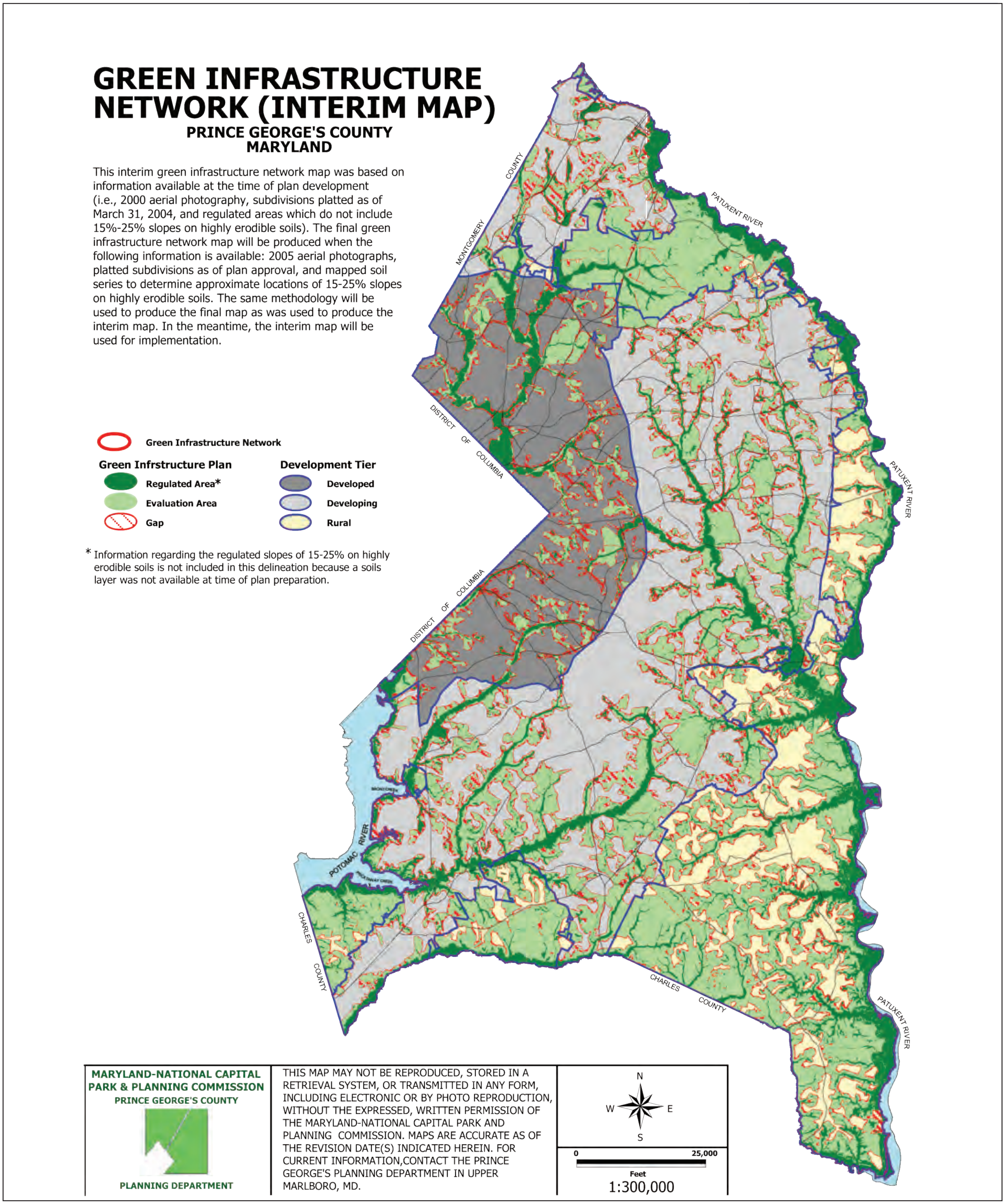
Priority Preservation Areas—The PPA is defined by the state in HB2-2006 as an area that is large enough to support profitable agricultural and forestry enterprises, that may or may not contain productive agricultural or forest soils, and that are governed by local policies established for the purpose of preventing development from encroaching or compromising these resources. This area is being preserved for the purpose of maintaining a stable land base appropriate for agricultural and forestry as well as for protection of wildlife and habitat and the scenic and historic vistas that characterize its rural character. Lands within the PPA are being preserved using a number of funding tools, including the purchase of development rights or agricultural easements and other types of easements. This effort is underway in the county.

The County's Green Infrastructure Plan—The plan identifies a potential green infrastructure network of approximately 167,000 acres or 54 percent of the county. About 32 percent of the network is categorized as regulated and includes features such as floodplains and steep slopes and is protected during the land development process. The remaining 68 percent comprises a variety of other environmentally sensitive features but is generally not regulated or protected. This remaining 68 percent represents a significant opportunity to target preservation for water quality improvement. See Map 6.

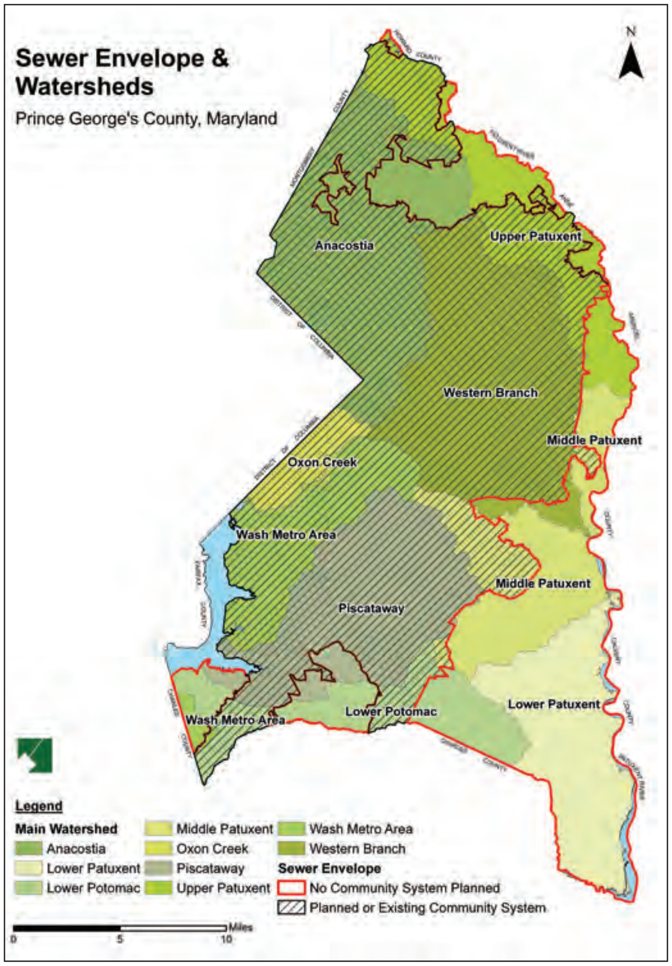
The 2008 Water and Sewer Plan—The 2008 *Water and Sewer Plan for Prince George's County* documents existing water resources and wastewater treatment capacities and identifies mechanisms needed to meet future demand. The sewer envelope, as depicted in Map 7, defines the boundary beyond which no community water and sewer facilities will be approved except in cases of public health and safety. Although the existing water and sewer boundaries established in the 2008 Water and Sewer Plan were established to conform to the General Plan Tier designations, excluding and/or limiting public water and sewer infrastructure in the Rural Tier, some discrepancies do exist. Notably some M-NCPPC properties inside the sewer envelope are not on a public wastewater system. This plan recommends the use of composting toilets at the public restroom facilities in order to eliminate private septic use within the sewer envelope.

Land use in relation to public water and sewer service, as well as individual wells and septic systems in the county, are also governed by this plan. Since 2000, the central and southern portions of the county outside the Beltway experienced increased population growth. This growth is expected to continue to 2030 with an increasing share of growth going to the southern portion of the county. After 2010, areas inside the Capital Beltway are expected to receive increased population growth with the promotion of infill development and

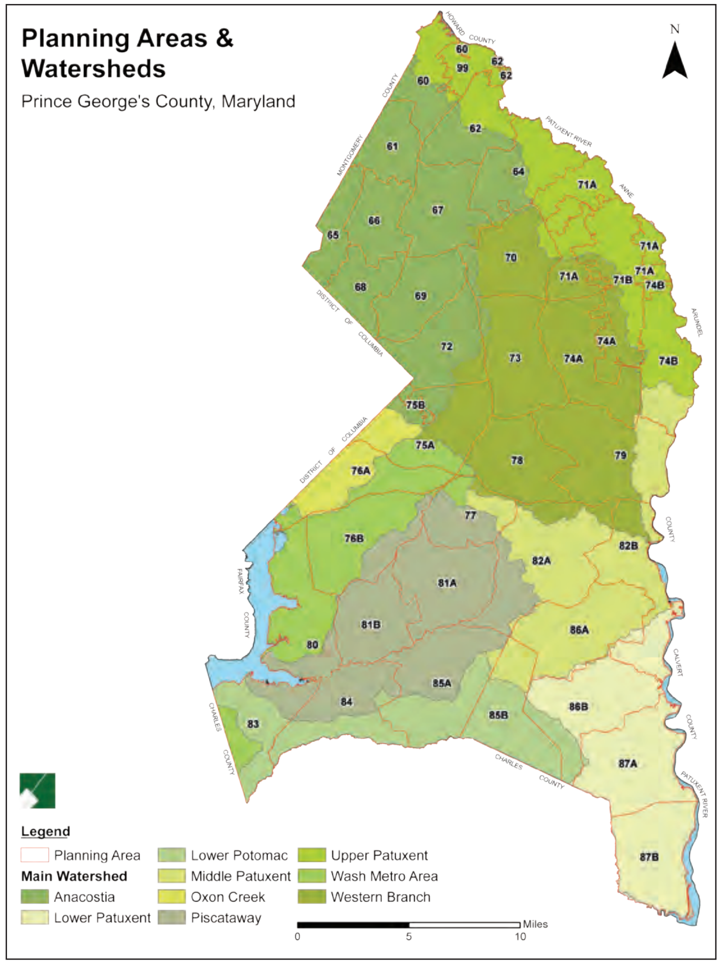
[8] http://www.mdp.state.md.us/msdc/PFA/Resid_Growth/ by_County/PFA_cnty_index.htm



Map 6: Countywide green infrastructure network.



Map 7: Sewer envelope per 2008 Water and Sewer Plan.



Map 8: Current planning areas per watershed.

redevelopment around Metro stations. Forecasted redevelopment around Metro stations is based on the General Plan goal of more intense development at transit stations. During the same time period, more growth is also expected in the northern part of the county. Factors such as transportation and job opportunities will play an important role in defining this growth within the county.

DEVELOPMENT CAPACITY

Growth in the county results in new developments to meet population and employment demands. The MWCOG/M-NCPPC 2030 population, employment and dwelling unit projections represent an anticipated level of growth to 2030. These projections, developed as Round 7.1, served as the basis for land use scenarios in the Water Resources Plan model with the totals serving as limiting parameters. Additional county projections have more recently been developed in Round 7.2A projecting growth until 2040.

The county's zoning code and subdivision ordinance regulates the amount of development that can occur—or the development capacity of the land under existing regulations. The limits within the zoning code in many cases do not represent the actual densities that have been constructed. There is a lack of consistency between the county's existing zoning categories and the type of development or land use that is built. For example, many areas that are zoned for high density are not being built to capacity. Additionally, many rural and forested areas of the county are zoned to permit low density residential development, making them vulnerable to suburban and exurban sprawl, especially in the Rural Tier. The development build-out of the county, when considering current zoning regulations, would result in a far greater number of households than is envisioned in the Round 7.1 and 7.2 Corporative Forecasts. Growth projections in the county are influenced by a number of factors and thoughtful planning is needed to ensure that existing regulations, including zoning, are considered in a comprehensive manner that integrates associated impacts on infrastructure, quality of life, and the environment (including water resources).

Growth trends to date indicate that low density land uses will continue to predominate despite untapped capacity in existing urban centers and corridors. Zoning build-out, were it to occur, would place severe stress not only on county infrastructure, but on the health of local waterways. More than 26,000 acres of the county land area is currently zoned R-A (Residential-Agricultural), permitting one dwelling unit per two acres. Approximately 61,000 additional acres are zoned O-S (Open Space), which permits one unit per five acres. These zoning categories are located almost entirely in the Rural Tier, and hold significant potential for residential development, well beyond what the General Plan recommends and in conflict with additional conservation and watershed planning goals.

Future land use plans in the county are developed as part of the master planning process at various scales. These plans serve as frameworks for growth and provide more specific guidance in support of the county's General Plan. There are seven subregion planning areas that are not currently aligned to watershed boundaries and, therefore, struggle to fully address the development suitability and capacity of the land from a watershed perspective.

An express benefit of the Water Resources Plan is to better integrate land use planning with overarching water supply and water quality considerations. In light of the potential for future state requirements for nutrient loading caps, proactive planning to restore and preserve water quality should be integrated with growth policies as they address the carrying capacity of watersheds and the assimilation of nutrients and should direct future development accordingly.

LAND USE SCENARIO DEVELOPMENT—THE MODEL

In order to explore the relationship between land use and water quality, development scenarios were formulated to accommodate anticipated population and employment growth in Prince George's County, as shown in the Round 7.1 Cooperative Forecasts. These scenarios were later integrated into a nonpoint source model to evaluate the impact these land use patterns will have on the county's watersheds.

Using the 2030 forecasts as constants, possible land use scenarios were developed applying development capacities and demonstrating alternative snapshots of county land use in 2030. Assuming the anticipated level of growth to be a constant, the scenarios explored how much undeveloped land must be converted to developed uses to accommodate the planned increase in population and employment by 2030. Scenarios were developed for the Potomac and Patuxent watersheds, along with more detailed analyses at the 8-digit level for the Western Branch and Piscataway watersheds. The latter two subwatersheds are of particular interest because of development pressures and existing county planning efforts in these areas.

Round 7.1 Cooperative Forecast for Prince George's County				
		2005	2030	Growth
Potomac	Population	570,708	655,566	+84,858
	Employment	245,258	361,439	+116,181
Patuxent	Population	282,175	337,305	+55,130
	Employment	102,627	156,949	+54,322

Table 8: MWCOG/M-NCPPC Growth Projections. Source: M-NCPPC

Land use scenarios were termed "trend" and "ideal," with trend scenarios representing the status quo, a continuation of existing land use patterns and continued development of greenfield as relatively low density residential neighborhoods. Ideal scenarios placed a greater emphasis on higher density and mixed-use development within the county's Developed Tier's designated centers and corridors. The ideal scenarios maintained ambitious infill and redevelopment targets to align with the objectives of the General Plan. In the development of both trend and ideal land use scenarios, new growth was purposely directed away from the designated green infrastructure network, including forests, wetlands, brush, and native grasslands. Because the ideal land use scenario places a higher emphasis on compact and mixed-use development to accommodate growth, maintaining green infrastructure land uses is generally more feasible and goals for green infrastructure conservation are more attainable than in the trend land use scenario. The drivers behind the ideal scenario included goals to incorporate: infill development, redevelopment in urban centers, and maximum green infrastructure conservation, acknowledging the known impacts associated with conversion of undeveloped land to developed uses. Infill, for purposes of this Water Resources Plan, represents densification of an existing land use, whereas redevelopment means conversion of one type of land use to another. The land use scenarios considered future land use and opportunities to achieve varying levels of green infrastructure preservation and protection while accommodating growth. The scenarios also took into consideration the unique size of, and existing land use pattern in, each subwatershed and the impacts these factors will have on recommendations for action. For example, because of the built-out development patterns that exist in the Potomac watershed, strategies will need to be developed that encourage the creation of green infrastructure and open space in urbanized areas through the redevelopment process and through stormwater management retrofits in older established communities. However, in the Patuxent watershed, as development pressure continues to push into the Rural Tier, strategies that permanently protect open space and conservation areas from development will be needed.

Comparison of existing (2007) land use by subwatershed with the hypothetical 2030 scenarios in the Water Resources Plan provided a summary of changes in land use, as well as a total of newly developed acreage. This information was fed into the nonpoint source model described in Technical Appendix I.

The ideal scenarios for both the Potomac and Patuxent watersheds indicated that the same level of population and employment growth could be accommodated by developing far fewer acres of new land. The same is true for the Western Branch and Piscataway subwatersheds. Subsequently, green infrastructure conservation targets were exceeded in nearly every watershed scenario by placing greater emphasis on compact mixed-use development.

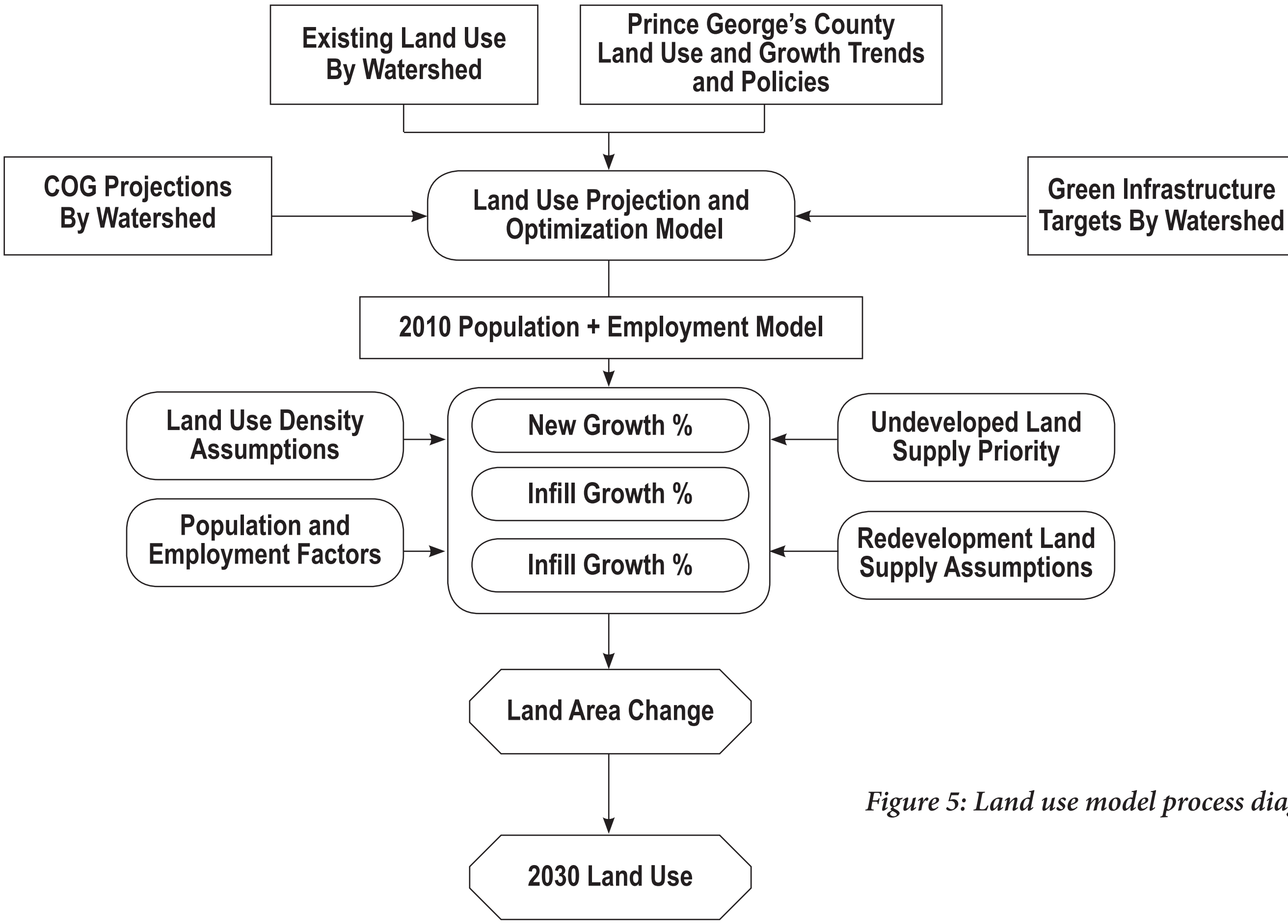


Figure 5: Land use model process diagram.

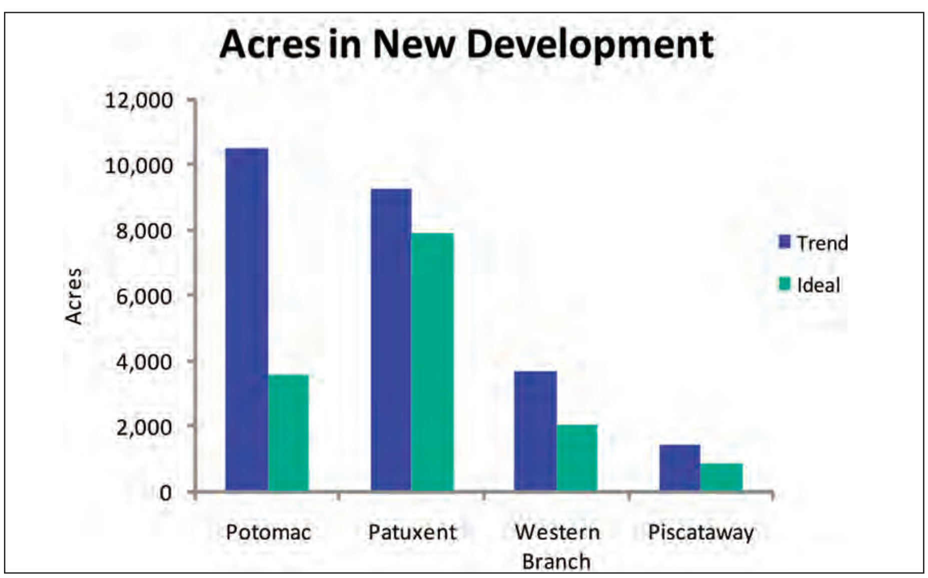


Figure 6: Newly developed acres per trend and ideal scenarios.

MODELING RESULTS

Although the differences in newly developed acres under the two scenarios are striking, it is important to place this in the context of the county as a whole. The total county land area is over 300,000 acres, and while the Potomac watershed ideal scenario results in nearly 7,000 fewer acres of new development as opposed to the trend scenario, this difference represents a relatively small percentage of the county's total land area.

The benefits of more compact development are many and varied, including reduced requirements for expanded infrastructure investments and conservation of forests, open space, and remaining viable agriculture lands. Although the amount of land required to meet new development to 2030 may seem to be unsubstantial in the context of the many thousands of acres developed to date, incremental changes nonetheless provide valuable benefits. Findings from the land use analysis emphasize the need for a multifaceted approach that addresses not only new development, but also urban redevelopment and changes to existing development.

SIGNIFICANCE OF DEVELOPMENT PATTERNS

The land use changes predicted by the future trend and ideal development scenarios will have a multitude of impacts to the water resources of Prince George's County. The increased densities reflected in the future ideal development scenario support Maryland's goals for preservation of land and green infrastructure and, compared to the more land-consumptive trend scenario, help lower the watersheds' percentage of impervious area by reducing the amount of paved roads and other infrastructure required to support the population accommodated within the development. Combined with environmentally sensitive design practices, compact or smart growth development can aid in the county's efforts to conserve natural drainage patterns and hydraulic conditions, reduce runoff volume, and improve groundwater recharge. In addition, the use of denser development preserves and protects natural resources and limits the quantity of soil disturbance, mass grading, and compaction, and therefore reduces the overall sediment and pollutant loads from land.

CHAPTER ISSUES SUMMARY

- Incorporating smart growth principles through compact development, balanced with open space and built green infrastructure, can help to reduce water-related infrastructure costs and contribute to water quality improvement.
- Both how and where development occurs in a watershed can help to mitigate negative water quality impacts.
- Future planning efforts should focus on preservation of the remaining natural areas in the Patuxent River watershed and on restoration of natural areas in the Potomac River watershed.
- Land use decisions should incorporate analysis and evaluation of data at a watershed scale.

POLICIES AND STRATEGIES

POLICY:

Incremental growth and development/redevelopment targets at multiple watershed levels considers the cumulative impacts of existing and future land use on water quality to ensure growth does not out-pace the assimilative capacity of county waterways.

STRATEGIES:

- Continue to update the county's land use classification database to ensure an accurate baseline is available to establish future land use and watershed protection decisions on the most current and accurate data available.
- Integrate nonpoint source modeling of land use into master plans at an appropriate watershed level in order to evaluate the impacts of existing and proposed land use, policy, and zoning changes.
- Continue to assess and evaluate the cumulative water quality impacts and benefits from development in watersheds.
- Maintain the growth targets within the General Plan to target new growth within the Developed Tier; direct growth in the Developing Tier to designated centers and corridors; and maintain little to no growth in the Rural Tier.
- Promote development and redevelopment of high density, mixed-use centers and corridors near transit stops in existing communities within the Developed Tier and within the centers and corridors of the Developing Tier.
- Develop programs and incentives that will maximize the preservation of forested land, which contributes the least amount of nutrient loading per acre.
- Develop programs and incentives to protect water resources that encourage urban redevelopment and retrofitting over greenfield development.
- Evaluate and utilize modeling results to inform growth policies, land use planning, regulatory requirements, and subsequent updates to the Water Resources Plan.
- Conduct a countywide study to identify opportunity sites for reforestation and stream valley parkland acquisition including both publicly and privately owned property.
- Establish and support transfer of development rights, purchase of development rights, and density transfers programs.

POLICY:

Sustainable development policies, goals, and criteria should be adopted and enforced to ensure the built environment contributes to improved water quality conditions.

STRATEGIES:

- Support and incorporate the protection of critical ecological areas such as wetlands, floodplains, and riparian corridors that serve to protect water quality, and ecosystem functions and provide natural filtering of stormwater, into master planning efforts.
- Develop an environmental checklist that requires developers to demonstrate that their development proposal is consistent with watershed goals and improves or does not damage, inclusive of mitigation, the overall health of all water resources, proximate to the development, within the watershed.

- Coordinate regional stormwater management opportunities with transit-oriented development and other mixed-use projects to the maximum extent practicable.
- Revise zoning and subdivision requirements to ensure built-in flexibility allowing reductions in road width requirements, parking requirements, and driveways with the intent to encourage compact development that:
  - Encourages common driveways
  - Establishes parking maximums
  - Permits shared driveways and walkways
  - Encourages or require shared parking
- Develop principles for open space design to guide development and ensure open space/habitat connectivity across sites and within and between watersheds.

V: WATERSHED PLANNING

Restoration and preservation policies for rivers, streams, tributaries, and wetlands begin with an identification of the existing conditions as issues and opportunities within watersheds, culminating in the development and implementation of effective solutions based on best management practices.

Water quality throughout Prince George's County has been impacted by the conversion of forest land to agricultural use over the past three centuries and to increasingly urbanized land over the past few decades. This conversion has resulted in degradation of streams, decline in forest and wetland habitats, and decreased opportunities to benefit from the recreational and economic opportunities that healthy water resources provide.

Prince George's County encompasses approximately 300,000 acres or five percent of the land area of Maryland and lies within the Chesapeake Bay watershed—the largest estuary in the United States and the third largest in the world. On May 12, 2009, President Barack Obama signed an executive order that recognizes the Chesapeake Bay as a national treasure and calls on the federal government to lead a renewed effort to restore and protect the nation's largest estuary and its watershed.[1]

WATERSHEDS

The term watershed is often applied to geographical areas of different sizes and scales. In general, the definition of a watershed is a geographic area in which water, sediments, and dissolved materials drain from higher elevations to a common low-lying outlet or basin discharging at a point on a larger stream, lake, underlying aquifer, or estuary.[2] The largest watershed management unit is called a basin, which is a large drainage area related to a lake, river, or estuary, such as the Chesapeake Bay. Within each basin is a group of subbasins that can extend over hundreds of square miles. Maryland contains 13 subbasins,

1 http://www.cbf.org/site/MessageViewer?em_id=38823.0

2 http://www.stormwaterauthority.org/glossary.aspx

ten of which fall within the Chesapeake Bay basin and correspond to ten tributary basins often referred to as Maryland's "6-digit" watersheds as defined by the Maryland Department of Natural Resources (DNR).

Subbasins contain groups of watersheds, which typically range from 20 to 100 square miles in size and are composed of groups of subwatersheds that cover an area of approximately ten square miles or less. Maryland DNR has defined 138 watersheds, which are often referred to as Maryland's "8-digit" watersheds. They collectively contain the approximately 1,100 subwatersheds referred to as "12-digit" watersheds.[3] Any of these units may be referred to as watersheds, and depending on their size and location, contain a number of land uses including forests, streams, and other natural areas; agricultural and natural resource areas; urban, suburban, and rural communities; roadways and other transportation systems; commercial development and industry; and schools, hospitals, government offices and other public facilities. Water resource issues including water supply, water quality, and habitat for fish and wildlife are closely linked and interdependent with human land uses. How land and water resources are used have impacts on the entire bay watershed.

IMPACTS OF LAND USE ON WATERSHEDS

Prince George's County's landscape has changed dramatically over the past century along with other areas of the Chesapeake Bay watershed, particularly in and around the metropolitan Washington area. As we have spread across the watershed and built away from existing infrastructure, we are using more land than we need. Between 1970 and 2000, the watershed's population increased by approximately eight percent. During this time, the average family size per household decreased but average home and lot sizes increased, and the amount of impervious surface area (roads, rooftops, parking lots, and other hardened or paved areas) increased by over 40 percent.[4] This type of low density residential and commercial growth has extended to larger geographic areas within the county, resulting in more development outside existing municipalities, cities, and town centers. Expansion requires additional infrastructure in the form of more schools, roads, and shopping centers that increases pavement and roof areas. Open areas between developed areas have gradually filled with new development, which reduces the quantity, quality, and connectivity of forests, riparian buffers, wetlands, and agricultural lands. Forests and stream buffers provide critical ecological services and act as buffers and filters within their watersheds; their loss causes increased pollution and degradation of land and water and, consequentially, quality of life for residents and visitors.

Population growth can result in economic benefits, but it can also have detrimental impacts on natural resources if not planned for carefully to control the use of, and avoid degradation to, water resources. Increasing populations require more domestic drinking water from available surface and groundwaters while increasing the amount of wastewater and stormwater pollutants (point and nonpoint source) that are discharged into the receiving waters. In addition, during and after the development process, the natural cycle of water is disrupted by alteration of the topography and the addition of impervious surfaces that result in reduced water infiltration through soils to groundwater and increased quantities and velocities of runoff carrying sediments and pollutants to

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[3] Center for Watershed Protection (CWP) User's Guide

[4] Ibid

streams. Stream flows are maintained through groundwater infiltration when rain falls on forested or naturally vegetated areas. After development, the increase in impervious surfaces, decrease of soil functionality, and decrease in available groundwater mean that stream flows receive more surface runoff and associated pollutants at generally higher temperatures.

The primary impacts to the hydrologic system from changes due to development include:

- Changes in stream flow—increased runoff volumes, increased peak discharges, greater runoff velocities, increased flooding, and lower dry weather stream flows.
- Changes in stream geometry—stream widening and down-cutting, loss of riparian tree cover, sedimentation in the channel, increased flood elevations, and disconnection of streams from adjacent wetlands and floodplains.
- Degradation of aquatic habitat—degradation of habitat structure, loss of pool-riffle structure, reduced stream base flows, increased temperatures, and reduced abundance and diversity of aquatic biota.
- Water quality impacts—reduced dissolved oxygen and increases in nutrient enrichment, microbial contamination, hydrocarbons (oils and grease), toxic materials (pesticides, metals, and organic contaminants), sedimentation, increased temperatures, and trash/debris.
- Impairment of drinking water supplies and increased cost of treatment.
- Declining values of fisheries, waterfront properties, and loss of recreational uses (boating, fishing, swimming, etc.).

LOCAL WATER QUALITY ISSUES

Degradation of the Chesapeake Bay has been recognized for decades, with excessive nutrient loading identified as a critical problem. Major sources of nutrients include urban, suburban, and agricultural runoff, failing septic systems and sewage treatment facilities, and atmospheric deposition from vehicles, power plants, and other sources. Excess nutrients cause algal blooms that reduce the amount of sunlight available to submerged aquatic vegetation. Decomposition of the algae depletes bottom waters of oxygen, which causes "dead zones" and harms aquatic living resources such as blue crabs and oysters. Other water quality issues affecting the bay include water pollution from sediments and chemicals, over-harvesting of aquatic resources, invasive plant and animal species, climate change, sea level rise, and tidal and nontidal wetland loss. Improved reduction and control of the pollutant sources, along with protection and restoration strategies, are needed in order to restore the bay to a fishable and swimmable condition.

As with many other tributaries to the bay, the majority of the watersheds of Prince George's County are degraded by nutrients, sediment and other pollutants. Based on the ecological health evaluated by the DNR Maryland Biological Stream Survey[5] program, the overall condition of Prince George's County streams is poor, particularly in the highly developed watersheds. High quality waters are found sparingly throughout the county but occur most frequently in and around areas of significant natural land. The majority of county streams are considered to be impaired.

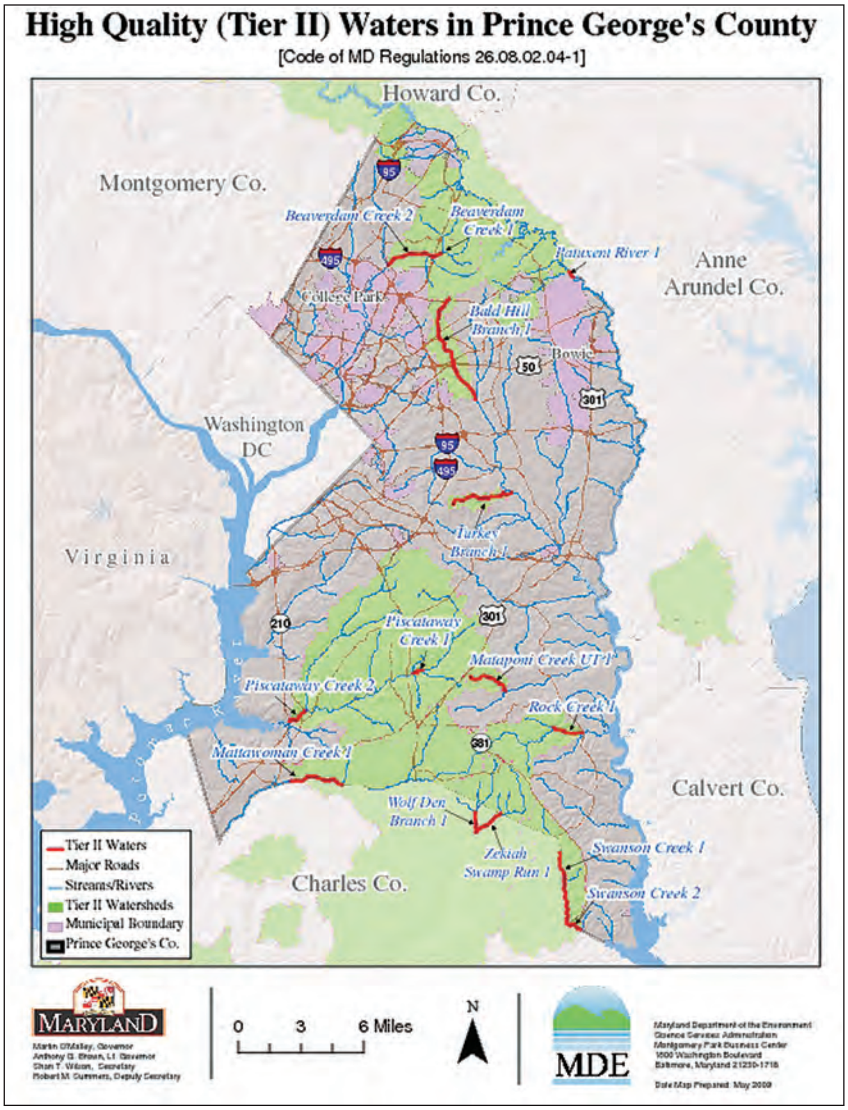
Down-cutting:
Downward or vertical erosion is a geological process that deepens the channel of a stream or valley by removing material from the stream's bed or the valley's floor. How fast down-cutting occurs depends on the stream's base level, which is the lowest point to which the stream can erode.

Sedimentation:
The deposition of soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants.

Pool:
A region of deeper slower-moving water with fine bed materials.

Ripple:
A region with coarse bed materials and shallow, fast moving water sometimes associated with whitewater. The pool-riffle is important in the cycling of nutrients in a stream.

5 http://www.dnr.state.md.us/streams/mbss/index.html



Map 9

Maryland's Antidegradation Policy follows the national model required by the U.S. Environmental Protection Agency (EPA). The antidegradation policies can be found in the Code of Maryland Regulations (COMAR) at 26.08.02.04, 04-1, and 04-2. Where a waterbody is designated Tier II water, based on a specific water quality measure, potential impacts to only that specific characteristic shall be subject to Tier II review. Before submitting application for a new discharge permit or major modification of an existing discharge permit, the discharger or applicant shall determine whether the receiving waterbody is Tier II.

Maryland has made a meaningful investment in upgrading the state's major wastewater treatment plants to significantly reduce the amount of nitrogen and phosphorus discharged to state streams each year; the county's facilities are planned to be upgraded by 2013. The primary challenge facing the county, in order to further reduce nutrient loading, remains the county's ability to adequately address loads from other sources such as septic systems and stormwater sources. Significant efforts have been made by Prince George's County, the State of Maryland, and the other states within the bay watershed resulting in water quality improvements in a number of the bay's tributaries. However, additional measures are required to improve the quality of the county's rivers and streams and to meet the goal of restoring and sustaining the Chesapeake Bay. The challenge of reducing nutrient pollution from land requires an extensive and diverse array of measures to address growth and management of a variety of land uses in rural and agricultural areas, suburban development, and urban communities. Significant inroads to achieve bay restoration requires increased federal coordination of the mitigation and protection efforts, resulting in new regulatory requirements to be implemented by all federal, state, and local agencies within the bay watershed, including Prince George's County. Because of the diverse range of issues required to improve water quality, a watershed framework is needed to facilitate and strengthen the county's ability to implement planning efforts and programs with numerous current and future watershed partners.

The *Approved Countywide Green Infrastructure Plan* specifies that the rating of each watershed should improve by at least one category by the year 2025, as opposed to simply maintaining the 2001 condition ratings as stated in the General Plan. Because the baseline information contained in the Green Infrastructure Plan is the only information available to date, no tracking information has been obtained.

Water Quality

Water quality ratings were reported in the Countywide Green Infrastructure Plan in 2005. These ratings were based on water sampling at specific sites around the county that are sampled every five years, with only one-fifth of the county sampled each year. In order to evaluate progress on water quality, based on the objectives in the General Plan and the Green Infrastructure Plan, water quality sampling data are needed. The Department of Environmental Resources discontinued the water sampling program in 2005. Staff is currently researching sources of state sampling data to ensure some continuity in the sampling and reporting processes.

WATERSHEDS AS A FRAMEWORK FOR PLANNING

Growth policy and planning decisions relative to land use are made by local governments for areas within their political boundaries. Comprehensive and smaller-scale planning is conducted within established and geographically defined planning areas to establish goals, programs, and policies to guide growth, development patterns, investment, infrastructure, preservation, and other aspects related to community and county needs and requirements. There is a strong background and basis for protecting water resources on a watershed basis. The Trust for Public Land and the National Association of Local Government Environmental Professionals has identified ten strategies for protecting and restoring water quality in communities as part of watershed management. These actions for advancing smart growth for clean water in your community are:

1. Connect the Issues of Land and Water
2. Establish a Greenprint[6] and a Blueprint for Your Community
3. Think and Act Like a Region
4. Revitalize Brownfields
5. Expand Urban and Community Forestry
6. Provide Incentives to Developers
7. Use GIS Technology
8. Partner with State Programs
9. Leverage New Resources
10. Use Watershed Management Approaches to Protect Land and Water Quality[7]

The benefits of watershed-based planning are well documented; it offers a framework for water resource planning that integrates the work of county departments that play a role in protecting and preserving water quality. Watershed-based planning also transcends political boundaries and considers all pollutants that drain to the watershed. The Center for Watershed Protection has identified the nine benefits associated with watershed-based planning described below.

Greenprint Maryland has a first in the nation web-enabled map showing the relative ecological importance of every parcel of land in the state.

6 http://www.greenprint.maryland.gov/

7 http://www.resourcesaver.com/file/toolmanager/CustomO93C337F42157.pdf

BENEFITS OF WATERSHED-BASED PLANNING

1. Provides comprehensive information needed for future planning and assessment of compliance with waste load allocations and other water quality requirements, such as nutrient loads, impervious cover estimates, water supply needs, and other information;
2. Provides a framework for identifying needs and prioritizing resources (e.g., staff and funding);
3. Protects wildlife habitat, improves natural resources, and improves quality of water for drinking and recreational use;
4. Controls flooding and protects property and public safety through restoration of riparian and wetland areas;
5. Provides educational opportunities for citizens to understand and become involved in affecting the interactions between development and natural resources management;
6. Provides a structure for communities to target conservation and development areas to maximize the efficiency and effectiveness of planning efforts;
7. Enables more efficient management of permitting programs;
8. Avoids development in sensitive areas, reduces mitigation requirements and reduces costs for environmental compliance and mitigation; and
9. Provides a framework for development and growth programs that are sustainable due to the environmental and economic benefits provided to the community.[8]

EPA has developed nine criteria for successful watershed-based planning and has established these as a baseline for issuing 319 grant funds for restoration and preservation projects. The nine elements of a comprehensive watershed plan are:

1. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.
2. An estimate of the load reductions expected for the management measures.
3. A description of the nonpoint source (NPS) management measures that will need to be implemented to achieve the load reductions and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
4. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.
5. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

[8] A User's Guide to Watershed Planning in Maryland, December 2005, published by: The Center for Watershed Protection

6. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.
7. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS total maximum daily loads (TMDLs) needs to be revised.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time.[9]

Watershed-based planning provides a framework that recognizes natural systems and acknowledges the impact of development on water resources, as well as the dependence of development on the ability of water resources to support or restrict future growth and economic success. Watershed-based planning considers the impacts of land use within an appropriately scaled watershed during the establishment of goals, programs, and policies for various planning areas. By identifying priority areas for preservation and development at the watershed level, communities can develop policies and incentives that accommodate growth and provide opportunities to protect and restore water resources, thereby allowing the community's public, economic, and environmental health to be sustained, according to EPA's *Protecting Water Resources with Smart Growth.*

A key aspect of watershed-based planning is the identification of planning area boundaries as part of a watershed system, requiring information related to public health requirements, development and economic needs, water quality or quantity issues, habitat requirements and challenges, infrastructure needs, and condition and extent of natural resources within the watershed. Therefore, watershed-based planning requires cooperation among a variety of stakeholders, such as government agencies, home and other property owners, environmental organizations, and a variety of industries, to establish the goals and objectives to make decisions. Finally, watershed-based planning requires the open and transparent exchange of information so that all stakeholders can make informed decisions. A shift to watershed-based planning requires development of new programs and systems that facilitate collection, storage, analysis, evaluation, and communication of information.

Watershed-based planning at the master plan level begins with the identification of existing condition; opportunities and constraints, and the eventual development of a plan that respects these conditions and provides strategies to incorporate and augment the natural system. The following is a table template to begin evaluate analysis of existing conditions in a watershed:

[9] http://www.epa.gov/npdes/pubs/watershed_techguidance.pdf

Watershed Characterization

Data		Current Conditions	Comments
Watershed	*percentage*		
6-Digit			
8-Digit			
12-Digit			
Tier	*percentage*		
Developed			
Developing			
Rural			
Land Use	*percentage*		
Urban Land			
Agricultural			
Industrial			
Institutional			
Easements			
Open Land			
Public Land			
Environmental	*percentage*		
Forest			
Floodplains			
Wetland			
Riparian Buffer			
Slopes			
Soils			
Habitat			
Biodiversity			
Stream Conditions			
Base Flow			
Flooding			

Synoptic Survey

Data		Current Conditions	Comments
Chemical Analysis			
Nutrients			
Sediments			
Trash			
Biological Survey			
Macro Invertebrates			
Fishes			
Habitat			

Stream Corridor Assessment

Data		Current Conditions	Comments
Physical Analysis			
Pipe Outfalls			
Erosion Sites			
Stream Buffers			
Fish Blockages			
Sewer Overflows			
Stream Base Flow			
Culverts			
Trash			
Channelization			
Unusual Conditions			

Table 9: Watershed Characterization Template

One of the key benefits of watershed planning is the opportunity for coordination and integration with related planning processes and programs. As with other areas of Maryland and the Chesapeake Bay watershed, Prince George's County faces a number of the water resource challenges, many of which are addressed by numerous groups and other local governments. The watershed management structure brings the multiple challenges and groups into an integrated and focused planning framework.

THE CHESAPEAKE BAY BASIN

The Chesapeake Bay basin encompasses 64,000 square miles of land and includes parts of six states (Maryland, Virginia, New York, Pennsylvania, West Virginia, and Delaware) and the District of Columbia; it was the nation's first estuary targeted by Congress for restoration and protection. Excessive nutrients have been long understood as a primary source of bay degradation, and cooperative watershed-wide efforts to restore the bay have been ongoing since the first Chesapeake Bay Agreement was signed in 1983. The efforts to protect and restore the bay are coordinated by the Chesapeake Bay Program, a regional partnership that includes the EPA; the U.S. Department of Agriculture; the states of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia; the District of Columbia; the Chesapeake Bay Commission; and advisory groups of citizens, scientists, and local government officials.

Coordinated efforts since the Chesapeake Bay Program began had resulted in reductions of nitrogen from 338 million pounds to 285 million pounds and phosphorus from 27.1 to 19.1 million pounds per year, but these were determined as insufficient to restore the bay to a healthy ecosystem. Computer models estimate the amount of nitrogen and phosphorus loads that can enter the bay and still achieve the water quality criteria. As a result, in March 2003, the bay partners agreed to reduce the amount of nutrients flowing into the bay and its rivers by more than twice as much as had been accomplished up to that time. The 1983 goals committed the six bay watershed states and the District of Columbia to reduce combined nitrogen from 285 million pounds to no more than 175 million pounds per year, and phosphorus from 19.1 million pounds to no more than 12.8 million pounds per year, by 2010. Each state and major subbasin was assigned nutrient reductions needed to meet the water quality goals. The states developed action plans called tributary strategies to define the activities that would be undertaken to meet the nutrient reduction goals in their tributaries. Maryland's allocations of the 1983 load caps are shown in Table 10.

Basin*	Nitrogen (million pounds/year)	Phosphorous (million pounds/year)	Sediments (million tons/year)
Patuxent	2.46	0.21	0.095
Potomac	11.81	1.04	0.364
* http://archive.chesapeakebay.net/pubs/waterqualitycriteria/nutrient_goals_by_state.pdf			

Table 10: Prince George's County 6-digit watershed nutrient goals.

The objective of the 1983 agreement was to achieve nutrient reduction goals by the year 2010 and preclude the need to develop a basinwide TMDL for these nutrients. TMDLs are regulated limits on the amount of a pollutant that can enter a waterbody from any source. However, despite the significant regional cooperation and over $5 billion invested in voluntary programs, the bay's nutrient reduction targets are not going to be met by the 2010 deadline. Therefore, a baywide TMDL will be issued by EPA in 2010 that will set regulatory-mandated nutrient limits for the bay, and these limits will be geographically refined into allocations for each subbasin within each state. The basins demonstrating the lowest water quality criteria will be assigned highest priority for nutrient reductions and, thus, they will receive the most stringent limits and vice versa. Additional programs will be developed to achieve further nutrient and sediment reductions to the Chesapeake Bay, but it has not yet been determined what these programs will be. Some possibilities include:

- Additional regulatory programs to increase controls on development.
- Additional permitting to reduce pollutants from urban and/or agricultural runoff.
- Federal, state and/or local policies and programs for nutrient caps.
- Incentive and/or penalty programs to enhance implementation of better land management techniques.
- Funding programs.
- Restructuring of planning and/or permitting authorities to provide more regional-scale decision making and land management authority.

In fall 2008, the Chesapeake Executive Council committed to set two-year measurable milestones to accelerate the rate of nutrient reduction from bay tributaries. The state's plans for actions through 2011 were released in May 2009 and described a number of programs and commitments including increased control of runoff from agriculture and urban/suburban lands through best management practices (BMPs). This unprecedented action will enhance water quality improvements and help the states prepare for the requirements that result from the basinwide TMDL to be issued by USEPA. Waste load allocations of the TMDL will likely be distributed within the state's basins and may be further refined in the form of small watershed allocations. These allocations and the efforts to increase the pace of nutrient reduction will require increased efforts from agencies and land management planners throughout the watershed, including local governments and landowners.

The U.S. Department of Agriculture (USDA) and EPA have announced additional measures for coordination and cooperation in prioritizing and implementing nutrient reduction activities in the Chesapeake Bay watershed (crop and pasture use account for 25 percent of land use in the bay watershed). USDA and EPA will focus nutrient reduction activities on septic systems, municipal wastewater, stormwater runoff from growing urban and suburban areas, and agricultural contributions from livestock, cropping, and forestry operations. Major environmental challenges affecting the Chesapeake Bay watershed include landscape change, toxic chemical contaminants, air pollution, sediment, and excess nutrients (primarily nitrogen and phosphorous).

The Watershed Assistance Collaborative is a partnership between MD DNR, Chesapeake Bay Trust, University of Maryland SeaGrant Extension, Environmental Finance Center, and others that provide funding and technical assistance for watershed restoration planning and design. The state has developed this service to connect local communities interested in undertaking comprehensive watershed restoration and protection projects to the people and programs that will help accomplish their goals.[10]

Training: The University of Maryland Environmental Finance Center, along with state partners, will provide hands-on training for communities interested in watershed targeting, planning, and financing strategies of long-term restoration efforts.

Resources: In partnership with the Chesapeake Bay Trust, the state will offer planning and design grants and technical assistance to meet the needs of local governments and communities preparing to undertake watershed management activities.

[10] http://www.ccgov.org/uploads/PublicWorks/WACOnePager2-09.pdf

Support: In partnership with the Maryland SeaGrant and the University of Maryland system, the state will to provide regional watershed specialists to provide implementation assistance focused on helping local and county watershed efforts.

PRINCE GEORGE'S COUNTY WATERSHEDS, TRIBUTARY TEAMS, AND WATERSHED RESTORATION ACTION STRATEGIES

Prince George's County is within the Patuxent River and Middle/Lower Potomac River subbasins of the Chesapeake Bay watershed. For the purposes of this plan, the Patuxent and Potomac River subbasins are referred to as Prince George's County's two "6-digit" watersheds. These subbasins are further subdivided into twelve "8-digit" watersheds defined by Maryland MDE and shown in Map 4, page 46. Watershed plans provide a mechanism for identifying local opportunities and needs for implementing the tributary strategy goals for nitrogen (N), phosphorous (P), and sediments. The goals of the tributary strategy should be considered as watershed plans are developed. Where appropriate, local watershed plans should include actions as recommended by the local tributary team. The tributary teams may also be a source of community advocacy to encourage local watershed groups' support for plan creation and implementation.

The Chesapeake Bay signatories committed to work with local governments, community groups, and watershed organizations to develop and implement locally supported watershed management plans in two-thirds of the bay watershed by 2010. These plans address the protection, conservation, and restoration of stream corridors, riparian forest buffers, and wetlands for the purposes of improving habitat and water quality, with collateral benefits for optimizing stream flow and water supply. The DNR-supported Watershed Restoration Action Strategy (WRAS) Program was developed to help coordinate local government efforts for the steady development of five new WRASs each year.

POTOMAC RIVER BASIN

Prince George's County lies within both the middle and lower portions of the Potomac River Basin. The Potomac River watershed drains approximately 14,670 square miles of land, covering four states. Major bodies of water in the area include the Potomac, Anacostia, Cacapon, Monocacy, the North Branch, the South Branch, the Occoquan, and the Shenandoah Rivers. The Potomac River flows over 383 miles from Fairfax Stone, West Virginia, to Point Lookout, Maryland. Major cities in the watershed include Washington, D.C., Bethesda, Cumberland, Frederick, Gettysburg, and Alexandria. Forest is the major land use, followed by actively farmed agriculture. The 2000 census population of the watershed was approximately 5.35 million residents, with 3.7 million residing in Washington, D.C. The Potomac River watershed received a moderate–poor ecological health score in the 2008 Ecocheck report card,[11] which is prepared by a partnership program between the National Oceanic and Atmospheric Administration's Chesapeake Bay Program Office and the Integration and Application Network (IAN) at the University of Maryland Center for Environmental Sciences (UMCES).

The Middle Potomac River Basin is the most urbanized of the three Potomac basins. It is highly populated with over half of the watershed developed. Point sources (municipal wastewater treatment plants and industrial outputs) contribute most of the nitrogen, and urban runoff contributes most of the phosphorus and sediment loads. The Blue Plains Wastewater Treatment Plant has flows up to 370 million gallons per day. Blue

Potomac River:
2008 moderate–poor ecosystem health. Highest score in the past five years due to improved water clarity and phytoplankton and benthic community condition.

Water quality:
Water quality index in 2008 was 45 percent (moderate). This is a slight improvement in water clarity compared to the past few years. The dissolved oxygen score in 2008 (78 percent—good) was consistent with scores over the past 20 years, which have ranged between 69 to 81 percent.

Biotic indicators:
Benthic and phytoplankton community condition improved in 2008, leading to the highest Biotic Index scores since 1993. Aquatic grass score has been declining for the past three years.

[11] http://www.eco-check.org/reportcard/chesapeake/2008/summaries/potomac_river/

Plains began implementing biological nutrient removal in October 1996 and was completely on-line by 2000, helping to reduce nitrogen loadings from this plant.[12] The Middle Potomac River basin drains approximately 610 miles of land, including portions of Montgomery and Prince George's County in Maryland. Approximately 130,000 acres of Prince George's County lie within the Middle Potomac basin; all of these within the Coastal Plain. The larger water bodies include Piscataway Creek and the Anacostia River. Small portions of the Middle Potomac watershed contain high quality waters that meet water quality criteria (Tier II),[13] including small areas within the Piscataway and nontidal Anacostia subwatersheds. Tier II waters trigger the state antidegradation requirements. Maryland's antidegradation policy has been promulgated in three regulations: COMAR 26.08.02.04 sets out the policy itself; COMAR 26.08.02.04-1 provides for implementation of Tier II (high quality waters) of the antidegradation policy; and COMAR 26.08.02.04-2 describes Tier III (outstanding national resource waters), the highest quality. No Tier III waters have been designated at this time.

However, many other areas of the Middle Potomac River basin watersheds have been identified as 303d impaired. Independent of the Chesapeake Bay basinwide TMDL that will be established in 2010 as described earlier in this section, TMDLs have previously been established to address water quality issues within these individual tributaries for various pollutant sources, including limits on polychlorinated biphenyls (PCB) in fish within the Potomac River upper tidal watershed, fecal coliform from nonpoint source runoff in Piscataway Creek, and a number of pollutants causing impairments in the tidal and nontidal portions of the Anacostia River.

Table 11: Prince George's County 303d Impaired Waters*

Tributary Basin or Other Name	Impairments
Patuxent River Area	
Western Branch	Dissolved oxygen due to wastewater treatment plant effluent
Patuxent River Middle	Biological, sediment, total phosphorus, total nitrogen, metals
Patuxent River Lower	Biological, sediment, total phosphorus, total nitrogen
Potomac River Middle/Lower	
Potomac River Upper Tidal	PCB in fish from upstream sources
Piscataway Creek	Fecal coliform from nonpoint sources
Mattawoman Creek	Total phosphorus, total nitrogen
Anacostia River Nontidal	PCB from upstream sources, fecal coliform from nonpoint sources, total suspended solids from urban run-off, impaired for trash (debris/floatables/trash)
Anacostia River Tidal	PCB in fish from upstream sources, fecal coliform from pet waste, upstream sources
* Maryland's 2008 Draft Integrated Report	

12 http://www.dnr.state.md.us/Bay/pdfs/MidPotBasinSum8505FINAL07.pdf

13 http://www.mde.state.md.us/assets/document/hb1141/prince_georges/PrinceGeorges_County.pdf

Middle Potomac Tributary Team—The mission of the Middle Potomac Tributary Team is to reduce nutrient and sediment inputs and to restore habitat in the Middle Potomac watershed through community participation. The primary focus of the team in 2004 was the revision of the state tributary strategy, particularly wastewater, urban stormwater, agriculture, and outreach and education aspects. The team continues to work closely with state and local governments to spur discussion and actions that will address the complex water quality issues that dominate the very urban nature of the Middle Potomac basin. These issues include multijurisdictional management of Potomac basin waterways, the Blue Plains Sewage Treatment Plant, urban stormwater retrofits, and highly impervious watersheds that characterize the Rock Creek and Anacostia Rivers. The team's perspective is that even though load allocations are not officially set, there are numerous areas where the tributary teams can make policy recommendations and help frame the issues regarding the format and content of the revised tributary strategies.

Potomac Riverkeeper[14]—The Potomac Riverkeeper, Inc. (PRK) is a nonprofit organization that protects and restores water quality in the Potomac River and its tributaries through community action and enforcement. The goal is to spread awareness of the pollution threatening the rivers and streams of the Potomac watershed and to initiate and support clean-up efforts. The Potomac River watershed is home to cities, farms, and forests. Its geographical diversity is matched only by its diversity of wildlife. PRK, through enforcement and community actions, is working to maintain this diversity and keep the watershed pristine and beautiful.

Anacostia River—The Anacostia River flows from the Maryland suburbs of Washington, D.C., to its mouth at the Potomac River near downtown Washington. The Anacostia River watershed comprises a 173-square-mile drainage area, contains 13 subwatersheds with a drainage area that is 49 percent in Prince George's County, Maryland, 34 percent in Montgomery County, Maryland, and 17 percent in the District of Columbia. The watershed is composed of three main drainage areas—the Northeast Branch, the Northwest Branch, and the tidal river. The main channel of the Anacostia, extending from the confluence of its two largest tributaries, the Northwest Branch and the Northeast Branch in Bladensburg, Maryland, drains 70 percent of the Anacostia watershed and forms the tidal Anacostia River. The Anacostia flows 8.4 miles through Maryland and Washington, D.C., until it meets the Potomac River at Hains Point. The other two major tributaries of the Anacostia, Lower Beaverdam Creek and Watts Branch, drain highly urbanized areas in Prince George's County and the District. The main channel of the Anacostia is an estuary with a variation in water level of approximately three feet over a tidal cycle. The Anacostia watershed is home to over 800,000 residents of Maryland and Washington, D.C., and includes some of the most economically distressed areas in the metropolitan region. The land uses include the highly urbanized areas of the District, old and newly developing suburban neighborhoods in the surrounding metropolitan areas, croplands and pastures at the USDA's Beltsville Agricultural Research Center, and forested parklands throughout the watershed.

Wetland loss, deforestation, and urbanization have significantly degraded the water quality of the Anacostia River and compromised its biological integrity. About 23 percent of the land area of the watershed is impervious. Urbanization is particularly dense on the east and west banks of the tidal river in Washington, D.C., where more than 70 percent of the land is covered by impervious surfaces.

Headwater Streams:
The small swales, creeks, and streams that are the origin of most rivers. These small streams join together to form larger streams and rivers or run directly into larger streams and lakes.

[14] http://www.potomacriverkeeper.org/cms/index.php

Lower Potomac—The Lower Potomac watershed drains approximately 730 square miles of Charles and St. Mary's Counties, and a small portion of Prince George's County (approximately 23,000 acres) within the headwaters of Mattawoman Creek and Zekiah Swamp. The area is characterized by forest with some development and agriculture, but it is experiencing growth faster than any of the other major watersheds in the state. The basin has six major wastewater treatment plants, none of which is located in Prince George's County.

Based on the results of the Chesapeake Bay watershed model, the most significant contributor of nitrogen and phosphorus in the Lower Potomac River basin was actively farmed agriculture, followed by urban sources and point sources. A portion of the Mattawoman Creek watershed in the Lower Potomac River basin has been identified as impaired with a TMDL established for nutrients (nitrogen and phosphorus) to address water quality issues by limiting the quantities of nutrients that can enter this tributary from all sources.

Lower Potomac Tributary Team—The Lower Potomac Tributary Team has a strong citizen base, representatives of Charles, St. Mary's and Prince George's Counties and the State of Maryland, local government, and the business community. The team's mission is to reduce nitrogen and sediment inputs and to restore habitat through community participation. Managing agricultural run-off and reducing the impacts from the increasing amount of developed lands are among the team's highest priorities.

PATUXENT RIVER BASIN

The Patuxent River basin encompasses 930 square miles of land in portions of St. Mary's, Calvert, Charles, Anne Arundel, Prince George's, Howard, and Montgomery Counties, and is the largest river completely in Maryland. The Patuxent River is also one of the most monitored and modeled rivers of its size in the world. The upper watershed includes trout streams and a dual reservoir system, then becomes a large tidal fresh water ecosystem, and continues as a productive tidal estuary until it empties into the Chesapeake Bay in Southern Maryland.

Over half of Prince George's land area, or approximately 158,000 acres, lies within the Patuxent River basin, with all but a few hundred acres within the Coastal Plain. Three main streams drain into the Patuxent River: the Little Patuxent, which drains much of the newly urbanized area of Columbia in Howard County, Maryland; the Middle Patuxent, which drains agricultural lands and the outer suburban areas of Columbia in the southern part of its watershed; and the upper Patuxent River, which has remained primarily agricultural.

Land use in the watershed is very mixed with significant forest, urban and agriculture development. The watershed has experienced significant suburban development in the past few decades. Columbia and Laurel have developed along the I-95 corridor, which bisects the upper half of the watershed. The 2000 census population for the watershed was 618,000 people.[15] Based on the results of the Chesapeake Bay watershed model, the most significant contributor of nitrogen in the Patuxent River basin was urban sources, followed by agriculture, point sources, and septic. For phosphorus, the largest contributor was urban sources, followed by point sources and agriculture. The Patuxent River watershed received a very poor ecological health score in the 2008 Ecocheck report card.[16] The lowest scores were received in the lower portion of the Patuxent estuary that drains Charles and St. Mary's Counties, with the middle portion draining Prince George's County showing some improvement over previous assessments.

[15] Maryland Tributary Strategy Patuxent River Basin Summary Report for 1985-2005 Data August 2007

[16] http://www.eco-check.org/reportcard/chesapeake/2008/

Patuxent River: 2008
Very poor ecosystem health. Most health indicators remained consistently poor over the past 20 years. Benthic community condition has declined in the 2000s compared to the late 1990s.

Water Quality:
In 2008, the score was 29 percent and largely attributable to very poor water clarity and chlorophyll a conditions. The water quality index has remained consistently poor, ranging between 24 and 40 percent over the past 20 years.

Biotic Indicators:
The aquatic grass and phytoplankton index scores in 2008 were very poor (12 and 11 percent, respectively), changing little from recent years. The benthic community score remains in poor condition since significant decline in 2000.

Table 12: Patuxent River Subwatersheds Quality Rating

Indicator Group	Subwatershed Quality Rating			
	Good	Fair	Poor	Very Poor
Water Quality Conditions	<5	5–11	12–17	>17
Living Resource Conditions	<18	18–39	39–65	>65
Habitat Conditions	<38	38–83	84–128	>128
Landscape Conditions	<33	33–72	73–111	>111
Hydrologic Conditions	<8	8–17	18–26	>26
OVERALL BCS	<101	101–220	220–345	>345

Several subwatersheds, as shown in Table 12, have high quality waters that meet water quality criteria, including small areas within the Western Branch, upper Patuxent River, middle Patuxent River, lower Patuxent River, and Zekiah Swamp watersheds. However, impairments have been identified for the Lower and Middle Patuxent River basins and nutrient and biological impairment limits will be set through establishment of TMDLs for both of these watersheds. In addition, TMDLs will be established for sediments and metals in the Middle Patuxent River basin. The Western Branch watershed has also been identified as impaired with a TMDL established for biological oxygen demand to address water quality issues in this tributary.

Patuxent River Commission—The Patuxent River Commission (PRC) developed the Patuxent River Policy Plan, a land management strategy to protect the river and its watershed, which was originally prepared in 1984 by representatives from the state and seven counties in the watershed and functions as the Patuxent River Tributary Team. The original 1984 Patuxent River Policy Plan established 20 goals that provided a broad vision to restore and maintain water quality, habitat, and groundwater and surface water supplies, and a high quality of life along the Patuxent River and its tributaries. The policy plan included recommendations to control nonpoint source pollution, including establishment of a primary management area along the river and its tributaries that created conglomerate vegetative buffers requirements to promote connectivity; development of programs for BMPs; survey and identification of major nonpoint pollution sites; development of state cost-share programs to aid local governments for retrofit of existing development; accommodation of future development to minimize water quality impacts and maximize existing development opportunities; protection of existing forest cover and reforestation of areas important for water quality protection; preservation of prime and productive agricultural land; management of sand and gravel extraction to avoid damage to the river; and adoption of an annual action program to implement the strategies. A 1997 update to the policy plan recommended the following actions:

- Implement a comprehensive watershed management approach to control all sources of pollution and resource degradation.
- Continue to restore, improve, and protect the habitat function of aquatic and terrestrial living resources.

- Concentrate new development in and around existing developed areas and population centers while protecting rural lands and the associated agricultural economy.
- Enhance the environmental quality and community design in new and existing communities.
- Develop a sense of stewardship for the Patuxent River and its watershed through increased public education and participation programs.
- Provide sufficient funding and staff to support continued programs, policies, and projects to meet the ten recommendations of the policy plan.

Since the 1997 update, the PRC is working with state agencies and stakeholders to develop and implement the tributary nutrient and sediment reduction strategy, continuing to partner with local groups for the preservation and restoration of riparian buffers, and working on adoption of updates to the policy plan.

Patuxent Riverkeeper—In coordination other interested groups and individuals, the Patuxent Riverkeeper prepared the Patuxent 20/20 report to outline specific policies and action strategies to forward the protection and restoration of the Patuxent River. The report identifies the primary sources of pollution in the Patuxent and the short- and long-term steps required to address them. Patuxent 20/20 was developed by integrating existing studies and reports on the river into a single document. It provides a brief overview of the Patuxent River, including a characterization of the watershed, the water quality challenges it faces, a history of restoration efforts, and an examination of the barriers to its restoration. Patuxent 20/20 then delves into the actions needed to restore the river, analyzing the steps needed to address growth and development, land preservation, point sources, agriculture, air deposition, and management of the resource.[17]

IMPLEMENTATION EFFORTS, WATERSHED ASSESSMENTS, AND WATERSHED RESTORATION ACTION STRATEGIES

The Maryland DNR, in partnership with the Prince George's County DER, completed watershed restoration action strategies for the Upper Patuxent Watershed (2002), the Western Branch Watershed (2003) and the Anacostia River Basin (2006). The Maryland DNR supports the Watershed Restoration Action Strategy (WRAS) Program has coordinated the steady development of five new WRASs each year with others prepared by local governments.

The WRAS Program is a multiyear, multiagency program focused on the comprehensive design and implementation of water quality and habitat improvement activities on a local watershed scale. The WRAS Program builds upon the 1998 Federal Clean Water Action Plan, which proposed an expanded collaborative effort by state, federal, and local governments, the private sector, and the public to address all aspects of watershed health. The Maryland Coastal Program and the state's Nonpoint Source Pollution Control Program (Clean Water Act §319) jointly fund the development and implementation of WRASs.

A completed WRAS is a work plan based on an assessment of natural resource conditions and scientific monitoring data, including:

[17] www.paxriverkeeper.org/patuxent-2020-report/05/03/2009

- A **Characterization Report** that includes a summary of readily available natural resource information on water quality, land use and cover, living resources, and habitat.
- A **Synoptic Survey** conducted by the Maryland Department of Natural Resources that contains both a water chemistry analysis (nutrients, temperature, conductivity, pH), and a biological survey (macro invertebrates, fishes, habitat) on 30–80 sites along stream corridors within the watershed.
- A **Stream Corridor Assessment** that examines and assesses 100 miles of streams within the watershed for problems such as pipe outfalls, erosion sites, lack of buffers, fish passage blockages, sewer outfalls, or unusual conditions. Each site is rated for accessibility, severity, and correctability.[18]

The Countywide Green Infrastructure Plan recommends that the results of these studies be used to address water quality concerns during the development review process. Currently the data have been stored in a database and are being used as individual applications are submitted that could significantly affect water quality. DER is developing a countywide database that contains all of the identified sites so that it can be used during the land development process to identify mitigation sites.[19]

A comprehensive WRAS strategy includes the following:

- A watershedwide assessment of existing and anticipated future conditions that significantly affect water quality and natural resources. The assessment should identify the principal sources and relative contributions of point and nonpoint source pollution; major sources of habitat loss; and threats to drinking water, aquatic life, and natural resources critical to maintaining the integrity of the watershed.
- Measurable environmental and programmatic goals and a timeframe for achieving significant milestones/accomplishments.
- A public involvement process that provides mechanisms for informing the public and incorporating their concerns and priorities.
- A process for targeting individual projects for preventive or remedial activities (e.g., identifying appropriate areas to implement BMPs and buffer strips that will maximize the achievement of clean water and other natural resource goals.
- A water quality and natural resource monitoring element that utilizes existing and supplemental data sources to document current and future changes occurring in the watershed.
- A process to routinely evaluate the effectiveness of projects and/or systems and their progress toward achieving environmental and programmatic goals.[20]

Anacostia Watershed Restoration Action Strategy—The state's long-term objective is to have WRASs that are comprehensive and address all aspects of watershed condition and water quality, including public health, aquatic living resources, physical habitat, and the landscape. A WRAS will provide information and guidance that will help the public, watershed organizations, and federal, state and local agencies focus their staff and monies in areas and on issues important to the public and that will result in measurable

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[18] http://www.dnr.state.md.us/Bay/czm/wras_06_04.pdf

[19] http://www.pgplanning.org/Resources/Publications/General_Plan_Growth_Policy_Update__Prince_George_s_County.htm

[20] http://www.dnr.state.md.us/cwap/

environmental improvement. The strategies may be drawn from existing assessments, plans and programs, such as a county's General Plan and Green Infrastructure Plan, stormwater and sewer plans, capital budgets, greenways and open space plans, watershed stewardship programs, site design standards/BMPs, erosion and sediment control plans, soil conservation district watershed work plans, and other efforts.

Prince George's County received a federal grant to prepare a WRAS for its portion of the Anacostia River watershed. As part of the WRAS project, the Maryland DNR provided technical assistance, including preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (uses field data to catalog issues and rate severity) and a synoptic survey (analyzes benthic macro invertebrates, fish, and water samples with a focus on nutrients). The Anacostia WRAS was developed by considering the information obtained through DNR's technical assistance. The WRAS includes: a goal aimed at protecting, preserving, and restoring habitat and water quality; a description of the stakeholder process; a discussion of opportunities, concerns, and challenges; and a description of natural resource management objectives.

The Maryland Department of the Environment (MDE) has identified the Anacostia as impaired by nutrients, sediments, fecal bacteria, impacts to biological communities in nontidal waters, toxins including PCBs and heptachlor epoxide, trash/debris, and PCBs in fish tissue in tidal waters. The District of Columbia has identified the Anacostia as impaired by biochemical oxygen demand, bacteria, organics, metals, total suspended solids, and oil and grease. TMDLs have been developed for the Anacostia River for these impairments and identify the baseline loads, the overall TMDL loading caps, and the percent reductions from the baseline loads required in order to attain water quality standards set by Maryland and the District of Columbia for the Anacostia.

The Anacostia Watershed Agreement was signed in 1987 and ushered in formal cooperation between various government agencies for restoration efforts. The agreement also resulted in the creation of the Anacostia Watershed Restoration Committee (AWRC). Progress toward achieving the goals enumerated below is tracked by restoration benchmarks set forth in the agreement. The following six major restoration goals were developed for the watershed as part of the agreement:

Goal 1: Dramatically reduce pollutant loads, such as sediment, toxins, CSOs, other nonpoint inputs and trash, delivered to the tidal river and its tributaries to meet water quality standards and goals.

Goal 2: Protect and restore the ecological integrity of the Anacostia River and its streams to enhance aquatic diversity, increase recreational use, and provide for a quality urban fishery.

Goal 3: Restore the natural range of resident and anadromous fish to historical limits.

Goal 4: Increase the natural filtering capacity and habitat diversity of the watershed by sharply increasing the acreage and quality of tidal and nontidal wetlands.

Goal 5: Protect and expand forest cover throughout the watershed and create a contiguous riparian forest buffer adjacent to its streams, wetlands, and river.

Goal 6: Increase citizen and private awareness of their vital role in both the cleanup and economic revitalization of the watershed, and increase volunteer and public/private partnership participation in watershed restoration activities.

Biological integrity **is commonly defined as "the ability to support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to those of natural habitats within a region." (Karr, J. R. and D. R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5: 55-68).**

Biological integrity **is equated with pristine conditions, or those conditions with no or minimal disturbance.**

In 2006, the Council of Governments Board adopted a resolution to the agreement that established a new Anacostia Watershed Restoration Partnership (AWRP). The AWRP aided in the development of the 2008 Anacostia Restoration Plan (ARP) Interim Report Framework, which serves as part of the planning effort to produce a ten-year plan for environmental and ecological restoration within the entire Anacostia River watershed and to enhance collaboration among all stakeholders. The ARP report uses the Sligo Creek subwatershed as a case study to demonstrate the methods and analyses that will be used to complete the study. As part of this effort, and inventory of various restoration projects (e.g., stormwater management facility retrofits, stream restoration, wetland creation, fish blockage removal or modification) were identified to improve the current condition of the watershed. A follow-up study will apply the method used for the Sligo Creek subwatershed to the remaining 13 subwatersheds and the tidal river reach in the Anacostia River basin, and a combined plan will be released for the entire watershed. The final ARP will serve as a ten-year restoration plan and set the framework for long-term restoration within the watershed.

Upper Patuxent River Watershed Action Strategy—The Upper Patuxent River WRAS was completed in 2003 to characterize and define priorities for actions to minimize water quality impacts to the river and its tributaries from land use changes. To accomplish this goal, action items were developed based on a review of historic and current natural resources and water quality conditions, as well as watershed stakeholder input. Anne Arundel and Prince George's Counties worked closely with state staff to collect information and develop an existing watershed profile and to field assess current watershed and water quality conditions. Additionally, the WRAS partners (Anne Arundel and Prince George's Counties and Maryland DNR) undertook public participation activities to ascertain the perceived issues and assets associated with the Upper Patuxent River watershed.

The urban land within this watershed was also reviewed and assessed for the potential to retrofit or implement environmentally sensitive, low impact, development techniques to address and reduce nonpoint source pollution from site runoff. From the existing information and current assessments, the WRAS partners developed a methodology to prioritize subwatersheds for restoration and/or protection activities based on differences in ecological conditions (e.g., water quality, habitat conditions, land uses). Restoration and protection action strategies were then developed to address and improve those ecological conditions and to achieve the overall WRAS goal.

The overall results of the Upper Patuxent WRAS included a prioritized listing of subwatersheds in need of restoration or protection; a prioritized listing of associated subwatershed projects that will address those restoration and protection needs; a list of the top ten projects prioritized on a watershedwide basis; and potential programmatic changes to protect and preserve the Upper Patuxent River watershed. Detailed descriptions of the watershed characterizations and recommendations can be found in: *Upper Patuxent River Watershed Restoration Action Strategy for Anne Arundel and Prince George's Counties, Maryland, Prince George's County, Final Report, July 2003.*

Western Branch Watershed Restoration Action Strategy—In a cooperative agreement, Prince George's County and the City of Bowie prepared a WRAS for the Western Branch watershed in 2004. The Western Branch WRAS was developed by considering the information obtained through technical assistance from the Maryland DNR as well as local knowledge from stakeholder involvement. The plan recommends the creation of a Western Branch Watershed Association to help implement the WRAS and ensure its continued updating and use. The technical assistance provided by the DNR for the WRAS included preparation of a watershed characterization (compilation of available water quality and natural resources information and identification of issues), a stream corridor assessment (used field data to catalog issues and rate severity), a synoptic survey (analyzed water quality with a focus on nutrients and assessed benthic macro invertebrates, habitat, and fish communities), a low impact development (LID) retrofit assessment (evaluated the feasibility of applying LID retrofits to various land uses for stormwater management), and a public participation process. The results and recommendations for each are as follows:

- **Watershed Characterization:** The characterization found that the watershed was 44 percent forested. A mapping effort was recommended to help identify priority protection areas for the subwatersheds within the Western Branch watershed.
- **Stream Corridor Assessment:** Environmental problems identified in the watershed included pipe outfalls, fish barriers, erosion, channel alterations, and trash dumping. Pipe outfalls, the most common concern, were addressed first using LID retrofitting. Other problems were then prioritized according to severity, restoration capabilities, and access.

TMDL has been developed for biological oxygen demand (BOD) in the Western Branch River, a tributary of the Patuxent River. The TMDL was developed to address low dissolved oxygen concentrations found near the confluence of the Western Branch and the Patuxent River. Modeling efforts determined that the dissolved oxygen impairments were due to BOD, which is a way of measuring the amount of oxygen taken up by microorganisms that decompose organic waste matter and is, therefore, used to express the amount of organic pollution. The water quality goal of the TMDL was to establish allowable BOD inputs at a level that ensures the dissolved oxygen standard (5.0 mg/l) will be consistently met in the river. The TMDL, which includes BOD load allocations, will be implemented through National Pollutant Discharge Elimination System (NPDES) permits and through the Maryland watershed cycling strategy, which includes follow-up monitoring within five years of establishing a TMDL.

Nutrients, specifically phosphorus, exceeded EPA recommended levels. Recommendations included conducting a pilot study in one of the subwatersheds to determine appropriate restoration efforts, including monitoring, with the ultimate goal of reducing phosphorus loading.

The watershed was assessed as poor for benthic macro invertebrates; partially supporting for physical habitat; and fair/poor for fish.

Urbanization and historic mining were identified as potential stressors. Various restoration and rehabilitation techniques were recommended for prioritized sites, including reestablishing hydrology and removing invasive species.

- LID Retrofit Assessment: 65 sites were ranked as part of the LID assessment. The WRAS recommended targeting one subwatershed for LID retrofits per year.
- Public Participation Process: Concerns identified by stakeholders included point sources, open space and forest cover loss, stream and water quality degradation, and resource and habitat loss. Recommendations from stakeholders included improving water quality using LID and providing and protecting public access to the main stem of the river.

Dissolved Oxygen (DO):
The oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. DO levels are considered a most important indicator of a water body's ability to support desirable aquatic life.

Water Clarity:
A measure of the amount of sunlight that penetrates into the water and reaches the leaves of underwater grasses. The amount of light is critical to survival of the underwater grasses that grow in shallow waters. These underwater bay grasses provide shelter for finfish and shellfish and food for waterfowl. Underwater bay grasses also stabilize the sediment in the bay and buffer wave action in shallow areas.

Watershed Flooding Studies—In addition to the county's partnerships in the larger watershed efforts described above, the Prince George's County Department of Environmental Resources (DER) conducts watershed studies that serve multiple purposes including evaluation of existing flooding and future flooding challenges, based on build-out conditions, and identification of opportunities to reduce flooding. These studies include detailed modeling that incorporates field data predicted conditions reflected in land use plans and other information regarding local conditions. These studies have been completed for small watersheds to date.

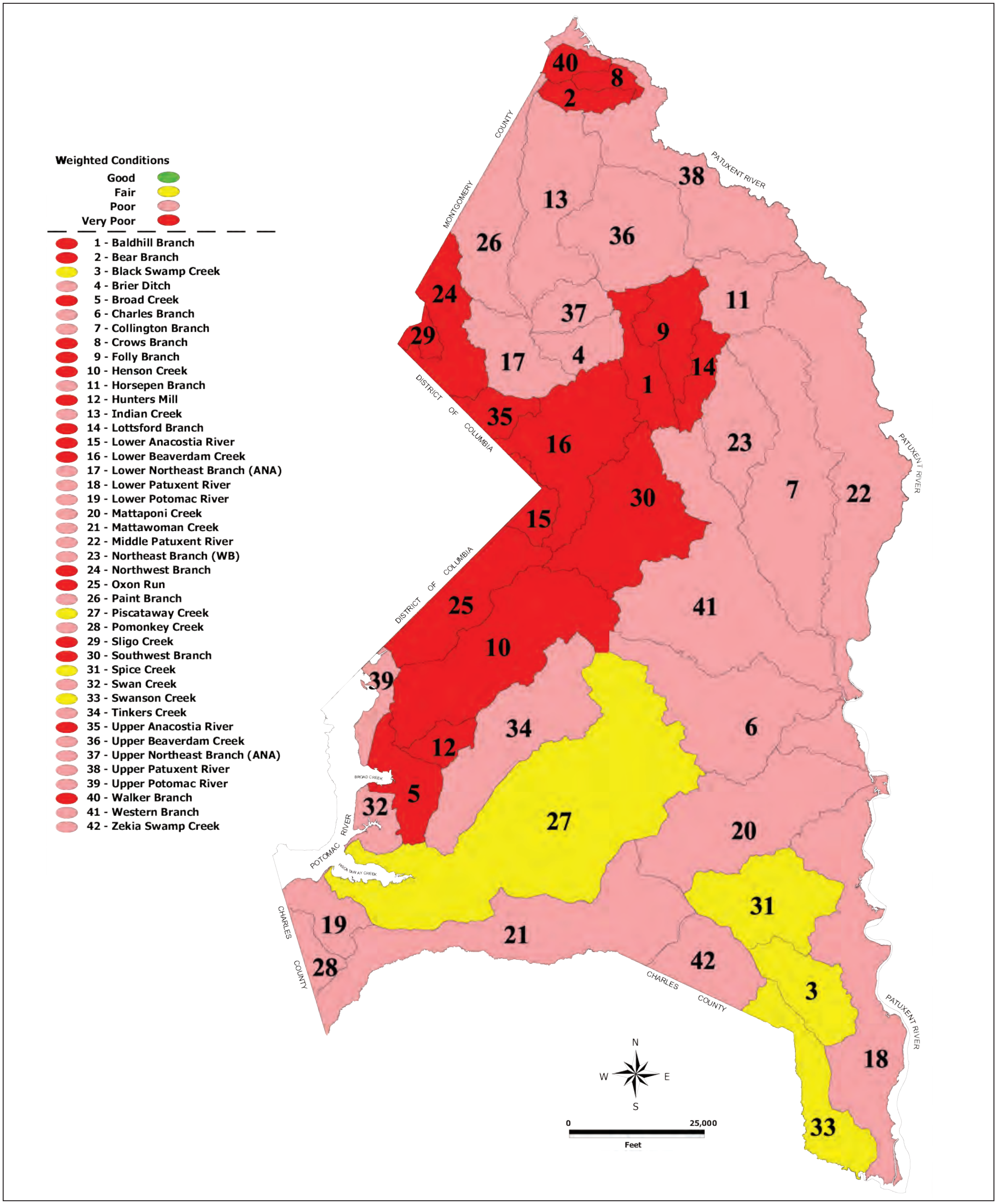
Water Quality Monitoring—DNR, through its Chesapeake Bay Water and Habitat Quality Monitoring Program, has collected water quality samples in Maryland tributaries since 1985. Samples are analyzed for nutrients, such as total nitrogen and total phosphorus, and for physio-chemical parameters, such as dissolved oxygen. This program assesses the water quality by evaluating the levels of nutrients and closely related habitat impacts such as dissolved oxygen and water clarity.

The Countywide Green Infrastructure Plan incorporated this water quality data into the establishment of specific improvement objectives:

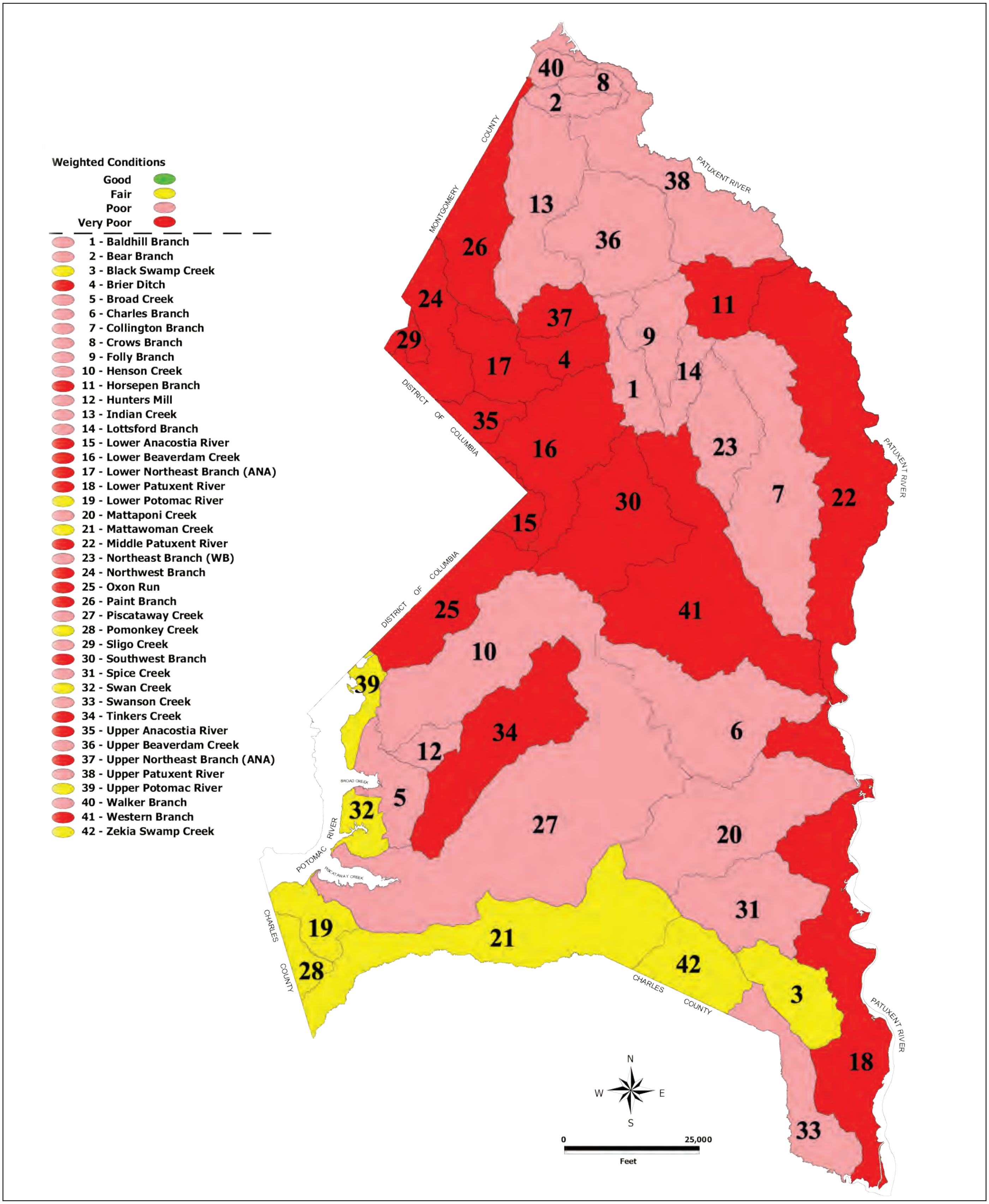
- By the year 2025, improve water quality in each major watershed to elevate the Benthic Index of Biological Integrity rating of the watershed by at least one category using as a baseline the 1999-2003 biological assessment of streams and watersheds of Prince George's County completed by DER (Map 12).
- By the year 2025, improve stream habitat in each major watershed to elevate the habitat rating of the watershed by at least one category using as a baseline the 1999-2003 biological assessment of the streams and watersheds of Prince George's County completed by DER (Map 11).

Stream Corridor Assessments—M-NCPPC, in conjunction with the Prince George's County DER, has been funding stream corridor assessments (SCAs) for all of the streams within the county. DNR created the SCA protocol in order to rapidly assess the generally physical condition of a stream system. This data can then be used to identify the location of a variety of common environmental problems within the corridors of these streams. Both M-NCPPC and DER utilize these data in regards to management decisions concerning stream preservation and restoration. The common physical problems identified during a SCA include:

- Erosion Sites
- Inadequate Stream Buffers
- Fish Migration Blockages
- Exposed or Discharging Pipes
- Channelized (concrete) Stream Sections
- Trash Dumping Sites
- In or Near Stream Construction
- Unusual Conditions



Map 10: Benthic IBI water quality of major watersheds 1999-2003 biological assessments.



Map 11: Habitat water quality of major watersheds 1999-2003 biological assessments.

The survey data also collects information regarding wetland creation and water quality retrofit sites, along with data with the general condition of in-stream habitat and riparian corridor habitat. The main objectives of the SCA survey are:

- To provide a list of observable environmental problems present within a stream system and along its riparian corridor.
- To provide sufficient information on each problem so that a preliminary determination of both the severity and correctability of a problem can be made.
- To provide sufficient information so that restoration efforts can be prioritized.
- To provide a quick assessment of both in and near stream habitat conditions so that comparative assessments can be made of the condition of different stream segments.

All of the streams within Prince George's County are expected to be walked and documented by 2011.

DER Watershed Management Program—DER is required under the Municipal Separate Storm Sewer System (MS4) to perform a detailed watershed assessment, evaluate restoration options, and develop a restoration strategy for one watershed per year. The overall goal is to ensure that each county watershed has been thoroughly evaluated and has an action plan to maximize water quality improvements. To this end, DER has developed a strategy that is summarized in its "Watershed Assessment and Planning Program: Supporting Clean Water and Livable Communities through Watershed Restoration and Protection." The document provides a framework that links multiple departments and existing regulatory requirements under a watershed approach.

DER Watershed Management Initiatives—Prince George's County DER has developed a strategy that provides a framework for initiating watershed management in Prince George's County. The framework will provide a mechanism that links multiple departments and existing regulatory requirements under a watershed approach. DER has completed the Bear Branch Watershed Strategy and is working on the Piscataway Creek Watershed Strategy. The strategies will provide a comprehensive blueprint for protecting and restoring these watersheds. They will include a comparative ranking of potential projects and guide future monitoring efforts, watershed assessments, and restoration/preservation strategy development.

The watershed strategy will engage multiple departments as it integrates land conservation, land development, water resources, and community issues into one consolidated framework. The watershed program will leverage data currently collected, such as MS4 permit monitoring data, and create a GIS-based data storage and retrieval system to share the data countywide. Planning on a watershed basis is envisioned by DER to help streamline existing requirements for MS4 permits, TMDLs, Chesapeake Bay restoration elements, and other regulatory requirements, as well as increase Prince George's County's eligibility for grant funds.

A substantial amount of information exists for the watersheds of Prince George's County, and numerous programs have been undertaken to improve and protect water quality. The Prince George's County Planning Department is charged with developing visions, goals, programs, and strategies for future county growth and development, while several departments within the county are responsible for implementation of the programs needed to support the county's visions and requirements. Although each of these topics is addressed separately in this plan, all of the agencies that provide the functions related to water resources share a common need for access to information on which to base their planning decisions, funding and resource programs, and coordination efforts. Additional organization and communication around a watershed framework would improve information sharing and strengthen the county's ability to provide effective watershed enhancement measures. In addition, trends indicate watershed-based regulatory and permitting programs are increasing and could possibly be implemented within the next few years. The EPA is exploring the concept of watershed-based NPDES permitting to encompass all stressors within a watershed rather than the current approach of addressing individual pollutant sources on a discharge-by-discharge basis. This type of permitting system may be created to more effectively coordinate and synchronize permits within a basin, or could include water quality-based effluent limits or TMDLs for subwatersheds or individual permit holders. Although this type of program is not yet established, recent recommendations from USEPA, the National Academies of Sciences, and President Obama's May 2009 Executive Order indicate that the concept of watershed-based permitting is gaining widespread support.

Any type of new watershed-based regulatory structure will affect multiple stakeholders including; federal agencies; state agencies; local governments; the business and development community; agricultural and other resource industries; and private landowners, necessitating successful forums for stakeholder participation and widespread public education. Organization of county planning efforts around a watershed-based framework will help Prince George's county prepare for anticipated changes. Prince George's County DER's 2008 watershed management report recommends initiating a watershed management program that links multiple county departments and existing regulatory requirements under a watershed approach. Planning around a similar framework will enhance M-NCPPC's efforts, and the ability of all decision-makers and stakeholders, to establish growth policies and programs that protect and restore the county's water resource. This approach will also help prepare the county's agencies for future changes in regulatory programs and requirements.

CHAPTER ISSUES SUMMARY

Watershed-based planning offers a framework for:

- Planning that integrates and coordinates the work of various county departments and partners responsible for the protection of water resources.
- Providing a clearinghouse for data sharing and collaboration.
- Giving nonprofit and citizen groups an opportunity to contribute their expertise and provide input.
- Prioritizing preservation of natural ecosystems and utilizing an environmentally sensitive development approach.

As conventional development increases, impervious surfaces such as roof tops, driveways, and parking lots also increase, creating more stormwater runoff into already impaired streams

At the watershed scale, impervious surface areas greater than ten percent begin to have deleterious effects on the ecological health of streams and groundwater supplies

POLICIES AND STRATEGIES

POLICY:

The county recognizes that a watershed-based system of information collection, analysis, evaluation, and land use planning strives to improve the quality of impaired water and protect healthy water. Watershed-based planning is the preferred analytical framework for land use planning and decision-making.

STRATEGIES:

- Evaluate environmental conditions at a watershed scale appropriate for the planning area during subregion, master, and sector planning efforts.
- Establish master planning protocols and practices that integrate data and resources from federal, state, and county agencies, watershed groups, and Planning Department staff to provide a cooperative and consensual watershed-based approach to environmental planning.
- Develop an assessment tool for master planning to better integrate a watershed analysis processes, particularly in watersheds with limited data. Identify and document potential consequences from changes in watershed conditions to help inform future decision-making in the watershed. Maintain consistent and structured coordination between planning and implementation agencies.
- Continue to document existing baseline water quality and watershed conditions and identify existing and potential opportunities, impacts, and risks. Establish a program to evaluate long-term water quality changes relative to land use and development changes.
- Integrate nonpoint source watershed modeling into master plans to evaluate existing conditions and impacts and proposed remediation, conservation, and protection strategies through development and redevelopment.
- Map and incorporate development and preservation decisions based on General Plan and Green Infrastructure Plan policies, priority funding areas, and priority preservation areas per watershed as part of the master planning process.

POLICY:

Watershed analysis and planning includes measurable criteria that defines data gaps and evaluates plan and program accomplishments.

STRATEGIES:

- Develop a countywide watershed plan that meets EPA's nine criteria for a watershed plan to be eligible for federal grant funding.
  - Create parameters to identify restoration and preservation priorities such as level of impairment or high quality waters and restoration of 303d impaired waters. Parameters should help establish localized policy, institute development requirements and proffers (including required BMPs), guide public investment decisions, raise countywide awareness, and catalog funding opportunities.
  - Identify priority 8-digit and 12-digit subwatersheds for preservation and restoration and identify priority actions within each watershed to be implemented in short-, mid-, and long-term time frames to protect and improve water quality and hydrologic conditions.

  - Track ongoing water pollution management activities in terms of TMDL implementation, NPDES requirements, MS4 permitting, and water quality attainment; including federal antidegradation policy implementation.
  - Establish and achieve measurable watershed goals related to compact land use, reduced impervious surface, additional and enhanced tree canopy/forestation (including street trees), improved water quality (aquatic life, use designation), contiguous and accessible open space, and parks. Goals should reflect existing conditions of each subwatershed, community goals, established limits of acceptable levels of nutrients concentrations, and measurable targets for improvement.

- Define existing and projected water quality nutrient concentrations based on a dynamic watershed simulation model integrating hydrologic data with other watershed conditions, such as land use or land cover to analyze stream flow and water quality conditions within watersheds.
  - Augment the existing water quality inventory with a comprehensive account of existing, biological, chemical, physical, and habitat data collected by county, state, and federal agencies and local watershed/volunteer groups for Prince George's County streams.
- Integrate water resources, watershed conditions, and water-related objectives into land use planning and development decisions to ensure that site by site decisions are evaluated for their cumulative impacts and benefits to the watershed.
- Develop a centralized GIS-based data storage and retrieval system to store multiple data types in order to access environmental information and make informed decisions about restoring and protecting water resources and natural processes.
- Routinely update watershed planning goals and priority actions to incorporate a systems-based adaptive management approach that responds to evolving federal and state requirements, changing conditions in water quality and watershed conditions, and sustainability goals, and utilizes a precautionary approach to water resource management.

VI: ENVIRONMENTAL RESOURCES & LAND DEVELOPMENT

Understand the relationship of the availability, quality, reliability, and overall sustainability of water and other natural resources relative to our land use decisions that establish where, how, and what we build.

Increased population and the associated land use changes continue to be primary factors causing water quality and habitat degradation in the Chesapeake Bay and its drainage basins. Development itself is not necessarily harmful to the water quality in our rivers, streams, creeks and tributaries; it is our development patterns and practices—where we locate new roads and buildings and how we build them—that can have a lasting negative impact on our natural environment.

As we spread across watersheds and build away from existing infrastructure, we are using more land than we need. Between 1970 and 2000 in the Chesapeake Bay watershed, the average national household population decreased; however, lot sizes increased by 60 percent. The average home size increased from 1,500 square feet to 2,265 square feet.[1]

The amount of land we use relative to our population growth is often measured by impervious surfaces: roads, rooftops, parking lots, and other hardened areas. Impervious surface data are used to gauge the rate of development across the watershed and to identify potential sprawling development patterns. Between 1990 and 2000, the amount of impervious area in the Chesapeake Bay watershed increased by nearly 250,000 acres, or about 41 percent. During that same time period, population increased by just eight percent,[2] resulting in a net loss of open space and forest.

This loss of forest is a permanent loss of air and water filters, wildlife habitat, and other ecosystem services that forests provide. In addition to forest loss, 60 percent of the Chesapeake Bay watershed forests are divided by roads, subdivisions, and farms into

[1] Chesapeake Bay Program, a watershed partnership

[2] Ibid

Development means any building, construction, renovation, mining, extraction, dredging, filling, excavation, or drilling activity or operation; any material change in the use or appearance of any structure or in the land itself; the division of land into parcels; any change in the intensity or use of land, such as an increase in the number of dwelling units in a structure or a change to a commercial or industrial use from a less intensive use; any activity that alters a shore, beach, seacoast, river, stream, lake, pond, canal, marsh, dune area, woodlands, wetland, endangered species habitat, aquifer, or other resource area, including coastal construction or other activity.

disconnected fragments surrounded by other land uses. Forest fragmentation isolates animal and plant populations into smaller areas, and makes forestland more vulnerable to development, fires, and invasive plant species. Additionally, conversion of farmland to residential and commercial developments can adversely impact the long-term sustainability of the agriculture industry, a significant part of the culture, open space conservation, heritage, and economy of the Chesapeake region.[3]

As we look forward to 2030, depending on the development choices we make and the policies we implement, we face significantly differing outcomes. According to studies prepared by the Maryland Department of Planning (MDP), a choice to let current trends continue by maintaining current planning policies, yields consumptive development patterns.[4]

In Prince George's County, the Planning Department has made population and employment projections through 2030. Assuming current development trends continue in the county, and that land will continue to be developed according to existing programs and policies (e.g., zoning, sewer service areas, etc.) that are currently in place, the depiction evaluated though 2030 shows additional acres of forest and agricultural land being converted from rural land uses to urban or suburban development. Forests and farms will be replaced by houses and highways. Water quality will degrade further and the cost to provide and maintain infrastructure to supply drinking water and wastewater management will increase. Changes to our current growth policies and development patterns can provide critical resource protection and overall quality of life enhancement.

"Human populations, and associated urban areas, are expected to grow to 19 million people by the year 2030 and will be the major factor impacting restoration of the ecosystem."—Boesch and Greer, 2003

WATER RESOURCES

All water resources respond to the natural hydrologic cycle. The hydrologic process is the renewing loop within which water cycles and recycles on earth. These processes include crystallization of ice; evaporation of liquid; transportation of moisture by air, rain, snow, river, lake, and ocean currents; and evapotranspiration of water by plants and other living organisms. All these processes are related to the physical and chemical properties of water. The hydrologic cycle renews our water resources over time and allows life processes to coexist and share in the responsibility for the use and management of water resources. Diminishing water quality and water availability, and the loss of critical habitat for fish and wildlife, are key issues facing Prince George's County. Our county depends on reliable supplies of clean water to support growing communities, sustain our natural resources, and provide for agricultural production. In order to move forward on increasingly critical water issues, citizens, interest groups, and government agencies will need to develop new, more collaborative and cooperative ways of solving problems.

[3] Ibid

[4] Where Do We Grow From Here? A Report of the Task Force on the Future for Growth and Development in Maryland, December 1, 2008, Maryland Department of Planning

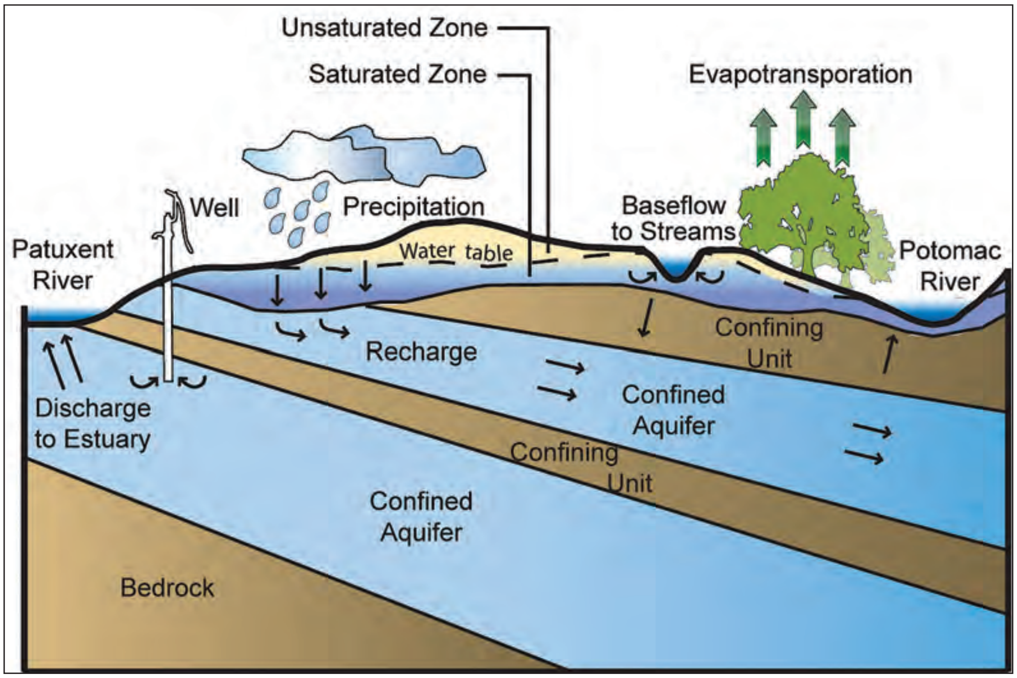


Figure 7: Water recharge.

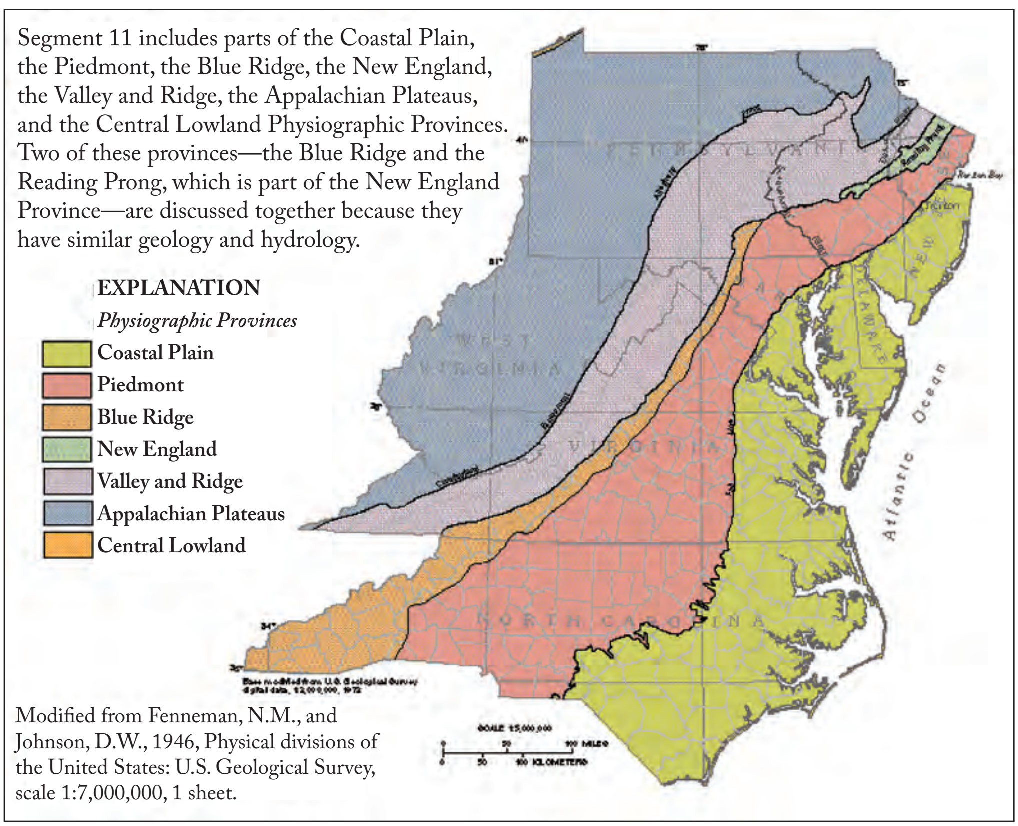


Figure 8: Physiographic provinces.
Source: USGS

Hydrologic Cycle:
A description of the circulation of water on Earth involving transfers and storage of water vapor from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to Earth, and through infiltration to ground water, runoff into streams, rivers, and lakes, and ultimately into the oceans.

Fluvial Geomorphology:
The study of landform evolution related to rivers. The variables affecting stream systems, such as climate, geology, vegetation, valley dimensions, hydrology, channel morphology, and sediment load, have different causal relationships with one another, depending upon the time scale of analysis.

Dynamic Equilibrium:
In constantly changing ecosystems, it is the ability of a stream system to persist within a range of conditions

Bankfull Flow:
Maximum amount of discharge that a stream channel can carry without overflowing.

Base Flow:
Normal sustained flow conditions between precipitation events. Base flows provide a range of suitable habitat conditions that support the natural biological community of a specific river subbasin.

Stream Morphology—Prince George's County's stream network can be divided into 14 subwatersheds that are best described as gently rolling to hilly and moderately dissected by broad, shallow valleys. Elevation ranges from sea level to 365 feet above sea level.[5] Hydrologically, one-half of the county drains easterly to the Patuxent River, while the remaining area drains southwesterly to the Anacostia River and other tributaries of the Potomac River. Several of the county's southern streams are tidally influenced.

Maryland's coastal plain streams extend from the fall line eastward toward the Atlantic Ocean. These streams are typically low gradient (less than one percent) and are found at elevations of less than 50 feet above sea level. Silt, sand, gravel, and small cobble are the dominant substrates. The type of substrate and the shape of the stream channel influence the type of in-stream habitat. There are four described types—pool, glide, riffle, and run. Most coastal plain streams contain only runs, glides and pools. Because coastal plain streams lack stable substrates such as bedrock and boulders, wood and submerged aquatic vegetation are important channel features. Submerged logs and tree roots slow the flow of nutrients and sediment, provide cover for fishes and stream insects, and control stream bank erosion.

Streams and stream corridors evolve in concert with and in response to surrounding ecosystems. Changes within a surrounding ecosystem (watershed) will impact the physical, chemical, and biological processes occurring within a stream corridor. Stream systems normally function within natural ranges of flow, sediment movement, temperature, and other variables, in what is termed "dynamic equilibrium."[6]

Over the years, human activities have contributed to changes in the dynamic equilibrium of stream systems everywhere. These activities center on manipulating stream corridor systems for a wide variety of purposes, including; domestic and industrial water supplies, irrigation, transportation, hydropower, waste disposal, mining, flood control, timber management, recreation, aesthetics, and fish and wildlife habitats. Increases in human population and industrial, commercial, and residential land use have placed heavy demands on the country's streams and their stream corridors. In Prince George's County, many of the older developed areas have highly altered streams and numerous streams are piped underneath the concrete and asphalt supporting development. A significant number of streams have been channelized, resulting in stream corridors paved to form trapezoidal channels. These altered channels provide no in-stream habitat for flora and fauna, can increase the temperature of receiving waters due to the heat collection of the pavement surface, and increase the velocity of stormwater flows. The cumulative effects of these activities have resulted in significant changes, not only to the corridors, but also to the ecosystems of which they are a part. These changes include degradation of water quality, decreased water storage and conveyance capacity, loss of habitat for fish and wildlife, and decreased recreational and aesthetic values (National Research Council 1992).[7]

Development greatly increases the frequency that a stream exceeds the critical discharge rate (the discharge rate associated with bankfull flow and dynamic equilibrium) that corresponds to the onset of channel erosion and enlargement. As a result, the streambed

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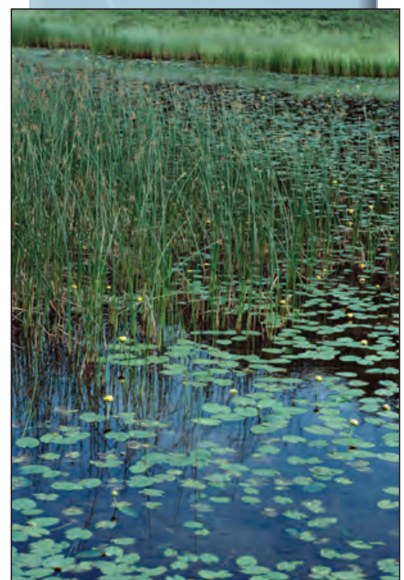
5 http://www.dnr.state.md.us/wildlife/WCDP_Chapter4_Part4_20050926.pdf

6 http://en.wikipedia.org/wiki/Dynamic_equilibrium

7 www.usda.gov/stream_restoration Oct 1998, Revised Aug, 2001, adapted as Part 653 of the National Engineering Handbook, USDA-Natural Resource Conservation Service

and banks are exposed to highly erosive flows more frequently and for longer periods. Streams typically respond to this change by increasing cross-sectional area to handle the more frequent and erosive flows either by channel widening or down cutting, or both. This results in a highly unstable phase where the stream experiences severe bank erosion and habitat degradation. The stream often experiences some or all of the following changes:

- Rapid stream widening.
- Increased streambank and channel erosion.
- Decline in stream substrate quality (through sediment deposition and embedding of the substrate).
- Loss of pool/riffle structure in the stream channel.
- Degradation of stream habitat structure.[8]



Development and its associated impervious surfaces reduce the infiltration of rainwater and consequently the recharge of groundwater and maintenance of base-flows in streams. Stream systems seek topographic low points and flow toward larger water bodies and eventually the sea. As surface water moves across the landscape it erodes the underlying soil and rock, incising the land and combining with groundwater to provide stream base-flows. When groundwater recharge is compromised due to impediments to the natural infiltration process, base-flows in streams decline and during drought conditions can disappear entirely.

There is a strong link between physical stream processes and the habitat and biology of the stream. Since most biological systems co-evolved within physical systems, an adaptive ecosystem management approach is recommended. Adaptive management allows protective strategies to develop as a greater understanding of biological conditions is attained to support stream functions. Research and action should:

- Improve ecosystem knowledge about stream systems and their physical processes and biological functions.
- Identify research gaps and the best methods to fill these gaps.
- Develop adaptive management tools to improve stream systems
- Provide training and technical support to plan and implement stream restoration.

Wetlands—A wetland is defined as an area of land where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of the year, including during the growing season. According to the Army Corps of Engineers, the three indicators of a wetland include:

Hydrology: The recurrent or prolonged presence of water at or near the soil surface.

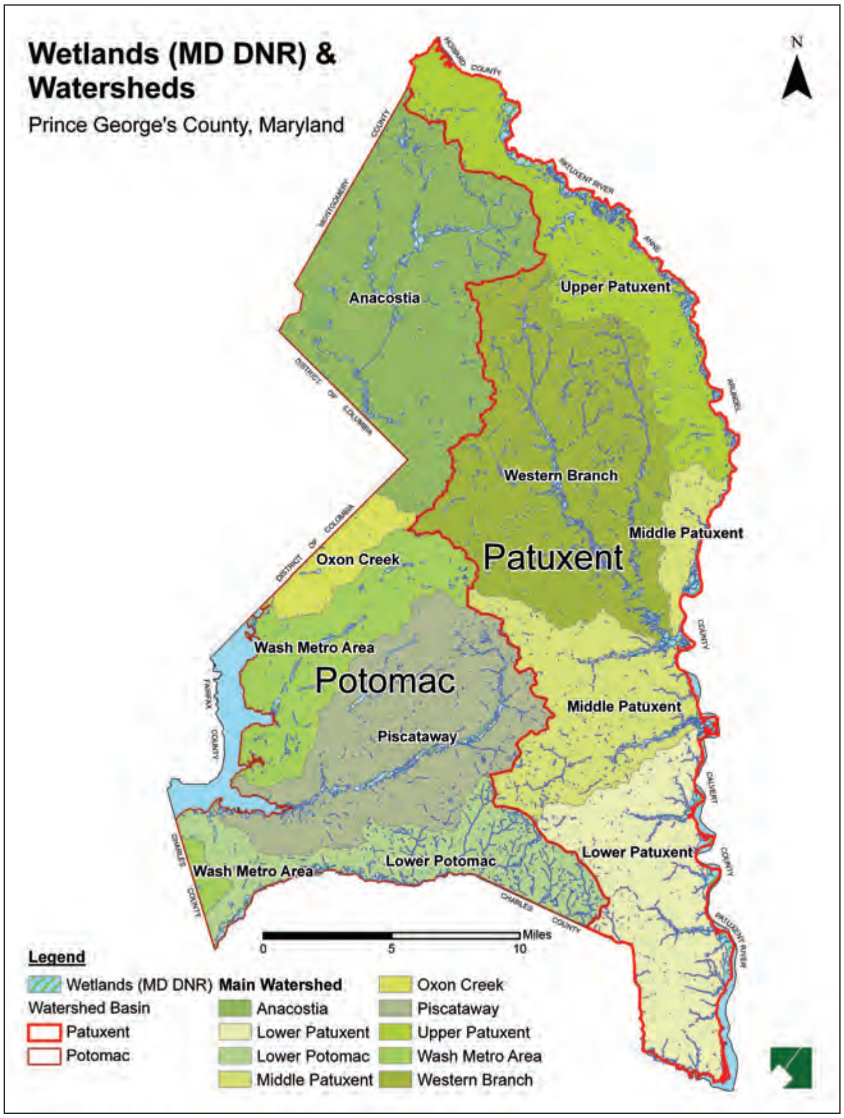
Hydrophytic Vegetation: Plants that are adapted to life in saturated or wet soils.

Hydric Soils: Soils that form under flooded or saturated conditions.[9]

Overall water quality improvement is due to the wetland's ability to process excess nutrients, intercept other pollutants, trap sediment, and reduce suspended solids in the

8 http://www.mde.state.md.us/assets/document/chapter1.pdf

9 http://el.erdc.usace.army.mil/wetlands/pdfs/wlman87.pdf



Map 12: Wetlands and watersheds.

overlying water. This quality makes wetlands important in urban and suburban areas where impervious surfaces increase the rate and volume of runoff. Wetland pockets often occur along the fringes of streams, where they coincide with the frequent inundation from water in the floodplain.

Wetlands also help control erosion and flooding. Like a natural sponge, wetlands soak up and hold large amounts of flood and stormwater, releasing water gradually back into the water systems. Fast-moving flood or stormwaters are slowed by the vegetation and temporarily stored in wetland areas. Subsequent gradual release of the water minimizes erosion and property damage. It is essential to preserve and protect wetlands because of their ability to act as buffers by regulating the flow of pollutants into the rivers, streams, and groundwater. Wetlands also recharge stream baseflows, especially during droughts.

Roughly 22,000 acres of vegetated wetlands in the Chesapeake Bay watershed were lost between 1982 and 1989, a number that indicates little change from the more than 2,800 acres a year that were lost during an earlier 1956-1979 study, though there were differences in the types of wetlands lost. The findings were based on a statistical analysis of aerial photos acquired during the 1980s for various portions of the bay's 64,000 square-mile watershed. The data covers a time when most states had no nontidal wetland programs and when the federal regulatory programs were evolving. The report estimated that about 1.7 million acres of wetlands remain in the bay watershed, of which about 12 percent are tidal wetlands—those in areas near the bay that are impacted by the Chesapeake's tides—and 88 percent are nontidal wetlands located further inland.[10]

Prince George's County's scattered tidal and nontidal wetlands exist as submerged, forested, ponded, and shrub/scrub wetlands. Digital information available from the National Wetlands Inventory as well as the Maryland Digital Orthophoto Quarter Quad (DOQQ) maps depict mapped wetlands. From these references MDE estimates that there are 22,530 mapped acres of vegetated wetlands. The State of Maryland maintains both Tidal and Nontidal Wetland Protection Acts. Although MDE is in the process of updating its Priority Areas for Wetland Restoration, Preservation, and Mitigation, it remains the most current local resource as an informational source and

[10] http://www.bayjournal.com/article.cfm?article=164

targeting guide for water quality protection and habitat conservation.[11] Stream and wetland mitigation sites, identified in the county, should be consistent with the recommendations in this document.

Floodplains—Floodplains are low-lying areas adjacent to streams and rivers. These areas naturally absorb the energy of floodwaters and reduce the damage to the river channel. Floodplains are also areas where excess sediment and debris associated with floods are deposited by the river after a storm. Floodplains provide natural nitrogen processing (denitrification) due to the bacteria present in the soil, and provide habitat for many plant and animal species. Floodplains are mapped by the Federal Emergency Management Agency (FEMA) as part of the National Flood Insurance Program (NFIP). The 100-year or one percent chance of a flood is mapped and used for regulatory purposes.

The types of land use in an area affect the overall nature of floods; in totally forested areas, rainfall is readily absorbed into the ground and flows slowly into streams through groundwater pathways. Roadways, parking lots, and rooftops in developed areas shed water quickly and channel it directly into streams, resulting in more damaging floods.

Groundwater/Aquifers—Groundwater is an integral part of the water system. When water vapor is cooled, clouds and rain develop. A portion of rainfall that falls on vegetated (or pervious) land percolates through the soil and into the underlying geological layers. The term groundwater refers to water that is found underground in the cracks and spaces in soil, sand and fractured rock. Groundwater is stored in, and moves slowly through, these layers of soil, sand, and rocks, called aquifers. These materials are permeable because they have connected spaces that allow water to flow

Ground Water:
The supply of fresh water found beneath the Earth's surface, often in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

[11] http://www.mde.state.md.us/assets/document/wetlandswaterways/CB_all.pdf

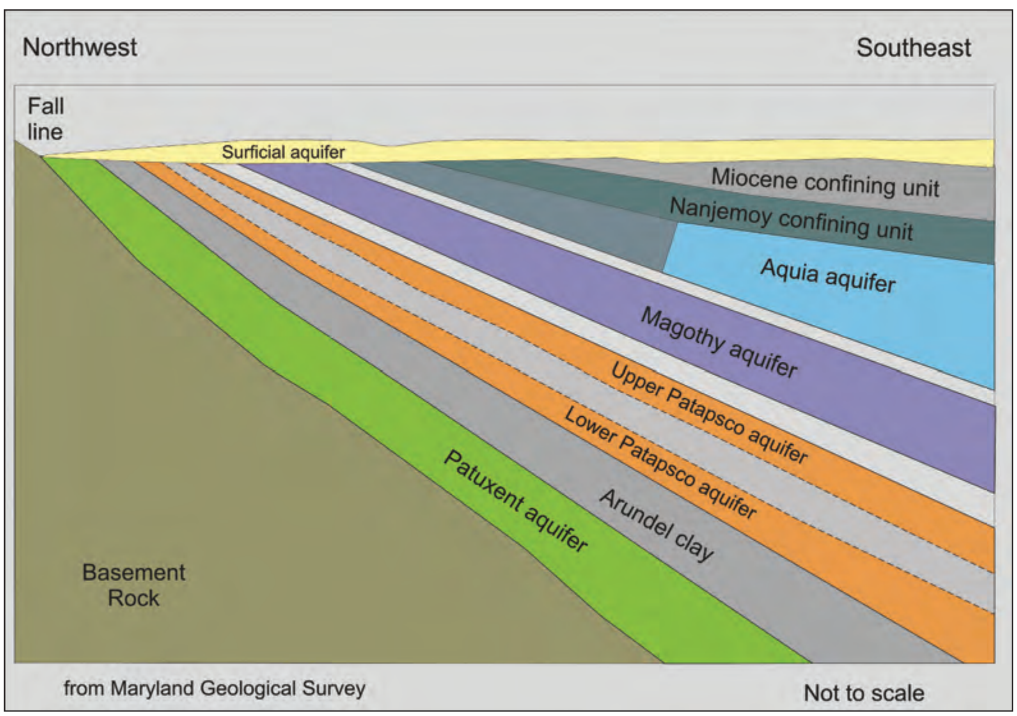
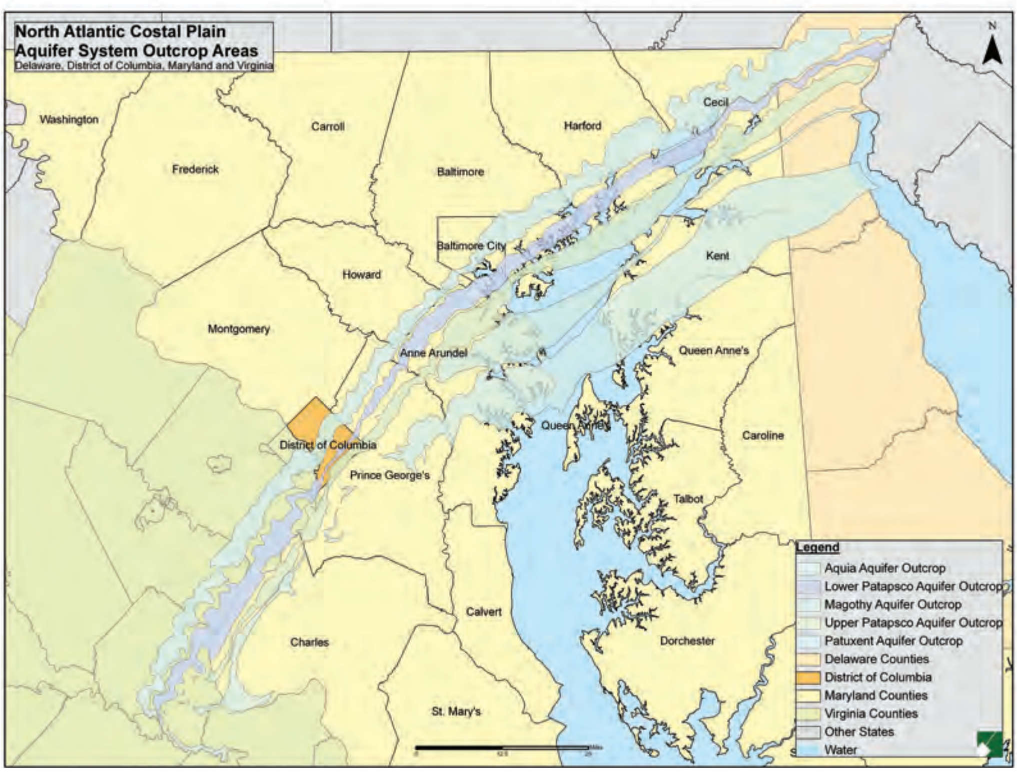


Figure 9: Coastal plain aquifers.
Source MGS

through. The speed at which groundwater flows, typically on the order of feet per year, depends on the size of the spaces in the soil or rock and how well the spaces are interconnected.

Except for a very small land area west of the geological fall line, Prince George's County is underlain by the Northern Atlantic Coastal Plain Aquifer System. This is a regional aquifer system that extends from New Jersey to North Carolina along the Atlantic coast. Outcrop areas for several important aquifers underlie the northern portion of Prince George's County. The outcrop areas, where most water for the aquifer systems is recharged, occur primarily in these more densely developed areas. Increases in impervious area development in these outcrop areas decreases groundwater recharge through percolation and infiltration and increases stormwater runoff. The reduced recharge mainly affects the water-table aquifer in the form of lower water levels and reduced groundwater discharge (baseflow) to streams.

The aquifers of the Northern Atlantic Coastal Plain Aquifer System can be either confined or unconfined. A particular aquifer is considered to be confined where it is bounded above and below by beds of distinctly lower permeability (i.e., clay) than that of the aquifer itself and, therefore, contains groundwater under pressure. This term is synonymous with artesian aquifer. An aquifer is considered to be unconfined where it is **not** bounded above by a bed of distinctly lower permeability than that of the aquifer itself and groundwater is under no or low pressure. This term is synonymous with "water-table aquifer." Typically, the aquifers of the Northern Atlantic Coastal Plain here in Prince George's County are unconfined in their outcrop areas, where there is an absence of a clay layer above the aquifer sands, and become confined to the southeast where younger clay layers overlay the aquifer sands. Some important differences between the unconfined and confined portion of the aquifers are that where they are unconfined they are more susceptible to contamination from sources at the land surface, are more readily influenced by short-term drought and climate change, and are more likely to discharge water into nearby surface water systems. Hence, groundwater in the shallow unconfined portion of the aquifers of the Coastal Plain is sensitive to how people manage and use the overlying land. The Maryland Department of the Environment has implemented a Wellhead Protection Program including strategies designed to protect public drinking water wells by managing the land surface around a well to minimize the potential of groundwater contamination by human activities that occur on the land surface or in the subsurface.



Map 13: Aquifer Outcrops. Source: M-NCPPC

Alternatively, where these aquifers are confined, while better protected from contamination because of the overlying lower permeability clay, they are susceptible to the adverse impacts of regional scale groundwater pumpage. Groundwater can be brought to the surface by pumping wells that are completely submerged into the saturated aquifer sands. The amount of water that can be pumped out depends on the structure and hydraulic properties of the aquifer and the competing water demands. Currently individual, private domestic wells in Prince George's County are predominantly supplied by four major aquifers—the Aquia, Magothy, Upper Patapsco, and Lower Patapsco. Public supply at the City of Bowie is predominantly from the Patuxent and Lower Patapsco aquifers. Declining water levels associated with regional scale pumpage in neighboring counties is a concern in several of these aquifers where groundwater levels have been declining at a rate of about two feet per year. Groundwater resources must therefore be actively managed at the same regional scale as the aquifer system.

The demand for groundwater has continued to increase over time. This demand may affect the character of streams and watersheds by diverting natural discharge. The emerging emphasis on ecosystem health as part of water resource planning demands sophisticated integration of diverse professional expertise. Water is the connecting element in the cooperative planning of multiple environmental disciplines. During development and redevelopment in areas of the county noted as aquifer recharge areas all plans should be reviewed for imperviousness and recommendations to reduce the current impervious coverage to the maximum extent practicable should be included.

Water Quality—In order to make proactive recommendations to improve water quality in Prince George's County, decision-makers rely on specific base data to understand existing stream conditions. Many agencies, departments, and organizations take an active role in the collection and evaluation of water quality data on the county's streams and water bodies. Thus, our overall understanding of the condition of our waterways has grown significantly over the last several years.

Collection and documentation of stream data is the first step in the evaluative process. Scientific and physical data on surface water conditions are by nature time sensitive and the conditions in streams are always in flux, responding to external conditions such as air temperatures; frequency, duration, and intensity of storm events; changes in land use, and changes in pollution control requirements and human behavior. Consequently, the timeline interface between data collection, interpretation, development of remediation strategies, and implementation is critical.

Water quality comprises many parameters and they all deal with the biological, chemical, or physical health of the measured water body. Table 13 indicates the most commonly measured parameters and what they mean for the health of the water being measured.

According to data collected by the U.S. Environmental Protection Agency (EPA) from nationwide water assessments, the top reported impairments in assessed rivers and streams regardless of designated use were the following:

- Sediment or siltation, which can smother streambeds, suffocate fish eggs and bottom-dwelling organisms, and interfere with drinking water treatment and recreational uses.
- Pathogens (bacteria), which indicate possible fecal contamination that may cause illness in people.
- Habitat alterations, such as disruption of streambeds and riparian areas.

Designated uses, water quality criteria, and an antidegradation policy constitute the three major components of a Water Quality Standards Program.

The designated uses (DUs) of a waterbody are those uses that society, through various units of government, determines should be attained in the waterbody. The DUs are the goals set for the waterbody. In some cases, these uses have already been attained, but sometimes conditions in a waterbody do not support all the DUs.

In Prince George's County, the assessments of water quality of the county's streams indicate impairments consistent with those listed above. The highly urbanizing nature of the county, habitat alterations, and consequent stream disturbances result in degraded water quality. Also, because of the widespread construction projects occurring within the county, sediment from construction sites is finding its way to streams through stormwater runoff, contributing to siltation. And finally, where older septic systems or sewer infrastructure is failing, pathogens like E. coli are reaching water sources, making them unsuitable for swimming or drinking.

Water Quality Parameter	**What it Means**
Temperature	The temperature is related to how much oxygen the water contains. Colder temperature waters can contain more oxygen than warmer waters.
Salinity	A measure of chloride ions in the water, or how "salty" the water is.
Conductivity	A measure of the electrical conductivity of water that is influenced by all the dissolved constituents in water.
pH	A measure of the hydrogen ions in the water, indicating how acidic or basic the water is.
Light attenuation	A measure of how much light is attenuated (diminished) through the water column. It is influenced by dissolved and suspended compounds in the water and is important to the heath of plants and algae.
Secchi depth	This measures the light attenuation by utilizing a round, flat, disk painted half black and half white. The disk is lowered in the water column until it cannot be seen; then its length is measured.
Dissolved oxygen	Measure of water quality indicating free O_2 dissolved in H_20.
Biological Oxygen Demand (BOD)	A measurement of the demand (usually by bacteria or chemical reactions) for dissolved oxygen in the water column.
Turbidity	A measure of the particles suspended in the water, including sediment, plankton, detritus.
Total Suspended Solids (TSS)	Similar to turbidity, TSS is a measure of suspended particles in the water column.
Fecal Coliform Bacteria	These are bacteria that exist in the intestines of mammals and birds. They indicate the presence of animal or human sewage that may contain pathogens.
Chlorophyll *a*	Chlorophyll *a* is a plant pigment used in photosynthesis (making plants green). This measures the amount of plant or algae material in the water.
Nutrients—nitrogen and phosphorous	Nutrients are important for the growth of algae and aquatic vegetation. Too much of them can cause algal blooms, which can have negative effects on water quality.
Heavy metals—arsenic, cadmium, mercury, lead, etc.	Heavy metals can be taken up by aquatic life and can harm them and the other animals, including humans, which feed on them.

Table 13: Water Quality

NATURAL RESOURCES

Natural resources provide the county and its residents with many needed materials and assets to sustain and allow for growth and adaptation. Water, soil, forests, wildlife, fish, and minerals are all part of the natural environment. Sustainable management of these natural resources ensures we respect their limitations and understand the natural processes that provide natural and water resource protection and renewal.

Green Infrastructure—The Prince George's County Green Infrastructure Plan was developed as a tool to help identify areas of greatest countywide ecological importance and to avert the risk of their loss to development. It identifies large contiguous blocks of natural land and incorporates an interconnected system of corridors to allow animal and plant dispersal and migration. Regulated, evaluation, and network gaps were identified within the county to establish prioritization for protection based on ecological importance and resistance to development. The Green Infrastructure Plan is also used to guide Prince George's County's ongoing land conservation efforts. At a multistate scale, the green infrastructure method has been used as the framework for setting landscape ecological priorities within the Chesapeake Bay watershed. At a regional scale, the method has been used to rank or focus areas for state land conservation programs. Within a local government planning context, the method is translated into relevant criteria to support county-scale green infrastructure initiatives.

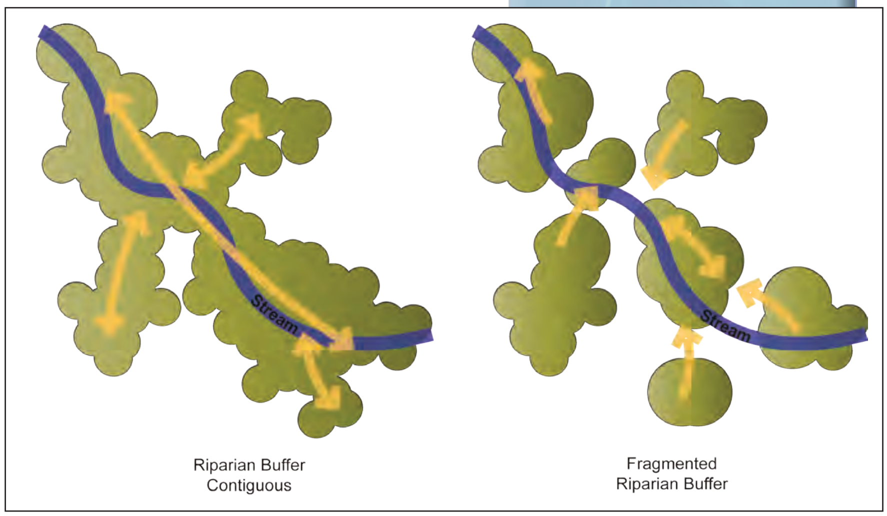


Figure 10: Contiguous and disconnected riparian buffers.

The Green Infrastructure Plan has set specific tree cover percentages objectives per tier.

Objective: Meet or exceed the following forest and tree cover goals within each tier and countywide by 2025:

- Developed Tier 26 percent
- Developing Tier 38 percent
- Rural Tier 60 percent
- Countywide 44 percent

According to the 2008 General Plan Growth Policy Update, the Developed and Developing Tier coverage was above the 2025 goal. The 2025 goal in the Rural Tier is currently being met. Forest and tree cover increased by three percent in the Rural Tier, while it decreased in the Developing Tier.

In the year 2000, an analysis was completed that showed the existing forest and tree cover percentage in each tier. The analysis was repeated in 2005 to show the changes by tier and to compare to the 2025 goal. The terms "forest" and "tree cover" were used in the General Plan to denote that both woodland areas and urban tree canopy should be used to meet the goals. The terms "forest" and "woodlands" are generally synonymous,

Tier	Woodland Cover in 2000 (acres)	Woodland Cover in 2000	Woodland Cover in 2005 (acres)	Woodland Cover in 2005	Net Change in Percentage Points of Woodland Cover (2000-2005)	Raw Data Percent Change (2000-2005)
Developed	14,886	27%	14,630	27%	0	-1.7%
Developing	65,035	43%	61,276	41%	-2	-5.8%
Rural	59,732	57%	62,916	60%	3	5.3%
Countywide	139,653	45%	138,822	45%	0	-0.6%

Table 14: Woodland cover objects per the Countywide Green Infrastructure Plan.

Habitat:
The place where a population (e.g. human, animal, plant, microorganism) lives and its surroundings, both living and nonliving.

except that the term "woodlands" has a specific definition in the Woodland Conservation Ordinance and the term "forest" is more general.

Green infrastructure has increasingly been tailored as the terminology used to represent an environmentally responsive built environment and restoration practices that strive to replicate natural systems and biological processes. The term "green infrastructure" is being applied at a wide range of landscape scales, from regional conservation networks to residential rain gardens. Fundamentally, green infrastructure is a planning framework for recognizing the valuable services that ecosystems provide. A green infrastructure network helps protect land and water resources that support healthy plants and animals, cleanse air and water, and provide natural spaces for people to recreate. It is also a tool that can help local communities become more resilient to natural hazards and adapt to climate change.[12]

At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains, and wetlands) are critical components of green stormwater management infrastructure. By protecting these ecologically sensitive areas, communities can improve water quality while providing wildlife habitat and opportunities for outdoor recreation. Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally responsible. Green infrastructure, as a stormwater management strategy, utilizes environmental process-based technologies to infiltrate, evapotranspire, capture, and reuse stormwater to maintain or restore natural hydrologies. On a small scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for nonpotable uses such as toilet flushing and landscape irrigation.[13]

Woodlands and Wildlife Habitats—Forests are one of the most beneficial land uses for improving and maintaining clean water. Similar to wetlands, forests act as giant sponges that absorb and slowly release pollutants and sediment from stormwater runoff. Forests store, clean and slowly release about two-thirds of the water that maintains stream-flow and replenishes groundwater. A healthy forest is a complex, interdependent community of plants, animals and soil. Each layer of the forest provides diverse habitats and helps to protect clean water.[14]

[12] http://www.csc.noaa.gov/magazine/2009/03/issue.pdf

[13] http://cfpub.epa.gov/npdes/home.cfm?program_id=298

[14] http://www.chesapeakebay.net/riverflow.aspx?menuitem=14714

Prince George's County has developed a Woodland and Wildlife Habitat Conservation Ordinance (WCO) that provides a regulatory framework to require woodland conservation and protection during and following the development process. The Green Infrastructure Plan provides guidance regarding targeted woodland preservation to protect waterways and support a contiguous forest. Enforcement protocols are in place within the WCO and penalties for infractions and noncompliance are enumerated.

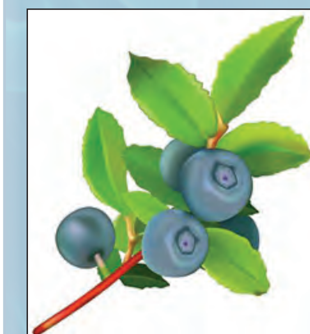
"All things being equal, forests are by far our most strategically important natural resource. In addition to protecting water quality, cleaning our air and providing wildlife habitat, one large tree can eliminate 5,000 gallons of stormwater runoff annually and well-placed trees can help reduce energy costs by 15 to 35 percent."
—Maryland Governor Martin O'Malley

Riparian Forest—Trees, shrubs, and other types of vegetation make up a filter strip along waterways known as a forest riparian buffer, or streamside forest. These plants buffer waterways from the impacts of surrounding land use. The plants prefer moist to very wet soil and can withstand the disturbance of water flowing over and around them. There are many functions attributed to the vital and beneficial resources that are streamside forests. They include:

- Slowing flood waters and reduce the volume of water through root absorption.
- Improving water quality by filtering runoff and promoting sediment deposition.
- Allowing water storage in plant roots and to providing pathways to groundwater layers.
- Providing canopy cover that shades and cools the stream, improving habitat conditions for instream organisms (fish, salamanders, frogs, etc.). This shade also provides relief from extreme heat for terrestrial animals.
- Providing habitat for a variety of birds and small mammals. The buffers also act as corridors of wildlife habitat, providing food, shelter, and nesting sites. Providing great opportunities for recreational activities such as fishing, hiking, bird watching, picnicking, and camping.[15]

Riparian forests that buffer streams significantly reduce the amount of pollutants that enter waterways, sometimes by as much as 30 to 60 percent if stormwater flows through the buffers rather than being piped directly into the stream. Forests currently buffer about 60 percent of the rivers and streams in the bay watershed.[16] Riparian forests shade the water beneath their canopies, maintaining cooler water temperatures in summer months. Mature trees also provide deep root systems that hold soil in place, helping to stabilize stream banks and reduce erosion and siltation. Trees that have fallen into a stream often provide in-stream habitat and a potential food source for aquatic animals.

Biodiversity—Species diversity is essential to the health of the ecosystem. Fauna rely on flora for food and habitat, and the vegetation likewise depends on animals to propagate seeds and spread pollens and spores. Native plants are critical and perform necessary functions to maintain the species diversity of our local ecosystem.



Biodiversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

15 http://www.naturalresources.umd.edu/YourWoodlandRiparianBuffers.html

16 http://www.chesapeakebay.net/forests.aspx?menuitem=14640

Biomass:
All of the living material in a given area; often refers to vegetation.

Microbial Activity:
The multiplication of microorganisms such as bacteria, algae, diatoms, plankton, and fungi.

Nonnative or invasive plants can overpopulate an area utilizing various aggressive reproductive and survival techniques. Without native predators that would naturally reduce the proliferation of the nonnative vegetation, they spread rapidly, often resulting in mono-cultures. Mono-cultures can create "feast" conditions and are susceptible to the rapid spread of disease or pests. The aggressive nature of invasives allows them to infiltrate at woodland edges and this becomes increasingly problematic when woodlands are fragmented due to development of roads and buildings. Nonnatives are often used in the ornamental horticulture industry and if aggressive and invasive, often escape into the wild and overtake native plant communities, disrupting the local ecosystem. Native plants generally have less maintenance requirements than their non-invasive alien counterparts. Because native plants have adapted to local growing conditions over time they are less likely to fail during periods of stress such as drought or prolonged cold.

Conventional lawn and garden care contributes to pollution of our air and water and uses up nonrenewable resources such as fuel and water. Many typical landscapes receive high inputs of chemicals, fertilizers, water and time, and require a lot of energy (human as well as gas-powered) to maintain. The effects of lawn and landscaping on the environment can be reduced if properties are properly managed by using organic alternatives applied correctly, decreasing the area requiring gas-powered tools, using native species that can be sustained with little watering and care, and using a different approach to maintenance practices. The state passed the Chesapeake Bay Phosphorus Reduction Act of 2009, SR-553, which bans phosphorus from being sold in lawn fertilizer (unless it is starter lawn fertilizer). The ban takes effect on April 1, 2011.[17]

Americans manage more than 30 million acres of lawn. We spend $750 million per year on grass seed. In managing our yards and gardens, we tend to over-apply products, using 100 million tons of fertilizer and more than 80 million pounds of pesticides annually. The average homeowner spends 40 hours per year behind a power mower, using a quart of gas per hour. Grass clippings consume 25 to 40 percent of landfill space during a growing season. Per hour of operation, small gas-powered engines used for yard care emit more hydrocarbon than a typical auto (mowers 10 times as much, string trimmers 21 times, blowers 34 times). A yard with 10,000 square feet of turf requires 10,000 gallons of water per summer to stay green; 30 percent of water consumed on the East Coast goes to watering lawns.[18]

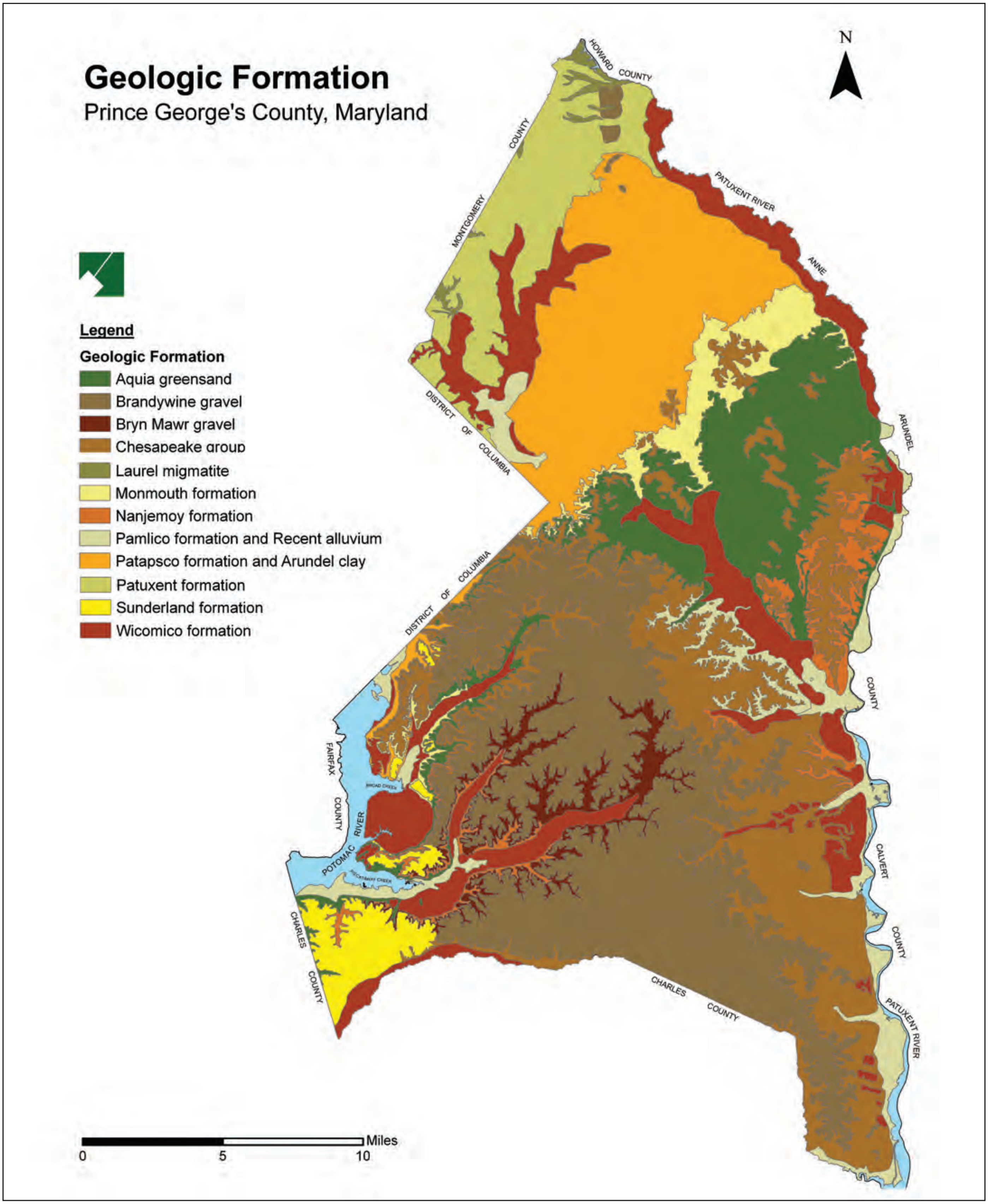
Gradually shifting landscaping practices to using native species provides rewards in terms of environmental quality, landscape sustainability, improved aesthetics, cost savings, and supporting wildlife on the property.

Soils and Slopes—Soil resilience[19] has recently been introduced into soil science to address sustainability of soil as a resource and as a measure to identify and combat soil degradation. Factors that affect soil resilience include soil type and vegetation, climate, land use, scale, and disturbance. Research continues in the development of indicators or quantitative measures regarding the ability of soils to recover from specific disturbances. The extent of soil degradation and the associated impacts on agricultural productivity can be evaluated through understanding of the processes and factors leading to establishment

[17] http://www.environmentmaryland.org/legislature/testimony/clean-water/clean-water/sb-553---chesapeake-bay-phosphorus-reduction-act

[18] http://www.nps.gov/plants/pubs/chesapeake/pdf/chesapeakenatives.pdf

[19] http://cat.inist.fr/?aModele=afficheN&cpsidt=1753670



Map 14: Prince George's County geology.

of the cause/effect relationships for major soils groups, eco-regions, and land uses. A quantitative assessment of soil degradation can be obtained by evaluating its impact on productivity for different land uses through decrease in productivity, reduction in biomass, and decline in the quality of the natural environment.[20] Microbial activities in soil are critical for pollutant reduction. Soils, in concert with vegetation, break down many of the chemicals and metals found in stormwater runoff.

The relationships between topsoil assets and topography indicate land management and development restrictions should consider this interdependent relationship when targeting improvements to soil quality in the county. The spatial variations of soil properties are affected comprehensively by topographic factors, land use, erosion, and erosion control practices in watersheds. Topographic conditions, along with soil structure, affect the capacity of erosive elements to act on soil particles. Soil erosion by water, wind, and tillage affects both agriculture and the natural environment. Soil loss, and its associated impacts, is one of the most important of today's environmental problems. In a small watershed, existing soil and water conservation measures play an important role in controlling soil loss and degradation. Because the restoration of soil properties is difficult to achieve, efforts to reduce loss is strategically more effective. Comparing untilled soil with conventionally farmed soil indicates a reduction in nutrient and structural health due to soil disturbance associated with tillage.[21]

Development activities traditionally strip and discard productive topsoil. Development practices that preserve and/or restore soil functionality should be encouraged. Development should be directed away from highly valuable and productive agricultural soils, ensuring they remain viable resources for future generations. Erosion and sedimentation control requirements reduce the transport of sediment from active construction sites but do not necessarily limit the footprint of disturbed area. Limiting the area graded during development, in addition to phasing active areas of grading, will reduce sedimentation to local waterbodies. In addition to limiting graded areas, Prince George's County may consider providing stormwater benefits to developers who restore soil functionality as part of the construction process, allowing water to infiltrate in ways that replicate similar to predevelopment conditions.

ENVIRONMENTAL AND NATURAL RESOURCES CONSERVATION

Conservation **is preserving and renewing, when possible, human and natural resources and the use, protection, and improvement of natural resources according to principles that will ensure their highest economic or social benefit.**

Parks and Open Space—M-NCPPC's Department of Parks and Recreation in Prince George's County has physical control over approximately 24,000 acres of land in its park system, as well as various structures and recreational amenities. The park system has about 6,200 acres of river parks, 7,100 acres of stream valley parks, and 5,200 acres of community parks. The acquisition of stream valleys for public parkland has been a major endeavor of Prince George's County since 1927 with the creation of The Maryland-National Park and Planning Commission (M-NCPPC). Site specific park plans (e.g., Patuxent River Park and the Anacostia River) establish conceptual uses for specific lands within a designated area of the park system. To date, 6,200 acres have been preserved as the Patuxent Greenways.

Water resource protection, which is closely tied to riparian buffers, is enhanced via the Department of Parks and Recreation's ownership of significant stream valley parkland. These park systems flank many of the county's waterways and offer environmental protection as well as recreational opportunities for county residents and visitors.

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[20] http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1691981

[21] http://adsabs.harvard.edu/abs/2008EnGeo..53.1663W

Planning, environmental evaluation, and public involvement concerning management actions that affect the natural resources of stream valley parks are essential for carrying out M-NCPPC's responsibilities. It is critical to ensure that the environmental costs and benefits of any proposed operation, development, and/or resource management are fully and openly evaluated before taking actions that may impact the parkland's natural resources. This evaluation must include appropriate participation by the public; the application of scholarly, scientific, and technical information in planning, evaluation, and decision-making; department knowledge and expertise through the creation of interdisciplinary teams and processes; and the aggressive incorporation of mitigation measures, pollution prevention techniques, and other principles of sustainable park management.[22]

Urban Forests—The urban forest is the system of trees and associated plants that grow individually, in small groups, or under forest conditions on public and private lands in cities, towns and municipalities, and their suburbs. Urban forest research and new technical analysis tools have defined a wider role and value for urban trees. There is greater recognition of how urban trees and forests improve air and water quality, reduce stormwater runoff, conserve energy, and protect public health, provide a wide range of ecosystem services, and increase property values. At the same time, the loss of trees and forests in watersheds experiencing development pressures continues, and urban tree canopy in inner cities deteriorates through removal, death, or lack of replacement. The rate of conversion of forests to urban uses increased twofold from 1982 to 2001 in the United States, reinforcing the need for greater integration of urban forestry and land use planning (Natural Resources Conservation Service, 2001).

In order to accurately and consistently plan for water resource protection, conservation, and preservation, the planning process should include research and technical analysis of land cover to support the ecosystem function of trees to improve air and water quality, as well as their ability to effectively reduce energy consumption. Public policies should be in place to provide an effective tree canopy program designed to protect and increase tree canopy in our urbanized communities. Prince George's County's developed communities need planning assistance to assess their existing tree cover, calculate the economic value of their trees as an ecosystem service, set tree canopy goals, and implement and fund steps to achieve them. Success stories of cities that have incorporated the ecosystem value of trees into their local ordinances, BMPs, and replacement value of destroyed trees are abundant and serve as motivation for Prince George's County to pursue similar goals.

Updates to the county WCO contain language to help promote, support, protect, and replant urban forests and tree canopy in the developed communities in Prince George's County. By site, the ordinance requires a 15 percent tree canopy for urban development, infill, and redevelopment projects.

Agricultural Land—Agricultural ecosystems are communities of plants and animals that have been modified by people to produce food, fiber, fuel, and other products for consumption and processing.

Nutrient:
Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Urban Forestry
refers to individual parks, yards, and street trees, as well as forest fragments such as wooded parkland, unimproved lots, and naturally regenerating areas.

[22] http://www.parks.ca.gov/?page_id=1334

Conservation Tillage:
To conserve moisture and reduce evaporation on sun-baked crop fields, farmers leave the stalks and leaves of harvested crops on the ground to create a type of natural mulch for newly planted crops.

"Agriculture is a land use that assumes a dynamic form and assumes functions of interrelationships and processes. An area used for agricultural production, is a complex managed system in which ecological processes found under natural conditions also occur, e.g., nutrient cycling, predator/prey interactions, competition, symbiosis, and successional changes." [23]

Year after year the Chesapeake Bay is inundated with nutrient pollution as millions of pounds of nitrogen and phosphorous flow into its tributaries from the land and fall into its waters from the air. Every summer the effects of that pollution are revealed in algae blooms and massive dead zones that spread over a third of the bay. Despite the best efforts of many farmers, agriculture remains one of the leading sources of these nutrients, which run off of both crop and animal farms.

Agriculture represents a significant land use in the rural and some suburban portions of Prince George's County. Agricultural activities such as tillage, drainage, intercropping, rotation, grazing, waste management, and extensive usage of pesticides and fertilizers have significant implications for water quality and wild species of flora and fauna. Agriculture is an intensive and changeable land use that is capable of quickly adjusting to changes and progress in the development of BMPs. The county and its agencies should actively support local framers' implementation of BMPs to ensure that agriculture, as the county's largest open space resource, contributes to the health of regional surface and groundwater resources.

Maryland law requires farmers to have nutrient management plans so they know how much fertilizer to use each season and can reduce their runoff by only applying what they need. The storage and disposal of animal waste is also a source of nutrients that affects the bay. There are additional methods, BMPs, that farmers can implement on their fields and farms to further reduce the nutrient runoff. In Prince George's County, the Agricultural Nutrient Management Program is funded by the Maryland Department of Agriculture. The program provides nutrient planning services to Maryland farmers via a network of nutrient management advisors at county extension offices, soil conservation districts, and with private consultants. These service providers administer continuing education and technical support to achieve certified nutrient management plans.

Active agriculture is also required to maintain soil conservation and water quality plans (SCWQPs). A SCWQP is a comprehensive plan that addresses natural resource management on agricultural lands and utilizes BMPs that control erosion and sediment loss and manage runoff. SCWQPs include management practices (such as crop rotations) and structural practices (such as sediment basins and grade stabilization). At the request of a farmer, a professional from a soil conservation district, the Maryland Department of Agriculture, or the USDA works with the farmer to determine the group or system of practices needed to address specific erosion and runoff concerns on the farm. The practices are designed to control erosion within acceptable levels and to be compatible with management and cropping systems. A SCWQP can be used for up to ten years without revision if substantial changes in management do not occur. Nutrient reduction is only one of many benefits derived from SCWQPs. Also included in a SCWQP are recommendations concerning forestry management, wildlife habitat and plantings, pond construction and management, and other natural resource management.

[23] Miguel A. Altieri, "Agroecology: Principles and Strategies for Designing Sustainable Farming Systems," University of California, Berkeley, 1995.

Forestry—Actively managing our forests, woodlands, and urban trees as sustainable and renewable resources is critical to maximizing the economic, social, and environmental benefits these resources provide. Foresters should demonstrate a proactive commitment to sustainability by developing and implementing a long-term forest management plan. Management plans should require active and adaptive participation in achieving the county's objectives, be consistent with the scale of the forestry operation, and reflect implementation of the most current BMPs available for forestry and natural resource management. The Natural Resource Conservation Service (NRCS) is available to provide technical assistance and sometimes grant funding for sites implementing best practices.

Sand and Gravel—Sand and gravel assets in Prince George's County represent a significant economic resource. These operations have historically created divisions within communities and represent an invasive land use that must be monitored and managed to minimize its operational impacts to social and environmental concerns. Sand and gravel extraction and crushing, washing, and screening from pits or hillsides leaves behind large holes and pits on the landscape and creates nonpoint source pollution that affects local waterbodies. When mining activities are located near water recharge or surface water areas, it can expose the saturated zones leaving groundwater vulnerable to contamination. Furthermore, abandoned pits have been used as illegal dumping sites for the disposal of solid and liquid wastes and runoff from these contaminants can cause additional pollutant impacts. BMPs for mining operations and reclamation should be reviewed and required in order to minimize the detrimental environmental consequences associated with this activity including:

- Install ditches and dikes to collect wash water and divert runoff to control erosion and sedimentation.
- Construct berms to prevent fuel and soil maintenance areas from contaminating large ground areas.
- Use reclamation activities to enhance the aesthetics of the land and prevent continued erosion, sedimentation, and infiltration of nutrients once mining activities are complete.

Prince George's County is currently reviewing sand and gravel practices and the associated regulatory requirements. New environmental legislation should require a natural resource inventory (NRI) to be submitted with applications for special exceptions to undertake mining activities.

Fisheries—The Chesapeake Bay Agreement includes commitments to aid in the restoration of the bay's once productive fisheries. One priority commitment is to "provide for fish passage at dams and remove stream blockages wherever necessary to restore passage for migratory fishes." Sections 4-501 and 4-502 of the Natural Resources Article, Annotated Code of Maryland, require the owners of dams "to construct and keep repaired at least one fish ladder if the DNR deems it necessary for the passage of fish." The definition of "dam" is considered to include any structure blocking the passage of fish such as road crossings, gauges, weirs and pipelines, etc.

Fish blockages can be caused by manmade structures such as dams or road culverts and by natural features such as waterfalls or beaver dams. Fish blockages occur for three main reasons. First, there is a vertical water drop, such as a dam, that it is too high for fish to swim over. A vertical drop of six inches may cause fish passage problems for some resident fish species, while anadromous fish can usually move through water drops of up to one-foot, providing there is sufficient flow and water depth. The second reason a structure may be a fish passage problem is because the water is too shallow. This can often occur in channelized stream sections or at road crossings where the water from a small stream has been spread over a large flat area and the water is not deep enough for fish. Finally, a structure may be a fish blockage if the water is moving too fast. This can occur at road crossings where the culvert pipe has been placed at a steep angle and the water moving through the pipe has a velocity higher than a fish's swimming ability.[24] The use of embedded or arched culverts at smaller crossings can preclude the need for fish ladders and allow for fish migration and also help reduce erosion common at bridges.

Due to the increasing amount of fish blockages on the various tributaries to the Patuxent and Potomac Rivers, fish that spawn in freshwater streams are not able to migrate upstream to lay their eggs. This blockage, coupled with intense fishing practices, has vastly decreased the populations of popular species like yellow perch and shad.

LAND DEVELOPMENT

Water quality is ultimately linked to population growth and development patterns; as we add more roads, septic systems, parking lots, and disturbed areas of land, we create more pathways for pollutants to reach surface water and groundwater at an ever escalating rate. As people move further away from city centers, they often have to spend more time on the road to reach their destinations, increasing both congestion and greenhouse gases. Vehicle emissions, a source of airborne nitrogen, eventually falls to the ground and is carried off in stormwater, adding to excessive nutrient loads in our streams. An increase in roadways and vehicle traffic also contributes other pollutants including metals, trash, and debris.

Building away from existing centers also dramatically changes the heritage and economic diversity of local communities. Increased development in small and rural communities can impact existing local industries, such as farming, fishing, and forestry. New residential and commercial development in these areas can also alter the visual character and "sense of place" that make the Chesapeake region unique.[25] Few decisions have greater impact on the quality, reliability, availability, and overall sustainability of water resources than how and where we grow.

Transportation—The rate of increase in imperviousness creates a compelling case for applying smart growth strategies to maximize the use of existing transportation infrastructure and implementing environmental site design (ESD) stormwater management practices to manage runoff along transportation corridors. Roads, bridges, driveways, and parking lots currently constitute a large portion of the impervious surfaces in the county. After construction, impervious area prevents rainfall from being absorbed into the ground, and therefore it becomes stormwater runoff. This development cycle negatively impacts water quality, bringing trash, oil, chemicals, and sediment along with the stormwater into waterbodies. Paved surfaces, even as bikeways, trails, and sidewalks, can exacerbate the problem of contaminated water resources resulting from this nonpoint pollution source.

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[24] http://dnr.md.gov/streams/res_protect/fish_barrier.html

[25] http://www.chesapeakebay.net/developmentpressure.aspx?menuitem=19514

Planning transportation infrastructure wisely is essential to improving the quality of water and reducing the quantity of water that enters streams, rivers and the bay as stormwater runoff. Long-term infrastructure needs, as represented in MDOT's Consolidated Transportation Program (CTP)[26] or the State Highway Administration's (SHA) Highway Needs Inventory (HNI)[27], significantly affect the placement and density of development within Prince George's County which in turn influence the local and regional water needs. Consistent with state policies, the Countywide Master Plan of Transportation emphasizes transit and nonmotorized modes of travel, demonstrating the county's commitment to environmental stewardship and healthier travel choices to the places where people live, work, shop, and engage in recreation. Rail and bus transit improvements, with accompanying enhancements to sidewalk connectivity, are planned for the Developed and Developing Tiers of the county, where most future development will occur. These measures are established to increase vehicle occupancy and foster more efficient use of existing transportation infrastructure. They reduce the need for new road construction, or widening of existing roads. The county's Rural Tier policies discourage additional development and encourage the maintenance of the existing transportation system that preserves its open space, rural character, and environmental quality. Implementation of these policies will lead to fewer emissions of nitrogen oxides, volatile organic compounds, and carbon dioxide, which build up from the burning of fossil fuels and find their way into surface and groundwater supplies. In addition, measures to improve vehicle efficiency use cleaner, lower-carbon content fuels from renewable sources and reducing vehicle miles traveled (VMT), are key to improving air and water quality and reducing greenhouse gases. Development that is close to and accessible via transit and nonmotorized transportation modes fosters the reduction of VMT. Shorter transportation trips are possible with compact development, also providing for more open space and green infrastructure opportunities.

Mitigating the adverse impacts of transportation infrastructure using nonstructural and/or structural techniques of stormwater management is essential to reducing the erosion of stream channels and improving long-term water quality. Acquiring rights-of-way for transportation projects should include provisions for stormwater management areas as well as bike lanes, shoulders, and sidewalks. The Countywide Master Plan of Transportation includes environmental stewardship strategies to minimize stream and wetland crossings; cross streams at right angles and with widths that match the stream width where possible; protect wildlife and habitat; use drainage structures that prevent road and ditch runoff from directly entering the stream; retrofit stream crossings in a way that removes fish blockages; and locate stormwater management strategies on-site and within the road rights-of-way and/or open section roads with bio-swales contain 2.5 feet of engineered soil, and gravel bottoms with underdrains). The county is also using permeable pavements where possible; minimizing impermeable pavement; prescribing limits to road widths and parking spaces required with development; and promoting efficient use of parking infrastructure.

Industrial—Prince George's County was developed at a time when the waterways formed the backbone of the county's transportation network. Riverbanks, floodplains, and riparian buffers were developed to support industry that required the transport of

[26] http://www.mdot.maryland.gov/Planning/2009_ctp_tour/Index

[27] http://www.sha.state.md.us/oppen/hni_PG.pdf

goods. Today, these land uses continue to flank many of the county's waterways with development patterns that consist of extensive paved surfaces, large, low buildings with significant roof surfaces, and occasionally, effluent discharges with little to no land available to assist in toxin removal, temperature reductions and/or velocity controls. Industrial stormwater discharges are only permitted under the National Pollutant Discharge Elimination System Program and facilities are required to maintain a stormwater pollution prevention plan to mitigate polluted runoff. Maryland's Brownfields Revitalization Incentive Programs was established in February 1997 as part of Maryland's Smart Growth policy. This program is intended to promote economic development, especially in distressed urban areas, by identifying and redeploying underutilized properties. Reusing real property makes efficient use of existing infrastructure while providing an alternative to developing open space that contributes to urban sprawl. MDE's brownfields site assessment and voluntary cleanup programs (VCP) may provide valuable assistance to the county for the rehabilitation, redevelopment, revitalization or property acquisition of commercial or industrial property. These programs involve environmental site assessment in accordance with accepted industry and financial institution standards for property transfers.[28]

Eco-industrial design (EID) is based on the idea that a flourishing economy and environmental health can coexist through strategies that integrate environmental, economic, and community development goals. At its root, however, is an emphasis on fostering networks among businesses and communities to optimize resource use and reduce economic and environmental costs. The eco-industrial concept encompasses a range of approaches, including pollution prevention; byproduct exchange; green design; life-cycle analysis; joint training programs; and public participation. The underlying principle of industrial ecology is that commerce and ecology should unite such that production and distribution mimic and enhance natural processes.[29] EID seeks to promote environmental stewardship at the business, site, and community levels. The ultimate environmental goals of eco-industrial strategies are to reduce the use of virgin materials, decrease pollution, increase energy efficiency, reduce water use, and decrease the volume of waste products requiring disposal. This approach encourages companies to adopt innovative processes and technologies that reduce waste of energy, water, and materials.[30]

Eco-industrial planning recommends closed production loops to support the elimination of wasted energy, water, and materials. "The goal is to minimize environmental impacts by changing both the way goods and services are produced (process technology) and the products themselves (product design)."[31] These systems promote recovery of end products and recycling of base materials and reusable industrial wastes back into the production process.

Residential, Commercial, and Institutional—Smart growth principles provide a template to develop standards and strategies regarding where and how we live, work, shop, recreate, and learn. Leadership in Energy and Environmental Design (LEED) standards are incorporated into sustainable site design and building techniques in order

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[28] http://www.mde.state.md.us/Programs/LandPrograms/ERRP_Brownfields/bf_info/index.asp

[29] http://www.eda.gov/PDF/1G3LR_5_schlarb.pdf

[30] Ibid.

[31] Ibid.

to create a built environment that protects water and other natural resources and minimizes energy use to the maximum extent practicable (MEP). Building in concert with the natural environment is cost-effective to construct and maintain, prioritizes human comfort and well-being, and represents value added because of these inherent environmental, economic, and social benefits. Selecting development sites that avoid protected resources and hazardous conditions makes it possible to build fewer roads and avoid associated construction impacts by limiting access. Development accessible by transit, sited within one-quarter to one-half mile of transit service, providing for greenway, bikeway, and sidewalk linkages, helps to reduce carbon and nitrogen emissions to both the air and the water. Energy conservation that emphasizes renewable energy sources such as solar, wind, and geothermal, also reduces greenhouse gas emissions, a major contributor to climate change.

Communities protect open space because it protects streams and water quality; provides habitat for plants and animals; preserves rural character; provides recreational areas; protects home values, and reduces costs of municipal services. Consequently, land conservation makes communities better places to live. Conservation subdivision design (CSD) is a green development strategy that can help communities preserve open space and natural areas in residential housing developments. Each time a property is developed into a residential subdivision, an opportunity exists for adding land to a communitywide network of open space. CSD rearranges the development on each parcel as it is being planned so that half (or more) of the buildable land is set aside as open space. Conservation subdivision can provide open space amenities on land that has been designated appropriate for residential development but should be discouraged in areas of the county that are better suited for farm and forest preservation. Without controversial "down zoning," the same number of homes can be built in a less land-consumptive manner, allowing the balance of the property to be permanently protected and added to an interconnected network of community green spaces. This "density-neutral" approach provides a fair and equitable way to balance conservation and development objectives[32] where appropriate.

Developments that use environmental site design (ESD), which conserves existing natural systems and topographic features, can reduce flooding and other stormwater challenges. ESD furthers stormwater infiltration, helping to reduce surface runoff during storm events. By controlling erosion and sedimentation during construction and throughout the building's useful life, natural systems will continue to function and provide protection from storms and maintain healthy ecosystems in our waterways. Impervious surfaces that contribute to negative environmental impacts can be mitigated through the enhancement of an urban tree canopy. Rooftop gardens provide shade and reduce heat generated by pavement, parking lots, and other hard surfaces, helping to cool surface water and stormwater. ESD reduces overall energy costs by decreasing the amount of impervious surfaces and increasing the amount of green space and tree canopy to reduce heating and cooling costs in buildings. Using ESD stormwater management enhances, restores, and protects the quality of the water resources that are critical to all living things.

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32 http://www.natlands.org/uploads/document_33200515638.pdf

CHAPTER ISSUES SUMMARY

- Water behaves in response to established scientific principles and protection and restoration strategies for water resources should be developed to respond to, and support, the natural hydrologic process.
- Sprawling growth patterns have resulted in degraded stream systems, fragmented forests, reduced groundwater and aquifer recharge, and a decrease in the amount of tidal and nontidal wetlands.
- Unsustainable development practices have consumed open space that provides social and environmental benefits and has contributed to economic burdens from the supportive and expansive infrastructure requirements.

POLICIES AND STRATEGIES

Hydrology, Water Quality, and Stream Morphology

POLICY:

Natural hydrologic patterns are maintained to the MEP to preserve stream base flows; control flooding; support neighborhood, community and countywide health; and protect and preserve environmentally sensitive features and living resources.

STRATEGIES:

- Complete and routinely update stream corridor and water quality assessments for all watersheds in the county to inform and support watershed restoration efforts.
- Acknowledge that stream water quality declines when impervious cover in watersheds exceeds 10 percent and is severely degraded when imperviousness exceeds 25 percent, and provide pre- and post-development accountability for reductions in impervious cover as appropriate in watersheds.
- Provide opportunities in development and redevelopment projects for groundwater recharge and stormwater infiltration through reduction of impervious surfaces.
- Protect and preserve headwater wetlands, headwater areas of streams, and riparian corridors by increasing buffers where practicable to preserve, restore and, maintain natural hydrology.
- Utilize a cautionary approach when recommending and implementing stream corridor restoration projects, acknowledging that singular actions have system-based effects.

Wetlands and Floodplains

POLICY:

Wetlands and floodplains are protected to regulate the flow of pollutants into the rivers, streams, and groundwater; control erosion and flooding; control the rate and volume of runoff; provide critical wildlife habitat; improve water quality; protect shorelines and property; and provide economic and recreational opportunities.

STRATEGIES:

- Reduce, mitigate, or eliminate any potential flood hazards and prevent future flood hazards caused by new development on flood-prone land through rigorous enforcement of existing floodplain regulations.

- Provide additional buffer protection for wetlands in critical flood-prone areas for their ability to soak up and hold large amounts of flood and stormwater.
- Develop a wetland protection program to identify, preserve, protect, enhance, and restore wetland resources in Prince George's County.
  - Develop a comprehensive inventory of wetland resources that identifies wetlands by location, type, extent, condition, and function.
  - Identify wetland resources that have been lost or impaired due to alterations to surface and groundwater quantity and quality from land use changes.
  - Prioritize protection, restoration, and enhancement of wetlands with highest priority given to enhancing surface and groundwater quality to meet regulatory requirements.
  - Provide wetland-related goals and priorities to inform and guide county master planning.
  - Review county environmental guidelines and environmental review criteria for needed changes and amendments to enhance wetland protection and restoration, such as increased wetland buffer requirements.
  - Increase regulatory protection requirements for wetlands and their buffers, as well as for development on land near high-quality wetlands that influence surface and groundwater.
  - Consider more restrictive zoning and higher standards for permits related to development, such as stormwater discharge permits, on land near high-quality wetlands.
  - Analyze the cumulative effect of all proposed development on wetlands and their buffers, and ensure the maintenance of adequate surface and groundwater quantity and quality to wetlands before allowing individual projects to proceed.

Groundwater and Aquifers

POLICY:

Source water aquifers, reservoirs, and streams are protected to assure the continued availability of high quality drinking water for county residents, workers, and visitors.

STRATEGIES:

- Educate citizens, developers, and regulatory agencies regarding the importance and sensitivity of groundwater resources.
- Raise public awareness regarding the importance of groundwater as a drinking water source and the necessity to prevent contamination.
- Provide planning and data sharing assistance to WSSC and regulatory agencies to help protect valuable drinking water resources. Improve data management and accessibility.
- Reduce existing impervious surfaces during redevelopment, and limit impervious surfaces during development projects in aquifer recharge areas of northern Prince George's County.
- Encourage ESD stormwater features that recharge groundwater, such as rain gardens, bioretention, infiltration areas, and created or enhanced wetlands, to maintain stream base-flows during drought.

Natural Resources

POLICY:

The county considers a broad-based green infrastructure approach to wet weather management that is cost-effective, sustainable, and utilizes environmental process-based technologies to infiltrate, clean, and manage stormwater.

STRATEGIES:

- Complete an assessment of urban forests, adopt local goals to increase urban tree canopy, and encourage measures to attain the established goals with local jurisdictions, municipalities, and/or communities.
- Protect and enhance ecological biodiversity through deer, geese, and invasive species management programs to ensure the long-term health of forests and help reduce fecal bacteria contamination of water resources.
- Protect the urban tree canopy in developing watersheds by encouraging preservation and requiring replacement of mature trees that are removed.
- Expand the definition of green infrastructure to apply to an urban context and include urban tree canopy, green roofs, and other environmentally beneficial features that are more feasible than land conservation in dense urban environments.
- Measure and document categories of green infrastructure in urbanized and urbanizing watersheds to establish green infrastructure goals based upon the current level of impairment, future compliance with total maximum daily loads, and develop a program to support implementation.
- Woodland mitigation sites should be actively identified during the planning process and landowners should be contacted and supported to place desirable woodlands into mitigation banks.

POLICY:

Land management and development practices to preserve and/or restore soil functionality consider the relationships between topsoil assets, topography, and climate. These practices provide targets for preservation of high-quality soils, improvements to degraded soils, and mitigation of topsoil loss through erosion in the county.

STRATEGIES:

- Provide quantitative assessments of soil degradation by evaluating its productivity for different land uses, any reduction in biomass, or general decline in the quality of the natural environment.
- Limit the area graded during development to the MEP and phase active areas of grading to reduce sedimentation to local waterbodies.
- Disallow development activities that strip and discard productive topsoil.
- Devise a method to provide stormwater management credits to developers who restore soil functionality as part of the construction process.

Parks and Open Space

POLICY:

The county recognizes the value and importance of establishing, preserving, restoring, and maintaining public conservation areas and easements for water resource protection.

STRATEGIES:

- Review all recreational development plans for conformity with water resource protection goals and county sustainability policies.
- Target parkland acquisition that makes important open space connections, protects sensitive environmental features, provides water resource protection, and assists in compliance with current and future TMDLs in the watershed.
- Evaluate public open space, particularly in urban centers, to meet multiple goals including stormwater management and restoration of natural systems, by integrating green infrastructure and ESD principles to the MEP.
- Design, build, and maintain trail networks in stream valley parks to minimize negative impacts to the natural environment resulting in loss of biodiversity, forest fragmentation, disruption of natural process, and the degradation of water resources.

Agriculture

POLICY:

Sustainable management of working forests and farms reduces and/or eliminates unsuitable agricultural practices and supports economic, environmental, and public health goals while contributing to a pastoral and cultural landscape that promotes water quality protection and provides ecological services.

STRATEGIES:

- Encourage the use of conservation tillage, no-till farming, rest-rotation grazing, crop rotation, and intercropping to minimize surface soil disturbance during planting to reduce soil erosion and sediment runoff.
- Encourage cover crops such as winter wheat, rye, or barley to reduce soil erosion and absorb excess nitrogen and phosphorous that remains in the soil after the summer crop has been harvested.
- Support farmers in the development of nutrient management and soil and water quality plans to comply with the state's nutrient management law and reduce nutrient and sediment loading rates associated with active agriculture.
- Identify opportunities to establish streamside buffers, wetlands, and other wildlife habitat areas through the Conservation Reserve Enhancement Program.
- Encourage reduction of pesticides, herbicides and fertilizers through integrated pest management.[33]

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[33] Integrated pest management (IPM) is an effective and environmentally sensitive approach to pest management.

- Support manure management programs including building manure sheds, transporting manure to areas for beneficial use, the use of watering troughs and fencing to keep livestock out of streams, and developing management plans to help farmers handle their excess waste.
- Encourage composting and recycling of biomass from agricultural sources.
- Manage organic matter, enhance soil biotic activity, support biodiversity, and encourage species and genetic diversification to provide favorable conditions for plant growth.
- Minimize water, soil and nutrient losses due to solar radiation, air flow, and water runoff via microclimate management, water harvesting, and soil protection through increased soil cover.

Forestry, Sand and Gravel Mining, and Fisheries

POLICY:

Sustainable natural resource industries that provide the county with economic stability are evaluated for associated environmental impacts, must provide a structured plan to minimize disturbance to the natural system, and are required to restore the landscape and water resources to a healthy biological community to the MEP during and following all natural resource industry-related activities in a timely fashion.

STRATEGIES:

- Enforce regulations with regard to timber harvesting and the protection of sensitive resources to ensure that harvesting operations are conducted in a manner that protects the resources remaining after the harvest.
- Support managed woodlands to promote sustainable forestry, improve stream health, stabilize soil, reduce nutrient runoff, and sequester carbon through actively growing forests and tree biomass.
- Prepare a special countywide study to analyze past, current, and future sand and gravel mining operations with regard to sensitive extraction, compatibility with existing communities, and appropriate future land uses.
- Ensure sand and gravel mining operations implement timely restoration, remediate environmentally hazardous conditions, and ensure fill materials do not contribute to surface water or groundwater degradation.
- Restore, enhance, and protect aquatic living resources, their habitats, and ecological relationships.
- Sustain fisheries and provide for a balanced ecosystem while maintaining the water quality necessary to support those living resources and to protect human health by regulating harvesting practices and protecting habitat quality.

Land Development

POLICY:

Growth policies, development patterns, zoning, environmental regulations, and building standards maintain environmental balances and sustainable land uses.

STRATEGIES:

- Support public transit and transportation oriented design strategies to reduce air deposition of pollutants.
- Evaluate transportation projects at a watershed level to determine the stormwater runoff impacts and opportunities for stormwater management.
- Plan transportation infrastructure to reduce carbon emissions, manage stormwater, and limit infrastructure costs.
- Acquire rights-of-way for transportation projects as opportunities for stormwater management as well as providing for bike lanes, sidewalks, shoulders, and utility easements where feasible.
- Design open section roads with bio-swales, encourage the use of pervious pavement, build to minimum pavement standards, and utilize nonstructural stormwater management in all new road projects where practicable.
- Retrofit highway median and interchanges using ESD techniques and plant vegetation in highway rights-of-ways, such as clover leafs and diamonds near interchanges, median strips, and required buffers. Where practicable, ensure that all transportation retrofits and new construction projects continue to provide safe transport for vehicles, bikes, and pedestrians.
- Review and support code modifications to adapt to emerging planning BMPs that reduce waste, minimize impervious surfaces, diminish impacts associated with construction, provide for conservation and efficient water standards, and incorporate smart growth principles.
- Work with communities to develop standards to encourage retrofit of county industrial land uses to minimize negative environmental impacts and improve stormwater management, including the reduction of discharge effluents, development of recycling strategies to reduce overall waste, establishment of energy reduction and efficiency goals, and reduction of water usage through conservation and recycling programs.
- Support adaptive reuse of buildings, infill development, redevelopment, and ESD retrofits in county centers and corridor nodes.
- Support LEED and other green building principles that reduce energy consumption and provide for long-term sustainability.
- Develop countywide building code standards that incorporate LEED certification requirements for implementation of green roofs, water reuse, and other green practices.
- Review the county's conservation subdivision standards to ensure the code supports the intent to protect and preserve more natural land and open space than would be protected through conventional development.
- Enforce stringent maintenance requirements and inspection schedules for all county and private stormwater management structures and facilities.

Stormwater management decisions will be made within a watershed-based system of knowledge based on the best available scientific data, regulatory requirements, watershed and development needs, economic, and environmental impacts, and local opportunities and constraints.

VII: STORMWATER

Stormwater runoff refers to rain that falls on impervious areas (hard surfaces such as paved streets, parking lots, and rooftops) or areas with limited permeability (lawns, decks, patios) and flows to the stormwater drainage system and/or local waterbodies. Impervious areas do not allow rainfall to soak or infiltrate into the soil; therefore, precipitation becomes stormwater runoff. Stormwater runoff affects water quantity and quality and is closely associated with land use. Because stormwater pollution is the result of everyone's everyday activities and existing land uses, the management of stormwater pollution requires a watershed-based effort and participation from a number of stakeholders.

Understanding the impacts of development on water quality continues to remain an undefined variable; however, there are known benchmark standards to assist in evaluating existing and proposed development. One such benchmark acknowledges that stream water quality declines when impervious cover in watersheds exceeds ten percent and is severely degraded when imperviousness exceeds 25 percent.[1]

Efforts to improve water quality have traditionally focused on reducing pollutants from point source discharges such as industrial facilities and municipal sewage treatment plants. Congress amended the Clean Water Act in the late 1980s and early 1990s, increasing the focus on stormwater pollution. According to EPA, stormwater pollution is the leading cause of water quality impairment in the United States.[2] Similarly, watershed impairment in the Chesapeake Bay basin and Prince George's County is attributed to stormwater pollution.

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1 Chesapeake Bay Program, a Watershed Partnership

2 http://www.epa.gov/owow/nps/whatis.html

STORMWATER LAND DEVELOPMENT REQUIREMENTS

The Prince George's County's landscape has changed dramatically over the past century along with other areas of the Chesapeake Bay watershed around the Washington metropolitan area. The land use changes in Prince George's County and their impact are outlined in greater detail in the sections on Watershed and Land Use Planning. Changes in the landscape and the intensity of development can cause a number of stormwater-related challenges, if not properly mitigated, including:

- Increased flooding and/or flood frequency.
- Increased the velocity of streamflow.
- Increased stream bank and instream erosion.
- Changed stream geometry.
- Reduced groundwater recharge and baseflows during drought periods.
- Altered stream hydrology.
- Impaired aquatic habitat and recreational uses of water resources and the bay.
- Reduced quality of life for Prince George's residents.

Stormwater runoff reaches streams very quickly following storms, allowing for minimal infiltration and causing decreased stream baseflows during dry times, thus increasing the frequency and intensity of flooding and accelerated stream erosion. As land cover changes from natural conditions to suburban and urban development, the percent of runoff increases. In addition to the increase in stormwater runoff, there is a corresponding decrease in deep groundwater recharge and interflow. Depressed levels of interflow can lead to dramatic changes in stream flows; flows are very heavy following rain events and very low during dry periods. The fluctuation in stream flows can stress aquatic life and aggravate stream bank erosion. Groundwater recharge is important in the rural areas of Prince George's County that rely on groundwater supplies to meet many of their water needs, including agriculture and fire suppression.

As stormwater runoff travels across the land, it picks up pollutants that can adversely affect water quality. The pollutants can negatively impact water quality, threaten drinking water supplies, impair aquatic habitat, and impact recreational uses of streams and the bay. In addition to stormwater pollutants, the increased velocity and quantity of stormwater increases streambank and in-stream erosion, adding additional sediment loads to local waterbodies. As the land use changes in the suburbanizing areas of Prince George's County, erosion can add sediment loads if construction sites are not properly protected during and after development. Topsoil also provides for infiltration and treatment of rainfall that is not achieved by impervious areas and the clay below the topsoil that can be exposed during the development process.

Past land use changes in Prince George's County have resulted in an increase in higher density residential areas, commercial, industrial, and institutional land uses that are more likely to produce potential stormwater pollutants. Similarly, agricultural lands that do not follow best management practices (BMPs) for nutrient application, erosion and sediment control, and waste management also add polluted stormwater runoff. The clearing of trees, alteration of natural topography, and stripping of top soil can result in changes to the natural underlying hydrology. Seeps and perched water tables can and may have resulted from this activity in Prince George's County. It is recommended that

Baseflow:
The proportion of water flowing in streams and rivers that comes from ground water. River flow during dry weather conditions may be virtually all baseflow. At least 40 percent of all the annual flow total of rivers in the U.S. is derived from baseflow.

Accelerated Erosion:
Erosion of soil and sediments at a much more rapid than (geologic) erosion, usually resulting from land use influences or natural catastrophes, such as fire, that expose soil surfaces.

Interflow:
Water that infiltrates the soil surface and then moves laterally through the upper soil layers toward stream channels and other water bodies (lakes andwetlands). Interflow occurs on slopes where lower soil horizons (layers) are less permeable.

reports of flooding be geographically documented and aligned with a soils and topography layer to identify patterns and hot spots. Current regulations for development practices, as well as additional practices recommended in this section, help protect water quality during future land use changes.

Mitigating Impact of Development—A key to protecting watershed health is to maintain as close to the natural hydrologic and water quality conditions and water balance as is achievable and practicable. This should be achieved through one or more of the following:

- Developing land in a way that minimizes its impact on a watershed and reduces both the amount of runoff and volume of pollutants generated.
- Using the most current and effective erosion and sedimentation control practices during the construction and post-construction phases of development.
- Controlling stormwater runoff peaks, volumes, and velocities to prevent both downstream flooding and streambank/channel erosion.
- Treating post-development stormwater runoff before it is discharged to a waterway.
- Implementing pollution prevention practices to prevent stormwater from becoming contaminated in the first place.
- Using various techniques and practices to maintain groundwater recharge.

It is important to assess various scaled watersheds during the evaluation of existing land use and land use planning. On a smaller local or site-level scale, there are a variety of structural, nonstructural, and site design measures that can be used for achieving the goal of water quality improvement.

"Development itself is not necessarily harmful to water quality; it is the way that land is developed—where new roads and buildings are located and how they're built—that can have a lasting negative impact on the natural environment. Clearing removes the vegetation that intercepts, slows, and returns rainfall to the air through evaporation and transpiration. Grading flattens hilly terrain and fills in natural depressions that would otherwise slow and provide temporary storage for rainfall. The topsoil and sponge-like layers of humus are scraped and removed and the remaining subsoil is compacted. Rainfall that once seeped into the ground now runs off the surface. The addition of buildings, roadways, parking lots, and other surfaces that are impervious to rainfall further reduces infiltration and increases runoff. "

– Chesapeake Bay Program Site

Best Management Practice (BMP):
Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Hydrology:
The scientific study of the properties, circulation, and distribution of water as it occurs within the atmosphere and at and below the earth's surface. Hydrology generally includes hydrologic aspects of ground water, rivers, and wetlands.

STORMWATER RESPONSIBILITY

Stormwater pollution results from developed land and the daily activities that occur on the land. Because of the vast number of sources of stormwater pollution, there are a number of departments within Prince George's County that have responsibility for stormwater management. A watershed-based approach to stormwater management provides a logical foundation for cooperation between these programs. The various departments, agencies, and working groups' roles and responsibilities are outlined below.

Department of Environmental Resources (DER)—The mission of DER is to protect and enhance the natural and built environments of Prince George's County by enforcing federal, state, and county laws to create a healthy, safe, and aesthetically pleasing environment for all the residents and businesses of the county. DER is responsible for the following stormwater related programs: municipal separate storm sewer system permits, floodplain studies and management, watershed assessments and planning, and pollution prevention. The extent of these programs is summarized below:

Municipal Separate Storm Sewer System Permit—DER is the permit administrator for compliance with the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase I permit, including annual reporting. Prince George's County has operated under a MS4 permit (MD0068284) since 1993, with the permit updated most recently in 2004. The MS4 permit is a requirement under the Clean Water Act to address stormwater water quality in the county. DER is responsible for compliance oversight with the MS4 permit requirements, including annual permit reporting. The permit requires the following program elements:

> **Source Identification—**Sources of pollutants in stormwater runoff will be identified and linked to specific water quality impacts on a watershed basis. This involves maintaining a Geographic Information System (GIS) database that includes the storm drain system, urban BMPs, impervious surfaces, monitoring locations, and watershed restoration projects. This process will be used to develop watershed restoration plans that effectively improve water quality
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> **Discharge Characterization—**Discharge characterization involves monitoring to assess the effectiveness of stormwater management programs and watershed restoration projects developed by the county.
>
> **Management Programs—**These included all areas served by the county's municipal separate storm sewer system implement programs designed to control stormwater discharges and include stormwater management, erosion and sediment control, illicit discharge detection and elimination, county property management, road maintenance, and public education and outreach.

The MS4 program is routinely evaluated by MDE and the permit is renewed every five years. In October 2009, DER's NPDES permit will be renewed. At this time, MDE will incorporate additional requirements related to impervious cover restoration and TMDLs, as well as the new requirements of the 2007 Stormwater Act. This review and update affords an opportunity to reexamine county MS4 standards in light of additional understandings regarding the impacts of stormwater as well as BMPs to manage those impacts.[3]

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[3] When MDE renews the permit they will provide guidance.

Floodplain Management—DER is responsible for many aspects of floodplain management within the county including delineating the floodplain boundaries and permitting development activities related to flood prevention. DER is currently studying several watersheds and updating flood maps based on hydrologic and hydraulic models. The DER manages the County's participation in FEMA's National Flood Insurance Program (NFIP) and Community Rating System (CRS). Prince George's County currently holds a Class 5 rating, which is in the top two percent of over 1,000 communities nationwide that participate in the CRS.

Under Prince George's County Code Subtitle IV, Group 4, the Department of Environmental Resources has the responsibility to conduct watershed-based flood studies in order to:

- Determine the magnitude and frequency of potential flood events based on existing conditions.
- Determine the magnitude and frequency of potential flood events based on development that is planned for the future.
- Define the possible alternative management techniques to control floods and minimize flood damage.
- Coordinate appropriate stormwater management strategies to alleviate the flooding impacts of land development and stream channel erosion consistent with federal, state and county programs and regulations.

Flood Management Studies—DER has performed watershed studies on 12 individual watersheds that serve multiple purposes including looking at existing flooding challenges and future flooding challenges based on build-out conditions and identifying opportunities to reduce flooding challenges.

Permitting Functions—DER oversees building review and zoning inspections for residential and commercial construction.

Citizen Drainage Complaint Response—DER staff investigates approximately 500 citizen complaints regarding drainage problems per year. Approximately 45 new drainage remediation projects are initiated each year as a result of either homeowner complaints, referrals by other agencies, or requests by county council members.

Department of Public Works and Transportation (DPW&T)—The mission of DPW&T includes maintenance, improvements, and beautification by dedicated, diverse professionals who use innovative technologies to stimulate livable communities through vibrant development.[4] The DPW&T has responsibility for several stormwater management programs including development plan review, maintenance of public stormwater facilities, erosion and sedimentation control inspections, the Livable Communities Initiative, the enforcement of woodland conservation, and the Chesapeake Bay Critical Areas compliance. DPW&T is responsible for most of the aspects of floodplain management as it relates to any proposed development, floodplain studies, and delineation approval.

Development Plan Review—DPW&T is responsible for review of all proposed development plans including the stormwater management conceptual approval through the issuance of site development grading permit. The quantity of

4 http://www.co.pg.md.us/Government/AgencyIndex/DPW&T/

stormwater discharge must satisfy the Stormwater Act of 2007 for water quality, channel protection, and recharge volume using environmental site design (ESD) practices. The Maryland Stormwater Act requires that each county and municipality adopt ordinances to implement a stormwater management program with a focus on mitigating post-construction stormwater runoff. The DPW&T review development plans for compliance with the 2000 Maryland Stormwater Design Manual to ensure that development activity does not negatively impact the stormwater system or the environment.

Stormwater Maintenance—DPW&T is responsible for the road right-of-way maintenance and repairs of the stormwater infrastructure. DPW&T responds to customer complaints and performs routine maintenance and emergency repairs to the system as needed. Services include maintenance of the public storm drainage and flood control facilities; the flood control pumping stations and their grounds; and stabilization of eroded stormwater channels.

Erosion and Sediment Control—DPW&T is responsible for inspecting county-permitted active construction sites for compliance with erosion and sediment control plans. The authority for erosion and sediment control is delegated to the county from the Maryland Department of the Environment (MDE) with the authority being renewed every two years. DPW&T coordinates with the Soil Conservation District (SCD) to ensure that active construction sites are properly maintained to reduce sediment entering the storm drainage system and local waterbodies. The municipalities of Bowie, Laurel, and Greenbelt provide inspection and maintenance for erosion and sediment control in their communities. The State Highway Authority is responsible for erosion and sediment control for all state highway projects within the county.

Woodland Conservation Program—As part of the construction process, DPW&T is responsible for the enforcement of the approved tree conservation plans (TCPs) and associated regulations of the Woodland Conservation Ordinance (WCO). The WCO applies to all sites containing at least 40,000 square feet in area or 10,000 square feet or more of woodlands that do not have a previously approved TCP. If woodland conservation targets cannot be provided on-site, off-site areas must be provided. The woodland conservation program supports The Countywide Green Infrastructure Plan and also supports the Chesapeake Bay Program agreement signed in 2000 (Chesapeake 2000),with a goal for permanent preservation of 20 percent of the land area in the watershed by 2010.

Livable Communities Initiative and Litter Control Programs—DPW&T oversees the Livable Communities Initiative (LCI), which began with an evaluation of environmental problems facing the county and identified opportunities to enhance existing successful programs and develop new programs to enhance livability. One of the LCI initiatives includes expanding the existing roadside debris management program with more expansive litter reduction programs. The DPW&T also manages the Adopt-A-Road/Median program that supports volunteers who routinely clean debris and trash from their adopted area. DPW&T provided logistical support to over 10,000 volunteers during Gorgeous Prince George's Day in FY 2009. The litter reduction programs, in part, are associated with the 2007 Trash Free Potomac Watershed Initiative that is committed to creating a trash free Potomac River by 2013. Prince George's County, as part of the Potomac River Watershed Trash Treaty, has committed to:

- Supporting and implementing regional strategies aimed at reducing trash and increasing recycling.
- Increasing education and awareness of the trash issue throughout the Potomac watershed.
- Reconvening annually to discuss and evaluate measures and actions addressing trash reduction.

Prince George's Soil Conservation District (SCD)—SCD reviews all construction plans for conformance with the 1994 Maryland Standards and Specifications for Soil Erosion and Sediment Control as well as the 2005 Prince George's Soil Conservation District Soil Erosion and Sediment Control-Pond Safety Manual. SCD also administers the county's agricultural land preservation and easement programs.

Prince George's County Cooperative Extension—The Prince George's Cooperative Extension is a countywide educational system. It is sponsored jointly by the University of Maryland, the Prince George's County government, and the U.S. Department of Agriculture. Among its other services, the Cooperative Extension provides education and outreach services to youth, home gardeners, and commercial agriculture. The Cooperative Extension agents are currently working on a number of recertification and certification programs related to this Water Resources Plan including; pest control, nutrient management, and landscape technician. These certification programs ensure that professionals are knowledgeable in their fields to protect the environment.

Office of Management and Budget—The Office of Management and Budget is responsible for budget formulation; fiscal control; program and project control and evaluation; and management and policy analysis. Although not directly responsible for stormwater management, the Office of Management and Budget is involved with the formulation of the budgets that support the departments who actively manage the stormwater infrastructure and the stormwater regulatory requirements. With county revenues expected to decline over time, budgets for both DER and DPW&T are decreased from previous funding levels. DER and DPW&T share a stormwater management enterprise fund through a combination of tax revenues and permit fees that include in-lieu of stormwater fees. Both departments also receive grant funds that assist with funding for special projects.

Maryland Department of Transportation (MDOT)—In Maryland many federal processes have been delegated to MDE or combined with MDE's in a joint review process. There are also several requirements that are unique to Maryland. Since MDOT projects are linear in nature, MDE allows MDOT to consolidate stormwater management features along the linear project to meet the state stormwater requirements.

Transportation projects are subject to review and approval by federal and state agencies responsible for regulating various aspects of the environment. These requirements begin in the earliest stages of planning and continue until a project is complete. In some cases there may also be post-construction processes, required maintenance, or operating permits that take effect after project completion.

STORMWATER REGULATIONS

Anticipated Regulatory Requirements

The watershed management framework discussed in Chapter V, Environmental Resources and Land Management, provides a format to ensure all water resource regulations are being met with consideration of the diversity of county departments involved in meeting these regulations. In addition to the existing stormwater-related requirements outlined in Chapter III, Planning Context, as part of the planning context, there are a number of new regulatory requirements that are anticipated in the near-term future.

Overall, the county has met the intent of all of the stormwater regulations including those related to their current NPDES MS4 permit. The county has developed a Watershed Restoration Action Strategy (WRAS) for the Upper Patuxent River and Western Branch watersheds; however the county still needs to continue developing restoration strategies to meet the impervious surface treatment goals. A lack of funding has slowed efforts toward implementing watershed restoration projects, although five restoration projects were completed within the 2006 MS4 permit reporting period.

The county's existing MS4 stormwater permit expired in October, 2009, and a new one has not yet been issued. The old permit will remain in effect until Prince George's County receives an approved new permit. Several additional requirements are anticipated and DER will look to Montgomery County's approved permit for guidance.[5] Currently, Prince George's County must identify projects and programs to reduce by ten percent the county's current impervious area. MDE is likely to require an increase in the reduction levels to 20 percent of the impervious surface area to the maximum extent practicable. The renewed MS4 permit will likely provide further support to the Trash Free Potomac Treaty and development of total maximum daily load (TMDL) implementation plans as defined in MDE's TMDL guidance document.[6] Currently, the emphasis is shifting from establishing TMDLs to implementation strategies. Whether the resources exist to actually accelerate implementation is not yet evident. Like wastewater treatment plants (WWTPs), MS4s are treated as point sources and are subject to receiving a waste load allocation (WLA) as a part of a TMDL. Although the explicit permit link between TMDLs and WWTPs is well established, the permit link between TMDLs and MS4s is still evolving and the specifics remain unclear. What is clear is that the legal requirements are increasing and that WLAs are anticipated. It is likely that this will be managed with BMP translators to quantify the necessary load reductions. The implementation guidance plan documents the strategies that will be incorporated to reduce pollutant loads based on the numerical reduction outlined in the TMDL. EPA notes that "effluent limitations in NPDES permits must be numeric unless such limits are infeasible to calculate, in which case they may be expressed as BMPs." The BMP approach appears to be pretty universally accepted for MS4 permits. However, linkages and quantification of some level of expected pollutant load reductions from a prescribed suite of BMP controls will likely be developed in order to satisfy the need to develop local load allocations. By 2011, baywide TMDLs

5 http://www.environmentmaryland.org/legislature/testimony/clean-water/clean-water/sb-553---chesapeake-bay-phosphorus-reduction-act

6 http://www.mde.state.md.us/assets/document/final_TMDL_Implementation_Guidance_for_LG.pdf

Table 15: Prince George's County TMDLs as of February 25, 2009		
TMDL	**DNR 8-digit Basin Number**	**Status**
Draft Total Maximum Daily Loads of Phosphorus and Sediments for Triadelphia Reservoir (Brighton Dam) and Total Maximum Daily Loads of Phosphorus for Rocky Gorge Reservoir, Howard, Montgomery, and Prince George's Counties, Maryland	02131107 Patuxent River	August 20, 2007 (submitted to EPA on Sept. 26, 2007)
Total Maximum Daily Loads of Nutrients/Biochemical Oxygen Demand for the Anacostia River Basin, Montgomery and Prince George's Counties, Maryland and The District of Columbia	02140205 Anacostia River	Approved June 5, 2008
Total Maximum Daily Loads of Fecal Bacteria for the Nontidal Piscataway Creek Basin in Prince George's County, Maryland	02140203 Piscataway Creek	Approved Sept. 20, 2007
Total Maximum Daily Loads of Sediment/Total Suspended Solids for the Anacostia River Basin, Montgomery and Prince George's Counties, Maryland and The District of Columbia	02140205 Anacostia River	Approved July 24, 2007
Total Maximum Daily Loads of Fecal Bacteria for the Anacostia River Basin in Montgomery and Prince George's Counties, MD	02140205 Anacostia River	Approved Mar. 14, 2007
Total Maximum Daily Loads of Nitrogen and Phosphorus for Mattawoman Creek in Charles County and Prince George's County, MD	02140111 Mattawoman Creek	Approved Jan. 5, 2005
TMDL of Biochemical Oxygen Demand (BOD) for the Western Branch of the Patuxent River, Prince George's County, MD	02131107 Western Branch	Approved June 6, 2000
Total Maximum Daily Loads For Polychlorinated Biphenyls (PCBs) Tidal Potomac & Anacostia River Watershed	02140205 Anacostia River	Approved Oct. 31, 2007
Anacostia River (nontidal) for PCBs	02140205 Anacostia River	Scheduled to be developed in 2010

for nutrients and sediment are scheduled for completion. These will, in effect, overlay and adjust localized TMDLs to assure restoration of local and downstream conditions in the lower river estuaries and the bay.

To streamline the stormwater-related activities within the existing organizational structure, Prince George's County should consider stormwater work groups that meet routinely to share information and follow up on ongoing initiatives. These working groups are recommended to meet at least quarterly and do not replace normal daily staff interactions. Working groups may focus on topics such as water quality, watershed planning, stormwater operations and maintenance, and public education, communication, and engagement.

Stormwater Funding—The Chesapeake Bay is an important environmental, economic, and social resource of regional and national significance. The regulatory requirements both for local governments, such as Prince George's County, and the private development

Designated Use:
Each major stream segment in Maryland is assigned a use. The use is a goal for water quality and may or may not be served now, but should be attainable.

Bottle Bill:
Failed HB 839, sponsored by Del. Pete Hammen, D-46, would have required a $.05 deposit, and subsequently a refund, on beverage containers (glass, aluminum and plastic) sold in Maryland. Currently, 11 states across the U.S. have bottle bills. Although every bill differs, the common thread running through them is that a person pays an extra amount when purchasing a bottle and receives it back when returning the bottle for recycling.

community may continue to increase. The increase in responsibilities may also lead to an increase in costs. For example, the increased requirements for ESD for new developments may increase initial costs for the development community at the time of design and construction; with a larger number of small stormwater facilities, it may also increase the cost of plan review and long-term stormwater facility inspections by Prince George's County staff. Similarly, the increased attention on restoring impaired waters has a financial impact on Prince George's County. Watershed restoration activities such as BMP retrofits, stream restoration, and bank stabilization are very expensive to design and construct, placing additional burdens on tight budgets. Retrofits to address water quality challenges are often needed in the most urban areas, where land is very expensive, good sites are difficult to identify, stormwater management is inadequate or is nonexistent, and underground infrastructure can increase design and construction costs. This plan recommends implementing more aggressive stormwater management funding strategies beyond the current ad valorum tax that is currently in place in Prince George's County.

Stormwater Utility Fees—Like other public utilities, stormwater utilities charge property owners for services provided by the local government. Stormwater utilities provide a stable and dedicated revenue source for most stormwater and watershed-related projects. Fees provide an alternative to tax increases or impact fees for the support of local programs. Stormwater utilities are very similar in nature to enterprise funds established by more traditional water and wastewater utilities.

Specifically, stormwater utilities collect fees from property owners in relationship to their stormwater impact to fund provided services. Stormwater impacts for each property are calculated based on their relative burden on the stormwater system resulting from changes that they have made to the character (volume, rate, and pollutant content) of the stormwater that runs off their property. Most stormwater utilities relate this burden to the type of land use activity and the percentage of impervious ground surface for each property. Properties with a greater level of impervious surface pay more for their increased negative contribution to the system. Because a stormwater utility is a fee for service provided, if property owners provide a portion of the service, then a credit should be issued that relates to the benefit provided. Services may be calculated to include: tree canopy, infiltration, green roofs, and other ESD practices.

Stormwater utilities have existed for a number of years in several states. A stormwater utility can provide a vehicle for consolidating and coordinating activities and responsibilities; generate funding that is adequate, stable, equitable, and dedicated; and develop programs that are comprehensive, cohesive, and consistent. More detail on stormwater utilities as a funding source and the process for developing a stormwater utility are outlined later in this section.

In Prince George's County the responsibility for stormwater services was transferred from WSSC to the county government in July 1987. The county is authorized to issue bonds to provide funds for stormwater management facilities. A Stormwater Management District has been established that includes all the land in the county excluding the City of Bowie. A Stormwater Management Enterprise Fund is used to pay for stormwater management operations and activities within the district. The stormwater fund is supported by a stormwater management ad valorum tax on all property assessed for tax purposes within the district that receives stormwater management services. Many of the county's stormwater structures are ten or more years old. They need significant maintenance to clear tree growth from dams, remove sediment that has reduced peak runoff control storage volumes, and repair clogged or deteriorated outlets. Without regular and adequate maintenance, these structures gradually lose their water quality protection functions and, eventually, some structures can become serious public safety hazards.

The current stormwater tax/fee structure in Prince George's County has not adequately addressed existing stormwater issues and will continue to fall short of water quality and regulatory requirements, as structured, in the future.

Supplemental Funding Options—A comprehensive stormwater management program requires either dedicated revenues from the general fund or a stormwater fee to fund the bulk of the programmatic requirements. There are, however, several sources of supplemental funding that can augment the primary funding source, including several different types of loans, service fees, and grants.

- **Loans/Bonds—**Loans and bonds allow immediate expenditures on stormwater and watershed projects beyond readily available local funds. Funds are typically paid over a 15- to 20-year period with interest charges, similar to a home mortgage. Despite interest charges, loans and bonds are often a financially sound method for funding capital improvement projects. For some capital improvement projects, such as replacement of culverts to avoid collapse or flood mitigation projects to reduce property damage, the up-front expenditure may be less than the long-term expense of damage repair due to deferred maintenance. Typically loans and bonds are used for capital improvement projects that cannot wait until local funds are available; they are not recommended for routine operations. Repayment schedules for loans and bonds can be developed to smooth out peaks and valleys in revenue requirements and, thus, reduce the need for sporadic large rate increases. MDE offers water quality revolving loans to eligible communities that can be used for stormwater, green infrastructure, and water quality improvement projects. In 2009, the grant amount may be up to $6 million per community.

- **Service Fees—**Local governments have the authority to establish special taxes or service fees to address specific local challenges. Service fees include special purpose local-option sales tax (SPLOST) funds, impact fees, special assessments/tax districts, in-lieu of construction fees, and mitigation banks. Prince George's County currently assesses service fees for plan reviews and construction site inspections. The county also has a stormwater management enterprise fund that includes tax revenues as well as permit fees and fee-in-lieu for facility construction.

- **Grants—**A grant is a form of federal or state financial aid that does not need to be repaid and is typically based on demonstrated need. Grants typically require a local match but are a good way to leverage existing funds. Although grants are helpful to extend locally-available funds, they typically are awarded on a competitive basis and involve a long lead time to secure funds. Most grants will not fund completed projects. Prince George's County currently has several grants. MDE offers a number of grants that support stormwater and watershed projects including 319(h) grants, a stormwater pollution control cost-share program, a small creeks and estuaries restoration program, and a comprehensive flood management grant program.

NUTRIENTS, SEDIMENT, AND TRASH

Maryland's efforts to reduce stormwater pollution have focused on protecting and restoring water quality in the Chesapeake Bay. The biggest challenges that face the county include nutrients, sediment and trash according to the results from the Chesapeake Bay program as outlined below. The watersheds that drain to the bay have accomplished significant reductions in pollution levels from point sources; however, stormwater pollution remains a challenge. A baywide TMDL will be issued by EPA in 2010 that will provide nutrient load allocations that will continue the existing progress toward protecting and restoring the bay.

The county has performed detailed water quality monitoring in the Beaverdam Creek watershed and has completed an initial assessment of 41 watersheds through the countywide biological monitoring program. The county is still developing a formal protocol for source identification to link pollutants of concern with a specific water quality impact for the watershed. A comprehensive water quality monitoring program that covers the entire county and looks at chemical, habitat, and biological conditions in major waterbodies will provide the framework necessary for a comprehensive watershed management program. The county should develop a method for collecting and analyzing data that can be used to document water quality trends. Efforts are underway to develop a shared database that would allow multiple departments to view and use collected data and forecasted trends. The trends will show if water quality is declining based on new land development and also document improvements related to BMPs.

Nutrients—Nutrients include nitrogen and phosphorus that in excessive quantities can cause disproportionate algae growth and reduce the oxygen levels in waterbodies, which may negatively impact aquatic conditions. Nutrients are typically associated with point source pollution and nonpoint sources such as fertilizer, wastewater, and runoff from active agricultural operations. The EPA's Chesapeake Bay Program Office created standards for dissolved oxygen, chlorophyll, and water clarity that were developed to protect the designated use of the tidal Anacostia River. There is a TMDL for nitrogen, phosphorus, and biological oxygen demand that addresses the exceedance of target levels for these parameters.

Within the Chesapeake Bay watershed, preliminary estimates indicated that 291 million pounds of nitrogen and 13.8 pounds of phosphorus reached the bay during 2008, which represents a 13 million pound decrease in nitrogen and a 7.5 million pound decrease in phosphorus from 2007 (Chesapeake Bay Program). Within Prince George's County, the nonpoint source nutrients are primarily associated with active agricultural and urban/suburban land uses according to the Water Resource Plan model in Appendix I.

Sediment—Sediment refers to organic and inorganic particles that result from stormwater runoff and instream processes that reduce the clarity of waterbodies and can negatively impact aquatic habitat. Sources of sediment in Prince George's County are primarily related to stormwater and include urban runoff, construction sites, agriculture, and instream/streambank erosion. Although Maryland does not have a numeric standard for sediment, MDE has estimated sediment loads and developed threshold sediment loads to determine streams with sediment impairment and subsequent TMDLs. The sediment impairment is based on comparing actual monitoring data results to a reference watershed that is not impacted. The Anacostia River is considered impaired for high sediment loads according to this methodology. A TMDL for sediment for the Anacostia River was published by MDE in 2007.

Within the Chesapeake Bay watershed, preliminary estimates indicate that 3.3 million tons of sediment reached the bay during 2008, a 700,000 ton increase from 2007 but an 800,000 ton decrease from the average load for 1990–2008 (Chesapeake Bay Program). Within Prince George's County, sediment loads are thought to be associated with instream erosion that results from increased stormwater flow velocities. Older developments within Prince George's County do not always meet contemporary stormwater management requirements and do not have BMPs to slow the flow of stormwater from the site.

Prince George's County, as part of the NPDES MS4 permit and WRAS, should identify development without proper stormwater management controls and seek to retrofit these conditions either with grant funding or through redevelopment activities. The county should also continue to enforce and upgrade existing regulations to prevent erosion and sedimentation from ongoing development activities.

Trash—Trash is a stormwater parameter of concern, mostly in urban areas, and includes debris that is picked up by stormwater flows and deposited in streams and stormwater treatment facilities. Trash is highly visible and, therefore, receives a great deal of public attention. Volunteer cleanup efforts can help remove trash from waterbodies. Proper maintenance of parking lots, dumpsters, and stormwater treatment facilities can reduce the volume of trash in urban waterways.

The Trash Free Potomac Watershed Treaty, which has been signed by the Governor of Maryland and Prince George's County, calls for a trash free Potomac by 2013.[7] The initiative encourages activities to reduce and remove trash from local waterbodies that impact the Potomac.

The D.C. Council unanimously approved legislation in June 2009 banning the use of disposable, nonrecyclable plastic bags and assessing consumers a five-cent fee per recyclable paper and plastic bag used to haul away purchases at places such as grocery and convenience stores.
—The Washington Times

In addition to municipal programs, Prince George's County enlists the support of the community to remove and reduce litter from roadways. DPW&T manages the Adopt-A-Road/Median Program that supports volunteers who routinely clean debris and trash from their adopted area. The DPW&T also provided logistical support to over 10,000 volunteers during Gorgeous Prince George's Day in FY 2009. According to the 2006 MS4 permit report, volunteers collected 52,900 tons of solid waste, 597 tires, and 72,700 gallons of hazardous waste through various cleanup activities.

State efforts to initiate a bottle bill in Maryland should be actively supported in Prince George's County to ensure recycling is sustained at the highest level possible in the county. A bag bill has been legislated in neighboring Washington, D.C., to remove nonrecyclable bags from the trash stream; it appears to be a governmental solution for a major pollution culprit in many waterways.

[7] http://www.fergusonfoundation.org/trash_initiative/trash_index.html

STORMWATER FACILITIES OPERATIONS AND MAINTENANCE

The Chesapeake Bay Tributary Strategies place emphasis on controlling nonpoint source pollution from urban runoff to help protect local streams and the bay. Since 1983, thousands of stormwater management facilities have been built throughout the state to slow the erosive effects of runoff and/or to capture and reduce pollutants from developed urban surfaces. In Prince George's County alone, over 170 private stormwater facilities were built between 2000 and 2006 for water quantity and/or quality controls. In addition, DPW&T inspects and maintains the 382 publicly owned and maintained stormwater management ponds in Prince George's County. Although DPW&T maintains the publicly owned stormwater system, DER assists with responding to drainage complaints.

Many of the county's stormwater structures are ten or more years old. They need significant maintenance to clear tree growth from dams, remove sediment that has reduced peak runoff control storage volumes, and repair clogged or deteriorated outlets. Without regular and adequate maintenance, these structures gradually lose their water quality protection functions and, eventually, some structures can become serious public safety hazards.

DPW&T maintains the stormwater facilities located within the right-of-way. Based on the 2006 MS4 permit report, Prince George's County performed preventative maintenance inspections on 297 county-owned stormwater facilities over a three-year period and collected 700 tons of leaves and cleaned 5,965 storm drain inlets. Some areas of Prince George's County were developed 20 to 30 years ago. The stormwater infrastructure in these areas is nearing the end of its useful life and materials used were occasionally substandard compared to modern materials and development requirements. Prince George's County will experience growing financial pressures to maintain and replace these portions of the aging infrastructure. In other portions of the county, there is new development that is extending the footprint of the existing municipal storm sewer system. The extension of the system should be carefully planned to ensure longevity and prevent future flooding.

There are seven county-owned and operated facilities that require NPDES industrial stormwater permits. According to the 2006 MS4 report, only three of the seven facilities have the required Stormwater Pollution Prevention Plan (SWPPP) that is required by their NPDES industrial stormwater permit. Prince George's County should consult the list of facilities that require industrial stormwater permits to ensure that all municipal facilities are covered and have SWPPPs to reduce impact to local water resources.

Private landowners are responsible for maintaining their stormwater facilities; however, Prince George's County, under the MS4 permit, is responsible for performing inspections of these facilities to ensure proper operations. Based on the 2006 MS4 permit comments from MDE, Prince George's County did not have a program for inspection of these private facilities. Many private landowners are not aware of their maintenance responsibility and/or are unaware of proper maintenance operations. Inspections of these stormwater facilities will help ensure they operate correctly to protect water resources.

Landscape and Road Maintenance—The DPW&T is responsible for road maintenance activities that include landscape maintenance in the right-of-way. One of the more recognizable road maintenance programs is street sweeping. According to the 2006

MS4 permit report, 434 tons of debris was removed from roadways through street sweeping. DPW&T sweeps all residential subdivisions annually and arterial and collector roadways twice a year.

DPW&T should strive to minimize the use of chemicals in the routine maintenance of roadways and rights-of-way to reduce water quality impacts. When designing new roadways or roadway maintenance projects, the county should use native landscaping where possible to reduce maintenance and increase survival rates. Stormwater runoff should be treated using green infrastructure and environmental site design techniques to the maximum extent practicable to reduce environmental impacts.

Erosion and Sediment Control—As discussed previously, excess sediment in local waterbodies reduces clarity and impacts the habitat of aquatic life. Understanding the erosion process is essential to the development and implementation of effective erosion control plans. The key to erosion control is preventing the detachment of soil particles and reducing the volume of runoff. This is achieved through the use of practices such as minimizing land disturbance activities and maintaining vegetative covers or substituting for lack of growing vegetation by mulching or applying a compost blanket or erosion control mat. Sediment control is trapping detached soil particles that are being transported and ensuring they are deposited on site to prevent damage to other properties or receiving waters. This is achieved by such practices as silt fence installation, and sediment control basins.

The initial construction of new developments can contribute substantial amounts of sediments to the stream systems and its tributaries. Construction sites can contribute, on a per-acre basis, 10 to 20 times as much sediment as agricultural lands. Excess suspended sediment is one of the largest contributors to the bay's impaired water quality. The culprits are the tiny clay- and silt-sized fractions of sediment. These particles are frequently suspended in the water because of their size and can be carried long distances during storms.[8] If properly designed, constructed, and maintained, erosion and sediment control measures can greatly reduce sediment from entering local waterbodies.

The Sediment and Erosion Control Program developed in 1970 is essentially the same that exists today with an approved plan being required for any earth disturbance of 5,000 square feet or more and 100 cubic yards or more; plan approval exemptions for agricultural uses; plan review and approval by local SCDs; grading ordinance adoption and project inspection by local jurisdictions; utility construction inspection by WSSC; and criminal penalties for sediment pollution. Agricultural pollution contribution is ultimately subject to MDE authority enforcement. Various programmatic improvements have included requiring sediment control plan approval prior to issuing grading and building permits (1973); requiring training and certification of responsible personnel (1980); shifting enforcement authority from local to state control and establishing delegation criteria (1984); limiting the exemption for single-family residential construction on two-acre lots (1988); requiring NPDES stormwater discharge permits for construction activity (1991).

The Maryland Department of the Environment (MDE) initiated a comprehensive review of the state's erosion and sediment control standards in early 2009 and has developed an initial draft of the "2010 Maryland Standards and Specifications for Soil Erosion and

8 http://www.chesapeakebay.net/sediments.aspx?menuitem=14691

Wetland:
An area inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (U.S. Army Corps of Engineers Regulation 33 CFR 328.3 (1988)).

Floodplain:
The generally flat area adjacent to rivers that is periodically flooded. Evolving over hundreds or thousands of years, the size of floodplains is related to the frequency of flooding, the energy of the flow of the river when in flood and the amount of sediment in the river system.

Sediment Control"[9] as part of the May 30, 2010, schedule for incorporation into regulation. Maryland's Erosion Control Law and regulations specify the general provisions for program implementation; provisions for delegation of enforcement authority; requirements for erosion and sediment control ordinances; exemptions from plan approval requirements; requirements for training and certification programs; criteria for plan submittal, review, and approval; procedures for inspection and enforcement; and applicant responsibilities. Clearly defining minimum standards is essential to make erosion and sediment control work. The current 1994 standards and specifications for soil erosion and sediment control are incorporated by reference into state regulations and serve as the official guide for erosion and sediment control principles, methods, and practices.[10]

Contractors and other construction industry personnel knowledgeable about erosion and sediment control principles, implementation and maintenance techniques, and specifications associated with various BMPs are an essential component of Maryland's statewide sediment control program. Well-trained construction personnel help to ensure that quality implementation and maintenance occur. Since 1980, many construction industry personnel have attended the MDE's Responsible Personnel Training for Erosion and Sediment Control Program.[11]According to the 2006 MS4 annual report, 137 individuals were certified as part of the "green card" erosion and sediment control training program that helps to ensure professionals are designing, constructing, and maintaining measures properly.

Although training and enforcement are important and erosion and sediment control measures minimize soil movement on disturbed areas, reducing the area disturbed during construction, especially areas with steep slopes, reduces erosion and sediment challenges. Prince George's County may consider establishing limits for areas disturbed during development, which protects greenspace and limits erosion potential. These limits are most beneficial in suburban and rural areas and not necessarily appropriate for higher density land uses.

FLOODING

Flooding in Maryland is caused by both heavy rains and wind. In the upland areas, storms can cause streams and rivers to overflow their banks, inundating the surrounding floodplains. Along the tidal reaches of the Atlantic, the Chesapeake Bay coastline, and in tidal areas of streams and rivers, wind-driven waves on top of elevated tidal levels can severely damage coastal property and endanger the lives of residents.[12]

Rain, wind, and snow storms of all sizes can cause flooding, depending on the amount of precipitation and its intensity and/or the speed and direction of the wind. Summer thunderstorms are generally very intense but short-duration events, which can cause flooding of major rivers. Hurricanes and "nor'easters" typically bring the sustained winds and rain necessary to cause significant flooding in large rivers and coastal areas.

9 http://www.mde.state.md.us/assets/document/sedimentstormwater/MD_ESC_Standards_10-15-09_DRAFT_III.pdf

10 http://www.mde.state.md.us/programs/waterprograms/sedimentandstormwater/erosionsedimentcontrol/standards.asp

11 http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/index.asp

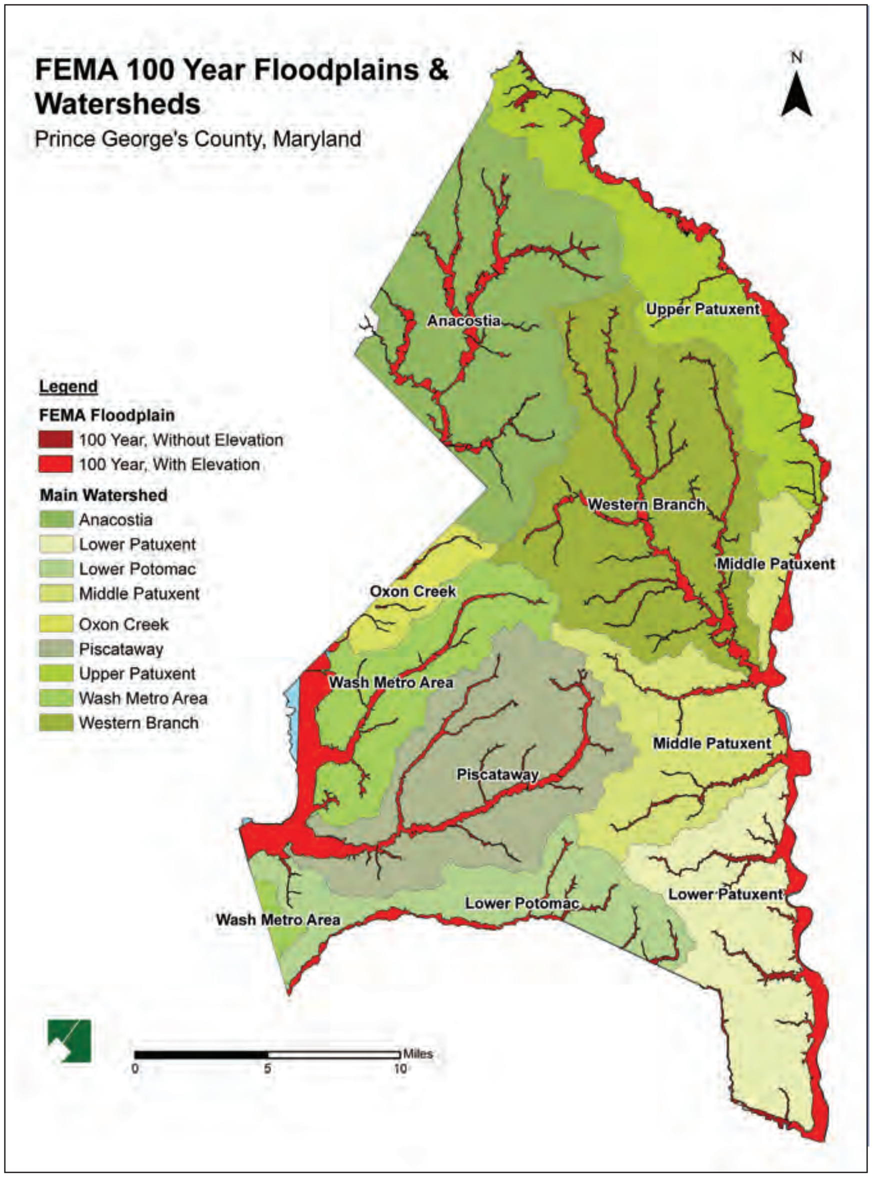
12 http://www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/reliefAssistance/index. asp

Prince George's County has a history of modest storm-related flooding. Most flooding events have usually occurred during mid and late summer and are associated with tropical storms and hurricanes. Small sections of the county are also subject to occasional flooding due to the influence of tides.

Storms are typically measured in terms of the average frequency that a storm of that size occurs. Hurricane Fran (1996) was classified as a "40-year storm" meaning a storm the size of Fran has a one in forty chance of occurring in any given year. Larger storms such as Hurricane Agnes (1972) have a 1 in 100 chance of occurring in a year. Isabel was considered to be a 75- to 80-year storm based on the tidal surge. In a few places, the rainfall from Floyd was 20 inches and exceeded the 500-year storm.

Flooding in Prince George's County is also attributed to changes in topography and increases in impervious surfaces due to development that can result in perched groundwater. Groundwater that migrates to the surface often results in seepage into building basements. Where these conditions exist, or could likely exist, a no-basement policy for construction should be considered.

Floodplain Management—New developments must be carefully designed to ensure that flooding in Prince George's County is not aggravated. In some cases, historic development practices have aggravated downstream flooding and changed natural stream flow dynamics. Flood damage is mitigated by preserving and protecting floodplains as natural areas able to hold stormwater during and following storm events.



Map 15: FEMA 100-Year floodplains and watersheds.

The National Flood Insurance Program regulates developments within mapped floodplains, typically the 100-year floodplain (or the area with a one percent annual chance of being flooded). Land development activities can alter a watershed's ability to handle storm events, thereby impacting the frequency of flood events. For example, the delineated 100-year floodplain may experience flooding more frequently than once every 100 years because upstream developments have changed the landscape and timing of flows into the stream. Floodplain maps are not updated regularly and, therefore, do not always indicate the true risk of flooding. In other words, an area delineated in the 100-year floodplain that has experienced recent upstream development

Perched groundwater occurs above the main body of groundwater and is separated from it by unsaturated, impermeable sediments or rocks.

activity may actually have a higher than one percent chance of being flooded. Prince George's County reviews stormwater plans as part of the land development process to ensure new developments preserve the floodplain and do not impact downstream landowners.

Flood Relief Assistance[13]**—**FEMA provides emergency financial assistance to individuals and communities following a flood if the damage threshold defining a federal disaster is exceeded in the area, or if federal flood insurance is in force. Flood insurance is offered by FEMA through participating commercial agents. For uninsured persons, the amount of the relief for a first time flood event is reduced by the amount of the premium that would have been required to insure the building and its contents. Relief for second and subsequent events may not be provided unless insurance has been purchased.

Under the state's Comprehensive Flood Management Grant Program (CFMGP), established in 1976 following hurricanes Agnes and Eloise, the legislature authorized MDE to request the sale of bonds to generate funds to purchase, relocate, and elevate houses. The program can also be used to establish warning systems and build flood control structures. State funds provided by this program are matched on a 50/50 basis with those from local governments.

ENVIRONMENTAL SITE DESIGN

ESD is defined by the Stormwater Management Act as "using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." ESD can also include conserving natural features, drainage patterns, and vegetation; minimizing impervious surfaces; slowing down runoff; and increasing infiltration. Prior to the Stormwater Management Act of 2007, ESD was encouraged through a series of credits within the Maryland Stormwater Design Manual. The Stormwater Management Act of 2007 requires that ESD be used to the MEP. MEP means designing stormwater management systems so that all reasonable opportunities for using ESD planning techniques and treatment practices are exhausted and, only where absolutely necessary, a structural BMP is implemented.

Figure 11: Schematic rendering on an on-lot bioretention area.
Source: DER

The regulatory definition for MEP consists of two parts: definition and performance. The definition requires that all reasonable opportunities for using ESD planning techniques and practices are exhausted. The threshold for meeting the MEP definition consists of performance criteria. MEP is met if channel stability and predevelopment groundwater

[13] http://www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/relief Assistance/index.asp

recharge rates are maintained and nonpoint source pollution is minimized. In both the definition and performance threshold, the condition is the same; structural stormwater practices may be used only if determined to be absolutely necessary. Although some flexibility and best professional judgment will be needed to determine when these conditions are met, the performance threshold is straightforward. Local plan review and approval agencies should not approve structural BMPs if ESD options are available.

DER has developed a bioretention handbook that been prepared to replace and update the 1993 edition of the *Design Manual for Use of Bioretention in Stormwater Management*. This manual builds on that work and further identifies methodologies, practices, and examples of bioretention. Changes that were made focus primarily on four parameters: (1) functionality and application; (2) pollutant removal efficiency; (3) aesthetics and site integration; and (4) design simplification for cost containment.[14]

Updates to County Stormwater Ordinance—Prince George's County is currently updating the county's Stormwater Ordinance to comply with the Stormwater Management Act of 2007. Changes will include requiring developers to demonstrate ESD to the maximum extent practicable before structural practices are considered and requiring coordination with the planning and approval, implementation, and maintenance agencies prior to approval. Other changes may emphasize the need for impervious surface area reductions associated with the anticipated MS4 permit revision. Coordination is critical to the success of the new stormwater regulations and the Planning Department, the Department of Environmental Resources, and the Prince George's County Soil Conservation District shall all take an active and participatory role in assuring that all stormwater management practices contribute to the protection and improvement of water quality in the county. Prince George's County has plans to submit the proposed stormwater ordinance revisions for state review. Once reviewed by MDE it must be adopted by Prince George's County by May 2010. This ordinance applies to all new and redevelopment projects that have not received final approval for erosion and sediment control and stormwater management plans by May 4, 2010.

BASIS FOR REVISION OF COUNTY STORMWATER POLICIES

The recommendations for the revision of existing stormwater policies and programs are based on an evaluation of the Prince George's County existing stormwater related programs, consideration of both existing and future regulatory requirements, and a review of national stormwater management trends. The stormwater policy recommendations also considered future land use pollutant load modeling analysis discussed in the Growth Policies and Land Use Planning section of this report. As described throughout this section and the entire Water Resources Plan, numerous programs provide effective stormwater management throughout the county, which protects water quality. However, additional organization and access to information would strengthen the county's ability to provide effective watershed enhancement measures.

[14] http://www.co.pg.md.us/Government/AgencyIndex/DER/ESG/Bioretention/pdf/Bioretention%20Manual_2009%20Version.pdf

CHAPTER ISSUES SUMMARY

- Current stormwater regulations require the use of nonstructural BMPs that mimic natural systems, encourage infiltration, and manage stormwater on-site to the maximum extent practicable.
- Development that predates current stormwater regulations and aging infrastructure failures has lead to degraded stream systems and flooding.
- Funding for stormwater management, to achieve water quality protection and improvement, requires a dedicated funding source managed at a watershed scale.
- Trash remains a significant impairment in many of Prince George's County's urban waterways and undermines community investment, environmental health, and economic viability for redevelopment.
- Stormwater issues cross governmental and jurisdictional boundaries and require cooperative solutions and community engagement and participation.

POLICIES AND STRATEGIES

Stormwater Management Organization

POLICY:

Stormwater management decisions are made within a watershed-based system of analysis based on the best available scientific data, regulatory requirements, watershed and development needs, economic and environmental impacts, and local opportunities and constraints.

STRATEGIES:

- Create a watershed-based organization to administer water protection and remediation activities built on stormwater and ecosystem BMPs. The framework and responsibilities of this organization should be based on input from a variety of working groups.
  - Create a stormwater working group(s) that encourages interjurisdictional and intrajurisdictional collaboration on stormwater issues within a watershed management framework. This group should support education, training, outreach, communication, and community engagement.
  - Create a water quality working group(s) that meets to discuss water quality trends, shares collected data, provides status reports on ongoing corrective actions, and discusses inter-relationships between programs.
  - Create a watershed planning working group based on the 2008 DER report *Watershed Management Program: Supporting Clean Water and Livable Communities through Watershed Restoration and Protection* to link multiple departments and existing regulations under one watershed management program.
- Develop an iterative approach for assessing progress toward pollutant loading reduction benchmarks and for identifying additional projects and programs if benchmarks are not achieved.

POLICY:

The countywide stormwater management program complies with the intent of any and all environmental requirements of the EPA, the State of Maryland, and any regional regulations or programs.

STRATEGIES:

- Properly fund programs and activities required to meet all stormwater regulatory requirements through a stormwater utility or other equitable and sufficient funding source or sources.
  - Assess stormwater utility fees associated with commercial and high density residential as a percentage of imperviousness minus any mitigation strategies such as tree canopy.
  - Stormwater fees for each property should be calculated based on their relative burden on the stormwater system resulting from changes that landowners have made to the character (volume, rate, and pollutant content) of the stormwater that runs off their property.
- Continue to develop and implement WRAS for county watersheds and monitor the effectiveness of projects at reducing stormwater pollutant loads. The WRAS may include the following elements:
  - Development of stream restoration plans to include strategies to reduce flow velocity and stream scouring and incising.
  - Construction of grade controls in streams to prevent further incision of the stream channel and create a riffle-pool system for aquatic habitat.
  - Establishment and achievement of measurable goals by watershed for forest cover, tree canopy, and impervious surface by percentages.
  - Identification and mitigation of pollution sources in the Patuxent and Potomac watersheds through proven and innovative techniques to meet the Tributary Strategies agreed to as part of the Chesapeake Bay Agreement in 2000.
- Manage point and nonpoint pollution sources to comply with county, regional, and state load allocations established by the Chesapeake Bay TMDL and subsequent geographical refinements.
  - Develop a framework for the coordination of TMDL implementation plans with state and county agencies; municipalities; adjacent counties and jurisdictions; and watershed organizations that adhere to a comprehensive watershed approach.
  - Require additional and enhanced stormwater volume reduction and quality improvement requirements for all new development and redevelopment in areas draining to waters with existing TMDLs, of known water quality impairments, or Tier II water quality.
  - Develop subwatershed tree canopy goals in county master and sector plans to achieve the forest protection and expansion strategies as set forth in the *Anacostia Watershed Forest Management and Protection Strategy*, June 2005.

Water Quality

POLICY:

The county is committed to improve the quality of impaired water and protect healthy water in the county through short-term actions as well as a long-term commitment to effective stormwater management and water resources protection.

STRATEGIES:

- Maintain and fund a comprehensive water quality, habitat, and biological monitoring program that provides data needed to assess watershed health and track the benefits of restoration activities.
- Respond to changes in environmental regulatory requirements to produce TMDL implementation plans and institute pollution limits for nutrients, trash, and sediment in streams and their tributaries based on benchmarks for stream health.
- Fund implementation projects that achieve significant and measurable improvement in water quality.
    - Reducing polluted run-off from urban development and agriculture.
    - Implementing TMDLs to restore impaired waterbodies.
    - Protecting and restoring habitat including riparian corridors, floodplains, wetlands, and the bay.
- Encourage partnerships among agencies and organizations that have purview over water quality and land use decisions to protect and restore watershed functions and values.

POLICY:

The county is obligated to achieve the committed goals of a trash-free Potomac River by 2013 by developing trash reduction, recycling, and education programs that promote liter reductions in all streams and creeks in the county.

STRATEGIES:

- Support effective yard waste and other recycling programs, street sweeping, and trash removal strategies to reduce trash and waste that can impede stormwater flow and impact rivers and streams.
- Develop an outreach and education program to improve trash management, increase recycling rates, and reduce littering and illegal dumping.
- Develop a baseline of existing levels of trash in the Potomac and benchmark ongoing programs to determine if they will meet the trash-free Potomac goal by 2013. Add additional public and private programs as necessary to meet the goal.
- Educate local businesses on the importance of trash and waste prevention through routine cleaning of parking lot areas, dumpster areas, and structural stormwater management facilities.
- Support statewide efforts to increase recycling and reduce trash through the other legislative examples such as; the bag and bottle bills.

Stormwater Operations and Maintenance

POLICY:

Ensure the efficient and safe performance of all stormwater management facilities including county-owned and privately owned facilities.

STRATEGIES:

- Complete and maintain an accurate database of all privately and publicly owned and maintained stormwater facilities and storm drainage systems in the county.
- Conduct preventative maintenance and inspections of county stormwater management facilities on a regular basis. Document and provide corrective measures as needed.
- Provide documentation of inspection schedules, enforcement actions, and other relevant information to guarantee optimum functioning of stormwater management systems.
- Develop a program for routine inspections of private stormwater facilities in compliance with NPDES MS4 permit requirements.
- Develop a program for inspecting and cleaning stream corridors of debris, both manmade and natural, especially in known flooding areas.
- Ensure that all municipal facilities that require industrial stormwater permits are kept current and have SWPPPs to reduce impact to local water resources.

Landscape and Road Maintenance

POLICY:

Reduce pollutants associated with road maintenance from herbicides, fertilizers, pesticides, deicing, and vegetation maintenance. Require ten acres or greater of treated roadway to follow the University of Maryland's guidelines for documenting all maintenance practices and be subject to inspections by the Maryland Department of Agriculture.

STRATEGIES:

- Incorporate green infrastructure and ESD into roadway construction and maintenance activities.
- Consider reducing street width and parking lot requirements to reduce impervious area.
- Utilize conservation landscaping techniques that reduce water consumption and the need for fertilizers or chemical applications.
- Plant adapted native vegetation and use efficient irrigation, mulching, soil preparation, and appropriate planning, design, and maintenance standards and techniques.
- Continue to limit the use of herbicides and fertilizers in roadway maintenance activities and implement measures to ensure deicing materials are not over-applied. Ensure that street sweeping materials and other debris collected during routine road maintenance is properly disposed.

- Capture and reuse rain water to provide irrigation and maintenance of landscaped areas, where practicable; create demonstration projects on public properties.
- Design landscaped areas to intercept stormwater, thereby increasing pollutant removal and reducing the need for irrigation.

Erosion and Sedimentation

POLICY:

The county proactively acts to prevent erosion from active and completed construction sites that may result in sedimentation of streams and creeks.

STRATEGIES:

- Keep disturbed areas to a minimum during construction, especially areas with steep slopes.
- Specify the amount of time allowed to stabilize exposed soil when construction activities have temporarily or permanently ceased.
- Require erosion and sediment control inspections to be conducted at least every 7 to 14 days or following any rainfall event of 0.5 inches or more.
- Require the removal of accumulated sediment from control devices when sediment storage capacity has been reduced by 25 percent.
- Provide continued training and education to construction site operators and inspectors regarding erosion and sediment control compliance.
- Require inspection and enforcement of all publicly permitted erosion and sediment control devices by means of regular site visits and documentation of all infractions that shall require fines and/or cease-work orders.

Flooding

POLICY:

Protect the health, safety, and welfare of Prince George's County citizenry and properties by identifying flood hazards within the county, seeking funding to address flood hazards, and protecting future flooding from new developments.

STRATEGIES:

- Prohibit inappropriate and incompatible uses in floodplains to maintain water storage functions to the MEP and provide for expanded environmental preservation opportunities.
- Create a strategy to address repetitive property loss through FEMA's buyout program or other permanent corrective action.
- Document flooding events associated with nonexistent and/or poorly performing stormwater management facilities, floodplain encroachments, or perched water tables and/or groundwater seeps and transfer identified data into a GIS mapping format.
- Spatially analyze existing flooding data and patterns and develop policy and action strategies, legislation, and building standards to remedy existing conditions and avert future problems.

- Identify soils and geology in the county associated with perched groundwater and/or water seeps that may cause flooding, particularly in structures with below grade construction.

Stormwater Land Development Standards

POLICY:

Land development practices will support healthy hydrologic systems that maintain minimum stream flows, control flooding, support neighborhood, community and countywide health, and protect and preserve environmentally sensitive features and living resources.

STRATEGIES:

- The quantity of stormwater discharge must satisfy the Stormwater Act of 2007 for water quality, channel protection, and recharge volume using ESD practices.
- Capture and manage, through infiltration and evapotranspiration, the first inch of rainwater associated with over 90 percent of all storm events in the county for urban development and redevelopment projects.
- Minimize use of impervious surfaces.
  - Design to the minimum parking requirements during development.
  - Establish incentives for shared parking programs.
  - Concentrate development in order to provide economic incentives to develop parking structures in centers.
  - Break up large expanses of paved surfaces with landscaped/infiltration areas.
  - Set maximums on areas of paved surfaces in development plans.
- Establish targets for impervious percentages within defined watershed, sub-watershed, and catchment areas based on land use and watershed conditions.
- Optimize conservation of natural features, including drainage patterns, topography, and vegetation during development and redevelopment projects.
- Manage changes in topography during development and redevelopment to encourage sheet flow and maximize length of flow paths.
- Disconnect impervious areas such as pavement and roofs from the storm drain network, allowing runoff to be transported over pervious areas to support infiltration and groundwater recharge.
- Preserve and provide vegetation along stream banks, roadways, and within large paved areas to reduce stormwater run-off velocity and temperature, absorb pollutants, diminish green house gases, and support biodiversity.
- Tie preserved natural land areas to the Green Infrastructure Plan so that they are tracked and counted toward the countywide goals.
- Develop a county tree ordinance that supports the preservation and enhancement of the urban tree canopy that is compatible with ESD requirements, the county's Green Infrastructure Plan, and associated environmental legislation or code requirements.

Environmental Site Design

POLICY:

The county supports and implements the stormwater design policies, principles, methods, and practices as put forth in the 2000 Maryland Stormwater Design Manual and its updates, as well as the provisions of Maryland's Stormwater Management Act of 2007 requiring stormwater to be treated nonstructurally to the MEP.

STRATEGIES:

- Update the county stormwater ordinance to comply with the Stormwater Management Act of 2007 to require developers to demonstrate ESD to the maximum extent practical before structural practices are considered.
- Recognize that nonstructural techniques and ESD mimic natural hydrologic runoff and infiltration characteristics and provide a long-term cost effective, low-impact method to minimize the impacts of land development on water resources.
- Design, develop, implement, and maintain ESD demonstration projects to manage nonpoint source stormwater run-off on public properties to provide educational opportunities, increase public awareness, and hone a knowledge base for refining site design and ESD best practices application.
- Secure the sustained success of ESD facilities by establishing guidelines and standards for design, implementation, maintenance, and evaluation of nonstructural and/or innovative stormwater management practices and technologies to manage nonpoint source run-off.
- Identify legislative, physical, and economic impediments to the implementation of ESD.
- Modify the development and redevelopment plan review and approval process to require coordination of sediment control and stormwater management design, inspection and maintenance practices, and planning policies and recommendations as necessary in order to implement ESD to the MEP.

VIII: DRINKING WATER AND WASTEWATER

Maintain, inspect, protect, and manage drinking water sources and distribution methods and wastewater management facilities and infrastructure systems to sustain public, environmental, and economic health.

A safe and adequate drinking water supply and wastewater treatment facilities are necessary for the vitality of current communities and future residents of Prince George's County. Human life and public health, safety, and welfare depend on clean and potable drinking water and sufficient wastewater management. Wastewater treatment is also important to ensure the protection of receiving waterways for recreational purposes and the health requirements of living organisms. As the population and growth of the county continues to increase, it is necessary to ensure that the potable water sources and the proper treatment of wastewater can be accommodated.

> ***Scientists estimate that each year up to seven million Americans become sick from contaminated tap water, which can also be lethal. Pollution, old pipes, and outdated treatment threaten tap water quality.***
> ***—The Natural Resources Defense Council***

Water and sewer systems provide the basic building blocks for a modern, growing and environmentally healthy community. Water and sewer planning is critical to the staging and promotion of orderly growth of communities and the prevention of urban sprawl. Therefore, water and sewer planning must be based on consideration of geographical features and environmental factors, community needs as expressed in the county's land use and development policies, federal and state policy guidance, and public health requirements. The contextual framework for water and sewer planning includes the natural environment, community planning and development, and legal requirements.

Source Water Protection Areas are delineated by a state for a public water supply or including numerous such suppliers, whether the source is groundwater or surface water or both.

Turbidity:
A cloudy condition in water due to suspended silt or organic matter.

Protozoa:
One-celled animals that are larger and more complex than bacteria; may cause disease.

Disinfection By-Products:
Chemical, organic, and inorganic substances that can form during a reaction of a disinfectant with naturally present organic matter in the water.

The Washington Suburban Sanitary Commission (WSSC) is the eighth largest water and wastewater utility in the nation, with a network of more than 5,500 miles of fresh water pipeline and nearly 5,400 miles of sewer pipeline. WSSC has serviced customers in Prince George's and Montgomery counties since 1918 and WSSC's drinking water has always met or surpassed federal standards. WSSC is required to conduct and submit an annual water use audit to MDE as a condition of its water appropriation permit.

The Water Resources Plan contains policy and strategy recommendations to address inspection and maintenance of existing water and wastewater infrastructure and to plan for future growth in response to drinking water and wastewater management demands and capacities. The Water Resources Plan promotes source water protection strategies and use and demand management of water resources. Through conservation and efficiency recommendations, this plan strives to establish achievable sustainability goals for water resources in Prince George's County.

DRINKING WATER

Plan for potable water demands through efficiency and conservation standards; protection of potable water sources; and oversight, monitoring, and enforcement of water quantity and quality standards.

Prince George's County's public drinking water supply originates from the Patuxent and Potomac Rivers, which is treated and distributed by WSSC. The remainder of the county is served by groundwater supplies in areas outside the WSSC service area and water and sewer envelope as defined in the 2008 Water and Sewer Plan. The same land use practices which impact the water quality and quantity of streams and rivers can also impact the availability and quality of the county's drinking water sources. Because headwaters and reservoirs that ultimately provide potable drinking water are beyond the jurisdictional boundaries of the county and the groundwater sources are part of a shared regional system, it is imperative that source water protection and groundwater management policies are coordinated with neighboring counties.

Approximately two-thirds of Prince George's County is serviced by a public water supply from WSSC. WSSC is a bicounty agency, which provides water and sewer service to 1.8 million residents in Montgomery and Prince George's Counties and to small portions of Howard and Charles Counties. Water for Prince George's County is drawn from both the Potomac River and one of two reservoirs on the Patuxent River. It is treated at the Potomac and Patuxent water filtration plants, respectively. Current water demand forecasts are prepared by WSSC (see Technical Appendix III, 2006 Water Production Projections) and indicate that WSSC's average production is expected to increase approximately one percent per year, reaching 224 million gallons per day (mgd) in the year 2030. The Interstate Commission on the Potomac River Basin (acting for WSSC, Fairfax (VA) Water, and Washington Aqueduct), also periodically prepares water demand forecasts as well as future resource availability assessments (see Technical Appendix III, Water Supply Reliability Forecast for Washington Metropolitan Area, Year 2025). This study indicates that current water resources are able to meet demand forecast for the region; including the area of Prince George's County served by WSSC, to the year 2025, and as projected to 2045 under drought conditions similar to those experienced in the period of record (the past 80 years).

According to the terms of a long-standing agreement, WSSC has extended public water supply infrastructure to Charles County. Charles County will relieve their current demands on the Patapsco aquifer by 1.4 mgd in the community of Waldorf through extension of the WSSC surface water source public system. Charles County has discussed purchasing additional water from WSSC, up to exceeding 5mgd. Additional public water systems within the county include the City of Bowie, located in Prince George's County, a groundwater source distribution system supplied by six wells that can provide up to the system's 5.2 mgd capacity to serve the northern portions of the City of Bowie. The current demand is approximately 2 mgd and not expected to reach the system capacity within the planning period addressed in this document. However, the county should develop projections of the estimated water demand for the City of Bowie based on residential and nonresidential population projections and the implementation of the city's land use plan. If the demand is forecasted to be greater than the city's groundwater appropriation permit, future land use plans should discuss ways to address this constraint. The remaining county residents are served by private wells that are concentrated in the southwestern, southern and eastern areas of the county. Several properties throughout the county that fall within the sewer envelope are currently on private water and/or sewer system. Individual water supply and septic systems, as well as shared systems, can only support relatively low-density development. The following have been noted as Category 6 designations within the sewer envelope:

- Greenbelt Park
- Fort Lincoln Cemetery, Port Towns
- Belt Woods
- National Harmony Cemetery
- Lincoln Memorial Cemetery, Suitland
- Oxon Hill Farm
- Rosaryville State Park
- Louise M. Cosca Regional Park

Also several parcels at the Duval Woods development and the Magruder Tract West in Upper Marlboro, and the Timber Highlands in Accokeek have been noted as Category 6 designations within the sewer envelope.

It is not anticipated that any community water or shared septic systems in the county will require expansion within the WRE planning period. In the event that a system would require public water or wastewater, review by WSSC for available capacity in the water pressure zone and the sewer basin where the development is located would be required.

Prince George's County's Rural Tier, approximately one-third of the land area, relies on individual well water for domestic supplies and other uses. The 2008 Water and Sewer Plan delineates the water and sewer envelope boundaries that are reviewed by the Planning Department during updates to the plan and during tri-annual water and sewer review cycles when requests for water and sewer category changes are considered. Protection of the quality and quality of this water resource is becoming more critical as regional demands on the aquifer system continue to increase, and groundwater levels continue to decline in many areas.

Cryptosporidium* *and Giardia
are parasites that exist in rivers and lakes. These parasites can cause intestinal illnesses.

Fecal Coliform
are bacteria, which are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste.

Dieldrin
is no longer produced or used. From the 1950s until 1970, aldrin and dieldrin were used extensively as insecticides on crops such as corn and cotton.

Patuxent Water Filtration Plant

Patuxent Water Supply Patuxent Water Supply—The Triadelphia and Rocky Gorge Reservoirs provide water to the Patuxent Water Filtration Plant (WFP) for treatment. These reservoirs, located in the upper reaches of the Patuxent River in Central Maryland between the cities of Baltimore and Washington, D.C., have a combined water storage capacity of 11 billion gallons and collect water from a 132-square-mile watershed; the vast majority of the watershed is located in Montgomery and Howard Counties, with only a small portion within Prince George's County. Much of the watershed is rural, although there are some areas of denser, mixed land use. WSSC owns and controls only 6.9 square miles of land immediately adjacent to the reservoirs. The primary purpose of this protected area is to provide a buffer zone to control sediment and pollutant runoff into the reservoirs. Prince George's County Code currently restricts impervious surfaces within the Rocky Gorge watershed to ten percent, while Code of Maryland Regulations prohibits the installation of a septic system within 300 feet of the spillway crest water level of a water supply reservoir. Potential sources of contamination for the reservoirs include a variety of point and nonpoint sources, such as roadways, a railroad, a petroleum product pipeline, agricultural activities, septic systems, surface water discharges, and stormwater runoff from developed areas. Based on water quality monitoring results and analyses conducted by WSSC, phosphorus is the primary contaminant of concern to the reservoirs. Additional contaminants of concern include turbidity, disinfection by-products, iron, manganese, and protozoa.

The Patuxent Reservoirs Watershed Protection Group was formed in 1998 to promote policies that would protect the long-term biological, physical and chemical integrity of the Patuxent reservoirs watersheds. The group engages participants from relevant programs in Howard County, Montgomery County, M-NCPPC, Prince George's County, Soil Conservation Services for Howard and Montgomery Counties, the State of Maryland, and WSSC. This group has historically supported initiatives targeted at reducing contaminant loading into the reservoirs, such as implementation of stormwater management BMPs along tributaries leading into the reservoirs. The group also is involved in public outreach activities and has sponsored workshops and Patuxent Reservoir Days every spring and fall. These outreach efforts have also promoted the establishment and recognition of several schools within Prince George's County as the Maryland Association for Environmental and Outdoor Education Green Schools.

The following recommendations were made in the Maryland Department of the Environment's 2004 Source Water Assessment for the WSSC Patuxent WFP to protect the reservoirs and ensure a safe and adequate water supply for WSSC customers:

- Strengthen the existing Patuxent Reservoirs Watershed Protection Agreement[1] (established in 1996).
- Expand protected property within the watershed and improve management of forested lands.
- Enhance WSSC's existing water quality sampling program.
- Reduce phosphorus loadings.
- Implement controls for spills at major highway crossings.
- Analyze traffic accident statistics and patterns to identify potential problem/spill locations.
- Establish notification and emergency response procedures for potential contaminant sources.

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[1] http://www.montgomerycountymd.gov/deptmpl.asp?url=/content/dep/csps/Watersheds/csps/html/upperpat.asp

Potomac Water Supply—The Potomac River is the water source for the Potomac WFP, which is also owned and operated by WSSC. The Potomac River watershed is approximately 11,400 square miles and is primarily forested, with significant agricultural use and some urban land uses. The existing intake for the plant is located on the bank of the Potomac River and is opposite several islands in the river. The intake structure, near the C & O Canal above Swain's Lock, was built in 1982. The WSSC's Potomac WFP has a maximum treatment capacity of 300 mgd. There are numerous long-standing efforts to improve water quality in the Potomac River. In particular, efforts are currently underway in the Watts Branch watershed in Montgomery County to identify priority stream restoration and stormwater management projects to improve both the habitat and water quality of the watershed. According to the findings of the 2002 Source Water Assessment for the Potomac WFP, contaminants that cause major challenges and are of particular concern include: natural organic matter and disinfection by-product precursors, sediment, cryptosporidium and giardia, taste and odor causing compounds, ammonia, sediment/turbidity, algae, fecal coliform, ammonia, and dieldrin (a banned pesticide). Sources of these contaminants are present throughout the watershed. The Potomac WFP is also vulnerable to spills and overflows from various transportation and industrial sources in the watershed.

Source water at the intake can become largely isolated from the main flow of the river and be heavily influenced by local run off from Watts Branch, which flows into the Potomac River approximately 1,800 feet upstream of the intake. WSSC analysts believe that the Watts Branch is the cause of sudden negative changes in raw water quality and treatability at the Potomac WFP intake. Analyses conducted as part of the 2002 Source Water Assessment for the WSSC Potomac WFP indicate that a submerged channel intake (at a mid-channel location) would allow the plant to effectively avoid these impacts.

The following recommendations were made in the Maryland Department of the Environment's 2002 Source Water Assessment for the WSSC Potomac WFP to protect the watershed and river and ensure a safe and adequate water supply for WSSC customers:

- Formulation of a watershed protection group representing all stakeholders. Among other things, this group should have aggressive involvement in upstream agricultural and animal farming BMP implementation plans to address nutrient, bacteria, and pathogen loads.
- Serious consideration should be given to an upgraded intake structure with flexibility to withdraw water from a submerged mid-channel location. As previously noted, such a structure would help moderate changes to raw water quality at the Potomac WFP intake.
- Preparation of a proactive spill management and response plan to minimize the risk of contamination resulting from spills in the watershed.
- Consideration of appropriate source evaluation and management practices for fecal contamination to improve public health protection.

The Potomac River Basin Drinking Water Source Protection Partnership (DWSPP) is a unique regional organization formed to help ensure that the basin's public drinking water sources, serving more than five million people, are protected from contamination that could adversely affect the health of consumers. The partnership was formalized in 2004. At the present time, 20 drinking water utilities and government agencies from throughout the Potomac River basin are DWSPP members.

Groundwater **is water present in saturated ground, where all the pore spaces are completely filled with water. Groundwater moves slowly, commonly less than one foot per day, and moves down gradient from higher to lower water table elevations.**

Groundwater and Aquifers—Groundwater is water found below the ground surface located in soil pore space and in rock fissures. Groundwater is recharged from, and can eventually flow to, the surface, discharging into streams and wetlands or as seeps and springs. An aquifer is an underground water layer within unconsolidated materials such as gravel sand or clay or fractured rock. Aquifers function as underground reservoirs that provide clean potable water via drilled wells that access the aquifer water and pump it to the surface. Coastal Plain aquifers composed primarily of sand and gravel with layers of silt and clay are productive groundwater sources of generally good quality domestic drinking water. Prince George's County groundwater levels from unconfined portions of the aquifers undergo seasonal fluctuation and are principally recharged by precipitation during the spring and winter months. Groundwater levels in the confined portions of the aquifers are subject to impacts from groundwater pumpage at a regional scale.

Increased water demands from a growing population place new and additional stresses on the aquifers, and additional analysis of the county's groundwater resources is needed to assess the long-term viability of the county's aquifers in the face of increasing demands. Except in some urban and industrial areas, county groundwater is generally of good quality and deeper, confined aquifers meet drinking water standards. The unconfined Coastal Plain aquifers are vulnerable to groundwater contamination associated with human activities on the land surface, but incidents of serious contamination are usually localized around specific sources. A historical source of contamination has resulted from abandoned sand and gravel mining operations that then became landfills or rubblefills. Certain heavy metals, pathogens, and other toxic elements easily combine and become activated by water resulting in contamination.

Maryland Groundwater Rights—Water rights in Maryland run with the land and are considered inseparable from the property's "bundle of rights." Landowners are allowed reasonable use of groundwater in view of the similar rights of others (reasonable use=without unreasonable interference to others). Because Maryland adheres to the reasonable use (American rule) for water rights, allocation includes the following prioritization of allowances and restrictions. If a "water supply emergency" exists, then priority is:

- Domestic and municipal uses for sanitation, drinking water, and public health and safety;
- Agricultural uses, including the processing of agricultural products; and
- All other uses.

Maryland's "recharge rule" is an unwritten administrative policy that calculates water recharge very conservatively. If one wishes to withdraw 3,000 gallons of groundwater per day and assume a recharge calculation of 300 gallons/day/acre, one must own or have control over ten acres of land. This policy can prove very problematic for public water suppliers and commercial users, because sufficient land area must be controlled to assume recharge equal to or greater than withdrawals.

Source Water Protection—The U.S. Environmental Protection Agency (EPA) provides funding through Section 106 of the Clean Water Act to assist in the coordination of groundwater protection activities. Maryland's annual funding for this program is approximately $385,000. These funds are used to support the coordination of activities, as well as for groundwater assessment projects, wellhead protection efforts, and educational outreach activities.

Groundwater aquifers, where unconfined (geologically protected by a clay layer), similar to surface water, can be contaminated and compromised by activities employed on the land. Pollutants can seep through the ground surface or streambeds and access groundwater. The Maryland Department of the Environment (MDE) is responsible for the development and implementation of the state Comprehensive Groundwater Protection Strategy and to coordinate efforts by other state agencies to protect and manage groundwater.

Maryland's environmental, agricultural, and natural resources protection programs administered by MDE, the Maryland Department of Agriculture (MDA), and the Maryland Department of Natural Resources (MDNR) work to achieve groundwater protection through the implementation and administration of programs that educate the general public, businesses, and industries concerning the importance of water quality protection and water conservation. In addition, these departments promote land use practices that strive to minimize the impacts of development in environmentally sensitive areas and encourage the preservation of natural resources by promoting development in growth centers where transportation and infrastructure exists.

The State of Maryland is committed to protect the physical, chemical, and biological integrity of the groundwater resource, in order to protect human health and the environment, to ensure that in the future an adequate supply of the resource is available, and in all situations, to manage that resource for the greatest beneficial use of the citizens of the state.
—The Maryland Groundwater Protection Strategy

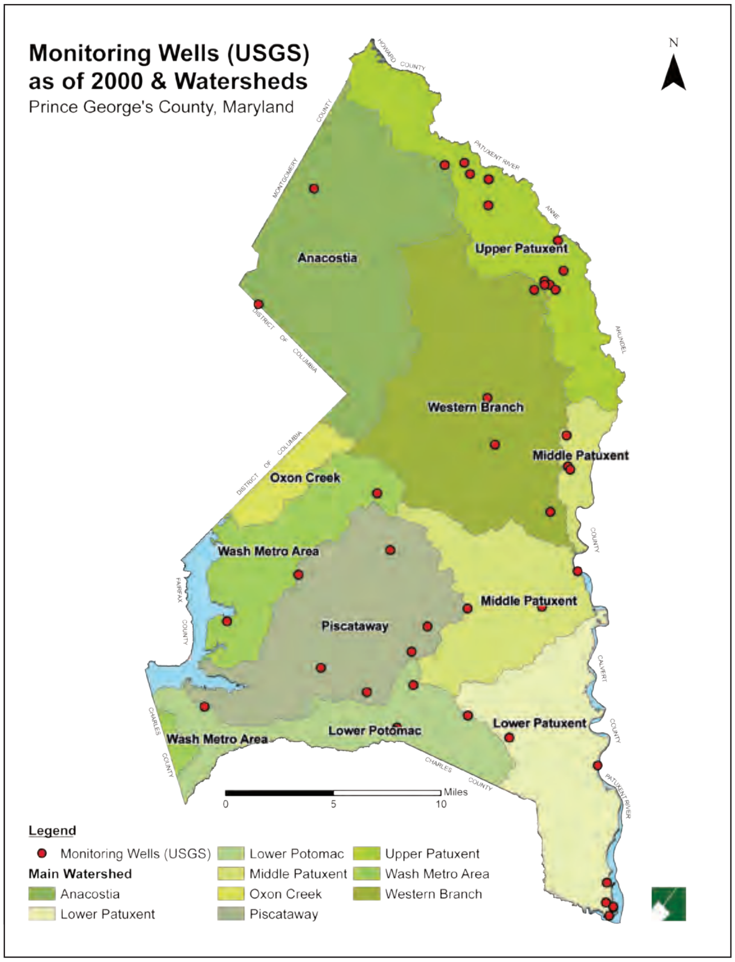
In order to protect important public water supply sources, Maryland has developed and implemented the Wellhead Protection Program (WHPP), a preventive program designed to protect public water supply wells from contamination by establishing a wellhead protection area (WHPA) around each well. Existing and potential contamination sources are identified and management plans are developed to identify the best means for protecting the sources. EPA approved Maryland's WHPP in June 1991. The program coordinates wellhead protection activities among State agencies, public water suppliers, local governments, and the public. The MDE's Water Supply Program (WSP) assists local governments in delineating WHPAs and in developing management programs to protect water supplies within the WHPAs. Participation at the local level is voluntary.

It is the responsibility of the WSP to ensure the safety of new public water supplies by reviewing and evaluating proposals for the siting of new wells. To ensure that wells are sited in the safest locations, staff review departmental databases to identify existing or potential contamination sources and use site investigations to verify this information and evaluate any additional factors that might influence the safety of the water supply. It is imperative that water withdrawal permitting consider the cumulative impacts of withdraws and ensure that residents and businesses in Prince George's County that currently rely on well water do not suffer adverse impacts to the quality and quantity of that resource due to over permitting to new customers.

Additionally, the use of surface and groundwater is controlled through the state water appropriation permits. These permits help to ensure that Maryland's water resources are conserved and protected while providing safe drinking water to the state. Specific proposed uses are reviewed to determine if the resource is adequate to sustain the requested allocation without adverse impacts and whether impacts are reasonable

Cone of Depression:
A depression in the water table that develops around a pumped well.

Drawdown:
(1) The drop in the water table or level of water in the ground when water is being pumped from a well.
(2) The amount of water used from a tank or reservoir.
(3) The drop in the water level of a tank or reservoir.



Map 16: Monitoring wells.

relative to the recharge rule requirements for surface water and unconfined groundwater and relative to the so-called 80 percent management (20 percent of pre-pumping drawdown) level reserve requirement for confined groundwater.

Aquifer and Groundwater Monitoring—Groundwater continues to be a plentiful natural resource serving as a significant source of drinking water in Prince George's County. About one third of the land area of the county and approximately 12 percent of its population depends on groundwater for its drinking water supply.

Groundwater also serves as a critical resource for agricultural communities and as a source of water base flow in county rivers and streams. As households and businesses increase in the county, demand for additional groundwater resources rises as well. As of 2008, the average daily well water demand in Prince George's County was estimated to be 0.2 million gallons a day (mgd). By 2030, development will create demand for approximately 0.36 mgd.[2]

Due to limited scientific study to this point, the amount of sustainable aquifer withdrawal in Prince George's County is unknown. The United States Geological Society (USGS) along with the Maryland Geologic Society (MGS) have been monitoring aquifer wells to verify the water levels over the past few decades. The general trend shows recharge is not keeping pace with withdrawals. This reality has created several large-scale cones of depression around both individual pumping well points and aquifer pumping centers throughout Maryland. These areas of groundwater-level depression have resulted in significant drops in water levels in several aquifers underlying Prince George's County, particularly in the southwestern areas of the county.

Hydrogeology:
The scientific study of the occurrence, distribution, and effects of groundwater.

Aquifer:
An underground geological formation, or group of formations, containing water. Aquifers are sources of groundwater for wells and springs.

MDE is considering extension of the existing water management strategy areas in Indian Head and Waldorf in Charles County, into southwestern and southern Prince George's County. This designation would allow MDE to adopt specific use restrictions or criteria for permit approval in order to protect the water resource or existing water users. There is also the option of directing domestic residential well users to a deeper aquifer, but that option has associated elevated well construction and energy demand costs.

The 2003 Advisory Committee on the Management and Protection of the state's water resources identified the need for a comprehensive assessment of groundwater resources in the Maryland Coastal Plain, where population is expected to grow by 44 percent between the years 2002 and 2030. In 2007, USGS, MGS, and MDE continued their Phase I work (2006-2008) on the Regional Coastal Plain Assessment of the Maryland Coastal Plain, documenting the hydrogeologic characteristics of the aquifer system.

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[2] Wolman Report: http://wsscwater.com/AnnualReports/WSSC-AR2003.pdf

Future assessment activities will include conducting detailed studies of the regional groundwater flow system and water budget; improving documentation of patterns of water quality in the aquifers; enhancing groundwater level, streamflow, and water quality monitoring networks; and developing tools to facilitate scientifically sound management of the groundwater resources in the Maryland Coastal Plain. Phase I activities are being jointly supported by funds and services from MDE, MGS, and USGS. Phases II and III will require significant additional investment from current and new funding partners from 2008 to 2013.

MGS continues the study, begun in 2001, of the hydrogeologic characteristics and water supply potential of the Patapsco aquifer system in southern Maryland. The objectives of the project are to obtain additional hydrogeologic information regarding the upper, middle, and lower Patapsco aquifers in Charles, Calvert, and St. Mary's Counties, to integrate these data into a quantitative assessment of the aquifers' capacity to supply future water demands in the tri-county region, and to construct observation wells to monitor future changes in Patapsco water levels. Preliminary analysis indicates that even though the Patapsco aquifers are widely distributed, their water-producing properties are locally variable. The Patapsco aquifer is the primary source for private wells in southwestern Prince George's County and impacts to and influences of withdrawals in the county have been reflected, to some extent, in this study. MGS should expand the study into southern Prince George's County to account for the broad-based regional influences on the Patapsco aquifer.

Water Supply Program[3]—The Water Supply Program (WSP) of the MDE is responsible for regulating public drinking water systems in Maryland and implementing development capacity standards. The WSP is a part of the Water Management Administration within the MDE. The mission of the WSP is to ensure that public drinking water systems provide safe and adequate water to all present and future users in Maryland, and that appropriate usage, planning, and conservation policies are implemented for Maryland's water resources. This mission is accomplished through proper planning for water withdrawal, protection of water sources that are used for public water supplies, oversight and enforcement of routine water quality monitoring at public water systems, regular on-site inspections of water systems, and prompt response to water supply emergencies. Capacity development is the process of water systems acquiring and maintaining adequate technical, managerial, and financial capabilities to enable them to consistently provide safe drinking water. Public drinking water systems fall into three categories. Community water systems serve year-round residents; non-transient non-community water systems serve regular consumers, such as in a school or day care setting; and transient non-community water systems serve different consumers each day, such as in a campground or restaurant. Historically, WSP has emphasized preventative measures to avert serious public health incidents instead of reactive enforcement actions. Preventative measures include activities such as sanitary surveys, training and technical assistance, comprehensive performance evaluations, monitoring, operator certification, financial assistance, consolidation, county water and sewer planning, source water assessments, and special initiatives. MDE's WSP recently initiated a statewide effort to evaluate watersheds by assessing the available water supply within a watershed as it relates to existing and future water

[3] Safe Drinking Water Act Capacity Development Report, September 2002, Maryland Department of the Environment Water Supply Program

demands. Although resources for this effort are limited, the goal is to provide regulators, planners, and water suppliers with information that can serve as a guide when planning for future water needs.

Wastewater Permits Program—The mission of the MDE's Water Management Administration (WMA) is to restore and maintain the quality of the state's ground and surface waters, and to plan for and supervise the development and conservation of the state's waters. WMA manages a broad range of activities, including regulating and financing municipal wastewater treatment systems; regulating the use and development of the state's water resources, public water supplies, and on-site residential sanitation systems; regulating well drilling and industrial pretreatment; providing technical assistance for water and wastewater utilities; financing small creek and estuary restoration; approving erosion/sediment control and stormwater management plans; issuing stormwater permits; inspecting and issuing dam permits; protecting and managing tidal and nontidal wetlands and waters; and regulating mining activities and mitigation problems associated with abandoned mines. These protections, financing, and regulatory activities help WMA ensure that state waters are safe for drinking, recreation, and wildlife.

MDE programs that are administered by WMA are designed to:

- Create outreach and assistance activities that can address cross-functional issues involving water regulatory programs.
- Manage water, wastewater, and nonpoint source pollution control capital projects that are funded through grants and loans from the department.
- Permit and provide construction inspection for water and sewerage facilities.
- Develop and implement the new federally mandated stormwater permitting program.
- Review and approve erosion/sediment control and stormwater management plans for state and federal construction projects.
- Inspect dams for safety, issue new permits, and approve downstream warning plans for high-hazard dams.
- Issue water appropriation permits for use of surface and groundwaters.
- Issue permits for discharges to surface and groundwater from both industrial and municipal facilities as required by the federal Clean Water Act.
- Oversee programs delegated by the department to local health departments. Activities include MDE's regional consultants who provide technical assistance to local health departments for on-site water and wastewater systems and assistance in developing and testing new innovative or alternative septic system designs.
- Regulate activities conducted in nontidal wetlands and their buffers, nontidal waterways (including the 100-year floodplain) and tidal wetlands.
- Create, restore, and enhance nontidal wetlands and streams; provide training and technical assistance for the development of watershed management plans.
- Inspect industrial and municipal wastewater discharges, coal and surface mining operations, agricultural sites, and construction activities involving sediment control, stormwater management, wetlands, and waterways.

- Regulate active mines and mitigate environmental problems associated with abandoned mines. Also, regulate oil and gas exploration, production, and storage.
- Ensure safe drinking water in Maryland by administering the federal Safe Drinking Water Act, develop the state's comprehensive groundwater protection program, and respond to local water supply emergencies.
- Conduct performance evaluations of surface water filtration plants to assist systems in optimizing treatment and reducing the risk of passing cryptosporidium (a protozoan parasite that can infect humans) into the finished water.
- Train public water and wastewater treatment operators, and provide on-site technical assistance to support the state's operator certification program and achieve compliance and pollution prevention goals.
- Finance stormwater management practices and small creek and estuary restoration projects.[4]

The Prince George's County Health Department has the responsibility to assure a safe and adequate water supply for every residence and business within the county. It is specifically mandated to evaluate well locations, permit the installation of wells, inspect wells during their construction and sample wells to assure the potability of the water supply. The department reviews monthly reporting from community water supply operators. The department also responds to calls from individual well users, along with complaints concerning illegal discharges of hazardous waste into streams or other water bodies, and requires environmental assessment as part of the county's subdivision review process if groundwater contamination is possible based on previous land use or evidence of illegal disposal of waste products. The Health Department is also responsible for assessing the necessity of water appropriation permits during subdivision review and to implement and enforce the State of Maryland's well construction regulations.

Senate Bill 970 was signed into law on May 8, 2007, and codified as Chapter 365 covering the environment, water appropriation permits, and penalties. This new law exempts most small water users (5,000 gallons per day or less) from the requirement to obtain a water appropriation permit and provides specified penalties for misappropriation or misuse of water. The new law will allow MDE to better allocate resources to address larger and more complex permits and to better enforce existing permit requirements. Public drinking water systems and withdrawals located in groundwater management strategy areas must still obtain a permit.

Other exemptions include temporary construction dewatering (up to 30 days and less than 10,000 gallons per day), creation of small subdivisions (5,000 gallons per day or less), individual domestic use, agricultural use under 10,000 gallons per day, and extinguishing a fire.

The most effective way for a water system to improve its water use efficiency is to develop and implement a water conservation plan. A water conservation plan is a written document developed for public and private drinking water systems that evaluates current and projected water use; assesses infrastructure, operations, and management practices; and describes actions to be taken to reduce water losses, waste, or consumption and increase the efficiency with which water is used, treated, stored,

[4] http://www.mde.state.md.us/Permits/WaterManagementPermits/index.asp#3.02

Waste Load Allocation: **The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. Waste load allocation is based on the portion of a stream's total assimilative capacity assigned to an individual discharge.**

and transmitted. As local governments, not-for-profits, and the private-sector industry look for cost-saving opportunities, we need to focus explicitly on water efficiency. The use of water-saving appliances, low-flush toilets (1.6 gallons) water-saving shower heads, and metered water faucets are examples of measures that individual households and businesses have used to reduce water consumption. The objective of conservation and efficiency is undermined by cracked and broken pipes, outdated metering systems, potable water used for inherently nonpotable uses, extensive public infrastructure extensions into exurban large lot residential communities, and water billing processes that fail to reward consumers for reducing water consumption.

WASTEWATER

Maintain a safe and efficient wastewater management system and sewage disposal to service Prince George's County's existing and future development needs and preserve human, environmental, and economic health.

Public Wastewater—During the 1940s, WSSC developed a sewage treatment plant in Bladensburg in Prince George's County to provide pollution control service to Maryland's portion of the bicounty Anacostia Basin. Shortly after the end of World War II, negotiations began with the District of Columbia for the joint Maryland and D.C. development of the Blue Plains Water Pollution Control Plant, which was designated as the regional facility for both Washington, D.C. and the Maryland suburbs. The cooperative arrangement permitted the abandonment of the WSSC's Bladensburg Plant in the early 1950s. The regional Blue Plains Wastewater Treatment Plant (WWTP) has a present day capacity of 370 mgd, of which just under 170 mgd has, by agreement, been allocated to the WSSC.

It was not until the late 1950s and the 1960s that WSSC began to develop some new permanent sewage treatment facilities of its own. These plants were located in Prince George's County to serve areas that were earmarked for growth and were financially and operationally out of reach of the regional Blue Plains WWTP. In the mid-1950s, WSSC designed and built the Parkway WWTP (opened in 1959), which has a current capacity of 7.5 mgd. The 1960s saw the opening of the Piscataway Plant in southwestern Prince George's County (now able to treat 30 mgd) and the Western Branch WWTP in eastern Prince George's County, where the nominal capacity is 30 mgd.

WSSC forecasts wastewater treatment demands based on population and employment figures compiled by Prince George's County and developed for the Metropolitan Washington Council of Governments. These projections are currently established in Prince George's County through the year 2040 as Round 7.2 and are reevaluated on a cyclical basis. WSSC develops wastewater flow projections (see Technical Appendix II) based on these figures to show existing and projected demands and capacity limits at their WWTP. WSSC forecasts indicate that current wastewater treatment capacity for Prince George's County is sufficient through the year 2030.

Additionally, several private and community systems are in place in Prince George's County to service areas of Bowie and Cedarville. A private system was originally installed in the Marlboro Meadows development but has been acquired by WSSC and effluents will be processed through the Western Branch facility by the year 2012.

Wastewater Treatment Plant Upgrades—The primary cause of the Chesapeake Bay's poor water quality and aquatic habitat loss is elevated levels of nitrogen and phosphorus. Excessive amounts of nitrogen and phosphorus create dense algae blooms that deplete oxygen and light, eventually killing grasses and aquatic species. Nutrients enter the bay through rivers and streams from point and nonpoint sources in Prince George's County and the entire bay watershed. The vast majority of point source discharges of nutrients are from sewage treatment plants, along with smaller contributions from industries. In recent years, all WSSC WWTPs have been equipped with some form of advanced treatment. The WSSC service area is generally ahead of the rest of the nation in the development of facilities that have taken a big step (tertiary treatment) beyond the conventional primary/secondary processing of wastewater. Consequently, it produces an exceptionally high quality of effluent (treated wastewater) at all of its plants. Wastewater plant treatment upgrades over time have made significant progress toward restoring water quality in county tributaries and the bay at large. Although plant upgrades have lowered concentrations of nutrients in discharges, increases in treatment volumes have resulted in additional flow into receiving waters.

The WSSC WWTPs servicing Prince George's County include Western Branch, Parkway, and Piscataway. These plants are all funded and scheduled for enhanced nutrient removal (ENR) upgrades in the next several years. The Blue Plains WWTP (owned and operated by D.C. Water and Sewer Authority) and Mattawoman WWTP (owned and operated by Charles County) also treat sewage from Prince George's County and have ENR treatment upgrades underway. The Bowie WWTP has a permitted capacity of 3.3 mgd and currently treats approximately 2.2 mgd of wastewater conveyed to the plant from its mostly developed service area. Future flows are not expected to exceed the plant's capacity; however, the county should develop projections of the estimated wastewater demand for the City of Bowie based on residential and nonresidential population projections and the implementation of the area master plan for growth to 2030 or to buildout. If the demand is forecasted to be greater than the city's WWTP capacity, future land use plans should discuss ways to address this constraint. Additionally the City of Bowie, in Prince George's County, has scheduled an ENR upgrade to its wastewater facility within the next year and a half.

"The need for ever-changing technology in the wastewater industry stems from past biological systems that did a good job at removing particulate matter that we knew existed. But instrumentation just kept getting better and better at detecting more and more trace compounds that we didn't know existed or couldn't detect in earlier years,"
—Robert McMillon, former president of the Water Environment Federation

Activated Sludge Treatment Process—In the early 1960s, the Blue Plains WWTP incorporated an activated sludge treatment process to improve the quality of treated wastewater that it discharges into the Potomac River. This process passes wastewater through screens, which captures large items. This is followed by a grit removal tank, which slows down the wastewater flow enough to settle relatively heavy particles such as sand. The screens and grit tank represent the preliminary treatment system. The wastewater then flows into a primary clarifier, in which the velocity of wastewater flow is further reduced to allow for lighter particles to settle. After this physical treatment process, the wastewater is directed to the biological treatment process in the aeration basin.

In the aeration basin, bacteria take in organic matter, ammonia, and added oxygen to produce carbon dioxide and nitrates. This biological process removes more biochemical oxygen demand and suspended solids. Approximately 90 percent of the sludge is returned to the aeration basin from the final clarifier to allow for more bacteria growth. One of the by-products of this treatment was the collection of massive quantities of solids far greater than could be managed at or near the plant. In 1974, a regional agreement was signed requiring each major jurisdiction sending flows to the plant—Montgomery County, Prince George's County, and the District of Columbia—to manage its share of the sludge.

Biological Nutrient Removal (BNR)—Raw or untreated wastewater contains ammonia, which is toxic to fish. Ammonia degrades to nitrates, which removes the oxygen from the stream, therefore, killing animal and plant life. Nitrates also become fertilizers promoting algae growth. As algae die and decompose, a high oxygen demand is created, which leads to low dissolved oxygen in the water. The BNR denitrification process can convert some of the nitrate into nitrogen gas bubbles that are harmless and the wastewater effluent has no deleterious effects on receiving waters.

Maryland honored its commitment of the Chesapeake Bay Agreement by establishing the Biological Nutrient Removal Program (BNR)[5] to reduce nutrients in treated sewage. The goal of the BNR Program, established in 1984, is to reduce nitrogen levels in the treated wastewater (effluent) down to 8 milligrams per liter (mg/l). Without BNR, a typical WWTP discharges nitrogen at a level of about 18 mg/l. To date, Maryland has provided funding for this program to upgrade 45 of the 66 targeted facilities with the BNR process. An additional estimated $100 million in state grant funding is needed to complete the remaining BNR upgrades, and the state has committed to provide the funding through annual capital appropriations.

Enhanced Nutrient Removal—Maryland's Enhanced Nutrient Removal (ENR) Program takes the next step beyond BNR and controls point source nutrient discharge by upgrading wastewater treatment plants to the limit of technology for nutrient removal. ENR reduces nitrogen discharge from BNR treatment level of 8 milligrams per liter to 3 mg/l and phosphorus from 3 to 0.3 mg/l. The Bay Restoration Fund provides grants to local governments for up to 100 percent of the cost of upgrading a BNR plant to ENR. As a common method to achieve ENR, filters are added to the BNR process for additional nitrogen and phosphorus removal. An external carbon source, such as methanol, is added to the filter to increase bacteria growth and further improve treatment. This process allows wastewater treatment facilities to achieve maximum nutrient removal with current technologies.

Point Source Load Data Input—An evaluation of the six major WWTPs located within Prince George's County was conducted to reflect point source loads for total nitrogen and total phosphorus for the initial and future scenarios. These WWTPs are identified in Table 16.

Initial (year 2005) and future (year 2030) nitrogen and phosphorus loads were determined based on review of several resources including:

- Demand and capacity projections prepared by WSSC for WSSC-owned WWTPs.
- 2005 National Pollutant Discharge Elimination System permit discharge limits for the WWTPs.
- Monthly discharge monitoring reports for WSSC-owned WWTPs.
- ENR preliminary engineering reports for WSSC-owned WWTPs.
- Maryland's Tributary Strategy Statewide Implementation Plan.

[5] http://www.mde.state.md.us/ResearchCenter/Publications/General/eMDE/vol1no7/enr.asp

Table 16: Approximate Population Forecasts by Sewershed in Prince George's County						
BASIN	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Blue Plains	407,110	425,381	440,766	450,204	456,129	458,289
Mattawoman	3,516	5,348	6,707	7,691	9,339	10,989
Parkway	54,125	55,649	55,725	55,585	55,375	55,091
Piscataway	158,835	165,315	171,417	175,374	178,771	181,490
Western Branch	167,601	185,641	196,857	204,723	210,963	216,883
Unsewered	20,212	21,924	22,775	23,414	24,197	24,702
TOTAL	811,399	859,258	894,247	916,991	934,774	947,444
Source: Prince George's County Planning Department (M-NCPPC) Round 7.1 Cooperative Forecasts, 2008.						

Loads were determined based on historic information contained in the above-mentioned resources and population forecasts to year 2030 by sewershed as represented in Table 16. The ultimate ENR total nitrogen and total phosphorus load caps are identified in the Statewide Implementation Plan as shown in Appendix II. This information shows that for the year 2030, the larger WWTPs will be near their ultimate nutrient load capacities.

Maryland's numerical limit is a maximum of 37 million pounds per year nitrogen and 2.9 million pounds per year phosphorus. To achieve this, Maryland still needs to reduce nitrogen loading by an additional 20 million pounds per year and phosphorus by 1.1 million pounds per year. Nutrient reduction from both point and nonpoint sources is necessary to accomplish this goal. The goal is to remove the bay and the tidal portions of its tributaries from the impaired waters list, Section 303d of the Clean Water Act, by 2010.

Alternative Distribution wastewater management can rely on land distribution and treatment methods in order to reduce direct discharges into streams. Land treatment systems are permitted in some states, but are not widely used because of their large land area requirements. For example, a spray irrigation system requires about four times the area of an individual home lagoon. When these systems are used, large buffer areas and fencing may be required to ensure minimal human exposure. Also, requirements include disinfection and significant pretreatment before application. Spray irrigation systems distribute wastewater evenly on a vegetated plot for final treatment and discharge. Spray irrigation can be useful in areas where conventional on-site wastewater systems are unsuitable due to low soil permeability, shallow water depth table or impermeable layer, or complex site topography. Treatment occurs within the soil before the wastewater reaches the groundwater.

The evapotranspiration/infiltration process is a subsurface system designed to dispose of effluent by both evapotranspiration and infiltration into the soil. In evapotranspiration/infiltration systems, effluent is allowed to percolate into the underlying soil. Modifications to evapotranspiration/infiltration systems include mechanical evaporating devices and a broad array of different designs and means of distribution, storage of excess influent, wicking, and containment or infiltration prevention. Some newer studies are using drip irrigation with distribution to forested areas with purported success.[6]

Infiltration or Percolation:
The technique of applying large volumes of waste water to land to penetrate the surface and percolate through the underlying soil.

Evapotranspiration:
The combined effect of water removal from a medium by direct evaporation and by plant transpiration.

6 http://www.epa.gov/nrmrl/pubs/625r00008/html/html/tfs6.htm

Rapid infiltration is a soil-based treatment method in which pretreated wastewater is applied intermittently to a shallow earthen basin with exposed soil surfaces. It is only used where permeable soils are available. Because loading rates are high, most wastewater infiltrates the subsoil with minimal losses to evaporation. Treatment occurs within the soil before the wastewater reaches the groundwater. The rapid infiltration alternative is rarely used for on-site wastewater management. It is more widely used as a small-community wastewater treatment system in the United States and around the world.

In an overland flow system, pretreated wastewater is spread along a contour at the top of a gently sloping site that has minimum permeability. The wastewater then flows down the slope and is treated by microorganisms attached to vegetation as it travels by sheet flow over very impermeable soils until it is collected at the bottom of the slope for discharge.

Today's wastewater treatment challenges are to improve or develop technologies that address the changing issues of society, while keeping an eye on the advances these technologies may provide in the future. Some technology advances will lead away from chemical additives and back to using naturally occurring bacteria as well as recycling what is produced naturally in the process, such as oxygen and methane. Such technologies must continue to advance and provide additional nutrient removal services to best manage effluents and wastewater discharges.

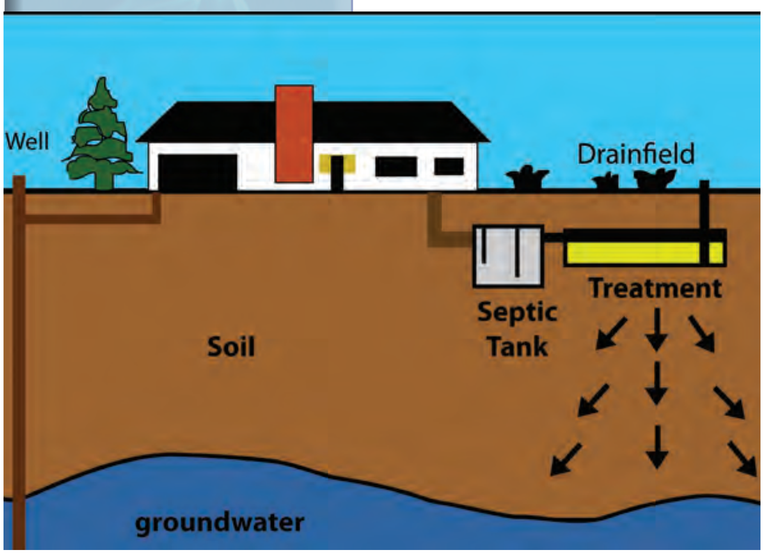

Figure 12: Septic system diagram.

Septic Systems—Ten to 12 percent of property owners in Prince George's County rely on on-site sewage disposal systems (OSDS), for wastewater treatment. The average person using a septic system delivers about 9.5 pounds of nitrogen per year to the groundwater. If you live on one of the over 51,000 properties in the county within the Chesapeake Bay critical area (the land within 1,000 feet of tidal waters) and are served by a septic system, approximately 80 percent of the nitrogen from your septic system will reach surface waters.

The standard on-site wastewater treatment system for homes and small businesses consists of a basic septic tank connected to a septic drainfield. Effluent from homes and businesses flows into the septic tank. Flows leave the tank through one solid-walled pipe that carries the effluent to a distribution box from whence the flow is distributed into a connected series of drainfields. The pipes within the drainfield are laid out parallel to the contour of the ground in regular spacing intervals to form a subsurface dispersal system. Perforations within the pipe walls allow effluent to leave the pipes at random rates of flow. Many modern septic systems are designed to use a pump chamber that allows the effluent to be pressure dosed, resulting in a more uniform rate of flow throughout the drainfield system. The use of small diameter pipes within the conveyance system associated with low pressure distribution and drip systems allow for the system to be located closer to the surface where evapotranspiration may more effectively remove nitrogen in the form of nitrates and phosphorus.

Of critical importance to the functioning of the septic system is the size of the central receiving tank. The volume of the central tank is directly proportional to the expected flow rate of the effluent. As a rule of thumb, the volume of the tank will be at least 50 percent more than the expected daily effluent flow. The tank serves as a settling basin that separates out the various components of the effluent. Fortunately, septic tanks within Prince George's County are sized 30 percent larger than in other jurisdictions. The use of two compartment tanks and outlet filters are options that result in improved septic tank effluent quality.

Most of the nitrogen in traditional septic tank effluent, where denitrification has not occurred, is discharged primarily as highly diluted nitrates into groundwater. Although shallow groundwater is still utilized as a drinking water source by some county residents, groundwater is predominantly discharged to surface waters. Septic systems have been designed to remediate most public health threats, but no matter how well the septic systems may have been constructed, they are not designed to significantly reduce discharged nitrogen. All septic systems are contributors of nitrogen to our local watersheds at varying degrees. This excess loading of nutrients, like nitrogen and phosphorus, from septic systems contribute to degraded water quality and negatively impact the ecology of the bay and its tributaries.

The Prince George's County Health Department plays an important part in the subdivision review and single-lot development process. During the process, the Health Department works with the applicant to determine the best type of sewage disposal as well as the best possible location of the sewage disposal system to maximize buffers to groundwater and distances to streams and other bodies of water. Through its testing procedures, the Health Department assures that the land has the capacity to assimilate sewage effluent as necessary to prevent health consequences. After testing, the applicant is required to provide the Health Department a site plan delineating the proposed sewage disposal areas and well locations for on-site systems. The department is also responsible for the review of site plans that designate the septic system design, the permitting of the construction of that system, and the inspection and documentation of the installation of the system. At a larger scale, the Health Department also plays an active role in the development of water and sewer plans for the county and provides comments and testimony for proposal and amendments to the plan. The local Health Department and environmental protection programs are in place to ensure the citizens of Prince George's County have safe drinking water, adequate septic systems, and clean streams.

Septic System Upgrades[7]—Nitrate contamination in groundwater has become an increasingly serious problem, especially in agriculture-oriented communities. Septic tank systems are the most common form of on-site wastewater management systems in the rural communities of Prince George's County. However, traditional septic systems fail to significantly treat nitrate and other contaminants, which make septic tank systems a minor source of nitrate contamination to surface waters within Prince George's County. Even though septic systems within the county likely contribute little to total nitrogen water resource loads, it has become imperative to remove nitrate from septic tank effluent in order to reduce the cumulative impacts from nitrogen in groundwater and in surface waters within the Chesapeake Bay critical areas and properties in the vicinity of the Patuxent reservoirs.

7 http://www.mde.state.md.us/ResearchCenter/Publications/General/eMDE/vol3no6/septic_upgrades.asp

Denitrification:
The biological reduction of nitrate to nitrogen gas by denitrifying bacteria in soil.

Infiltration:
The penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

One of the most efficient methods to treat nitrate is the biological denitrification process. Biological denitrification is effective in nitrate removal as long as there is sufficient external organic carbon to support bacteria growth, something that is typically available in the discharge of household waste. Currently there are several approved aeration treatment units that utilize biological denitrification to effectively remove approximately 40 percent of the nitrogen within a septic system. Through the Bay Restoration Fund the MDE has awarded grants totaling approximately $9 million to ten jurisdictions statewide to provide money for septic system upgrades. The grants will finance the implementation of approximately 700 septic system upgrades annually in Maryland. Recently, funding has been limited to the installation of these systems as part of a replacement system for failing septic systems located in the critical area. Several property owners within Prince George's County are taking advantage of these monies in the remodeling of their disposal systems. A law enacted by Senate Bill 554 requires that all residences built within the Chesapeake Bay critical area after October 1, 2009, incorporate bay restoration systems into their septic system design.

The Bay Restoration Fund is also being used to support the upgrading of the 66 largest wastewater treatment plants in Maryland to ENR technology and to expand planting of nitrogen deposition reducing cover crops on agricultural land.

By 2030, based on the normal lifetime of a septic system, it can be assumed that all existing septic systems will need to be repaired due to the system failures that will likely occur during the next 20 years. This will be a daunting task since there is no mandated law enforcement for upgrades and self-reporting or a house by house inspection cannot be expected. With this assumption, a 100 percent implementation of septic system upgrade is unlikely. Therefore, the default implementation rate of 50 percent for nonpoint sources is used in the nutrient model exercise of this plan for the existing septic system upgrade, 100 percent for any new septic system, and somewhere near five percent is assumed to be connected to public systems by 2030.

Sanitary Sewer Overflows (SSO) is an unintentional discharge of untreated, raw sewage into local waterways. Overflows occur when there are too much infiltration and inflow into the sanitary system from surface water or groundwater infiltrating through cracks in the pipe infrastructure, particularly during significant rain events; rain water, snow-melt, or groundwater flowing into the sanitary system through roof drains or house leads connected to sewers; undersized sanitary systems with sewers and pumps that are too small to carry the sewage; system failures due to tree roots growing into the sewer; sections of sewer pipe settling or shifting so that pipe joints no longer match; stream incising below sewer pipes in streambeds, undermining their support causing the pipes to rupture; sediments, fats, oils, grease and/or other material building-up and causing blockages; equipment and pump failures; power failures; and human error.

The environmental impact of SSOs is difficult to quantify; however, there are several related items that put them in context regarding WSSC's sewer system in Prince George's County. SSOs occur in wet weather and in dry weather. Wet weather SSOs are by far the fewest by number in the system and are caused by power outages at sewage pumping stations, system limitations, and external inflow (ground and surface water). In order to control the sources of these overflows, WSSC has begun installing permanent electricity generators at critical locations, building permanent facilities to temporarily store high flows in a controlled manner, and inspecting and repairing leaky sewers in order to reduce inflow. Dry weather SSOs are by far the largest by number in our system. They are caused by blockages from grease, tree roots, trash, and cracked pipes. WSSC is addressing dry weather SSOs by implementing a Fats, Oils and Grease (FOG) program whereby restaurants are required to keep grease out of the sewers, and residents are encouraged to do the same. Nutrient concentrations would be variable based upon whether the SSO occurred in dry or wet weather, and the annual nutrient load would vary depending on whether it was a wet or dry year. In addition, a program is underway to inspect and remediate root blockages and cracked pipes. Also, by regulation, WSSC is prohibited from having SSOs and is fined by MDE when they happen.

Sewer overflows have taken place at the Broad Creek pumping station and Piscataway and Western Branch WWTPs. These overflows, as well as sewer line breaks, have discharged untreated wastewater into county waterways. WSSC has begun planning and design of a sewer from the Broad Creek pumping station to Piscataway WWTP and a wastewater storage tank at the WWTP. This tank is expected to serve as a back-up in event of failures at Broad Creek and to prevent sewage discharges there. In 2005 WSSC entered into a consent decree with MDE and the U.S. EPA for Prince George's and Montgomery Counties to implement reporting, monitoring, inspection, maintenance, repair and replacement remedial measures for its sewage collection system as part of a comprehensive 12-year plan. In the area specific to the Piscataway WWTP, WSSC must conduct sewer system evaluation surveys, develop a water quality monitoring plan, determine bacteria sources, and test for fecal coliform. State and federal regulations require WSSC to reduce overflows and meet Clean Water Act requirements.

Sanitary sewers are designed and installed with sufficient diameter to carry the normal waste discharges from a residence or business. When fats, oils, and grease (FOG) are discharged to the sewer, it cools and accumulates on the sidewalls of the sewer pipes. Over time, this accumulation of grease restricts the flow and causes blockages in the sewer that may result in overflowing manholes or basement backups. SSOs can discharge to storm drains and creeks that ultimately flow to the Chesapeake Bay. All food service establishments (FSE) having the potential to discharge FOG must apply for a FSE wastewater discharge permit. The establishments may include restaurants, cafeterias, grocery stores, hotel kitchens, church kitchens, school kitchens, bars, or any other commercial or industrial operation that discharges grease-laden wastewater.[8]

Upon the issuance of a FSE wastewater discharge permit, WSSC provides inspection services to address compliance. WSSC is currently partnering with the Restaurant Association of Maryland to help the food service industry understand the problems associated with FOG discharges and to provide business owners assistance managing FOG correctly through the use of BMPs.

Waste vegetable oil ("yellow grease") from restaurants is becoming a resource for the agricultural industry because it can be converted to bio-fuel and run much of its farm equipment and trucks on converted diesel engines. Currently restaurants must pay a hauler to carry away the cooking oil waste. Pennsylvania implemented a program to swap cooking oil for fresh produce when the farmers came into the city with goods. This program not only ensures that cooking oil doesn't reach the sewer systems but supports local farmers and food production. Montgomery and Prince George's County's parks are also possible users for recycled cooking oil in converted diesel equipment.

[8] http://www.wsscwater.com/rsg/FOGProgram/index.cfm#overview

Greywater
is nonindustrial wastewater generated from domestic processes such as dish washing, laundry and bathing. Greywater comprises 50-80% of residential wastewater. Greywater comprises wastewater generated from all of the house's sanitation equipment except for the toilets (water from toilets is blackwater, or sewage).

Reclaimed Water Reuse is wastewater, graywater, or rainwater that has been treated to such a high level it can be used safely and effectively for nondrinking purposes such as landscape and agricultural irrigation, heating and cooling, and industrial processing. Reclaimed water is available year-round, even during dry summer months or when a drought strains other water resources. Reclaimed water is highly filtered and disinfected and is tested often. It contains only trace amounts of some nutrients and dissolved chemicals. Although reclaimed water is not drinking water, it is safe for human contact, even unintentional swallowing or exposure to open cuts. Reclaimed water is distributed through a separate set of purple pipes. Purple is the nationally designated color marking reclaimed water pipes, hoses, pumps, and other equipment. Development of a plan to study opportunities for reclaimed water will require an open regional participation process to provide input and advice throughout the planning process. The participation process should provide a broad range of opportunities to engage community leaders, environmental groups, regulatory agencies, water/wastewater utilities, business and civic organizations, the general public, and potential agricultural, recreational, commercial, and industrial user groups.

Panda Energy,[9] a gas-fired power plant in Brandywine, developed a reclaimed water system to support the plant's cooling operation. Panda worked closely with the Power Plant Research Program10 to study the feasibility of bringing treated effluent water into the facility for cooling. Ultimately the plant devised a combination permit for water access: one permit for an average of 64,000 gallons per day of groundwater for the boiler structure and other auxiliary uses and a second for effluent from the Mattawoman WWTP in Charles County for the five unit mechanical draft cooling towers. All effluents are then returned to Mattawoman WWTP. Panda constructed a 17-mile pipeline to bring tertiary treated effluent to the plant for the cooling tower that entered commercial operation on October 31, 1996.

Mirant's Chalk Point Generating Plant, the largest power plant in Maryland, helps support the D.C. area's thriving economic hub. Chalk Point, located in Aquasco, is predominately a coal-fired steam generating power plant. Steam generating plants use large volumes of water for cooling and Chalk Point uses the nearby Patuxent River as its water source. The surface water appropriation is based on a forecast of the plant's water needs over several years. The surface waters also receive the effluent and wastewater discharges from the power plant. Both withdrawal and discharge of water at power plants can adversely affect surface water quality. MDNR's Power Plant Research Program is working in partnership with electric utilities to avoid, minimize, and mitigate adverse impacts on both local and regional scales. Recent research on the regional level undertaken by MDNR includes a statewide biological stream survey to provide comprehensive baseline information on the health of freshwater systems in Maryland and to reference-based ecological indicators. These indicators are critical for assessing the effects of different degrading activities and measuring progress toward environmental goals. A related cumulative impact model, currently under development, will couple indicators of biological integrity with spatial data on

9 http://esm.versar.com/PPRP/powerplants-new/pandainfo.htm#aspects

10 http://www.dnr.state.md.us/Bay/pprp/

land uses, power-related impacts, and other anthropogenic stressors to evaluate watershed impacts on aquatic systems.[11]

Chalk Point has recently applied for permits to drill to the Patuxent aquifer, in order to withdraw water for the plant's air scrubbers as a part of its compliance with updates to the Clean Air Act. This additional consumption of potable water for nonpotable use should be carefully scrutinized in light of the statewide decline in aquifer water levels. Alternative recycled wastewater options should be analyzed for feasibility and cost.

Although ample water is available to provide cooling for Chalk Point, adverse environmental impacts can result from withdrawing, heating, and discharging such large volumes of water. The aquatic organisms are impacted through entrapment, impingement, entrainment, and discharge effects. Alternative recycled graywater options should be analyzed for feasibility and cost. A partnership with WSSC could alleviate the need for drilling, aquifer water withdrawal, and further decline of water resources in the county. Considerations should include:

- Technical feasibility and cost effectiveness of various pollution control alternatives.
- Air emissions of acid rain precursors and particulate matter, including heavy metals.
- Aquatic impacts of cooling water withdrawals and discharges.
- Beneficial use of combustion by-products.
- Unique approaches to minimize resource consumption.

Mirant is in the process of a $1.6 billion upgrade to the coal-burning plant to install scrubbers that will filter out sulfur, nitrogen, and mercury before they leave the smoke stacks. The measures are expected to be complete by early 2010. Currently Mirant has received permit approval from MDE to remove potable water from the Patuxent aquifer for this process. WSSC and Mirant discussed using recycled graywater from the Western Branch WWTP for the air scrubbers. The study indicated that Mirant was unable to use wastewater from the western branch facility until the plant had completed its ERN upgrade.

During the combustion of coal, bottom ash, fly ash, flue gas desulfurization waste, and fluidized bed boiler waste may be produced.

Although some of these wastes are used in building materials and as structural fill material, the majority is disposed in landfills and surface impoundments. The potential for groundwater contamination from leachate originating from these landfills and surface impoundments represents the greatest environmental concern for disposal of coal combustion by-products. Leachate from coal combustion by-products can contain elevated concentrations of boron, sulfate, trace metals, and other inorganic constituents. To properly evaluate the potential impact of coal combustion by-products disposal on groundwater quality, the physical and chemical properties of coal combustion by products, transport processes in groundwater, and the solution techniques of mathematical models must be understood.[12]

Fly Ash
is produced from the burning of pulverized coal in a coal-fired boiler is a fine-grained, powdery particulate material that is carried off in the flue gas and usually collected from the flue gas by means of electrostatic precipitators, baghouses, or mechanical collection devices such as cyclones.

[11] http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V78-3XK0PBH-22&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=980667681&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3e3102fa59548aec29fa8edfae14fa53

[12] http://www.mcrcc.osmre.gov/PDF/Forums/CCB/6-1.pdf

Rainwater Harvesting—On-site rainwater collection is one means to augment fresh water needs and help prevent rapid stormwater accumulation and runoff from roof areas. Harvested rainwater is rainwater that is captured from the roofs of buildings and can be used indoors or for irrigation depending on its processing and intended use. Rainwater harvesting techniques can provide a free, high-quality water source once the initial investment in collection and storage systems is recouped. Systems as simple as rain barrels, or more complex with filters and purifiers, are becoming increasingly more mainstream and commercially available. The U.S. Green Building Council supports rainwater harvesting and applies certification credits for implementation of a rainwater collection and reuse system[13].

Rainwater Harvesting Rooftop Collection Estimation: One inch of rainfall on a 1,000-square-foot roof could collect 600 gallons of water.
—Tucson Water; Rain Water Harvesting and Gray Water Reuse Resources

CHAPTER ISSUES SUMMARY

- Plans for future growth must take into account protection of the county's water supplies for drinking water and assimilative capacity of streams for wastewater treatment.
- Aquifers cross jurisdictional boundaries and are utilized by many counties and municipalities, necessitating the need for regional planning for conservation of these resources.
- Conservation and efficiency standards for potable water should be defined and incentivized.

POLICIES AND STRATEGIES

POLICY:

Water and sewer service area boundaries are consistent with county growth policies recognizing that public water and sewer should service high-density development that is greater than one dwelling unit per acre except in cases involving public health and welfare risks.

STRATEGIES:

- Modify the 2008 Water and Sewer Plan to prohibit public water and sewer extensions to the Open-Space (O-S), Rural-Agricultural (R-A), and Rural-Estate (RE) zones with the exception of cases with documented septic and/or well health or adequacy issues that cannot be met on-site.
- Continue to review water and sewer category changes during scheduled review cycles (three times per year) to address policy inconsistencies, new environmental regulations or conditions, and/or public health and welfare concerns.
- Create and maintain adequate funding mechanisms to finance perpetual maintenance and replacement of public water and sewer infrastructure.
    - Infrastructure renewal fees.
    - Phased implementation of additional fees.
- Public education to increase understanding of additional fees and why they are necessary, how they work, and the direct and indirect benefits they provide.

[13] http://www.greenhomeguide.org/documents/leed_for_homes_rating_system.pdf

- Adopt a stewardship education and outreach program that promotes and supports standards for residential, commercial, and institutional practices that reduce water use, and support water reuse and wastewater recycling for nonpotable uses.

POLICY:

The reuse of reclaimed water including wastewater; grey water; and rainwater for nonpotable purposes offers the potential to reduce the existing and future demands for potable water and support of our natural hydrologic cycle.

STRATEGIES:

- Capture, treat, and reuse wastewater for nonpotable uses including industry, commerce, agriculture, and irrigation.
- Develop a water reuse program that establishes standards for regional participation.
  - Consolidate issue analysis and coordinate with community leaders, environmental groups, regulatory agencies, water/wastewater utilities, business and civic organizations, the general public, and potential agricultural, recreational, commercial, and industrial user groups.
- Evaluate elements of a future reclaimed water program within Prince George's County to include:
  - Identification of regional issues related to developing a reclaimed water program including environmental, public health, financial, regulatory, community, and wastewater system operational issues.
  - Consideration of treatment, transport and reuse standards as part of future reuse strategies.
  - Description of costs, challenges, and benefits associated with reclaimed water including financial, operational, social, and environmental considerations. Evaluation of the county's building code for regulatory impediments to the reuse of wastewater, graywater or rainwater for residential, commercial, institutional, and commercial uses.
  - Coordination with WSSC to establish advantages, disadvantages, feasibility, and actions needed to develop a reclaimed water program.
- Identify opportunities for using reclaimed water including:
  - Nonpotable domestic uses
  - Commercial uses
  - Industrial uses
  - Steam flow augmentation
  - Wetlands enhancement
  - Groundwater recharge
  - Irrigation
  - Fire suppression
- Develop policies that facilitate implementation of feasible, beneficial, and economical applications of reclaimed water.

POLICY:

Adequate public and private drinking water and sewerage disposal are sufficiently addressed in the planning, development, and subdivision process, and the role of water and sewer service categories as an implementation tool for county growth policies is comprehensively addressed in the Ten-Year Water and Sewer Plan.

STRATEGIES:

- Evaluate the current planning, review, and approval process for water and sewer permitting to assure consistency with General Plan policies.
- Bring WSSC into the master planning and development review process earlier in order to assure capacity management plans and water demand forecasts are current with ongoing and planned development in the county.
- Proactively pursue state and other grants for installing innovative and alternative nitrogen removal septic systems and connecting failing systems to community systems if appropriate.

Drinking Water

A safe and adequate drinking water supply is critical to the sustainability of existing communities and to the viability of future planned growth.

POLICY:

The county provides a safe and ample supply of drinking water from both surface and groundwater sources to county residents, workers, and visitors.

STRATEGIES:

- Provide regulatory protection for source water resources including reservoirs, rivers, streams, wetlands, and aquifers to assure high quality and an adequate quantity of drinking water.
- Preserve and enhance the green infrastructure network to provide pollutant removal benefits, provide some protection for both groundwater and surface sources of drinking water, and provide groundwater recharge opportunities.
- Establish and maintain quality standards and controls for local drinking water, and routinely maintain and improve drinking water infrastructure systems to sustain public, environmental, and economic health.
- When reviewing land development proposals, emphasize the protection and preservation of source water resources including wetlands and headwater areas of streams and the preservation and maintenance of natural hydrology and topography. Encourage groundwater recharge through techniques such as rain gardens, existing wetland area enhancements, and riparian buffer preservation and creation to the maximum extent practicable.
- Evaluate the existing aquifer draw downs, provide future use projections, establish conservation and efficiency strategies and locate, put into operation, and maintain monitoring wells to verify assumptions and realities.
- Conduct a comprehensive aquifer study in coordination with neighboring jurisdictions to evaluate future growth scenarios and watershed environments considering water supply conditions and demands.

- Utilize source water assessment reports, water quality assessments conducted by the U.S. Geological Survey (USGS) or the Maryland Geological Survey (MGS) and other available county or region-specific assessments to provide information for assessing areas served by residential wells.
- Develop source water assessment reports to provide recommendations for public and private water systems and develop area-specific, countywide or regional water management solutions, for example, interjurisdictional agreements for protecting regional reservoirs.
- Develop a water conservation plan for public and private drinking water systems that evaluates current and projected water use, assesses infrastructure, operations, and management practices, and describes cost effective actions to be taken to reduce water losses, waste, or consumption and increase the efficiency with which water is used, treated, stored, and transmitted.[14] [15]
- Upgrade the Potomac River WFP intake structure with flexibility to withdraw water from a submerged mid-channel location if deemed feasible.
- Establish county and localized strategies for efficiency regarding demand and supply for drinking water.

  Supply Side

  - Ensure source water protection
  - Implement improvements in metering and billing
  - Locate illegal or unregistered connections
  - Inspect, clean, and perform maintenance on pipes to prevent leaks
  - Manage pressure to reduce volume and frequency of water loss
  - Control water levels to reduce storage overflow

  Demand Side

  - Eliminate downsizing, or postponing the need for capital projects
  - Extend the life of existing facilities
  - Lower variable operating costs
  - Avoid new source development costs
  - Improve drought or emergency preparedness
  - Educate customers about the value of water
  - Improve reliability of safe and dependable yields
  - Protect and preserve environmental resources[16]

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[14] http://www.mde.maryland.gov/assets/document/water_cons/WCP_Guidance2003.pdf

[15] http://www.epa.gov/WaterSense/pubs/guide.html

[16] Developing and Implementing a Water Conservation Plan Guidance For Maryland Public Water Systems On Best Management Practices For Improving Water Conservation And Water Use Efficiency, 2003, Maryland Department of the Environment Water Supply Program

POLICY:

The county recognizes the limitations of groundwater resources in the county and establishes priority uses as well as conservation and efficiency standards.

STRATEGIES:

- Consider water withdrawals and availability on a watershed basis to allow for evaluation of demands being placed on groundwater resources by others and evaluate recharge opportunities within the watershed.
- Evaluate the existing aquifer draw downs, provide future use projections, establish conservation and efficiency strategies and locate, put into operation, and maintain monitoring wells to verify assumptions and realities.
- Work with USGS and MGS to continue to update aquifer draw down and stream flow data and coordinate data collection and findings with neighboring jurisdictions that rely on, and contribute impacts to, shared water resources to account for the broad-based regional influences on the Patapsco aquifer.

Wastewater

Safe, functional, and efficient wastewater management and sewage disposal systems are critical to the preservation of human, environmental, and economic health.

POLICY:

Wastewater management treatment technologies are consistently becoming more efficient and versatile. Incorporate the most effectual and ecologically sustainable technologies to countywide wastewater systems.

STRATEGIES:

- Reduce or eliminate septic system failure and compromised functions that contribute significant nitrogen loads to waterways particularly relative to soil conditions and in relationship to physical proximity of surface waters.
- Require nitrogen removal septic systems for all new development and retrofit existing septic systems within 1,000 feet of surface waters and tributaries.
- Require all new or failing septic systems countywide to be replaced with the best available technology.
- Develop an inspection and maintenance program for traditional and denitrification septic systems.
- Continue to support wastewater treatment facility upgrades to achieve ENR standards.
- Support funding and implementation of advanced treatment technologies and other future capital upgrades required for wastewater treatment facilities to meet wasteload allocations.
- Consider alternatives to surface water discharges, where applicable, by identifying land for future spray irrigation of treated wastewater if the direct discharge of effluent into a stream could become limited by a TMDL or the Bay Agreement nutrient allocations.

- Establish growth and development planning policies and programs requiring assessment of impacts to wastewater conveyance capacity, treatment capacity, wasteload allocations, and other factors impacting water resource management.

POLICY:

Wastewater treatment plant and infrastructure failures result in untreated effluent being directly discharged onto surface water and groundwater. Coordinate with WSSC to promote strategies, programs, and funding required to minimize these events. Develop strategies to eliminate, or at a minimum, mitigate these events.

STRATEGIES:

- Coordinate with WSSC to support implementation of programs, funding, and outreach for wastewater collection system upgrades that will reduce sewage overflows and flooding due to pipe failure, capacity constraints, infiltration, blockages, and power, process, and pump station failure.
- Develop stream bank restoration and protection programs to reduce erosion that can contribute to pipe failure.
- Support development of a "yellow grease" recapture program at bicounty restaurants to eliminate grease that can cause sewer overflows and provide a reusable resource for agricultural and parks departments' needs utilizing diesel-powered equipment converted to bio-fuel derived from cooking oil.
- Support programs and funding that prioritize infrastructure repair in developed communities and designated centers and corridors, particularly in areas designated for redevelopment through other county plans.
- Inspect all oil/water separators, grease interceptors, and grit traps on an annual basis to ensure they are operating properly and that oil and accumulated sediments are removed before they exceed the capacity of the vessel.
- Support implementation of programs and funding needed to provide any necessary investments in infrastructure such as holding tanks and back-up generators at wastewater treatment plants that assist with flow management during power loss, human error, or excess capacity contributing to unintended raw sewage discharges.

IX: STEWARDSHIP AND IMPLEMENTATION

Achieve water resource protection and restoration through implementation strategies that incorporate scientific research; data collection and dissemination; funding opportunities; regulatory revision; conservation programs and strategies; community engagement; outreach and education; and interagency and interjurisdictional communication, coordination and cooperation to achieve measurable goals and successes for water quality improvement.

A viable water resource protection and restoration plan will require a more expansive planning strategy than is currently in practice in Prince George's County. New planning methodologies, coupled with expanded data resources and modeling technologies, allow local planning departments to examine existing conditions and projected impacts from proposed development and growth scenarios more thoroughly using systems-based analysis. To implement water resource protection, mitigation, and remediation strategies, Prince George's County will need to assess existing and future development patterns while considering the cost of infrastructure, environmental protection and land conservation, and the integration of data and technological resources. It is the responsibility of the county's agencies, departments, and political electorate to establish a clear communication of *consensual* intent to the citizenry regarding the policies and priorities for the existing and future protection of the county's natural environment, social well-being, and economic stability. Smart growth principles offer a range of implementation strategies for ensuring a sustainable quality of life:

Intergovernmental Cooperation and Communication

- Education and Outreach
- Community Engagement and Funding
- Data Collection, Management, Distribution, and Incorporation
- Conservation, Preservation, and Restoration Programs
- Regulatory Revision
- Systems-Based Management

INTERGOVERNMENTAL AND INTERJURISDICTIONAL COMMUNICATION, COOPERATION, AND COORDINATION

Collaborate with, and develop planning initiatives and actions between, governmental agencies and political representatives, neighboring jurisdictions, and county municipalities that share responsibility for water resource protection and management.

Diminishing water availability and quality and the loss of critical habitat for fish and wildlife are key issues facing Prince George's County. The county depends on reliable supplies of clean water to support growing communities, restore our natural resources, and provide for agricultural production. In order to move forward on increasingly critical water issues, citizens, interest groups, and government agencies will need to develop new, more collaborative ways of solving problems.

Land use decisions in Maryland are overwhelmingly made by municipal and county governments, whereas many environmental regulations, such as water withdrawal and allowable quantities of wastewater delivered to the receiving waters, are made and enforced by the federal and state governments through the U.S. Environmental Protection Agency (EPA) and the Maryland Department of the Environment (MDE). These regulations have direct and indirect incentives and impacts that affect land use decisions.

Lack of coordination sometimes poses a conflict between local government growth plans and the influences and limitations that are placed upon those plans by the state. In fact, there are a few examples in which MDE has asserted its authority in ways that resulted in development moratoria that frustrated growth plans. MDE asserted its authority due to limited water supplies or because wastewater treatment plans were over their capacity and unable to meet permit limits.[1]

Bringing together the county's agencies, utilities, and the municipalities' planning objectives into one process allows planners, regulators, and the electorate to work as partners to evaluate more specifically the resource protection needs in watersheds and identify strategies to provide water and wastewater service to support future planned growth. Water supply and wastewater planning must be done in concert with local planning objectives, interests, and needs and must be accomplished at the county level in close coordination with the agencies that have water resource responsibility within the county. Thus, water resource planning must be performed as a multiagency effort for water resource management of shared watersheds and sewersheds for water supply and/or wastewater disposal.

The Water Resources Element (WRE) of the Prince George's County's General Plan has been developed as an integrated countywide Water Resources Functional Master Plan (Water Resources Plan) in order to establish a framework for, and provide guidance to, water resource protection and restoration, and to provide support for, and information to, similar planning efforts at various agencies and at various planning jurisdictional levels. Ongoing coordination with MDOT, SHA, DER, DPW&T, SCD and other local and state agencies is critical to the long-term success of this plan's goals and policies.

[1] Challenges of a Growing Maryland Balancing Land Use and Environmental Decisions, A Series of Workshops Sponsored by: Maryland Department of the Environment and Maryland Department of Planning.

EDUCATION AND OUTREACH

Provide environmental educational resources, training, and activities to the residents, businesses, institutions, industries, and other county land users through an open and transparent platform that serves to inform and engage the community in shared goals, policies, and strategies for water resource preservation, protection, and restoration.

Stormwater runoff results from our daily activities; therefore, public education is an important component of a stormwater management program. Stormwater education efforts should include traditional educational efforts and activities for the public to become involved and engaged in stormwater management. Messages should focus on the daily activities of residents and businesses that contribute to stormwater pollution. Stormwater education is considered one of the most cost-effective best management practices (BMPs).

Anne Arundel County, Maryland, offers a great example— **The Watershed Stewards Academy**[2]—of community education coupled with active project engagement. This program, created by the Anne Arundel County Department of Public Works (DPW) and Anne Arundel County Public Schools, trains county residents to work in their communities to reduce the pollution that flows into the county's storm drains, local rivers and, eventually, the bay.

The idea for the Watershed Stewards Academy formed when DPW partnered with **Arlington Echo**[3], which is part of the Anne Arundel County Public School system, to find a way to teach citizens about reducing pollution in order to meet federal pollution reduction regulations. The long-term goal of the Watershed Stewards Academy is to reduce polluted runoff to the bay and empower citizens through improving their understanding of the actions they can take to rainscape, reduce nitrogen and phosphorus, properly dispose of pet waste, and plant more trees and native species. The Watershed Stewards Academy goal is:

To give Master Watershed Stewards the tools to educate, engage, and empower citizens, businesses, and communities to restore subwatersheds in Anne Arundel County. Restoration efforts will emphasize stormwater infiltration to restore watershed function.
—The Master Watershed Stewards

The **Surf Your Watershed** project is a cooperative effort involving the Maryland Departments of the Environment and Natural Resources to catalog important environmental, socioeconomic, and programmatic information on a watershed basis. The project provides a database in which natural resources and biological information (including hydrologic, hydraulic, and water quality); bibliographic references; contacts, programs and activity descriptions; and other data can coexist and be easily obtained for watershed management, planning, and natural resource conservation programs and projects.[4] This project affords all interested parties in Prince George's County access to watershed information. The county should actively support this project and help educate citizens regarding its use and its applicability.

2 http://www.arlingtonecho.net/Restoration-Projects/Watershed-Stewards-Academy.html.

3 http://www.arlingtonecho.net/

4 http://www.dnr.state.md.us/watersheds/surf/

Green industries and environmental technologies offer multiple opportunities to provide economic, social, and environmental benefits to the county and its residents. Partnerships with schools, nonprofits, environmental education centers, and green businesses can facilitate countywide participation in programs, funding opportunities, and accessing informational resources in order to proactively engage in personal and community management of water resources. By maximizing an array of education and participation opportunities, we optimize the chance to connect with people in the context of their interest and values, and augment their current level of understanding or motivation.

Community and citizen participation in water resources protection and preservation is critical to the long-term success of implementation strategies. Educational training, workshops, conferences, tours, and other events for the general public, as well as environmental professionals, community groups, and the business and industrial community should provide:

- Technical environmental training
- Home and building efficiency education
- Personal sustainability education and events
- Civic leadership training

COMMUNITY ENGAGEMENT AND FUNDING

The Prince George's County citizenry and business community should be informed, engaged, supported, and included in decision-making that establishes and achieves shared community visions and objectives to protect, restore, and manage water resources.

Community support for resource protection by planning and regulatory agencies increases a community's capacity to respond to change and opportunity, thereby increasing community resilience. Providing the opportunity for communities to actively participate in evaluating their existing conditions and development experiences enables them to avoid errors and replicate successes. Resilient communities can actively influence and prepare for economic, social, and environmental change. Communities that utilize social capital maintain access to good information and communication networks and can call upon a wide range of external as well as internal resources. Although community members cannot control all the changes that impact their community, they can respond effectively to those changes and can continue to improve their community's ability to thrive and change. Such a strategy will need to engage stakeholders, identify and set priorities for action, assign responsibility, monitor implementation, and keep strategies under regular review.

The **Alliance for the Chesapeake Bay** is a regional nonprofit organization that builds and fosters partnerships to protect and restore the bay and its rivers. The alliance does not lobby or litigate. Instead, they bridge dialogue between groups that do not see eye-to-eye, forming strategies for joint solutions, and build the capacity of communities for local-level action. To this end, the alliance:

- Develops methods and tools for restoration activities and trains citizens to use them.
- Mobilizes decision-makers, stakeholders, and other citizens to learn about bay issues and participate in resolving them.

- Provides analysis, information, and evaluation of bay policies, proposals, and institutions.

The Alliance for the Chesapeake Bay builds partnerships and consensus to protect and restore the bay. Their activities are organized within four major program areas:

- **Watershed Protection and Partnerships—**Projects that teach or promote sustainable practices for how to live, work, and play in the bay watershed. Projects often involve: (1) training of individuals, organizations, local governments, and businesses on watershed protection techniques; (2) involvement of citizen volunteers in the planning and implementation of local activities; and (3) a strong partnership component. Projects include RestoreCorps, BayScapes, Businesses for the Bay, and River Sojourns.
- **Restoration and Monitoring—**Projects involve on-the-ground restoration and monitoring activities, often for the purpose of demonstrating innovative restoration or monitoring techniques. Projects usually involve citizen participation. Projects include submerged aquatic grass restoration and monitoring.
- **Communication and Information—**Projects that present balanced, objective, and in-depth information on issues central to the restoration of the Chesapeake Bay watershed. Projects include Bay Journal, Ask the Bay Experts, and Alliance fact sheets and white papers, as well as the annual Taste of the Chesapeake and the Frances Flanigan Environmental Leadership Award.
- **Public Policy—**Projects and roles that facilitate the balanced analysis of Chesapeake Bay policy issues, fosters citizen participation in the establishment of sound policy, and builds consensus where constructive dialogue is lacking. Projects include Citizens Advisory Committee to the Chesapeake Bay Program and Builders for the Bay roundtables.

Many communities in Prince George's County are actively engaged and participate in the planning process. During the development of sector, master, and subregion plans, the planning process must include a significant outreach and public participation program. Many residents go beyond the scope of participation in community planning and have organized groups, committees, and nonprofits that address complex environmental, social, and economic issues. As part of a countywide effort to remediate, protect, and manage water resources, it is clear that these groups, and the engaged and concerned citizenry of Prince George's County, represent an invaluable human resource that is critical to the success of the implementation, oversight, monitoring, and regulatory enforcement of the Water Resources Plan's goals.

It is imperative that the county recognize and empower its citizenry to actively engage in water resources protection. The residents are the eyes and ears of the county. Citizens have on-the-ground, real-time connections to their neighborhoods and communities and offer a de facto monitoring service that should be recognized, acknowledged, and supported through transparent documentation and follow-up actions. All reported incidents of environmental infractions should be taken seriously and, on DER's county web site, accepted, documented, and made available for review by neighbors and other citizens.

Funding sources from federal, state, and regional programs encourage cooperative partnerships that are established with clear intents and incentives for continued community and stakeholder investment. The county should support, encourage, and help facilitate communities to access financial resources and utilize human capital to achieve shared environmental goals to protect and enhance water resources. The Department of Natural Resources (DNR) provides a number of direct grant and project grant programs, as well as reimbursement programs and low interest and no interest loans.[5]

The Town of Edmonston has recently proven, by example, that a directed partnership with clear intent and will, can in fact achieve positive and impactful results. Edmonston constructed several bioretention facilities to reduce runoff and pollutants entering the northeast branch of the Anacostia River in Edmonston. The work was done by the University of Maryland, College Park's chapter of Engineers Without Borders, the Anacostia Watershed Restoration Partnership, and the City of Edmonston. The project team, consisting of students, faculty advisers and various professionals, designed a bioretention system and implemented it in a park owned by The Maryland-National Capital Park and Planning Commission near Edmonston's Decatur Street.

Forest Heights, a community along Oxon Run in Prince George's County, is preparing for construction of an eco-friendly roof for its administration building. Unlike traditional flat rooftops, a green roof has multiple membrane layers to absorb and drain water. The roof would better insulate the building and reduce energy costs. The renovations are expected to cut the town's energy bill by up to 50 percent. Councilwoman Jacqueline Goodall said the town hopes to become a "green" model for other municipalities. The goal, she said, is for the town to produce zero stormwater runoff into the Chesapeake Bay watershed because stormwater often carries pollutants.[6]

The U.S. Department of Agriculture provides many support programs that family and individual landowners can use to conserve their working land. The programs provide expert technical advice and often include financial assistance for landowners who use specific management practices. Some programs also offer rental payments to offset income losses due to changes in land use.

These are voluntary programs—property owners choose the program that most closely matches their management goals, such as improving wildlife habitat or restoring a wetland. The Natural Resources Conservation Service administers many of the programs and the U.S. Forest Service and Farm Service Agency manage other programs.

Stormwater task forces could provide opportunities to engage the public in identifying stormwater solutions that benefit their community and the county. The county currently includes citizens in a number of stormwater-related programs including Adopt-A-Road/Median, Livable Communities Initiative, and Gorgeous Prince George's Day. Concepts for new opportunities to engage the public in stormwater task forces are outlined below.

- **Stormwater Program Funding Task Force—**Funding ongoing stormwater management programs is a continuing challenge for Prince George's County as revenue streams decrease and regulatory requirements increase. Many communities across the United States have sought the advice of citizens through a task force to evaluate funding opportunities that address the community expectations for stormwater services and quality of life. Typically, the task force will look at existing

5 http://www.dnr.state.md.us/land/grantsandloans/grants.asp

6 http://www.gazette.net/stories/10012009/clinnew190523_32529.shtml

funding levels and the cost of meeting regulatory requirements. The task force will also evaluate how the cost increases as additional services are provided to the community. The committee will then analyze existing and potential future revenue sources, such as stormwater fees, and make a recommendation for moving forward. A stormwater program funding task force can be a very powerful tool for developing a sound funding strategy that provides for compliance with regulatory requirements and meets the community's expectations for service.

- **Commercial and Industrial Stormwater Task Force—**A task force could be created to educate and share success stories from local commercial and industrial facilities within Prince George's County and beyond. This task force could develop in a few different directions; the task force could be a voluntary group of commercial and industrial business who seek to learn and share, it could become an avenue for public recognition where participating commercial and industrial businesses receive "green" recognition, or it could have a learning focus and involve entities with recent stormwater violations and/or commercial and industrial businesses new to Prince George's County who may need stormwater pollution education. The nature of the task force and the emphasis may change over time or the Prince George's County government may determine that more than one of the options would be beneficial. This task force may also travel throughout Prince George's County to increase participation from commercial and industrial businesses. One area of emphasis for the commercial and industrial stormwater task force should be the maintenance of private stormwater infrastructure, to clarify responsibility for maintenance as well as provide an overview of proper maintenance practices, as required by the municipal separate storm sewer systems (MS4) permit. This task force may be coordinated with ongoing activities by the county business license office, water conservation education efforts, or commercial sanitary waste education efforts.

DATA COLLECTION, MANAGEMENT, AND DISTRIBUTION

Provide all countywide stakeholders a base of information to inform county policies and support specific actions for water resource protection, preservation, and restoration.

Data provides baseline information to inform planning and development decisions. Data quality and quantity must be managed within a structured and transparent process and with defined management protocols to ensure its incorporation into decision-making is clear and comprehensive.

Natural systems are dynamic and evolving. Data collection and interpretation must remain timely and continued updates must be prepared to ensure planning decisions are relevant to the most current conditions. Data alone cannot provide the guidance necessary to make informed decisions regarding our natural environment and our county's water resources. It is important to develop data collection protocols with a clear understanding of its intended use. Data alone serves no function; it is the application of data for decision-making that is the true purpose.

Data, management, interpretation, and application combine to form the basis of scientifically informed decision-making.

The Water Resources Plan has provided a starting point and a tool for ongoing and future water quality impact assessments of the county's watersheds. Assessment of nutrient loads from different types of land uses can be best achieved through small-scale analysis using locally tested loading rates, measured impervious percentages, topographic and soil conditions, and hydraulic, hydrologic, and other data relative to the watersheds being modeled. In addition to estimation of loads from primary land uses, these analyses should include assessment of the specific treatment techniques or BMPs known to exist within the modeled area using local effectiveness data for those specific treatment techniques. As described previously, the water treatment model (WTM) provided by the Center for Watershed Protection contains the functionality to analyze small areas, and so was incorporated into the pollutant load analysis model (PLAM) to provide the county with the ability to conduct and compile analyses of individual subwatershed areas over time. The PLAM model developed for the Water Resources Plan provides a tool for the county's future assessment of policy and watershed management impacts within individual development sites, small subwatersheds, or larger hydrologic units, as more local information and data become available.

LAND CONSERVATION, PRESERVATION, AND RESTORATION PROGRAMS

Continue to support land preservation programs and activities, such as the Maryland Agricultural Land Preservation Foundation (MALPF), Conservation Reserve Enhancement Program (CREP), the Historic Agricultural Resource Preservation Program (HARPP), and Rural Legacy, and the woodland conservation program. Encourage the purchase of land by public agencies and private organizations as conservation easements, stream buffers, and wetland protection on land that drains to Tier II waters, waters with established total maximum daily loads (TMDLs) or water quality impairments, or in priority protection watersheds where impervious cover approaches or exceeds ten percent.

Conservation, preservation, and restoration of our natural environmental and associated ecosystems are critical to water resource protection. Clear criteria for, and identification of, high priority preservation areas are the initial requirements for the establishment of a preservation strategy that responds to natural and developed conditions within watersheds. The state, the Chesapeake Bay Program, and EPA have all developed guidelines relative to percentages of developed and open lands within watersheds to maximize protection of water quality and minimize impacts due to development and development patterns.

Prince George's County farmers, under pressure from rising costs of living and farming, have been subdividing their land to make ends meet or to cover their retirements. This dynamic is altering the land use patterns in the more rural portions of the county. Strategies, programs, and policies are in place to stem this trend, but the needed support for the continued economic viability of agriculture in Prince George's County should continue to be strengthened.

The Prince George's County Soil Conservation District provides agricultural land use support by bringing various agencies together to provide a multipurpose service center for the local farm community. Currently there are over 63,000 acres of agricultural land in the county, with 917 parcels over ten acres in size and 712 parcels less than ten acres in size. There are over 29,000 acres of active cropland in the county. The Soil Conservation District currently maintains over 500 soil and water quality conservation plans on file. These plans inventory the natural resources on a specific property and offer technical advice based on sound engineering and agronomic principles that address soil erosion and water quality issues.

As the face of agriculture has changed, so has the farming community. The horse industry In Prince George's County has become the fastest growing sector within the agricultural landscape. According to the 2002 Maryland Equine Census,[7] Prince George's County has the fourth largest number of horses in Maryland. This industry uses almost 20 percent of the agricultural land in the county and requires special needs as related to soil erosion, soil compaction, waste management, and water quality.

Agriculture is a significant landscape of Prince George's County, both as an industry and as a contributor to the county's character. That economy adds millions of dollars of income to the citizens of Prince George's County. Therefore serious efforts are underway to protect our agricultural lands and rural character.

The Prince George's Soil Conservation District also administers the county's agricultural preservation programs. From 2006 to 2008 a total of 565 acres of prime farm land has been perpetually protected from development and an additional 3,500 acres have applied to be protected. The land will be preserved forever as productive farmland, woodland, wildlife habitat, and open space that will keep a part of the county's rural heritage alive. In the future many more farms will be preserved with help from these programs.[8] The Green Infrastructure Plan established a land preservation objective:

> Protect a countywide average of 1,500 acres per year of agricultural, strategic forest, or other sensitive lands through the use of the Rural Legacy Program, county-funded acquisitions, and other conservation programs.

According to the 2008 General Plan Policy Update, this objective has not been met to date. A total of 3,233 acres were protected from January 2002 through December 2006 under various programs, for an average of 646.6 acres per year. Since the beginning of 2002, over 100 woodland conservation easements have been established that protect over 1,493 acres. The trends are different for the different programs as noted in Table 17. Overall, there is an increase in the total amount of preserved land in the last two years. The Prince George's County Historic Agricultural Resource Preservation Program (HARPP) is in the process of identifying and preserving properties totaling over 1,500 acres.

The trends track closely with the amount of state funds available for easement and land acquisition. Various programs are in place to protect sensitive lands through the establishment of easements or through acquisition. Except for woodland conservation, which is achieved through the implementation of the Woodland Conservation Ordinance, the programs rely on state funding. Some years there has been little or no funding available for preservation programs.

Various federal and state conservation programs, along with those of Prince George's County, have been summarized in Appendix IV, Land Conservation Programs.

Conservation Corps—The Maryland Conservation Corps (MCC) is an award-winning AmeriCorps program that engages young adults in extensive natural resource management and park conservation projects. Managed by the Maryland Park Service

7 http://www.equinestudies.umd.edu/extension/Bennett.pdf

8 http://www.pgscd.org/

Table 17: Preservation Acres by Year					
Year	**2002**	**2003**	**2004**	**2005**	**2006**
Woodland conservation easements	315	203	522	163	290
Maryland Environmental Trust easements	115	172	0	74	71
Rural Legacy Program acquisitions/easements	61	188	0	240	0
Program Open Space acquisitions	83	2	0	119	360
Maryland Agricultural Land Preservation Foundation easement	0	123	0	132	0
Total 3,233 acres	574	688	522	728	721
Average 646.6 acres per year					

since 1984, MCC provides members with opportunities for skill development and personal growth through a supportive, team-based environment, emphasizing the satisfaction of completing projects that benefit Maryland's natural resources. Under the supervision of experienced Maryland DNR staff, MCC members work in crews consisting of five to seven persons. From state parks and forests to the Chesapeake Bay, they are engaged in projects in Maryland's most beautiful places.[9]

At the Merkle Wildlife Sanctuary, positioned on the Upper Patuxent River in Prince George's County, the conservation service activities include: trail maintenance, environmental education, stream and wetland restoration, park facility improvements, invasive species removal, and bay grass planting. The sanctuary's nature center is operated by the crew and includes interpretive exhibit development, programming, special events, and the care of live animals. The wildlife sanctuary is a beautiful natural area renowned for providing critical resting habitat for wintering Canada geese.

The Bay Crew is based out of Mitchellville, Maryland, located in Prince George's County. The team's service focuses on various facets of the protection and restoration of the Chesapeake Bay. Bay Crew members conduct stream corridor assessments for the Maryland DNR, identifying physical problems in the watershed for potential mitigation by the state or county. Members participate in scientific studies such as inventorying migrating waterfowl and assessing the health of the oyster populations at the Academy of Natural Sciences. The Bay Crew also assists in shoreline and wetland restoration projects, removal of invasive, nonnative species, and the replanting of native bay vegetation. Like the other crews, this team performs hazardous tree removal, trail construction, and trail maintenance at various parks.

Cedarville State Forest was purchased In the 1930s in an effort to create a forest demonstration area. The Civilian Conservation Corps (CCC) developed Cedarville's roads and trails for fire protection and future recreation development. From 1933 to 1935, approximately 160 men of the CCC, mostly African-Americans from Baltimore and Washington, D.C., worked at Cedarville.

Conservation corps provide the implementation arm critical to the success of any and all environmental restoration projects. Conservation corps and other training and educational organizations provide the county with opportunities to implement projects, engage and educate youth about natural process, and reinvest in local communities.

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[9] http://www.dnr.state.md.us/mcc/

REGULATORY REVISION

Adopt and implement policies through legislation, ordinances, codes, standards, and programs to guide both development and conservation in order to establish a suitable balance between meaningful regulation and permanent protection to improve water quality and proactively sustain water resources.

An important consideration in the assessment of land use impacts is the capability of local government agencies to administer land and water management policies and programs. These should provide sufficient regulatory controls and planning tools to improve current environmental conditions and mitigate environmental impacts from land use change.

Evaluations of current regulations occur in the county with review of zoning, subdivision, and environmental ordinances and comprehensive plans for policy consistency in order to achieve countywide smart growth and sustainability. Evaluation and review make it possible to identify regulations that are not meeting the stated goals and to note resource protection that has been overlooked or inadequately monitored by local or state government agencies. Natural resource inventories, tree conservation plans (TCP), site plan, subdivision, and development review provide an excellent regulatory process to ensure that development does not negatively impact the environment.

Green building techniques, urban landscape, wetland protection, biodiversity, transportation systems, plumbing, environmental site design watershed planning, wastewater and water system maintenance, and neighborhood development standards should be codified to incorporate the most current understandings and technologies to achieve water resources sustainability.

Our current zoning, development standards, and building codes should reflect the county's desire to maximize opportunities for smart growth in the county. Many communities nationally are devising incentive programs along with mandates to foster change in their building and development paradigms to achieve long-term sustainability of the built and natural environment. Prince George's County should develop consistency between county growth policies and building and development standards to sustain and protect water resources in the county.

Accomplishing a comprehensive restoration plan for an ecosystem as complex as the Chesapeake Bay requires the full engagement of restoration leaders, citizens, and all stakeholder groups throughout the watershed. All of the bay's stakeholders require a base of information and motivation to take action. By providing an array of opportunities we optimize our chance to connect with people in the context of their interests, values, and current level of understanding or motivation —The Chesapeake Bay Program.

SYSTEMS-BASED MANAGEMENT

Employ systems-based management by integrating multiple disciplines and stakeholders, adapting management decisions based on scientifically collected data, taking precaution in decision-making, and incorporating sustainable management decisions to most effectively and efficiently address the impacts to water resources from land use practices.

The systems-based management approach assimilates four principles—integrating multiple users and uses of resources, providing for a sustainable use of resources, taking precaution against making deleterious actions, and adapting management decisions based on past-experiences.[10] Although systems-based management is not new, it is difficult to implement comprehensively and requires a proactive effort on the part of many stakeholders, including the public, scientific groups, and governmental regulators, along with the political will to prioritize water resource protection and sustainable management. The Water Resources Plan is an excellent example of when the adoption of a systems-based management approach may be necessary and can result in significant success due to the considerable overlap among many groups responsible for current water resource management and for its sustainability to accommodate future growth.[11]

To ensure a true systems-based approach to managing water resources, it is vital that scientific data along with other information is integrated into the management decisions regarding water resources. Many different agencies in Prince George's County have various roles in water resource management, and it is imperative that integration of scientific findings are incorporated into the management decisions and resulting policies.

Adaptive Management—Promising advances for natural resource management can be seen in the area of adaptive management (or adaptive environmental assessment and management), through the integration of ecological and participatory research advancements.

Many current research efforts concentrate on establishing approaches that more closely link science, management, and policy at an ecosystem level. These efforts represent a desire for research and implementation standards that combine:

- Resource management testing, evaluation, innovation, and flexibility.
- Natural resource system management at a watershed scale.
- Methods for bringing about action strategies among multiple agencies.
- Facilitation of the social and political processes and organizational capacity to realize adaptive management goals.

Adaptive management focuses on learning and adapting, through partnerships among managers, scientists, and other stakeholders who together devise strategies and action plans to create and maintain sustainable ecosystems. Managers must maintain flexibility in their decisions, knowing that uncertainties exist, and provide the latitude to adjust direction to improve progress toward desired outcomes. This management technique is based on learning from past experiences that influence the future of current decision-making regarding the health and sustainability of water resources. Management decisions are best influenced through comprehensive and long-term data collection.

Precautionary Principle—Admittedly, uncertainty exists regarding planning decisions and management practices for natural resource protection, yet risks of serious and irreversible damage to environmental, human, and economic health exist. The precautionary principle underlies the execution of conservation efforts and promotes actions to avoid serious or irreversible environmental harm, despite lack of scientific certainty as to the likelihood, magnitude, or cause of the harm.

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[10] Boesch, D.F. 2006. "Scientific requirements for ecosystem-based management in the restoration of the Chesapeake Bay and Coastal Louisiana." Ecological Engineering 26: 6-26.

[11] http://www.dnr.state.md.us/met/ce.html

The release and use of toxic substances, resource exploitation, and physical alterations of the environment have had substantial unintended consequences on human health and the environment. Although human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists, and other individuals must adopt a precautionary approach to all human endeavors. Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.[12]

Sustainability—In order to apply sustainability principles to decision-making for water resource protection, a holistic evaluation of costs is necessary. Typically, financial decisions have been made in response to short-term/up-front financial cost, but time has shown that the long-term costs of decisions have far-reaching impacts and a new and broader understanding of cost over time and for various impacts is essential to establish sustainable solutions.

The triple bottom line (or "TBL," "3BL," or "people, planet, profit") captures an expanded spectrum of values and criteria for measuring organizational (and societal) success: economic, ecological, and social.[13] This new paradigm of measure has been incorporated into true cost analysis of projects, particularly infrastructure projects. With an eye to sustainability, it has become increasingly clear that our current standards of measure for project costs are patently remiss in addressing long-term sustainability. The triple bottom line is a form of reporting that takes into account the impact a business has in terms of social and environmental values along with financial returns. TBL reporting is becoming an increasingly recognized concept and accepted way for businesses to demonstrate they have strategies for sustainable growth. Traditional economic models are about profit, profit, and more profit; triple bottom line accounting recognizes that without happy, healthy people to staff businesses and a healthy natural environment to sustain people and supply resources for trade, business is fundamentally unsustainable in the long run.

People: This is also known as human capital. It means treating employees right, but also the community where the business operates. In this part of the TBL model, business not only ensures a fair pay for fair work but also ensures some of the business gains return to the community through sponsorships, donation, or projects that go toward the common good.

Planet: This is also known as natural capital. Business should strive to minimize ecological impact in all aspects of its work from sourcing raw materials, to production processes, to shipping and administration. It is a "cradle to grave" approach or "cradle to cradle" including taking responsibility for goods after they have been sold through offering a recycling or take-back program. A TBL business refrains from the production of toxic items.

Profit: This is about making an honest profit, not profit at any cost—profit that comes in accord with the other two principles of people and planet. Some big box stores have begun "greening" up their image and in doing so, demanding that their suppliers use less packaging or banning certain ingredients from products. The public response has been positive and in the process people have gained a greater understanding of sustainability and community responsibility.

[12] Wingspan Statement on the Precautionary Principle

[13] http://en.wikipedia.org/wiki/Triple_bottom_line

TBL is not an award, accreditation, or a certification but an ongoing process that helps businesses keep on track in an effort to run greener and demonstrate to the community at large they are working not just toward riches, but the greater common good.

Resiliency—In the emerging field of ecosystem restoration, the term resiliency is being used under the larger sustainability heading. Resiliency is the ability of an ecosystem or community to handle disturbances, like storms, fire, or pollution, without shifting into a qualitatively different state. A resilient system is able to withstand these disturbances and shocks, and if damaged, is able to self-correct and rebuild itself. When designing restored ecosystems, this principle sets out to mimic natural systems that are self-correcting and, therefore, sustainable. Restoring ecosystems in a well-rounded, comprehensive, and resilient manner will lead to sustainable resources that will provide free ecosystem services like clean water well into the future.

Climate Change—Because of its vulnerability to climate change, the Chesapeake Bay estuary may be an omen for the rest of the country regarding potential impacts from sea level rise, increasing storm intensities, and other effects. Although the magnitude of anticipated impacts from climate change are unknown, enough information is available to suggest that adaptive estuary management, assessments of the ecosystems' vulnerabilities, development of adaptation plans, and implementation of adaptation measures will be required to protect water resources as much as possible from direct and indirect impacts. Due to the tidal coast line along the Potomac and Patuxent Rivers in Prince George's County, it is imperative that management decisions start to integrate data and information with an eye toward precaution against the unpredictable nature of the estimated sea level rise changes.

The Maryland Commission on Climate Change issued a technical report entitled "Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland" in July 2008 based on modeled predictions of climate change effects across Maryland. With a chapter devoted to "Water Resources and Aquatic Ecosystems," the report assesses the following threats and challenges in regards to the predicted impacts of climate change:

- Reliability of freshwater supply, including both surface water and groundwater.
- Changes in flood hazards.
- Effects of changes in runoff and water temperature on aquatic habitats and populations.
- Impacts on water quality with implications for management and regulation of sediments and nutrients.
- Potential salt contamination of aquifers and freshwater intakes as the boundary between fresh and brackish water shifts with rising sea level.

The study also incorporates projections of impacts of both climate change and development on water resources. The key take-home points from this study regarding the impacts of climate change on water resources and aquatic ecosystems include:

- Increased precipitation would supply reservoirs but not alleviate overdraft of aquifers.
- Urban flooding will likely worsen because of intensification of rainfall events.
- Aquatic ecosystems will likely be degraded by increased temperatures and flashy runoff.

Although no formal study has been conducted in Prince George's County regarding the predicted effects of climate change specific to this area, it is recommended that the county engage in a study in cooperation with all agencies that would have a role in implementing management decisions based on this report. A greenhouse gas (GHG) emissions inventory should be conducted as soon as possible for the county to establish a baseline against which it can measure the effectiveness of needed GHG reduction strategies.

As a member of the Metropolitan Washington Council of Governments (MWCOG), the county endorsed the National Capital Region Climate Change Report[14] in November 2008 and agreed to collaborate in meeting the following reduction targets:

- 10 percent below business as usual levels by 2012.
- 20 percent below 2005 levels by 2020.
- 80 percent below 2005 levels by 2050.

The National Estuarine Research Reserve System[15] is developing a habitat restoration strategy to provide the scientific basis and technical expertise to restore, enhance and maintain estuarine ecosystems. The plan will develop and transfer effective approaches to identify, prioritize, restore, and monitor degraded or lost coastal habitat. The strategy uses a partnership approach coupled with education and community involvement. The restoration areas in which the reserve system hopes to play a national role include:

- Planning project.
- Developing effective approaches to test and evaluate innovative technology for restoration.
- Monitoring restoration response.
- Serving as local reference or control sites.
- Translating/transferring restoration information.
- Providing scientific and technological advice to support policy and regulatory decisions.
- Building awareness for the value of restoration science.
- Coordinating regional science.[16]

CHAPTER ISSUES SUMMARY

- Data sharing and communication between partners responsible for water resources protection, preservation, and restoration is needed to achieve the goals of this Water Resources Plan.
- Outreach, education, and stewardship awareness give citizens better opportunities and responsibility for water resource protection and management.

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[14] http://www.mwcog.org/store/item.asp?PUBLICATION_ID=334 National Capital Region Climate Change Report, 11/12/2008.

[15] http://nerrs.noaa.gov/

[16] http://nerrs.noaa.gov/Restoration/Strategy.html

- Current regulations, ordinances, and codes can be a barrier to progressive and innovative ideas and solutions for water resource management and should be reviewed and updated.
- Systems-based thinking will help integrate work programs and galvanize efforts to improve the quality of water and water resources in Prince George's County.

POLICIES AND STRATEGIES

Implementation of water resource protection, preservation, and remediation strategies unites making choices concerning existing and future development patterns with consideration of the cost of infrastructure, environmental protection, a clear communication of intent, and the integration of data and technological resources.

Intergovernmental Cooperation and Communication

POLICY:

Shared data and resources between agencies provide for better assessment of existing conditions, prevent additional negative environmental impacts, and help foster plans for remediation and long-term protection of water resources.

STRATEGIES:

- Bring together the county's and state's agencies and departments responsible for infrastructure planning and development to work as partners to evaluate more specifically the resource protection needs in watersheds.
- Set protocols for data and resource sharing between agencies, communities, and organizations that have an interest and responsibility for water protection and conservation.
- Develop a web-based communication platform that will enable county agencies as well as county residents to coordinate the mission and information needed to protect water resources.

POLICY:

Water supply and wastewater planning and stormwater management is performed in concert with local planning objectives, interests, and needs and is accomplished at the county level through close coordination with the agencies that have water resource responsibility within the county.

STRATEGIES:

- Evaluate plans, policies, and strategies developed for the Patuxent and Potomac watersheds by various agencies and jurisdictions, and incorporate appropriate policies and strategies into county plans.
- Incorporate existing studies developed by various governmental and nonprofit organizations into county plans and regulations to help mitigate water quality degradation, improve existing conditions, and preserve and avert future harmful impacts to water resources in county watersheds.

POLICY:

Coordination with federal, state, county, local agencies, and municipalities to develop land use, zoning, redevelopment, urban design, forest conservation, wetland preservation, and green infrastructure policies is necessary to achieve implementation of the Water Resources Plan.

STRATEGIES:

- Create an interagency water resource policy board at the department head level to recognize the need for broad-based interagency coordination to address the ongoing and developing water resources and water quality-related regulatory and sustainability issues and needs the county is facing.
- Continue and expand M-NCPPC's participation in local and regional advisory committees and workgroups that focus on and support environmental, watershed, and water quality protection and improvement planning.

Community Engagement

POLICY:

The county supports communication and cooperation among residents, communities, environmental groups, and county agencies promoting activities such as stream monitoring, streamside tree plantings, trash removal, and storm drain inlet stenciling.

STRATEGIES:

- Engage county communities and municipalities to plant and conserve trees on private properties.
- Create landscape incentives and technical support in urban areas to increase number, quality, and survivability of trees planted in the public right-of-way and on private property.
- Build and maintain an information network service that provides on-line water resource updates on county programs and regular specific suggestions such as "green tips" to inform and encourage residents to take action to conserve and protect water resources.
- Establish and coordinate a coalition with representation from a broad range of community organizations to support outreach, raise awareness of the water resources protection strategies, and to provide opportunities and support for education programs.
- Create a water resource task group that includes a diversity of interest groups, organizations, and citizens to forward the water resource goals and policies as established in the Water Resource Plan.
- Establish a citizen's advisory committee to evaluate impacts to, and provide mitigation recommendations for, water resources from land use changes and development projects.

POLICY:

The county strives to provide scientific basis and technical expertise to restore, enhance, and maintain estuarine ecosystems.

STRATEGIES:

- Promote individual stewardship and assist individuals, community-based organizations, businesses, local governments and schools to undertake initiatives to achieve the goals and commitments of this plan.
- Support municipalities to work with local governments to identify small watersheds where community-based actions are essential to meeting bay restoration goals—in particular wetlands, forested buffers, stream corridors, and public access, and work with local governments and community organizations to bring an appropriate range of bay program resources to these communities.
- Enhance funding for locally based programs that pursue restoration and protection projects that will assist in the achievement of the goals of this and past agreements.
- Develop and maintain a clearinghouse for information on local watershed restoration efforts, including financial and technical assistance.
- Develop easily-accessible information suitable for analyzing environmental conditions at a small watershed scale and work with planning and other county agencies to apply this information to growth and land use decision-making.

Education and Outreach

POLICY:

Information is made publicly available regarding the impacts of stormwater discharges on receiving waters, why controlling these discharges is important, and what the individual citizens as well as business and industry can do to reduce pollutants in stormwater runoff.

STRATEGIES:

- Establish, coordinate, and maintain a county interdepartmental education and outreach program to address water conservation and water quality protection goals.
- Implement and maintain an education and outreach program to help reduce the discharge of pollutants caused by stormwater runoff.
- Maintain and monitor a publicly accessible database of all reported incidents of environmental infractions including location and nature of the reported situation, date of the report, and follow-up actions taken to remedy the condition.
- Provide training and education to construction site operators and inspectors regarding erosion and sediment control compliance.
- Adopt a stewardship education and outreach program that promotes and supports standards for residential, commercial, and institutional practices that reduce fertilizer, herbicide, pesticide, and water use.
- Provide county support for education and training programs that prepare citizens, especially youth, for environmental jobs and provide environmental services to communities and the county.

- Conservation Corps
- AmeriCorps
- Environmental Education Centers
- Internships

POLICY:

The county maintains an interdepartmental education and outreach program to explain stormwater management challenges, reduce the discharge of pollutants caused by stormwater runoff, and provide technical assistance to the regulated community.

STRATEGIES:

- Provide informational, technical, and research assistance to communities proactively pursuing environmental and ecological restoration projects.
- Encourage and foster school programs, integral to curricula, that promote increased student involvement and engagement in forest and tree planting, water conservation, and stormwater prevention programs within their communities.
- Support and publicize opportunities for interaction between residents, community and environmental groups, and county agencies promoting annual activities such as stream monitoring, streamside tree plantings, trash removal, and storm drain inlet stenciling.
- Consider creating stormwater task forces to engage citizen representatives in stormwater decision-making. These task forces could address stormwater program funding and/or commercial and industrial stormwater.
- Develop educational materials on maintenance of private stormwater infrastructure and to respond to common commercial/industrial stormwater pollution sources identified through NPDES MS4 permit inspections.

Data Collection, Management, and Distribution

POLICY:

Provide accessibility to and incorporation of the best available science, technology, and data for planning recommendations that support the protection, preservation, and restoration of water resources.

STRATEGIES:

- Work with Maryland Geological Society and U.S. Geological Society to evaluate the existing aquifer drawdowns, incorporate future land use projections, establish conservation and efficiency strategies, and locate, put into operation, and maintain monitoring wells to verify assumptions and realities.
- Work with DER to develop ecosystem and science-based watershed management plans that provide a clear identification of the sources, impacts, and consequences of existing pollution problems.
- Identify information gaps in the scientific, technological, and ecological systems data necessary to make informed decisions to restore and protect watershed system functions, water quality, and stream health.

- Continue to develop and expand existing Geographic Information Systems (GIS), support the development of watershed management plans, and continue to evaluate and update water quality and stream morphology conditions to provide the best possible data to assist in decision-making and planning efforts.
- Build and maintain an information network service that provides on-line updates on county programs and legislation and specific suggestions to inform and encourage residents to take action to protect and improve stream and groundwater quality.
- Build and maintain an informational web-based network service that provides transparent online documentation of, updates to, and actions taken on environmental violations as reported by the public, noted by permitting and inspection agencies, or otherwise observed.
- Work with DER to develop a web-based communication platform that will enable county residents, as well as county agencies, to coordinate the mission and information needed to protect water resources.
- Minimize the timeline interface between data collection, interpretation, development of remediation strategies, and implementation of BMPs.

Conservation, Preservation, and Restoration Programs

POLICY:

Land conservation programs are a focused preservation method to achieve woodland, forest, and tree cover; stream and wetland buffers; and open space goals for water resource protection.

STRATEGIES:

- Develop simplified processes and economic incentives to enable landowners to establish conservation easements and/or protection areas.
- Provide adequate funding, technical assistance, and enforcement to ensure that the agricultural community implements nutrient management plans on farmland utilizing natural system protection and enhancement to protect water quality.
- Continue to acquire targeted parcels and sites along stream corridors to create contiguous stream buffers.
- Support agricultural certification efforts in the county in order to acquire additional funding for MALPF easements, purchase of development rights, and HARPP through the identification and protection of countywide priority preservation areas (PPA).

Regulatory Revision

POLICY:

Prince George's County regulates consumption of, and impacts to, water resources through the activities employed on the land acknowledging that resource depletion must be relative to the rate at which that resource can be replenished.

STRATEGIES:

- Ensure county regulations prevent the loss of open space, tree canopy, and rural character, which is important to quality of life, environmental health, and economic stability in the county.
- Provide for coordinated planning and communication among agencies and the community to avoid controversial development patterns that may impact communities in an indirect and cumulative manner.
- Seek and leverage federal, state, and local funding to acquire or permanently protect sensitive and ecologically valuable lands through conservation programs and easements.

POLICY:

The county reviews and updates methods to achieve stronger policy support for water resource protection through the county's development and site plan review, environmental analysis, regulation, and preservation requirements.

STRATEGIES:

- Develop land use and zoning principles, standards, and guidelines that champion compact growth outside of environmentally sensitive and valuable resource land areas, and within transit serviceable centers and corridors.
- Identify existing legislation, regulation, and code standards that create barriers to effective and innovative implementation of water resources and water quality protection goals.
- Identify and modify current zoning classifications that are not tied to existing environmental legislation and constraints.
- Clearly show that development proposals have identified existing water resource conditions and have developed appropriate preservation, mitigation, and restoration strategies through the development proposal and approval process.
- Establish adequate public drinking water and public wastewater treatment capacities, appropriate septic treatment areas and methods, and well water withdrawal capacity and availability concurrent with various development plan approvals.
- Based on existing land use information, estimate the current level of impervious surface in watersheds.
- Based on water quality characteristics of the receiving waterways of the watershed, establish a target level of impervious area.
- Calculate the potential capacity for additional impervious surface in the watershed based on current zoning categories and on an assumed full build-out of existing allowable zoning.
- Require surface water quality and stream morphology analysis as part of the natural resource inventory requirements.

POLICY:

Prince George's County reviews, and changes as necessary, county regulations, ordinances, permitting, and enforcement requirements to support green infrastructure, environmental site design (ESD), stormwater management, Leadership in Energy Environmental Design (LEED) building and development standards (or other similar or equivalent standards), water conservation and efficiency, and effective wastewater treatment.

STRATEGIES:

- Modify codes and regulations to remove impediments for existing development, new development, and redevelopment to implement water conservation and reuse practices and technology.
- Support and incorporate innovative planning tools including: watershed planning; environmental-based and agricultural zoning; conservation, and low-density rural subdivision; and ESD and low-impact building design standards to protect water resources and rural character.[17]
- Evaluate existing residential zoning and associated density regulations, specifically as defined by one- to three-acre minimum lot sizes, which do not adequately protect natural systems and has resulted in rural sprawl.
- Develop a zoning category to protect land identified as agricultural and/or forest resource through the PPA process.
- Evaluate the intent and success of the current Conservation Subdivision Ordinance to achieve open space, natural resource protection, and rural landscape preservation.
- Provide incentives for constructing new green buildings and green retrofitting of existing buildings, green development, and redevelopment.
    - Expedited Permitting
    - Tax Incentives
    - Floor Area Ratio Bonuses
    - Stormwater Billing Credits
    - Cost Sharing
    - Low-Income Assistance
    - Grant Programs
    - Rate Incentives

[17] http://www.dnr.state.md.us/met/ce.html

POLICY:

Local regulations are developed in concert with established federal and state regulatory requirements.

STRATEGIES:

- Improve the permit review and oversight procedures for wastewater discharge, National Pollution Discharge Elimination System permits, and well water withdrawals to achieve point source pollution control and support conservation management of aquifers.
- Aggressively enforce laws regarding erosion control, critical area encroachment, wetland and source water protection, stormwater management, and woodland conservation.
- Revise the environmental guidelines, Landscape Technical Manual, and woodland and wildlife conservation laws and regulations to enhance and add measures and requirements that will increase the success of tree planting efforts to establish healthy new forests and protect and improve water quality.
- Tie future changes in environmental regulatory requirements to total maximum daily loads (TMDLs) implementation needs. If higher stormwater management standards are needed to meet TMDLs, then assume additional regulatory requirements may be necessary.

Systems-Based Management

POLICY:

Objectives, measurables, testing, and flexibility standards are developed to achieve water resources protection and restoration goals.

STRATEGIES:

- Establish, monitor, and evaluate measurable goals to comply with watershed and/or subwatershed forest cover and impervious percentages.
- Plans, programs, projects, and policies should be monitored and evaluated to determine whether the expected land conservation and protection results are achieved and to improve future programs and practices.
- Develop modeling and scientifically sound approaches to integrate land use change findings and forecasts with respect to impacts to water quality, quantity, and environmentally sensitive habitats and resources.
- Synthesize research and modeling findings and develop support for strategies to conserve lands that provide water quality and ecological benefits.

POLICY:

Prince George's County's waterways and water-related resources are protected from potential impacts from sea level rise, increasing storm intensities, and other climate change related effects.

STRATEGIES:

- Incorporate natural design features, through best practices, with an emphasis on creating a resilient system, and protect and restore natural shorelines, tidal wetlands, and vegetated stream buffers that inherently shield shoreline development and resources from the impacts of sea level rise and coastal storm events.
- In cooperation and consultation with all relevant stakeholders, engage in a climate change impact study for Prince George's County and its water resources.
- Promote programs and policies aimed at the avoidance and/or reduction of impact to existing development, as well as future development, in areas vulnerable to sea level rise and ensuing coastal hazards.
- Evaluate sea level rise impacts to wastewater treatment facilities, power plants, and other vulnerable industrial services.
- Avoid the financial risk of development and redevelopment in highly hazardous flood-prone areas.

APPENDIX I: NONPOINT SOURCE MODELING FOR PRINCE GEORGE'S COUNTY

One of the key tasks of the Prince George's County Water Resources Functional Master Plan (Water Resources Plan) project is evaluation of nutrient loads to each of the county's 6-digit watersheds through stormwater runoff based on various land uses. Several models exist to estimate watershed pollutant loads under different land use scenarios. In order to produce a tool that supports dynamic water resources planning for and beyond the evaluations assessed for this plan, the planning team and consultants evaluated several existing modeling options to estimate land use-based watershed pollutant loads. The evaluation included the project needs, which are guided by the Maryland Department of Planning's Models & Guidelines 26, The Water Resources Element: Planning for Water Supply and Wastewater and Stormwater Management (MDP MG26, 2007), in addition to the scale of analysis appropriate for the county as future evaluations progress at increasingly smaller hydrologic units.

Appendix I provides an overview of watershed pollutant load models that were reviewed and a description of the pollutant load analysis model (PLAM) developed for use in the evaluation of nonpoint nutrient loads as part of the Water Resources Plan. The description of PLAM includes a detailed discussion of the population and employment projections and future land use scenarios developed as part of the analysis. The 6-digit watersheds located within the county (Patuxent Below Fall and Potomac Below Fall) were assessed as well as one smaller, 8-digit subwatershed within each of the larger watersheds (Western Branch and Piscataway, respectively). Descriptions and results of the various nonpoint source loading model runs conducted for the plan are provided, followed by a summary of findings from the modeling effort as well as a discussion of future use of PLAM.

REVIEW OF NONPOINT SOURCE MODELS

Water Resources Element Model

A nonpoint source loading spreadsheet was developed by the State of Maryland to serve as a default analytical tool for conducting the nonpoint source analysis component of the Water Resources Element of local comprehensive plans, and the MDP MG26 provides a default methodology for utilizing the state's spreadsheet. The State of Maryland's nutrient load analysis spreadsheet and the MDP MG26 default methodology are subsequently referred to herein as the "Water Resources Plan model."

The Water Resources Plan model calculates existing and projected nitrogen and phosphorus loads from nonpoint sources based on existing and future land cover. The model uses the Maryland Department of Planning's (MDP) 2002 Land Use/Land Cover for existing land use conditions, and uses nitrogen and phosphorus loading rates that are based on the Watershed Model (Phase 4.3) of the Chesapeake Bay Program (CBP). The loading rates vary by land use category (LUC) and state basin (i.e., 6-digit watershed), and are also affected by best management practices (BMPs) implemented to control nutrient loads. Two sets of loading rates are included in the Water Resources Plan model:

- "2002 Best Management Practice (BMP) Implementation," which reflects implementation of BMPs at the rates reported by local jurisdictions in 2002; and
- "Tributary Strategy Implementation," which reflects the anticipated achievement of nitrogen and phosphorus reduction goals through a rate of BMP implementation developed by the state in coordination with CBP as part of the state's 2003 Chesapeake Bay tributary strategy.

The version of the model that was evaluated by the team was developed for Prince George's County and provided to The Maryland-National Capital Park and Planning Commission (M-NCPPC) by the Maryland Department of the Environment (MDE). The Prince George's County version includes annual terrestrial nutrient (i.e., nitrogen and phosphorus) loading rates for various LUCs in the county's land area within the 6-digit Patuxent and Potomac basins, and a nitrogen load equation for septic systems in the form of annual pounds per equivalent dwelling unit (EDU). The terrestrial loading rates are specific to the two large watersheds, with two sets of load rates provided for lands within the Patuxent watershed above and below the fall line, which bisects the northern part of the county and separates its Patuxent watershed into the Piedmont physiographic and Coastal Plain provinces, respectively. Therefore, the model provides three sets of terrestrial loading rates for each of the BMP implementation scenarios described above—Patuxent Above Fall, Patuxent Below Fall, and Potomac Below Fall, since all of the county's Potomac basin land area is within the Coastal Plain province. The MDP's 2002 land cover and septic estimates for each of these areas were included in the spreadsheet provided by MDE, as were the estimated annual nitrogen and phosphorus loads from those 2002 land covers and septic systems.

The annual terrestrial loading rates discussed above were intended to reflect average nutrient loads generated from land from current (2002) land management practices documented by the county, and the lower loading rates anticipated from more aggressive land management practices contained in the tributary strategy. Many of the BMPs incorporated in these two scenarios are the same, but the tributary strategy includes additional implementation of some BMPs that are expected to effectively reduce nutrient runoff. The types of BMPs included in these two load rate scenarios include typical stormwater management practices such as urban infiltration and filtering practices, in addition to urban stream restoration, reforestation, wetland restoration, forest and grass buffers, agricultural land retirement, and numerous agricultural runoff and nutrient management strategies. In some cases, the nutrient loading rates for the tributary strategy are higher than those reflecting 2002 BMPs (e.g., higher phosphorus loading from cropland), but in most cases the tributary strategy loading rates are the lower of the two sets of rates. Additional information regarding state land use categories and other Water Resources Plan model parameters can be found in a draft document entitled "User's Guide for Nutrient Load Analysis Spreadsheet in Support of the Water Resources Element" provided by MDE with the Prince George's version of the model, and additional information regarding Maryland's tributary strategy, BMP implementation, nutrient loads, and other data related to the Chesapeake Bay restoration effort can be found on the web sites for the Chesapeake Bay Program, Maryland Department of Natural Resources, and Maryland Department of the Environment.

Use of the Water Resources Plan model entails five basic steps:

1. Estimate initial land cover and septic EDUs (MDP's 2002 land cover provided in MDE spreadsheet).
2. Estimate the future land cover and septic EDUs.
3. Estimate the nonpoint source nitrogen and phosphorus loads for initial conditions (provided in MDE spreadsheet).
4. Estimate the nonpoint source nitrogen and phosphorus loads for the future conditions.
5. Compare the initial loads to the future loads.

The Water Resources Plan model also contains user input cells for current and future annual point source nutrient loads, which the model adds to the nonpoint and septic loads calculated as described above to generate a total annual load estimate. The model's results are presented in tabular and graphical format and provide estimated annual nitrogen and phosphorus loads for:

1. Current (2002) land use conditions using the load rates reflecting 2002 BMP implementation
2. Current (2002) land use conditions using the load rates reflecting tributary strategy implementation.
3. Future land use conditions using the load rates reflecting tributary strategy implementation, compared to current (2002) land use conditions using load rates reflecting tributary strategy implementation.

The model is formatted to include up to four future land cover scenarios that are specified, developed, and input by the user. The nutrient loads are categorized to distinguish those generated from various terrestrial categories (development, agriculture, forest, and other terrestrial sources), versus septic systems or point sources. In addition, for each scenario, the model allows input of land cover acreages, septic EDUs, percentage of land cover as open space (agriculture or forest), and percentage of land cover as impervious area.

The intent of the Water Resources Plan model is to provide the countywide change in future nutrient loads, impervious cover, and open space compared to the current (2002) land use conditions, based on user-defined future development scenarios. For each of the modeled development scenarios, the model utilizes one set of loading rate coefficients per large watershed area (i.e., the tributary strategy implementation loading rates). Therefore, the Water Resources Plan model's terrestrial nutrient load estimates reflect changes that occur from shifting existing land acres into different land use categories and do not reflect impacts that could occur through modified land management practices.

Watershed Treatment Model

The Watershed Treatment Model (WTM), which was developed by the Center for Watershed Protection (CWP), is another tool that was evaluated for modeling nonpoint source nutrient loads as part of the Prince George's County Water Resources Plan. The WTM is a tool for rapid assessment and quantification of various watershed treatment options, including stormwater treatment practices and stormwater management programs. In addition to calculating nitrogen and phosphorus loads, the WTM can also track sediment and bacteria loads.

The WTM has two basic components: (1) pollutant sources, and (2) treatment options. The pollutant sources component estimates the load from a watershed without treatment measures in place and accounts for both primary land uses and secondary pollutant sources, such as septic systems, sanitary and combined sewer overflows, channel erosion, and other factors. The primary land use component of the model is similar to the Water Resources Plan model in that nutrient load factors are used to estimate annual loads from various land use categories. The model calculates the loads for both existing and one future condition scenario based on land use acreages and other inputs defined by the user.

The WTM differs significantly from the Water Resources Plan model in its treatment option component, which allows the user to identify and claim credits (i.e., load reductions) for a variety of BMPs and other watershed treatment practices, such as lawn care and pet waste education programs, sediment and erosion control measures, street sweeping, and other pollution reduction approaches. The user identifies treatment options applied to existing conditions as well as those future treatment options or extensions of existing programs that are planned for the watershed being modeled. The WTM contains default loading rates for pollutant sources and "discounts" for a suite of treatment options; however, the user is encouraged to modify these values as appropriate based on local conditions or knowledge.

Due to its structure, the WTM provides a significant amount of flexibility for the user to estimate nutrient changes resulting from changes in future land uses such as those estimated by the Water Resources Plan model, in addition to changes in future land management practices that may affect the nutrient loading rates generated from different types of land covers. However, because the WTM includes default loading rates for only a few LUCs, generation of load estimates from changes based on land use requires a significant amount of local knowledge regarding typical loads from land uses within the watershed being modeled. Similarly, the discounts provided for treatment options are based on data collected from numerous sources that may or may not reflect local effectiveness rates. Therefore, the flexibility offered by the WTM is most beneficial in watershed analyses conducted on a small scale using well-documented user inputs, which cannot easily be extended to conduct an evaluation on a larger scale. In order to use the WTM at the county scale, discount factors and land use-based loading rates would need to be obtained for multiple watershed areas, and each area would need to be modeled independently with the results summarized outside the WTM framework.

POLLUTANT LOAD ANALYSIS MODEL STRUCTURE

As previously stated, the state's Water Resources Plan guidance document (MDP MG26) provides a default methodology for conducting the required nonpoint source loading analysis, utilizing the Water Resources Plan nonpoint source loading spreadsheet developed by the state for this purpose. However, the document notes that local governments may refine the default methodology or use their own method for conducting the nonpoint source loading analysis component of the Water Resources Plan, provided that assumptions are justified and sources of information are documented. In order to provide flexibility and functionality for Prince George's County's future use of the state's pollutant load analysis tool, Prince George's County Planning Department chose to depart from the default methodology and spreadsheet and tasked AECOM, the Water Resource Plan's consultant team, with development of the Prince George's County Pollutant Load Analysis Model (PLAM). The Center for Watershed Protection's WTM and the Water Resources Plan model discussed above form the basis of PLAM. The structure of PLAM is further explained below.

PLAM was developed based on the Water Resources Plan model described above. Similar to the state's spreadsheet, PLAM is a spreadsheet model that estimates nitrogen and phosphorus loads from specific land use categories within the modeled watershed(s). Nitrogen loads from residential and nonresidential onsite disposal systems are also estimated, and point source nitrogen and phosphorus loads are included to provide a total nutrient load estimate per watershed. To provide the county with maximum future flexibility, AECOM constructed the model to incorporate up to ten watersheds, with the estimated loads from each modeled watershed summed in tabular and graphical format. This format allows the county to model numerous watersheds at one time for a side-by-side comparison, or divide a larger watershed into numerous small subwatersheds to calculate a total watershed load based on the varying local load rates, and/or land uses that reflect each small area.

The land use acreages for initial and future development scenarios can be manually input into PLAM, or automatically entered through links established in PLAM that import data from an external land use data file, which is formatted to contain acreages for up to ten watersheds. The terrestrial loading rates for each land use category can also be manually entered into PLAM or imported from an external load rates data file, which is formatted to contain up to ten sets of load rates. This structure allows the user to establish numerous sets of load rates based on various current and/or future land management scenarios or varying degrees of BMP implementation for individual watersheds, and select which rates to apply for the scenarios being modeled. The user can also refine terrestrial loading rates based on available detail and better understanding of physical conditions (e.g., soil information) that might affect the effectiveness of BMPs

As in the state's Water Resources Element model, PLAM will model loads from terrestrial, septic and point sources for initial conditions and up to four future Water Resources Plan scenarios, with initial and future loads for the modeled watersheds shown individually within each of the four Water Resources Plan scenario worksheets. The total initial and future loads calculated for each development scenario are also tabulated in a worksheet entitled "Water Resources Plan Summary Results" and illustrated in a worksheet entitled "Water Resources Plan Charts," both of which can be modified as needed to present results in the user's preferred format. A list of the worksheets developed based on the Water Resources Plan nutrient load analysis methodology is provided in Table 1.

The results provided by the PLAM worksheets shown in Table 1 are very similar to the output from the state's default Water Resources Plan model, in that the output summaries provide the change in nutrient loads resulting from changes in land use, estimated septic loads, and point sources. Although PLAM is constructed to provide the user flexibility to model multiple watersheds, land use scenarios, and/or loading rates, like the Water Resources Plan model, PLAM's default construction relies on one set of loading rates that are applied across the initial and future scenarios. As described later in this document, the above worksheets were used in this fashion to generate nutrient load estimates as part of the development of the Water Resources Plan based on land uses, septic systems, and estimated point source loads within the Patuxent and Potomac watersheds of Prince George's County.

Table 1: PLAM Worksheets Developed for the Prince George's County Planning Department **(Based on Maryland's Default Water Resources Plan Nutrient Load Analysis Spreadsheet)**
Instructions for Water Resources Plan-PLAM
Watersheds
Water Resources Plan Scenario 1
Water Resources Plan Scenario 2
Water Resources Plan Scenario 3
Water Resources Plan Scenario 4
Water Resources Plan Summary Results
Water Resources Plan Charts

Descriptions of the land use and loading rate data inputs and the initial and future development land use scenarios are discussed in the Methodology Section below.

In order to provide additional functionality beyond the state's nutrient load analysis default approach developed for the Water Resources Plan, AECOM provided the Water Resources Plan scenario and results worksheets within a workbook structure provided by CWP's WTM version 3.1. The WTM version 3.1 worksheet names are shown in Table 2.

Table 2: Watershed Treatment Model Worksheets in PLAM
Primary Sources
Secondary Sources
Existing Management Practices
Future Management Practices
Future Land Use
New Development
Discounts—Existing
Existing Loads
Loads with Future Practices
Loads Including Growth
Summary Sheet

The WTM provides the user with the flexibility to model primary sources (loads from land use categories) separately from secondary sources (e.g., sewer overflows, channel erosion, etc.), as well as modifications related to implementation of specific BMPs. Because these functionalities are not provided in the Water Resources Plan-based approach provided by the state, PLAM was constructed to export the "initial conditions" land use acreage data for one watershed (i.e., the initial land use data for the first watershed included in the Water Resources Plan Scenario 1 worksheet) automatically into the WTM Primary Sources worksheet. In addition, the land use acreage data from one future development scenario (i.e., the future land use data for the first watershed included in the Water Resources Plan Scenario 1 worksheet) are automatically exported into the WTM Future Land Use worksheet.

The loading rates used for the Water Resources Plan portions of PLAM are not exported into the Primary Sources worksheet, since the baseline state-provided Water Resources Plan loading rates are considered to be inclusive of both primary sources and secondary sources (per land use category), and the user may wish to separate those sources. Therefore, appropriate loading rates need to be entered by the user in the WTM Primary Sources worksheet included in PLAM. The default loading rates and impervious areas originally included in the WTM version 3.1 Primary Sources worksheet were removed from this worksheet in PLAM, because the land use categories exported from Water Resources Plan Scenario 1 may not be the same as the land use categories contained in the original WTM files.

With the exceptions noted herein, the other WTM version 3.1 worksheets were incorporated into PLAM in their original format without modification, and the use of their functionality should be guided by the user's experience and/or direction from the Center for Watershed Protection.

METHODOLOGY FOR PRINCE GEORGE'S COUNTY WATER RESOURCE PLAN NONPOINT SOURCE MODELING

The PLAM model described above was utilized to generate data in support of Prince George's County's Water Resources Plan. To generate data consistent with the default Water Resources Plan model methodology, the base runs for the Water Resources Plan were generated using the PLAM worksheets shown in Table 1 to estimate changes in nutrient loads resulting from changes in land use by applying a uniform set of loading rates across the initial and future scenarios. The worksheets shown in Table 2 were incorporated into PLAM to provide a greater level of flexibility for the county's future evaluation of smaller-scale watershed programs, but were not needed for generation of the data requested by the state for the Prince George's County Water Resources Plan.

The land use acreages, septic systems, and point source loads for initial and future development scenarios were compiled in a data input workbook entitled "Land Use Data.xls" and imported into PLAM model runs using external reference formulas. The loading rates used for the model were complied in a data input workbook entitled "Load Rates.xls" and imported into PLAM model runs using external reference formulas. The majority of data inputs were identical to or based upon the data provided in the MDE-provided spreadsheets created for the WRE. However, there were a few variances from the MDE model that were incorporated due to inherent county information (e.g., county land use categories) or format of county data (e.g., data on employment use of septic systems), or a few other reasons, and these variances are discussed throughout this methodology section and summarized at the end of Appendix I, Attachment 1. Both sets of data inputs are described below.

Land Use Data Input

The land use data provided for the nonpoint source modeling work was prepared in close coordination with the Planning Department's information management and planning personnel. The consultant team utilized a geographical information system (GIS) and land use modeling in conjunction with data provided by the Planning Department and Maryland Department of Planning (MDP) to generate the data discussed in more detail below.

INITIAL CONDITIONS

MDP publishes statewide land use/land cover data based on analysis of parcel information in conjunction with high altitude aerial photography and satellite imagery. The default Water Resources Plan model spreadsheet provided by MDE contained MDP's 2002 land cover data for initial conditions for the following 6-digit watersheds located within Prince George's County: Patuxent Above Fall, Patuxent Below Fall, and Potomac Below Fall. Subsequent to receipt of the default Water Resources Plan spreadsheet, MDP released a draft 2007 Land Use/Land Cover Update. The purpose of this update was to capture and analyze the consumption of land due to recent development and to characterize the new development. The Prince George's County Planning Department evaluated both data sets and selected the 2007 data since it reflected the most current and accurate existing conditions. Thus, the state's 2007 land use data was incorporated into PLAM and represents initial conditions for the Water Resources Plan's nonpoint source loading analysis.

Attachment 1 of this appendix provides the land use categories included in the Water Resources Plan model spreadsheet created by MDE for Prince George's County, along with the respective associated impervious cover percentages and loading rates. In MDP's 2007 land use data, two new urban land use categories were included that replace the state's 191—Rural Residential land use category included in the Water Resources Plan model. The state's definitions for these categories are provided below and in Attachment 1:

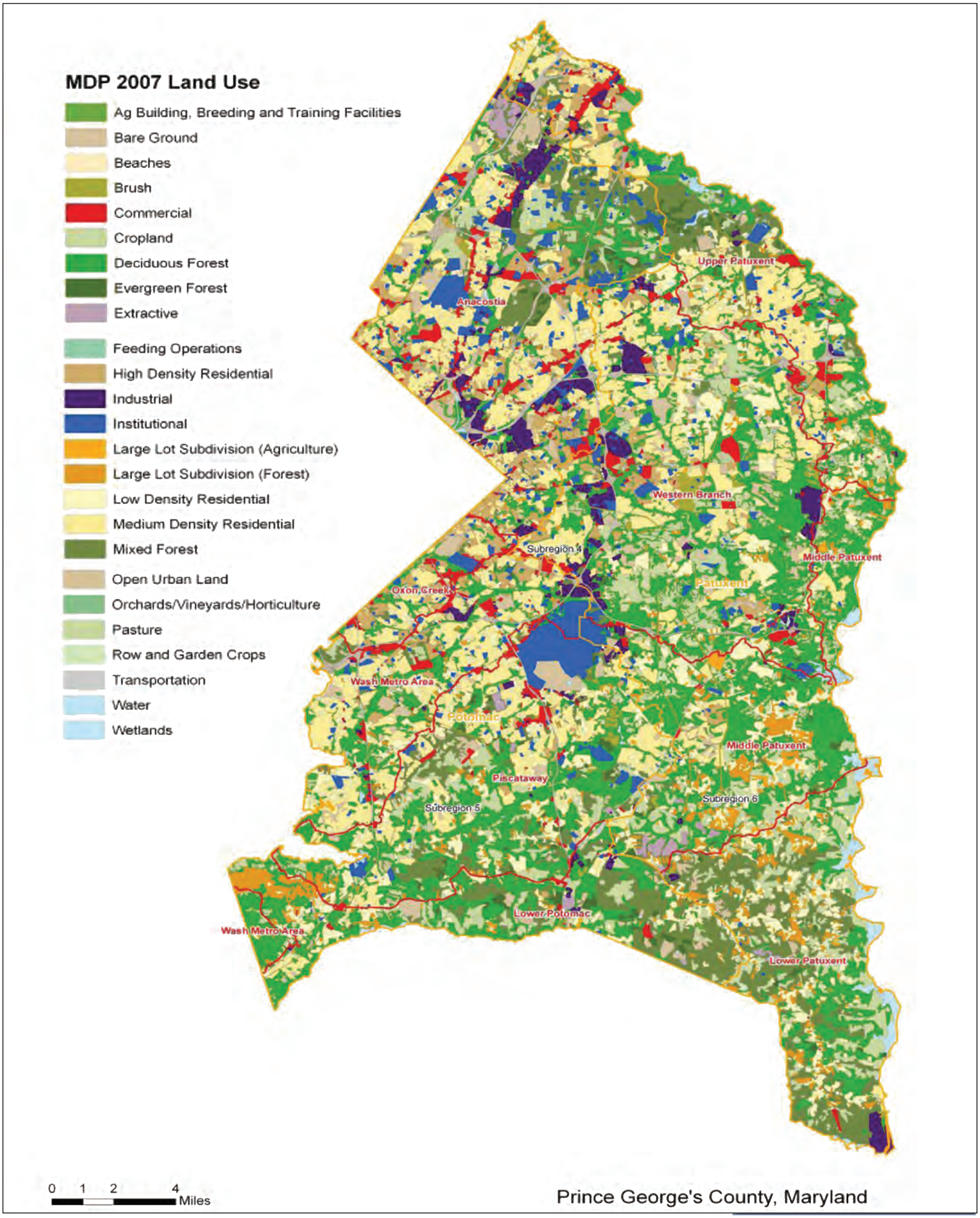
- 191—Large Lot Subdivision (Agriculture)—Residential subdivisions with lot sizes of less than 20 acres but at least five acres, with a dominant land cover of open fields or pasture.
- 192—Large Lot Subdivision (Forest)—Residential subdivisions with lot sizes of less than 20 acres but at least five acres, with a dominant land cover of deciduous, evergreen, or mixed forest.

The land area within the Patuxent basin above the fall line is very small (600 acres compared to 161,000 acres below the fall line), and the line is not defined within the state or county's GIS, making delineation of land uses above and below the fall line difficult. Therefore, the analysis conducted for the Water Resources Plan was developed based on the assumption that the entire county was contained within the two 6-digit watersheds Patuxent Below Fall and Potomac Below Fall, and all the county's acreage from the state's 2007 land use data for the various land use categories were assigned to these two watersheds in the PLAM model runs. In preparing the 2007 land use data for the model input files, the data were divided among the nine 8-digit subwatersheds located within the Patuxent Below Fall and Potomac Below Fall watersheds. Of these nine 8-digit subwatersheds, per the direction of the Prince George's County Planning Department, the following two watersheds were fully incorporated into the land use analysis and PLAM for the Water Resources Plan: Western Branch (within the Patuxent Below Fall) and Piscataway (within Potomac Below Fall). Table 3 outlines the land cover categories included under the 2007 MDP Land Use/Land Cover analysis, as well as the associated 2007 acreage data for Prince George's County. A map illustrating the 2007 data is provided as Map 1 (Appendix I).

Table 3. MDP 2007 Land Use/Land Cover Categories

Land Use Code	Description	Existing Acres
242	Agricultural Building, Breeding and Training Facilities	198
73	Bare Ground	6,175
71	Beaches	58
44	Brush	3,135
14	Commercial	9,516
21	Cropland	23,616
41	Deciduous Forest	77,416
42	Evergreen Forest	3,545
17	Extractive	1,695
241	Feeding Operations	0
13	High Density Residential	13,542
15	Industrial	8,333
16	Institutional	14,537
191	Large Lot Subdivision (Agriculture)	2,121
192	Large Lot Subdivision (Forest)	8,821
11	Low Density Residential	29,774
12	Medium Density Residential	52,504
43	Mixed Forest	29,628
18	Open Urban Land	7,946
23	Orchards/Vineyards/Horticulture	27
22	Pasture	8,867
25	Row and Garden Crops	260
80	Transportation	3,573
50	Water	1,401
60	Wetlands	2,693
	Total	**309,382**

In addition to the land use/land cover categories provided by the MDE Water Resources Plan spreadsheet, the PLAM Land Use Data.xls spreadsheet includes a number of land use categories used by Prince George's County Planning Department and informational management system. Notes regarding correlations between the state and county land classifications are included in the PLAM workbooks where applicable.


MDP 2007 Land Use
Ag Building, Breeding and Training Facilities
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Beaches
Brush
Commercial
Cropland
Deciduous Forest
Evergreen Forest
Extractive
Feeding Operations
High Density Residential
Industrial
Institutional
Large Lot Subdivision (Agriculture)
Large Lot Subdivision (Forest)
Low Density Residential
Medium Density Residential
Mixed Forest
Open Urban Land
Orchards/Vineyards/Horticulture
Pasture
Row and Garden Crops
Transportation
Water
Wetlands
Upper Patuxent
Anacostia
Western Branch
Subregion 4
Middle Patuxent
Patuxent
Oxon Creek
Wash Metro Area
Potomac
Middle Patuxent
Piscataway
Subregion 6
Subregion 5
Lower Potomac
Wash Metro Area
Lower Patuxent
0 1 2 4 Miles
Prince George's County, Maryland

Future Land Use Scenarios

The Metropolitan Washington Council of Governments (COG), through a Cooperative Forecasting Program with local governments, creates and maintains population and employment projections through 2030. The COG data is generally considered as a reliable source for most regional planning studies, and the Water Resources Plan bases its future land use analysis on the 2005 MWCOG/M-NCPPC baseline and 2030 projections. However, COG maintains its data aggregated by traffic analysis zones (TAZs) that do not correspond to the watershed boundaries used as analysis units by the Water Resources Plan. In order to create a more applicable data set, AECOM used simple scaling methods to aggregate TAZ-based data into 8-digit and 6-digit watershed-based population and employment totals. Using GIS, AECOM attached the COG tables to a TAZ GIS layer. Assuming uniform distribution within each TAZ, AECOM calculated a linear scaling ratio, or density of attribute/acre of TAZ for each population, employment, and dwelling units attribute for each of the years: 2005, 2010, 2015, 2020, 2025 and 2030. Then a copy of this modified TAZ layer was clipped to the watershed boundary. The area of the clipped polygon was recalculated and then the resulting attribute information was updated by using the formula:

Updated Attribute = Updated Area x Attribute Scaling Ratio

e.g., 2030 Population = (TAZ area in watershed) x original population density (pop/acre)

Each TAZ polygon was then tagged with the watershed ID of the 8-digit watershed it was contained within. Each attribute was then summed by using the watershed ID to produce a new table (see Table 4) with totals of population, employment, and dwelling units by watershed and by year (2005, 2010, 2015, 2020, 2025 and 2030). The population data for the City of Laurel was included as part of the Upper Patuxent subwatershed in Table 4. The methodology was validated by both COG and county planners.

Table 4: MWCOG/M-NCPPC Population, Dwelling Unit, and Employee Data and Projections

Watershed	Subwatershed	Population 2005	Dwelling Units 2005	Employment 2005	Population 2030*	Dwelling Units 2030*	Employment 2030*
Patuxent	Lower Patuxent	3,727	1,322	661	3,735	1,390	746
Patuxent	Middle Patuxent	22,768	8,039	5,312	30,282	11,302	6,361
Patuxent	Upper Patuxent	93,317	36,899	27,794	101,034	41,680	44,703
Patuxent	Western Branch	162,363	60,193	68,860	202,254	79,217	105,138
Potomac	Anacostia	326,839	119,320	167,107	366,474	142,745	255,233
Potomac	Lower Potomac	8,133	2,906	3,704	15,593	5,872	4,715
Potomac	Oxon Creek	67,166	27,998	16,699	69,512	30,474	21,105
Potomac	Piscataway	67,172	23,007	23,357	81,512	29,522	28,932
Potomac	Wash Metro Area	101,398	39,282	34,392	122,476	50,297	51,455
		852,883	**318,966**	**347,885**	**992,871**	**392,498**	**518,388**

* COG Projections by TAZ (Round 7.1 Cooperative Forecast for Prince George's County)

The difference between 2005 and 2030 population and employment figures represents the anticipated growth during that time and the serves as the basis for the development scenarios. This level of new growth was assumed to be constant within a particular watershed. Table 5 defines the population and employment growth to be accommodated to 2030 (from a 2005 baseline) by 6-digit or 8-digit watershed.

Table 5: Population and Employment Growth to 2030 by Subwatershed		
Watershed	**Population Growth to 2030**	**Employment Growth to 2030**
Potomac	84,858	116,181
Piscataway	14,339	5,574
Patuxent	55,129	54,322
Western Branch	39,891	36,278

The development capacity of the land in terms of residential and employment zoning densities also served as a constant in developing the 2030 land use scenarios. Existing county zoning capacity by dwelling units per acre, as well as Floor Area Ratios and square footage per employee standards, were studied in order to assign values to each state land cover category. Despite the fact that no exact correlation exists between county zoning and state land cover designations, the densities selected to represent each category were chosen in consultation with the county and are closely linked to the corresponding zoning. Tables 6 and 7 show the density data used to calculate the scenario acreages.

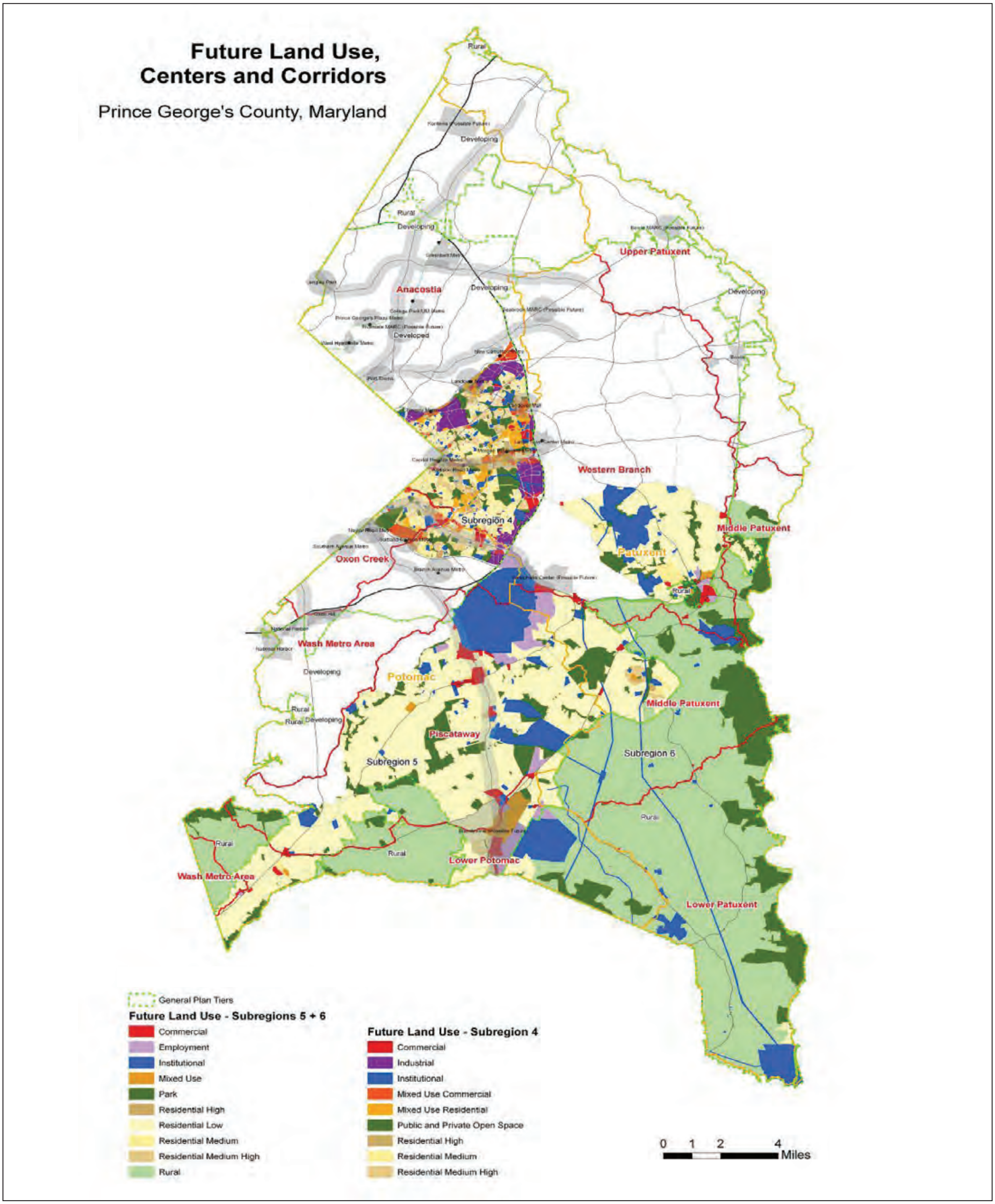
Table 6: Residential Densities by MDP Land Cover Category	
Land Use	**Dwelling Unit Density**
Large Lot Subdivision (Agriculture)	0.05
Large Lot Subdivision (Forest)	0.05
Residential Low	2
Residential Medium	5
Residential High	16
Mixed-Use Residential	8

Table 7: Employment Density Factors by MDP Land Cover Category		
Land Use	**FAR**	**SF/Employee**
Commercial	0.41	325
Mixed-Use Commercial	0.41	325
Industrial	0.31	700
Institutional	0.41	1,250
Mixed-Use Residential	1.5	325

The compilation and structure of the future development scenario data used in PLAM were the same as described above for the initial conditions data. In addition, the following three land use categories were incorporated into the future development scenarios to reflect the county's smart growth initiatives:

- 129—Mixed Use Residential: Dense urban residential development such as high-rise apartment or condominium dwelling units over ground-level commercial development comprising a mix of approximately 50 percent high-density residential space, 20 percent commercial space, ten percent open urban or parkland, and 20 percent undeveloped space. The percentage of impervious area is higher than high-density residential development but lower than commercial development due to the open and undeveloped space provided.
- 129s—Mixed Use Residential: This land use category was developed to reflect the Prince George's County Planning Department's vision of smart growth around transportation centers and growth corridors, which reflects moderately dense, mixed suburban residential development such as apartments and condominiums, town houses, and dense detached housing combined with commercial development. This land use category is envisioned to comprise approximately 50 percent medium and high density residential and institutional space, 10 percent commercial space, 20 percent open urban, parkland and recreational space, and 20 percent undeveloped space. The percentage of impervious area is lower than the more densely developed urban mixed residential category described above, and similar to medium high density development.
- 149—Mixed Use Commercial: Dense urban commercial development with mix of retail, office and other nonresidential development. The percentage of impervious area is the same as commercial development.

In developing the Water Resources Plan model scenarios, two future land use scenarios were considered for the year 2030, which were guided by a set of related factors as discussed in detail below. The overall approach was to develop contrasting alternatives to compare land use acreages under what were termed trend and ideal development scenarios. The trend scenario represented a continuation of existing land use patterns to accommodate future population growth, so the trend scenario extrapolated the composition of future land use by watershed in line with what currently exists in the county by subwatershed. By contrast, the ideal scenario was developed to represent the county's smart growth vision, which consists of more compact development around transportation centers and growth corridors to accommodate future growth. The completed portion of the county's future land use plan (being prepared separate from the Water Resources Plan for strategic planning purposes), along with designated transportation centers and growth corridors, are illustrated in Map 2 (Appendix I). The county's land use planning efforts have historically been targeted at specific planning subregions, and the available data included small area and sector plans, as well as the partial county land use plan illustrated here. This information helped to guide the scenario development, and is discussed in more detail for each subwatershed in the Future Land Use Scenarios Section to follow.



Map 2 (Appendix I): County future land use and designated centers and corridors.

Future Trend Development vs. Future Ideal Development Input

In order to fully define the distinction between trend and ideal scenarios, a set of parameters was established for each watershed. The three overarching drivers behind each scenario were targets related to infill, redevelopment, and preservation of county green infrastructure acreage. Figure 1 provides a graphical representation of the process used to generate the land use scenarios. The first of these, infill, represented the proportion of the new population and employment that could be accommodated within existing land uses. For instance, densification of an existing commercial or residential area does not change the overall land use acreage, but simply absorbs new growth within an existing context. The infill percentage thereby represents the percentage of population growth that does not require development of new acreage.

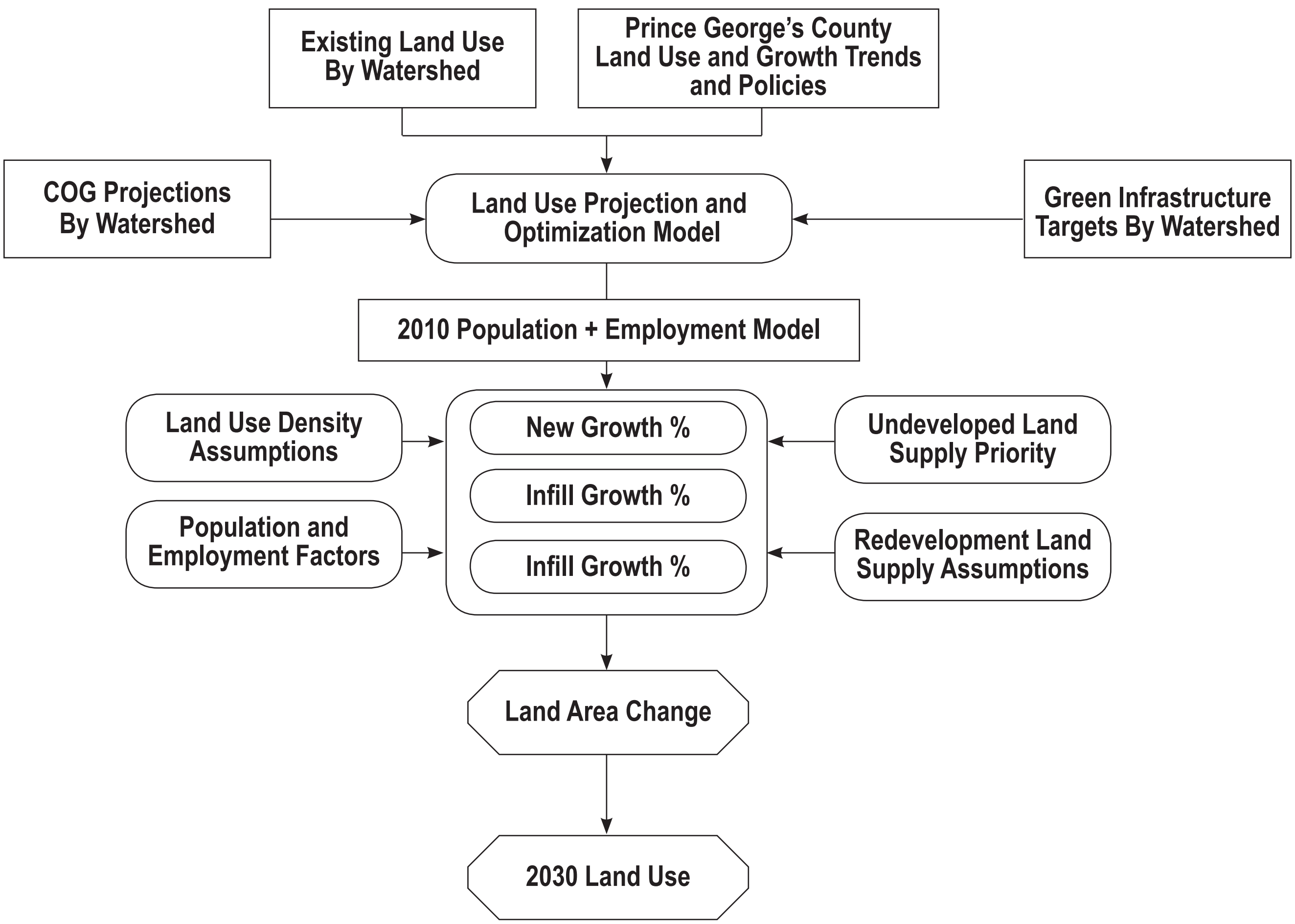


Figure 1: Land use model process diagram.

In contrast to infill, redevelopment involves growth within previously developed land, but in a manner that changes the use signature of the land. Conversion of land from commercial to a mixed-use land use category is an example of redevelopment that allows for new population and employment growth without development of greenfield acres. The redevelopment percentage represents the percentage of new population and employment growth that can be accommodated in this way.

Finally, the county green infrastructure network deserved special attention in terms of accommodating new development. The acreages associated with the three categories of land as defined in the Approved Countywide Green Infrastructure Plan, namely the regulated area, the evaluation area, and network gap were considered as targets for preservation under future land use scenarios, but strictly as a quantitative exercise. The ideal scenarios represented attempts to fully preserve the sum total of all acreage identified as part of the green infrastructure network, while the trend scenarios included a lower preservation threshold. Due to the fact that the land use scenario model is not spatial, the designation of acreages to be preserved was not meant to be a literal interpretation of the Countywide Green Infrastructure Plan or to translate into policy, but was intended to serve as a planning tool for purposes of scenario development. Green infrastructure acreage targets were represented in terms of forest, brush, and other undeveloped MDP land use categories, which were targeted for preservation.

Table 8 provides the infill and redevelopment percentages utilized for each watershed under trend and ideal scenarios, as well as the corresponding green infrastructure preservation targets.

Priority Conversion of Redevelopment Acreage. Assignment of land for redevelopment was done on a prioritization basis by watershed and scenario. This effort was tailored to the unique situation in each subwatershed and the perceived potential for redevelopment. For example, the presence of substantial large lot residential acreage in certain subwatersheds provides the most logical target for redevelopment, whereas in others the focus is aging or underutilized commercial properties. The target redevelopment percentage translates into a specific acreage based on these parameters in combination with the previously established zoning data. The land supply for redevelopment derived from existing large lot subdivision, residential low, commercial, and industrial uses. Conversion to new land uses was specified for both residential (population) and employment growth. The specific redevelopment calculations are specified in Tables 9 to 24 by watershed and scenario, where Tables 9 to 16 outline the redevelopment targets, and Tables 17 to 24 show the land supply necessary to accomplish the targets. In the case of the latter, the land uses for redevelopment supply are assigned percentages to represent each in relation to the total acreage necessary for redevelopment.

Table 8. Infill, Redevelopment and Conservation Targets by Watershed, Trend and Ideal Scenarios

Potomac Watershed		Trend	Ideal
Infill		5%	20%
Redevelopment		15%	50%
Green Infra-structure	Regulated Area	100%	100%
	Evaluation Area	60%	100%
	Network Gap	20%	100%
Patuxent Watershed		**Trend**	**Ideal**
Infill		5%	8%
Redevelopment		10%	30%
Green Infra-structure	Regulated Area	100%	100%
	Evaluation Area	60%	100%
	Network Gap	20%	100%
Piscataway Watershed		**Trend**	**Ideal**
Infill		5%	10%
Redevelopment		10%	25%
Green Infra-structure	Regulated Area	100%	100%
	Evaluation Area	60%	100%
	Network Gap	20%	100%
Western Branch Watershed		**Trend**	**Ideal**
Infill		5%	10%
Redevelopment		15%	50%
Green Infra-structure	Regulated Area	100%	100%
	Evaluation Area	60%	100%
	Network Gap	20%	100%

Table 9: Redevelopment Target for Potomac Trend Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	137.2	6,364
129	Mixed Use Residential	Mixed Use Residential	50.0	201.5	6,364
			100.0	**338.7**	**12,728**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	40.0	126.9	6,970
149	Mixed Use Commercial	Mixed Use Commercial	10.0	31.7	1,742
15	Industrial	Industrial	20.0	180.7	3,485
16	Institutional	Institutional	10.0	122.0	1,742
129	Mixed Use Residential	Mixed Use Residential	20.0	52.0	3,485
			100.0	**513.2**	**17,424**

Table 10: Redevelopment Target for Potomac Ideal Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	457.2	21,214
129	Mixed Use Residential	Mixed Use Residential	50.0	447.8	21,214
			100.0	**905.0**	**42,428**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	20.0	211.4	11,618
149	Mixed Use Commercial	Mixed Use Commercial	50.0	528.5	29,045
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	5.0	203.3	2,904
129	Mixed Use Residential	Mixed Use Residential	25.0	144.5	14,522
			100.0	**1,087.7**	**58,089**

Table 11: Redevelopment Target for Patuxent Trend Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	59.4	2,756
129	Mixed Use Residential	Mixed Use Residential	50.0	87.3	2,756
			100.0	**146.7**	**5,512**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	9.9	543
149	Mixed Use Commercial	Mixed Use Commercial	40.0	39.5	2,172
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	10.0	38.0	543
129	Mixed Use Residential	Mixed Use Residential	40.0	32.4	2,172
			100.0	**119.9**	**5,430**

Table 12: Redevelopment Target for Patuxent Ideal Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	178.2	8,269
129	Mixed Use Residential	Mixed Use Residential	50.0	261.8	8,269
			100.0	**440.0**	**16,538**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	29.7	1,629
149	Mixed Use Commercial	Mixed Use Commercial	40.0	118.6	6,518
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	10.0	114.1	1,629
129	Mixed Use Residential	Mixed Use Residential	40.0	97.3	6,518
			100.0	**359.6**	**16,294**

Table 13: Redevelopment Target for Piscataway Trend Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	10.0	9.9	143
13	Residential High	Residential High	45.0	13.9	644
129	Mixed Use Residential	Mixed Use Residential	45.0	20.4	644
			100.0	**44.2**	**1,431**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	1.0	55
149	Mixed Use Commercial	Mixed Use Commercial	30.0	3.0	167
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	25.0	9.7	139
129	Mixed Use Residential	Mixed Use Residential	35.0	2.9	194
			100.0	**16.7**	**555**

Table 14: Redevelopment Target for Piscataway Ideal Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	38.6	1,792
129	Mixed Use Residential	Mixed Use Residential	50.0	56.7	1,792
			100.0	**95.4**	**3,584**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	2.5	139
149	Mixed Use Commercial	Mixed Use Commercial	40.0	10.1	557
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	15.0	14.6	208
129	Mixed Use Residential	Mixed Use Residential	35.0	7.3	487
			100.0	**34.6**	**1,391**

Table 15: Redevelopment Target for Western Branch Trend Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	10.0	41.3	598
13	Residential High	Residential High	45.0	58.0	2,692
129	Mixed Use Residential	Mixed Use Residential	45.0	85.3	2,692
			100.0	**184.5**	**5,982**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	9.9	544
149	Mixed Use Commercial	Mixed Use Commercial	40.0	39.6	2,176
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	10.0	38.1	544
129	Mixed Use Residential	Mixed Use Residential	40.0	32.5	2,176
			100.0	**120.1**	**5,440**

Table 16: Redevelopment Target for Western Branch Ideal Scenario					
Residential Redevelopment Allocation					
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Population**	**Area Required (acres)**	**Redevelopment Population**
12	Residential Medium	Residential Medium	0.0	0.0	0
13	Residential High	Residential High	50.0	214.9	9,972
129	Mixed Use Residential	Mixed Use Residential	50.0	315.8	9,972
			100.0	**530.7**	**19,944**
Nonresidential Redevelopment Allocation					
14	Commercial	Commercial	10.0	33.0	1,813
149	Mixed Use Commercial	Mixed Use Commercial	30.0	99.0	5,441
15	Industrial	Industrial	0.0	0.0	0
16	Institutional	Institutional	25.0	317.4	4,534
129	Mixed Use Residential	Mixed Use Residential	35.0	94.7	6,348
			100.0	**544.2**	**18,136**

Table 17: Supply of Land for Redevelopment, Potomac Trend Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	160.0	23	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	20.0	160.0	23	0
11	Residential Low	Residential Low	5.0	40.0	231	0
14	Commercial	Commercial	30.0	240.0	0	13,186
15	Industrial	Industrial	25.0	200.0	0	3,857
			100.0	**513.2**	**17,424**	**17,043**
	Existing Residents Accommodated—277					
	Existing Employees Accommodated—17,043					

Table 18: Supply of Land for Redevelopment, Potomac Ideal Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	10.0	184.8	26	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	10.0	184.8	26	0
11	Residential Low	Residential Low	30.0	554.5	3,216	0
14	Commercial	Commercial	20.0	369.7	0	20,313
15	Industrial	Industrial	30.0	554.5	0	10,696
			100.0	**1,848.3**	**3,268**	**31,009**
	Existing Residents Accommodated—3,268					
	Existing Employees Accommodated—31,009					

Table 19: Supply of Land for Redevelopment, Patuxent Trend Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	46.8	6	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	5.0	11.7	67	0
14	Commercial	Commercial	30.0	70.2	0	3,859
15	Industrial	Industrial	45.0	105.3	0	2,032
			100.0	**234.1**	**73**	**5,891**
	Existing Residents Accommodated—73					
	Existing Employees Accommodated—5,891					

Table 20: Supply of Land for Redevelopment, Patuxent Ideal Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	5.0	35.1	5	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	20.0	140.5	814	0
14	Commercial	Commercial	30.0	210.7	0	11,579
15	Industrial	Industrial	45.0	316.1	0	6,097
			100.0	**702.4**	**819**	**17,676**
	Existing Residents Accommodated—819					
	Existing Employees Accommodated—17,676					

Table 21: Supply of Land for Redevelopment, Piscataway Trend Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	11.6	1	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	30.0	17.4	100	0
14	Commercial	Commercial	30.0	17.4	0	956
15	Industrial	Industrial	20.0	11.6	0	223
			100.0	**58.0**	**101**	**1,179**
	Existing Residents Accommodated—101					
	Existing Employees Accommodated—1,179					

Table 22: Supply of Land for Redevelopment, Piscataway Ideal Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	24.5	3	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	40.0	49.1	284	0
14	Commercial	Commercial	20.0	24.5	0	1,348
15	Industrial	Industrial	20.0	24.5	0	473
			100.0	**122.7**	**287**	**1,821**
	Existing Residents Accommodated—287					
	Existing Employees Accommodated—1,821					

Table 23: Supply of Land for Redevelopment, Western Branch Trend Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	54.4	7	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	10.0	27.2	157	0
14	Commercial	Commercial	30.0	81.6	0	4,486
15	Industrial	Industrial	40.0	108.9	0	2,099
			100.0	**272.1**	**164**	**6,585**
	Existing Residents Accommodated—164					
	Existing Employees Accommodated—6,585					

Table 24: Supply of Land for Redevelopment, Western Branch Ideal Scenario						
Redevelopment Land Supply						
LU Code	**Description**	**Used Description**	**Percent of Redevelopment Acres Required**	**Area Lost**	**Existing Population**	**Existing Employment**
101	Large Lot Subdivision (Agriculture)	Rural (Agriculture)	20.0	196.0	28	0
102	Large Lot Subdivision (Forest)	Rural (Forest)	0.0	0.0	0	0
11	Residential Low	Residential Low	20.0	196.0	1,136	0
14	Commercial	Commercial	20.0	196.0	0	10,772
15	Industrial	Industrial	40.0	392.0	0	7,562
			100.0	**980.1**	**1,164**	**18,334**
	Existing Residents Accommodated—1,164					
	Existing Employees Accommodated—18,334					

One consideration in redevelopment calculations is the displacement of existing residents and employees by conversion of one land use type to another. This population is factored back into the calculations as part of the growth to be accommodated. For instance, conversion of a low-density residential neighborhood to a higher density or mixed-use development will, at least from the perspective of the watershed, necessitate an adjustment of the growth potential to consider the displaced population.

Priority Conversion of Greenfield Acreage. The population and employment growth to be accommodated beyond the established redevelopment and infill capacity requires conversion of greenfield land to developed uses. A hierarchy with respect to land supply for conversion as well as future land use designations was established to correspond to the goals for a specific scenario and watershed. Based on coordination with the Prince George's County Planning Department, existing bare ground was chosen as the first land use for conversion to development, followed by brush and cropland. The land use categories constituting the green infrastructure designation, including forests, pasture, and wetlands, were last in the conversion sequence in order to allow for meeting the previously discussed conservation targets. Caps were set with respect to each land use category to represent the maximum percentage of each category available for conversion before proceeding to the next land use in sequence (termed maximum utilization percentage in the tables that follow). The floor area ratio (FAR) and gross floor area (GFA) data allows for calculation of employment figures under the assumption of standard square footages per employee. The specific greenfield development parameters are specified in Tables 25 to 32 by watershed and scenario.

Table 25 Greenfield Development Parameters for Potomac Trend Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.01%	0.05
102	Large Lot Subdivision (Forest)	0.05	0.05%	0.05
11	Residential Low	2	6.8%	6.9
12	Residential Medium	5	49.0%	49.0
13	Residential High	16	43.9%	34.0
129	Mixed Use Residential	8	0.0%	10.0
18	Open urban land	0.15	0.3%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	58.4%	48.4
149	Mixed Use Commercial	0.41	0.0%	10.0
15	Industrial	0.31	14.8%	14.8
16	Institutional	0.41	26.8%	21.8
129	Mixed Use Residential	1	0.0%	5.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	3,292	90
44	Brush	2	1,042	75
21	Cropland	3	7,318	60
22	Pasture	4	3,624	10
41	Deciduous forest	5	33,282	5
43	Mixed forest	6	15,433	5
42	Evergreen forest	7	2,342	5
17	Extractive	8	864	0
24	Agricultural building breeding and training	9	141	0
25	Row and garden crops	9	47	0
50	Water	9	534	0
60	Wetlands	9	234	0
80	Transportation	9	2,273	0
71	Beaches	9	58	0
			68,152	

Table 26 Greenfield Development Parameters for Potomac Ideal Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.01	0.05
102	Large Lot Subdivision (Forest)	0.05	0.05	0.05
11	Residential Low	2	6.8	2.9
12	Residential Medium	5	49.0	10.0
13	Residential High	16	43.9	37.0
129	Mixed Use Residential	8	0.0	50.0
18	Open urban land	0.15	0.3	0.0
			100.0	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	58.4	10.0
149	Mixed Use Commercial	0.41	0.0	45.0
15	Industrial	0.31	14.8	5.0
16	Institutional	0.41	26.8	20.0
129	Mixed Use Residential	1.5	0.0	20.0
			100.0	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	3,292	80
44	Brush	2	1,042	25
21	Cropland	3	7,318	5
22	Pasture	4	3,624	5
41	Deciduous forest	5	33,282	5
43	Mixed forest	6	15,433	5
42	Evergreen forest	7	2,342	5
17	Extractive	8	864	0
24	Agricultural building breeding and training	9	141	0
25	Row and garden crops	9	47	0
50	Water	9	534	0
60	Wetlands	9	234	0
80	Transportation	9	2,273	0
71	Beaches	9	58	0
			68,152	

Table 27 Greenfield Development Parameters for Patuxent Trend Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.0%	0.5
102	Large Lot Subdivision (Forest)	0.05	0.1%	0.5
11	Residential Low	2	17.2%	17.2
12	Residential Medium	5	47.9%	47.9
13	Residential High	16	34.5%	23.9
129	Mixed Use Residential	8	0.0%	10.0
18	Open urban land	0.15	0.2%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	59.2%	44.1
149	Mixed Use Commercial	0.41	0.0%	10.0
15	Industrial	0.31	23.4%	23.4
16	Institutional	0.41	17.5%	17.5
129	Mixed Use Residential	1	0.0%	5.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	2,883	90
44	Brush	2	2,093	75
21	Cropland	3	16,298	10
22	Pasture	4	5,243	10
41	Deciduous forest	5	44,134	5
43	Mixed forest	6	14,196	5
42	Evergreen forest	7	1,203	5
17	Extractive	8	832	0
24	Agricultural building breeding and training	9	58	0
25	Row and garden crops	9	213	0
50	Water	9	868	0
60	Wetlands	9	2,458	0
80	Transportation	9	1,300	0
71	Beaches	9	0	0
			90,478	

Table 28 Greenfield Development Parameters for Patuxent Ideal Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.0%	1.0
102	Large Lot Subdivision (Forest)	0.05	0.1%	1.0
11	Residential Low	2	17.2%	5.0
12	Residential Medium	5	47.9%	20.0
13	Residential High	16	34.5%	25.0
129	Mixed Use Residential	8	0.0%	48.0
18	Open urban land	0.15	0.2%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	59.2%	10.0
149	Mixed Use Commercial	0.41	0.0%	60.0
15	Industrial	0.31	23.4%	2.0
16	Institutional	0.41	17.5%	8.0
129	Mixed Use Residential	1	0.0%	20.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	2,883	90
44	Brush	2	2,093	65
21	Cropland	3	16,298	5
22	Pasture	4	5,243	5
41	Deciduous forest	5	44,134	5
43	Mixed forest	6	14,196	5
42	Evergreen forest	7	1,203	5
17	Extractive	8	832	0
24	Agricultural building breeding and training	9	58	0
25	Row and garden crops	9	213	0
50	Water	9	868	0
60	Wetlands	9	2,458	0
80	Transportation	9	1,300	0
71	Beaches	9	0	0
			90,478	

Table 29 Greenfield Development Parameters for Piscataway Trend Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.01%	0.01
102	Large Lot Subdivision (Forest)	0.05	0.10%	0.10
11	Residential Low	2	17.3%	17.3
12	Residential Medium	5	72.1%	67.5
13	Residential High	16	10.1%	10.1
129	Mixed Use Residential	8	0.0%	5.0
18	Open urban land	0.15	0.3%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	47.9%	20.0
149	Mixed Use Commercial	0.41	0.0%	20.0
15	Industrial	0.31	4.0%	10.0
16	Institutional	0.41	48.1%	40.0
129	Mixed Use Residential	1	0.0%	10.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	907	80
44	Brush	2	446	70
21	Cropland	3	3,042	50
22	Pasture	4	1,083	50
41	Deciduous forest	5	12,797	5
43	Mixed forest	6	3,598	5
42	Evergreen forest	7	616	5
17	Extractive	8	193	0
24	Agricultural building breeding and training	9	58	0
25	Row and garden crops	9	19	0
50	Water	9	123	0
60	Wetlands	9	72	0
80	Transportation	9	324	0
71	Beaches	9	0	0
			22,955	

Table 30 Greenfield Development Parameters for Piscataway Ideal Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.01%	0.01
102	Large Lot Subdivision (Forest)	0.05	0.10%	0.10
11	Residential Low	2	17.3%	10.0
12	Residential Medium	5	72.1%	25.0
13	Residential High	16	10.1%	29.9
129	Mixed Use Residential	8	0.0%	35.0
18	Open urban land	0.15	0.3%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	47.9%	10.0
149	Mixed Use Commercial	0.41	0.0%	20.0
15	Industrial	0.31	4.0%	10.0
16	Institutional	0.41	48.1%	40.0
129	Mixed Use Residential	1	0.0%	20.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	907	80
44	Brush	2	446	70
21	Cropland	3	3,042	50
22	Pasture	4	1,083	50
41	Deciduous forest	5	12,797	5
43	Mixed forest	6	3,598	5
42	Evergreen forest	7	616	5
17	Extractive	8	193	0
24	Agricultural building breeding and training	9	58	0
25	Row and garden crops	9	19	0
50	Water	9	123	0
60	Wetlands	9	72	0
80	Transportation	9	324	0
71	Beaches	9	0	0
			22,955	

Table 31: Greenfield Development Parameters for Western Branch Trend Scenario				
LU Code	**Description**	**DU Density**	**Existing Percent of Population**	**Target Percent New Population**
101	Large Lot Subdivision (Agriculture)	0.05	0.01%	0.0
102	Large Lot Subdivision (Forest)	0.05	0.03%	0.03
11	Residential Low	2	10.6%	10.6
12	Residential Medium	5	50.5%	40.5
13	Residential High	16	38.7%	28.9
129	Mixed Use Residential	8	0.0%	20.0
18	Open urban land	0.15	0.2%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	**Description**	**FAR**	**Existing Percent of Employment**	**Target Percent New Employment GFA**
14	Commercial	0.41	55.1%	39.1
149	Mixed Use Commercial	0.41	0.0%	10.0
15	Industrial	0.31	27.2%	23.4
16	Institutional	0.41	17.7%	17.5
129	Mixed Use Residential	1	0.0%	10.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	**Description**	**Order of Development**	**Total Area**	**Maximum Utilization Percent**
73	Bare ground	1	1,628	90
44	Brush	2	1,185	75
21	Cropland	3	5,183	50
22	Pasture	4	1,900	50
41	Deciduous forest	5	17,569	5
43	Mixed forest	6	725	5
42	Evergreen forest	7	135	5
17	Extractive	8	0	0
24	Agricultural building breeding and training	9	33	0
25	Row and garden crops	9	36	0
50	Water	9	273	0
60	Wetlands	9	143	0
80	Transportation	9	706	0
71	Beaches	9	0	0
			28,810	

Table 32: Greenfield Development Parameters for Western Branch Ideal Scenario				
LU Code	Description	DU Density	Existing Percent of Population	Target Percent New Population
101	Large Lot Subdivision (Agriculture)	0.05	0.01%	0.0
102	Large Lot Subdivision (Forest)	0.05	0.03%	0.00
11	Residential Low	2	10.6%	0.0
12	Residential Medium	5	50.5%	25.0
13	Residential High	16	38.7%	40.0
129	Mixed Use Residential	8	0.0%	35.0
18	Open urban land	0.15	0.2%	0.0
			100.0%	**100.0**
Nonresidential (Employment)				
LU Code	Description	FAR	Existing Percent of Employment	Target Percent New Employment GFA
14	Commercial	0.41	55.1%	20.0
149	Mixed Use Commercial	0.41	0.0%	20.0
15	Industrial	0.31	27.2%	10.0
16	Institutional	0.41	17.7%	25.0
129	Mixed Use Residential	1	0.0%	25.0
			100.0%	**100.0**
Priority Order of Conversion to Greenfield Development				
LU Code	Description	Order of Development	Total Area	Maximum Utilization Percent
73	Bare ground	1	1,628	80
44	Brush	2	1,185	70
21	Cropland	3	5,183	50
22	Pasture	4	1,900	50
41	Deciduous forest	5	17,569	5
43	Mixed forest	6	725	5
42	Evergreen forest	7	135	5
17	Extractive	8	0	0
24	Agricultural building breeding and training	9	33	0
25	Row and garden crops	9	36	0
50	Water	9	273	0
60	Wetlands	9	143	0
80	Transportation	9	706	0
71	Beaches	9	0	0
			28,810	

LAND USE RESULTS

The descriptions and tables on the following pages outline the changes in land use associated with the 2030 trend and ideal scenarios as compared to the 2007 baseline data for each subwatershed. The changes in percentage of each land use category are indicated as well, drawing attention to the shifts in land use necessary under each scenario to accommodate the projected level of population and employment growth.

Potomac Watershed

Based on county existing land use information, the Potomac watershed is largely built up with an average medium density residential with denser developments around Metro stops. Industrial and commercial uses occur along key corridors such as US 1, US 50 and MD 4. The central portion of the watershed lies under the county's Developed Tier classification while most portions of the northern and southern parts are classified under the Developing Tier. A small portion of the watershed in the north is classified under the Rural Tier and incorporates the rural, very low density development.

According to county projections, the Potomac watershed will experience population increase of 84,858 and an employment increase of 116,181 persons by 2030. The county future land use plan for the Potomac watershed includes some major new developments such as Brandywine but also emphasizes smart growth concepts for intensification of uses along corridors and nodes organized mostly around transit opportunities. The general intent of the plans reviewed confirms the development pattern is intended to follow the tiers—with the Developing Tier experiencing most of the new growth and the Developed Tier absorbing infill and redevelopment.

FUTURE LAND USE SCENARIOS

The trend scenario for Potomac watershed assumes that five percent of the population growth will be accommodated as infill and 15 percent as redevelopment. The areas of redevelopment and infill will predominantly be around the corridors and nodes. New areas of development will largely be in the southern Developing Tier. This scenario projects that around 10,925 acres of new land, or around 7.2 percent of the watershed land area, would be required to accommodate the population growth. Table 33 provides the land use results for the Potomac trend scenario.

The ideal scenario is based on more aggressive and optimistic assumptions on following the future land use patterns and the nodes and corridor concepts promoted in the General Plan. The scenario assumes that 20 percent of the growth will be absorbed as infill and 50 percent of the growth will be absorbed as redevelopment. This redevelopment will largely occur along the highway corridors, the Beltway, MARC and Metro stations, and other nodes and transform low density and industrial uses to more medium density and mixed-use patterns. The ideal scenario requires 3,555 acres to accommodate new development or 2.3 percent of the watershed area, but requires nearly 1,888 acres to be redeveloped and transformed. The ideal scenario proposes an overall higher average density of development (12.5 DU/acre) than the trend scenario (5.5 DU/acre) promoting a more compact development than the existing pattern. Table 34 provides the land use results for the Potomac ideal scenario.

Table 33: Potomac Trend Scenario Land Use Results						
LU Code	**Land Use Description**	**Potomac**		**Potomac**		**Change in Percentage**
		Existing Acres	**Percent**	**2030 Acres**	**Percent**	
101	Rural (Agriculture)	325	0.21	400	0.26	0.05
102	Rural (Forest)	3,194	2.11	3,269	2.16	0.05
11	Residential Low	11,029	7.27	11,800	7.78	0.51
12	Residential Medium	31,643	20.87	33,946	22.39	1.52
13	Residential High	8,852	5.84	9,489	6.26	0.42
129	Mixed Use Residential	0	0.00	417	0.28	0.28
14	Commercial	5,904	3.89	6,760	4.46	0.56
149	Mixed Use Commercial	0	0.00	232	0.15	0.15
15	Industrial	4,272	2.82	7,012	4.62	1.81
16	Institutional	10,441	6.89	12,292	8.11	1.22
18	Parks & Open Space	5,468	3.61	5,978	3.94	0.34
21	Cropland	7,318	4.83	2,927	1.93	-2.90
22	Pasture	3,624	2.39	3,261	2.15	-0.24
24	Agriculture Facilities	141	0.09	141	0.09	0.00
25	Row and Garden Crops	47	0.03	47	0.03	0.00
41	Deciduous Forest	33,282	21.95	31,618	20.85	-1.10
42	Evergreen Forest	2,342	1.54	2,342	1.54	0.00
43	Mixed Forest	15,433	10.18	15,128	9.98	-0.20
44	Brush	1,042	0.69	261	0.17	-0.52
50	Water	534	0.35	534	0.35	0.00
60	Wetlands	234	0.15	234	0.15	0.00
73	Bare ground	3,292	2.17	329	0.22	-1.95
71	Beaches	58	0.04	58	0.04	0.00
17	Mining	864	0.57	864	0.57	0.00
80	Transportation	2,273	1.50	2,273	1.50	0.00
Total		**151,609**	**100.0**	**151,609**	**100**	**0**

Table 34: Potomac Ideal Scenario Land Use Results						
LU Code	**Land Use Description**	**Potomac**		**Potomac**		**Change in Percentage**
		Existing Acres	**Percent**	**2030 Acres**	**Percent**	
101	Rural (Agriculture)	325	0.21	239	0.16	-0.06
102	Rural (Forest)	3,194	2.11	3,108	2.05	-0.06
11	Residential Low	11,029	7.27	10,618	7.00	-0.27
12	Residential Medium	31,643	20.87	31,841	21.00	0.13
13	Residential High	8,852	5.84	9,538	6.29	0.45
129	Mixed Use Residential	0	0.00	751	0.50	0.50
14	Commercial	5,904	3.89	5,866	3.87	-0.03
149	Mixed Use Commercial	0	0.00	1,068	0.70	0.70
15	Industrial	4,272	2.82	4,059	2.68	-0.14
16	Institutional	10,441	6.89	11,617	7.66	0.78
18	Parks & Open Space	5,468	3.61	5,978	3.94	0.34
21	Cropland	7,318	4.83	6,952	4.59	-0.24
22	Pasture	3,624	2.39	3,442	2.27	-0.12
24	Agriculture Facilities	141	0.09	141	0.09	0.00
25	Row and Garden Crops	47	0.03	47	0.03	0.00
41	Deciduous Forest	33,282	21.95	33,169	21.88	-0.07
42	Evergreen Forest	2,342	1.54	2,342	1.54	0.00
43	Mixed Forest	15,433	10.18	15,433	10.18	0.00
44	Brush	1,042	0.69	782	0.52	-0.17
50	Water	534	0.35	534	0.35	0.00
60	Wetlands	234	0.15	234	0.15	0.00
73	Bare ground	3,292	2.17	658	0.43	-1.74
71	Beaches	58	0.04	58	0.04	0.00
17	Mining	864	0.57	864	0.57	0.00
80	Transportation	2,273	1.50	2,273	1.50	0.00
Total		**151,609**	**100.0**	**151,609**	**100**	**0**

Patuxent Watershed

Based on county land use information, the Patuxent watershed's existing developed land use consists of mostly low density to rural uses with the exception of the Western Branch subwatershed that has a denser, more conventional suburban character. The Patuxent watershed has a nearly equal division between the Developing and Rural Tiers.

According to county projections, the Patuxent watershed will experience a population increase of 55,129 and an employment increase of 54,322 persons by 2030. The county future land use plan for Patuxent shows development mostly focused in the Developing Tier portion in central and upper-central portions of the Patuxent watershed. The remaining areas remain largely rural with some growth in the Upper Marlboro area.

FUTURE LAND USE SCENARIOS

The trend scenario for Patuxent assumes that five percent of the population growth will be accommodated as infill and ten percent as redevelopment. This rationale assumes that the majority of development will occur as new development largely in the Developing Tier. The trend scenario requires 9,278 acres to accommodate new development or 5.9 percent of the watershed area. Table 35 provides the land use results for the Patuxent trend scenario.

The ideal scenario is based on more aggressive and optimistic assumptions that future growth will follow the priority corridor concepts promoted in the General Plan. The scenario assumes that eight percent of the growth will be absorbed as infill and 30 percent of the growth will be absorbed as redevelopment. This redevelopment will largely occur along the Beltway and Largo Town Center and around MARC stations, transforming low density and industrial uses to more medium density and mixed-use patterns. New development will focus on Westphalia and new suburbs on the eastern portion of the Western Branch subwatershed. The ideal scenario requires 7,904 acres to accommodate new development or 5.0 percent of the watershed area. The ideal scenario proposes an overall slightly higher average density of new development (2.4 DU/acre) than the trend scenario (2.0 DU/acre). Table 36 provides the land use results for the Patuxent ideal scenario.

Table 35: Patuxent Trend Scenario Land Use Results						
LU Code	Land Use Description	Patuxent		Patuxent		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	1,796	1.14	3,368	2.13	1.00
102	Rural (Forest)	5,627	3.57	7,245	4.59	1.03
11	Residential Low	18,745	11.88	20,125	12.76	0.87
12	Residential Medium	20,861	13.22	22,412	14.21	0.98
13	Residential High	4,690	2.97	4,992	3.16	0.19
129	Mixed Use Residential	0	0.00	236	0.15	0.15
14	Commercial	3,612	2.29	3,969	2.52	0.23
149	Mixed Use Commercial	0	0.00	134	0.09	0.09
15	Industrial	4,062	2.57	5,147	3.26	0.69
16	Institutional	4,096	2.60	4,805	3.05	0.45
18	Parks & Open Space	2,478	1.57	2,808	1.78	0.21
21	Cropland	16,298	10.33	14,669	9.30	-1.03
22	Pasture	5,243	3.32	4,719	2.99	-0.33
24	Agriculture Facilities	58	0.04	58	0.04	0.00
25	Row and Garden Crops	213	0.13	213	0.13	0.00
41	Deciduous Forest	44,134	27.98	41,928	26.58	-1.40
42	Evergreen Forest	1,203	0.76	1,164	0.74	-0.02
43	Mixed Forest	14,196	9.00	13,486	8.55	-0.45
44	Brush	2,093	1.33	523	0.33	-0.99
50	Water	868	0.55	868	0.55	0.00
60	Wetlands	2,458	1.56	2,458	1.56	0.00
73	Bare ground	2,883	1.83	288	0.18	-1.64
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	832	0.53	832	0.53	0.00
80	Transportation	1,300	0.82	1,300	0.82	0.00
Total		**157,746**	**100.0**	**157,746**	**100**	**0**

Table 36: Patuxent Ideal Scenario Land Use Results						
LU Code	Land Use Description	Patuxent		Patuxent		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	1,796	1.14	4,175	2.65	1.51
102	Rural (Forest)	5,627	3.57	8,040	5.10	1.53
11	Residential Low	18,745	11.88	18,906	11.99	0.10
12	Residential Medium	20,861	13.22	21,344	13.53	0.31
13	Residential High	4,690	2.97	5,057	3.21	0.23
129	Mixed Use Residential	0	0.00	794	0.50	0.50
14	Commercial	3,612	2.29	3,524	2.23	-0.06
149	Mixed Use Commercial	0	0.00	679	0.43	0.43
15	Industrial	4,062	2.57	4,012	2.54	-0.03
16	Institutional	4,096	2.60	4,531	2.87	0.28
18	Parks & Open Space	2,478	1.57	2,808	1.78	0.21
21	Cropland	16,298	10.33	15,483	9.82	-0.52
22	Pasture	5,243	3.32	4,981	3.16	-0.17
24	Agriculture Facilities	58	0.04	58	0.04	0.00
25	Row and Garden Crops	213	0.13	213	0.13	0.00
41	Deciduous Forest	44,134	27.98	41,928	26.58	-1.40
42	Evergreen Forest	1,203	0.76	1,203	0.76	0.00
43	Mixed Forest	14,196	9.00	13,530	8.58	-0.42
44	Brush	2,093	1.33	732	0.46	-0.86
50	Water	868	0.55	868	0.55	0.00
60	Wetlands	2,458	1.56	2,458	1.56	0.00
73	Bare ground	2,883	1.83	288	0.18	-1.64
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	832	0.53	832	0.53	0.00
80	Transportation	1,300	0.82	1,300	0.82	0.00
Total		**157,746**	**100.0**	**157,746**	**100**	**0**

Piscataway Watershed

Based on county land use information, the Piscataway watershed has an existing developed land use of mostly medium to low density residential with portions of Joint Base Andrews (institutional) and commercial uses along the northern portion of MD 5 (Branch Avenue). A large portion of the watershed remains undeveloped or under very low density rural development.

According to county projections, Piscataway watershed will have a population increase of 14,339 and an employment increase of 5,574 persons by 2030. The county future land use plan for Piscataway shows development mostly focused along the entire stretch of Branch Avenue (MD 5) and portions of MD 210. The Brandywine proposed development in the southern portion of the watershed is a major mixed-use development along Branch Avenue. Other locations of expansion and redevelopment include areas around of Joint Base Andrews, which are expected to grow in the near future. The general intent of the plans reviewed suggests that a low-medium suburban form of development will occur along corridors and that a substantial portion of the watershed will be maintained with a rural character.

FUTURE LAND USE SCENARIOS

The trend scenario for Piscataway assumes that five percent of the population growth will be accommodated as infill and ten percent as redevelopment. This rationale assumes that the majority of development will occur as new development because redevelopment opportunities are relatively limited along the Branch Avenue corridor. This scenario projects that around 1,400 acres of new land, or around 3.5 percent of the watershed land area, would be required to accommodate the population growth. Table 37 provides the land use results for the Piscataway trend scenario.

The ideal scenario is based on more aggressive and optimistic assumptions on following the priority corridor concepts promoted in the General Plan. The scenario assumes that ten percent of the growth will be absorbed as infill and 25 percent of the growth will be absorbed as redevelopment. This redevelopment will largely occur along the Branch Avenue corridor and around of Joint Base Andrews, transforming low density and industrial uses to medium density and mixed-use patterns to a greater degree than was deemed possible under the trend scenario. The ideal scenario requires 878 acres to accommodate new development or two percent of the watershed area. The ideal scenario proposes an overall higher average density of development (6.8 DU/acre) than the trend scenario (4.2 DU/acre) due to focusing development along the main corridors of MD 5 and MD 210. Table 38 provides the land use results for the Piscataway ideal scenario.

Table 37: Piscataway Trend Scenario Land Use Results						
LU Code	Land Use Description	Piscataway		Piscataway		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	97	0.23	94	0.22	-0.01
102	Rural (Forest)	1,087	2.53	1,171	2.73	0.20
11	Residential Low	4,822	11.23	5,171	12.04	0.81
12	Residential Medium	8,020	18.68	8,601	20.03	1.36
13	Residential High	352	0.82	393	0.92	0.09
129	Mixed Use Residential	0	0.00	40	0.09	0.09
14	Commercial	845	1.97	850	1.98	0.01
149	Mixed Use Commercial	0	0.00	25	0.06	0.06
15	Industrial	200	0.47	250	0.58	0.12
16	Institutional	3,259	7.59	3,443	8.02	0.43
18	Parks & Open Space	973	2.27	1,059	2.47	0.20
21	Cropland	3,042	7.09	2,638	6.14	-0.94
22	Pasture	1,083	2.52	1,083	2.52	0.00
24	Agriculture Facilities	58	0.14	58	0.14	0.00
25	Row and Garden Crops	19	0.04	19	0.04	0.00
41	Deciduous Forest	12,797	29.81	12,797	29.81	0.00
42	Evergreen Forest	616	1.44	616	1.44	0.00
43	Mixed Forest	3,598	8.38	3,598	8.38	0.00
44	Brush	446	1.04	134	0.31	-0.73
50	Water	123	0.29	123	0.29	0.00
60	Wetlands	72	0.17	72	0.17	0.00
73	Bare ground	907	2.11	181	0.42	-1.69
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	193	0.45	193	0.45	0.00
80	Transportation	324	0.75	324	0.75	0.00
Total		**42,933**	**100.0**	**42,933**	**100**	**0**

Table 38: Piscataway Ideal Scenario Land Use Results						
LU Code	Land Use Description	Piscataway		Piscataway		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	97	0.23	79	0.18	-0.04
102	Rural (Forest)	1,087	2.53	1,153	2.69	0.15
11	Residential Low	4,822	11.23	4,938	11.50	0.27
12	Residential Medium	8,020	18.68	8,185	19.07	0.39
13	Residential High	352	0.82	453	1.06	0.23
129	Mixed Use Residential	0	0.00	163	0.38	0.38
14	Commercial	845	1.97	833	1.94	-0.03
149	Mixed Use Commercial	0	0.00	30	0.07	0.07
15	Industrial	200	0.47	204	0.48	0.01
16	Institutional	3,259	7.59	3,435	8.00	0.41
18	Parks & Open Space	973	2.27	1,059	2.47	0.20
21	Cropland	3,042	7.09	3,042	7.09	0.00
22	Pasture	1,083	2.52	1,083	2.52	0.00
24	Agriculture Facilities	58	0.14	58	0.14	0.00
25	Row and Garden Crops	19	0.04	19	0.04	0.00
41	Deciduous Forest	12,797	29.81	12,797	29.81	0.00
42	Evergreen Forest	616	1.44	616	1.44	0.00
43	Mixed Forest	3,598	8.38	3,598	8.38	0.00
44	Brush	446	1.04	295	0.69	-0.35
50	Water	123	0.29	123	0.29	0.00
60	Wetlands	72	0.17	72	0.17	0.00
73	Bare ground	907	2.11	181	0.42	-1.69
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	193	0.45	193	0.45	0.00
80	Transportation	324	0.75	324	0.75	0.00
Total		**42,933**	**100.0**	**42,933**	**100**	**0**

Western Branch Watershed

Based on county existing land use information, the Western Branch watershed has a distinct development pattern with high and medium density residential and denser commercial and industrial uses predominantly along the I-495 Beltway and Largo Town Center, low to medium density suburban residential in the north and northeastern portions, and more rural and low density residential in the southern portions of the watershed.

According to county projections, the Western Branch watershed has a projected population increase of 39,891 and an employment increase of 36,278 persons by 2030. The Western Branch watershed will accommodate a majority of the growth projected for the larger Patuxent watershed. The county future land use plan for Western Branch shows several new large developments planned for this area. In the southern portion, the Westphalia proposed development includes medium-high to medium density residential as well as mixed-use developments around a potential new Metro stop. In the northern portion, there is potential for transit oriented development (TOD) around the MARC stations. Other areas to the east show substantial expansion of institutional uses in the watershed as well as growth in the Upper Marlboro area. The general intent of the plans reviewed suggests that most of the watershed will be built out with denser urban areas on the west transitioning to a low density suburban character to the east.

FUTURE LAND USE SCENARIOS

The trend scenario for Western Branch assumes that five percent of the population growth will be accommodated as infill and 15 percent as redevelopment. The areas of redevelopment and infill will predominantly be around the Beltway, but a majority of growth will occur as new development in Westphalia and other expansion areas. This scenario projects that around 3,691 acres of new land, or around 6.2 percent of the watershed land area, would be required to accommodate the population growth. Table 39 provides the land use results for the Western Branch trend scenario.

The ideal scenario is based on more aggressive and optimistic assumptions on following the future land use and the nodes and corridor concepts promoted in the General Plan. The scenario assumes that ten percent of the growth will be absorbed as infill and 50 percent of the growth will be absorbed as redevelopment. This redevelopment will largely occur along the Beltway, MARC stations and other nodes and transform low density and industrial uses to more medium density and mixed-use patterns. The ideal scenario requires 2,050 acres to accommodate new development or 3.5 percent of the watershed area, but requires nearly 980 acres to be redeveloped and transformed. The ideal scenario proposes an overall higher average density of development (11 DU/acre) than the trend scenario (6.2 DU/acre) promoting a more compact development than the existing pattern. Table 40 provides the land use results for the Western Branch ideal scenario.

Table 39: Western Branch Trend Scenario Land Use Results						
LU Code	Land Use Description	Western Branch		Western Branch		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	247	0.42	192	0.32	-0.09
102	Rural (Forest)	672	1.13	737	1.24	0.11
11	Residential Low	6,087	10.26	6,646	11.21	0.94
12	Residential Medium	11,619	19.59	12,557	21.17	1.58
13	Residential High	2,780	4.69	3,038	5.12	0.43
129	Mixed Use Residential	0	0.00	288	0.49	0.49
14	Commercial	1,929	3.25	2,111	3.56	0.31
149	Mixed Use Commercial	0	0.00	104	0.18	0.18
15	Industrial	2,711	4.57	3,324	5.60	1.03
16	Institutional	2,377	4.01	2,876	4.85	0.84
18	Parks & Open Space	1,362	2.30	1,601	2.70	0.40
21	Cropland	5,183	8.74	3,848	6.49	-2.25
22	Pasture	1,900	3.20	1,900	3.20	0.00
24	Agriculture Facilities	33	0.06	33	0.06	0.00
25	Row and Garden Crops	36	0.06	36	0.06	0.00
41	Deciduous Forest	17,569	29.63	17,569	29.63	0.00
42	Evergreen Forest	135	0.23	135	0.23	0.00
43	Mixed Forest	725	1.22	725	1.22	0.00
44	Brush	1,185	2.00	296	0.50	-1.50
50	Water	273	0.46	273	0.46	0.00
60	Wetlands	143	0.24	143	0.24	0.00
73	Bare ground	1,628	2.75	163	0.27	-2.47
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	0	0.00	0	0.00	0.00
80	Transportation	706	1.19	706	1.19	0.00
Total		**59,302**	**100.0**	**59,302**	**100**	**0**

Table 40: Western Branch Ideal Scenario Land Use Results						
LU Code	Land Use Description	Western Branch		Western Branch		Change in Percentage
		Existing Acres	Percent	2030 Acres	Percent	
101	Rural (Agriculture)	247	0.42	51	0.09	-0.33
102	Rural (Forest)	672	1.13	672	1.13	0.00
11	Residential Low	6,087	10.26	5,891	9.93	-0.33
12	Residential Medium	11,619	19.59	11,915	20.09	0.50
13	Residential High	2,780	4.69	3,143	5.30	0.61
129	Mixed Use Residential	0	0.00	506	0.85	0.85
14	Commercial	1,929	3.25	1,886	3.18	-0.07
149	Mixed Use Commercial	0	0.00	219	0.37	0.37
15	Industrial	2,711	4.57	2,659	4.48	-0.09
16	Institutional	2,377	4.01	3,294	5.55	1.54
18	Parks & Open Space	1,362	2.30	1,601	2.70	0.40
21	Cropland	5,183	8.74	5,183	8.74	0.00
22	Pasture	1,900	3.20	1,900	3.20	0.00
24	Agriculture Facilities	33	0.06	33	0.06	0.00
25	Row and Garden Crops	36	0.06	36	0.06	0.00
41	Deciduous Forest	17,569	29.63	17,569	29.63	0.00
42	Evergreen Forest	135	0.23	135	0.23	0.00
43	Mixed Forest	725	1.22	725	1.22	0.00
44	Brush	1,185	2.00	438	0.74	-1.26
50	Water	273	0.46	273	0.46	0.00
60	Wetlands	143	0.24	143	0.24	0.00
73	Bare ground	1,628	2.75	326	0.55	-2.20
71	Beaches	0	0.00	0	0.00	0.00
17	Mining	0	0.00	0	0.00	0.00
80	Transportation	706	1.19	706	1.19	0.00
Total		**59,302**	**100.0**	**59,302**	**100**	**0**

Land Use Scenario Summary

The results of the trend and ideal scenarios by watershed served to validate the original hypothesis that greater emphasis on mixed-use and higher density development would allow for accommodation of the projected population and employment growth via conversion of fewer greenfield acres and preservation of a higher percentage of green infrastructure assets. The difference is most striking with respect to the Potomac watershed, where the newly developed acreage under the ideal scenario is less than half that of the trend.

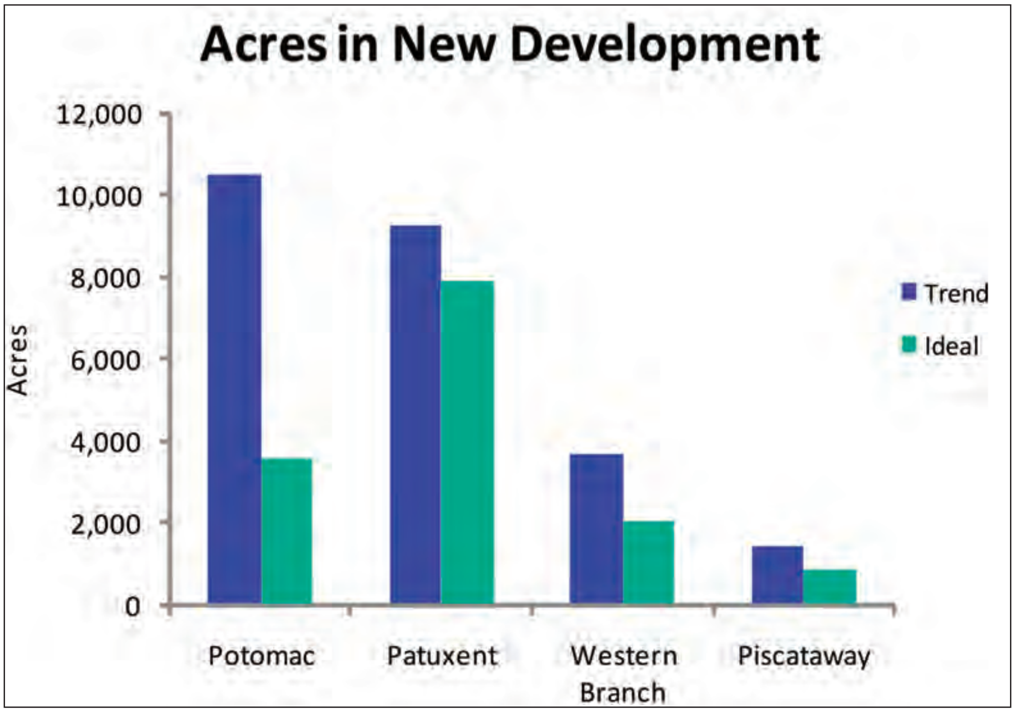
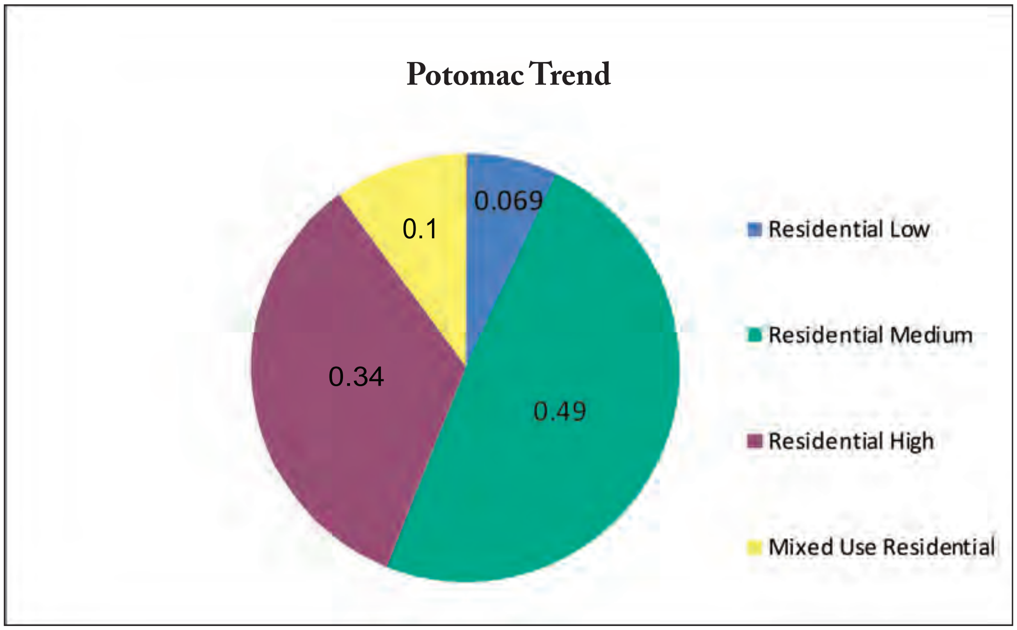


Figure 2: Greenfield development acreage by subwatershed, trend, and ideal.

A combination of factors makes possible the significant reduction in the land requirement for the Potomac, notably the aggressive infill and redevelopment targets already discussed for the Potomac watershed. In addition, the target residential and employment land uses for greenfield development make more efficient use of the land available possible. For instance, whereas the trend scenario specified that ten percent of the greenfield growth in residential population be in the form of mixed-use residential land use, the target for the ideal scenario is 50 percent. The dwelling unit densities associated with the shift in emphasis from low and medium density residential growth to high and mixed-use residential growth result in a significant reduction in associated acreage to accommodate the identical population growth.



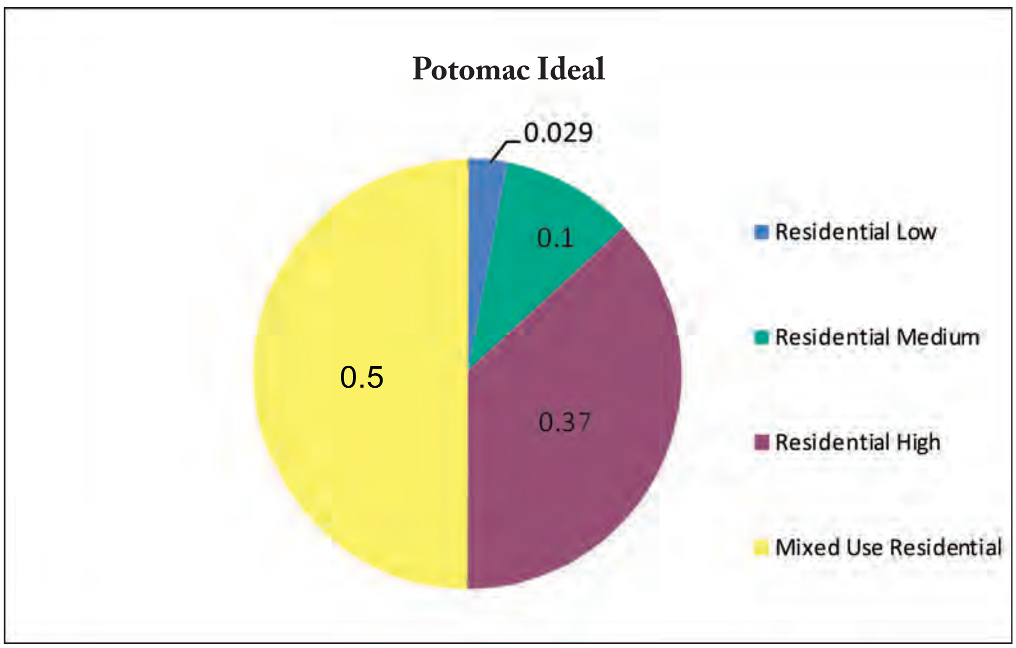


Figure 3. Greenfield residential land use targets, potomac trend and ideal scenarios.

In tandem with the reduction in new development described above, the ideal scenarios allowed for a greater degree of conservation of green infrastructure acreage. In each case, the ideal scenario resulted in preservation of additional quantities of forested and pasture areas as compared to the trend. Conservation goals go hand in hand with more compact development.

Significance for the Water Resources Plan

Although the differences in newly developed acres under the two scenarios are striking, it is important to place this in the context of the county as a whole. The total county land area is over 300,000 acres, and while the Potomac watershed ideal scenario results in nearly 7,000 fewer acres of new development as opposed to the trend scenario, this difference represents a relatively small percentage of the total land area in the county.

The benefits of more compact development are many and varied, including reduced requirements for infrastructure investment and conservation of forests and viable agriculture lands. Although the amount of land required to meet new development to 2030 may be small in the context of the many thousands of acres developed to date, incremental improvements are a valuable component of a viable long-term development plan. Findings from the land use analysis emphasize the need for a multifaceted approach that addresses not only new development, but redevelopment and existing development.

SEPTIC SYSTEM DATA INPUT

The number of residential septic systems included in the 2007 initial conditions scenario was based on the number of households in non-sewered areas, as reflected in the county's 2005 population information, and the county's 2030 population projections provided the number of households in non-sewered areas for the future 2030 land use scenarios. The number of households from the population data was allocated to the county's watersheds, resulting in septic system data inputs of 8,661 current versus 10,117 future households in the Patuxent watershed, and 7,423 current versus 9,295 future households in the Potomac watershed. The nitrogen loads from septic systems were calculated using an estimated load per equivalent dwelling unit (EDU), as described in the Load Rate Data Inputs Section, below.

The number of nonresidential septic systems included in the 2007 initial conditions scenario was based on the number of employees in non-sewered areas, as reflected in the county's 2005 population information, and the county's 2030 population projections provided the number of employees in non-sewered areas for the future 2030 land use scenarios. The number of employees from the population data was allocated to the county's watersheds, resulting in septic system data inputs of 5,317 current versus 12,721 future employees in the Patuxent watershed and 12,402 current versus 16,276 future employees in the Potomac watershed. The method of estimating nonresidential septic loads provided by MDE in the Water Resources Plan model is based on estimated nonresidential septic flow per nonresidential acre. Because the county's GIS system used for future land use projections does not delineate nonresidential acres in non-sewered areas, this method was not applicable for future load estimates. Therefore, the county's available data reflecting the number of employees outside the sewer envelope were used with a conversion factor to estimate nitrogen loads based on factors provided in the MDE Water Resources Plan model as well as data provided by WSSC, as described in more detail in the Load Rate Data Inputs section, below.

The majority of residential and nonresidential septic systems are located in Rural Tier which is delineated fairly closely with the sewer envelope as illustrated in Maps 2 and 7 in Chapter IV. However, county planning information indicates a few small areas served by individual systems inside the sewer envelope, most notably in the 6-digit Western Branch, Washington Metro and Oxon Hill subwatersheds. The systems inside and outside the sewer envelope were included as inputs to the non-point source loading model described in subsequent sections.

POINT SOURCE LOAD DATA INPUT

An evaluation of the six major wastewater treatment plants (WWTPs) located within Prince George's County was conducted to develop point source loads for total nitrogen and total phosphorus for the initial and future scenarios. These WWTPs are identified in Table 41.

As shown in Table 41, the loads from the six major wastewater treatment plants in Prince George's County are projected to be near their ultimate nutrient load capacities in the year 2030.

LOADING RATE DATA INPUTS

To conduct the nonpoint source loading analysis, nitrogen and phosphorus loading rates (pounds per acre per year) were applied to the land use categories used in the initial and future land use scenarios described above. Generally, the "2002 BMP implementation" and full "tributary strategy implementation" nitrogen and phosphorus loading rates and percent of impervious covers provided by MDE for the Water Resources Plan's pollutant load analysis spreadsheet were used for the Planning Department's analysis. However, the following modifications to the MDE loading rates were made to reflect new land use categories contained in the state's 2007 land use dataset, the mixed-use categories discussed above, and knowledge of local conditions in Prince George's County:

- 129—Mixed-Use Residential (Prince George's County Land Use Code): The pervious versus impervious loading rates are the same for each of the developed land uses in the MDE model, but the total loading rate is calculated by applying the percent of impervious area from each LUC to determine the relative weight of the pervious versus impervious portions of the load. Therefore, creation of a new loading rate requires determination of the appropriate percent impervious to be applied to the developed LUC loading rates. The loading rate for the 129—Urban Mixed-Use Residential category was created using an impervious factor to reflect the following land use allocations: 20 percent LUC 13 Residential High; 50 percent LUC 14 Commercial; and 20 percent LUC 18 Urban Open Land. In addition, a ten percent undeveloped area was included as LUC 44 Brush. In reality, the development mix may more closely approximate 50 percent residential versus 20 percent commercial use, but the purpose in creation of this category was the generation of an impervious profile that would be expected with this type of development (i.e., >= 45 percent).
- 129s—Mixed Use Residential—Smart Growth: This loading rate for this suburban mixed-use residential category was calculated using the same approach as described above for LUC 129, using an impervious factor to reflect the following land use allocations: 20 percent LUC Residential Medium; 22 percent LUC 13 Residential High; 10 percent LUC 14 Commercial; 8 percent LUC 16 Institutional; 10 percent

Table 41. Estimated Current and Future Point Source Nitrogen and Phosphorus Loads							
Major Wastewater Treatment Plant	Discharge Location/ Sub-Watershed	2005		2030		Chesapeake Bay Program Limit	
		TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
Patuxent Below Fall Watershed							
Parkway WWTP[1]	Patuxent River/ Upper Patuxent	63,557	3,890	82,800	6,210	91,370	6,850
Bowie WWTP[2]	Unnamed Tributary of Patuxent River/ Upper Patuxent	34,525	1,225	40,201	3,015	40,201	3,015
Western Branch WWTP[1]	Western Branch/ Western Branch	86,663	29,677	340,940	25,570	372,600	27,945
Marlboro Meadows WWTP[1]	Unnamed Tributary of Patuxent River/ Western Branch	12,490	1,038	---	---	---	---
Total Patuxent Point Source Load		**197,235**	**35,830**	**463,941**	**34,795**	**504,171**	**37,810**
Potomac Below Fall Watershed							
Piscataway WWTP[1]	Potomac River/Piscataway	191,776	6,941	328,763	14,794	365,300	16,440
Beltsville USDA East WWTP[2]	Unnamed Tributary of Beaverdam Creek/Anacostia	3,566	1,710	7,553	566	7,553	566
Total Potomac Point Source Load		**195,342**	**8,651**	**336,316**	**15,360**	**372,853**	**17,006**
Total Six Major WWTPs with Discharges in Prince George's County		**392,577**	**44,481**	**800,257**	**50,155**	**877,024**	**54,816**
Blue Plains WWTP*	Potomac River (DC)	669,550	13,896	645,349	29,041	NA	NA

Nitrogen and Phosphorus Load Data Sources:

[1] Washington Suburban Sanitary Commission. Notes: The Marlboro Meadows WWTP will not be operating in 2030. Flows will be directed to the Western Branch WWTP (as reflected in the loads data presented in this table). ***The Blue Plains WWTP treats flow from Prince George's County sewersheds but does not discharge into Prince George's County watersheds. Therefore Blue Plains loads were not included in the NPS nutrient modeling runs which were conducted to estimate nutrient loads to county watersheds.**

[2] Loads for Bowie and Beltsville USDA WWTPs for 2005 and 2030 (assumed equal to the Maryland ENR total load caps) taken from Maryland's Tributary Strategy Statewide Implementation Plan, 2008. The Town of Bowie anticipates flows lower than the 3.3 mgd plant capacity in 2030, which would be expected to produce loads lower than the ENR caps if the plant is achieving ENR performance. The higher ENR caps therefore provide a conservative estimate of Bowie WWTP point source loads in lieu of plant-specific data, but should be revisited after the plant's ENR upgrades are brought into service, or upon any revisions to the terms of the plant's NPDES permit.

As shown above, the loads from the six major wastewater treatment plants in Prince George's County are projected to be near their ultimate nutrient load capacities in the year 2030.

NA = not applicable

LUC 81 Roads; and 10 percent LUC 18 Urban Open Land. In addition, 20 percent undeveloped as 18 percent LUC 44 Brush and 2 percent LUC 60 Wetlands was included. In reality, ten percent Open Urban Land and 20 percent Undeveloped Area may not be achievable, but the mix of open urban, brush and wetland LUCs was used to reflect loading rates representing more natural landscaping anticipated with future smart growth development, as opposed to managed turf and other managed landscaping reflected in the MDE 2002 open urban loading rates. Therefore the goal was to provide a loading rate that reflects less managed open space without changing the open urban rates provided by MDE. The overall impervious percent associated with this LUC is approximately 35 percent.

- 149—Mixed Use Commercial (Prince George's County Land Use Code): This LUC was created using the same impervious factor and loading rates as LUC 14 Commercial to reflect mixed commercial use including retail, office, and other nonresidential uses.
- 191—Large Lot Subdivision (agriculture): Loading rates and impervious factor are the same as the Rural Residential land use category provided in the state's default spreadsheet.
- 192—Large Lot Subdivision (Forest): Impervious factor is the same as Rural Residential. However, pervious loading rates adjusted to reflect 90 percent Forested (LUC 41) and 10 percent developed as Residential Low (LUC 11).
- 72—Bare Exposed Rock and 73—Bare Ground: Impervious loading rates changed to match pervious loading rates to correct the state-issued impervious rate of 0.0 for these two LUCs.

In addition, new loading rate data sets were created for some model runs to reflect the application of various BMPs. Descriptions of these model runs, including an explanation of how these BMPs were applied, are provided in the Model Runs section, below.

Septic Loading Rate Estimates

The nitrogen loads from residential septic systems were calculated using the formula provided by MDE in the Water Resources Plan model, which is based on an estimated average annual pounds of nitrogen per person, an average number of persons per household or equivalent dwelling unit (EDU), and a transport factor, as shown below.

N lbs/yr = EDUs x 9.5 lbs/person/year x average people/household x 0.4 (transport factor)

Where:

- Number of septic systems = households or EDUs
- Mean household size year 2000 = 2.74
- Mean household size year 2030 = 2.54
- The transport factor, 0.4, represents the fraction of nitrogen that is estimated to reach the nearest surface waters. This value was adopted from the Chesapeake Bay Program.

The effect of septic denitrification is estimated by halving the load, i.e., by multiplying by 0.5 for the residential estimates.

The method of estimating nonresidential septic loads provided by MDE in the Water Resources Plan model is based on an estimated nonresidential septic flow per nonresidential acres. As with the residential loads, the effect of septic denitrification is estimated by halving the load. However, because the county's GIS system does not delineate nonresidential acres outside the sewer envelope, this method was not applicable to future load estimates. Therefore, the county's available data reflecting the number of employees outside the sewer envelope were used with a conversion factor to estimate nitrogen loads based on factors provided in the MDE Water Resources Plan model as well as data provided by WSSC, as shown below:

N lbs/yr = Employees x 9.5 lbs/person/year x .44 (conversion factor) x 0.4 (transport factor)

Where:

- Load per resident = 9.5 lbs/person/year based on MDE's residential equation described above.
- The transport factor = 0.4 as described above in MDE's residential equation.
- Load per employee = 0.44 x load per resident, based on
  - 250 gpd per EDU*/2.74** = 91 gpd per resident
  - 40 gpd per employee*/91 gpd per resident = 1 employee = .44 residents. Based on the current and future population data (described in the preceding Septic System Data Input section), in the Patuxent watershed, 8,661 current households and 5,317 current employees are estimated to yield an annual nitrogen load of 99,070 pounds, versus future scenarios in which 10,117 households and 12,721 employees are predicted to yield an annual nitrogen load of 118,919 pounds. In the Potomac watershed, 7,423 current households and 12,402 current employees are estimated to yield an annual nitrogen load of 98,037 pounds, versus future scenarios in which 9,295 households and 16,276 employees are predicted to yield an annual nitrogen load of 116,927 pounds. These estimated loads were used as the septic system data inputs for the nonpoint source modeling runs described in the next section.

* Flow factors used by WSSC=250 gpd per residential dwelling unit and 40 gpd per employee (Note: the future land use scenarios used for the Water Resources Plan do not indicate nonresidential growth, such as planned heavy water use industries, that would alter this employee average.)

**Average year 2000 household size as provided in MDE's residential load formula.

NONPOINT SOURCE LOADING MODEL RUNS AND RESULTS

A number of model runs were conducted with PLAM to obtain information on the potential range of loading rates if land use acreages alone are changed and if BMPs are also changed. The land use acreage used as the basis for the model runs are encompassed in the initial conditions scenario (described on page 200), and the future trend and future ideal scenarios (described beginning page 207). These model runs included the following:

- Run 1—Base Conditions, Potomac and Patuxent 6-Digit Watersheds: Application of the Water Resources Plan "2002 BMP Implementation" loading rates to countywide land use categories for initial conditions acreage and future trend and future ideal scenarios.
- Run 2—Septic Upgrades, Potomac and Patuxent 6-Digit Watersheds: Similar to Run 1, but factored in upgrading of septic systems to achieve denitrification.
- Run 3—Base Conditions, Western Branch 8-Digit Watershed: Conducted in the same manner as Run 1, but conducted for the Western Branch subwatershed only.
- Run 4—Base Conditions, Piscataway 8-Digit Watershed: Conducted in the same manner as Run 1, but conducted for the Piscataway subwatershed only.
- Run 5—Enhanced BMP Implementation: Several suites of BMPs were applied as model iterations to determine the impact of improved land management practices.

Each run is further described below along with a summary of results.

Run 1—Base Conditions, Potomac and Patuxent 6-Digit Watersheds

The Water Resources Plan "2002 BMP Implementation" loading rates (with the modifications noted above) were applied countywide to land use categories for initial conditions acreage and the future trend and future ideal land use scenarios. By applying one set of loading rates across each of the scenarios, this run provided the change in terrestrial loads resulting from changes in acreage categories without evaluating impacts from changes in land management practices (such as increased BMP implementation), similar to the methodology developed by the state for the Water Resources Plan.

In addition, this run estimated changes in septic loads based on population projections representing growth outside the Rural Tier compared to current populations, and incorporated estimated changes in point source loads shown in Table 41, which provide future wastewater treatment plant total load allocations compared to the plants' estimated current loads.

SUMMARY OF RUN 1 MODEL PREDICTIONS

The results of Run 1 are shown in Table 43. Future development is projected to cause increased nitrogen and phosphorus loads from land use, septic systems, and point sources.

The increased density associated with the county's Smart Growth Initiative as reflected in the future ideal scenario results in fewer acres converted from forest and rural uses to development, compared with the current development patterns reflected in the future trend scenario.

Table 42: 2002 BMP Implementation Loading Rates

		Basin 1 Loading Rates Patuxent Above Fall (lbs/acre/year)				Basin 2 Loading Rates Patuxent Below Fall (lbs/acre/year)				Basin 3 Loading Rates Potomac Below Fall (lbs/acre/year)			
	Impervious	Nitrogen		Phosphorus		Nitrogen		Phosphorus		Nitrogen		Phosphorus	
MDP Land Use Categories	*ImpPct*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*
LULC11 (Low Density Residential)	0.14	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC12 (Medium Density Residential)	0.28	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC13 (High Density Residential)	0.41	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC14 (Commercial)	0.72	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC15 (Industrial)	0.53	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC16 (Institutional)	0.34	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC17 (Extractive)	0.02	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC18 (Open Urban Land)	0.09	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC21 (Cropland)	0.00	23.07	0.00	1.17	0.00	13.10	0.00	0.68	0.00	16.11	0.00	0.84	0.00
LULC22 (Pasture)	0.00	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC23 (Orchards)	0.00	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC24 (Feeding Operations)	0.02	27.24	0.00	1.24	0.00	18.84	0.00	1.00	0.00	22.42	0.00	1.31	0.00
LULC25 (Row and Garden Crops)	0.00	23.07	0.00	1.17	0.00	13.10	0.00	0.68	0.00	16.11	0.00	0.84	0.00
LULC41 (Deciduous Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC42 (Evergreen Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC43 (Mixed Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC44 (Brush)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC50 (Water)	0.00	10.28	0.00	0.57	0.00	9.68	0.00	0.57	0.00	9.75	0.00	0.57	0.00
LULC60 (Wetlands)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC71 (Beaches)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC72 (Bare Rock)	1.00	11.32	0.00	1.13	0.00	7.15	0.00	0.60	0.00	9.45	0.00	1.22	0.00
LULC73 (Bare Ground)	0.09	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC80 (Transportation)	0.95	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC191 (Rural Residential)	0.04	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC241 (Feeding Operations)	0.02	27.24	0.00	1.24	0.00	18.84	0.00	1.00	0.00	22.42	0.00	1.31	0.00
LULC242 (Agricultural Buildings)	0.02	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00

Patuxent Watershed—Using the MDE impervious factors and loading rates, the ideal land use pattern results in a small net decrease in future watershedwide nitrogen and phosphorus loads from terrestrial sources (i.e., <1 percent decrease) compared to the future trend development pattern. The improvements in nonpoint source nutrient loads are more clearly seen when the changes in land use acreages projected by the ideal and trend development scenarios are isolated from the remaining unconverted land in the watershed. The model estimates an 18 percent reduction in annual pounds of nitrogen from ideal scenario land use conversions compared to the trend scenario land use conversions, and a 59 percent reduction in annual pounds of phosphorus from the ideal scenario compared to the trend scenario. Although these improvements are significant, they are masked by the baseline loads generated from terrestrial sources in 2007 initial conditions land use patterns, which comprise 80 percent of the future annual nitrogen load and greater than 95 percent of the future annual phosphorus load from terrestrial sources.

Nitrogen loads from septic systems are predicted to increase by 20 percent from the initial conditions to 2030. Nitrogen loads from point sources are predicted to increase by 135 percent and phosphorus loads from point sources are predicted to increase by one percent from the initial conditions to 2030. Septic and point source loads are equivalent in both future development scenarios. Four WWTPs were included in this analysis: Parkway, Western Branch, Bowie, and Marlboro Meadows.[1] The majority of the predicted nitrogen load increases are expected to occur due to increases in flows to be treated at the Western Branch WWTP. The plant's current upgrade to ENR technology will reduce the loads that would have otherwise occurred from increased future flows and will reduce total phosphorus loads that are reflected in the relatively small watershedwide point source phosphorus increases resulting from future development.

Potomac Watershed. Using the MDE impervious factors and loading rates, the ideal land use pattern results in a small net increase in future watershedwide nitrogen loads from terrestrial sources (i.e., <2 percent increase in N) and a small net decrease in watershedwide phosphorus loads from terrestrial sources (i.e., ~2 percent decrease in P) compared to the future trend development pattern. Although the nitrogen load from developed acres is lower in the ideal scenario compared to the trend scenario, the small net increase (compared to the trend scenario) is seen because the rural land (cropland) modeled for initial conditions using MDE's 2002 BMP loading rates produce higher loads than the reductions resulting from land preservation in the ideal scenario compared to the trend scenario. In addition, in contrast to the Patuxent watershed, MDE's nitrogen loading rates for the Potomac watershed place a larger component of the total load on the pervious component of the developed land use categories, which is particularly pronounced in the 2002 BMP loading rates. Consequently, the model's application of MDE's 2002 BMP rates provides results that do not support improvements in runoff and pollutant control typically expected from impervious area reductions. By using the MDE's Water Resources Plan model protocol, which applies the same loading rates over the initial conditions and both development scenarios, the Run 1 results do not reflect any nutrient reductions from improved future development

[1] WSSC 2030 projected loads were used for Parkway and Western Branch WWTPs, and total ENR nutrient load allocation as defined by the Statewide Implementation Plan was used for 2030 loads for the Bowie USDA WWTP. No projected loads were reported for Marlboro Meadows WWTP since this facility is shutting down and flows will be directed to Western Branch WWTP. Initial conditions estimated as described in the Point Source Load Input Section.

Table 43. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Run: 1

Description: Water Resources Plan PGCo Run 1—
Base Conditions, 6 Digit Watersheds, 2002 BMP Loading Rates applied consistently across all scenarios.

Land Use Summary

Potomac and Patuxent Watersheds No changes in land management	**Initial Conditions 2007 Land Use**			**Scenario 1 Future Trend**			**Scenario 2 Future Ideal**		
Land Use Summary	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**
Total Development Acres	70,982	87,556	**158,537**	77,661	95,059	**172,720**	76,292	88,476	**164,768**
Total Forest Acres	64,084	52,333	**116,417**	59,559	49,583	**109,142**	59,851	51,959	**111,810**
Total Rural Acres	21,812	11,187	**32,999**	19,658	6,434	**26,092**	20,735	10,640	**31,375**
Total Other Land Use Acres	868	534	**1,401**	868	534	**1,401**	868	534	**1,401**
Total Acres	**157,746**	**151,609**	**309,355**	**157,746**	**151,609**	**309,355**	**157,746**	**151,609**	**309,355**
Total Impervious Area (acres)	18,572	27,218	45,789	20,517	31,138	51,656	19,714	28,735	48,448
Watershed Impervious	12%	18%	15%	13%	21%	17%	12%	19%	16%

Nitrogen lbs/year

Potomac and Patuxent Watersheds	**Initial Conditions**			**Scenario 1**			**Scenario 2**		
2002 BMP Load Rates	**2007 Land Use**			**Future Trend**			**Future Ideal**		
Nitrogen Load Sources:	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**
Terrestrial Load	821,829	992,120	**1,813,949**	834,333	973,495	**1,807,827**	832,130	986,282	**1,818,412**
Septic Load	99,070	98,037	**197,107**	118,919	116,927	**235,846**	118,919	116,927	**235,846**
Point Source Load	197,235	195,342	**392,577**	463,941	336,316	**800,257**	463,941	336,316	**800,257**
Total Nitrogen Load	**1,118,134**	**1,285,499**	**2,403,633**	**1,417,193**	**1,426,738**	**2,843,930**	**1,414,990**	**1,439,525**	**2,854,515**

Phosphorus lbs/year

Potomac and Patuxent Watersheds	**Initial Conditions**			**Scenario 1**			**Scenario 2**		
2002 BMP Load Rates	**2007 Land Use**			**Future Trend**			**Future Ideal**		
Phosphorus Load Sources:	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**
Terrestrial Load	56,024	101,631	**157,655**	56,736	101,121	**157,857**	56,316	98,943	**155,259**
Point Source Load	35,830	8,651	**44,481**	34,795	15,360	**50,155**	34,795	15,360	**50,155**
Total Phosphorus Load	**91,854**	**110,282**	**202,136**	**91,531**	**116,481**	**208,012**	**91,111**	**114,303**	**205,414**

or land management practices such as environmental site design practices that are applied to reduce runoff and nutrient loads.

Nitrogen loads from septic systems are predicted to increase by 19 percent from the initial conditions to 2030. Nitrogen loads from point sources are predicted to increase by 72 percent and phosphorus loads from point sources are predicted to increase by 78 percent from the initial conditions to 2030. Two WWTPs were included in this analysis: Piscataway and Beltsville USDA East WWTPs.[2] The majority of the loads occur at the Piscataway WWTP, which is expected to receive increased flows due to future development. Septic and point source loads are equivalent in both future development scenarios.

CONCLUSIONS

This model run illustrates the impact of current land use conditions on nutrient loads to the watersheds of Prince George's County. The impervious acres estimated for the future ideal versus future trend development scenarios demonstrate the benefits of the county's smart growth vision compared to existing development patterns, which would be expected to result in a two percent increase in the percentage of county land area covered by impervious surfaces by 2030. In contrast, the results of the ideal scenario indicate impervious coverage increases can be controlled by increasing the rates of redevelopment and infill development versus the current trends toward greenfield development. By applying MDE's loading rates consistently over the initial and future scenarios, the nutrient impacts of modifying future degrees of development densities and land preservation are predicted to be small in comparison with current estimated loads, which demonstrates the need for improved land management methods to reduce loading rates from existing land in addition to improved development practices to reduce runoff and nutrient loads.

[2] WSSC 2030 projected loads were used for the Piscataway WWTP, and total ENR nutrient load allocation as defined by the Statewide Implementation Plan was used for 2030 loads for the Beltsville USDA WWTP. Initial conditions estimated as described in the Point Source Load Input section of this memorandum.

Run 2—Septic Upgrades, Potomac and Patuxent 6-Digit Watersheds

Run 2 is a duplicate of Run 1, with the exception of the septic load calculation in the future ideal scenario. In this scenario, the septic loads were recalculated to simulate the effects of upgrading half of the existing septic systems included in the initial conditions run to achieve denitrification. In addition, all of the new septic systems (i.e., the net increase between initial conditions and 2030) were calculated as denitrifying systems. The nitrogen loads from denitrifying septic systems are calculated as 50 percent of the loads from conventional systems. All of the septic systems in the initial conditions and future trend scenarios were entered as conventional systems.

SUMMARY OF RUN 2 MODEL PREDICTIONS

The results of Run 2 are shown in Table 44, and are identical to Run 1 with the exception of the reduced nitrogen loads reflected in the results for the ideal scenario. Nitrogen reductions of approximately 36,000 pounds in the Patuxent watershed and 35,000 pounds in the Potomac watershed (30 percent reductions) resulted from applying the loading rate calculations for denitrifying septic systems to all of the new systems installed between initial conditions and 2030, and to one-half of the systems included in the initial conditions scenario. The model predicts that this scale of septic system upgrade would result in a reduction of approximately 61,000 pounds of nitrogen countywide, or approximately two percent of the nitrogen loads compared to the trend scenario, which does not include any denitrifying septic systems.

CONCLUSIONS

The model predicts that a significant countywide septic system upgrade program would generate small reductions in total nitrogen loads to the Patuxent and Potomac watersheds.

Table 44. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Run: 2
Description: Water Resources Plan PGCo Run 2—Base Conditions with 2002 BMP Loading Rates + Septic Upgrades in Ideal Scenario.

Land Use Summary

Potomac and Patuxent Watersheds No changes in land management	**Initial Conditions 2007 Land Use**			**Scenario 1 Future Trend**			**Scenario 2 Future Ideal**		
Land Use Summary	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**
Total Development Acres	70,982	87,556	158,537	77,661	95,059	172,720	76,292	88,476	164,768
Total Forest Acres	64,084	52,333	116,417	59,559	49,583	109,142	59,851	51,959	111,810
Total Rural Acres	21,812	11,187	32,999	19,658	6,434	26,092	20,735	10,640	31,375
Total Other Land Use Acres	868	534	1,401	868	534	1,401	868	534	1,401
Total Acres	157,746	151,609	309,355	157,746	151,609	309,355	157,746	151,609	309,355
Total Impervious Area (acres)	**18,572**	**27,218**	**45,789**	**20,517**	**31,138**	**51,656**	**19,714**	**28,735**	**48,448**
Watershed Impervious	12%	18%	15%	13%	21%	17%	12%	19%	16%

Nitrogen lbs/year

Potomac and Patuxent Watersheds 2002 BMP Load Rates	**Initial Conditions 2007 Land Use**			**Scenario 1 Future Trend**			**Scenario 2 Future Ideal**		
Nitrogen Load Sources:	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	***Patuxent***	***Potomac***	***Total***
Terrestrial Load	821,829	992,120	1,813,949	834,333	973,495	1,807,827	832,130	986,282	1,818,412
Septic Load	99,070	98,037	197,107	118,919	116,927	235,846	82,581	81,562	164,143
Point Source Load	197,235	195,342	392,577	463,941	336,316	800,257	463,941	336,316	800,257
Total Nitrogen Load	**1,118,134**	**1,285,499**	**2,403,633**	**1,417,193**	**1,426,738**	**2,843,930**	**1,378,652**	**1,404,160**	**2,782,812**

Phosphorus lbs/year

Potomac and Patuxent Watersheds 2002 BMP Load Rates	**Initial Conditions 2007 Land Use**			**Scenario 1 Future Trend**			**Scenario 2 Future Ideal**		
Phosphorus Load Sources:	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**	**Patuxent**	**Potomac**	**Total**
Terrestrial Load	56,024	101,631	157,655	56,736	101,121	157,857	56,316	98,943	155,259
Point Source Load	35,830	8,651	44,481	34,795	15,360	50,155	34,795	15,360	50,155
Total Phosphorus Load	**91,854**	**110,282**	**202,136**	**91,531**	**116,481**	**208,012**	**91,111**	**114,303**	**205,414**

Run 3—Base Conditions, Western Branch 8-Digit Watershed

Run 3 was conducted in the same manner as Run 1 using the 2002 BMP implementation loading rates for the initial conditions and future trend and ideal scenarios, but was conducted for the Western Branch subwatershed only. Western Branch is one of the 8-digit watersheds within the Patuxent River basin.

SUMMARY OF RUN 3 MODEL PREDICTIONS

The results of Run 3 are shown in Tables 45 and 46. Future development is projected to cause increased nitrogen and phosphorus loads from land use, septic systems, and point sources.

The increased density associated with the county's Smart Growth Initiative as reflected in the future ideal scenario results in fewer acres converted from forest and rural uses to development, compared with the current development patterns reflected in the future trend scenario.

Current development patterns reflected in the trend scenario predict a net increase of approximately 2,200 developed acres, and decreases in forested and rural land by approximately 900 and 1,300 acres by 2030, respectively. Smart growth development patterns reflected in the ideal scenario predict a net increase of approximately 750 developed acres from conversion of forested land, or preservation of approximately 1500 acres of forested and rural land from conversion to development compared to the trend scenario (i.e., 66 percent of the acres developed in the future trend scenario are preserved under the ideal scenario).

Using the MDE impervious factors and loading rates provided for the 2002 BMP loading rates, on the subwatershed scale, the ideal land use pattern generates approximately a four percent lower nutrient loading from development acres due to the reduction in the number of acres developed, but a small net increase in future subwatershedwide nitrogen

Table 45. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Run 3b: Impacts of Enhanced BMP Implementation

Western Branch Subwatershed Improved Land Management Methods	**Scenario 2—Future Ideal with 2002 BMP Rates**	**Scenario 3—Future Ideal with TribStrat Implementation Rates**	**Nutrient Reductions from Enhanced BMPs**	
Load Sources:	**Western Branch**	**Western Branch**	**Annual Lbs**	**%**
Terrestrial Nitrogen Load	341,888	248,961	92,927	27
Total Nitrogen Load	**688,711**	**595,784**	**92,927**	**13**
Terrestrial Phosphorus Load	24,060	19,011	5,049	21
Total Phosphorus Load	**49,625**	**44,581**	**5,044**	**10**

Table 46. Results Of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Run: 3

Description: WRE PGCo Run 3 - Same parameters as Run 1, applied to 8-Digit Western Branch Subwatershed only (Patuxent).

Land Use Summary

Western Branch Subwatershed	**Initial Conditions**	**Scenario 1**	**Scenario 2**
No changes in land management	**2007 Land Use**	**Future Trend**	**Future Ideal**
Land Use Summary	Western Branch	Western Branch	Western Branch
Total Development Acres	32,120	34,343	32,868
Total Forest Acres	19,757	18,869	19,010
Total Rural Acres	7,152	5,817	7,152
Total Other Land Use Acres	273	273	273
Total Acres	**59,302**	**59,302**	**59,302**
Total Impervious Area (acres)	9,860	10,999	10,550
Watershed Impervious	17%	19%	18%

Nitrogen lbs/year

Western Branch Subwatershed	**Initial Conditions**	**Scenario 1**	**Scenario 2**
Patuxent Watershed 2002 BMP Load Rates	**2007 Land Use**	**Future Trend**	**Future Ideal**
Nitrogen Load Sources:	Western Branch	Western Branch	Western Branch
Terrestrial Load	336,455	335,064	341,888
Septic Load	5,601	5,883	5,883
Point Source Load	86,663	340,940	340,940
Total Nitrogen Load	**428,719**	**681,887**	**688,711**

Phosphorus lbs/year

Western Branch Subwatershed	**Initial Conditions**	**Scenario 1**	**Scenario 2**
Patuxent Watershed 2002 BMP Load Rates	**2007 Land Use**	**Future Trend**	**Future Ideal**
Phosphorus Load Sources:	Western Branch	Western Branch	Western Branch
Terrestrial Load	24,060	23,937	24,055
Point Source Load	29,667	25,570	25,570
Total Phosphorus Load	**53,727**	**49,507**	**49,625**

and phosphorus loads from all terrestrial sources (i.e., ~2 percent increase in N and <1 percent increase in P). These results occur because the rural land (cropland) modeled for initial conditions using MDE's 2002 BMP loading rates produce higher loads than the reductions resulting from land preservation in the ideal scenario.

Because the 2002 BMP loading rates were applied over the initial conditions and both development scenarios, the model results do not reflect any potential improvements in loading rates that could occur from improved future development or land management practices to reduce runoff and nutrient loads.

This is shown in the results of an additional model run provided below, which was conducted using MDE's tributary strategy implementation loading rates applied to the ideal scenario, which predicted significant nutrient reductions that could be achieved through enhanced BMP implementation. The application of MDE's loading rates reflecting aggressive BMP application predicted annual nitrogen reductions of 93,000 pounds, which represents 27 percent of the watershed's terrestrial nitrogen load and 13 percent of the watershed's total nitrogen load, as shown below. Of the 93,000 pounds reduced, 70 percent were from developed acres and 30 percent were from rural acres (primarily cropland). The application of MDE's tributary strategy rates resulted in annual phosphorus reductions of 5,000 pounds, which represents 21 percent of the watershed's terrestrial phosphorus load, and ten percent of the watershed's total phosphorus load. Almost all of the phosphorus reductions resulted from enhanced BMP implementation on developed acres (primarily residential).

Nitrogen loads from septic systems are predicted to increase by five percent from the initial conditions to 2030. Nitrogen loads from the Western Branch WWTP are expected to increase by 293 percent, with phosphorus loads decreasing by 14 percent from the initial conditions to 2030.[3] Septic and point source loads are equivalent in both future development scenarios. The plant's current upgrade to ENR technology will reduce the loads that would have otherwise occurred from the increased future flows resulting from development.

CONCLUSIONS

This model run illustrates the impact of current land use conditions and future development on nutrient loads in the Western Branch subwatershed. The comparison of ideal scenario terrestrial loading rates calculated with MDE's 2002 BMP implementation loading rates versus the tributary strategy loading rates illustrates the nutrient reductions that can be achieved through improved land management. However it should be noted that full implementation of Prince George's County's portion of the 2003 tributary strategy may not be the ultimate approach adopted as part of Maryland's nutrient reduction strategy, and the results from this model iteration do not necessarily reflect the county's most current watershed management programs. Evaluation of alternate strategies for nutrient reductions from improved land management practices were modeled and are discussed as part of Run 5.

[3] Based on projected 2030 loads as provided by WSSC and initial conditions estimated as described in the Point Source Load Input section of this memorandum.

Run 4—Base Conditions, Piscataway 8-Digit Watershed

Run 4 was conducted in the same manner as Run 1 using the 2002 BMP implementation loading rates for the initial conditions and future trend and ideal scenarios, but was conducted for the Piscataway subwatershed only. Piscataway is one of the 8-digit watersheds within the Potomac River basin.

SUMMARY OF RUN 4 MODEL PREDICTIONS

The results of Run 4 are shown in Table 47. Future development is projected to cause increased nitrogen and phosphorus loads, primarily from additional wastewater treatment and septic loads.

The increased density associated with the county's Smart Growth Initiative as reflected in the future ideal scenario results in fewer acres converted from forest and rural uses to development, compared with the current development patterns reflected in the future trend scenario.

Current development patterns reflected in the trend scenario predict a net increase of approximately 700 developed acres, and decreases in forested and rural land (cropland) by approximately 300 and 400 acres by 2030, respectively. Smart growth development patterns reflected in the ideal scenario predict a net increase of approximately 150 developed acres from conversion of forested land, or preservation of approximately 550 acres of forested and rural land (cropland) from conversion to development compared to the trend scenario (i.e., 79 percent of the acres developed under the future trend scenario are preserved under the ideal scenario.

Like the results seen for the Potomac watershed in Run 1, the ideal land use pattern results in a small net increase in future subwatershedwide nitrogen loads and a small decrease in phosphorus loads from terrestrial sources (i.e., <1 percent increase in N and ~1 percent increase in P). These results occur because although the loads from developed lands are lower in the ideal scenario versus the trend scenario, the rural land (cropland) modeled for initial conditions using MDE's 2002 BMP loading rates produce higher loads than the reductions resulting from land preservation in the ideal scenario, and less rural land (cropland) is converted in the ideal scenario than in the trend scenario.

As shown in Run 3, because the 2002 BMP loading rates were applied over the initial conditions and both development scenarios, the model results do not reflect any potential improvements in loading rates that could occur from improved future development or land management practices to reduce runoff and nutrient loads, which illustrates the need for improved land management in addition to improved development practices.

Nitrogen loads from septic systems are predicted to increase by 63 percent from the initial conditions to 2030. Nitrogen loads from the Piscataway WWTP are expected to increase by 71 percent with phosphorus loads more than doubling from the initial conditions to 2030.[4] Septic and point source loads are equivalent in both future development scenarios. The plant's current upgrade to ENR technology will reduce the loads that would have otherwise occurred from the increased future flows due to development. Septic and point source loads are equivalent in both future development scenarios.

Conclusions

This model run illustrates the impact of current land use conditions and future development on nutrient loads in the Piscataway subwatershed, as predicted using MDE's 2002 BMP implementation loading rates applied over initial conditions and future development scenarios.

[4] Based on projected 2030 loads as provided by WSSC and initial conditions estimated as described in the Point Source Load Input section of this memorandum.

Table 47. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan			
Run: 4 **Description: WRE PGCo Run 4—Same parameters as Run 1, applied to 8-Digit Piscataway Subwatershed only (Potomac).**			
Land Use Summary			
Piscataway Subwatershed **No changes in land management**	**Initial Conditions** **2007 Land Use**	**Scenario 1** **Future Trend**	**Scenario 2** **Future Ideal**
Land Use Summary	**Piscataway**	**Piscataway**	**Piscataway**
Total Development Acres	21,078	21,795	21,230
Total Forest Acres	17,529	17,216	17,377
Total Rural Acres	4,202	3,798	4,202
Total Other Land Use Acres	123	123	123
Total Acres	**42,933**	**42,933**	**42,933**
Nitrogen lbs/year			
Piscataway Subwatershed **Potomac Watershed 2002 BMP Load Rates**	**Initial Conditions** **2007 Land Use**	**Scenario 1** **Future Trend**	**Scenario 2** **Future Ideal**
Nitrogen Load Sources:	**Piscataway**	**Piscataway**	**Piscataway**
Terrestrial Load	268,213	266,067	267,560
Septic Load	12,183	19,899	19,899
Point Source Load	191,776	328,763	328,763
Total Nitrogen Load	**472,172**	**614,729**	**616,222**
Phosphorus lbs/year			
Piscataway Subwatershed **Potomac Watershed 2002 BMP Load Rates**	**Initial Conditions** **2007 Land Use**	**Scenario 1** **Future Trend**	**Scenario 2** **Future Ideal**
Phosphorus Load Sources:	**Piscataway**	**Piscataway**	**Piscataway**
Terrestrial Load	26,683	26,362	26,081
Point Source Load	6,941	14,794	14,794
Total Phosphorus Load	**33,624**	**41,156**	**40,875**

Run 5—Enhanced BMP Implementation

For Run 5, several suites of BMPs were applied as model iterations to determine the impact of improved land management practices. Unlike the state's default methodology and the previously described model runs, this analysis requires application of watershed treatment methods such as those included in the WTM model, or application of modified loading rates to reflect future improvements in land management techniques. The latter method was included in one of the Run 5 iterations, which compared estimated loads from application of 2002 BMP implementation loading rates in the initial conditions scenario versus estimated loads from application of tributary strategy loading rates, as presented at the end of this discussion.

The suite of BMPs included in the tributary strategy loading rates was developed as part of the state's work toward nutrient reductions to achieve the Chesapeake Bay Program's 2003 restoration goals and reflected in the full tributary strategy implementation loading rates developed by the Bay Program and included in MDE's Water Resources Plan model. However, the direction of the bay program is evolving, with issuance of a basinwide TMDL anticipated from EPA at the end of 2010 that will replace the 2003 goals. Therefore, full implementation of Prince George's County's portion of the 2003 tributary strategy may not be the ultimate approach adopted as part of Maryland's nutrient reduction strategy. Therefore, several other iterations were developed to evaluate the effectiveness of various land management practices, as summarized below.

RURAL AND AGRICULTURAL BEST MANAGEMENT PRACTICES

A suite of BMPs was applied to select acreages of agricultural and rural land uses, and results were compared against Run 1's initial conditions results to identify any resulting reductions to nutrient loads. A May 2009 Chesapeake Bay Program publication entitled "2011 Milestones for Reducing Nitrogen and Phosphorus" was used as a guide to estimate the extent of BMP application in the model runs. This publication identifies short-term goals for the seven Chesapeake Bay jurisdictions (including the State of Maryland) that were set by the Chesapeake Executive Council to reduce pollution to the bay and accelerate the pace of restoration of the bay and its tributaries. Where possible, the quantities of BMPs presented in the 2011 milestones for the State of Maryland were extrapolated to Prince George's County acreage to estimate BMP applications in the county that would be proportional to the state's restoration goals. This process resulted in the application of BMPs at the level described below in Tables 49 and 50. Nitrogen and phosphorus reduction efficiencies compiled through a literature review were tabulated and average values were selected for use in the model runs, also shown in Table 49.

Together, the data shown in Table 49 were applied in this set of model runs to determine the nutrient reductions that could be achieved from a suite of BMPs developed to represent the state's most currently available bay restoration strategies. This approach was not prepared based on county-provided information, and accurate assessments of the impacts of county strategies can only be evaluated through a much more detailed analysis. Therefore, while this modeling run is not intended to estimate future nutrient loads from any specific county strategy, the results provide a hypothetical analysis of potential nutrient reductions achievable through various improved rural land management approaches.

Table 48: Application of BMPs to Agricultural and Rural Land Uses			
Run 5: Affects of Rural and Agricultural BMPs			
BMP	**Extent of Applicability in County[2]**	**N Load Reductions[1]**	**P Load Reductions[1]**
Cover crops	32% of cropland = 7,800 acres	35%	10%
Soil Conservation and Water Quality Plans	9% of agricultural land = 3,000 acres	6%	10%
Barnyard Runoff Control	Assume applied to all 198 acres	75%	75%
Stream Protection with and without Fencing	0.4% of agricultural land = 130 acres	45%	55%
Land Retirement	0.25% of agricultural land = 60 acres	50%	80%
Wetland Restoration	.03% of county = 85 acres	40%	55%
Grass Buffers	0.1% of county = 400 acres	41%	57%
Forest Buffers	.08% of county = 250 acres	65%	64%

1. The following sources were reviewed to determine the nitrogen and phosphorus reduction efficiencies displayed in this table:

- Maryland Department of Natural Resources, 2005. A User's Guide to Watershed Planning in Maryland. Prepared by Center for Watershed Protection. December 2005.
- Chesapeake Bay Program, 1998. Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings. Appendix H: Tracking Best Management Practice Nutrient Reductions in the Chesapeake Bay Program. August 1998.
- Chesapeake Bay Program, 2006. Nonpoint Source Best Management Practices that have been Peer-Reviewed and CBP-Approved for Phase 5.0 of the Chesapeake Bay Program Watershed Model. Revised 1/18/06.
- University of Maryland, 2009. BMP Efficiencies for Chesapeake Bay Program Tributary Strategies. Prepared by Mid-Atlantic Water Program.

2. The extent of BMP application estimated for this modeling scenario was developed based on a review of Maryland's BMP commitments summarized in the May 2009 Chesapeake Bay Program publication entitled "2011 Milestones for Reducing Nitrogen and Phosphorus" compared to Maryland agricultural acreage as reported in the USDA 2008 State Agricultural Overview for Maryland (http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MD.pdf) and other data, as shown in Table 49.

Table 49. Development of Rural and Agricultural BMP Application Rates Shown in Table 48

Maryland Statistics[1]	Prince George's County Statistics[2]		Notes
MD Total Acres—6,300,000 MD agricultural acreage—2,050,000 MD principal crop acreage—1,463,000 MD total farms—12,850 Average farm size in acres—160	County Total Acres—300,000 Rural/agricultural acreage—33,000 23,616 Cropland, 8,867 Pasture 260 Row, garden crops 58 Beaches 198 Ag bld brd train		5% of total state land area 65% Patuxent 35% in Potomac
Maryland 2011 Milestone Commitments[3]	**Estimated[4] % of Statewide Application**	**Proportional County Application**	**Notes**
Cover Crops—460,000 ac/yr	460,000/1,400,000 = 33%	23,616 ac crop x 33% = 7,800 ac	70% Pax/30% Pot
SC&WQ Plans—200,000 ac	200,000/2,050,000 = 9%	33,000 ac rural x 9% = 3,000 ac	Applied to pasture and cropland
Runoff/Waste Control Structures— 145 Livestock Waste Structures 53 Poultry Waste Structures 75 Runoff Control Systems 400 Poultry Area Concrete Pads	673/12,085 = 5%	198 ac	County has minimal agricultural feeding acreage, applied to all 198 ac
Stream Protection—3,000 ac	3,000-ac MD x 5% = 150-ac Co	150 ac/33,000 rural ac = 0.4%	Applied to 150 ac crop & pasture
Grass Buffers—8,000 ac	8,000-ac MD x 5% = 400-ac Co	400 ac/300,000 total ac = 0.1%	Applied to 400 ac crop & pasture
Forest Buffers—5,100 ac	5,100-ac MD x 5% = 255-ac Co	255 ac/300,000 total ac = 0.08%	Applied to 250 ac crop & pasture
Wetland Restoration—1,700 ac	1,700-ac MD x 5% = 85-ac Co	85 ac/300,000 total ac = 0.03%	Converted 85 ac crop & pasture to wetland
Retire Highly Erodible Land—1,500 ac	1,500-ac MD x 5% = 75-ac Co	75 ac/33,000 rural = 0.25% agric	Converted 75 ac cropland to forest

[1]Data from USDA's 2008 State Agricultural Overview for Maryland , http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MD.pdf

[2]Data from 2007 Land Use data prepared for this project, as described for model Run 1

[3]Data from May 2009 Chesapeake Bay Program publication entitled "2011 Milestones for Reducing Nitrogen and Phosphorus"

[4]Estimates are very approximate based on review of data referenced above

SUMMARY OF RUN 5 RURAL AND AGRICULTURAL BMP MODEL PREDICTIONS

The effects of the suite of rural and agricultural BMPs that were applied in the model are compared to the loads generated under Run 1's initial conditions scenario (i.e., 2007 land use with MDE 2002 BMP implementation loading rates) in Table 51. The suite of BMPs shown in Table 48 produced a net 12 percent reduction in annual nitrogen loads from rural and agricultural land uses. This equated to approximately three percent reduction compared to all terrestrial nitrogen sources, and a two percent reduction in total loads from all sources. In addition, a net five percent reduction in annual phosphorus from rural and agricultural land uses was estimated, which equated to an approximately one percent reduction from all terrestrial sources and <1 percent reduction in annual phosphorus from all sources.

Urban and Other Developed Land Best Management Practices

A suite of BMPs was applied to select acreages of urban and other developed land uses, and results were compared against Run 1's initial conditions results to identify any consequent reductions to nutrient loads. Nitrogen and phosphorus reduction efficiencies compiled through a literature review were tabulated and average values were selected for use in the model runs, as shown in Table 51. The suite of BMPs applied were selected based on availability of efficiency data to provide approximate nutrient reductions that could be achieved through a hypothetical suite of improved land management approaches, but are not intended to provide nutrient reductions anticipated from any specific county watershed management strategy.

SUMMARY OF RUN 5 URBAN AND OTHER DEVELOPED LAND USE BMP MODEL PREDICTIONS

The effects of the suite of developed land use BMPs that were applied in the model are compared to the loads generated under Run 1's initial conditions scenario (i.e., 2007 land use with MDE 2002 BMP implementation loading rates) in Table 53. The suite of BMPs shown in Table 52 produced an approximately five percent reduction in annual nitrogen and phosphorus loads from developed land uses. This equated to an approximately three percent reduction in nitrogen and a four percent reduction in phosphorus compared to all terrestrial nitrogen sources, and a two percent reduction in nitrogen and three percent reduction in phosphorus compared to total annual loads from all sources.

Application of MDE's Tributary Strategy Loading Rates

A model run was conducted to compare the loads generated for the Initial Condition's 2007 land use data using MDE's Water Resources Plan 2002 BMP implementation load rates to their Water Resources Plan tributary strategy implementation load rates. The purpose of this run was to determine the net impact of the aggressive suite of BMPs reflected in the tributary strategy rates compared to the more moderate suites of BMPs described above. The BMPs included in the tributary strategy loading rates reflect the state's 2003 plan for Chesapeake Bay restoration goals, but the direction of the bay program is evolving, and the state's earlier strategy may be revised upon issuance of the basinwide TMDL in 2010. Therefore, the results of this run provide a hypothetical analysis of potential nutrient reductions based on the loading rates provided by MDE, and should not be used as an estimate of predicted reductions from any specific county watershed management strategy.

Table 50. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan						
Reductions from Selected Suite of Rural BMPs Compared to Run 1 Results Potomac and Patuxent Watersheds						
	Run 1 Results for Initial Conditions 2007 Land Use	**Run 5 Results for Rural BMPs 2007 Land Use**		**Run 1 Results for Initial Conditions 2007 Land Use**	**Run 5 Results for Rural BMPs 2007 Land Use**	
Nutrient Load Sources:	**Total Nitrogen lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**	**Total Phosphorus lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**
Development	1,244,829	NA	NA	125,218	NA	NA
Forest	148,602	NA	NA	1,949	NA	NA
Rural	406,917	48,205	12%	29,694	1,587	5%
Other	13,601	NA	NA	794	NA	NA
Total Terrestrial:	**1,813,949**	**48,205**	**3%**	**157,655**	**1,587**	**1%**
Septic Load	197,107	NA	NA	NA	NA	NA
Point Source Load	392,577	NA	NA	44,481	NA	NA
Total Nutrient Load	**2,403,633**	**48,205**	**2%**	**202,136**	**1,587**	**1%**

Table 51. Application of BMPs to Urban and Other Developed Land Uses			
BMP	**Extent of Applicability Modeled**	**N Load Reductions[1]**	**P Load Reductions[1]**
Street Sweeping, Mechanical	10% of residential impervious surfaces = 9,582 acres	24%	24%
Street Sweeping, Regenerative Air	5% of other developed impervious surfaces (roads, industrial, commercial, institutional = 1,798 acres	18%	18%
Residential Nutrient Management	10% residential, 5% open urban & institutional pervious surfaces = 10,706 acres	17%	22%
Upland Reforestation (from turf)	5% open urban pervious surfaces = 397 acres	95%	95%
Impervious Cover Reduction	5% developed pervious surfaces = 7,295 acres	90%	90%
Improved Structural Controls	20% of developed impervious surfaces = 29,180 acres	18%	22%

[1] The following sources were reviewed to determine the nitrogen and phosphorus reduction efficiencies displayed in this table:

- Maryland Department of Natural Resources, 2005. A User's Guide to Watershed Planning in Maryland. Prepared by Center for Watershed Protection. December 2005.
- Chesapeake Bay Program, 1998. Chesapeake Bay Watershed Model Application and Calculation of Nutrient and Sediment Loadings. Appendix H: Tracking Best Management Practice Nutrient Reductions in the Chesapeake Bay Program. August 1998.
- Chesapeake Bay Program, 2006. Nonpoint Source Best Management Practices that have been Peer-Reviewed and CBP-Approved for Phase 5.0 of the Chesapeake Bay Program Watershed Model. Revised 1/18/06.
- University of Maryland, 2009. BMP Efficiencies for Chesapeake Bay Program Tributary Strategies. Prepared by Mid-Atlantic Water Program.

SUMMARY OF RUN 5 TRIBUTARY STRATEGY BMP MODEL PREDICTIONS

The effects of the suite of BMPs reflected in MDE's tributary strategy loading rates are compared to the loads generated under Run 1's initial conditions scenario (i.e., 2007 land use with MDE 2002 BMP implementation loading rates) in Table 53. The tributary strategy implementation loading rates produced an approximately 22 percent reduction in annual nitrogen loads from all terrestrial sources, which equated to a net 16 percent reduction in nitrogen loads from all sources. In addition, application of the tributary strategy rates resulted in an estimated 19 percent reduction in annual phosphorus loads from all terrestrial sources, which equated to a net 15 percent reduction in phosphorus loads from all sources. This included a net increase in estimated phosphorus loads from rural land uses (since the MDE tributary strategy loading rates for pasture are actually greater than the MDE 2002 BMP implementation loading rates for pasture), with the majority of reductions resulting from the BMPs applied to developed lands.

Conclusions

The Run 5 model runs were conducted to provide the county with estimated impacts resulting from the application of moderate to aggressive land management practices reflected in the BMPs described herein. In each case, the BMPs were applied to initial conditions data, so the results provide the estimated net effect of enhanced BMP application compared to the BMPs encompassed in MDE's Water Resources Plan 2002 BMP implementation loading rates and are not predictions of future nutrient reductions based on any specific county watershed management strategies.

Table 52. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Reductions from Selected Suite of Developed BMPs Compared to Run 1 Results Potomac and Patuxent Watersheds

	Run 1 Results for Initial Conditions 2007 Land Use	**Run 5 Results for Rural BMPs 2007 Land Use**		**Run 1 Results for Initial Conditions 2007 Land Use**	**Run 5 Results for Rural BMPs 2007 Land Use**	
Nutrient Load Sources:	**Total Nitrogen lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**	**Total Phosphorus lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**
Development	1,244,829	55,999	5%	125,218	6,539	5%
Forest	148,602	NA	NA	1,949	NA	NA
Rural	406,917	NA	NA	29,694	NA	NA
Other	13,601	NA	NA	794	NA	NA
Total Terrestrial:	**1,813,949**	**55,999**	**3%**	**157,655**	**6,539**	**4%**
Septic Load	197,107	NA	NA	NA	NA	NA
Point Source Load	392,577	NA	NA	44,481	NA	NA
Total Nutrient Load	**2,403,633**	**55,999**	**2%**	**202,136**	**6,539**	**3%**

As noted previously, the tributary strategy BMPs included in the loading rates applied in this model run may be revised upon issuance of the basinwide TMDL. By 2010, baywide TMDLs for nutrients and sediment are scheduled for completion. These will, in effect, overlay and adjust localized TMDLs to assure restoration of local and downstream conditions in the lower river estuaries and the bay. The presence of a TMDL is a sign that pollution control efforts must outweigh additional pollution impacts from future land use change, septic tanks, and WWTP flows to prevent further degradation of the waterbody. For the receiving waters in Prince George's County without a nutrient TMDL, a determination of the suitability of receiving waters cannot be made. However, for waterbodies with nutrient TMDLs, a preliminary assessment can be made. The pollution forecasts, although capable of comparing the relative benefits of different land use plans, are not precise enough to allow for a direct comparison to nutrient TMDLs. Prince George's County recognizes, though, that waterbodies with nutrient TMDLs can only be considered suitable receiving waters if future nutrient impacts are offset. This Water Resources Plan includes recommendations for pollution control efforts to help achieve that goal. In addition, this Water Resources Plan recommends refining the pollution forecast in the future to allow for direct comparison to nutrient TMDLs as information becomes available. In addition, the tributary strategy BMP effectiveness is under review by the bay program, and the loading rates used in the earlier version of the Chesapeake Bay Watershed Model (Phase 4.3) are being revised in the current version (Phase 5) to reflect lower efficiency data than previously modeled. Therefore the tributary strategy implementation loading rates provided by MDE for the Water Resources Plan process may not provide accurate predictions of currently understood BMP effectiveness. In order to develop predictions of reductions that may be achieved through county land management decisions, a set of much more rigorous analyses within specific subwatersheds should be conducted using locally tested loading rate and BMP efficiency data.

Table 53. Results of Prince George's County Pollutant Load Analysis Modeling for the Water Resources Plan

Reductions from MDE Water Resources Plan Tributary Strategy BMP Implementation Load Rates Compared to Run 1 Results Potomac and Patuxent Watersheds

	Run 1 Results for Initial Conditions 2007 Land Use	Run 5 Results Trib Strat BMPs 2007 Land Use		Run 1 Results for Initial Conditions 2007 Land Use	Run 5 Results Trib Strat BMPs 2007 Land Use	
Nitrogen Load Sources:	**Total Nitrogen lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**	**Total Phosphorus lbs/yr (2002 BMP Load Rates)**	**Lbs Reduction from BMPs**	**%**
Development	1,244,829	279,741	22%	125,218	35,931	29%
Forest	148,602	7,470	5%	1,949	197	10%
Rural	406,917	108,576	27%	29,694	-6,341	-21%
Other	13,601	2,148	16%	794	0	0%
Total Terrestrial:	**1,813,949**	**397,935**	**22%**	**157,655**	**29,787**	**19%**
Septic Load	197,107	NA	NA	NA	NA	NA
Point Source Load	392,577	NA	NA	44,481	NA	NA
Total Nutrient Load	**2,403,633**	**397,935**	**17%**	**202,136**	**29,787**	**15%**

SUMMARY OF FINDINGS FROM PRINCE GEORGE'S COUNTY MODELING

Run 1 (Base Conditions, Potomac, and Patuxent 6-Digit Watersheds) provides the nonpoint source loading data required for development of the Water Resources Plan. By applying one set of loading rates across each of the future land use scenarios (trend scenario and ideal scenario), this run provided the change in terrestrial loads resulting from changes in acreage categories without evaluating impacts from changes in land management practices (such as increased BMP implementation), similar to the methodology developed by the state for the Water Resources Plan. The trend scenario represented a continuation of existing land use patterns to accommodate future population growth, and the ideal scenario was developed to represent the county's smart growth vision, which consists of more compact development around transportation centers and growth corridors to accommodate future growth.

The results of Run 1 predict a net increase in future 2030 nutrient loads compared to the initial conditions. The predicted loads include data for terrestrial, septic, and point sources. The analysis of wastewater point source and septic loads indicate that on a per capita basis, the annual nitrogen loads from populations served by septic systems average approximately 3.1 pounds per person, versus approximately 0.6 to 1.1 pounds per person for the populations served by wastewater treatment plants. The analysis of land use scenarios in Run 1 show that terrestrial loads are significant (averaging approximately 2.1 pounds of nitrogen per person per year), and that the alternate land use scenarios impact the amount of impervious coverage and nutrient loading generated from development, but these differences are masked by the magnitude of the existing loads that comprise a very large percentage of the future terrestrial loads. These results demonstrate the need for improved land management methods to reduce loading rates from existing land in addition to improved development practices that result in reduced runoff and nutrient loads.

The benefits of compact development are many and varied, including reduced requirements for infrastructure investment and conservation of forests and viable agriculture lands. Although the amount of land required to meet new development to 2030 may be small in the context of the many thousands of acres developed to date, incremental improvements are a valuable component of a viable long-term development plan. Findings from the land use analysis emphasize the need for a multifaceted approach that addresses not only new development, but redevelopment and existing development. Determination of impacts of development patterns on water resources can be achieved through small-scale analysis using locally tested loading rate and BMP efficiency data that reflect the county's strategies for watershed management within the areas to be developed.

The results of Run 2 (Septic Upgrades, Potomac and Patuxent 6-Digit Watersheds) show that a countywide program to upgrade half of the existing septic systems to achieve denitrification and a requirement that all new septic systems be denitrifying would only generate a small (approximately two percent) reduction in the countywide total nitrogen load. However, on a per capita basis, this analysis shows that the annual loads per person could be reduced by approximately one-third by implementing this type of strategy, reducing the estimated nitrogen loads per person from approximately 3.1 pounds to 2.1 pounds per year. This reduced per capita load is still approximately two to four times higher than the estimated loads per person for populations served by advanced wastewater treatment plants.

Additional model runs were conducted to evaluate the impacts of development on a smaller scale (i.e., for the Western Branch and Piscataway subwatersheds) and the impacts of improved land management practices in the form of several suites of BMPs that were evaluated. The purpose of these model runs was to provide information for the county's assessment of future land management programs, but they do not provide estimates of future nutrient loads or impacts of any specific county programs. The Water Resources Plan provides a starting point and a tool for ongoing and future water quality impact assessments of the county's watersheds. As additional data become available the ensuing water resources plans should continue to update and refine NPS analysis appropriately.

ATTACHMENT 1
DATA PROVIDED BY MARYLAND'S DEFAULT WATER RESOURCES PLAN SPREADSHEET

		2002 BMP Implementation Loading Rates											
		Basin 1 Loading Rates Patuxent Above Fall (lbs/acre/year)				Basin 2 Loading Rates Patuxent Below Fall (lbs/acre/year)				Basin 3 Loading Rates Potomac Below Fall (lbs/acre/year)			
	Impervious	*Nitrogen*		*Phosphorus*		*Nitrogen*		*Phosphorus*		*Nitrogen*		*Phosphorus*	
MDP Land Use Categories	*Imp Pct*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*
LULC11 (Low Density Residential)	***0.14***	***11.32***	***8.04***	***1.13***	***0.50***	***7.15***	***7.57***	***0.60***	***0.50***	***9.45***	***7.70***	***1.22***	***0.50***
LULC12 (Medium Density Residential)	0.28	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC13 (High Density Residential)	0.41	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC14 (Commercial)	0.72	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC15 (Industrial)	0.53	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC16 (Institutional)	0.34	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC17 (Extractive)	0.02	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC18 (Open Urban Land)	0.09	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC21 (Cropland)	0.00	23.07	0.00	1.17	0.00	13.10	0.00	0.68	0.00	16.11	0.00	0.84	0.00
LULC22 (Pasture)	0.00	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC23 (Orchards)	0.00	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC24 (Feeding Operations)	0.02	27.24	0.00	1.24	0.00	18.84	0.00	1.00	0.00	22.42	0.00	1.31	0.00
LULC25 (Row and Garden Crops)	0.00	23.07	0.00	1.17	0.00	13.10	0.00	0.68	0.00	16.11	0.00	0.84	0.00
LULC41 (Deciduous Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC42 (Evergreen Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC43 (Mixed Forest)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC44 (Brush)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC50 (Water)	0.00	10.28	0.00	0.57	0.00	9.68	0.00	0.57	0.00	9.75	0.00	0.57	0.00
LULC60 (Wetlands)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC71 (Beaches)	0.00	1.78	0.00	0.02	0.00	1.27	0.00	0.02	0.00	1.28	0.00	0.02	0.00
LULC72 (Bare Rock)	1.00	11.32	0.00	1.13	0.00	7.15	0.00	0.60	0.00	9.45	0.00	1.22	0.00
LULC73 (Bare Ground)	0.09	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00
LULC80 (Transportation)	0.95	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC191 (Rural Residential)	0.04	11.32	8.04	1.13	0.50	7.15	7.57	0.60	0.50	9.45	7.70	1.22	0.50
LULC241 (Feeding Operations)	0.02	27.24	0.00	1.24	0.00	18.84	0.00	1.00	0.00	22.42	0.00	1.31	0.00
LULC242 (Agricultural Buildings)	0.02	6.65	0.00	0.59	0.00	6.02	0.00	0.86	0.00	10.68	0.00	2.03	0.00

DATA PROVIDED BY MARYLAND'S DEFAULT WATER RESOURCES PLAN SPREADSHEET (CONT'D)

Tributary Strategy Implementation Loading Rates												
		Basin 1 Loading Rates Patuxent Above Fall (lbs/acre/year)				Basin 2 Loading Rates Patuxent Below Fall (lbs/acre/year)				Basin 3 Loading Rates Potomac Below Fall (lbs/acre/year)			
	Impervious	*Nitrogen*		*Phosphorus*		*Nitrogen*		*Phosphorus*		*Nitrogen*		*Phosphorus*	
MDP Land Use Categories	*Imp Pct*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*	*Per-vious*	*Imper-vious*
LULC11 (Low Density Residential)	***0.14***	***7.76***	***6.15***	***0.69***	***0.41***	***5.01***	***5.83***	***0.39***	***0.41***	***6.88***	***6.60***	***0.72***	***0.37***
LULC12 (Medium Density Residential)	0.28	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC13 (High Density Residential)	0.41	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC14 (Commercial)	0.72	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC15 (Industrial)	0.53	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC16 (Institutional)	0.34	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC17 (Extractive)	0.02	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC18 (Open Urban Land)	0.09	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC21 (Cropland)	0.00	15.22	0.00	1.25	0.00	7.74	0.00	0.65	0.00	10.04	0.00	0.78	0.00
LULC22 (Pasture)	0.00	4.31	0.00	0.16	0.00	6.30	0.00	1.01	0.00	16.87	0.00	3.79	0.00
LULC23 (Orchards)	0.00	4.31	0.00	0.16	0.00	6.30	0.00	1.01	0.00	16.87	0.00	3.79	0.00
LULC24 (Feeding Operations)	0.02	17.75	0.00	1.10	0.00	11.94	0.00	0.85	0.00	14.16	0.00	1.07	0.00
LULC25 (Row and Garden Crops)	0.00	15.22	0.00	1.25	0.00	7.74	0.00	0.65	0.00	10.04	0.00	0.78	0.00
LULC41 (Deciduous Forest)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC42 (Evergreen Forest)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC43 (Mixed Forest)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC44 (Brush)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC50 (Water)	0.00	8.65	0.00	0.57	0.00	8.17	0.00	0.57	0.00	8.19	0.00	0.57	0.00
LULC60 (Wetlands)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC71 (Beaches)	0.00	1.68	0.00	0.02	0.00	1.21	0.00	0.01	0.00	1.21	0.00	0.02	0.00
LULC72 (Bare Rock)	1.00	7.76	0.00	0.69	0.00	5.01	0.00	0.39	0.00	6.88	0.00	0.72	0.00
LULC73 (Bare Ground)	0.09	4.31	0.00	0.16	0.00	6.30	0.00	1.01	0.00	16.87	0.00	3.79	0.00
LULC80 (Transportation)	0.95	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC191 (Rural Residential)	0.04	7.76	6.15	0.69	0.41	5.01	5.83	0.39	0.41	6.88	6.60	0.72	0.37
LULC241 (Feeding Operations)	0.02	17.75	0.00	1.10	0.00	11.94	0.00	0.85	0.00	14.16	0.00	1.07	0.00
LULC242 (Agricultural Buildings)	0.02	4.31	0.00	0.16	0.00	6.30	0.00	1.01	0.00	16.87	0.00	3.79	0.00

MARYLAND DEPT. OF PLANNING LAND USE/LAND COVER CLASSIFICATION DEFINITIONS

The land use/land cover classification scheme described below has been used to identify the predominant usage of land that could be interpreted from high altitude aerial photography and satellite imagery. The LU_CODE field, in each county land use shape file, contains the 2 or 3 digit integer numbers identified below.

In general, only land uses greater than ten acres in size have been identified. Transportation features such as roads, highways, rail lines and utility lines have not been included in this GIS database. Transportation features are better represented by the point and line files available from the Maryland State Highway Administration.

10 Urban Built-Up

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

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

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

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

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

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

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

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

191 Large lot subdivision (agriculture)—Residential subdivisions with lot sizes of less than 20 acres but at least 5 acres, with a dominant land cover of open fields or pasture.

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

20 Agriculture

21 Cropland—Field crops and forage crops.

22 Pasture—Land used for pasture, both permanent and rotated; grass.

23 Orchards/vineyards/horticulture—Areas of intensively managed commercial bush and tree crops, including areas used for fruit production, vineyards, sod and seed farms, nurseries, and green houses.

24 Feeding operations—Cattle feed lots, holding lots for animals, hog feeding lots, poultry houses, and commercial fishing areas (including oyster beds).

241 Feeding operations—Cattle feed lots, holding lots for animals, hog feeding lots, poultry houses.

242 Agricultural building breeding and training facilities, storage facilities, built-up areas associated with a farmstead, small farm ponds, commercial fishing areas.

25 Row and garden crops—Intensively managed truck and vegetable farms and associated areas.

40 Forest

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

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

43 Mixed forest—Forested areas in which neither deciduous nor evergreen species dominate, but in which there is a combination of both types.

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

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

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

70 Barren land

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

72 Bare exposed rock—Areas of bedrock exposure, scarps, and other natural accumulations of rock without vegetative cover.

73 Bare ground—Areas of exposed ground caused naturally, by construction, or by other cultural processes.

80 Transportation—Miscellaneous Transportation features not elsewhere classified.

PLAM Variances from MDE Methodology

PLAM was created to provide a tool for Prince George's County that would allow greater flexibility for future modeling of terrestrial nutrient loads as compared with the MDE spreadsheet provided for the WRE. However, the structure and function of PLAM as applied in this exercise are based on the MDE spreadsheet in format as well as input factors. There were a few variances from the MDE model which were incorporated due to inherent county information (e.g., county land use categories) or format of county data (e.g., data on employment use of septic systems), or a few other reasons as summarized below.

Land Use Categories and Loading Rates

To conduct the nonpoint source loading analysis, nitrogen and phosphorus loading rates (pounds per acre per year) were applied to the land use categories used in the initial and future land use scenarios described in the Loading Rate Data Inputs section. Generally, the MDE "2002 BMP implementation" and full "Tributary Strategy Implementation" nitrogen and phosphorus loading rates and percent of impervious covers provided by MDE for the Water Resources Plan's pollutant load analysis spreadsheet were used for the Planning Department's analysis. The "baseline" conditions in the MDE spreadsheet would have compared initial conditions land use to future 2030 land use based on the full tributary strategy implementation loading rates. In the Planning Department's analysis, the baseline modeling run (Run 1) was run loading rates based on MDE's 2002 BMP implementation rate instead, in order to obtain load estimates that would more likely reflect the current conditions for the county. However the methodology was the same, in that the application of consistent rates across the initial and future conditions illustrated the effect of land use change on terrestrial loading rates.

The following modifications to the MDE 2002 BMP and Tributary Strategy loading rates were made to reflect new land use categories contained in the state's 2007 land use dataset, new mixed-use categories discussed, and knowledge of local conditions in Prince George's County:

- 129—Mixed-Use Residential (Prince George's County Land Use Code): The pervious versus impervious loading rates are the same for each of the developed land uses in the MDE model, but the total loading rate is calculated by applying the percent of impervious area from each LUC to determine the relative weight of the pervious versus impervious portions of the load. Therefore, creation of a new loading rate requires determination of the appropriate percent impervious to be applied to the developed LUC loading rates. The loading rate for the 129—Urban Mixed-Use Residential category was created using an impervious factor to reflect the following land use allocations: 20 percent LUC 13 Residential High; 50 percent LUC 14 Commercial; and 20 percent LUC 18 Urban Open Land. In addition, a 10 percent undeveloped area was included as LUC 44 Brush. In reality, the development mix may more closely approximate 50 percent residential versus 20 percent commercial use, but the purpose in creation of this category was the generation of an impervious profile that would be expected with this type of development (i.e., >= 45 percent).
- 129s—Mixed Use Residential—Smart Growth: This loading rate for this suburban mixed-use residential category was calculated using the same approach as described

above for LUC 129, using an impervious factor to reflect the following land use allocations: 20 percent LUC Residential Medium; 22 percent LUC 13 Residential High; 10 percent LUC 14 Commercial; 8 percent LUC 16 Institutional; 10 percent LUC 81 Roads; and 10 percent LUC 18 Urban Open Land. In addition, 20 percent undeveloped as 18 percent LUC 44 Brush and 2 percent LUC 60 Wetlands was included. In reality, 10 percent Open Urban Land and 20 percent Undeveloped Area may not be achievable, but the mix of open urban, brush and wetland LUCs was used to reflect loading rates representing more natural landscaping anticipated with future smart growth development, as opposed to managed turf and other managed landscaping reflected in the MDE 2002 open urban loading rates. Therefore the goal was to provide a loading rate that reflects less managed open space without changing the open urban rates provided by MDE. The overall impervious percent associated with this LUC is approximately 35 percent.

- 149—Mixed Use Commercial (Prince George's County Land Use Code): This LUC was created using the same impervious factor and loading rates as LUC 14 Commercial to reflect mixed commercial use including retail, office, and other nonresidential uses.
- 191—Large Lot Subdivision (agriculture): Loading rates and impervious factor are the same as the Rural Residential land use category provided in the state's default spreadsheet.
- 192—Large Lot Subdivision (Forest): Impervious factor is the same as Rural Residential. However, pervious loading rates adjusted to reflect 90 percent Forested (LUC 41) and 10 percent developed as Residential Low (LUC 11).
- 72—Bare Exposed Rock and 73—Bare Ground: Impervious loading rates changed to match pervious loading rates to correct the state-issued impervious rate of 0.0 for these two LUCs.

In addition, some county land use categories were used in PLAM in lieu of the state provided land use categories, as summarized below.

- 81 Roads—Same as LUC 80 Transportation loading rates, but with 100 percent impervious. Assumes this is 100 percent pavement, not right-of-way.
- 101 Rural (Agriculture)—Loading rates and impervious same as LUC 191, Rural Residential.
- 102 Rural (Forest)—Impervious same as LUC 191. Adjusted pervious loading rates to reflect 90 percent Forested (LUC 41), 10 percent developed as LUC 11 - Residential Low. Same as LUC 192.
- 111 Rural—Loading rates and impervious same as LUC 191, Rural Residential. County definition of 111 = density 5 to 20 acres same as 191.
- 112 Residential Low Medium—Adjusted impervious to reflect 50 percent LUC 11 Residential Low, 50 percent LUC12 Residential Medium. Loading rates same as other residential.
- 123 Residential Medium High—Adjusted impervious to reflect 50 percent LUC 12 Residential Medium, 50 percent LUC 13 Residential High. Loading rates same as other residential.

- 241 Feeding operations 2—Impervious increased to 10 percent to be consistent with MDP assumptions; accounts for agricultural building rooftops.
- 242 Agricultural building breeding and training—Impervious increased to 10 percent to be consistent with MDP assumptions; accounts for agricultural building rooftops.

New loading rate data sets were also created for some model runs to reflect the application of various BMPs. Descriptions of these model runs, including an explanation of how these BMPs were applied, are provided in the Model Runs section.

Septic Data

The septic data inputs were developed per MDE methodology except for the number of non-residential septic inputs. As described in the Septic System Data Inputs section, the method of estimating nonresidential septic loads provided by MDE in the Water Resources Plan model is based on estimated nonresidential septic flow per nonresidential acre. Because the county's GIS system used for future land use projections does not delineate nonresidential acres in non-sewered areas, this method was not applicable for future load estimates. Therefore, the county's available data reflecting the number of employees outside the sewer envelope were used with a conversion factor to estimate nitrogen loads based on factors provided in the MDE Water Resources Plan model as well as data provided by WSSC, as described in more detail in the Load Rate Data Inputs section.

APPENDIX II: WSSC WASTEWATER CAPACITY PROJECTIONS

WASHINGTON SUBURBAN SANITARY COMMISSION

Interoffice Memorandum

TO: CRAIG A. FRICKE, GROUP LEADER
PLANNING GROUP

FROM: KENNETH DIXON, PLANNING UNIT COORDINATOR
PLANNING GROUP

DATE: MAY 8, 2008

SUBJECT: ADOPTION OF DRAFT 2006 WSSC WASTEWATER FLOW PROJECTIONS

The Planning Group's Wastewater Planning Unit developed wastewater flow projections for the wastewater treatment plants serving the Sanitary District. Using the same methodology as used in the December 2001 projections report, wastewater treatment flow projections were made from 2005 to 2030 using "sewered area" Round 7 demographic forecasts for single- and multi-family households as well as employees in the Bi-County service area.

Attached are the most recent projections conducted in 2006, at five-year increments, with the accompanying charts indicating the current (2006) projection and the previous projection made in 2001.

I recommend that these 2006 Wastewater Flow Projections be approved for wastewater planning purposes.

Endorsed and transmitted to the Chief Engineer:

Recommend approval

cc:

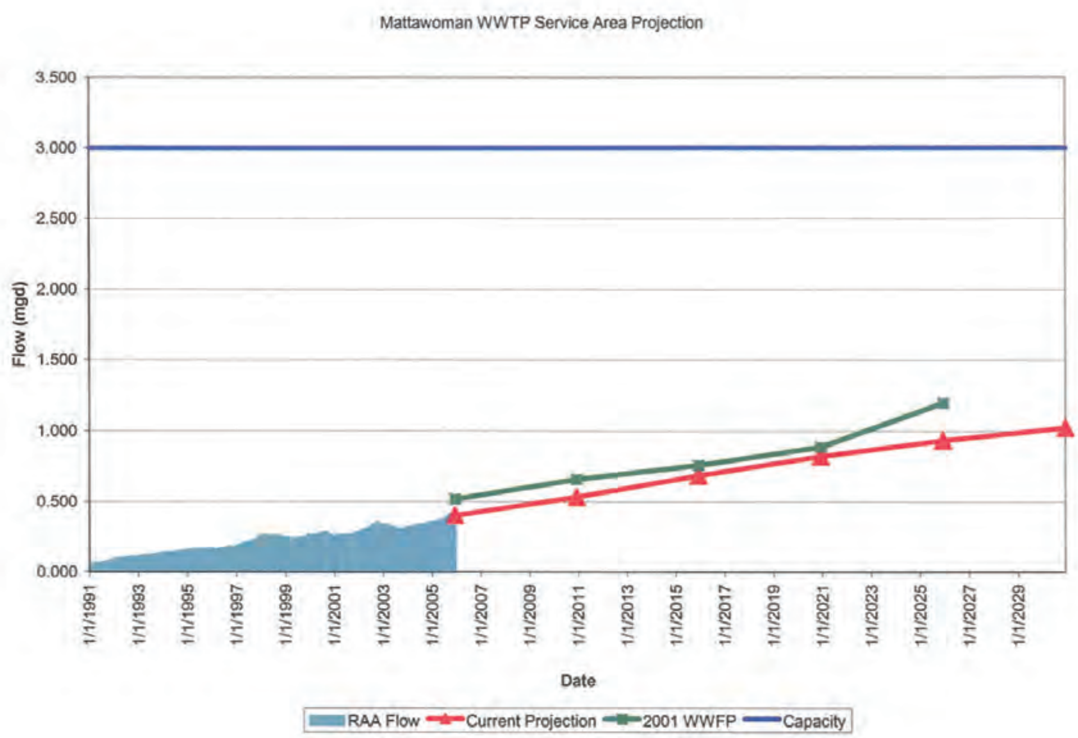
Mattawoman

Existing Flow 2005	0.40	mgd
Total	0.40	mgd

Flow Factors

SFDU =	255	gpd/sfdu
MFDU =	178	gpd/mfdu
EMP =	40	gpd/emp

	Units					
Year	**SFDU**	**MFDU**	**EMP**	**AWF**	S.S.Study Projections	**Capacity**
2005	1074	3	2312	0.40 mgd	0.52	3
2010	1489	3	2958	0.53 mgd	0.66	3
2015	1894	58	3952	0.68 mgd	0.76	3
2020	2275	63	4923	0.82 mgd	0.89	3
2025	2567	63	5842	0.93 mgd		3
2030	2761	227	6127	1.02 mgd		3



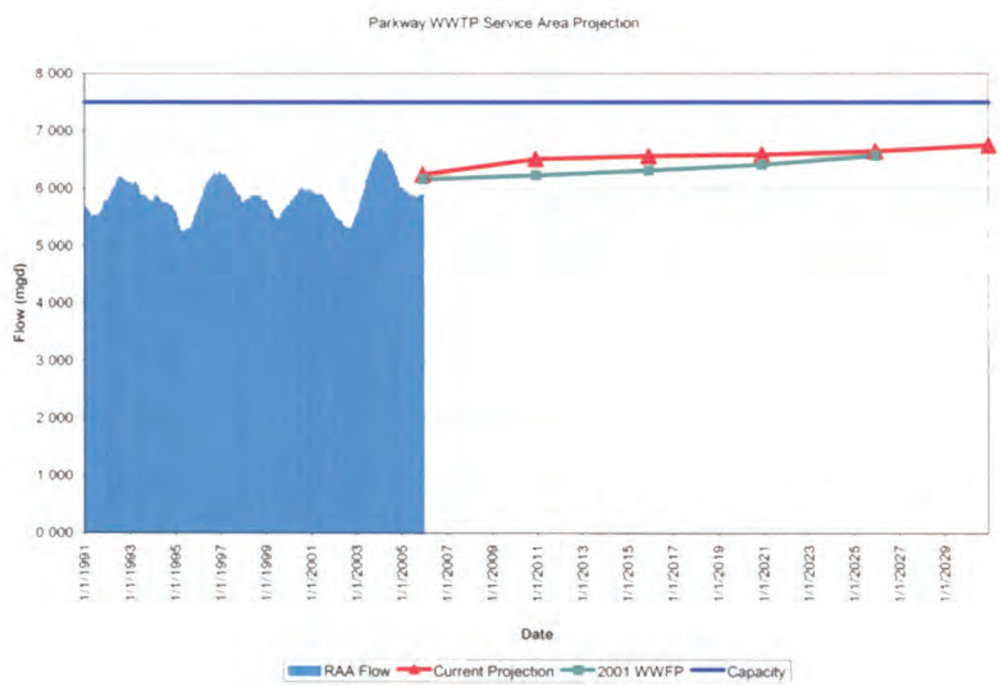
Parkway

Existing Flow 2005	6.24	mgd
Total	6.24	mgd

Flow Factors

SFDU =	255	gpd/sfdu
MFDU =	178	gpd/mfdu
EMP =	40	gpd/emp

Year	SFDU	MFDU	EMP	AWF		2001 WFP	Capacity
2005	9537	6917	18097	6.24	mgd		7.5
2010	10154	7216	19607	6.51	mgd		7.5
2015	10466	7088	19438	6.56	mgd		7.5
2020	10594	6989	19751	6.59	mgd		7.5
2025	10693	7038	20417	6.65	mgd		7.5
2030	10789	7230	21445	6.75	mgd		



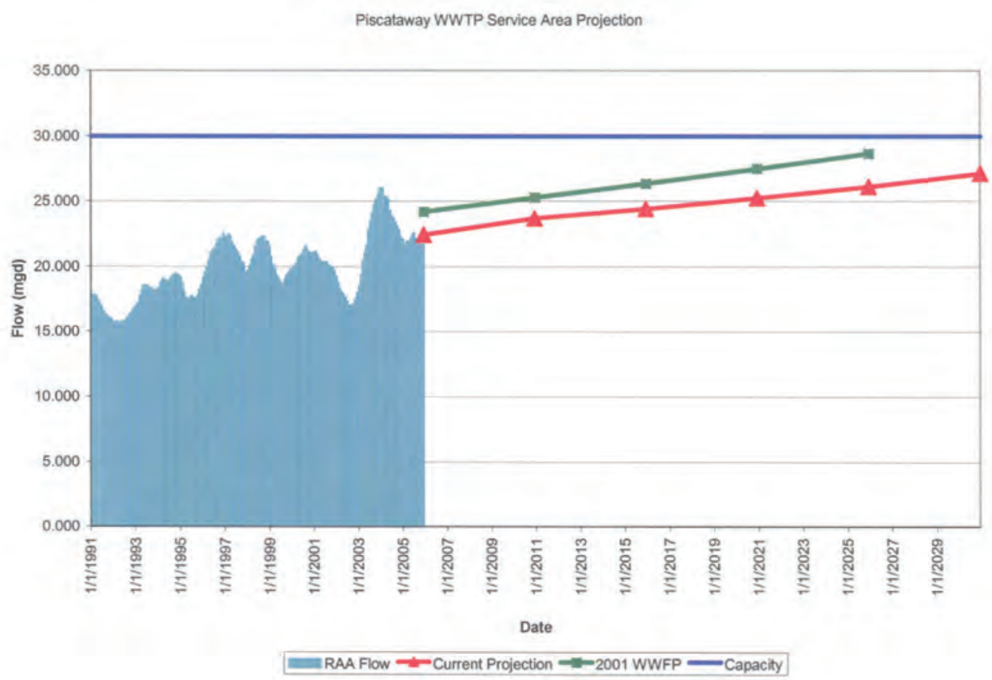
Piscataway

Existing Flow 2005	22.42	mgd
Total	22.42	mgd

Flow Factors

SFDU =	255	gpd/sfdu
MFDU =	178	gpd/mfdu
EMP =	40	gpd/emp

Year	SFDU	MFDU	EMP	AWF		2001 WWFP	Capacity
2005	42373	12679	52134	22.42	mgd	24.22	30
2010	46095	13516	56081	23.68	mgd	25.32	30
2015	46945	14635	63993	24.41	mgd	26.38	30
2020	47764	16726	69938	25.23	mgd	27.52	30
2025	48747	18601	76952	26.10	mgd	28.68	30
2030	50226	20764	83488	27.12	mgd	#N/A	30



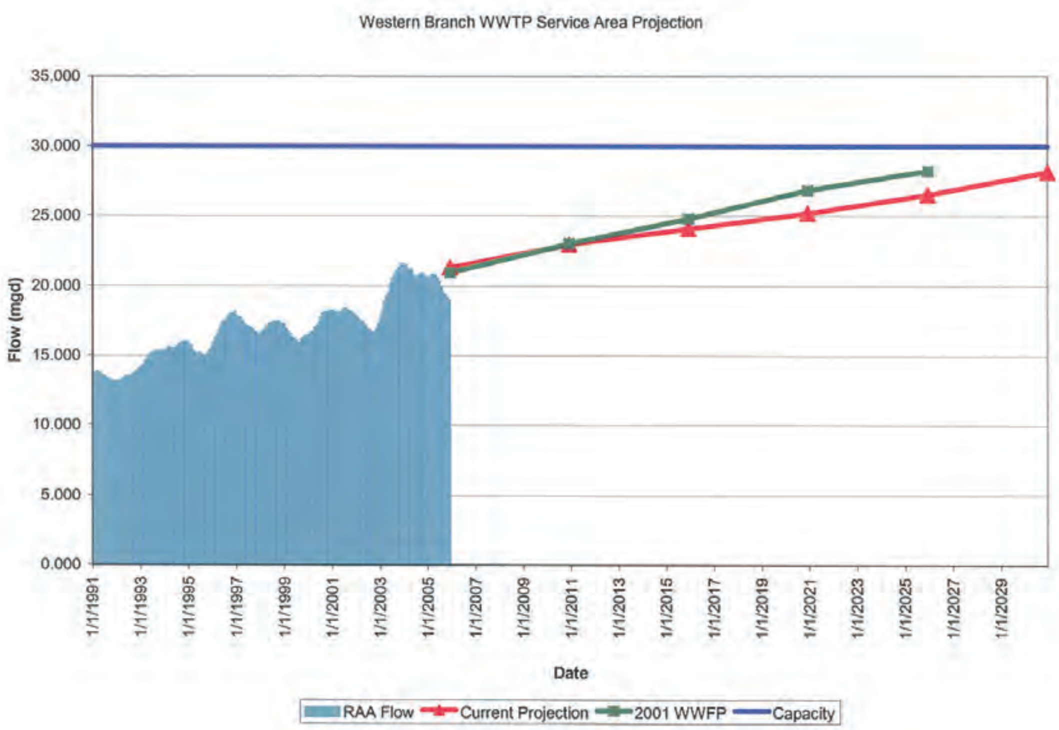
Western Branch

Existing Flow 2005	21.29	mgd
Total	21.29	mgd

Flow Factors

SFDU =	255	gpd/sfdu
MFDU =	178	gpd/mfdu
EMP =	40	gpd/emp

Year	SFDU	MFDU	EMP	AWF		2001 WWFP	Capacity
2005	67514	11100	81517	21.29	mgd	20.96	30
2010	71766	12612	88859	22.94	mgd	23.03	30
2015	74447	14209	92842	24.06	mgd	24.83	30
2020	76582	16176	98270	25.17	mgd	26.87	30
2025	78653	17890	110674	26.50	mgd	28.25	30
2030	82600	19859	117509	28.13	mgd		30



Blue Plains

Existing Flow 2005	131.12	mgd
Total	131.12	mgd

Flow Factors

SFDU =	255	gpd/sfdu
MFDU =	178	gpd/mfdu
EMP =	40	gpd/emp

Year	SFDU	MFDU	EMP	AWF		2001 WWFP	Capacity
2005	238032	140016	570796	131.12	mgd	127.08	169.6
2010	247504	151189	595271	136.50	mgd	131.8	169.6
2015	249759	168198	647286	142.19	mgd	135.67	169.6
2020	253280	182086	691923	147.34	mgd	139.74	169.6
2025	256506	195270	735747	152.26	mgd	143.34	169.6
2030	258884	209906	772129	156.93	mgd	#N/A	169.6

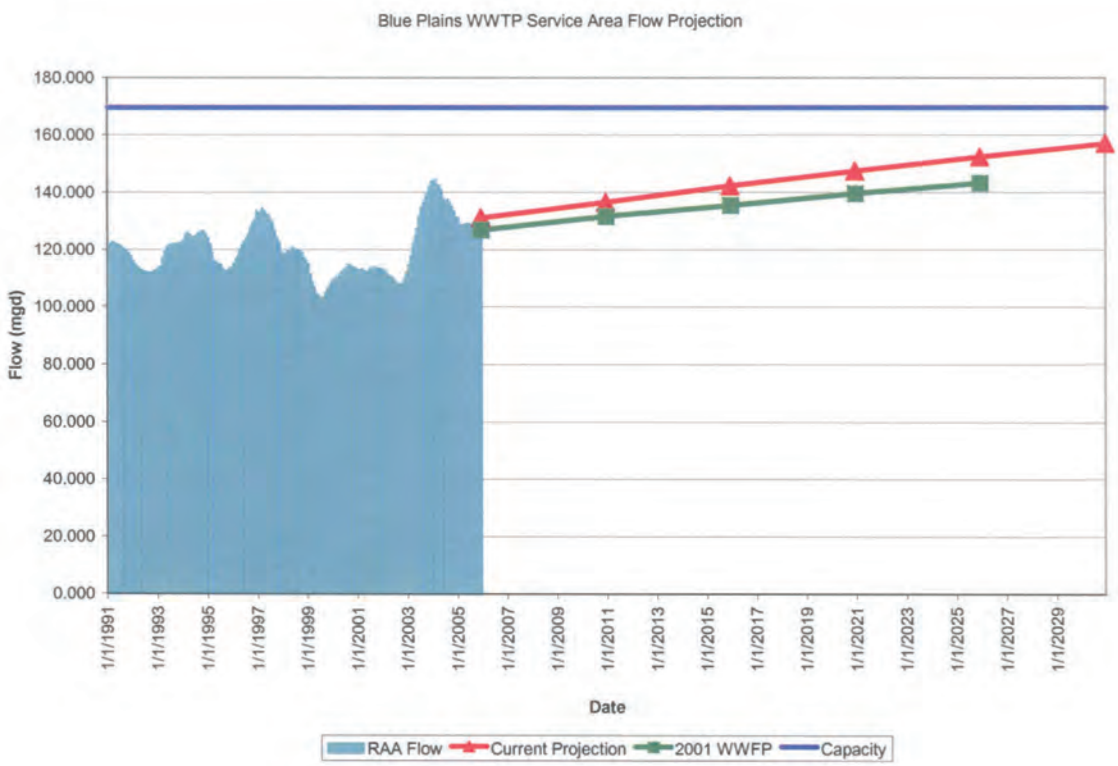


Table 1: Estimated Current and Future Point Source Nitrogen and Phosphorus Loads

Major Wastewater Treatment Plants	Discharge Location/ Subwatershed	2005		2030		Chesapeake Bay Program Limit	
		TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
Parkway WWTP[1]	Patuxent River/ Upper Patuxent	63,557	3,890	82,800	6,210	91,370	6,850
Bowie WWTP[2]	Unnamed Tributary of Patuxent River/ Upper Patuxent	34,525	1,225	40,201	3,015	40,201	3,015
Western Branch WWTP[1]	Western Branch/ Western Branch	86,663	29,677	340,940	25,570	372,600	27,945
Marlboro Meadows WWTP[1]	Unnamed Tributary of Patuxent River/ Western Branch	12,490	1,038	---	---	---	---
Total Patuxent Point Source Load		***197,235***	***35,830***	***463,941***	***34,795***	***504,171***	***37,810***
Potomac Below Fall Watershed							
Piscataway WWTP[1]	Potomac River/ Piscataway	191,776	6,941	328,763	14,794	365,300	16,440
Beltsville USDA East WWTP[2]	Unnamed Tributary of Beaverdam Creek/ Anacostia	3,566	1,710	7,553	566	7,553	566
Total Potomac Point Source Load		***195,342***	***8,651***	***336,316***	***15,360***	***372,853***	***17,006***
Total Six Major WWTPs with Discharges in Prince George's County		392,577	44,481	800,257	50,155	877,024	54,816
Blue Plains WWTP*	Potomac River (DC)	669,550	13,896	645,349	29,041	NA	NA

Nitrogen and Phosphorus Load Data Sources:

[1] Washington Suburban Sanitary Commission. Notes: The Marlboro Meadows WWTP will not be operating in 2030. Flows will be directed to the Western Branch WWTP (as reflected in the loads data presented in this table). *The Blue Plains WWTP treats flow from Prince George's County sewersheds but does not discharge into Prince George's County watersheds. Therefore Blue Plains loads were not included in the NPS nutrient modeling runs which were conducted to estimate nutrient loads to county watersheds.

[2] Loads for Bowie and Beltsville USDA WWTPs for 2005 and 2030 (assumed equal to the Maryland ENR total load caps) taken from Maryland's Tributary Strategy Statewide Implementation Plan, 2008. The Town of Bowie anticipates flows lower than the 3.3 mgd plant capacity in 2030, which would be expected to produce loads lower than the ENR caps if the plant is achieving ENR performance. The higher ENR caps therefore provide a conservative estimate of Bowie WWTP point source loads in lieu of plant-specific data, but should be revisited after the plant's ENR upgrades are brought into service, or upon any revisions to the terms of the plant's NPDES permit.

As shown above, the loads from the six major wastewater treatment plants in Prince George's County are projected to be near their ultimate nutrient load capacities in the year 2030.

NA = not applicable

Table 2

Sanitary Sewer Overflows Documented in 2009								
Type	Munic./Facility	Duration			Zip	Gals. (Est.)	Cause	Receiving Waters
		Days	Hours	Min				
SSO	WSSC	0	1	19	20737	5	unknown	Northwest Branch
SSO	WSSC	0	6	54	20744	288813	Excess flow	Broad Creek
SSO	WSSC	0	4	48	20744	1900	Excess flow	Broad Creek
SSO	WSSC	0	4	44	20774	1419	Grease	Western Branch
SSO	WSSC	0	1	22		30	unknown	
SSO	WSSC	0	2	51	20607	100	unknown	Piscataway Creek
SSO	WSSC	0	1	45	20607	7350	Precipitation	Piscataway Creek
SSO	WSSC	0	2	25	20744	69700	Precipitation	Broad Creek
SSO	Bowie, City of	0	2	0	20715	30000	Pipe break	Unknown
SSO	Bowie, City of	0	2	0	20715	30000	Construction error	Unknown
SSO	WSSC	0	7	33	20740	250	Roots	Northeast Branch
SSO	WSSC	0	3	59	20744	24		Unknown
SSO	WSSC	0	2	22	20707	80	Grease	Patuxent River
SSO	WSSC	0	3	14	20715	10	unknown	Horsepen
SSO	WSSC	0	0	15	20707	4200	Other	Patuxent River
SSO	WSSC	0	1	15	20735	5	unknown	Piscataway Creek
SSO	WSSC	0	5	23	20743	1614	Grease	Oxon Run
SSO	WSSC	0	2	14	20743	134	unknown	Oxon Run
SSO	WSSC	0	3	22	20772	5	Roots	Western Branch
SSO	WSSC	0	3	20	20782	200	Debris	Northwest Branch
SSO	WSSC	0	2	9	20901	1548	Grease	Sligo Creek
SSO	Bowie, City of				20715	2000	operator error	Unknown
SSO	WSSC	0	0	10	21705	2000		
SSO	WSSC	0	2	29	20737	297	2976	Northeast Branch
SSO	Bowie, City of				20715	3000	Mechanical Failure	Unknown
SSO	WSSC	0	4	44	20607	28	Debris	Mattawoman
SSO	WSSC	0	4	6	20607	130872	Excess Flow	Piscataway Creek
SSO	WSSC	0	8	25	20747	2021	Debris	Western Branch
SSO	WSSC	0	2	6	20774	126	Roots	Western Branch
SSO	WSSC	0	2	10	20782	1	Debris	Sligo Creek
SSO	WSSC					5	unknown	
SSO	WSSC	0	1	5	20782	65	unknown	Sligo Creek
SSO	WSSC						Mechanical Failure	Unknown
SSO	WSSC				20854			
SSO	WSSC	0	2	37	20785	943	Grease	Beaverdam Branch
SSO	WSSC						Pipe break	
SSO	WSSC	1	0	16	20735	146	Defective material	Piscataway Creek
SSO	WSSC	0	1	39	20744	1	Damaged by others	Broad Creek
SSO	WSSC	0	1	43	20706	31	Grease	Northeast Branch
SSO	WSSC	0	2	59	20735	179	Grease	Piscataway Creek
SSO	WSSC					1	unknown	Unknown

Table 2 (cont'd)

SSO	WSSC	0	3	0	20743	90	Grease	Beaverdam Branch
SSO	WSSC	0	2	5	20747	125	Grease	Broad Creek
SSO	WSSC	0	2	17	20785	205	Debris	Beaverdam Branch
SSO	WSSC	0	2	1	20613	1	Roots	Mattawoman
SSO	WSSC	0	3	42	20705	4	unknown	Northeast Branch
SSO	WSSC	0	12	35	20744	755	Force main failure	Piscataway Creek
SSO	WSSC							
SSO	U.S.D.A. Beltsville	0	0	45		1000	Rainfall	Unknown
SSO	WSSC	0	4	24	20770	100	Roots	Northeast Branch
SSO	WSSC	0	2	59	20785	358	Grease	Beaverdam Branch
SSO	WSSC	0	4	47	20743	57	Damaged by others	Beaverdam Branch
SSO	WSSC	0	4	21	20715	15	Debris	Horsepen
SSO	WSSC	0	1	10	20735	70	Grease	Piscataway Creek
SSO	WSSC	0	3	5	20720	924	Grease	Horsepen
SSO	WSSC	0	6	52	20735	82	Grease	Piscataway Creek
SSO	WSSC	0	3	13	20772	1	Damaged by others	Patuxent River
SSO	WSSC	0	5	20	20783	677	Other	Northwest Branch
SSO	WSSC	0	4	38	20753	1389	Grease	Oxon Run
SSO	WSSC	0	2	38	20706	158	Grease	Northeast Branch
SSO	WSSC	0	0	5	20708	999	Other	Patuxent River
SSO	WSSC	0	1	40	20735	501	unknown	Piscataway Creek
SSO	WSSC	0	6	53	20746	826	Defective material	Broad Creek
SSO	WSSC	0	2	59	20743	89	Grease	Oxon Run
SSO	WSSC	0	7	59	20708	2594	Grease	Patuxent River
SSO	WSSC	0	2	6	20744	252	Grease	Western Branch
SSO	WSSC	0	5	59	20710	500	unknown	Northeast Branch
SSO	WSSC	0	6	57	20706	40	Roots	Oxon Run
SSO	WSSC	0	3	33	20710	35	Tampering	Northeast Creek
SSO	USDA				20705	8000	abandoned pipe leak	Beaver Dam Creek
SSO	WSSC	0	2	51	20744	855	Grease	Broad Creek
SSO	WSSC	0	4	12	20910	6300	Grease	Patuxent River
SSO	WSSC	0	13	45	20707	11570	Tampering	Patuxent River
SSO	NASA	0	0	45	20771	30	Blockage	Beaverdam Creek
SSO	WSSC	0	1	10	20707	1	unknown	Patuxent River
SSO	WSSC	0	2	20	20785	70	Grease	Beaverdam Branch
SSO	WSSC	0	5	5	20607	30500	Debris	Piscataway Creek
SSO	WSSC	0	5	32	20607	50	Damaged by others	Unknown
SSO	WSSC	0	3	8	20773	188	Grease	Western Branch
SSO	WSSC	0	3	12	20781	576	Debris	Anacostia River
SSO	WSSC	0	3	2	20744	909	unknown	Piscataway Creek
SSO	WSSC	0	0	45	20745	270	Debris	Oxon Run
SSO	WSSC	0	4	43	20747	850	Grease	Broad Creek
SSO	WSSC	0	4	43	20747	850	Grease	Broad Creek
SSO	WSSC	0	18	0		300	Clarifiers cracked	Unknown
SSO	WSSC	0	2	3	20721	123	unknown	Western Branch
SSO	WSSC	0	1	53	20735	5	Debris	Piscataway Creek
SSO	WSSC	0	7	40	20708	920	unknown	Northeast Branch

Table 2 (cont'd)

SSO	WSSC	0	5	45	20743	4	Defective material	Oxon Run
SSO	WSSC	0	3	43	20774	2232	Debris	Western Branch
SSO	WSSC	0	2	45	20782	330	Grease	Anacostia River
SSO	WSSC	0	18	14	20743	5469	Debris	Beaverdam Branch
SSO	WSSC	0	3	4	20782	1842	Grease	Sligo Creek
SSO	WSSC	0	8	5	20744	485	Defective material	Broad Creek
SSO	WSSC	0	10	53	20782	19584	Other	Sligo Creek
SSO	WSSC	0	0	30	20846	30	Grease	Broad Creek
SSO	WSSC	0	3	34	20707	10710	Grease	Patuxent River
SSO	WSSC	0	28	30	20745	1000	Force main failure	Oxon Run
SSO	WSSC	0	2	9	20735	129	Roots & Grease	Piscataway Creek
SSO	WSSC	0	14	55	20744	895	Roots	Piscataway Creek
SSO	WSSC	0	1	58	20747	2069	Grease	Broad Creek
SSO	WSSC	0	7	10	20737	430	Roots	Northeast Branch
SSO	WSSC	0	5	11	20705	311	Debris	Northeast Branch
SSO	WSSC	0	5	12	20747	15600	Grease	Western Branch
SSO	WSSC	0	2	5	20705	624	Grease	Patuxent River
SSO	WSSC	0	4	55	20721	1476	Grease	Western Branch
SSO	WSSC	0	12	10	20781	5111	Debris	Beaverdam Branch
SSO	WSSC	0	2	42	20742	30	Debris	Paint Branch
SSO	WSSC	0	8	3	20781	966	Grease	Anacostia River
SSO	WSSC	0	8	45	20735	525	Other	Piscataway Creek
SSO	WSSC	0	11	10	20807	670	Other	Piscataway Creek
SSO	WSSC	0	5	17	20745	1584	Grease	Broad Creek
SSO	WSSC	0	6	6	20707	37	Debris	Patuxent River
SSO	WSSC	0	14	42	20743	4410	Debris	Beaverdam Branch
SSO	WSSC	0	1	53	20748	1	Unknown	Oxon Run
SSO	WSSC	0	2	33	20744	77	Unknown	Piscataway Creek
SSO	WSSC	0	8	49	20772	1588	Workmanship failure	Western Branch

Disclaimer: Data on this spreadsheet was generated using the MDE website. In no event shall MDE, nor its employees, officers or agents become liable to users of the data provided herein for any loss arising from the use, operation or modification of the data.

APPENDIX III: WSSC 2006 WATER PRODUCTION PROJECTIONS

EXECUTIVE SUMMARY

WSSC's average water production is expected to increase by about one percent per year, reaching 224 million gallons per day (mgd) in the year 2030. These latest projections are slightly lower than the previous projections done in 2001 (Water Productions Projections, WSSC, Planning Group, April 2001).

The actual water production of 171.9 mgd in 2005 was the second highest in WSSC history, behind 1994. After declining and flat water productions from 1994 to 2003, recent years have shown steady increases. Per (household) unit water production has remained flat over the past five years after significant decreases during the preceding 15 years. If per unit production continues to hold steady, total production will continue to increase as new units are added.

The ratio applied to projected average production to obtain a future year's projected maximum day production has been recalculated by including the most recent actual data. The resulting ratio of 1.48 is a very slight (less than one percent) decrease from the previous ratio. As has been the case since 1994, the calculation of this ratio incorporates a 20 percent probability that it will be exceeded by the actual ratio in any given year.

Water supply to other jurisdictions (wholesale) recently increased (due to supply interruptions from alternate sources) to 3.92 mgd (2.3 percent of current production), and outstanding commitments are about 12.4 mgd (seven percent of our current production). Such supplies and potential requests for additional supplies present possibilities for additional future increases in our production requirements.

INTRODUCTION

This report provides the latest WSSC water production projections and provides background information on how the projections were developed. In subsequent planning efforts, these water production projections will be used to analyze the adequacy of the existing water system to meet future needs and to determine the timing and sizing of needed improvements.

The development of water production projections involves these major steps:

- Development of per unit water production factors.
- The allocation of units provided by demographic growth forecasts to water system pressure zones.
- The calculation of annual average water production (by pressure zones), the grouping of pressures zones, and the calculation of group and system totals.
- The calculation of maximum day ratios for the system and pressure zone groups.
- The accounting for supplies to other jurisdictions.

PER UNIT WATER PRODUCTION FACTORS

This is a critical step in the development of water production projections. Per unit production factors are multiplied by the number of forecasted units to calculate projected water production. These factors reflect whether WSSC customers are using more or less water per unit and what those use patterns are expected to be in the future.

The units for which per unit production data are developed are: single family households, multifamily households, and employees. These types of units are included in the Cooperative Growth Forecasts provided by the Metropolitan Washington Council of Governments and The Maryland-National Capital Park and Planning Commission.

Here it is important to distinguish between water production and water consumption. Water production is the amount of water leaving the treatment plants and entering the distribution system. Water consumption is the amount of water being measured as it leaves the distribution system. The difference between the two is the water leaving the distribution system without being measured. This water is sometimes called unaccounted-for water. The ratio of production divided by consumption is referred to here as the production factor.

Since production is the amount of water that must flow through the distribution system, water production is usually more relevant than water consumption for the purposes of water system analysis and planning. To obtain per unit production data, per unit consumption is calculated from customer service data and then multiplied by the production factor.

One problem when comparing production data with consumption data is a lack of synchronization. Since the hundreds of thousands of customer meters in the WSSC system are read on different schedules, there is no single time interval for which total system consumption is available. To minimize the inaccuracies from asynchronous meter readings, a year's worth of consumption is averaged and compared with the corresponding production data. For this report, consumption data from January 2005 to December 2005 was used.

The term "DAC" refers to daily average consumption. Figure 1 shows a pie chart of 2005 DAC for the entire system, divided by unit type.

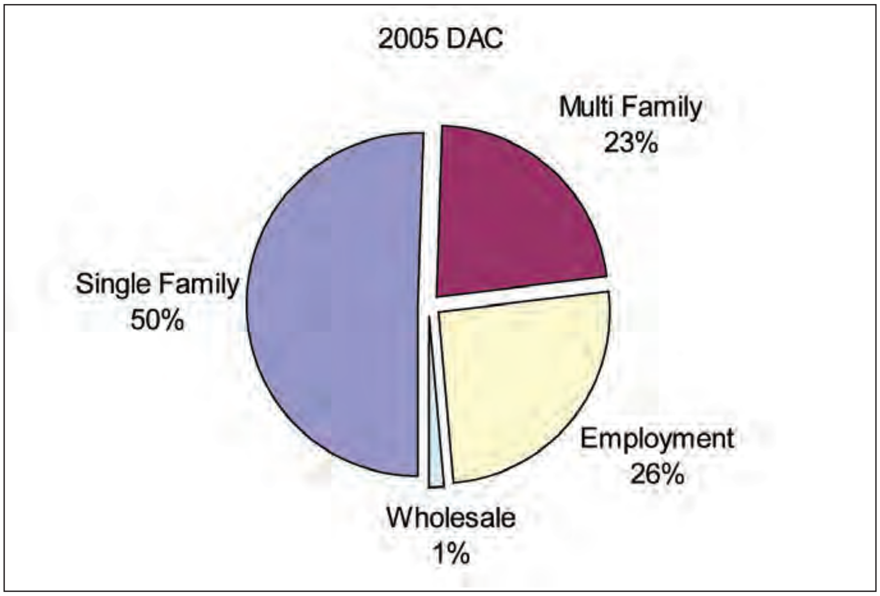


Figure 1: Daily average consumption.

The production factor (production divided by consumption) for the year was calculated at 1.196. This is within the range of production factors calculated over the previous ten years, as shown in Figure 2. (Note: since this calculation was not done using all "known" water uses, only "metered" water uses, it should not be considered a complete water audit appropriate for all purposes).

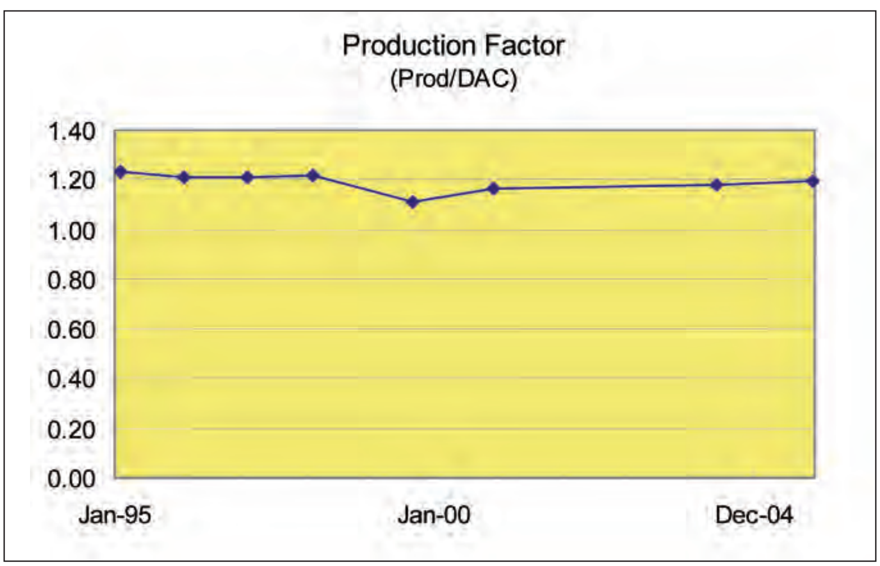


Figure 2: Production factors.

The per unit production factors for all existing units were calculated (in gallons per day) to be: single family—218; multifamily—194; and employees—56. Graphs showing these numbers in the context of historical trends over the past 20 years are shown in Figures 3, 4, and 5. The trends for single family and multifamily show the factors have been consistent over the most recent five years after steady decreases over the first 15 years. The factor for employees is more variable, probably because water use is less strongly a function of the number of employees and the number of employees must be derived from demographic data rather than WSSC's customer service data.

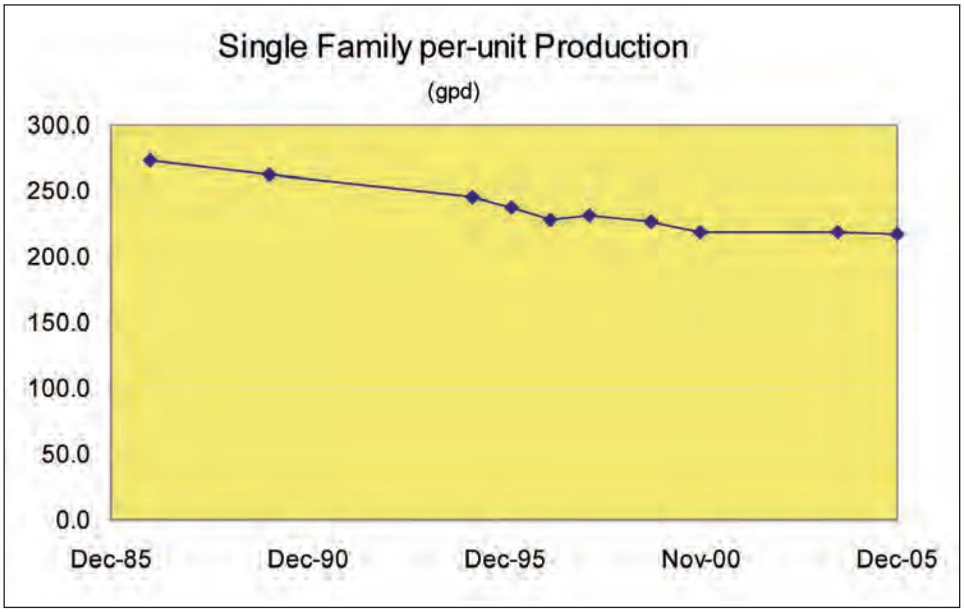


Figure 3: Single-family unit production.

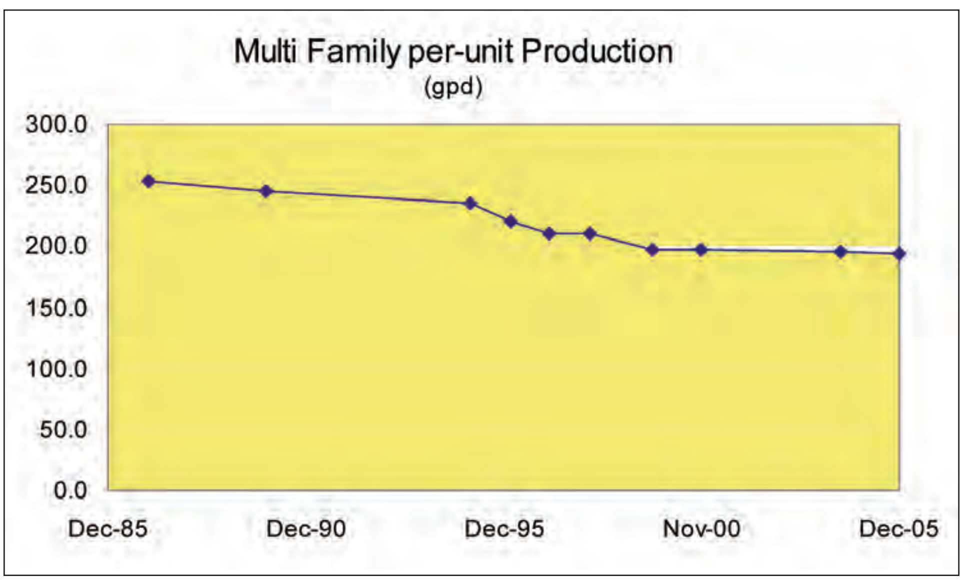


Figure 4: Multifamily unit production.

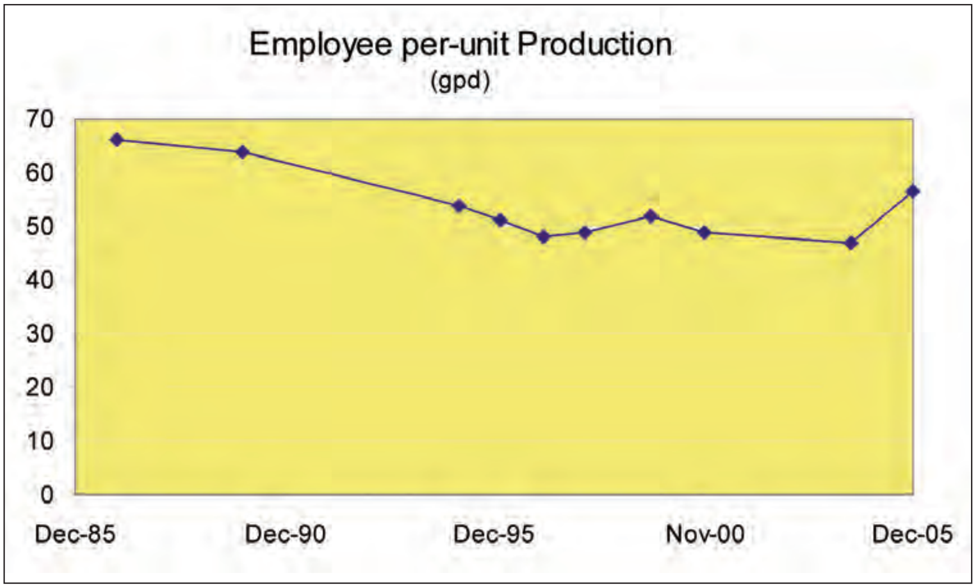


Figure 5: Employees per-unit production.

From 1994 to 2003 actual water production declined or remained flat due to decreasing per unit production offsetting increases in the number of units served. Since 2003, production has increased moderately, resulting in a total production of 171.9 mgd in 2005, the second highest in WSSC history. Given the recent (flat) trends in per unit production, it is expected that total production will increase as new units continue to be added. Because of factors such as weather and economics, the increase in actual production will likely be somewhat erratic.

In an effort to predict the per unit production for future units, a per unit analysis was done only for units built since 1994. The results (in gpd) were: single family—228 and multifamily—181; there was no such analysis for employees. Interestingly, for single-family units, the usage for the newer units is greater than usage for all existing units, while for multifamily units, this usage for newer units is lower than the usage for all existing units.

For projecting future average production, the factors developed from the newer units will be applied to units forecasted after 2005, while the factors developed from all existing units will be applied to units included in the forecast for 2005, as shown in the following table.

Table 1: Recommend Per-Unit Production Factors (in gpd)

	Single-Family	Multifamily	Employment
For units existing as of 2005	218	194	56
For units added after 2005	228	181	56

GROWTH AND AVERAGE PRODUCTION FORECASTS

Round 7.0 Growth Forecasts have been provided by the M-NCPPC for both Prince George's and Montgomery Counties. This data includes single-family and multifamily households, employees, and population in five-year increments through 2030. (Although population data is not used in the calculation of projected water production, it is often useful data with regard to the water system).

The demographic data is provided by geographic units called COG Analysis Zones (CAZs). In general, these geographic units have no relationship to the water system boundaries, so the demographic data must be allocated to water system pressure zones. In past analyses, the allocation process involved tedious and time-consuming manual calculations. Today, WSSC's Geographical Information System (GIS) automates this process and vastly increases the speed at which these allocations are made.

Table 2 shows the number of units allocated to the WSSC water pressure zones, as used for water production projections, and population. For each five-year increment, the table shows units for each county and the total. Based on these numbers and overall population projections, as of 2005, WSSC served 90 percent of the Montgomery County population, 95 percent of the Prince George's County population, and 93 percent of the bicounty population.

By applying the per unit production factors, the demographic data is converted to average water production data and then allocated to water system pressure zones. The resulting water production projections, by pressure zone, are shown in Table 3. In this table, "wholesale" represents supplies to other jurisdictions, which are discussed in more detail later. The wholesale number included for 2005 represents the average actual usage for that year while the number included for the remaining years represents the last three months, when usage increased noticeably.

Although analysis of the impact of these projections on specific projects is beyond the scope of this report (and will be conducted on a project-by-project basis, as needed), some comparison of this data with past projections is appropriate. In general, these water production projections represent a slight decrease in system totals from the previous projections done in 2001. For the year 2005, the decrease is 4.3 mgd (2 percent); for 2020 the decrease is 0.8 mgd (0.4 percent). The breakdown of the system totals between the major zone groups (two in each county) is very consistent with the previous projections.

The year 2005 projection of 174.6 mgd is slightly greater than the 2005 actual production of 171.9 mgd (a difference of 2.7 mgd or 1.6 percent) because there are more units from the demographic data allocated within the water service boundaries than are contained in our customer service data. This possibly is due to existing units currently using wells and other factors. Since units using wells may convert to public water, no adjustment for this difference has been made.

Table 2: Projected Units Served (3/20/2006)					
Year	***County***	***Single Family***	***Multifamily***	***Employees***	***Population***
2005	Montgomery	215851	102380	428079	850770
	Prince George's	195861	98357	350971	812859
	Totals	**411712**	**200738**	**779050**	**1663629**
2010	Montgomery	222909	114896	461860	899299
	Prince George's	201549	105736	382000	832710
	Totals	**424459**	**220631**	**843860**	**1732009**
2015	Montgomery	229849	124968	490478	931463
	Prince George's	205983	113824	415584	853101
	Totals	**435832**	**238792**	**906062**	**1784565**
2020	Montgomery	234262	135606	516289	960543
	Prince George's	210361	121074	451873	873648
	Totals	**444624**	**256680**	**968162**	**1834190**
2025	Montgomery	236243	149510	541189	995052
	Prince George's	215570	129575	491698	907794
	Totals	**451813**	**279085**	**1032888**	**1902846**
2030	Montgomery	237027	164718	561822	1031925
	Prince George's	226348	135661	534741	950098
	Totals	**463375**	**300379**	**1096563**	**1982024**

Table 3: Projected Average Water Production							
Group	***Zone***	***2005***	***2010***	***2015***	***2020***	***2025***	***2030***
mchigh	560A	6.29	6.41	6.61	6.80	6.88	6.92
	660A	35.90	37.69	39.77	41.79	44.05	45.84
	685A	2.12	2.20	2.24	2.27	2.32	2.35
	760A	1.13	1.34	1.54	1.70	1.82	2.02
	836A	0.71	1.48	2.18	2.55	2.79	2.96
	960A	0.79	0.81	0.86	0.90	0.90	0.91
		46.93	**49.93**	**53.19**	**56.01**	**58.76**	**61.00**
mcmain	350A	0.47	0.48	0.48	0.48	0.48	0.48
	495A	44.97	47.80	49.79	51.60	53.45	55.52
	552A	0.64	0.65	0.65	0.65	0.65	0.66
		46.09	**48.92**	**50.92**	**52.73**	**54.58**	**56.65**
pghigh	280A	1.66	1.86	2.10	2.32	2.72	3.07
	290B	3.64	3.89	4.28	4.73	5.07	5.41
	317A	7.44	8.31	8.74	9.09	9.71	10.15
	328A	0.52	0.61	0.70	0.77	0.81	0.90
	355B	1.43	1.48	1.51	1.57	1.64	1.82
	385B	7.04	7.80	8.35	8.84	9.46	10.66
	450A	16.30	16.49	16.95	17.56	18.45	19.34
		40.44	**42.62**	**44.88**	**47.86**	**51.33**	**38.04**
pgmain	320A	31.26	32.68	33.98	35.14	36.44	37.91
	350E	3.58	3.81	4.00	4.17	4.25	4.49
	415A	6.84	7.11	7.56	8.08	8.46	9.04
		41.68	**43.60**	**45.54**	**47.39**	**49.15**	**51.43**
Wholesale		1.92	3.62	3.62	3.62	3.62	3.62
System Totals		**174.6**	**186.5**	**195.9**	**204.6**	**214.0**	**224.0**

Based on Round 7.0 Growth Forecasts and Per-Unit Production:
20-Mar-06 through 2005 SF-218 MF-194 Emp-56; after 2005 SF-228 MF-181 Emp-56

MAXIMUM DAY PROJECTIONS

For many water system analyses and planning tasks, it is necessary to use the highest anticipated daily flow into the distribution system. This value is calculated by multiplying the projected average production by the ratio of the highest daily to average flow, as derived from historical data. This ratio is called the maximum day ratio.

Table 4 shows historical water production data including the actual systemwide maximum day ratios experienced for the period 1985 through 2005. A statistical analysis of historical maximum day ratios can provide the probability of any selected ratio being exceeded during a single year. A statistical analysis can also yield a design maximum day ratio resulting from a selected exceedance probability. This is the method used to determine the maximum day ratios for maximum day production projections.

Table 4: Historical Maximum Day Ratios

Year	Average Production	Maximum Day Production	Ratio	Date of Maximum Day
1985	148.6	197.4	1.33	8-Sep
1986	160.8	226.7	1.41	11-Jun
1987	163.3	238.8	1.46	23-Jul
1988	169.9	267.3	1.57	8-Jul
1989	165.3	227.6	1.38	11-Sep
1990	166.9	235.2	1.41	30-Jun
1991	171.0	255.9	1.50	20-Jul
1992	162.5	220.4	1.36	20-Jul
1993	167.0	242.7	1.45	11-Jul
1994	173.5	230.6	1.33	14-Jun
1995	167.1	233.9	1.40	4-Aug
1996	161.3	198.9	1.23	12-Mar
1997	164.7	245.8	1.49	15-Jul
1998	166.6	219.8	1.32	30-Aug
1999	168.2	263.4	1.57	8-Jun
2000	162.0	200.8	1.24	11-Jun
2001	167.4	253.2	1.51	11-Sep
2002	164.8	221.8	1.35	13-Aug
2003	164.3	206.5	1.26	21-Jan
2004	168.1	210.4	1.25	29-Aug
2005	171.9	226.2	1.32	26-Jun

The implications of using different exceedance probabilities were addressed in the 1992 "Peak Water Consumption Management Study" by O'Brien and Gere. In summary, it concluded that increasing the exceedance probability resulted in a trade-off between reduced water system cost and the increased possibility of limitations on outdoor water use during dry summers. WSSC management directed that a 20 percent exceedance probability be used to calculate the projected maximum day ratio. In others words, it was decided to plan the water system based on production projections that, on average, will be exceeded once in five years, with the expectation that outdoor water use or other limitations will then be implemented.

The maximum day ratios for the four pressure zone groups would normally be calculated as part of this effort. Unfortunately, a significant gap in the data needed to calculate these ratios was created when Project 80 flow into Prince George's County was initiated, but not recorded, in November 2000. This data gap was closed in November 2004, but it may be several more years before a statistically significant data sample will be available again. In the absence of available new data, it is recommended that the results from the previous 2001 report continue to be used. (The ratios for the different zones and the system ratio need not occur on the same day, so it is mathematically permissible for all zone ratios to be greater than the system ratio.)

Table 5: Calculated Maximum Day Ratios for Projections

Zones	Maximum Day Ratio
System	1.48
MC High*	1.51
MC Main*	1.73
PG High*	1.56
PG Main*	1.53

**From 2001 report, see preceding paragraph.*

This new system maximum day ratio represents a very slight decrease from the previous ratio of 1.49, calculated in 2001.

Figure 6 provides a graph of the projected average and maximum day production through 2030 and historical average and maximum day production since 1980.

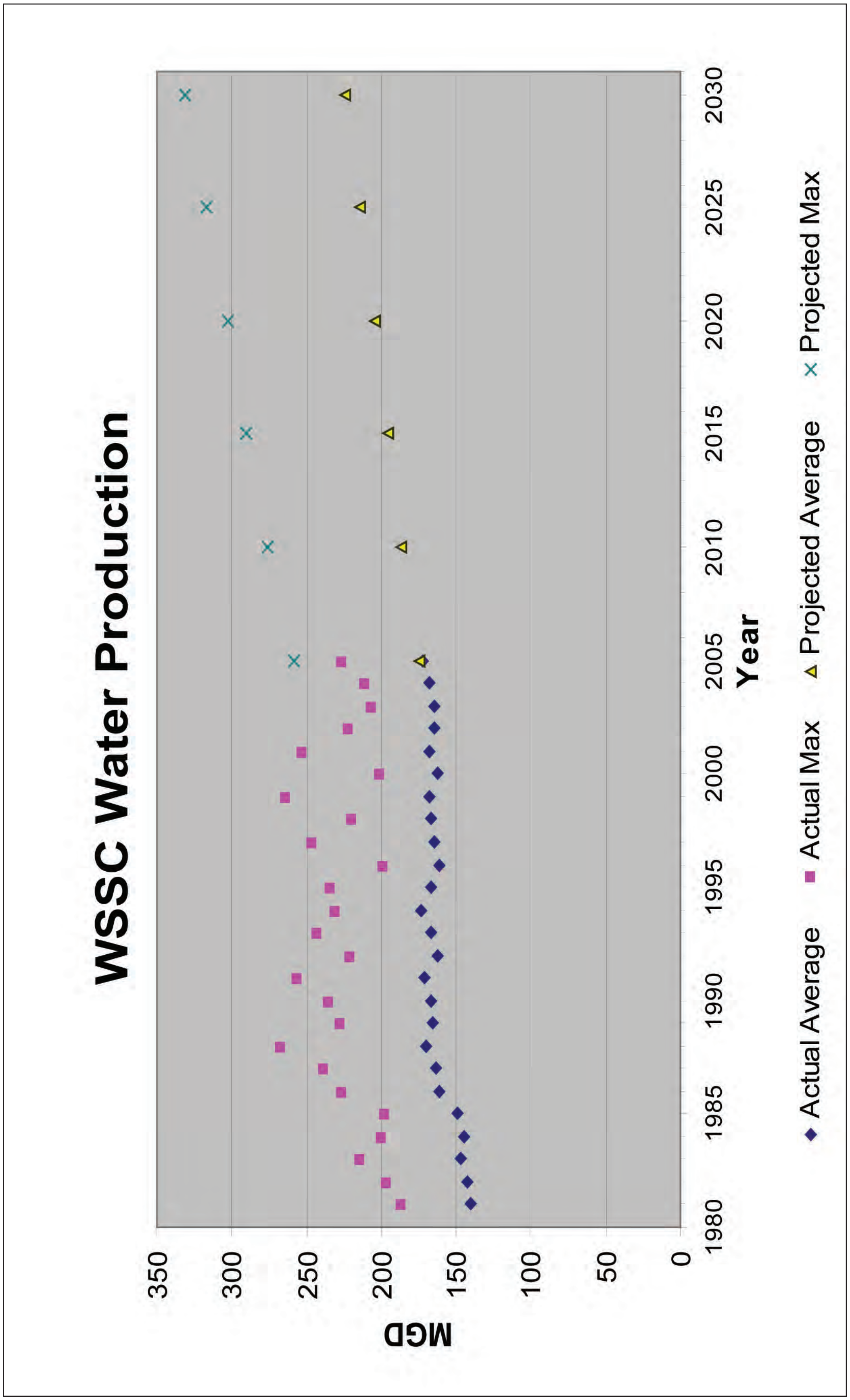


Figure 6: Historical and projected water production.

SUPPLIES TO OTHER JURISDICTIONS

The WSSC has water system interconnections with several other jurisdictions. Some of these interconnections are subject to formal agreements while others operate based on informal understandings. Some of these supply arrangements are used as an everyday supply, some are for emergencies only and some are used to meet the other jurisdiction's peak demands. In cases where the interconnections are used to meet the other jurisdiction's peak demands, the cost to the WSSC may exceed the revenue recovered from the per-gallon cost of the water used and other compensation should be arranged.

Table 6: Supplies to Other Jurisdictions

Jurisdiction	Allowable Withdrawal (mgd)	Average Withdrawal* (mgd)	WSSC Pressure Zone
City of Bowie	Not specified – emergency only	Not currently metered	Hg350E
Charles County	1.4	0.001	Hg328A
Howard County	5.0	3.07	Hg415A
City of Rockville	6.0	Negligible	Hg660A
DC-WASA	Not specified	0.01	Hg495A

**Based on meter readings from March 2005 to February 2006.*

DRINKING WATER AVAILABILITY AND CAPACITY

Water Supply Reliability Forecast for Washington Metropolitan Area, Year 2025

Produced by: The Interstate Commission on the Potomac River Basin

The Interstate Commission on the Potomac River Basin (ICPRB) is charged with enhancing, protecting, and conserving the water and land resources of the Potomac River basin. Among its concerns are ensuring adequate future water supplies for the growing Washington, D.C., metropolitan area, through its work with utilities on drought planning. These planning efforts help fulfill the intent of HB 1141 by taking into account the availability of water for waste disposal and safe drinking.

ICPRB recognizes the importance of groundwater for supplying drinking water and ensuring a steady water flow into the basin's rivers and streams. It has evaluated public drinking water availability, and in the Water Supply Reliability Forecast for Washington Metropolitan Area, Year 2025 study, it concluded that current water resources are sufficient to meet demand forecast for the region, including the area of Prince George's County served by WSSC, to the year 2025, and as projected to 2045. ICPRB has established the Potomac Drinking Water Source Protection Partnership, consisting of water suppliers and government agencies, and is working to meet the basic need for an ample supply of safe drinking water. Monitoring of the Potomac River continuously measures the water level in order to predict river flow and improve the efficiency of water supply releases from North Branch reservoirs in case of drought. These reservoirs help maintain water quality in addition to providing drought relief, balancing those needs with the increasing interest in recreational boating and fishing activities. Studies of the competing interests are used to develop reservoir operation plans that balance the relative importance of competing needs. The Middle Potomac River Watershed Assessment, one of the projects of ICPRB, helps define environmentally sustainable flows that maintain the Potomac River's value as a natural and cultural resource, as well as serve the environmental needs of the regional population base.

ICPRB provides assistance to Maryland and the other states in the Potomac basin on their total maximum daily load programs, which determines and maintains pollutant levels below a maximum amount entering rivers, streams, lakes, or estuaries. In order to regulate discharges from waste water treatment plants as well as nonpoint sources of pollutants, computer models seek to manage pollutant loads so that they do not reduce water quality standards to below required levels. ICPRB has used computer simulation models, for example, to assist the Anacostia River watershed community, which includes a substantial part of Prince George's County's Developed Tier, in addressing problems such as low summer dissolved oxygen level, high sedimentation rates, high fecal coliform levels, and fish consumption advisories caused by high levels of toxic chemicals.

APPENDIX IV: LAND CONSERVATION PROGRAMS

THE PRINCE GEORGE'S COUNTY PURCHASE OF DEVELOPMENT RIGHTS PROGRAM AND THE HISTORIC AGRICULTURAL RESOURCE PRESERVATION PROGRAM[1]

The purpose of these programs is to preserve and protect the valuable scenic, agricultural, and environmentally fragile lands of Prince George's County. The area designated as the Rural Tier contains most of this land in the county. In order to preserve the aesthetically valuable environment and retain land for the production of food and fiber for the citizens of Prince George's County, the County Council and the County Executive have established the Prince George's Rural Land Preservation Program.[2]

The Prince George's Purchase of Development Rights (PDR) Program is a voluntary program that focuses on the purchasing of development rights from agricultural landowners. This program permits any owner of agricultural land that meets the program's minimum qualifying criteria to apply to sell their development rights. If the development rights on the property are purchased by the program, an easement is placed on the property restricting any future development in perpetuity, except what is permitted under the programs' child lot exclusion provisions.

The Historic Agricultural Resource Preservation Program (HARPP) is a county PDR initiative administered by the M-NCPPC Department of Parks and Recreation and the Prince George's County Soil Conservation District to preserve agricultural areas and activities that are assessed by historic resource professionals to be vital aspects of Prince George's County's history. A historic agricultural resource preservation easement is placed on the property and is conveyed to the Commission for the purpose of acquiring, preserving, restoring, or rehabilitating historic properties. In exchange, the landowner receives a grant from the county in compensation for limiting future development uses of the property to agricultural and commercial uses related to agriculture.

1 http://egov.co.pg.md.us/lis/data/z%20TERRY/tdm/B2007024%20DR-2.doc

2 http://www.pgscd.org/Ag%20Land.htm

THE MARYLAND AGRICULTURAL LAND PRESERVATION FOUNDATION[3]

The Maryland Agricultural Land Preservation Program (MALPF), in existence since 1977, is one of the most successful programs of its kind in the country. Its primary purpose is to preserve sufficient agricultural land to maintain a viable local base of food and fiber production for the present and future citizens of Maryland. MALPF provides a unique opportunity to assure that agricultural land will remain in the county through permanent preservation by the purchase of agricultural preservation easements on properties.

MALPF's program,locally managed by the county's Soil Conservation District (SCD) is closely tied to state statute. Every year, different aspects of the program are subject to public discussion and revision during the legislative session.[4] Prince George's County is currently in the process to receive agricultural certification which will provide additional monies from the county agricultural real estate transfer tax to be utilized in the county for MALPF easement purchases. To date, Prince George's County transfer taxes have been used to purchase agricultural easements statewide.

RURAL LEGACY PROGRAM[5]

The Rural Legacy Program was established by an act of the Maryland General Assembly in 1997. The program encourages local governments and private land trusts to identify Rural Legacy areas and to competitively apply for funds to complement existing land preservation efforts or to develop new ones. Easements or fee estate purchases are sought from willing landowners in order to protect areas vulnerable to sprawl development that can weaken an area's natural resources, thereby jeopardizing the economic value of farming, forestry, recreation, and tourism. Through the use of easements and fee estates, the program enhances agriculture, natural resources, forestry, and environmental protection. The purpose of the Rural Legacy Program is to protect and conserve strategic natural resources, large contiguous tracts of land, and other areas from sprawl development. Rural Legacy land exists uniquely along the Patuxent River corridor currently protecting many acres of riparian buffer. The M-NCPPC Department of Parks and Recreation administers this land preservation program in multiple stream valley parks and is responsible for the majority of stream buffer protection in the county.

TRANSFER OF DEVELOPMENT RIGHTS

Although a strategic recommendation of the General Plan, this land conservation program has not been adopted by Prince George's County. In an effort to utilize a full complement of land protection strategies, the county will continue to explore methods to make this program work. TDR programs can represent many goals but research has shown that successful programs have straightforward and clearly defined goals. Traditionally, TDR programs arise in response to a specific goal, such as farmland preservation, habitat conservation, or regional water quality management.

A common technicality of creating interest in a TDR program is balancing the incentives for both sending and receiving area landowners. Also, an initial investigation

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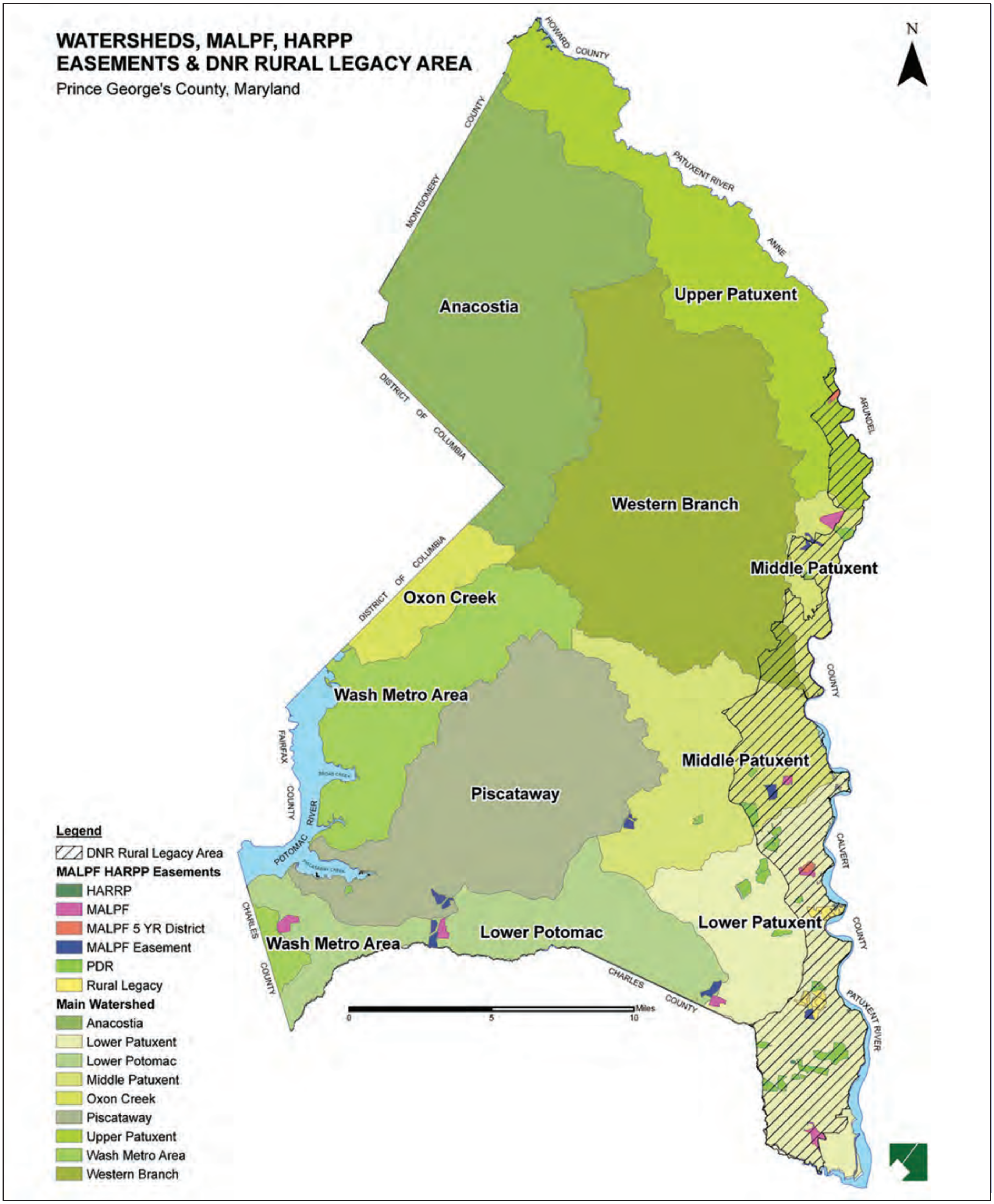
3 www.malpf.info/

4 County CR82: www.mncppc.org/county/CR_82_2006.pdf

5 www.dnr.state.md.us/rurallegacy/



Map 1 (Appendix 1): County preservation areas.

on how much a developer is willing to pay for added density would help provide rural landowners with a better idea if selling their development rights is comparable to selling their land for development. This is crucial for obtaining initial support for TDR programs among rural landowners.

Creating a TDR program that is simple to understand, has a streamlined application process, and is financially feasible will be necessary for long-term success of the program. TDR programs are a mix of voluntary participation and regulatory enforcement, and finding a balance between these two forces is imperative to sustaining a healthy market. If a program is too financially burdensome, either for the government to administer or for the developer to participate in, then the program will likely fail.

Consistency within the decision-making process is also key to a successful TDR program. Receiving density bonuses via the purchase of development rights should be the only way a developer can receive additional density. Offering alternatives for granting density, such as permitting "up-zoning" or by providing density bonuses for affordable housing, will undermine the legitimacy of a TDR program. Simply put, why would developers buy something they could get for free? Therefore, it is important to offer one type of density "currency"; in this case, purchasing development rights.

PRIORITY PRESERVATION AREAS

The Priority Preservation Area (PPA) in Prince George's County encompasses a large portion of the Rural Tier in Subregions 1, 5, and 6. This area is being preserved for the purpose of maintaining a stable land base appropriate for agricultural, forestry, and mineral extraction uses, as well as for protection of wildlife and habitat, and the scenic and historic vistas that characterize its rural character. The PPA is defined as an area that is large enough to support profitable agricultural and forestry enterprises, that may or may not contain productive agricultural or forest soils, and that is governed by local policies established for the purpose of preventing development from encroaching or compromising these resources. The PPA is included in the land mass that constitutes 80 percent of the undeveloped land in the county and that is targeted for preservation through easements and zoning.

In Subregion 1, publicly owned properties and large federal research facilities such as the Beltsville Agricultural Research Center and the Patuxent Research Refuge are in the Rural Tier and would be part of the PPA, as in the Subregion I plan, currently being updated. In Subregion 5, the PPA amounts to 8,950 acres, or 69 percent of the Rural Tier in that subregion. There is another 39,000 acres, or 58 percent of the Rural Tier, in Subregion 6 that is also included. Lands within the PPA are being preserved using a number of funding tools, including the purchase of development rights or agricultural easements and other types of easements. Conservation subdivisions, a type of development that is compatible with the PPA, can be included in the PPA if a majority of the acreage is preserved as woodland or open space.

STATE LAND CONSERVATION PROGRAMS

The State of Maryland provides support and resources to counties, communities, and municipalities to assist in the identification and preservation of sensitive and unique natural lands.

Maryland Environmental Trust[6]**—**The Maryland Environmental Trust (MET) is a statewide land trust governed by a citizen board of trustees. It was created by the General Assembly in 1967. The goal is the preservation of open land, such as farmland, forest land, and significant natural resources. The primary tool to achieve this is the conservation easements, a voluntary agreement between a landowner and MET.

A conservation easement is a tool for landowners to protect natural resources and preserve scenic open space. The landowner who gives an easement limits the right to develop and subdivide the land, now and in the future, but still remains the owner. The organization accepting the easement agrees to monitor it forever to ensure compliance with its terms. No public access is required by a conservation easement.

Program Open Space[7]**—**Established under the Department of Natural Resources (DNR) in 1969, Program Open Space (POS) symbolizes Maryland's long-term commitment to conserving our natural resources while providing exceptional outdoor recreation opportunities for our citizens. POS Stateside funds are used for the acquisition of parklands, forests, wildlife habitat, natural, scenic, and cultural resources for public use. To improve the strategic use of these limited funds, DNR developed a new POS Targeting Land Conservation System, which is based first on protecting targeted ecological areas, the most ecologically valuable lands in the state. POS also has funds that it distributes to local governments (POS Localside) for conserving recreational open space. These funds, in addition to other county and municipal conservation efforts, are used for preservation.

Today there are more than 5,000 individual county and municipal parks and conservation areas that exist because of the program. Almost all of the land purchased by the Maryland DNR in the last 40 years was funded at least in part through POS.

FEDERAL LAND CONSERVATION PROGRAMS

The federal government supports state and local efforts to protect natural lands and resources and ensures that preservation strategies are achieved in despite strong development pressures.

The Conservation Reserve Enhancement Program[8] **(CREP)** is a voluntary, incentive-based federal program that pays farmers and farm landowners attractive incentives for putting their least productive lands into conservation practices that benefit wildlife, improve water quality, and conserve soil.

Under CREP, farmers place a portion of their farm under a 10- or 15-year contract that requires the land to be put into the conservation cover the farmer chooses. Farmers can establish forest, native warm-season grasses, or cool-season grasses. In return, the farmer receives cost-share, annual rental payments, and generous bonus payments.

Generally, agricultural land (crop land or pasture) adjacent to perennial or intermittent waterways, certain highly erodible lands within 1,000 feet of a waterway, and prior

6 http://www.dnr.state.md.us/met/ce.html

7 http://www.dnr.state.md.us/land/pos/index.asp

8 http://www.nrcs.usda.gov/programs/CRP/

converted wetlands qualify for the program. Local DNR foresters and wildlife biologists can also help enroll participants. Participants can also enter the CREP program in conjunction with Rural Legacy, MALPF, or donated easement programs such as MET.

Used in conjunction with nutrient management and sediment and erosion control practices, streamside forests can benefit property owners and their streams through:

- Providing a dependable income to the owner.
- Removing nutrients and sediment from shallow groundwater and surface water.
- Reducing pesticide and herbicide spray drift and runoff to streams.
- Providing important habitat for aquatic life, birds, and small game.
- Supporting recreational hunting and fishing opportunities.

Land and Water Conservation Fund[9]—(LWCF) creates parks and open space, protects wilderness, wetlands and refuges, preserves wildlife habitat, and enhances recreational opportunities from two complementary programs: a federal program and a state matching grants program. The federal program provides funds to purchase land and water resources for national parks, forests, wildlife refuges, and other public lands, while the state matching grants program provides federal funds to states to assist in the acquisition of more urban open space and creation of local recreation facilities. The success of the LWCF has helped create parks for people to enjoy in 98 percent of the counties in the U.S. and has provided protection for more than five million acres of land and water areas across the country.

The Maryland State Highway Administration (SHA) asked the LWCF to coordinate a Natural Resources Work Group with the Maryland Department of Natural Resources and the U.S. Fish and Wildlife Service. The work group is utilizing a green infrastructure approach to strategically prioritize conservation and restoration projects that provide environmental benefits to the communities affected by a planned road improvement.

The 2008 Farm Bill[10] received wide support from agriculture, nutrition, and conservation groups because it brings meaningful change to current farm policy, protects farmers, and increases funding and support for conservation programs through its Conservation Reserve Program. The 2008 Farm Bill includes a U.S. Department of Agriculture program, the Specialty Crop Research Initiative, which has made available more than $28 million to provide solutions to problems such as plant breeding, pests, and diseases that pertain to specialty and other crops. The programs within the Farm Bill bolster industries that thrive on undeveloped land and help preserve its future productivity.

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9 http://www.tpl.org/tier3_cd.cfm?content_item_id=10566&folder_id=191

10 http://www.usda.gov/wps/portal/farmbill2008?navid=FARMBILL2008

GLOSSARY OF ACRONYMS

A

ACE	Army Corps of Engineers
ARP	Anacostia Restoration Plan
AWRC	Anacostia Watershed Restoration Committee
AWRP	Anacostia Watershed Restoration Partnership

B

BCS	Basin Condition Score
BMP	Best Management Practice
BNR	Biological Nutrient Removal

C

C2K	Chesapeake 2000 Bay Agreement
CAZ	Analysis Zones (Council of Governments)
CBP	Chesapeake Bay Program
CBPC	Chesapeake Bay and Water Resources Policy Committee
CCC	Civilian Conservation Corps
CFMGP	Comprehensive Flood Management Grant Program
CFN	Community Forestry Network
CNMP	Comprehensive Nutrient Management Plan
COG	Council of Governments
COMAR	Code of Maryland Regulations
CREP	Conservation Reserve Enhancement Program
CRW	Community Rating System
CSD	Conservation Subdivision Design
CSO	Combined Sewer Overflow
CTP	Consolidated Transportation Program
CWA	Clean Water Act
CWP	Center for Watershed Protection

D

DAC	Daily Average Consumption
DER	Department of Environmental Resources
DNR	Department of Natural Resources
DOQQ	Digital Orthophoto Quarter Quad
DPW&T	Department of Public Works and Transportation
DU	Dwelling Units/Designated Uses
DWSPP	Drinking Water Source Protection Partnership

E

EDU	Equivalent Dwelling Unit
EID	Eco-Industrial Design
ENR	Enhanced Nutrient Removal
EPA	Environmental Protection Agency (or USEPA)
ESD	Environmental Site Design

F

FEMA	Federal Emergency Management Agency
FSE	Food Service Establishments
FY	Fiscal Year

G

GFA	Gross Floor Area
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GPD	Gallons Per Day

H

H_20	Water
HARPP	Historic Agricultural Resource Preservation Program
HB	Maryland House bill
HNI	Highway Needs Inventory

I

IAN	Integration and Application Network (at the University of Maryland Center for Environmental Sciences)
IBI	Index of Biotic Integrity
ICLEI	International Council for Local Environmental Initiatives
ICPRB	Interstate Commission on the Potomac River Basin
IPM	Integrated pest management

L

Lbs	Pounds
LCI	Livable Communities Initiative
LEED	Leadership in Energy and Environmental Design
LU	Land Use (in Appendix I tables)
LUC	Land Use Category
LULC	Land Use Land Cover
LWCF	Land and Water Conservation Fund

M

MALPF	Maryland Agricultural Land Preservation Foundation
MBSS	Maryland Biological Stream Survey
MCC	Maryland Conservation Corps
MDA	Maryland Department of Agriculture
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MDOT	Maryland Department of Transportation
MDP	Maryland Department of Planning
MEP	Maximum Extent Practicable
MG26	Models and Guidelines #26
Mg	Milligram
MGD	Million Gallons Per Day
MGS	Maryland Geological Survey
M-NCPPC	The Maryland-National Capital Park and Planning Commission
MS4	Municipal Separate Storm Sewer System
MWCOG	Metropolitan Washington Council of Governments

N

N	Nitrogen
NA	Not Available
NFIP	National Flood Insurance Protection
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	National Resource Conservation Service
NRI	Natural Resource Inventory

O

O	Oxygen
O-S	Open Space Zoning
OSDS	On-Site Sewage Disposal Systems

P

P	Phosphorous
PCB	Polychlorinated Biphenyls
PDR	Purchase of Development Rights
PFA	Priority Funding Area
pH	Measure of the Acidity or Basicity
PLAM	Pollutant Load Analysis Model
POS	Program Open Space
PPA	Priority Preservation Area
PRC	Patuxent River Commission
PRK	Potomac Riverkeeper, Inc.
PWP	Potomac Watershed Partnership

R

R-A	Residential Agricultural Zoning

S

SB	Maryland Senate Bill
SCA	Stream Corridor Assessments
SCD	Soil Conservation District
SCS	Soil Conservation Service
SCWQP	Soil Conservation and Water Quality Plan
SHA	State Highway Administration
SPLOST	Special Purpose Local-Option Sales Tax
SSO	Sanitary Sewer Overflows
SWPPP	Stormwater Pollution Prevention Plan

T

TAZ	Traffic Analysis Zone
TBL	Triple Bottom Line; also known as 3BL
TCP	Tree Conservation Plan
TDR	Transfer Of Development Rights
TMDL	Total Maximum Daily Loads
TN	Total Nitrogen
TOD	Transit-Oriented Development
TP	Total Phosphorous
TSS	Total Suspended Solids

U

USCES	University of Maryland Center for Environmental Sciences
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency (or EPA)
USGS	U.S. Geological Survey

V

VCP	Voluntary Cleanup Programs
VMT	Vehicle Miles Traveled

W

WCO	Woodland and Wildlife Habitat Conservation Ordinance
WFP	Water Filtration Plant
WHPA	Wellhead Protection Area
WHPP	Wellhead Protection Program
WLA	Waste Load Allocation
WMA	Water Management Administration
WRAS	Watershed Restoration Action Strategy
WRD	Water Resources Discipline
WRE	Water Resources Element
WSP	Water Supply Program
WSSC	Washington Suburban Sanitary Commission
WTM	Water Treatment Model
WWTP	Wastewater Treatment Plant

Other

303d	EPA List of Impaired Waters
3BL	Triple Bottom Line; also known as TBL

M-NCPPC No. 10-22

RESOLUTION

WHEREAS, The Maryland-National Capital Park and Planning Commission, by virtue of Article 28 of the Annotated Code of Maryland, is authorized and empowered, from time to time, to make and adopt, amend, extend and add to a General Plan for Physical Development of the Maryland-Washington Regional District; and

WHEREAS, the Prince George's County Planning Board of The Maryland-National Capital Park and Planning Commission, held a duly advertised joint public hearing with the Prince George's County Council, sitting as the District Council, on February 23, 2010 on the *Preliminary Water Resources Functional Master Plan*, being also an amendment to the 2002 *Prince George's County Approved General Plan;* 2009 *Approved Master Plan of Transportation;* 2008 *Approved Public Safety Facilities Master Plan;*1983 *Adopted and Approved Public School Sites Functional Master Plan;* 1994 *Bladensburg, New Carrollton and Vicinity (PA 69) Approved Master Plan;* 1994 *Melwood/Westphalia Approved Master Plan;* 1994 *Planning Area 68 Approved Master Plan;* 1997 *College Park Metro-Riverdale Transit District Development Plan;* 2000 *Brentwood Mixed-Use Town Center Zone Development Plans and Design Guidelines;* 2000 *Approved Sector Plan and Sectional Map Amendment for the Addison Road Metro Town Center and Vicinity;* 2000 *The Heights and Vicinity Approved Master Plan;* 2001 *Anacostia Trails Heritage Area Management Plan;* 2001 *Greenbelt Metro Sector Plan;* 2004 *Riverdale Park Mixed-Use Town Center Zone Development Plans and Design Guideline;* 2004 *Approved Gateway Arts District Sector Plan and Sectional Map Amendment;* 2004 *Approved Sector Plan and Sectional Map Amendment for the Morgan Boulevard and Largo Town Center Metro Areas;* 2005 *Approved Sector Plan and Sectional Map Amendment for the Tuxedo Road/Arbor Street/ Cheverly Metro Area;* 2005 *Countywide Green Infrastructure Plan;* 2006 *Master Plan for Bowie and Vicinity and Sectional Map Amendment for Planning Areas 71A, 71B, 74A, 74B;* 2006 *Sector Plan and Sectional Map Amendment for the East Glenn Dale Area for portions of Planning Area 70;* 2006 *Approved Master Plan and Sectional Map Amendment for Henson Creek-South Potomac Planning Area;* 2006 *Approved West Hyattsville Transit District Development Plan and Sectional Map Amendment for Transit District Overlay Zone;* 2007 *Approved Bladensburg Town Center Sector Plan and Sectional Map Amendment;* 2007 *Adopted Westphalia Sector Plan and Sectional Map Amendment;* 2008 *Adopted Capitol Heights Transit District Development Plan and Transit District Overlay Zoning*

Map Amendment; 2008 *Adopted Branch Avenue Corridor Sector Plan and Sectional Map Amendment;* 2009 *Adopted Port Towns Sector Plan and Sectional Map Amendment;* 2009 *Adopted Landover Gateway Sector Plan and Sectional Map Amendment;* 2009 *adopted Marlboro Pike Sector Plan and Sectional Map Amendment;* 2009 *Adopted Subregion 5 Master Plan and Sectional Map Amendment;* 2009 *Adopted Subregion 6 Master Plan and Sectional Map Amendment;* 2010 *Adopted Glenn Dale-Seabrook-Lanham and Vicinity Sector Plan and Sectional Map Amendment;* and

WHEREAS, the Prince George's County Planning Board, after said public hearing and due deliberation and consideration of the public hearing testimony, on April 22, 2010, adopted the master plan with revisions, as described in Prince George's County Planning Board Resolution PGCPB No. 10-44, and transmitted the plan to the District Council on April 26, 2010; and

WHEREAS, the Prince George's County Council, sitting as the District Council for the portion of the Maryland-Washington Regional District lying within Prince George's County, held work sessions on June 1, 2010 and June 15, 2010, to consider hearing testimony; and

WHEREAS, upon consideration of the testimony received through the hearing process, the District Council on June 22, 2010, determined that the adopted plan should be approved as the functional master plan for water resources for Prince George's County, Maryland, subject to the modifications and revisions set forth in Resolution CR-059-2010; and

NOW, THEREFORE, BE IT RESOLVED, that The Maryland-National Capital Park and Planning Commission does hereby adopt said *Water Resources Functional Master Plan*, together with the General Plan for Physical Development of the Maryland-Washington Regional District within Prince George's County as approved by the Prince George's County District Council in the attached Resolution CR-059-2010; and

BE IT FURTHER RESOLVED, that copies of said amendment shall be certified by The Maryland-National Capital Park and Planning Commission and filed with the each Clerk of the Circuit Court of Prince George's and Montgomery Counties, as required by law.

* * * * * *

CERTIFICATION

This is to certify that the foregoing is a true and correct copy of Resolution No. 10-22 adopted by The Maryland-National Capital Park and Planning Commission on motion of Commissioner Wells-Harley, seconded by Commissioner Cavitt, with Commissioners Parker, Carrier, Alfandre, Cavitt, Presley, Vaughns, and Wells-Harley voting in favor of the motion, with no Commissioner voting against, with Commissioners Clark, Dreyfuss, and Squire being absent during the vote, at its regular meeting held on Wednesday, September 8, 2010, in Riverdale, Maryland.

Patricia Colihan Barney
Executive Director

Reviewed and Attested To
For Legal Sufficiency

Andree Green Checkley/George Johnson

Certificate of Adoption and Approval

The *Approved Water Resources Functional Master Plan* amends the 2002 *Prince George's County Approved General Plan;* 2009 *Approved Master Plan of Transportation;* 2008 *Approved Public Safety Facilities Master Plan;*1983 *Adopted and Approved Public School Sites Functional Master Plan;* 1994 *Bladensburg, New Carrollton and Vicinity (PA 69) Approved Master Plan;* 1994 *Melwood/Westphalia Approved Master Plan;* 1994 *Planning Area 68 Approved Master Plan;* 1997 *College Park Metro-Riverdale Transit District Development Plan;* 2000 *Brentwood Mixed-Use Town Center Zone Development Plans and Design Guidelines;* 2000 *Approved Sector Plan and Sectional Map Amendment for the Addison Road Metro Town Center and Vicinity;* 2000 *The Heights and Vicinity Approved Master Plan;* 2001 *Anacostia Trails Heritage Area Management Plan;* 2001 *Greenbelt Metro Sector Plan;* 2004 *Riverdale Park Mixed-Use Town Center Zone Development Plans and Design Guideline;* 2004 *Approved Gateway Arts District Sector Plan and Sectional Map Amendment;* 2004 *Approved Sector Plan and Sectional Map Amendment for the Morgan Boulevard and Largo Town Center Metro Areas;* 2005 *Approved Sector Plan and Sectional Map Amendment for the Tuxedo Road/Arbor Street/Cheverly Metro Area;* 2005 *Countywide Green Infrastructure Plan;* 2006 *Master Plan for Bowie and Vicinity and Sectional Map Amendment for Planning Areas 71A, 71B, 74A, 74B;* 2006 *Sector Plan and Sectional Map Amendment for the East Glenn Dale Area for portions of Planning Area 70;* 2006 *Approved Master Plan and Sectional Map Amendment for Henson Creek-South Potomac Planning Area;* 2006 *Approved West Hyattsville Transit District Development Plan and Sectional Map Amendment for Transit District Overlay Zone;* 2007 *Approved Bladensburg Town Center Sector Plan and Sectional Map Amendment;* 2007 *Adopted Westphalia Sector Plan and Sectional Map Amendment;* 2008 *Adopted Capitol Heights Transit District Development Plan and Transit District Overlay Zoning Map Amendment;* 2008 *Adopted Branch Avenue Corridor Sector Plan and Sectional Map Amendment;* 2009 *Adopted Port Towns Sector Plan and Sectional Map Amendment;* 2009 *Adopted Landover Gateway Sector Plan and Sectional Map Amendment;* 2009 *adopted Marlboro Pike Sector Plan and Sectional Map Amendment;* 2009 *Adopted Subregion 5 Master Plan and Sectional Map Amendment;* 2009 *Adopted Subregion 6 Master Plan and Sectional Map Amendment;* 2010 *Adopted Glenn Dale-Seabrook-Lanham and Vicinity Sector Plan and Sectional Map Amendment.* The Prince George's County Planning Board of The Maryland-National Capital Park and Planning Commission adopted the plan by Resolution PGCPB No. 10-44 on April 26, 2010, after a duly advertised joint public hearing on February 23, 2010. The Prince George's County Council, sitting as the District Council, approved the plan by Resolution CR-059-2010 on June 22, 2010. The Maryland-National Capital Park and Planning Commission adopted the plan by Resolution M-NCPPC No. 10-22 on September 8, 2010.

The Maryland-National Capital Park and Planning Commission

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Secretary-Treasurer

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Maryland Department of Planning

Maryland Department of Environment

Maryland Department of Natural Resources

Maryland Department of Natural Resources, MD Geological Survey