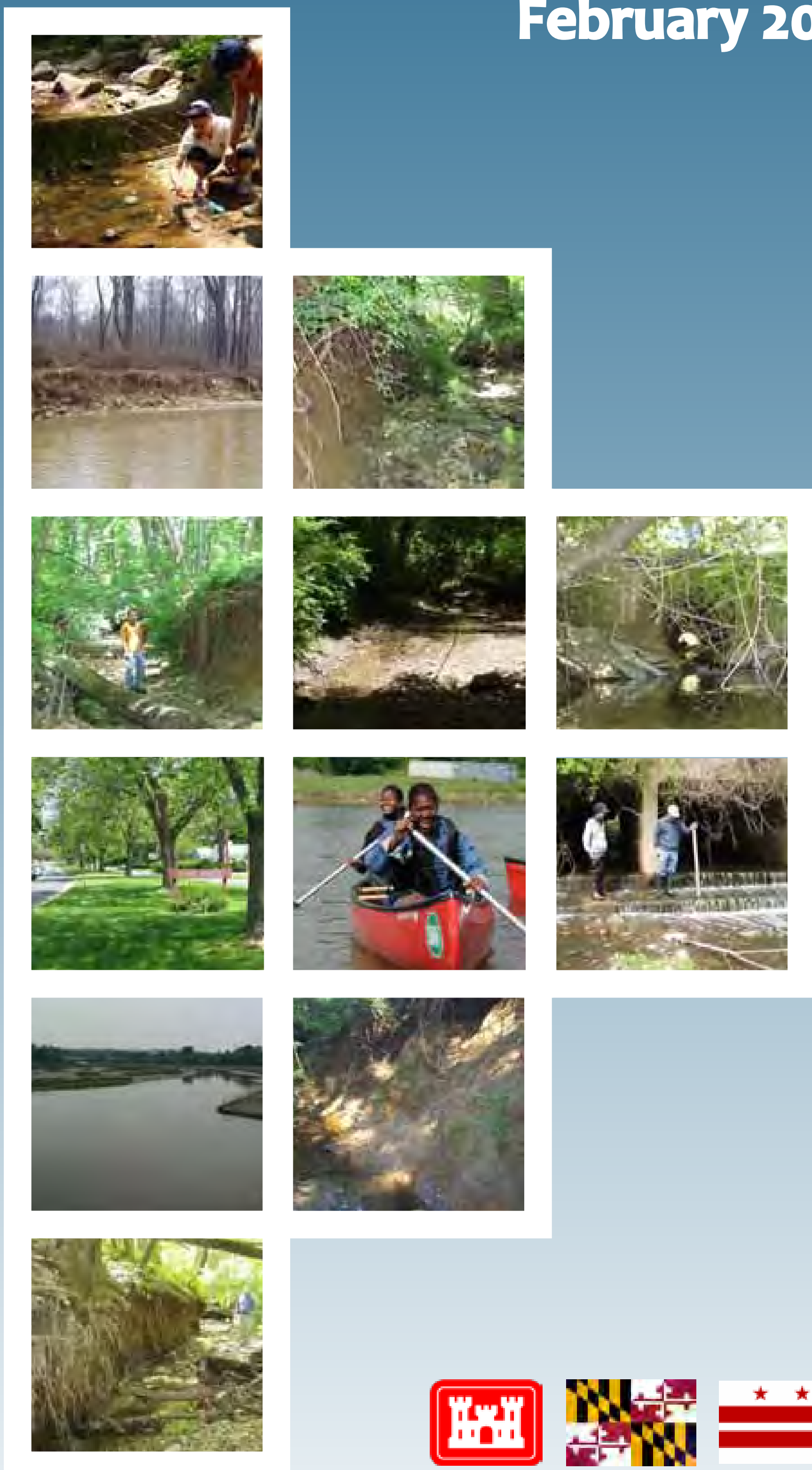
Anacostia River Watershed Restoration Plan and Report

Final Draft

February 2010



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Executive Summary

The Anacostia River Watershed Restoration Plan (ARP) and report is the product of a two year planning effort to produce a systematic 10-year restoration plan for environmental and ecological restoration within the entire Anacostia River watershed. While much has been accomplished over the previous decades to restore this important urban watershed in and around our nation's capital, the river and its tributaries remain highly polluted and ecologically stressed. The public and all levels of government have demonstrated their interest and commitment to restoring the watershed's ecological integrity and function so communities can reap the benefits of a clean river that supports use by its residents and contributes to the overall environmental improvement and quality of life.

In August 2008, the Anacostia Watershed Restoration Partnership (AWRP) issued an Action Agenda that described the Partnership's accomplishments and the actions planned for the next three years to restore the Anacostia River watershed. Numerous actions currently underway are addressing major problems caused by uncontrolled stormwater runoff, deficiencies in the water and sewer infrastructure, excessive sedimentation, and excessive trash accumulation in the river, among other problems. While many positive actions have been taken and others are planned, most have been undertaken as independent projects in separate jurisdictions rather than within the framework of a holistic plan that considers the needs of the entire watershed. The ARP has been developed to articulate this holistic plan and to enhance collaboration among all stakeholders. The ARP is intended to provide a mechanism to promote a more comprehensive, meaningful, cost-effective, and rapid restoration of the entire watershed.

The purpose of the ARP is to develop a watershed restoration plan to direct future restoration efforts that comprehensively address the watershed's problems, and to assist the AWRP in achieving its six restoration goals through projects designed to alleviate the watershed's problems.

AWRP Restoration Goals

1. Dramatically Reduce Pollutant Loads
2. Protect and Restore Ecological Integrity
3. Improve Fish Passage
4. Increase Wetland Acreage
5. Expand Forest Cover
6. Increase Public and Private Participation

Restoration Opportunities

The ARP identifies numerous restoration opportunities within each of the Anacostia River's 14 primary subwatersheds and the tidal river reach. The candidate projects fall within eight action-oriented restoration strategies, including stormwater retrofit opportunities that employ low impact development technologies, habitat restoration, trash reduction, and parkland acquisition projects. Table E-1 and Figure E-1 present the opportunities identified, the estimated benefits, and estimated costs for further study and/or possible implementation. Note that cost estimates were computed by using unit costs associated with restoration practices, which were selected based on consultation with the project delivery team (PDT). No additional chemical contaminant sources were identified as part of the watershed evaluation; however, existing areas of concern have been extensively documented within the tidal river reach.

Table E-1: Candidate Restoration Project Inventory Summary

Candidate Project Type		Number of Projects	Estimated Cost ($)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	1,892	$1,252,404,065	10,600.3				
2.	Stream Restoration	342	$179,687,500		72.5			
3.	Wetland Creation/ Restoration	116	$6,807,400			137.4		
4.	Fish Blockage Removal/ Modification	146	$35,172,500				41.7	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	152	$2,752,750			347.0		
6.	Trash Reduction	181	$711,675					124.7
7.	Toxic Remediation	0						
8.	Parkland Acquisition	189	$251,203,400			2,512.1	41.7	
	Total	**3,018**	**$1,728,739,290**	**10,600.3**	**72.5**	**2996.5**		**124.7**

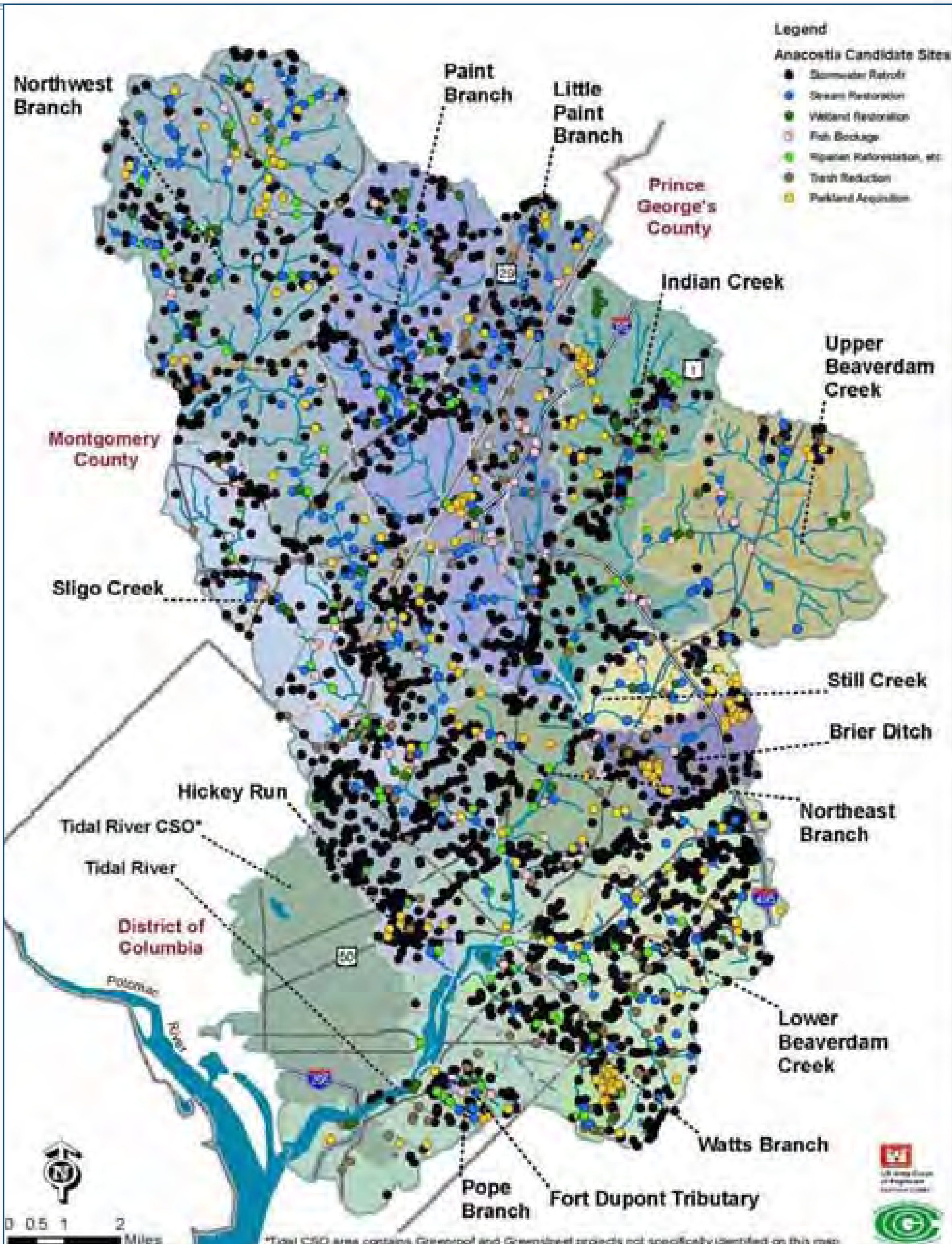

Figure E-1: Locations of Candidate Restoration Project Areas

After identifying the restoration opportunities, the PDT developed a 100-point scoring scheme to evaluate each candidate project independently, which resulted in a ranking of candidate restoration projects within each of the 14 primary subwatersheds and the tidal river reach. The scoring process included the following criteria: environmental benefits, including the candidate projects' potential contribution to the six AWRP goals; feasibility; impacts; estimated costs; outreach and community connection; and permitting. The scores were separated into Tier I, Tier II, and Tier III projects. The presentation of the scoring and ranking results of the candidate restoration projects is included in each of the 15 subwatershed (14 primary subwatersheds and tidal river reach) action plans and subwatershed provisional restoration project inventories, appended to the ARP report.

After evaluating each subwatershed, the PDT evaluated the entire basin to determine which areas to prioritize and focus restoration efforts following the ARP study. The primary stressor in the Anacostia River watershed is pollution from uncontrolled and untreated stormwater runoff. Throughout the watershed, stormwater runoff from impervious surfaces, such as roads, parking lots, and rooftops, enters local streams and wetlands and eventually drains to the Anacostia River. The priority of the ARP and restoration within the Anacostia River watershed is, therefore, to focus restoration efforts around stormwater retrofit projects. Restoration efforts are recommended to be implemented as part of demonstration restoration project areas, or clusters of candidate restoration projects identified as part of the ARP that are within proximity to Tier I stormwater retrofit projects. Once each demonstration restoration project area was defined, the PDT then developed a ranking system to rank each of the demonstration restoration project areas across the entire watershed. Figure E-2 and Table E-2 present the location and ranking of demonstration restoration project areas and the estimated benefits and costs.

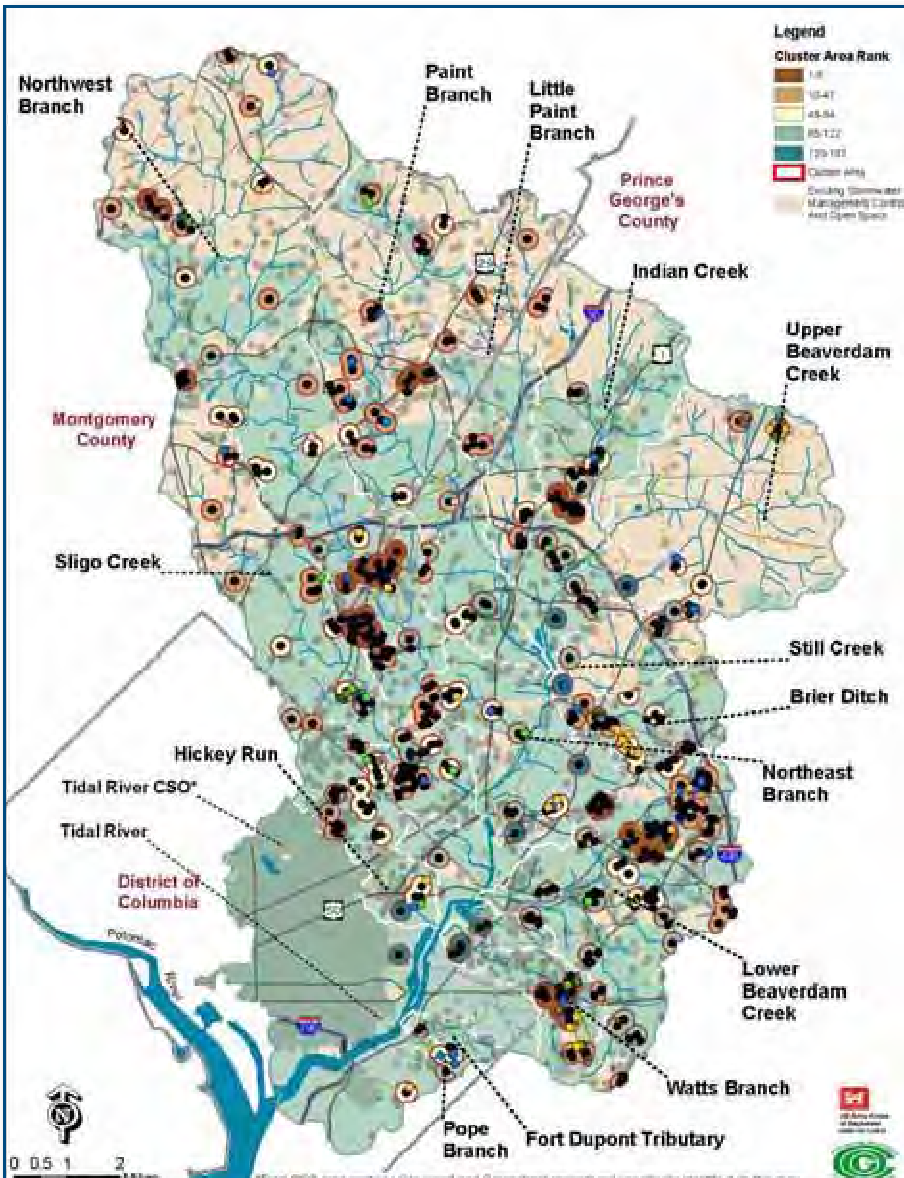

Figure E-2: Ranking of Demonstration Restoration Project

Table E-2: Summary of Candidate Restoration Projects included in the Demonstration Project Areas								
Candidate Project Type		Number of Projects	Estimated Cost (millions)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	535	$552	4,595				
2.	Stream Restoration	47	$23.9		8			
3.	Wetland Creation/ Restoration	14	0.8			15		
4.	Fish Blockage Removal/ Modification	18	$4.7				4.0	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	23	$0.3			40		
6.	Trash Reduction	39	$0.2					17.6
7.	Toxic Remediation	0						
8.	Parkland Acquisition	27	18.7			187		
	Total	**703**	**$601**	**4,595**	**8.1**	**242**	**4.0**	**17.6**

As part of the 10-year restoration plan presented in the ARP, three different scenarios of restoration action were considered: minimal, moderate, and aggressive. The minimal restoration scenario consists of the currently ongoing restoration effort. The moderate restoration effort includes the implementation of the highest-ranking demonstration restoration project areas up to current regulatory requirements for controls on impervious surfaces. The aggressive restoration approach includes the moderate restoration effort plus all candidate stormwater retrofit projects identified as part of the ARP.

In addition to identifying and prioritizing candidate restoration projects, other analyses were conducted to evaluate the potential to reduce pollutant loadings. Scenarios analyzed include: (1) modifying impervious surfaces on private property with low impact development practices, (2) street sweeping, (3) designing GreenStreets or retrofitting roads with bioretention controls, and (4) combining these methods to determine potential cumulative pollutant reduction. For the cumulative pollutant reduction analysis, six scenarios were evaluated to determine cumulative pollutant reductions based on estimates of percent impervious surface control for short-term (10-year) and long-term planning time frames.

To achieve water quality standards for a fishable and swimmable river, pollutant loadings must be reduced. Under current conditions, the conceptual and planning-level analyses completed as part of the ARP identify a gap between the reduction required to achieve accepted water quality standards and what could potentially be achieved through impervious surface treatments. While the implementation of candidate restoration projects will not fully achieve water quality standards within a 10-year timeframe, the restoration efforts must continue in order to protect public health and safety and to preserve recreational opportunities and natural resources for future generations.

Looking Forward

The restoration of urban watersheds like the Anacostia River watershed presents significant challenges related to large and concentrated population centers, multiple sources of pollution, changing land use patterns, and the various stressors and effects associated with each. The complete restoration of the Anacostia River watershed will not occur within 10 years, but over the course of decades. Nevertheless, restoration is possible, and progress can and should be made. As more research is conducted, pollutant removal efficiencies associated with current stormwater management projects should increase, and new practices may be developed. In addition, the combination of projects, as part of demonstration restoration project areas, may yield greater reductions in pollutant loads than otherwise would be associated with individual stormwater retrofit projects. In many cases, the cumulative effect of concentrated restoration efforts may promote and enhance other ecosystem functions. For example, a combination of stormwater retrofit projects along with stream restoration projects may allow for the reestablishment and reconnection of floodplain functions that provide additional treatment capacity for pollutants in stormwater runoff. These synergistic and cumulative effects were not evaluated as part of this large-scale planning effort. Further study is required to determine the potential benefits of demonstration projects like stormwater retrofits, stream restoration, and private conservation efforts within the prioritized areas of the watershed.

The next step in the restoration of the Anacostia River watershed is to conduct feasibility studies that analyze, evaluate, design, and implement the candidate projects in each subwatershed. A focused, holistic, and comprehensive approach to restoration must be pursued because water quality goals will not be achieved with the current level of funding or with sporadic restoration projects implemented by various parties acting independently under different jurisdictions and authorities. In addition, current policies toward land use planning, stormwater management requirements for development and redevelopment, and restoration programs should be carefully evaluated to complement the implementation of candidate projects identified as part of the ARP. Included in the ARP are policy and programmatic recommendations from the AWRP Steering Committee to address not only existing problems, but also future stressors.

The conceptual approach developed as part of the ARP will require additional funding as well as political will to accomplish restoration objectives. A funding strategy should be developed to ensure holistic restoration rather than continue piecemeal restoration efforts that have had only limited successes. Collaborative projects across jurisdictional boundaries should occur where it makes sense, ecologically and fiscally. In addition, public participation will be required to control impervious surfaces on private properties. These efforts will require educational outreach to foster watershed awareness.

The ARP was developed to reach across all levels of public and private entities and interested organizations committed to the restoration of the Anacostia watershed. By the participation of Federal, state, and local government agencies, as well as community watershed groups, non-profit organizations, and other active volunteers, water quality, fish and wildlife habitats, and flow regimes are expected to improve as the restoration actions proposed in the ARP are implemented over the next 10 years. In addition, public awareness of environmental issues in the watershed and public participation in the restoration efforts are expected to increase. The ARP will not only serve as a 10-year restoration plan but also as a roadmap for long-term restoration within the watershed.

The ARP and report, along with subwatershed action plans, subwatershed environmental baseline conditions and restoration reports, and subwatershed provisional restoration project inventories, are available online at www.Anacostia.net.

Acknowledgments

The development of the ARP was led by the U.S. Army Corps of Engineers (USACE), Baltimore District, in full partnership and cost-sharing with the Metropolitan Washington Council of Governments (MWCOG), Montgomery and Prince George's Counties, the District of Columbia, the Maryland-National Capitol Park and Planning Commission (M-NCPPC), Maryland Department of the Environment (MDE), and Maryland Department of Natural Resources (DNR).

Special thanks to USACE, Baltimore District Planning Division and Projects and Programs Management Divisions' staff and management for assistance with the completion of the ARP effort, including coordination, meetings, plan formulation, production, review, and guidance. In addition, USACE special thanks to agency technical reviewers, North Atlantic Division staff, and USACE headquarters staff for review, guidance, and comments.

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Special thanks to the staff and management of the District of Columbia Department of the Environment, Montgomery County Department of Environmental Protection, and Prince George's County Department of Environmental Resources, for providing funding and work-in-kind services to the ARP effort. Work-in-kind services that contributed to the ARP effort include numerous meetings and discussions, considerable guidance with the fieldwork effort to identify provisional restoration projects, and invaluable working knowledge of the various subwatersheds.

Additional support and contributions to the ARP effort that require special thanks was provided by the staff and management of M-NCPPC, MDE, and DNR. Work-in-kind services that contributed to the ARP effort include numerous meetings, discussions, and reviews, as well as institutional knowledge of the watershed and guidance on current regulations and ongoing restoration efforts. Special thanks to MDE staff and management for contributing to the peak discharge calculations included in this report.

As part of the ARP effort, the project delivery team (PDT) received guidance and special insight from representatives of the AWRP Management and Steering Committees, which requires special thanks. In addition, the Executive Director requires special thanks for the considerable contributions to various components of the ARP effort, such as drafting the funding strategy and the policy and programmatic component to the ARP.

A very special thanks to the effort contributed by the staff and management of The Louis Berger Group, Inc. to complete the considerable task of generating subwatershed provisional restoration project inventories, including considerable coordination in addition to numerous meetings and discussions. Furthermore, a special thanks is required for the effort to complete the task of developing the layout and presentation of the ARP.

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Special thanks to Anacostia Watershed Citizens Advisory Committee (AWCAC) for attending meetings and discussions as well coordination efforts. In addition, very special thanks is required for the Anacostia Watershed Society, Friends of Sligo Creek, and those members of community subwatershed groups who volunteered their time and participated in meetings and discussions as well as reviewing and ranking provisional restoration projects.

Special thanks to the Center of Watershed Protection (CWP) for completing a thorough review of the ARP Interim Report Framework as well as participating in various discussions and answering questions on the application of the Watershed Treatment Model. In addition, special thanks to the CWP, the Interstate Commission on the Potomac River Basin, and the Washington Suburban Sanitary Commission for participating in various meetings and discussions with the PDT.

Finally, the use of proprietary information in this report is for example only and should not be considered an endorsement by USACE or any of the stakeholders identified in this document.

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List of Acronyms

ANS Audubon Naturalist Society
AOC Area of Concern
ARP Anacostia Watershed Restoration Plan
AWCAC Anacostia Watershed Citizens Advisory Committee
AWRC Anacostia Watershed Restoration Committee
AWRP Anacostia Watershed Restoration Partnership
AWS Anacostia Watershed Society
AWTA Anacostia Watershed Toxics Alliance
BARC Beltsville Agricultural Research Center
BMP Best Management Practice
BOD Biochemical Oxygen Demand
BOD5 Five-day BOD
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CSO Combined Sewer Overflow
CWA Clean Water Act
CWP Center for Watershed Protection
DA Drainage Area
DC District of Columbia
DCWASA District of Columbia Water and Sewer Authority
DDOE District Department of the Environment
DDOT District Department of Transportation
DDT Dichloro-Diphenyl-Trichloroethane
DNR Maryland Department of Natural Resources
DO Dissolved Oxygen
DOH District of Columbia Department of Health
EPA Environmental Protection Agency
ESD Environmental Site Design
FOSC Friends of Sligo Creek
FY Fiscal Year
GIS Geographic Information Systems
IA Impervious Area
ICPRB Interstate Commission on the Potomac River Basin
I&T Indicators & Targets
LID Low Impact Development
LTCP Long Term Control Plan
M-NCPPC Maryland-National Capital Park and Planning Commission
MDE Maryland Department of the Environment
MEP Maximum Extent Practicable
MSHA Maryland State Highway Administration
MS4 Municipal Separate Sanitary Sewer System
MWCOG Metropolitan Washington Council of Governments
N Nitrogen
NOAA National Oceanic and Atmospheric Administration
NPDES National Pollutant Discharge Elimination System
NPS National Park Service
P Phosphorous
PAHs Polycyclic Aromatic Hydrocarbons
PCBs Polychlorinated Biphenyls
PDT Project Delivery Team
PGDER Prince George's County Department of Environmental Resources
PMP Project Management Plan
Q1.25 Peak discharge associated with a rainfall event that has the likelihood of occurring once every 1.25 years
RCRA Resource Conservation and Recovery Act
SAV Submerged Aquatic Vegetation
SOD Sediment Oxygen Demand
SPA Special Protection Area
SSO Sanitary Sewer Overflows
SWAP Subwatershed Action Plan
TMDL Total Maximum Daily Load
TN Total Nitrogen
TP Total Phosphorous
TSS Total Suspended Solids
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
WRDA Water Resources Development Act
WSSC Washington Suburban Sanitary Commission
WTM Watershed Treatment Model

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Introduction to the

Anacostia River Watershed Restoration Plan

Purpose and Organization of the Report

The ARP is organized into a restoration plan and main report document. Appended to the main report include various appendices, 15 Subwatershed Action Plans (SWAPs), 15 Subwatershed Baseline Conditions and Restoration Reports, and 15 Subwatershed Provisional Restoration Project Inventories. The purpose of the report organization is to provide an overview of restoration within the Anacostia River watershed as discussed in the restoration plan and main report document, but also to develop detailed discussion for restoration opportunities within the 14 primary subwatersheds and the tidal river reach.

Introduction to the
Anacostia River Restoration Plan

Watershed Assessment—
Existing Conditions in the
Anacostia River Watershed

Restoration Progress, Policies and Programs

Problem Identification and Plan Formulation

Findings and Conclusions

Public Involvement and Agency Coordination

References

Plan Formulation Appendix
Anacostia Watershed Environmental Baseline
Conditions and Restoration Report

Appendices for the 14 Subwatersheds
and the Tidal River Reach

- Subwatershed Action Plan
- Subwatershed Environmental Baseline Conditions and Restoration Report
- Subwatershed Provisional Restoration Project Inventory

Study Area and Environmental Setting

The Anacostia River flows through the heart of the nation's capital and drains portions of Montgomery and Prince George's counties in Maryland and the District of Columbia. A tributary to the Potomac River, the Anacostia River is located within the Chesapeake Bay watershed and drains an area with an estimated population of more than 860,000 – one of the most densely populated areas along the eastern coast of the United States (Figure 1-1). The Anacostia River watershed has a drainage area of approximately 176 square miles and is composed of 14 primary subwatersheds and the tidal Anacostia River.

The confluence of the Northwest Branch and Northeast Branch forms the tidal Anacostia River and contributes approximately 93-percent of the river flow. Downstream of the confluence, the river is partially channelized and runs for approximately 8.4 miles before discharging into the Potomac River.

The Anacostia watershed has changed dramatically since the 17th century when it was a thriving center of Native American culture set amidst the Piedmont and Coastal Plain physiographic provinces. The Anacostia River was once a highly productive ecosystem with healthy populations of sturgeon, American and hickory shad, white and yellow perch, redbreast sunfish, pickerel, catfish, and herring, which provided the native Nanchotank, or Nacotchtank, Indians with a plentiful food supply. Lush forests and abundant wildlife complemented clean waters that flowed into the Potomac River and ultimately emptied into the Chesapeake Bay. The river's decline began as settlers cleared fields for agriculture and then accelerated rapidly in the late 19th century and continued to the present with increased urbanization and industrialization.

Now confined to an urban landscape, the Anacostia River watershed is characterized by alteration of the natural landscape and an increase in impervious areas from population growth and regional economic development. The increase in impervious areas disrupted the natural hydrologic cycle and ultimately affected the environmental health of the Anacostia River and its tributaries. Urbanization throughout the years caused excessive runoff and a reduction in groundwater recharge, a reduction in water quality through the transport of pollutants, a loss of riparian areas, and ultimately a degradation of the watershed's ecological habitat.

In addition to the degradation of the river caused by urbanization, aging infrastructure and antiquated combined sewer systems also contributed to the decline of the Anacostia River's ecological health. In fact, like many older cities, the District of Columbia has a sewer system that combines wastewater with stormwater runoff, which overflows during light to moderate rainstorms and forces the discharge of untreated sewage and stormwater runoff directly through Combined Sewer Overflow (CSO) outfalls and into the Anacostia River.

Environmental and ecological degradation in addition to a lack of adequate investments and national attention has defined the Anacostia River's reputation as "the other river" or "the forgotten river." In fact, before 1987, the Anacostia's problems were largely ignored and most of the environmental concern and focus was on the larger, polluted Potomac River.

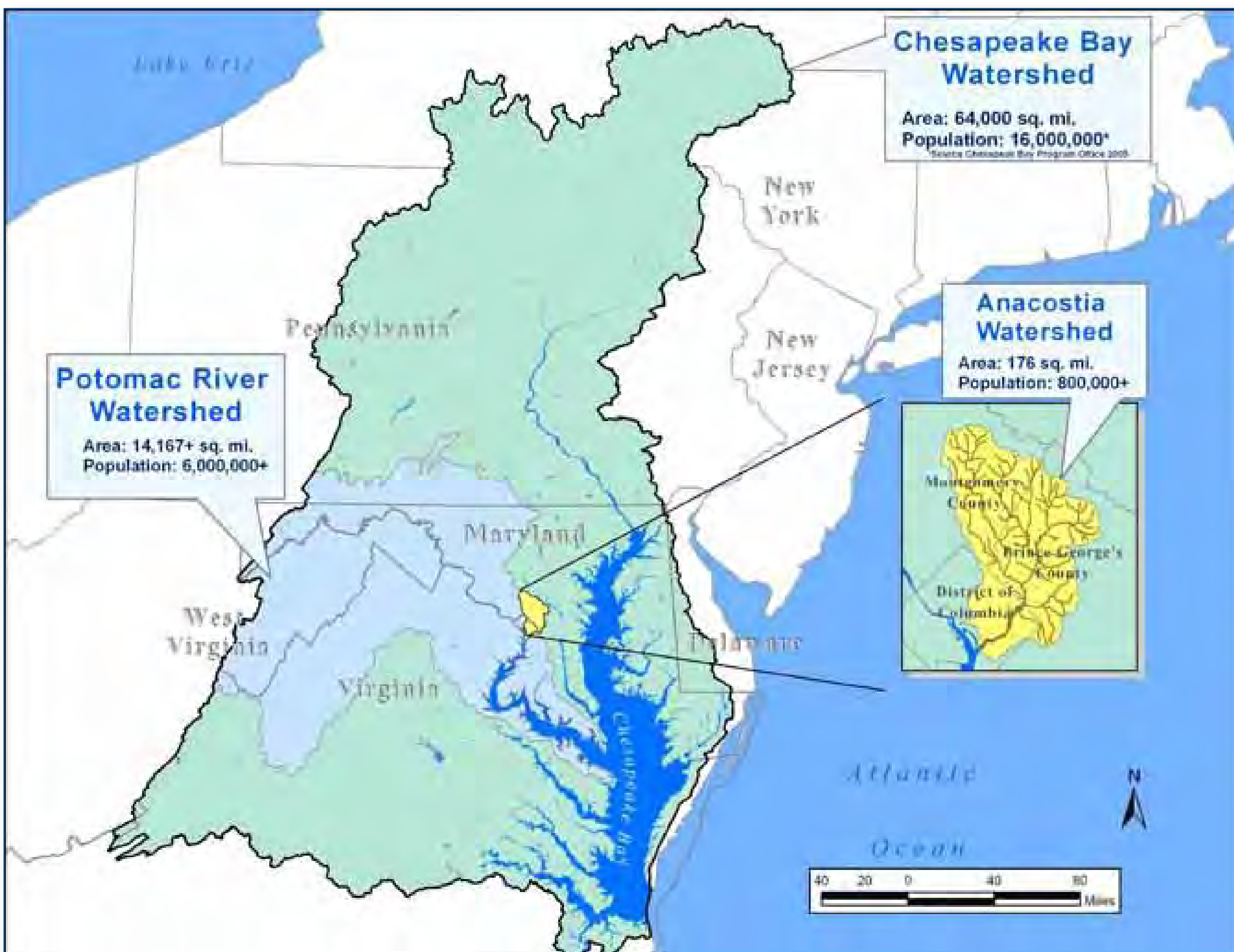

Figure 1-1: The Chesapeake Bay, Potomac River, and Anacostia River Watersheds

Ecological Problems in the Anacostia River Watershed

Before Europeans settled the area in the early 1600s, the Anacostia River watershed was a productive environment with unimpaired waters and diverse flora and fauna. Each successive wave of colonization cleared more and more forested land to make way for agriculture, livestock activities, and development. This intensifying deforestation as well as additional land use alterations due to urbanization triggered ecological problems that continue today. Past and present environmental neglect have resulted in the loss of forest and wetland habitats, habitat fragmentation, and alteration of natural drainage patterns and streamflow leading to increases in erosion and sedimentation. Nonpoint source pollution, CSO discharges, and industrial waste have also contributed to the decline of the river's ecological health.

As impervious surfaces increase, so too does stormwater runoff that ultimately deposits various pollutants into streams...

At the turn of the 20th century, high rates of malaria in areas of the District of Columbia adjacent to the river wetlands as well as the direct flow of sewage into the Anacostia River from its neighborhoods spurred years of environmental abuse. Due to high sedimentation levels and foul smelling tidal mud flats, Congress in 1902 authorized a program for river dredging and wetland reclamation that resulted in further environmental degradation of the Anacostia River. Dredging and wetland reclamation continued into the 1950s and resulted in a narrower river channel surrounded by limestone seawalls. Additional reclamation and flood damage reduction projects during the 1950s to 1970s straightened and channelized the river within levees, further altering the natural hydrologic and hydraulic processes as well as the riparian areas surrounding the river.

Present ecological conditions in the Anacostia River watershed are similar to those in other urbanized systems. Burdens faced by the Anacostia include lack of stormwater management; loss and degradation of forest, wetland, stream, and riparian habitat; pollution from nutrients, chemical contaminants, sediment, and trash; and loss of species diversity. Poor water quality, the main issue, stems from numerous factors, including the high level of impervious surfaces associated with development, such as parking lots, roads, and rooftops. As of 2000, more than 70-percent of the Anacostia watershed had been developed and impervious surfaces cover approximately 25-percent of the watershed. As impervious surfaces increase, so does stormwater runoff that ultimately deposits various pollutants into streams, including sediments, nitrogen, phosphorus, oil, heavy metals, bacteria, and trash, which seriously degrade aquatic habitat.

Although new infrastructure that is built requires strict stormwater management practices, these regulations were nonexistent in the past and even now are absent in many older developments. Uncontrolled and untreated stormwater runoff allows pollutants to directly enter the river and causes flow volume, rates, and velocities to increase, resulting in channel entrenchment and streambank erosion (Figure 1-2, Figure 1-6, and Figure 1-7). Increased sediment within stream channels carries pollutants, reduces water clarity, impairs aquatic and riparian habitat, and ultimately impairs the local ecosystem and ultimately the Potomac River and Chesapeake Bay. The adverse effects from sedimentation are not only due to the sediment itself but also to the pollutants attached to the fine-grained sediment. Elevated levels of chemical contaminants such as Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) have been identified in concentrated areas of the tidal river reach. Lastly, huge amounts of trash from urbanized landscapes throughout the watershed accumulate in the tidal Anacostia River due to its location and sluggish flow.

In 1996, the Environmental Protection Agency (EPA) listed the Anacostia River watershed as impaired by nutrients under the Clean Water Act (CWA). Nutrients such as nitrogen and phosphorus negatively impact freshwater ecosystems by triggering algal blooms, which eventually produce areas of low dissolved oxygen

(DO). Conditions of low DO degrade aquatic habitats and may deteriorate the environment to such an extent that fish and aquatic plants die off. A large source of excess nutrients within the Anacostia River watershed stems from CSOs. Approximately one third of the District of Columbia stormwater and sewer infrastructure is combined. According to the District of Columbia Water and Sewer Authority (DCWASA), each year there is an average of 82 overflow events in the Anacostia River (DCWASA, 2002). During moderate rainfall events the combined wastewater and stormwater infrastructure systems exceed capacity and both stormwater and untreated sewage are discharged directly into the river. One ecological problem associated with CSOs is the high levels of bacteria released into the waterway, making it unsuitable for fishing or swimming. Other nutrient contributions to the system occur as the result of fertilizers applied to homeowner's lawns, eroding soils, and atmospheric deposition. Other bacteria contributions originate from human, pet, and wildlife waste.

Other ecological problems include terrestrial and riparian habitat loss mainly caused by development (Figures 1-3 and 1-4). Seventy percent of the Anacostia watershed, which originally was almost completely covered in forest, has been deforested. The removal and damage to upland ecosystems in addition to forests and other riparian habitats decreases the ability of the environment to attenuate and filter stormwater runoff. The removal or alteration of habitat types also negatively affects wildlife as well as tree and plant diversity, which ultimately fragments the landscape and further diminishes the value and functional capacity of the ecosystem.

Wetlands provide critical services for an ecosystem that allow it to function and flourish, providing value to human populations. Both emergent tidal wetlands and non-tidal wetlands have been substantially reduced in the Anacostia watershed because of various shoreline building, filling, dredging, and other anthropogenic (human) activities. There has been an estimated loss of 6,500 acres of tidal and non-tidal wetlands from the watershed due to development within the last 50 years. Most of the wetland loss has occurred in the

Figure 1-2: Channel entrenchment and streambank erosion

Figure 1-3: Land use changes and sedimentation cause ecological problems in the Anacostia watershed

Figure 1-4: Development within the Anacostia watershed

Coastal Plain physiographic province of the watershed, and the tidal wetland loss constitutes a much greater percentage than non-tidal wetland loss. The remaining wetlands are degraded and fragmented, and their functions, such as flood damage reduction and water quality protection, have been severely diminished.

Submerged Aquatic Vegetation (SAV) in the Anacostia River watershed provides necessary habitat and food for invertebrates, fish, and waterfowl. In addition, SAV stabilizes bottom sediments and is an indicator of good water quality such as high water clarity, low nutrient concentrations, and increased levels of DO. From the 1950s to the 1970s, the SAV in the watershed died off because of poor water quality, as was evident from massive and persistent algal blooms. With upgrades to sewage systems and treatment plants in the 1980s, water quality in the area improved and SAV began to return to the waterways. Although SAV was detected until at least 2000, recent monitoring has found little evidence of SAV in the Anacostia River tidal portion.

The Anacostia River and its tributaries provide an important habitat for fish migration. Although this habitat has been seriously altered by hundreds of years of development, the fisheries in the watershed are very diverse. Fish passage barriers, in addition to biological and chemical pollution, significantly reduce the available habitat for migratory and resident fish. A fish passage barrier is any obstruction within the stream channel that impedes the movement of fish, including utility lines formerly buried that become uncovered through stream channel erosion; road culverts; and anthropogenic weirs from previous stream channelization projects (Figure 1-5). Some migrating fish are unable to pass through depths of several inches or obstructions of only six inches in height. Approximately 120–130 major fish barriers remain in the Anacostia watershed, including numerous blockages in the mainstem channels of the 14 primary subwatersheds (Maryland Department of Natural Resources (DNR), 2006 and 2007; Metropolitan Washington Council of Governments MWCOG, 2008).

Figure 1-5: Fish barriers block suitable habitat and impede migration

Benefits for the People Who Live in the Anacostia River Basin

Every American resides in a watershed. For those residents living within the Anacostia River watershed, or any of its subwatersheds, there are numerous opportunities for recreation, including boating, fishing, and swimming. The Anacostia River watershed has an extensive existing parkland system primarily owned and managed by the M-NCPPC along with other areas by NPS and District of Columbia Department of Parks and Recreation, most of which is included within stream valleys of subwatersheds or adjacent to the Anacostia River within the District of Columbia. Streams are intrinsic to communities, especially within an urban setting like the Anacostia River watershed. Washington D.C. receives 15 million visitors annually who bring in approximately $5 billion in business. A part of sustaining and increasing tourism in the area is maintaining a healthy watershed. Another economic implication for the residents of the Anacostia watershed will be the increase in green jobs from the implementation of this plan. Degradation of the watershed due to pollution and trash reduces the quality of life and in some cases poses a health threat, such as floatables from CSO events, syringes from stormwater outfalls, and sharp metals at localized dumpsites. Not only is it important to protect a resource like the Anacostia River and its tributaries from an environmental or ecological perspective, but also from a social perspective so residents and visitors can enjoy and cherish it. Finally, the future generations of Americans should be afforded the opportunity to enjoy the Anacostia River watershed and its resources.

The Anacostia River Watershed Restoration Plan Effort:

The Need for a Holistic Watershed Restoration Plan

In 1987, after recognizing the need for environmental restoration in the Anacostia watershed, local jurisdictions and the State of Maryland came together to sign the first Anacostia Watershed Restoration Agreement, which created the Anacostia Watershed Restoration Committee (AWRC; now called the Management Committee). The signatory members of the AWRC included the District of Columbia, Montgomery and Prince George's counties in Maryland, the State of Maryland, the U.S. Army Corps of Engineers (USACE), the EPA, and the National Park Service (NPS). USACE was designated as the Federal liaison and MWCOG was the primary provider of administrative policy and technical support to the AWRC and its restoration efforts.

In 1991, the original signatories further recognized the need for measures to monitor restoration progress, and signed a second restoration agreement that established six guiding restoration goals. These goals were further developed in 1999 by the creation of the Indicator and Target (I&T) Project, which resulted in the development of quantifiable indicators and targets to further aid in measuring the success of restoration efforts. These six distinct restoration goals were revaluated and confirmed in 1999 and are still in place today.

In 1996, the AWRC recognized the importance and need for citizen input and involvement in the restoration by creating the Anacostia Watershed Citizens Advisory Committee (AWCAC). AWCAC provides a link between the watershed community and the AWRC to ensure that public interests are considered during all restoration and protection projects and activities.

In June 2000, the Chesapeake Bay Program officially recognized the importance of the restoration of the Anacostia River watershed. The Chesapeake Bay 2000 Agreement called for the Anacostia River watershed partners to "eliminate public health concerns and achieve the living resource, water quality and habitat goals of this and past Agreements" by 2010.

In December 2001, the restoration partners adopted the completed I&T Project, reaffirmed their commitment to the six fundamental goals, and established restoration indicators to measure progress and set targets to be achieved.

In 2005, following a series of facilitated meetings, the AWRC and other stakeholders recognized that despite the diligent efforts of the numerous governmental and state agencies, the 2010 targets adopted in 2001 were proving challenging to achieve. The facilitation process ended with unanimous endorsement of the "Anacostia Watershed Restoration Governance Report" in December

Anacostia River Restoration Goals

1. Dramatically Reduce Pollutant Loads
2. Protect and Restore Ecological Integrity
3. Improve Fish Passage
4. Increase Wetland Acreage
5. Expand Forest Cover
6. Increase Public and Private Participation


Figures 1-6 and 1-7: Streambank erosion within the watershed

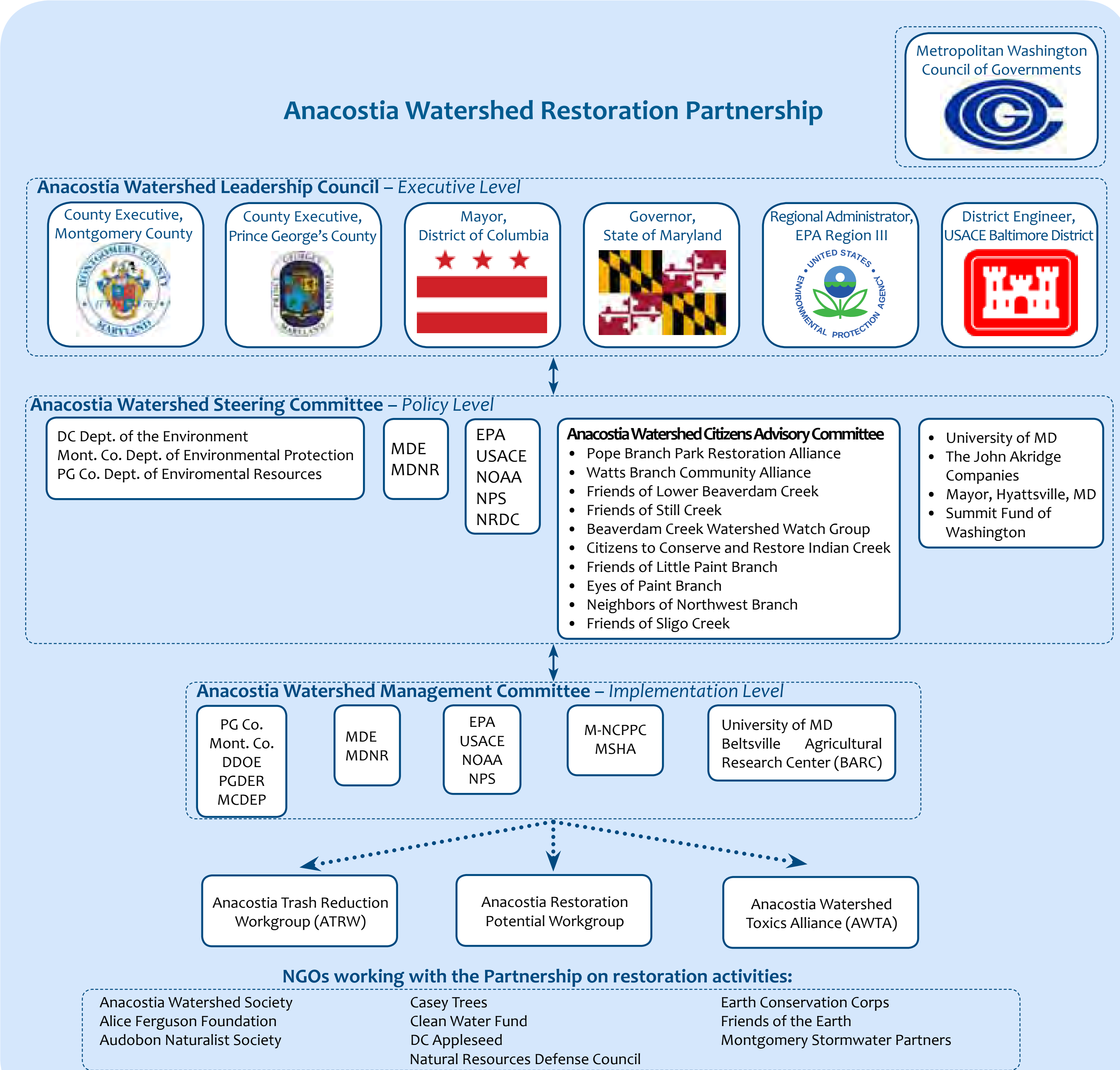

Figure 1-8: Anacostia Watershed Restoration Partnership

2005. The document encouraged AWRC to reconstitute its organizational structure and work with USACE to develop a holistic watershed restoration plan. The completion and adoption of a holistic watershed restoration plan was identified as a fundamental key to the 10-year restoration plan's success.

In September 2006, after the adoption of the new Anacostia Watershed Restoration Partnership (AWRP) (Figure 1-8), USACE and MWCOG, among other state and local stakeholders including the three jurisdictions, Maryland DNR, Maryland Department of the Environment (MDE), and the Maryland-National Capital Park and Planning Commission (M-NCPPC), formed the Project Delivery Team (PDT) to conduct the Anacostia Watershed Restoration Plan Study (ARP). In September 2007, the study agreement was modified with the completion of the final scope of work for the restoration plan, which was to identify and prioritize a diverse set of opportunities and strategies to protect and restore the Anacostia River watershed.

The Anacostia River Watershed Restoration Plan

The primary objective for the ARP is to present a 10-year restoration plan that systematically identifies and prioritizes restoration opportunities as well as to help AWRP achieve its six restoration goals for 2010. The ARP is unique in that all three local jurisdictions and stakeholders are working collaboratively with the State of Maryland, MWCOG, and USACE to satisfy the need for a holistic approach to restoration within the watershed as opposed to completing individual and separate restoration projects within each jurisdiction. This holistic approach will identify and prioritize restoration opportunities to direct future restoration efforts but also facilitate the leveraging of resources from multiple sources to address the many challenges that the basin faces.

This collaborative effort of Federal, state, and local governments, as well as public and private community organizations, to combine resources to undertake large-scale, urban watershed restoration is unprecedented within the mid-Atlantic region. The Anacostia River will never again be the pristine river watershed it was before development and urbanization. However, the watershed can and should be restored and protected to achieve environmental and ecological function and sustainability. This vision of environmental and ecological sustainability, including improved water quality, increased biological functions, and overall aesthetic appearance, is what the ARP strives to achieve. The ARP presents the strategies, projects, and programs that the Federal, state, and local governments, as well as private landowners, can undertake to promote this vision and purpose.

Extensive previous efforts have been accomplished and many efforts are ongoing in the Anacostia River watershed by many Federal government agencies, state and local agencies, watershed groups, and citizens (Figures 1-9 to 1-11). This ARP study is part of the ongoing efforts. Previous or existing activities, action plans, and efforts were considered during the development of the ARP.

The ARP has been conducted under the USACE General Investigations Program and is cost-shared equally between the Federal government, represented by USACE, and the non-Federal sponsor MWCOG. MWCOG, in turn, has separate cost-sharing agreements with the three local jurisdictions, MDE, and DNR. MWCOG is signatory to the agreement to undertake the ARP on behalf of all the non-Federal stakeholders. The study was authorized September 8, 1988, in a resolution of the Committee on Public Works and Transportation, U.S. House of Representatives, which reads as follows:

> *Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Anacostia River and Tributaries, District of Columbia and Maryland, published as House Document No. 202, 81st Congress, 1st Session, with a view to determining if further improvements for flood control, navigation, erosion, sedimentation, water quality and other related water resources needs are advisable at this time.*

Further direction for this effort was provided by the House report to accompany the fiscal year (FY) 2004 Energy and Water Resources

**Figure 1-9:
Kenilworth Marsh Restoration Project**

Figure 1-10: Low Impact Development Measures in the District of Columbia

Figure 1-11: Tidal wetland restoration at Anacostia East Mitigation Site 11 for the Woodrow Wilson Bridge Project (M-NCPPC and Prince George's County)

Appropriate Bill, which stated that an Anacostia River watershed restoration study should be conducted "to develop work begun in the early 1990s into a Comprehensive Plan to prioritize restoration activities in the Anacostia River Basin."

Subsequently, a Section 905(b) reconnaissance-level analysis prepared by USACE titled "Anacostia River and Tributaries, Maryland and the District of Columbia Comprehensive Watershed Plan" was completed in July 2005. According to the 905(b) report, proposed alternatives would be prioritized and appropriate agencies would be identified for implementation.

Finally, specific direction for this study was provided under Section 5060 of the Water Resources Development Act (WRDA) of 2007, which states the following:

Not later than one year after the date of enactment of this Act, the Secretary, in coordination with the Mayor of the District of Columbia, the Governor of Maryland, the county executives of Montgomery County and Prince George's County, Maryland, and other interested entities, shall develop and make available to the public a 10-year comprehensive action plan to provide for the restoration and protection of the ecological integrity of the Anacostia River and its tributaries.

The modification of the previous agreement among the PDT in September 2007 identified the completion of the ARP within two years, or by September 2009. The ARP Interim Report Framework, issued to the public on November 21, 2008, was intended to respond to the WRDA 5060 language with final completion of the ARP pending appropriation of full Federal funding. Although the ARP Interim Report Framework responded directly to language stated in WRDA 2007, the report provided the opportunity to describe the work completed to date and outlined the remaining steps to complete the ARP over the course of the next year.

Collaboration among Federal, state, and local government agencies along with community watershed group participation and feedback was an integral and fundamental component to the ARP. The Anacostia River watershed extends across three jurisdictions, and essentially two states, considering the District of Columbia is a Federal district to government of the United States. In addition, participation and feedback provided by representatives of community watershed groups provided the local, grass-roots perspective regarding the importance and necessity of restorative actions. Having several representatives from each government agency as well as from AWCAC and community watershed groups participate in the development of the ARP for the benefit of the entire watershed was a significant accomplishment, and unprecedented in the region to date.

It must be noted that the 10-year roadmap for restoration of the Anacostia River watershed represented in the ARP will not result in the complete restoration of the watershed within that short timeframe. Rather, the ARP will tie into existing restoration plans and initiatives already in place and identify realistic and attainable targets for the year 2020 and beyond.

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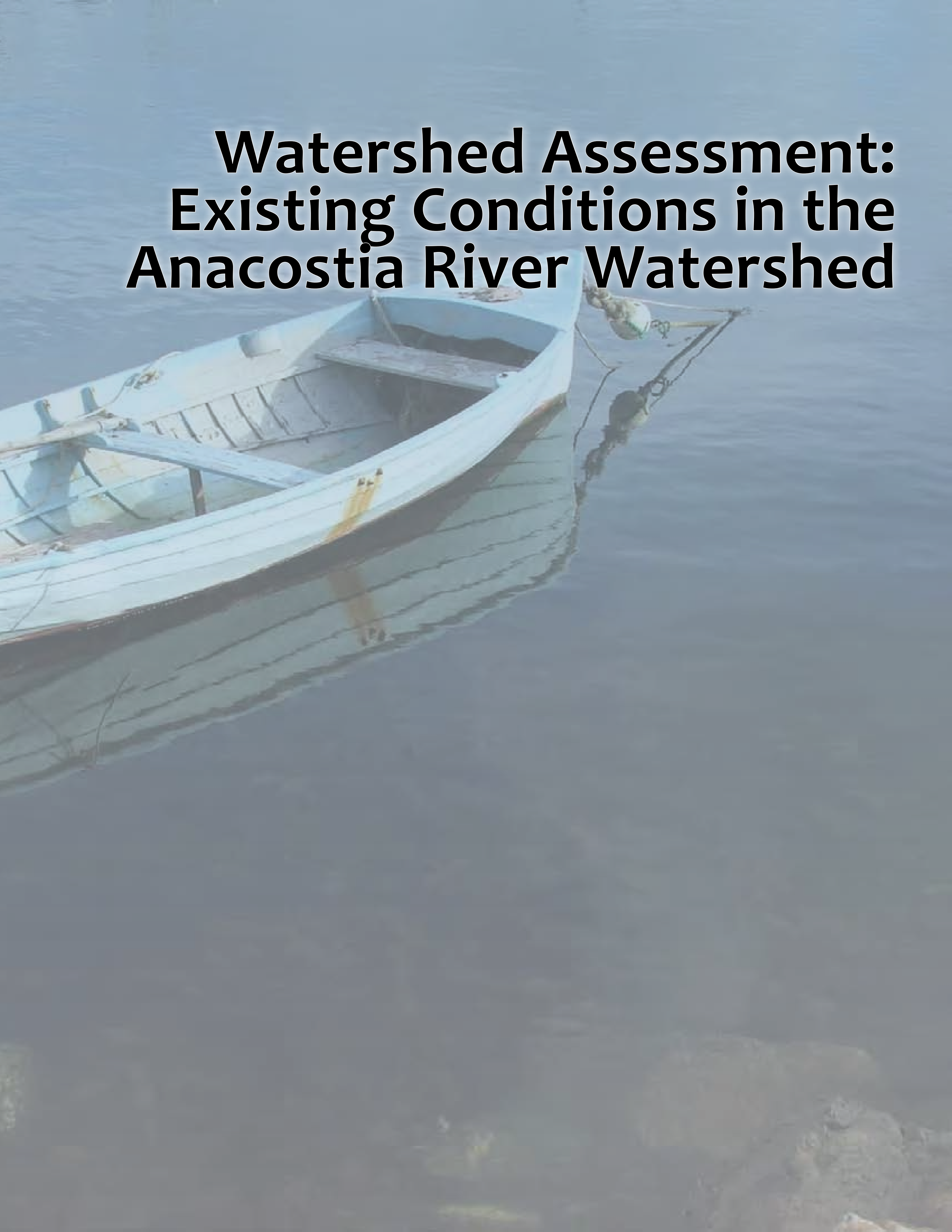
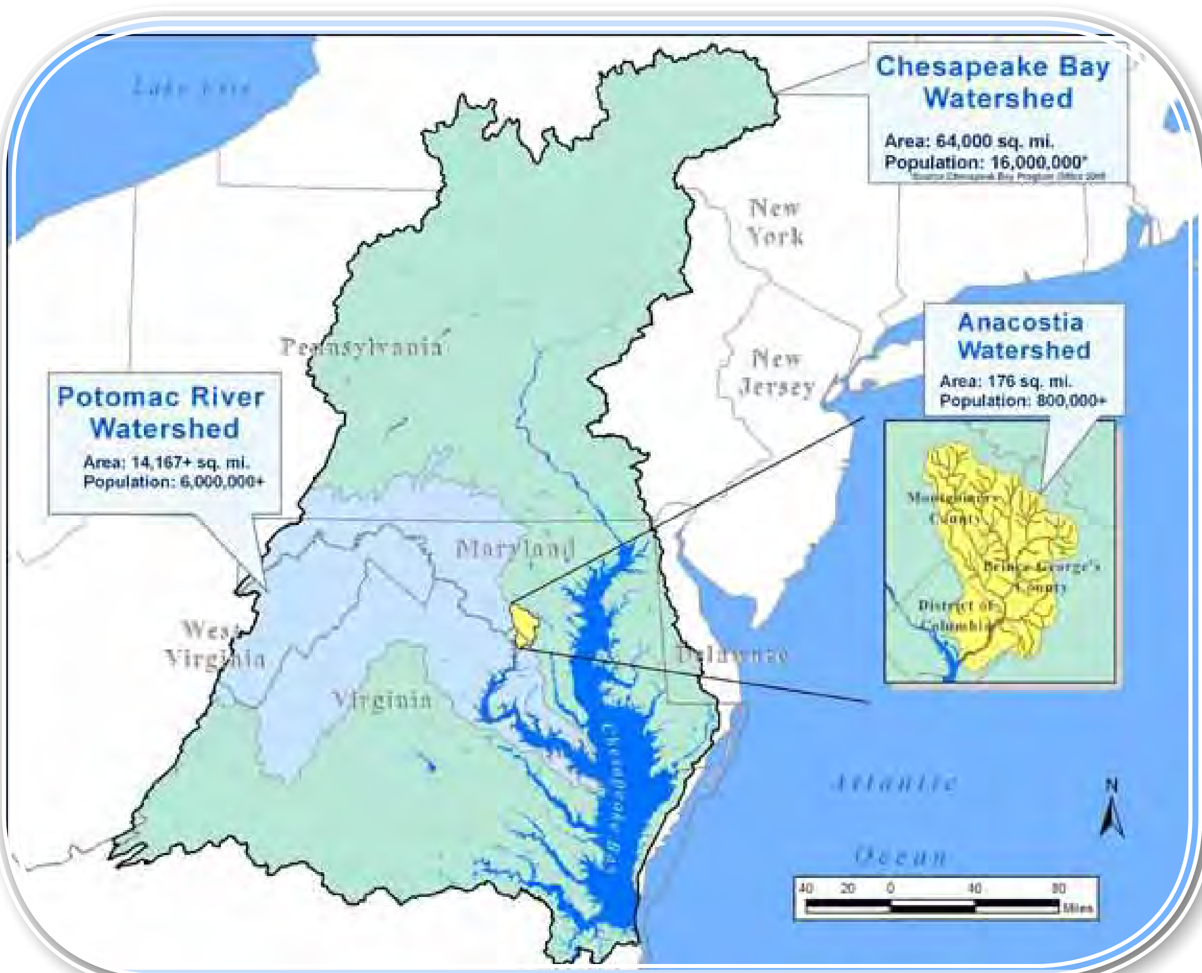
Watershed Assessment: Existing Conditions in the Anacostia River Watershed



Watershed Characterization

This section presents a summary of the existing or baseline conditions of the Anacostia River watershed. It describes the Anacostia River watershed's physical condition, land use distribution, and chemical and biological conditions. Additionally, the section presents a discussion of the river's pollution sources and conditions contributing to its degradation. A detailed discussion of existing conditions for the entire Anacostia River watersheds is included in the Anacostia Watershed Environmental Baseline Conditions and Restoration Report (MWCOG, 2008), appended to this report. In addition, a detailed discussion of the existing conditions in each of the 14 primary subwatersheds and tidal river reach is included in the corresponding Subwatershed Environmental Baseline Conditions Report prepared by MWCOG, appended to this report.



Watershed Location and Boundary

The Anacostia River, a tributary to the Potomac River that ultimately drains to the Chesapeake Bay, flows through the heart of the nation's capital, draining portions of Montgomery and Prince George's counties in Maryland and the District of Columbia. The entire watershed has a drainage area of approximately 176 square miles and is composed of 14 primary subwatersheds and the tidal Anacostia River. Figure 2-1 presents the boundaries of the Anacostia River watershed and its 14 primary subwatersheds and the tidal river reach.

Figure 2- 1: Location and Boundaries of the Anacostia River Watershed

Stream Network in the Anacostia River Watershed

The Anacostia River watershed contains 23 major and medium-size tributaries, which have a combined stream channel length of approximately 292 miles (Table 2-1) (MWCOG, 2008). The streams in the Anacostia River watershed are located either in the Piedmont or Coastal Plain physiographic provinces. Figure 2-2 shows an example of a Piedmont stream, Good Hope Tributary, and Coastal Plain stream, Little Paint Branch, respectively.

The confluence of the Northeast Branch and Northwest Branch near the Town of Bladensburg, Maryland, forms the Anacostia River, which accounts for approximately 93-percent of the river's total stream flow. The Anacostia River flows approximately 8.4 miles before its confluence with the Potomac River at Hains Point in the District of Columbia. Downstream from the confluence of the Northeast and Northwest Branches, the river is mostly channelized and is considered to be a freshwater tidal river.

The tributaries in the Anacostia River watershed are characterized by their flashiness, which cause them to rapidly rise and carry their floodwaters quickly downstream. In contrast, the Anacostia River, which is a largely channelized and fairly shallow freshwater tidal river, averaging between 4 and 18 feet deep at low tide, has sluggish properties, which results in detention for approximately 23 to 28 days on average and 60 to 90 days under extended dry weather conditions (MWCOG, 2008). Apart from the Anacostia River, there are several

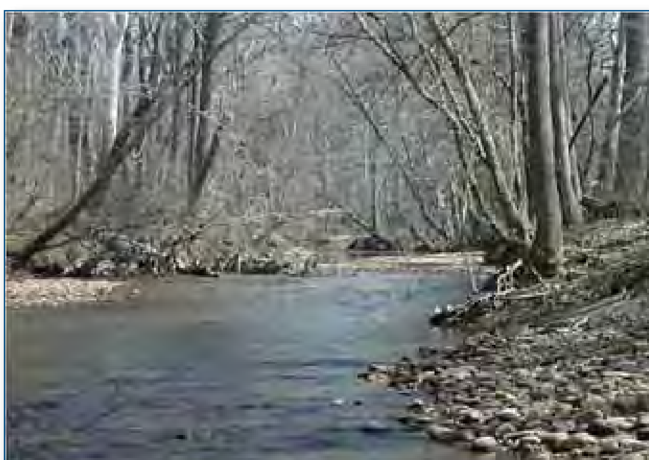


Figure 2-2: A Piedmont Stream (top) and Coastal Plain Stream (bottom) in the Anacostia River Watershed

Table 2-1: Stream Channel Length of Tributaries in the Anacostia River Watershed

No.	Tributary	Stream Channel Length (mi.)*
1	Northwest Branch**	75
2	Paint Branch **	41
3	Upper Beaverdam Creek **	34
4	Lower Beaverdam Creek **	27
5	Indian Creek **	25
6	Sligo Creek **	22
7	Little Paint Branch **	19
8	Northeast Branch **	12
9	Tidal River **	8
10	Still Creek **	7
11	Watts Branch **	7
12	Brier Ditch **	6
13	Fort DuPont **	3
14	Pope Branch **	1
15	Nash Run	1
16	Hickey Run **	1
17	Piney Run	1
18	Fort Chaplin	0
19	Southeast Bank	0
20	Northwest Bank	0
21	Fort Davis	Piped
22	Fort Stanton	Piped
23	Stickfoot	Piped
Total Watershed		**292**

** This length includes the mileage for all mainstems and tributaries for each subwatershed.*
*** One of 14 primary watersheds.*
Source: Adapted from MWCOG, 2008

Coastal Plain streams that have tidal-influenced reaches, such as the Northwest Branch, Northeast Branch, Lower Beaverdam Creek, Watts Branch, and Hickey Run.

As part of the State of Maryland and District of Columbia's efforts to protect surface water quality, the Anacostia streams were classified by MWCOG based on their potential or intended use. These classifications are presented in Table 2-2. In Maryland, water use classes are typically categorized by Class I, water contact recreation and protection of non-tidal warm water aquatic life; Class III, natural trout waters; and Class IV, recreational trout waters. Water Use Class III applies only for the Paint Branch in the upper portion of the watershed upstream of Interstate 495, and Water Use Class IV applies only for the Northwest Branch, which is approximately upstream from the confluence with Sligo Creek. All remaining portions of the Anacostia River in Maryland are designated as Water Use Class I. In the District of Columbia, Water Use Classes A, B, C, D, and E are applied. Over the entire Anacostia River watershed in the District of Columbia, water use is typically categorized by Water Use Classes B, secondary contact recreation and aesthetic enjoyment; Water Use Class C, protection and propagation of fish, shellfish, and wildlife; Water Use Class D, protection of human health related to consumption of fish and shellfish; and Water Use Class E, navigation in the Anacostia River. Figures 2-3 and Figure 2-4 illustrate Water Use Classes in Maryland and the District of Columbia.

Table 2-2: Watershed Water Use Classes in the Anacostia River Watershed

Location	Water Use Class	General Description
Maryland	I	Water contact recreation and protection of non-tidal warm water aquatic life
	II*	Support of estuarine and marine aquatic life and shellfish harvesting
	III	Natural trout waters
	IV	Recreational trout waters
District of Columbia	A	Primary contact recreation
	B	Secondary contact recreation and aesthetic enjoyment
	C	Protection and propagation of fish, shellfish, and wildlife
	D	Protection of human health related to consumption of fish and shellfish
	E	Navigation

**No class II in the Maryland Anacostia River*
Source: Adapted from MWCOG, 2008

Figure 2-3: Water Use Classes in Maryland

Figure 2-4: Water Use Classes in the District of Columbia (Source: MWCOG, 2008)

The Watershed's Geology, Soils, and Climate

The watershed encompasses two physiographic provinces: the Coastal Plain and the Piedmont. In general, the portion of the Anacostia River watershed located in Montgomery County falls within the Piedmont Province, and the portions located in Prince George's County and the District of Columbia fall into the Coastal Plain Province. The change between the Piedmont and Coastal Plain Provinces is known as the "fall line" area and runs approximately parallel to U.S. Route 29/Colesville Road forming small- to medium-sized cataracts, or small waterfalls, in Sligo Creek, Northwest Branch, Paint Branch, and Little Paint Branch. The cataracts are natural barriers for anadromous fish such as alewife and blueback herring. The Piedmont Province is generally characterized by gently rolling to hilly topography separated by drained fertile valleys and narrow stream valleys. Streams are generally low to moderate gradient and are composed of coarser bed material, such as gravel or cobble. The Coastal Plain Province is characterized by generally flatter topography and low gradient streams with finer bed materials. Relief in the Piedmont Province ranges from 200 to 570 feet above mean sea level. In the Coastal Plain Province, the highest elevation is 400 feet above mean sea level.

The Piedmont province is underlain by crystalline metamorphic rock, including granite, gneiss, and schists, of pre-Cambrian to Paleozoic age. Soils in the Piedmont are predominately finer grained micaceous silt loams. The makeup of the Coastal Plain, however, is more complex. There are fluvial deposits of quartz with some sandstone and chert. These deposits are associated with the Potomac Group, or Patuxent Formation, which dates from the early Cretaceous to Quaternary periods. The Coastal Plain province also includes Arundel Clay and portions of the lower Patapsco Formation, and terrace deposits from stream erosion during the Quaternary period are also present. These deposits are largely unconsolidated sediments. Alluvial materials such as micaceous sands, gravels, silts, and clays are present in the Anacostia River valley area, but soils in the Coastal Plain are predominately coarser grained, sandy loams.

Typical of the Mid-Atlantic region of the United States, the climate within the study area is humid, temperate, and semicontinental. Winter months are generally mild and summer months are warm and humid. During spring and fall, weather conditions are variable. The coldest months are January and February, and the warmest temperatures occur in late July and early August. The total annual precipitation ranges from approximately 40-45 inches, and most of the rainfall occurs from April through September (NCDC, 2005).

Land Use Distribution

The watershed is highly developed, reflecting the urban pattern of other metropolitan areas. The densest development is concentrated near the urban center, within Interstate 495/Capital Beltway. As of 2000, approximately 70-percent of the Anacostia River watershed had been developed (Figures 2-5 and 2-6) (MWCOG, 2008). Residential development, including single-family houses, townhouses, and apartments, is the most common land use and comprises approximately 45-percent of the watershed (MWCOG, 2008).

Undeveloped land use includes forest, parks, and wetlands and comprises approximately 30-percent of the watershed. Of the 30-percent of undeveloped land in the Anacostia River watershed, 50-percent is parkland. Most of this parkland, 75-percent, is owned and managed by the bi-county M–NCPPC, and the remaining 25-percent is managed by the NPS, the District of Columbia Department of Parks and Recreation, and local municipalities. Agricultural areas encompass approximately 4-percent of the watershed, and industrial and manufacturing areas encompass approximately 4-percent of the watershed. These industrial and manufacturing areas are composed of predominately light industry and are concentrated in the Anacostia River tidal reach and in the Hickey Run, Lower Beaverdam Creek, and Indian Creek subwatersheds. Sand and gravel mining occur primarily in the Little Paint Branch and Indian Creek subwatersheds.

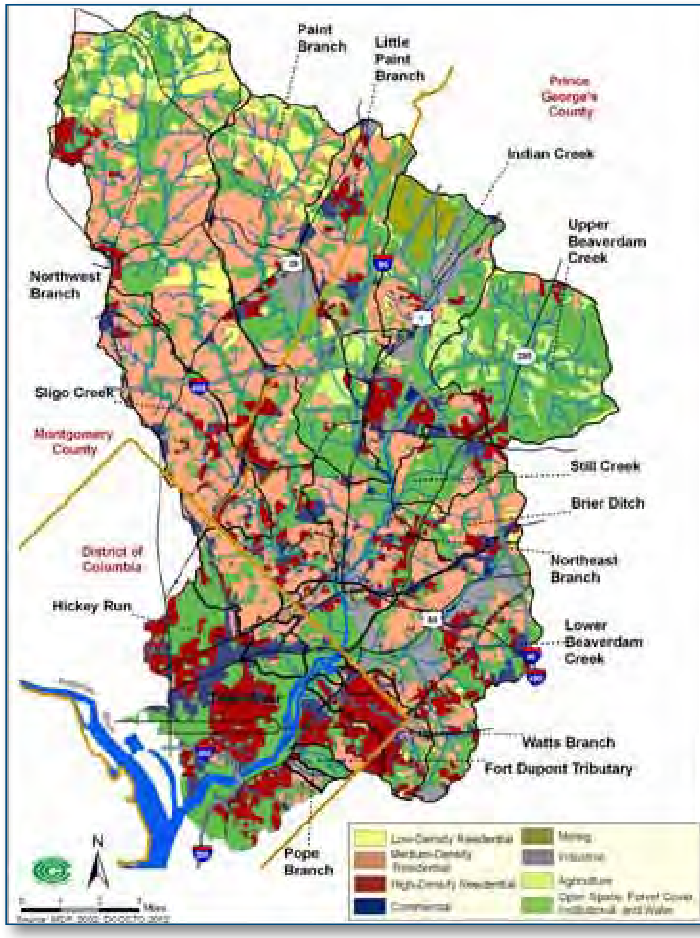


Figure 2- 6: Anacostia River Watershed Land Use (2002)

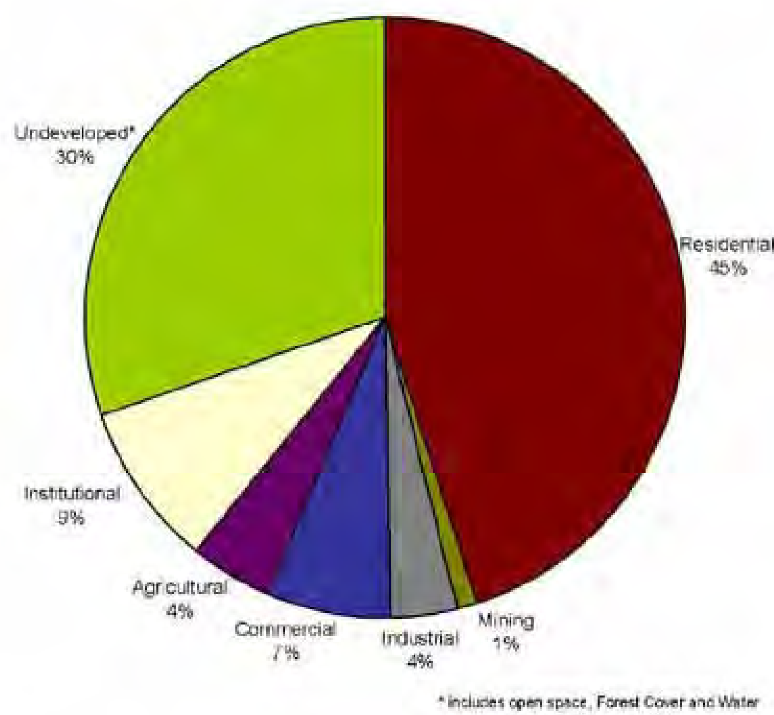


Figure 2-5: Land use distribution within the Anacostia River Watershed

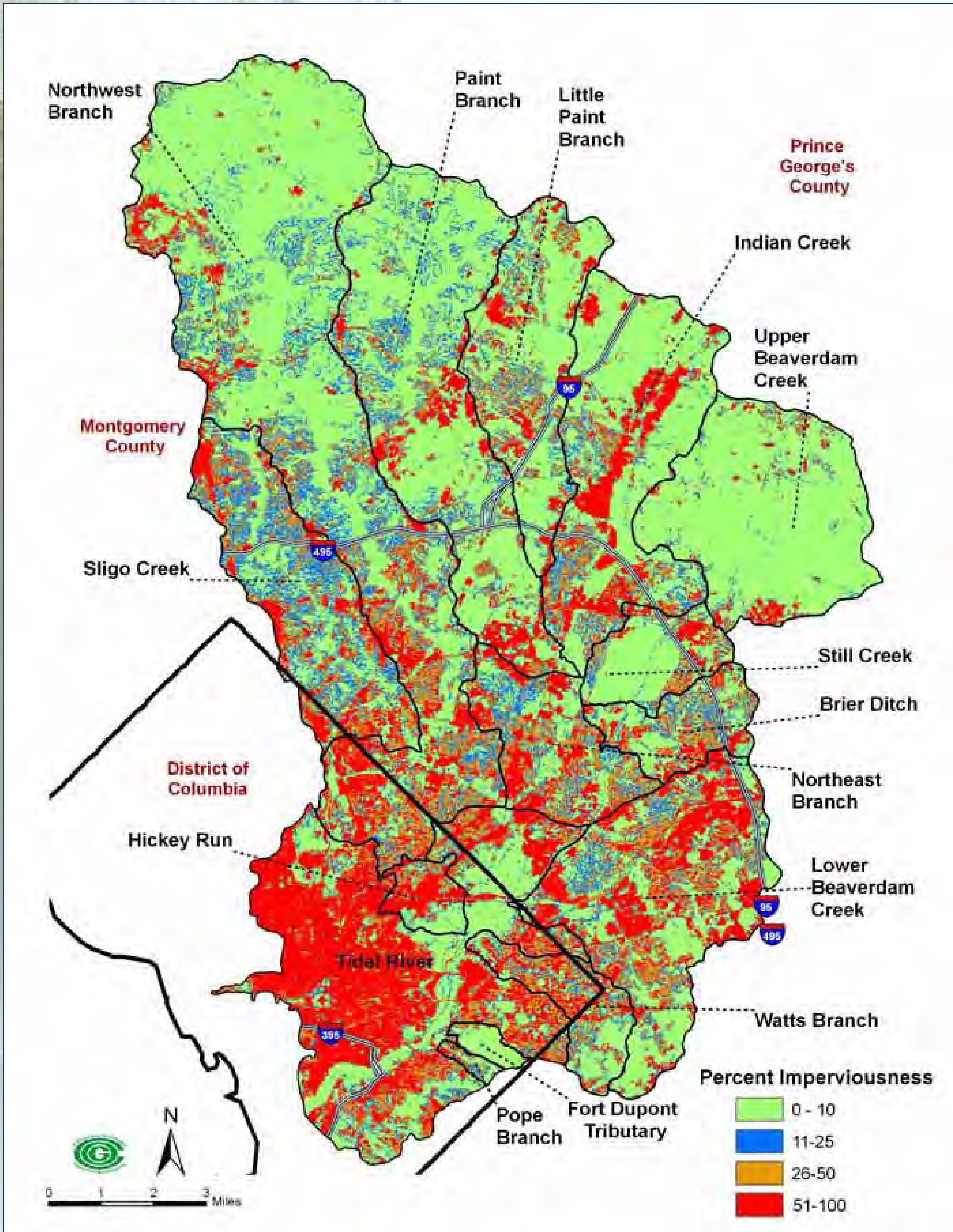


Figure 2-7: Impervious Cover in the Anacostia River Watershed

Approximately 14-percent of the land in the Anacostia River watershed is owned by eight Federal entities, including the U.S. Department of the Treasury, U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Army, U.S. Navy, U.S. Marine Corps, U.S. Air Force, and National Aeronautics and Space Administration. The U.S. Department of Agriculture, Beltsville Agricultural Research Center (BARC), and the Department of the Interior, NPS, are the two largest Federal landowners in the watershed, accounting for 73-percent of the Federally-owned lands. In general, the land uses of the Federally-owned lands vary considerably between highly developed, like the Washington Navy Yard, and agriculture/forest, like BARC and the National Arboretum. It should be noted that the land owned by BARC is recognized as critical habitat for wildlife because of its relatively unfragmented and pristine nature and because it contains some of the healthiest streams and most intact remaining non-tidal wetlands. In particular, the Upper Beaverdam Creek portion of BARC is a critical wildlife corridor between the Anacostia River watershed and the Patuxent River watershed through which wildlife such as wild turkey and river otter have recently returned to this subwatershed.

Impervious surfaces associated with development, such as parking lots, roads, and roofs, cover approximately 25-percent of the watershed ranging from between 6-percent in Upper Beaverdam Creek and 41-percent in Hickey Run (Figure 2-7 and Table 2-3) (MWCOG, 2008).

Table 2-3: Impervious Cover in the Anacostia River Watershed

Subwatershed	Impervious Cover (%)
Lower Beaverdam Creek	32
Hickey Run	41
Sligo Creek	33
Watts Branch	31
Tidal Anacostia	40
Northeast Branch	37
Indian Creek	21
Little Paint Branch	20
Paint Branch	17
Northwest Branch	19
Upper Beaverdam Creek	6
Still Creek	19
Brier Ditch	29
Fort DuPont Tributary	11
Pope Branch	32

Environmental Conditions

This section presents the environmental conditions of the remaining forest, wetland, submerged aquatic vegetation, stream water, and aquatic faunal communities. Additionally, it describes the impact of stormwater, including CSOs, on the morphology of the streams, in-stream water quality, and aquatic life.

Forest Cover

At the time of European settlement, the entire Anacostia River watershed was forested. As of 2000, approximately 70-percent of the forest cover had been lost because of land clearing for agriculture, timber harvest, sand and gravel extraction, and urbanization. The loss of forest due to urbanization became increasingly prevalent after 1936, because the availability of agricultural area for development decreased substantially. As a result, forest cover further decreased by eight percent between 1936 and 2000 (Figures 2-8 and 2-9). In fact, most of the forest loss took place in riparian areas along streams. Forest cover in riparian areas is particularly critical to the stream's health, because tree cover reduces bank erosion, maintains stream temperature, and filters pollutants

Forest cover did not decrease evenly, however, throughout all 14 subwatersheds from 1936–2000. In fact, in some watersheds the forest cover increased. The three watersheds with the largest loss of forest cover occurred in Fort Chaplin by 46.8-percent, Brier Ditch by 34.6-percent and Pope Branch by 31.7-percent. Of the 14 subwatersheds, six increased their forest coverage because of natural succession of abandoned agricultural land to forest and parkland acquisition, including Watts Branch by 7.7-percent, Fort DuPont Tributary by 4.6-percent, Stickfoot by 2.2-percent, Upper Beaverdam Creek by 1.8-percent, Tidal River by 1.2-percent, and Northwest Branch by 0.7-percent.

Figure 2-8: Forest Cover in 1936/1938 (Source: MWCOG, 2008)

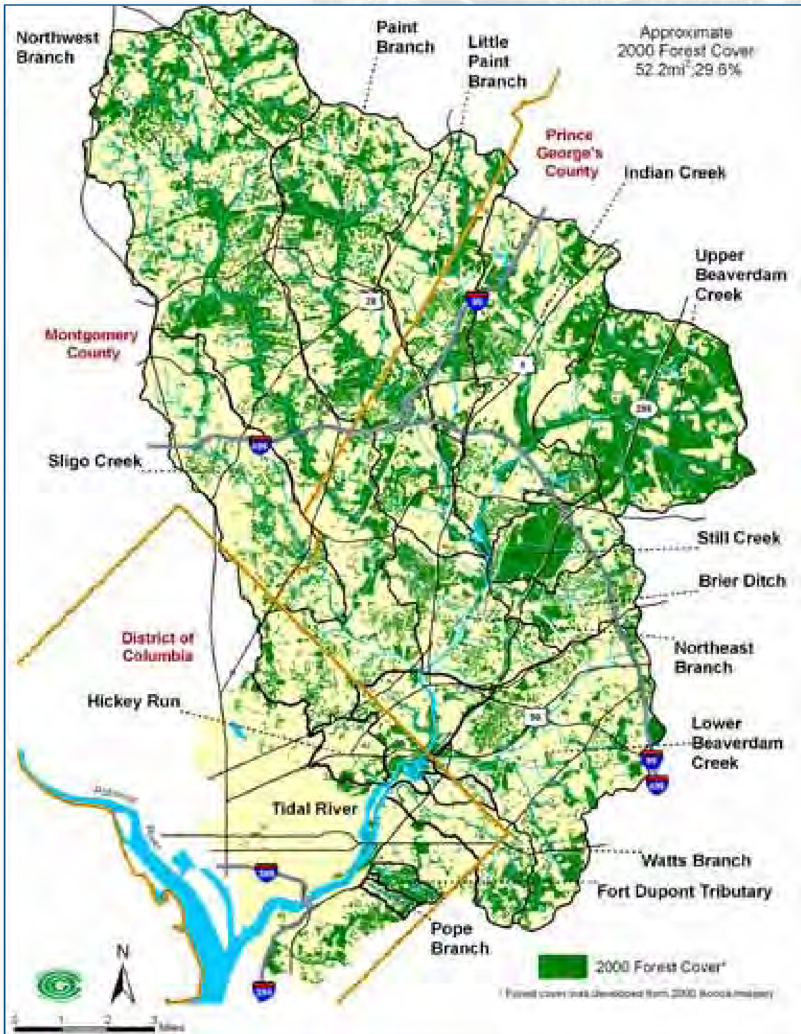


Figure 2-9: Forest Cover in 2000 (Source: MWCOG, 2008)

As of 2000, the existing forest consisted of 51.9-percent deciduous forest, 28.4-percent mixed forest, 12.4-percent regenerating shrub, and 7.3-percent coniferous forest. Approximately 59.1-percent of the forest is composed of mature hardwood stands and is on public land. This hardwood has a high ecological value; however, as development expanded the forest cover was not only reduced but also became isolated and created a fragmented landscape in which wildlife migration became restricted or impossible. As a result, the potential ecological value of this remaining forest has been strongly diminished. Table 2-4 presents four categories of forest tract sizes in the Anacostia River watershed. Each category represents fragmented forested area with a certain size or size range. It is notable that the smallest category, in which the forest tract size ranges between 1 and 12, acres, shows the most forest tracts.

Table 2-4: Forest Tract Sizes in the Anacostia River Watershed

Category No.	Forest Tract Size Range (acres)	Number of Tracts	Forest Tract Area (acres)
Category 1	1-12	1,503	5,608
Category 2	13-25	134	2,398
Category 3	26-75	99	4,222
Category 4	>75	72	21,149

Tidal and Non-Tidal Wetlands

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands can be tidal and non-tidal and can include swamps, marshes, bogs, and similar areas (33 CFR Part 328.3).

Wetlands play a critical role as habitat for flora and fauna, buffer for pollutants, and erosion control. Additionally, wetlands have the ability to store and attenuate flow and hence reduce flooding farther downstream.

There are three types of wetland in the watershed (Figure 2-10):

1. Palustrine wetlands, including marshes, swamps, and small shallow ponds under 20 acres in size dominated by trees, shrubs, and persistent grasses
2. Riverine, including freshwater tidal and non-tidal stream that contain water at least periodically
3. Lacustrine, including lakes and ponds with less than 30-percent coverage by wetland grasses, trees, or shrubs

Palustrine wetlands comprise more than three-quarters of the wetlands, and the rest are Riverine and Lacustrine, comprising 20- and 4-percent, respectively.

There are approximately 2,550 acres of remaining wetlands in the Anacostia River watershed (MWCOG, 2008). The loss of tidal wetlands has been more extensive than the loss of non-tidal wetlands. Of the estimated 2,500 acres of original tidal wetlands, 93-percent have been destroyed or altered, and of the estimated 6,390 acres of original non-tidal wetlands, 63-percent have been destroyed or altered (Figure 2-11). The information presented in Figure 2-11 does not indicate the current trend of wetland losses as the watershed is almost completely developed. The loss of these wetlands was caused by historic land conversion to agriculture, sand and gravel mining, urban development, flood damage reduction projects, and dredging within and along the tidal river. Also to some extent, the loss of historic non-tidal wetland is linked to the complete extirpation of beavers in the watershed, since their habitat, which once caused flooding, disappeared with the development of the wetlands.

Submerged Aquatic Vegetation (SAV) in the Anacostia River watershed provides the necessary habitat and food for area invertebrates, fish, and waterfowl. Historically, through the 1930s, the Potomac River housed an abundant amount of diverse SAV such as water stargrass, coontail, and wild celery. From the 1950s to the 1970s, SAV in the area died off because of massive and persistent algal blooms. Upgrades of sewage systems and treatment plants in the 1980s improved water quality in the area, and between 1987 and 1996, SAV, including wild celery, coontail, water stargrass, milfoil, and hydrilla, began to return in the lower reaches of the Anacostia River. However, SAV has decreased considerably in recent years and the lower tidal areas contain only the invasive species hydrilla.

Figure 2-10: Tidal and Non-Tidal Wetlands (Source: MWCOG, 2008)

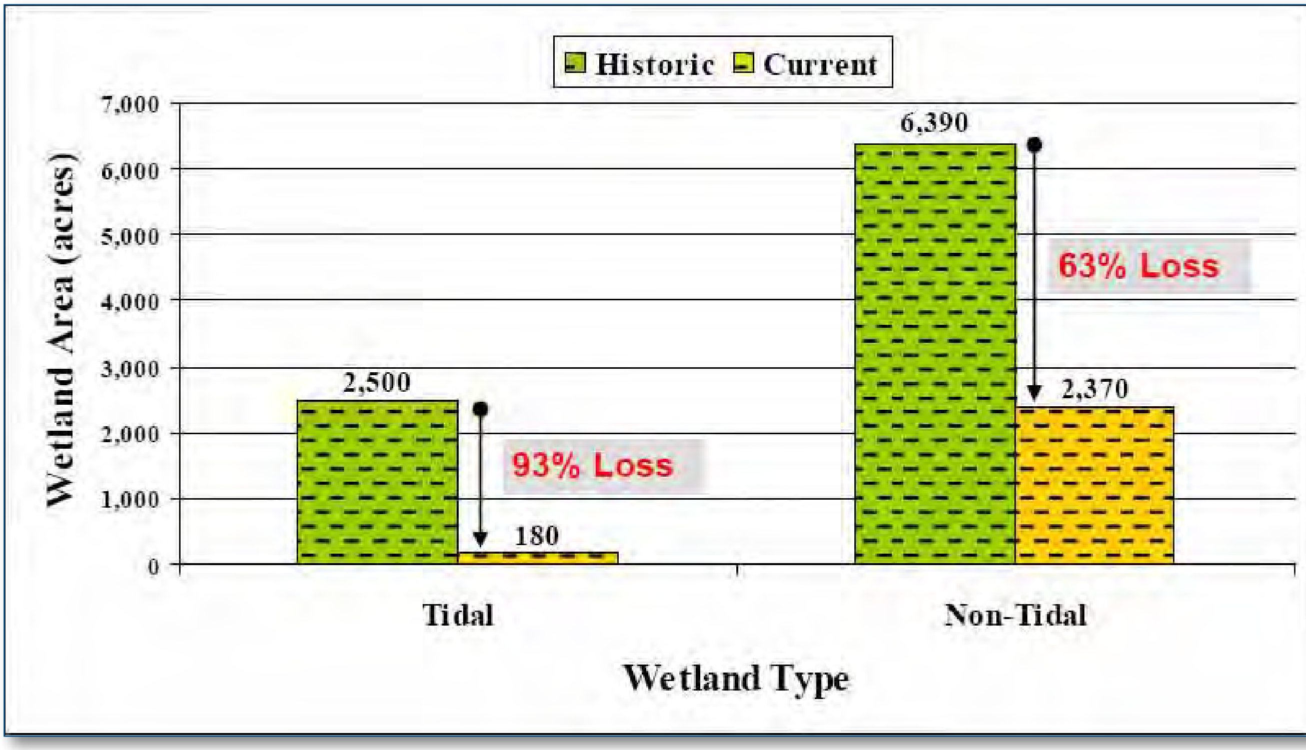


Figure 2-11: Loss of Tidal and Non-Tidal Wetlands
(Source: Adapted from MWCOG, 2008)

Sanitary Sewer System and Combined Sewer Overflows

The sewer system in the Anacostia River watershed comprises combined storm sewers, which carry runoff from storm events and sanitary sewers that transmit sanitary wastes from homes and businesses to wastewater treatment facilities. Combined sewer systems, however, are only present in the District of Columbia. Separate sewers exist in the District of Columbia, Montgomery County, and Prince George's County.

Most of the sanitary sewer systems in the District of Columbia and Montgomery and Prince George's counties have exceeded or will soon approach the end of their normal expected service lives. Additionally, many sewer lines are exposed and damaged because of the accelerated streambed erosion caused by urban runoff. As a result, some of the sewer lines leak or are damaged, causing increased bacteria and organic loading into area streams. As part of a 2006 EPA Consent Decree, the Washington Suburban Sanitary Commission (WSSC) in Maryland is required to rehabilitate and replace the leaking, undersized and aging sewer lines in the Maryland portion of the Anacostia River watershed within 12 years. The decree also includes a water quality management plan of the tributaries in the Anacostia River to identify areas of concern and their sources.

Combined sewers collect wastewater, or sewage, and stormwater flow in a single system of pipes and transport it to a wastewater treatment plant. As shown in Figure 2-12, approximately one-third, or 12,478 acres, of the District of Columbia is served by combined sewer and stormwater systems (DCWASA, 2002). Under dry weather conditions, these systems convey sewage to the Blue Plains Advanced Wastewater Treatment Facility (DCWASA, 2009). The Blue Plains Advanced Wastewater Treatment Facility, which serves over two million people in the District of Columbia, Maryland, and Virginia, is the largest advanced wastewater treatment facility in the world, treating approximately 370 million gallons of wastewater per day as average annual capacity (DCWASA, 2009). The facility is also the single largest point source contributor of total nitrogen (N) to the Chesapeake Bay watershed (DCWASA, 2009). Under certain wet weather conditions, however, the combined sewer system exceeds its pipe capacity, causing an overflow. The outflow is discharged into the Anacostia River by 15 CSO outfalls (DCWASA, 2009). The location of the combined CSO outfalls is presented in Figure 2-13.

Most of the CSO outfalls are located in the lower section of the Anacostia River. In the past, these CSOs led to severe bacterial contamination. In fact, the CSOs account for approximately 61-percent of the bacterial loadings and 14-percent of the biochemical oxygen demand (BOD) load in the river (DCWASA, 2001). Figure 2-14 presents the geometric mean of fecal coliform concentration in the Anacostia River between 1986 and 2007. Maryland's

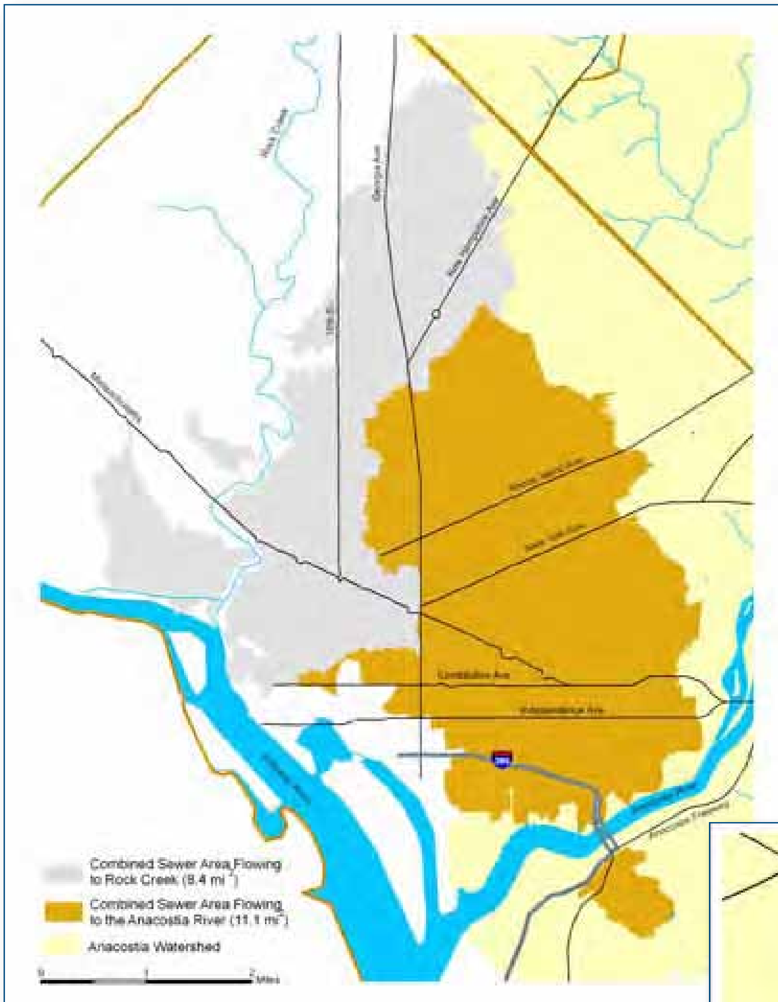


Figure 2-12: Combined Sewer Area (Source: MWCOG, 2008)

Figure 2-13: Location and Relative Size of Active Combined Sewer Overflow Outfalls (Source: MWCOG, 2008)

government and the Anacostia Watershed Society (AWS) collected the bacteria data. Note that over the last 21 years (1986-2007) bacteria levels, or the geometric mean of fecal coliform in the Anacostia River, have exceeded Maryland's and the District of Columbia's fecal coliform bacteria standard of 200 Most Probable Number/100mL. Pursuant to EPA's national CSO policy, DCWASA approved a Long Term Control Plan (LTCP) for the Anacostia River in 2002. The LTCP intends to address and mitigate CSO events and will be completed in 2025 with a total investment of over $3 billion (DCWASA, 2009). With considerable funding assistance, however, it could be implemented within 15 years. Pertaining specifically to the Anacostia River drainage area, the LTCP control measures, upon implementation by 2025, would limit CSOs from 75 to two events per year, a 98-percent reduction (DCWASA, 2009). Seven inflatable dams and a pump station rehabilitation completed in 2009 reduces CSO volume into the Anacostia River from 2,142 million gallons per year to 1,282 million gallons per year, or approximately 40-percent (DCWASA, 2009). In addition, construction on the Blue Plains Tunnel and the Anacostia River tunnel will be completed by 2018 (DCWASA, 2009).

Decreasing the number of CSO events would have a significant impact on water quality within the river by reducing the concentrations of N and bacteria, potentially meeting the fecal coliform Total Maximum Daily Load (TMDL). A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. In addition, the LTCP would reduce the potential for fish kills by improving DO levels and reducing the trash and other waste discharged from outfalls during a CSO event (DCWASA, 2002). Although the LTCP will be an integral component to the Anacostia River's overall restoration, the upstream contributions of pollution due to stormwater runoff must be addressed concurrently.

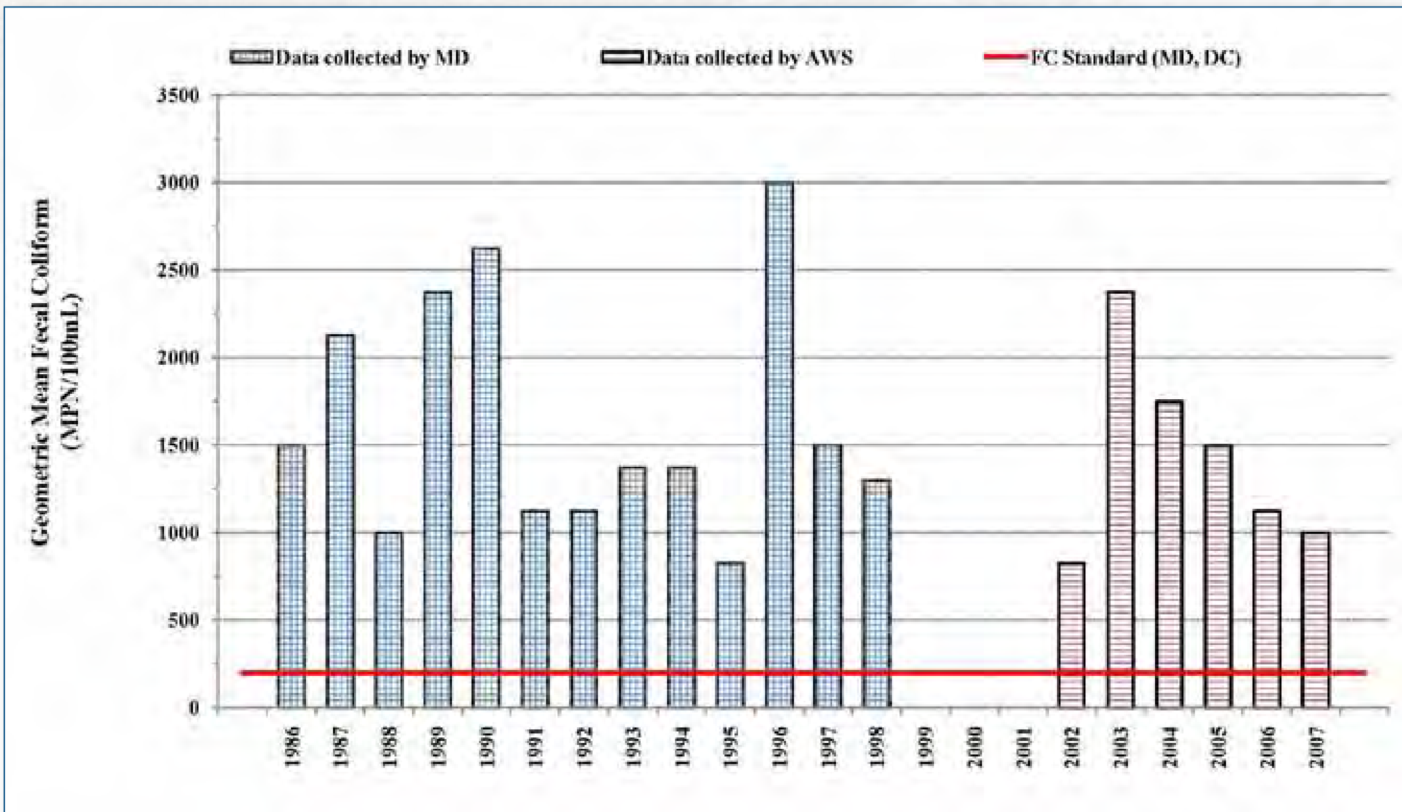


Figure 2-14: Fecal Coliform Concentrations in the Anacostia River (1986–2007) (AWS, 2007)

Stormwater

The urbanization or development of a watershed increases the impervious cover and leads to surface runoff to the receiving stream if the impervious area is directly connected to a storm sewer or stream channel. Depending on the extent of impervious cover within the drainage area and the intensity of the rain, the volume of surface runoff generated and its velocity may have considerable adverse effects on the receiving stream.

Direct impacts of the generated volume and velocities on the stream are bottom scour, bank erosion, and flooding that leads to in-stream erosion and sediment deposition. Consequently this leads to habitat loss for aquatic life, such as benthic macroinvertebrates, fish, and riparian life. Additionally, surface runoff carries sediments, nutrients, and chemical contaminants into the receiving stream, which also adversely affects the aquatic and riparian life of the stream.

The imperviousness of the Anacostia River watersheds ranges from 6-percent to 41-percent, with an average of approximately 25-percent (MWCOG, 2008). Generally, areas with impervious cover greater than 25-percent do not support their designated uses as stipulated in the Water Use Classes for the State of Maryland and the District of Columbia (Table 2-2) (CWP, 2003).

Management controls for stormwater and its pollutants in Maryland were initiated in 1971, and since 1984 stormwater quantity and water quality controls are required for all new development. As a result, historic urban and industrial areas of the watershed, such as areas in the District of Columbia and most of Maryland (64-percent of the watershed), have no stormwater control management (Figure 2-15). However, since 2001, approximately 1,360 acres of previously uncontrolled land have been retrofitted with stormwater management controls (MWCOG, 2008). It should also be noted that new Maryland permits require property owners to implement stormwater management controls to the maximum extent practicable (MEP) so some of this controlled area may need additional quantity or quality controls to meet the MEP.

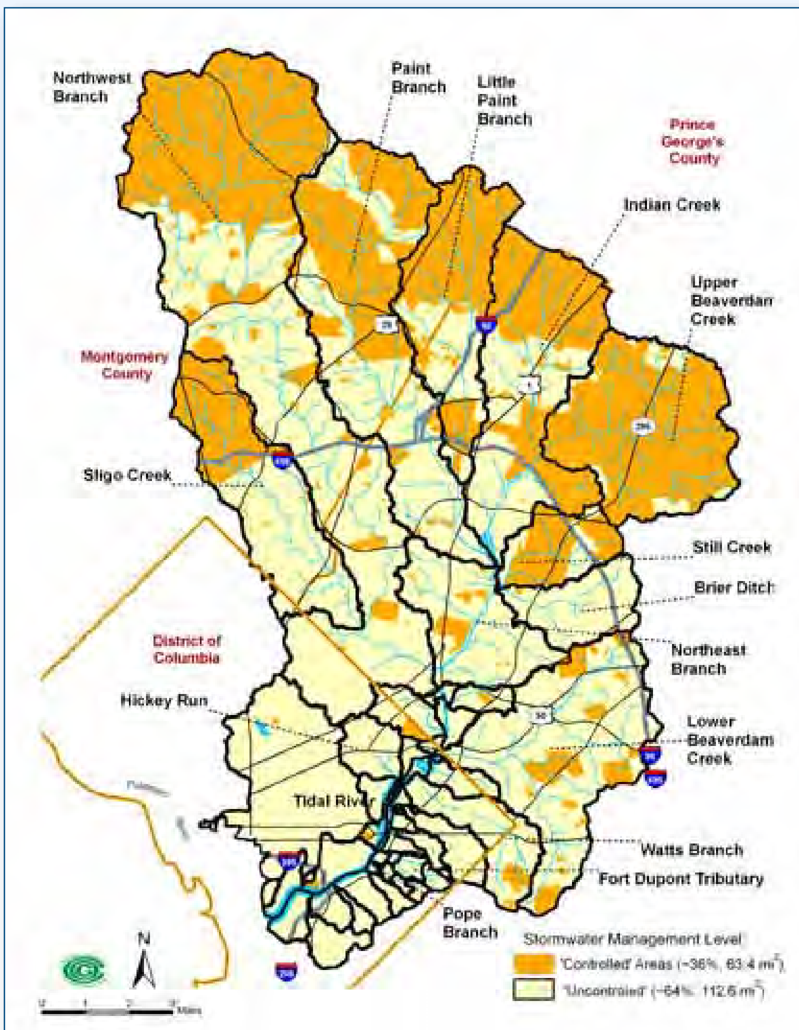


Figure 2-15: Areas of Controlled and Uncontrolled Stormwater Management (Source: MWCOG, 2008)

Water Quality Conditions

Because of the high percentage of imperviousness in the watershed and the lack of stormwater management, stormwater runoff generally carries considerable concentrations of pollutants. At different locations throughout the watershed, stormwater may contain various kinds and concentrations of the following pollutants: sediment; nutrients, including nitrogen (N) and phosphorus (P); organic matter; bacteria; heavy metals, including cadmium, copper, and zinc; organic chemical contaminants, including PAHs, PCBs, and pesticides; and trash. The amount and types of pollutants entering the Anacostia through stormwater runoff has raised concerns about the quality of water in the watershed.

Water bodies that do not or are not expected to meet water quality standards as required by Sections 303(d) of the CWA (1972) are considered "impaired" for certain pollutants. Because it receives so many pollutants, the water quality of the Anacostia River is impaired according to the CWA definition. The following sections summarize the pollutants and their impact on the Anacostia River watershed.

Stream Channel Erosion and Sedimentation

The high level of impervious cover combined with the fact that at least 64-percent of the watershed has inadequate stormwater management controls, including approximately 3,000 storm drain outfalls, has caused severe stream channel erosion in the non-tidal watersheds. The erosion is exacerbated by the flashiness of the runoff from the landscape, which is eroding stream channels and causing sedimentation in the tidally influenced watersheds (Figure 2-16). As a result of the flashy tributaries, most of the delivered sediment load to the Anacostia River, which is estimated as being approximately 70-75-percent, is associated with stream channel erosion within the tributaries (MDE, 2007). Also, based on the U.S. Geological Survey estimator model, the Northwest Branch and the Northeast Branch delivered large sediment loads that are an order of magnitude higher than those estimated in the more rural Potomac and Susquehanna River watershed. Most of the delivered sediments, estimated as approximately 85-percent, are trapped in the Anacostia River tidal reach because of its sluggish properties and long residence times, averaging 23 to 28 days. Consequently, the Anacostia River requires frequent costly sediment removal to maintain marina areas and navigation channels.

Pursuant to section 303(d) of the CWA, the EPA mandates and authorizes the development of a TMDL to eliminate impairments in water bodies. The Anacostia River was listed by the State of Maryland in 1996 as being impaired for sediment. In 2007, EPA approved the sediment, or total suspended solids (TSS), TMDL for the Anacostia River. Based on this TMDL, sediment loads must be reduced by 85-percent to achieve water quality standards (MDE, 2007). Control of stormwater runoff will have a direct impact on reducing the in-stream channel erosion and sediment loads.

Figure 2-16: In-stream erosion at tributaries in the Anacostia River Watershed

Nutrients

Nutrients such as phosphorus and nitrogen can significantly impact freshwater ecosystems. Typical sources of phosphorus and nitrogen include fertilizers, animal wastes, automotive exhaust, atmospheric deposition, organic materials and soils. When slow-moving streams receive excess nutrients such as phosphorus and nitrogen, it can stimulate the growth of excessive algae and nuisance plants. This enhanced plant growth reduces DO as the plant material dies and the decomposition depletes the water of its dissolved oxygen.

Based on the final nutrient and BOD TMDL for the Anacostia River, most of the nutrient loads are delivered from developed land, excluding CSOs, and accounting for approximately 67- and 80-percent of the Total Phosphorus (TP) and Total Nitrogen (TN) load, respectively (MDE, 2008). The remaining loads originated from CSOs, in-stream erosion, agriculture, and miscellaneous sources. Table 2-5 shows the sources of TP and TN in the tidal Anacostia River (MWCOG, 2008).

Organic Loadings and BOD

In addition to the DO level decreases resulting from excessive nutrients in a water body, organic matter that enters a water body as a result of stormwater runoff, CSOs, leaking sewer lines, and natural processes also reduces the DO.

The five-day BOD (BOD5) is a measure of the amount of oxygen required to decompose organic matter taken over five days. When characterized as a pollutant load, BOD5 is expressed in terms of the total organic load, which is biologically oxidizable, to a receiving water body.

The results of the modeling effort to develop a BOD5 TMDL indicated that the BOD5 pollutant loads for the entire Anacostia watershed is 5 to 6 times higher than the pre-European settlement conditions. The results of the nutrient and BOD TMDL modeling also showed that in general the BOD5 pollutant load was directly proportional to the subdrainage area of the Northwest and Northeast branches, which comprise 74-percent of the total watershed and generate approximately 72-percent of the watershed BOD5 (MDE, 2008).

High BOD5 loads, particularly during warmer summer months, can reduce DO concentrations to levels that are lethal to fish and other aquatic organisms. Other factors that influence DO concentrations include river flow, water temperature, sediment oxygen demand (SOD), and as discussed previously, organic loadings from CSO events and excessive nutrients. The oxidation of organic matter in bottom sediments causes SOD (Chapra, 1997), and within the tidal Anacostia River, particularly in the vicinity of CSO outfalls, SOD has been found to have a major negative influence on DO. As shown in Figure 2-13, most of the CSO outfalls are located in the lower section of the Anacostia River and discharge in the vicinity of the East Capitol Street and South Capitol Street bridges.

The District of Columbia has established 5.0 mg/L as the minimum DO concentration required to support aquatic life. As shown in Figure 2-17, in summertime, the DO concentration in the tidal Anacostia River at the South Capitol Bridge chronically does not meet the District of Columbia's minimum DO standard of 5 mg/L (MDE, 2008). However, it should be noted that although the DO concentration in the tidal Anacostia River has been consistently measured near or below the minimum standard, the number of fish kills reported in the tidal river over the past 20 years has declined. The District of Columbia's Fisheries Management Branch, which investigates fish kill reports within the Anacostia River, has observed three fish kills: June 1991, June 1992, and April 2001. The DO levels associated with the 1991 fish kill were reported at 0.4 to 1.8 mg/L (MDE, 2008).

In addition to the DO level decreases resulting from excessive nutrients in a water body, organic matter that enters a water body as a result of stormwater runoff, CSO, leaking sewer lines, and natural processes also reduces the DO.

Bacteria

The Anacostia River is affected by high levels of bacteria due to leaking sewers, CSOs, human, pet, and wildlife waste. The District of Columbia, like

Table 2-5: Sources of Total Phosphorus and Nitrogen in the Tidal Anacostia River

Source	Total Phosphorus (%)	Total Nitrogen (%)
Developed Land	67	80
In-stream Erosion	14	-
CSOs	13	7
Agriculture	3	9
Miscellaneous Sources	2	4

many cities with older infrastructure, has a sewer system that combines wastewater with stormwater runoff. During normal dry weather conditions, all of the sewage in these combined sewers is processed by the Blue Plains Wastewater Treatment Plant. During light to moderate rainstorms, the combined sewer system reaches its capacity, and overflows of mixed untreated sewage and stormwater runoff enter directly into the Anacostia River. According to the DCWASA, in an average year, there are about 82 overflow events in the Anacostia River, 75 in the Potomac River, and 30 in Rock Creek (DCWASA, 2002).

As shown in Figure 2-13, most of the CSO outfalls are located in the lower section of the Anacostia River. CSO events have led to severe bacterial contamination of the Anacostia River, accounting for approximately 61-percent of its bacteria load. Table 2-6 presents the principal sources of fecal bacteria and relative contributions for Northeast and Northwest Branches.

In March 2007, the EPA approved the final fecal bacteria TMDL for the Maryland portion of the Anacostia watershed (MDE, 2006). The approved TMDL considered six hydrological conditions, including high flow, low flow, high flow seasonal conditions, low flow seasonal conditions, 30-day high flow, and 30-day low flow. To better protect the downstream tidal water quality in the District of Columbia, the 30-day high and low flow were selected. The fecal bacteria TMDL load for the Maryland portion of the watershed is 357 Most Probable Number bacteria/day (MDE, 2006).

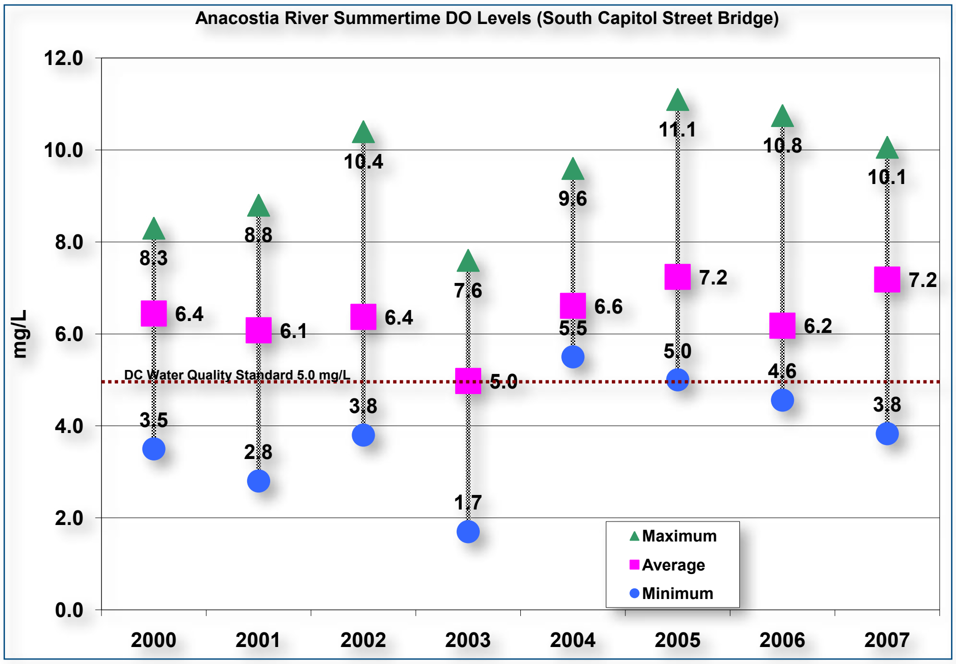


Figure 2-17: Anacostia River Summertime Dissolved Oxygen Levels, 1997–2005 (South Capitol Street Bridge)

Table 2-6: Principal Sources of Bacteria and Relative Contribution for Northeast and Northwest Branches

Contributing Source	(%) Contribution
Human	9-55
Domestic Animals	24-28
Livestock	6-28
Wildlife	12-38

Trash

Trash is perhaps the most visible sign of pollution within the Anacostia River watershed. It is estimated that more than 20,000 tons of trash and debris enter the river annually (Prince George's County, 1994). The relatively low flow rate of the tidal Anacostia; long turnover times, approximately 90 days, in flushing out debris, stormwater outfalls, and CSO outfalls; and many mudflats and deltas exposed at low tides are problems that are intrinsic to the debris control on the river. More than 500 tons of trash is removed from the tidal river reach every year by DCWASA's skimmer boat fleet, trash trapping devices, and volunteers (DCWASA, 2002). Figure 2-18 shows the trash removed from the Anacostia River from 1993 through 2005. In addition, USACE Debris Removal Team removes on average approximately 180 tons of debris from the Anacostia and Potomac Rivers annually (USACE, 2009 (personal correspondence)).

Trash and debris interfere with establishment of aquatic plants and are hazards to wildlife, because they can ingest or become entangled in the debris. Other problems from trash in the river include leaching of chemical contaminant materials from oil quarts, containers, and batteries.

In 2006, both the State of Maryland and the District of Columbia listed the Anacostia River as impaired for trash under the CWA. A trash TMDL baseline monitoring program was completed in late 2007 and monitoring in the Maryland portion of the watershed began in mid-2008.

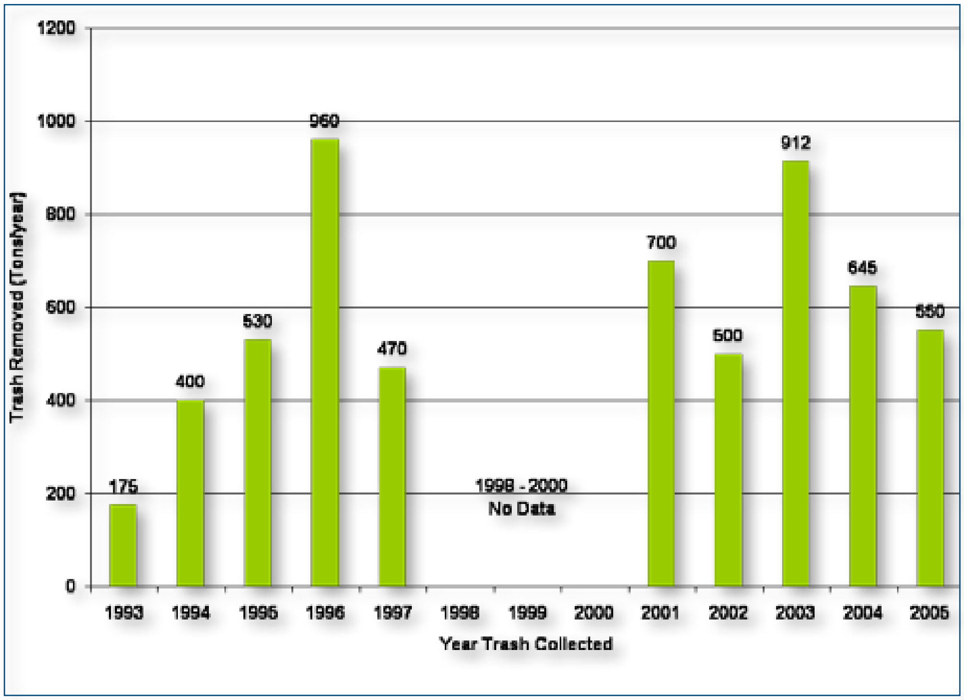


Figure 2-18: Trash Removed From the Anacostia River (1993–2005)
(Source: MWCOG, 2008)

Chemical Contaminants

In 1999, EPA convened the Anacostia Watershed Toxics Alliance (AWTA), a coalition of over 25 different groups, agencies, and institutions, to address chemical contaminants in sediments with a focus on investigation and potential management actions associated with waste sites. The hazardous contaminants fouling the Anacostia watershed are being investigated and addressed by this coalition of public and private volunteer stakeholders, who are performing this work without the issuance of judicial or administrative orders.

Chemical contaminants enter the Anacostia from individual facilities or waste sites along the river, storm water discharges, CSOs, nonpoint source runoff throughout the watershed, atmospheric deposition, and input from tributaries. The nature of the

Figure 2-19: Anacostia River Toxic Areas of Concern (Source: MWCOG, 2008)

source (point source vs. nonpoint source) and the transport mechanism within the river have an impact on the distribution of contaminants within the river (EPA and NOAA, 2009). Additionally, historic or legacy sources of chemical contamination exist in the watershed, particularly in sediments, and continue to degrade the Anacostia River ecosystem. The sluggish nature of the tidal river has exacerbated contamination as sediments laden with chemical contaminants remain trapped in the slow moving river. The primary chemicals of concern in the Anacostia River are PAHs and PCBs due to their toxicity and widespread distribution (EPA and NOAA, 2009). Additionally, the following chemical substances are present and pose an unacceptable risk to human health and the environment: dichloro-diplenyl-trichlorethane (DDT), chlordane, atrazine, arsenic, mercury, copper, cadmium, and lead (Velinsky et al., 1994; Wade et al., 1994; Velinsky and Ashley, 2001; McGee et al., 2009; MWCOG, 2008). PAHs and PCBs, organic contaminants, are toxic to aquatic life and are possible human carcinogens.

Manufactured domestically beginning in 1929, PCBs were used in a wide variety of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment, as a plasticizer, and in pigments and dyes until its ban in 1979. Additionally, PCBs were used in a variety of other products like some paints, rubbers and plastics, adhesives and tapes, caulking, old electrical devices or appliances containing PCB capacitors, various types of electrical equipment, floor finish, and carbon-less copy paper (EPA, 2009). Use and disposal of PCBs is specifically regulated under the Toxic Substances Control Act administered by EPA.

PAHs are found in oil, coal, and tar deposits and result from the incomplete combustion of fossil fuels. PAHs are present in heavy processed oils and tars such as in common road asphalt. Combustion of oil or coal in power plants produces PAHs, as does combustion of fuel in vehicle engines. The PAHs from such exhausts is likely particulate, of a size that much of it falls to the ground and introduced into stream networks via stormwater runoff. PAHs are ubiquitous in urban areas. Leaking motor oil, coal-tar pavement sealants, tire particles, and broken up asphalt from driveways and parking lots also contribute PAHs into the environment (CBP, 2009).

Current research has identified that PAHs and PCBs are transported in stormwater runoff in the Anacostia (Foster et al., 2000; Mason and Sullivan, 1998; Stein et al., 2006; Hwang and Foster, 2006; Hwang and Foster, 2008). Hwang and Foster (2006 and 2008) determined that stormwater was enriched in the particulate phase of both these contaminants and suggested that best management practices (BMPs) focused on sediment removal such as low impact development (LID) would likely decrease PCBs and PAHs inputs to the stream network significantly.

Chlordane was used widely within the Anacostia River watershed for termite control until EPA suspension in 1988 (EPA, 1990). DDT is a pesticide that was banned in 1972 by the based

on the risks it posed to the environment and human health (EPA, 2010a). Although no additional loadings are expected due to EPA's restrictions, chlordane and DDT may remain at elevated levels for many years due to their slow rate of decomposition. The presence of legacy chlordane has been identified in the Anacostia watershed (Phelps 2005, Phelps, 2008).

Contaminated sediments can affect burrowing organisms that live within the sediment, fish that feed on those organisms, and people who consume those fish along with piscivorous mammals and birds of prey such as osprey (EPA and NOAA, 2009). PCBs are primarily a concern for human consumers of fish (and possibly for wildlife that consume fish) while PAHs are a main concern for fish tumors. PCBs are particularly troublesome because they also bioconcentrate—that is, increase in concentration relative to the environment—at higher levels in the food chain. Therefore, even relatively low environmental concentrations can have impacts on higher level predators. PCBs have been shown to cause cancer, as well as have serious effects on the nervous, immune, endocrine, and reproductive systems of laboratory animals (ATSDR, 2000). Studies in humans have shown potential cancerous and non-cancerous effects. Studies conducted by the U.S. Fish and Wildlife Service – Chesapeake Bay Field Office have indicated that 50-68-percent of the brown bullhead catfish studied from the Anacostia River have liver tumors and 13-23-percent have skin tumors (Pinkney et al., 2004). The prevalence of liver tumors in brown bullhead catfish is equivalent to the highest recorded in North America. These rates are alarming, as scientists consider an area with a liver tumor rate of more than 5-percent to be highly contaminated. The liver tumors have been associated with exposure to PAHs based on analysis of DNA adducts, sediment contamination, and biliary PAH metabolites (Velinsky and Cummins, 1991; 1996, Pinkney et al., 2004). However, PAHs are not the only class of chemicals that can cause tumors (Pinkney, personal communication).

The District of Columbia Department of Health (DOH) has posted a Public Health Advisory for fish consumption due to the presence of PCBs and other chemical contaminants that have continued to be found in certain fish species caught in the Anacostia River and its tributaries. Due to their ability to bioaccumulate and the human health risk associated with eating fish, the DOH advises the general public to limit consumption of fish from all District of Columbia waters and has instructed the public not to consume catfish, carp, or eel (DOH, 2010).

AWTA is leading a three-phased approach to address sediment contamination. The Phase I assessment involved compiling and evaluating all relevant existing data on the Anacostia River that could be used for characterizing contamination, developing a preliminary watershed conceptual model, and assessing potential risk to humans and ecological receptors (SRC and NOAA, 2000). Phase I was completed by 2000. Phase II focused on investigations designed to address critical data gaps and was completed in 2002. Phase II culminated in the development of a report titled "Toxic Chemical Management Strategy for the Anacostia River," which is meant to address the issue of chemical contamination remediation in the river and watershed (AWTA, 2004). Phase III, currently underway, is the development and implementation of a comprehensive contaminated sediment management strategy with associated cost estimates.

Through AWTA's efforts, four potential sites that may be point sources for PCBs, PAHs, or both have been identified: Pepco Benning Road, Poplar Point, Kenilworth Landfill, and Washington Gas and Light Company. EPA and NOAA (2009) provided the following descriptions of the sites:

> Pepco Benning Road is a 77 acre site on Benning Road used by Pepco Energy Incorporated to manage

operations and maintain equipment associated with their electrical distribution system. Several releases to the environment have occurred between 1987-2003 resulting from spills of contaminated oil or leaking equipment.

The Poplar Point site is 110 acres in size. Portions of the site are contaminated from past use by the District of Columbia, the Architect of the Capitol and the Navy. Past studies have found contamination of soil, sediment, groundwater, and surface water with a wide variety of chemicals including metals, pesticides, petroleum products and solvents.

The Kenilworth landfill is a 50 acre site that was used by the District of Columbia as a municipal dump from the 1950's to the 1970's. During this period the landfill extended into the Anacostia River and no barriers were constructed to prevent migration of wastes mixed with soil into the water. Sampling results indicated that fill materials had elevated levels of PCBs, PAHs, arsenic, and lead.

The Washington Gas and Light site is the location of the former manufactured gas plant which operated from 1888 to 1948. This site includes two locations totaling 15.6 acres in size. Sampling has indicated that soil and groundwater on the site were found to be contaminated with waste byproducts of coal tar wastes such as PAHs, volatile organic compounds, and metals including beryllium, arsenic, and lead.

Significant source and non-point control efforts have been implemented or are being planned at the sites. Further details are available in EPA and NOAA (2009).

Several chemical contaminant hotspots have been identified in the tidal river reach where sediment is contaminated with PAHs and PCBs at concentrations that are considered

hazardous to aquatic life (Velinsky and Ashley, 2001; EPA and NOAA, 2009). The combined area of the PAH and PCB hotspots is approximately 59 acres out of a study area of 628 acres, or about 9-percent (EPA and NOAA, 2009).

Capping of hotspots was evaluated to diminish the ecological and human health risks and reduce contaminant migration. In 2004, AWTA initiated a sediment capping demonstration project designed to evaluate the placement of four different capping materials over a contaminated riverbed area: (1) AquaBlokTM, a clay material for permeability control; (2) apatite, a phosphate mineral for metals control; (3) coke, an organic sequestration agent; and (4) sand material for a control cap (Reible et al., 2006). All capping materials remained in place. The contaminants remain sequestered under the capping material. Interim postcap monitoring after 18 months indicated that all cap materials effectively isolated contaminants. However, at the interim point of the study, it was not yet possible to differentiate between conventional sand and active cap layer performance (Reible et al., 2006).

In addition to the sediment capping demonstration, AWTA and its members have completed various chemical contamination remediation efforts including repairing over 6.5 miles of leaking storm sewers; constructing 6 sand filters to reduce trash flow to the river; building protective covers over 30 acres of the tidal river to reduce contaminate migration; removing over 7,500 gallons of coal tar, 20,000 gallons of petroleum, and 25 pounds of mercury; and abating over 27,000 tons of contaminated soil and 1 million gallons of surface and groundwater (EPA 2009b).

The previous discussion focused on the tidal river reach. Little existing data is available as to the presence of chemical contaminants in the non-tidal area of the watershed. Dr. Harriette Phelps with support from the Water Resources Research Institute of the District of Columbia has used biomonitoring with the Asiatic clam, (Corbicula fluminea), to indicate the presence of EPA Priority Pollutants in the freshwater Anacostia River watershed of the District of Columbia and Maryland. Although the sources of those contaminants remain undetermined, her recent work has indicated the presence of PCBs in the Lower Beaverdam Creek subwatershed,. Further, biomonitoring studies using Corbicula fluminea indicated the presence of elevated levels of bioavailable PCBs upstream of the confluence of Northeast and Northwest Branches (MDE, 2005). In a study conducted in 2007, elevated levels of PAHs, PCBs, and chlordane, were found in clams placed in subwatersheds such as Indian Creek, Lower Beaverdam Creek, Still Creek, and Northeast Branch (Phelps, 2007; Phelps, in prep).

Active biomonitoring was able to better locate and identify some major sources of Anacostia River contaminants in Maryland low order streams and remains an initial monitoring effort. Additional monitoring studies and research will be required to identify legacy and contemporary sources of contaminants in order to identify specific sources within the watershed. Once a source is identified, remediation and enforcement action can be commenced.

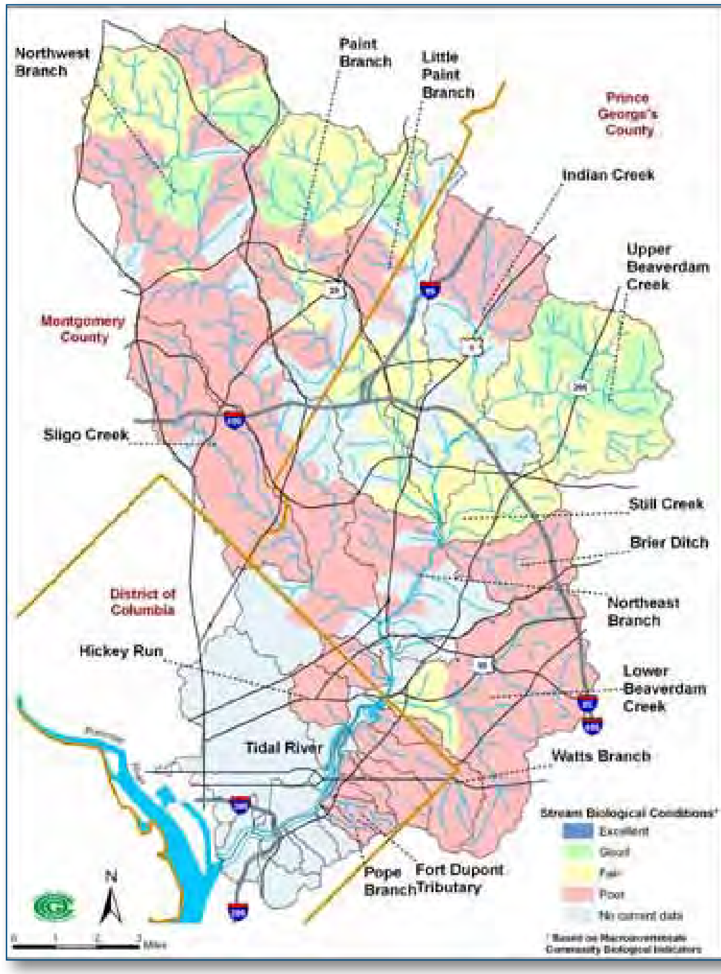


Figure 2-20: Stream Biological Conditions for Macroinvertebrate Communities (Source: MWCOG, 2008)

Figure 2-21: Stream Biological Conditions for Fish (Source: MWCOG, 2008)

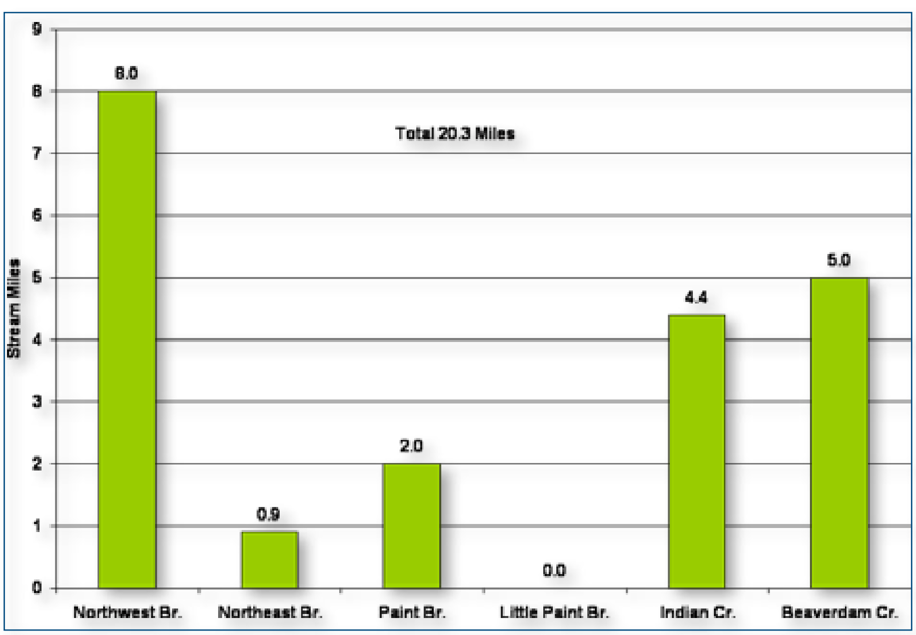


Figure 2-22: Increase in Available Tributary Herring Spawning Habitat (1991–2007)

Aquatic Community Health

Assessments of fish and macroinvertebrate communities in the Anacostia River enable natural resources professionals to estimate the health of the overall watershed. Through the use of an Index of Biotic Integrity, the characteristics of current communities are compared with those in unimpaired reference streams; the resulting index score shows the health of the community and therefore the stream biological condition. Figures 2-20 and 2-21 show the stream biological conditions for macroinvertebrates and fish. Overall, poor and fair conditions for macroinvertebrates and fish prevail in the Anacostia River watershed. However, fish communities seem to be healthier in several areas of the watershed. In particular, the headwaters of Paint Branch show excellent fish community conditions. In fact, Paint Branch is considered to be the highest quality Piedmont stream system in the Anacostia Watershed, supporting a naturally reproducing brown trout population. The upper Paint Branch subwatershed was designated in a joint effort by the Montgomery County Department of Environmental Protection and the M-NCPPC as a Special Protection Area (SPA).

Many years of deforestation and associated sedimentation and stream warming, pollution, overfishing and dams have greatly reduced if not extirpated herring, Atlantic sturgeon, shortnose sturgeon, brook trout, and paddlefish fisheries. Although development has altered the composition of Anacostia River watershed fish communities, they have retained their high species richness as seen in current surveys documenting 93 species. Recently, some fish populations have been growing, possibly because of improving conditions associated with water quality, habitat measures

such as fish barrier removal or modification, or through the intentional introduction of species into various streams. As an example, before restoration projects began in the late 1980s in Sligo Creek, only three species were collected in contrast to the 12 to 14 species now documented. Introductions of various types of bass, sunfish, crappies, and catfish (Jenkins, R.E. and N.M. Burkhead, 1993; Uhlerand Lugger, 1876; MWCOG, 2008) increased the fishery populations in the 1800s to the mid-1950s, and recently the highly predatory northern snakehead was unintentionally introduced into the watershed. At present, the brown trout population is noticeably declining in the upper Paint Branch, which since 1995 has been an SPA.

Even though the past several decades have seen the removal or modification of fish barriers through means such as riffle grade control structures, there are still 120 to 130 prominent fish blockages within the river reaches of the Anacostia watershed (MDDNR, 2006 and 2007; MWCOG, 2008) (Figure 2-23) that prevent, for instance, herrings from spawning in their historic range (Figure 2-24). The migrations of adult anadromous fish such as herring, shad, and striped bass, which return to freshwater only to spawn, have been curtailed during the past 40 years because of the numerous fish barriers located on the lower reaches of the tributaries. Although modification and removal of blockages starting in 1991 has made more stream habitat available (Figure 2-22), some fish migration runs are still on the decline. Possible natural causes include lower spring water temperatures and fewer floods associated with spring thaws as well as human-induced causes such as overfishing.

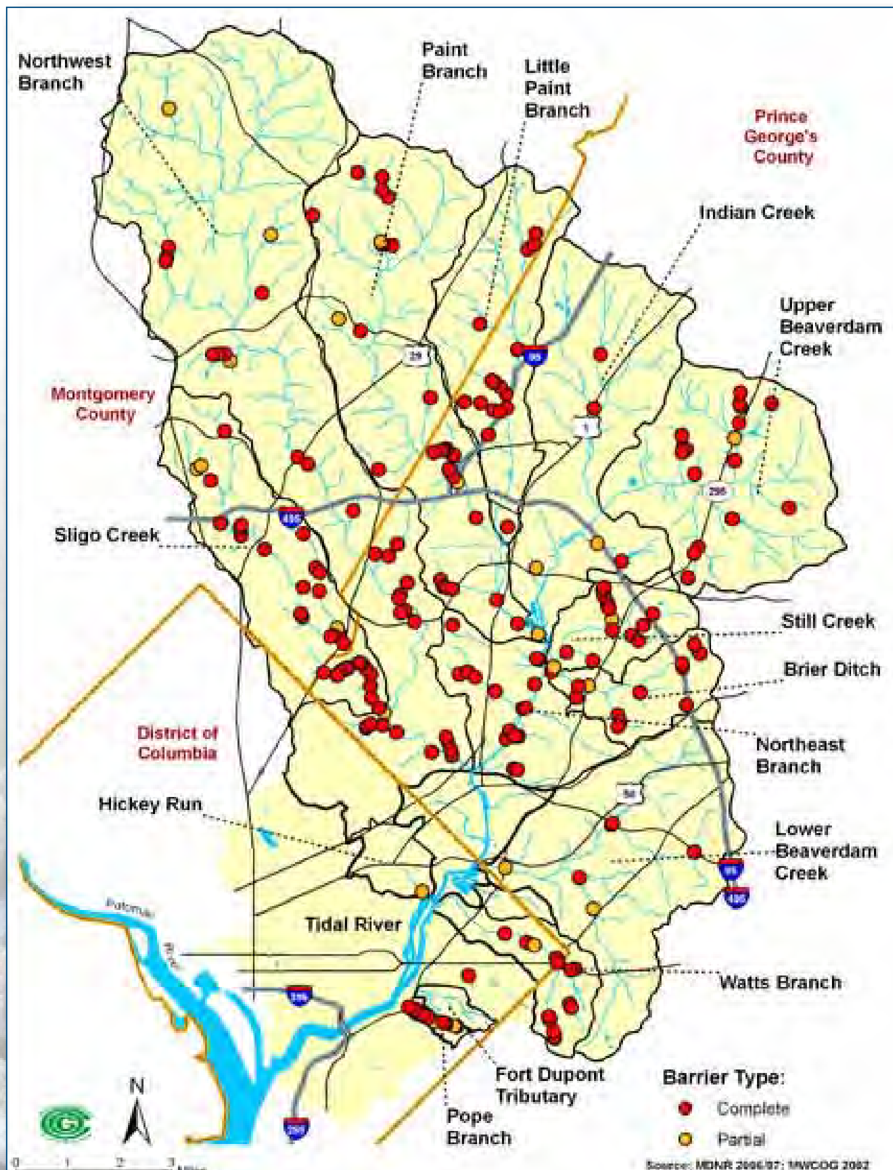


Figure 2-23: Major Fish Barriers (Source: MWCOG, 2008)

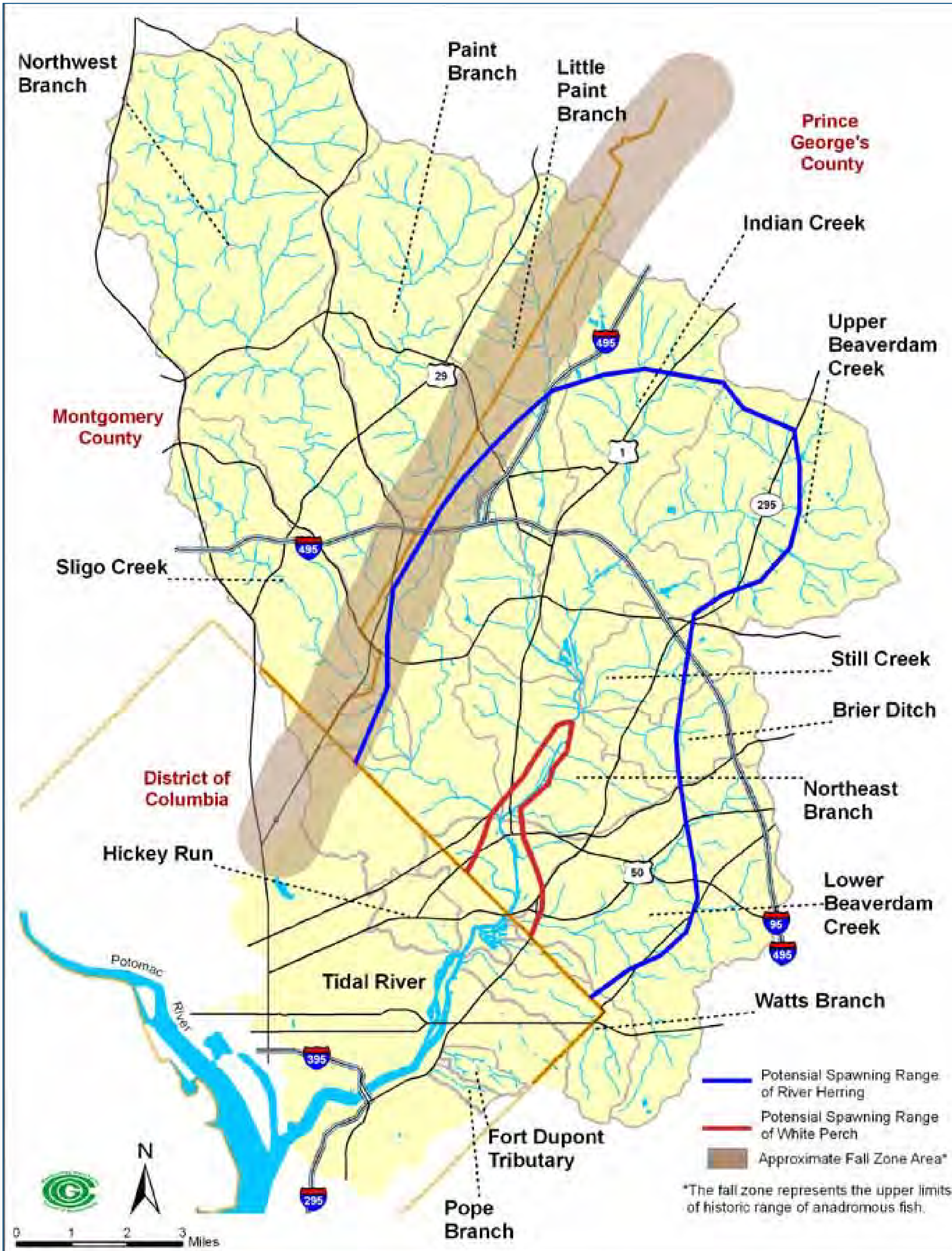


Figure 2-24: Historical Range of Anadromous Fish
(Source: MWCOG, 2008)

Rare, Threatened and Endangered Species

American bald eagles were known to nest in the Anacostia River watershed historically, but disappeared from the watershed in the 1980's and 1990's. A USFWS coordination letter, dated May 4, 2005, solicited as part of the 905(b) reconnaissance report completed by USACE in 2005, Anacostia River and Tributaries, Maryland and the District of Columbia Comprehensive Watershed Plan, documented two active nesting sites for the threatened American bald eagle in the study area, but made no mention of the presence of any other rare, threatened, or endangered species. Since that time, the American bald eagle has been delisted, but remains in a 5-year monitoring period. In a letter dated May 26, 2009, the USFWS stated that there are no Federally proposed or listed endangered or threatened species known to exist in the Anacostia River watershed.

Although no Federally-listed endangered or threatened species are known to exist within the Anacostia River watershed, there are several rare, threatened, and endangered plant and animal species identified through the Maryland DNR Wildlife and Heritage Service as well as habitat areas of special state concern. In addition, the District of Columbia, Department of the Environment, has similarly identified species and habitat areas of greatest conservation need. Additional information is included in the Anacostia Watershed Environmental Baseline Conditions Report (MWCOG, 2008).

Future Conditions Forecast Without Planned Restoration Actions

The Anacostia River watershed is cited as one of the most polluted waterways in the nation, and its natural hydrology has been severely disrupted by urban and suburban development. Without any actions, all of the impairments previously discussed, including uncontrolled stormwater runoff, CSOs, degraded streams, fish blockages, trash, chemical contaminants, impaired aquatic and terrestrial habitats, etc., will continue and likely become more severe as development continues throughout the watershed.

Although the watershed is almost completely developed, two large development projects within the headwaters of the watershed include the Intercounty Connector Transportation Project, which will impact the Indian Creek, Little Paint Branch, Paint Branch and Northwest Branch subwatersheds; and Konterra Town Center development, located in the northern portion of the Indian Creek subwatershed. Compliance with Maryland stormwater management requirements notwithstanding, these two large-scale land use changes will generate additional pollutants and trash based on existing pollutant removal efficiencies of stormwater treatment practices. In addition, the vast areas developed prior to environmental controls will continue to have inadequate or no stormwater management until the time comes to redevelop. As a result, without treating impervious surfaces or addressing streambank erosion, the likely future conditions following additional development would be an increase in TSS, N, P, bacteria, and trash. Furthermore, although the wetland loss trend is not the current trend, as indicated in Figure 2-11, palustrine wetlands, or those small areas of hydric soils within riparian areas in greenfield areas, would be at risk to future development pressure within watershed headwaters. The development and the construction of impervious surfaces would change the local hydrology and, without adequate stormwater management controls, could result in the disconnection of the floodplain and wetland areas from the stream channel due to downcutting and erosion.

Residential areas typically do not experience large-scale redevelopment; however, commercial areas that have reached the end of their life cycle, or greyfield malls, are renovated or even demolished and reconstructed as part of redevelopment initiatives. A greyfield mall, on average, is 32 years old with the last major renovation occurring 13 years ago, and about 8-10 years older than a non-greyfield mall (Congress for the New Urbanism, 2001). These greyfield malls, typical of those developed areas within the Anacostia River watersheds with a few commercial buildings surrounded by parking lots, provide an opportunity to control stormwater runoff by retrofitting existing infrastructure with treatment practices at the time of redevelopment. Without installing treatment practices at the time of renovation or redevelopment, these areas of large impervious surfaces and subsequent stormwater runoff will continue to degrade streams, wetlands, and potentially cause additional fish passage blockages.

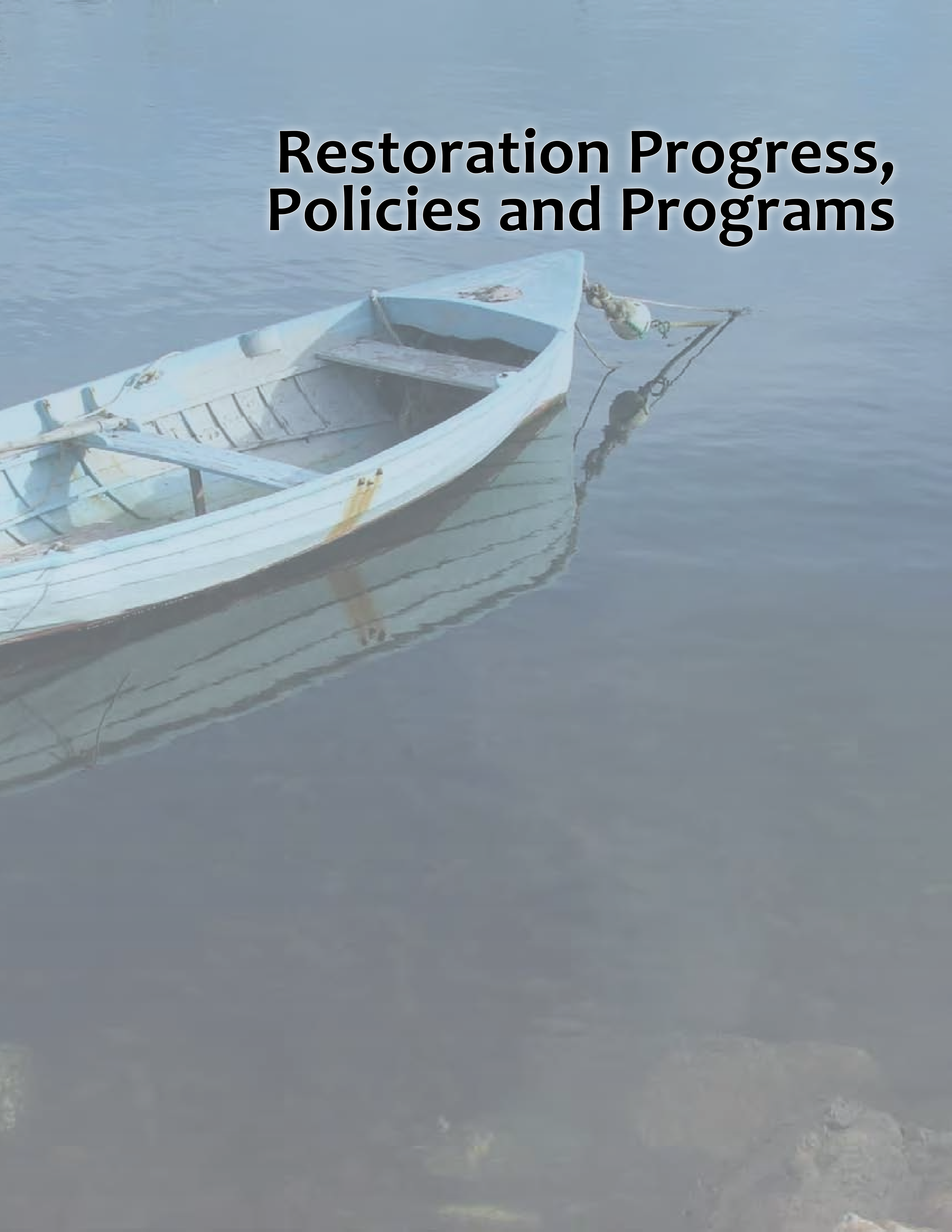
Without increased education initiatives for watershed awareness and changes in personal behavior, trash and illicit discharges will continue to be a problem facing the Anacostia River watershed. Litter and dumping is the primary source of trash within the watershed

(MWCOG, 2007a). Eight-five percent of the trash items surveyed in the Anacostia River tidal reach included plastic bags, Styrofoam products, snack wrappers, and beverage containers (bottles and cans) (AWS, 2008). In addition, the Anacostia River watershed contains industrial land uses in which illicit discharges of chemicals and other industrial wastes were observed being dumped directly into storm drains ((USACE, 2009) personal correspondence during September 19, 2009 community watershed group workshop). Without increasing watershed awareness and educating residents of the risks their behavior poses to the ecological integrity as well as aesthetic appearance, litter, dumping, and illicit discharges will continue.

Restoration of impairments within the Anacostia River watershed will continue to be a focus of local jurisdictions, as well as community watershed groups, to comply with regulatory requirements to reduce pollution in the near future without this study, resulting in the existing piece-meal restoration effort without measurable results at the watershed scale. The AWRP also will continue to work towards achieving its 2010, and post-2010, restoration goals. Furthermore, assuming funding continues, the LTCP will continue to be implemented and ultimately will substantially control CSOs.

The Anacostia River watershed faces many challenges and the restoration of the forgotten river will be a daunting task requiring a multi-pronged effort to address the many, varied impairments. One of the prime needs is for communication and cooperation across the many jurisdictions and agencies. The Anacostia River flows from its headwaters in Montgomery and Prince George's Counties to the tidal river in the District of Columbia. The ARP has brought all restoration partners together and provided multiple public opportunities to help lay out a watershed-wide restoration plan for the first time. The coordination needed to fulfill restoration on a watershed-wide scale over the long-term will be missing without efforts being undertaken by this study. A focused effort, such as this plan, is intended to provide a restoration plan that more efficiently accomplishes restoration and uses available funding for the strategic implementation of restoration opportunities, and promotes coordination between the numerous stakeholders. This study plans to identify an extensive list of restoration projects across the watershed aimed at addressing the impairments as mentioned. No other similar effort is planned for the complete watershed that will provide such a systematic approach that can be coordinated among all stakeholders.

Restoration Progress, Policies and Programs



Restoration Progress

Since the establishment of a formal commitment by local, state, and Federal partners to the restoration of the Anacostia in 1987 (AWRC), synchronized efforts from all parties have resulted in numerous successful projects designed to rehabilitate the watershed and progress toward a healthy and attractive area with opportunities for recreation and education. The involvement of citizen subwatershed groups in the restoration of the Anacostia River is necessary for the long-term success of the restoration effort. Along with providing support, ideas, and resources for the efforts of the ARWP, these groups also plan and implement actions of their own such as a rain garden constructed in 2005 by the Friends of Sligo Creek (FOSC). The AWRP documents the progress and actions taken to restore the watershed in an annual Action Agenda (AWRP, 2008) Figure 3-1 presents selected restoration projects in the Anacostia River Watershed since 1989.

More than 750 restoration projects ranging from wetland and stream restoration, stormwater retrofits, fish barrier removal or modification, sewer infrastructure maintenance, and tree and vegetation plantings have been identified, and 60 planning tasks and studies have been developed by AWRP and others concerned about the Anacostia watershed. More than $250 million has been used to research, design, and implement the various restoration efforts, and another $2–$3 billion is estimated to complete them (MWCOG, 2008).

The sanitary sewer systems in Maryland and the District of Columbia are aging and will be a growing concern and problem over the course of the next several decades. The WSSC is responsible for maintaining, upgrading, and refurbishing sewer lines in the Maryland portion of the Anacostia River watershed, whereas DC-WASA has similar responsibilities within the District of Columbia. In 1997, WSSC completed an approximately $20 million

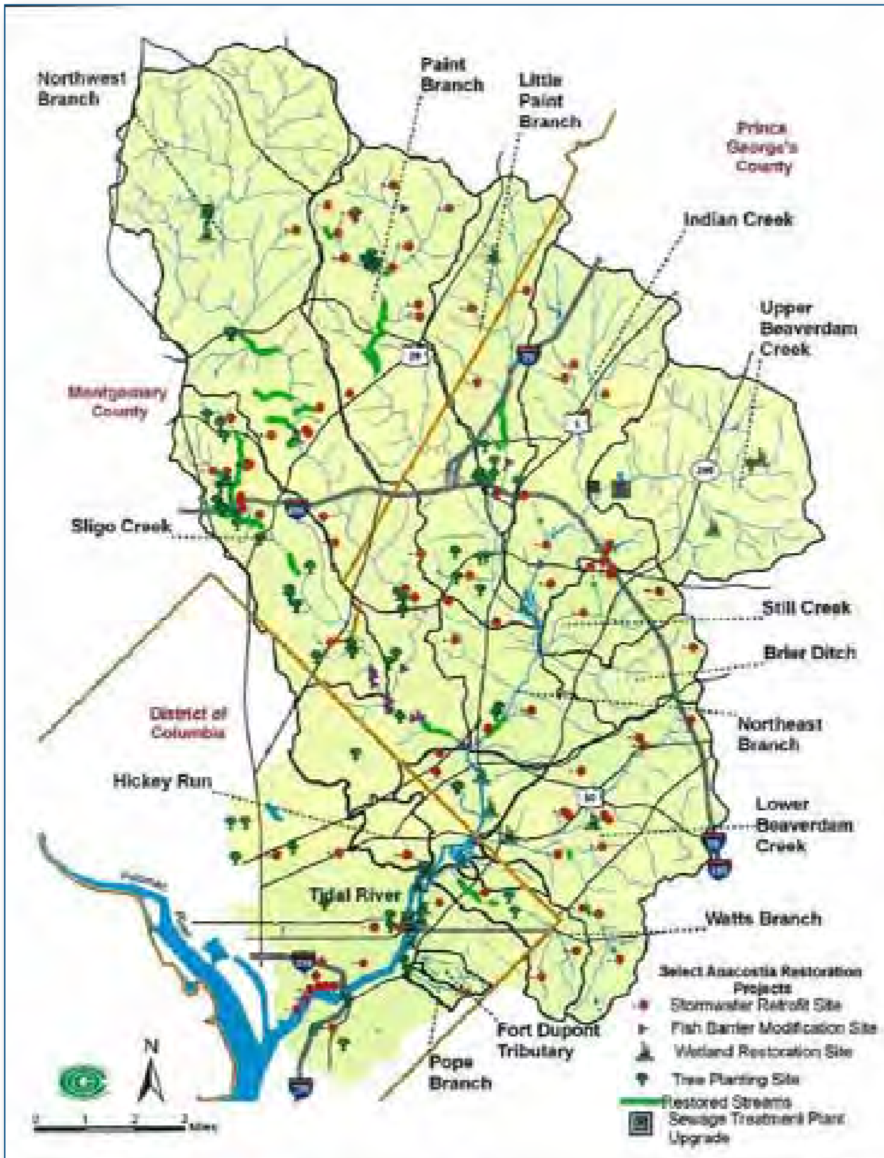


Figure 3-1: Selected Restoration Projects in the Anacostia River Watershed since 1989 (Source: MWCOG, 2008)

sewer line rehabilitation and replacement within the Sligo Creek subwatershed of Montgomery County, and within the Lower Beaverdam Creek subwatershed of Prince George's County. Currently, DC WASA is working on replacing aged and leaking sewer trunk lines within the Pope Branch subwatershed as well as rehabilitating others in Watts Branch (MWCOG, Sept. 2008). Additional information can be obtained by visiting the WSSC and DC WASA websites: http://www.wsscwater.com/, and http://www.dcwasa.com/, respectively.

Approximately $12 million total has been expended by Montgomery County towards restoration projects in the Anacostia River, including 38 stormwater retrofit projects controlling approximately 680 impervious acres of drainage area as well as 13 miles of stream restoration. In addition, Montgomery County has invested over $2.5 million restoring its portion of the Sligo Creek subwatershed alone through various stormwater retrofit projects, wetland creation, stream restoration and riparian buffer projects. Prince George's County has received over $4 million in grants from the EPA to conduct LID demonstration projects (Prince George's County, 2008). A trash net was also installed in the Takoma Branch subcatchment. Fourteen major fish passage barriers also were recently removed from the lower mainstems of Sligo Creek, Northwest Branch, Little Paint Branch, and Indian Creek.

The progress made toward the restoration goals is made possible by multiple layers of cooperation between the AWRP members and other organizations. Each of the three jurisdictions have seen restoration projects planned, constructed, and completed because of the work done by the AWRP as well as other affiliated organizations. The following restoration project overviews and photos detailing progress by the AWRP can be found in "Anacostia Watershed Restoration Highlights: 1987–Present."

In Montgomery County, Maryland, numerous projects have been constructed or developed in conjunction with the M-NCPPC parkland system (Figure 3-2). Wheaton Branch and Sligo Creek stormwater management and retrofit projects ameliorate runoff issues and allow for suitable conditions for wetland creation and stream restoration efforts on the

Wheaton Branch, Northwest Branch, Sligo Creek, and Paint Branch. Additional restoration measures and supporting activities in the county include stream buffers, designation of SPAs in the Paint Branch, structural and nonstructural pollution management, and public outreach.

Many of the restoration efforts in Prince George's County, Maryland, focus on the use of LID methods and programs to treat and decrease the pollutants in urban runoff and attenuate peak flows (Figure 3-3). Most of the techniques used are small in scale and focus on the source of the runoff, such as a street-level filtration area. Regulations, education, TMDLs, National Pollutant Discharge Elimination System, CSO retrofits, and redevelopment are also incorporated into the program. Restoration of the Little Paint Branch and Northwest Branch/Sligo Creek fish passages for herring and other species included riffle grade control structures and other stream manipulations to remove or modify the blockages. Prince George's County, with the help of concerned citizens, also has strengthened levees and made them more aesthetically pleasing, implemented plantings, bank stabilization, and trash removal efforts on the Cabin Branch, a tributary to Lower Beaverdam Creek, for stream restoration. It has also updated water quality monitoring programs.

The District of Columbia has conceived of and implemented various restoration initiatives focusing on habitat restoration and water quality improvement (Figure 3-4). Stream restoration projects on Hickey Run, Watts Branch, Fort Chaplin, and Fort DuPont Tributary are planned improvements to the stream channel incorporating stabilization and reconfiguration, installation of stormwater management devices and trash traps, and increased public education efforts. Wetland restoration at Kenilworth Marsh and along Kingman Lake and the main stem of the Anacostia River increased wildlife habitat and allowed for increased filtration of runoff. Additional habitat alterations created and enhanced meadows, vernal pools, and in-stream habitat to provide better conditions for terrestrial and aquatic organisms. The LTCP for CSOs is an ongoing project recommending LID techniques, updates to sewer infrastructure, and construction of storage tunnels. Partners in these efforts included EPA, USACE, U.S. Fish and Wildlife Service, DCWASA, and the District Department of the Environment (DDOE), Environmental Health Administration, Bureau of Environmental Quality, Watershed Protection Division.

Wheaton Branch Stormwater Retrofit

Park Acquisition in the Upper Paint Branch Special Protection Area (>400 acres and >$20 million since 1996)

Figure 3-2: Sample Restoration Projects – Montgomery County

LID Projects at the College Park City Hall parking lot on Knox Road | Adelphi Road | Fairland Regional Park

Figure 3-3: Sample Restoration Projects – Prince George's County

Kingman Lake Wetland Restoration | Kenilworth Marsh Wetland Restoration

Figure 3-4: Sample Restoration Projects – District of Columbia

Restoration Policies and Programs

The existing restoration policies and programs are and summarizes the existing programs and policies presently in place, including a brief description of the federal and state laws which have a major bearing on the restoration of the watershed, including CWA, that are implemented by the EPA, MDE, and the District of Columbia. The section will also provide detailed information on existing policies and programs of the District of Columbia, Montgomery County and Prince George's County and programs and policies within other jurisdictions that have been cited as being "models."

Federal Policies and Programs

The Clean Water Act

TMDLS

Pursuant to the CWA and relevant State of Maryland and District of Columbia laws, MDE and the District of Columbia have established "designated uses," for their rivers and streams, such as fishing and swimming, so that the public can enjoy these uses of the waters. They also have set water quality standards, both quantitative and narrative, to establish the amount of pollution that can be present while still protecting the designated uses.

It has been determined by MDE and the District of Columbia, that the Anacostia River's waters do not meet several of these water quality standards and so the Anacostia and its tributaries are deemed to be "impaired." Impaired suggests that the existing pollutant loadings received to the water body are over the accepted pollutant loadings for the public to use and enjoy the designated uses, including swimming, fishing and the enjoyment of wildlife. As a result, TMDLs, which can be described as water pollution budgets, have been or will be established for the Anacostia River. Once a TMDL is established for an "impaired" water body, stormwater dischargers and other dischargers, including Municipal Separate Storm Sewer Systems (MS4s), which includes the three jurisdictions, must work aggressively toward meeting the CWA's requirement of attaining water quality standards.

Table 3-1 shows the designated uses, the water quality standards which are exceeded, and status of the TMDL preparation for the standards that are exceeded. The preparation of TMDLs has been very important for the watershed because the TMDLs have identified most of the sources of pollutants in the watershed, and have highlighted the critical role of stormwater in the control of pollution in the watershed.

The Chesapeake Bay TMDL for nutrients and sediments must be developed no later than May 1, 2011, and the Chesapeake Bay Program's Principals' Staff committee requested the TMDL be developed by December 2010 (EPA, 2010). As part of the Chesapeake Bay TMDL initiative, those water sources for which sediment and nutrient TMDLs are established such as the Anacostia River Watershed will remain in effect if more stringent than the Chesapeake Bay TMDL.

Table 3-1: Anacostia Watershed Clean Water Act
Designated Uses, Impairments, and Total Maximum Daily Load Status

Designated Uses

District of Columbia	Maryland
• Primary contact recreation (swimming) • Secondary contact recreation and aesthetic enjoyment (rowing, boating and other activities with only incidental contact) • Protection and propagation of fish, shellfish, and wildlife • Protection of human health related to consumption of fish and shellfish • Navigation Tributaries are not designated for navigation. Watts Branch and Hickey Run are not designated for primary contact recreation.	• Contact recreation • Protection of aquatic life • Wholesomeness of fish consumption Two small portions of the Prince George's County near the border with Montgomery County have designated uses intended to protect existing or potential trout habitat. The designated use for Paint Branch and all its tributaries above the Capital Beltway (I-495) is for naturally reproducing trout populations. The designated use for Northwest Branch and all tributaries above East West Highway (Rt. 410) is for recreational trout, i.e. to provide conditions for survival of stocked trout.

Principal Impairments and Status of TMDLs
(in the watershed generally, may not be in all subwatersheds)

District of Columbia Water Quality Standard Exceeded	TMDL Adopted	Maryland Water Quality Standard Exceeded	TMDL Adopted
• Bacteria	8/03—TMDL relates to fecal coliform standard not in effect after 12/31/07	• Bacteria	3/07
• Sediment	7/07	• Sediment	7/07
• Nutrients and Biological Oxygen Demand (BOD)	Submitted jointly and approved by EPA 6/08		
• Trash	In progress--2009	• Trash	In progress--2009
		• Biological	Pending
• Organics: chlordane, DDD, DDE, DDT, Dieldrin, Heptachlor Epoxide, PAH1, PAH2, PAH3 • TPCBs • Metals: Arsenic, Copper, Lead, and Zinc	9/03 10/07 9/03	• Heptachlor Epoxide • Polychlorinated Biphenyls (PCBs) Tidal • Polychlorinated Biphenyls (PCBs) • Non Tidal	Pending 10/07
• Metals: Arsenic, Copper, Lead, and Zinc	9/03		
• Oil and Grease	9/03		

NPDES

Under the 1972 CWA, the NPDES permit program regulates point source discharge of pollutants into surface waters throughout the United States. One way the EPA regulates the NPDES program by issuing MS4 permits. Specifically, an MS4 is a conveyance or system of conveyances that is:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the United States;
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.); and
- Does not carry or treat sewage or combined sewerage and stormwater.

To prevent harmful pollutants from being washed or dumped into waters of the United States by MS4s, the CWA requires operators of MS4s to obtain NPDES permits and implement a stormwater management program. EPA issued regulations for MS4s in two phases:

- Phase I, issued in 1990, which addresses medium and large cities or certain counties with populations of 100,000; and
- Phase II, issued in 1999, which addressed federal and state facilities, small MS4s in urbanized areas, and small MS4s outside the urbanized areas that are designated by the permitting authority to obtain NPDES permits.

In Maryland, this authority is delegated to MDE, whereas in the District of Columbia, the authority is delegated to the DDOE. Most of the MS4s in the Anacostia River watershed are Phase I MS4s, including the Maryland State Highway Administration (MSHA) and must get individual permits from EPA in the case of the District of Columbia, and from MDE in the cases of Montgomery and Prince George's Counties. The NPDES MS4 permit allows discharge of stormwater from

the MS4 in accordance with the conditions specified therein, and the purpose is to reduce pollutant loadings to receiving waters, which contributes toward meeting water quality standards. The jurisdictions are currently completing efforts to reapply for the NPDES MS4 permit. The Montgomery County Final Determination NPDES MS4 permit has provisions for achieving waste load allocations for EPA-approved TMDLs and a 20-percent countywide watershed restoration goal (effective date February 16, 2010). Figure 3-5 presents the NPDES sites within the Anacostia River watershed.

EPA Section 319

Under EPA Section 319, grants are awarded to jurisdictions to implement projects or programs that achieve reduction in non-point sources of pollution. For those restoration projects receiving funding under the Section 319 grant program, they must be supported by a watershed plan that includes specific criteria. That criteria includes the following:

a. Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the watershed plan.
b. Estimates of pollution load reductions expected through implementation of proposed non-point source management measures.
c. A description of the non-point source management measures that will need to be implemented
d. An estimate of the amount of technical and financial assistance needed to implement the plan.
e. An information or education component that will be used to enhance public understanding and encourage participation.
f. A schedule for implementing the non-point source management measures.
g. A description of interim, measurable milestones.
h. A set of criteria to determine load reductions and track substantial progress towards attaining water quality standards.
i. A monitoring component to determine whether the watershed plan is being implemented.

Figure 3-5: Anacostia River NPDES Sites

EPA Clean Water Act Consent Decree Requiring DCWASA CSO Improvements

The LTCP is a large-scale restoration program being implemented by DCWASA as required by a EPA consent decree to address CSOs. The LTCP consists of measures that increase the storage of the mixed sewage and stormwater so that the Blue Plains Advanced Wastewater Treatment Facility is not bypassed during heavy rainstorms. Pursuant to the consent order, DCWASA has already increased the storage in the existing sewage collection system, and reduced the volume of CSOs by 40-percent. However, attaining the remainder of the LTCP's goals involves the construction of over 13 miles of large tunnels the size of Metrorail train tunnels. These tunnels will extremely expensive to build, costing nearly $2 billion (DCWASA, 2009).

In order to generate the revenues to implement the remaining phase of the LTCP (as well as implementation of the District of Columbia's MS4 permit), the District and DCWASA created and implemented an impervious surface fee that District of Columbia property owners must pay. This fee will soon have to be raised to pay for the construction of the tunnels, nearly doubling over the next 10 years. Although the LTCP will be an integral component to the overall restoration of the Anacostia River, the upstream contributions of pollution due to stormwater runoff must be addressed concurrently.

EPA/MDE Clean Water Act Consent Decree Requiring WSSC Sanitary Sewer Overflow Improvements

In 2005, a consent decree was entered into by the United States, the State of Maryland and several citizen groups and WSSC that requires WSSC to undertake inspections and repairs of its sewage system to prevent sanitary sewer overflows (SSOs). WSSC is presently making good progress on its efforts to inspect over 1,745 miles of its sewer lines, pursuant to the order, and implementing its 12-year, $350 million plan for repairing sewer lines so that SSOs can be eliminated. Coordination efforts between WSSC and the ARP occurred to share information regarding exposed sewer pipes.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) is the primary law that governs the disposal of solid and hazardous wastes. The law features three interrelated programs designed to encourage states to develop holistic plans to manage nonhazardous solid wastes and municipal waste; control hazardous waste production, use, and disposal; and regulate underground storage tanks containing hazardous substances and petroleum products. A significant facility in the Anacostia subwatershed under RCRA regulation is the Southeast Federal Center (SEFC). The SEFC is underway with or has completed cleanup projects for the removal on contaminated sediments (heavy metals and PCBs) at numerous outfalls, issuance of a NPDES permit, abated/razed 12 building contaminated with heavy metals/PCBs/asbestos, remediation of soil hot spots at 11 sites contaminated with PCBs and heavy metals, and restoration of the seawall at the Anacostia River (http://www.epa.gov/reg3hwmd/super/DC/anacostia-river/pad.htm) Figure 3-6 presents the RCRA sites within the Anacostia River watershed.

Figure 3-6: Anacostia River RCRA Sites (Source: MWCOG, 2008)

Comprehensive Environmental Response, Compensation and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund provides a federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment (http://www.epa.gov/lawsregs/laws/cercla.html). Under CERCLA, only those releases included on the National Priority List (NPL) are considered eligible for Superfund-financed remedial action but removal actions are not limited to NPL sites. Remedial actions funded by other sources such as states or potentially responsible parties can occur on non-NPL sites, too (EPA, 40 CFR Part 300). As a federal trustee for coastal and marine natural resources, National Oceanic and Atmospheric Administration (NOAA) works with lead cleanup agencies, co-trustees, responsible parties, and the public to address natural resource injuries caused by the release of oil and hazardous substances. Relative to the Anacostia River, under the 1999 Federal Facility Agreement between the Washington Navy Yard, the District of Columbia, and the EPA, the Navy Yard has implemented numerous cleanup projects designed to remove lead paints, PCBs, and mercury as well as site infrastructure rehabilitation through LID stormwater management practices in addition to storm drain and sanitary sewer replacement and upgrades (http://www.epa.gov/reg3hwmd/npl/DC9170024310.htm).The two sites shown in Figure 3-7 are listed under CERCLA.

Figure 3-7: Anacostia River CERCLA Sites (Source: MWCOG, 2008)

Energy Independence and Security Act

The recently enacted Energy Independence and Security Act of 2007 that contains provisions that require the "sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." In less technical terms, the law requires new and redeveloping Federal facilities to be designed and built to manage the volumes of stormwater generated by these facilities on site.

While applicable only to Federal facilities, the new law can be a help to the watershed. EPA has conducted studies regarding the practicability of stormwater volume control and has issued guidance that indicates that it expects all Federal facilities to control the volume of stormwater contained in 95-percent of all storms events occurring in one year, or 1.7 inches. Twenty-two Federal agencies own approximately 13-percent of the land within the Anacostia River watershed (USACE, 2002). Furthermore, this legislation is important to the District of Columbia where about 30-percent of all property is Federally owned.

Chesapeake Bay Executive Order

On May 12, 2009, President Obama issued Executive Order 13508 to protect and restore the Chesapeake Bay and its watershed. The Executive Order declared the Chesapeake Bay a national treasure, and directed the Federal government to exercise a greater leadership role to restore this ecological, economic, and cultural resource.

The challenge of restoration and protecting the Chesapeake Bay watershed requires new approaches and renewed commitments at the Federal level and for state and local governments as well as its many stakeholder groups. In November 2009, the Federal Leadership Committee designated by Executive Order 13508 issued a series of reports containing recommendations for addressing challenges facing the health of the Chesapeake Bay watershed. The recommendations include the following: tools and actions to improve water quality; a focus to conserve resources; strengthening of stormwater management requirements at Federal facilities; consideration of climate change impacts; science and decision-making support for ecosystem management; and habitat and research activities. A comprehensive strategy will be issued in 2010.

Executive Order 13514

On October 8, 2009, President Obama issued Executive Order 13514 to requires Federal agencies lead by example in order to create a clean energy economy that will increase the Nation's prosperity, promote energy security, protect the interests of taxpayers, and safeguard the health of our environment. As it relates to water resources, Executive Order 13514 requires Federal agencies to conserve and protect water resources through efficiency, reuse, and stormwater management.

State Policies and Programs

State of Maryland 2009 Stormwater Regulations

The Maryland State Legislature recently adopted the Stormwater Management Act of 2007. This act requires that environmental site design (ESD) be implemented to the maximum extent practicable, and that only as a last resort should conventional stormwater management practices be implemented. According to MDE, ESD means "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 is sometimes also referred to as LID. MDE's implementing regulations also require that counties in Maryland propose revisions to their stormwater regulations by November of 2009 and to adopt revised stormwater regulations by May of 2010.

ESD practices include:

- Preserving and protecting natural resources;
- Conserving natural drainage patterns;
- Minimizing impervious area;
- Using green roofs, permeable pavement, reinforced turf, and other alternative surfaces;
- Limiting soil disturbance, mass grading, and compaction;
- Clustering development;
- Disconnection of rooftop runoff;
- Disconnection of non-rooftop runoff;
- Sheet flow to conservation areas;
- Rainwater harvesting and reuse;
- Landscape infiltration;
- Infiltration berms;
- Dry wells;
- Micro-bioretention;
- Rain gardens; and
- Swales.

Most of the Anacostia River watershed's subwatersheds no longer have the space available to construct traditional large scale stormwater controls, such as large stormwater management ponds. Implementing ESD along roads and integrating this approach into existing developments is the next step towards retrofitting the uncontrolled areas of the Anacostia

River watershed. However, it is recognized that the benefits of ESD's may require an extended period of time to be recognized due to the slow rate of redevelopment.. Further, these practices can address stormwater pollutants and volume.

Stormwater volume is increasingly understood to be a major source of pollutants and erosion damage in the watershed. Studies supporting the Maryland sediment TMDL for the Anacostia watershed indicate that approximately 70-75-percent of the sediments in the waters of Maryland portion of the watershed come from streambank erosion. Most of the streams in the watershed exhibit what is known as "urban stream syndrome." This syndrome has been described in one scholarly paper as follows:

The term "urban stream syndrome" describes the consistently observed ecological degradation of streams draining urban land. Symptoms of the urban stream syndrome include a flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology, and reduced biotic richness, with increased dominance of tolerant species. More research is needed before generalizations can be made about urban effects on stream ecosystem processes, but reduced nutrient uptake has been consistently reported. The mechanisms driving the syndrome are complex and interactive, but most impacts can be ascribed to a few major large-scale sources, primarily urban stormwater runoff delivered to streams by hydraulically efficient drainage systems (Walsh et al., 2005).

In less technical terms, during rainstorms, the impervious surfaces in urban areas carry fast-moving rainwater, along with the pollutants and trash in the rain water's path into the streams, where these heavy volumes badly erode the streams and produce additional sediment pollution.

The Anacostia watershed is a severe example of "urban stream syndrome."

The recognized solution to "urban stream syndrome" is reduction of stormwater volumes. Reduction in stormwater volumes would reduce the amount of pollutants that flow into the river, including trash, and permit restoration of the stream channels. In short, the Maryland Stormwater Act of 2007's focus on using smaller ESD practices, which in many cases are practicable as a means of retrofitting in tight spaces, is significant for the restoration of the Anacostia River watershed.

Anacostia 2032: Plan for a Fishable and Swimmable Anacostia River

The District of Columbia's Anacostia 2032: Plan for a Fishable and Swimmable, is a restoration initiative that began in 2007 with the ultimate goals of allowing residents and visitors to fish and swim in the waters. The plan includes five stages to achieve these goals: 1) creating a visually presentable river, 2) making the river navigable, 3) restoring the river's ability to support stable fish and wildlife populations, 4) producing a swimmable river, and 5) reestablishing a river that supports fish that are safe to eat. Each of the five stages includes a timeframe in which the stage will be achieved, ranging from six years for the river to be visually presentable to 25 years for the safe consumption of fish. In addition, the plan identifies visions, strategies, benefits, and estimated costs, as well

as discussing the challenges to achieve each of the five goals.

Water Resources Element (WRE)

In Annapolis, Maryland during the 2006 legislative session, the General Assembly enacted House Bill 1141 Land Use – Local Government Planning (HB 1141). HB 1141 requires local jurisdictions to include their future plans for water supply, sanitary wastewater, and non-point pollution of water resources in their comprehensive plans. The first set of local comprehensive plans that address the requirements of HB 1141 must be submitted to the State by October 1, 2009 (MDE, 2008).

As part of the WRE as it applies to the ARP, all jurisdictions that exercise planning and zoning authority must incorporate requirements into municipal comprehensive plans to reduce the impact of nonpoint pollution on water resources.

2010 Trust Fund

In the State of Maryland during the 2008 Legislative Session, Senate Bill 213 established the 2010 Trust Fund. The 2010 Trust Fund was passed to provide financial assistance to local governments in order to address non-point source pollution. Multiple state agencies, including MDE and DNR, receive funding to assist local governments in the implementation of non-point source pollution control projects.

Regional Policies and Programs

Chesapeake 2000 Bay Agreement

The Anacostia River watershed is a tributary to the Potomac River, which ultimately drains into the Chesapeake Bay. Restoration and protection of the Anacostia River and its tributaries compliments the Chesapeake Bay Program's goals by supporting aquatic resources that are part of the larger Chesapeake Bay watershed.

As stated in the Chesapeake 2000 Bay Agreement, the goal is to:

> *"Preserve, protect and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Bay and its rivers."*

The implementation statement is:

> *"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 protections, conservation and restoration of stream corridors, riparian buffers and wetlands for the purposes of improving habitat and water quality, with collateral benefits for optimizing stream flow and water supply."*

Potomac River Watershed Trash Treaty

The goal of the Potomac River Watershed Trash Treaty is to dramatically improve the enjoyment of the rivers and streams of the Potomac River by committing to a trash free Potomac by 2013. This treaty has been endorsed by 105 elected officials in the Potomac River watershed. The treaty will focus its efforts on supporting and implementing regional strategies aimed at reducing trash and increasing recycling, increasing education and awareness of the trash issue throughout the Potomac Watershed and reconvening annually to discuss and evaluate measures and actions addressing trash reduction.

Local Ordinances and Restoration Programs

The District of Columbia, Montgomery County and Prince George's County also implement a host of local programs and policies that benefit the watershed. These local policies and programs are keys to restoration and to the protection of the watershed from further pollution and ecological damage. The District of Columbia, Montgomery County, and Prince George's County are working diligently within their jurisdictions to improve and expand these programs and policies. The AWRP is a key forum that can help support and coordinate these efforts.

The following table presents an overview of key District of Columbia, Montgomery, and Prince George's Counties programs and policies affecting the Anacostia River watershed.

Table 3-2: Local Ordinances and Restoration Programs

District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Incentives for Private Property ESD Retrofits			
RiverSmart Homes • Incentive based program to install low-cost residential BMPs including downspout disconnection, rain barrel installation, large shade tree planting, impervious surface removal and pervious surface installation, and native plant landscaping practices • Stormwater audits of homeowner's properties to identify potential alternatives to reduce stormwater pollution and provide an opportunity for education • Up to $1,200 per household for landscape enhancements by the District with the homeowner cost of $100 for a rain garden and $75 for native landscaping • $30 cost to homeowner for rain barrel installation • $50 cost to homeowner for planting a shade tree • The District of Columbia is developing methods to remain in contact with program participants to ensure proper care of landscaping enhancements • To date, this program anticipates installing 600 large rain barrels, 200 rain garden or permeable pavement retrofits, and 500 trees by the end of FY 2010. The total cost of this effort has been about $1.86 million.	RainScapes Rewards Rebate Program • Incentives for private property for the voluntary installation of new rain gardens, native landscaping that replaces turf grass, creation of new urban tree canopy, removal of impervious surface and replacement with pervious surface, green roofs, rain barrels, cisterns, and dry wells. • Targeted Neighborhoods: County identifies properties for priority runoff management and • provides rain barrels, installation services for rain gardens and permeable pavers up to $2,200 per property • Watershed Group Assistance: County directly purchases materials for rain gardens and provides installation assistance. • 'Make and Take' Rain Barrel Workshops: County provides one 55-gallon barrel and hardware and instruction on assembly and installation • $1,200 maximum financial reward to single-family residential property owners depending on project type and actual costs. • $5,000 maximum financial reward, or $0.50 per square foot of impervious area treated, for multi-family, commercial, or institutional property.	Rain Barrel Program currently does not receive funding requirements.	Benefits • Controls stormwater—the critical pollutant source for the watershed. • Incentive for installing ESD at single family homes, which may not be redeveloped in the near term and therefore, would not be subject to redevelopment retrofit requirements. • Homeowner gets assistance with technical issues as well as financial assistance. • Promotes active stewardship among residents, businesses, and resource users • Many of the practices are desirable for purpose of improving community aesthetics, decreasing heat island effect and energy use, and increasing biodiversity in the suburban landscape. Challenges • Limited funding budgeted for the programs. • Require considerable staff time to assist homeowners and administer the programs. • Homeowner demand exceeding program capacity. • Requires application, pre-, and post-installation site inspections Property owner must pay for project and then be reimbursed with a Letter Agreement with the County to allow future inspection.

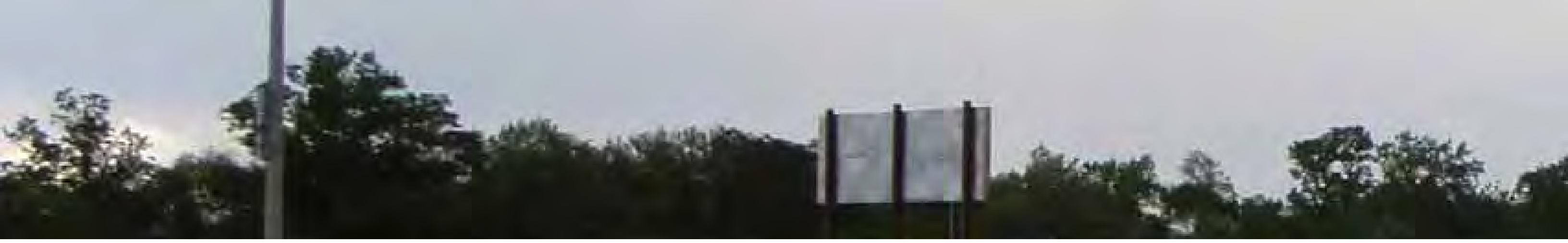


Table 3-2: Local Ordinances and Restoration Programs			
District of Columbia	**State of Maryland**		**Benefits and Challenges**
	Montgomery County	**Prince George's County**	
Existing and Proposed Stormwater Regulations for Development and Redevelopment			
Proposal Includes: • Redevelopment requirements the same as new development. • Development and redevelopment in Anacostia development zone to capture one inch of stormwater onsite. • Remainder of city to capture ¾ of an inch of stormwater. • Requirements triggered by proposed disturbance of 5,000 square feet of land area or a major rehab of a building. • Onsite stormwater management controls include ESD: green roofs, permeable pavement, rain barrels, etc.	Current ordinance includes: • Development and redevelopment must control water quality volume and channel protection volume (1 inch and 2.6 inches, respectively), though the channel protection volume requirement is waived for redevelopment if impracticable at a given site. • Requirements triggered by proposed disturbance of 5,000 square feet of land area or more. • ESD not prioritized but this is likely to change when new ordinance is proposed pursuant to new MDE regulation.	Current ordinance includes: • New development must control channel protection and water quality volume. • Redevelopments must reduce existing site impervious areas by at least 20 percent. Where site conditions prevent the reduction in impervious area, then stormwater management practices must be implemented to provide water quality treatment of one inch for at least 20 percent of the site's impervious area. When a combination of impervious area reduction and stormwater practice implementation is used, the combined area shall equal or exceed 20 percent of the site • Requirements triggered by proposed disturbance of 5,000 square feet of land area or more. • ESD not prioritized but this is likely to change when new ordinance is proposed pursuant to new MDE regulation. • Volume controls for redevelopment are also likely to be increased.	Benefits • Addresses stormwater, the principal source of pollutants in the Anacostia. • Can address volumes of stormwater from development and redevelopment • Can address stormwater from existing development if strong provisions for redevelopment or building rehabs are included. • Can require ESD which has many ancillary benefits in addition to stormwater control. • Challenges • Improvement of these ordinances requires amendment of existing ordinances. • Regulated parties (developers and redevelopers) may object to cost of additional requirements. • Changing the threshold to cover additional developments and redevelopments will require additional staff to review them.

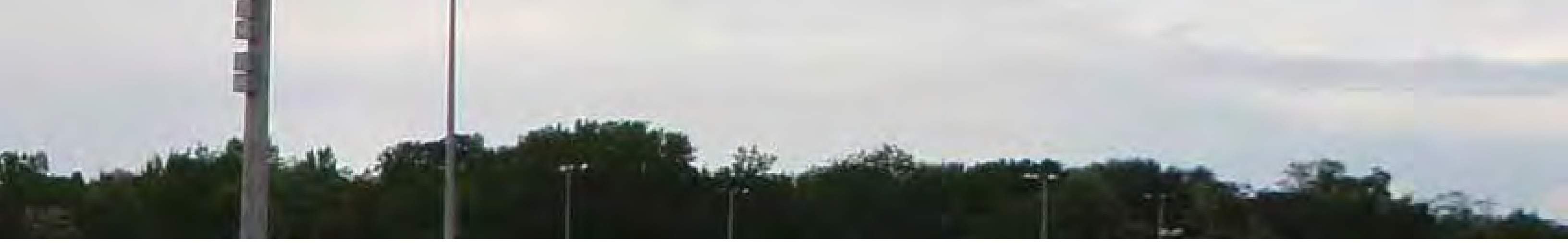


Table 3-2: Local Ordinances and Restoration Programs

District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Recently Revised MS4 Permits			
The MS4 Permit for the District, dated August 2004 and amended in 2006, imposes narrative effluent limits to manage stormwater quality and quantity through the use of BMPs and incorporates various LID techniques. • The Permit also requires development of plans to implement approved TMDL limits. • In modifications to the MS4 permit, the District of Columbia agreed to undertake innovative measures to stem storm water flow and pollution, including using natural systems such as trees, green roofs, and vegetated buffers. • Improvements will be incorporated into the MS4 Permit for the District of Columbia, which was up for renewal in 2009.	The new requirements in Montgomery County's draft MS4 permit include: • By the end of this permit term, complete the implementation of those restoration efforts that were identified and initiated during the previous permit term • By the end of this permit term, complete the implementation of restoration in a watershed, or combination of watersheds, to restore an additional twenty percent of the County's impervious surface area that is not restored to the MEP. • The next round permit incorporates the Potomac River Watershed Trash Treaty and commitments for trash abatement program implementation, education, and evaluation to improve the quality of the Potomac River and its tributaries. It requires the County to develop an Anacostia trash reduction strategy and work plan. • Developing implementation plans for pollutant loading reductions (benchmarks) to be achieved by specific deadlines and to describe those actions necessary to meet the storm drain system's share of waste load allocations in EPA approved TMDLs • Establishing a long-term schedule for performing comprehensive water quality assessments that includes identifying sources of pollution and water quality improvement opportunities for all watersheds in the County. • Review existing planning and zoning and public works ordinances and other local codes to identify impediments to, and opportunities for, promoting the implementation of ESD to the MEP and to modify codes based on this review. • Any new road will provide water quality volume (WQv) treatment and channel protection storage volume (CPv) for the entire area of the public improvement easement (PIE) and right-of-way. • Any renovated road will provide water quality volume (WQv) treatment and channel protection storage volume (CPv) for the limits of disturbance for the reconstructed area of the PIE and right-of-way. • Roadway project will include a goal to treat 25% WQv using Vegetated Integrated Management Practices. • All of these requirements are in addition to existing countywide management programs and ongoing monitoring efforts.	Prince George's County's MS4 permit has not been recently amended and expired in October 2009. It is likely that MDE will propose a permit similar to that of Montgomery County.	<u>Benefits:</u> Among other benefits: • Requires enforceable requirements for stormwater retrofits. • Requires MS4s to create and implement plans for meeting TMDL limits and ultimately attainment of water quality standards. • Requires permittees to adequately fund these programs <u>Challenges</u> • The main challenge involves funding the implementation of the permits.

Table 3-2: Local Ordinances and Restoration Programs			
District of Columbia	**State of Maryland**		**Benefits and Challenges**
	Montgomery County	**Prince George's County**	
Stormwater Fees or Taxes to Pay for Stormwater Improvements			
• The District of Columbia recently adopted impervious surface fee of $2.57 per month per Equivalent Residential Unit in FY 2010. That is, for each 1,000 square feet of impervious surface on a property, the owner will be charged $2.57. This applies for home owners, commercial, government and other properties.	• The Water Quality Protection Charge, paid by residents (but not businesses, unless they use a residential stormwater facility) as part of the County tax bill, provides funds for a comprehensive inspection and maintenance program for homeowner stormwater facilities in the County. This program helps to protect streams, water supplies, and property by keeping stormwater facilities functioning properly so that they remain capable of removing pollution, recharging groundwater, protecting stream banks, and keeping roads and property from flooding. • As of July 2009, the rate is $45.50 per emission reduction unit per year. This means that single family home owners pay a flat rate of $45.50 and town home owners pay a flat rate of $15.02 per year. • The charge was not intended and is not adequate to fund general stormwater needs, including the required implementation of the County's MS4 permit. Currently the country is assessing options to fund the MS4 permit.	• Effective FY 2005 to present, the Ad Valorem Tax for District 1 is 5.4 cents per $100 of assessed value; and for District 2 is 1.2 cents for $100 of assessed value. • This tax may not be sufficient to fund the number of restoration projects identified in this report on an accelerated time frame. • State legislation requiring counties to adopt stormwater utility fees sufficient to pay for their stormwater programs likely to be introduced into the 2010 session of the Maryland legislature. (See Senate Bill 672 introduced in the 2009 session of the Maryland legislature by Senator Jamin Raskin at http://mlis.state.md.us/2009rs/billfile/sb0672.htm)	Benefits • Stormwater utility fees provide a way to charge residents and businesses fees based on the extent of their impervious surfaces, which can be perceived as a fairer approach for funding stormwater needs. • Because property owners are charged based on the amount of impervious surface they own, the fees may have the benefit of discouraging the increase in impervious surface. • The fees can be designed to incentivize the installation of ESD features such as green roofs, rain gardens, and replacement of impervious surfaces with pervious ones. • District and County stormwater managers have dedicated sources of funding for implementing needed projects. Challenges • Rate payers and taxpayers may not understand the need for stormwater controls and may oppose increases. • Since each local jurisdiction already has a program of fees or taxes in place, it may be difficult to get these raised to the point where they are adequate to fund the needed projects and programs.

Table 3-2: Local Ordinances and Restoration Programs			
District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Programs and Policies Implementing Road Retrofits Controlling Stormwater			
Among the provisions of the Comprehensive Stormwater Management Enhancement Amendment Act of 2008) was a requirement that by January 23, 2010: The Director of the Department of Transportation (DDOT) shall submit to the Director an action plan recommending policies and measures to reduce impervious surfaces and promote LID projects in the public space. The action plan shall incorporate: • (1) New DDOT policies to reduce impervious surface and employ other LID measures in right-of-way construction projects and retrofit projects; • (2) A revised DDOT public space permitting process and the development of a mechanism to minimize stormwater runoff from the public right-of-way; • (3) Requirements and incentives for private developers to reduce impervious surface and employ LID measures when their projects extend into the public right-of-way; • (4) Policies, including fees, for the use of public space to manage stormwater runoff from private property; • (5) Policies to address ongoing maintenance of LID or stormwater best management practices installed in public right-of-way areas adjacent to private property; • (6) Strategies to remove impediments to LID projects on residential properties relating to public space; and • (7) Costs for each recommendation and a recommended timeline for funding in the Mayor's proposed budget. The Mayor shall incorporate these recommendations in the next and subsequent proposed annual budgets.	The following "road code" provisions have been adopted by the County on December 9, 2008: New road construction and roadway renovation projects must control the channel protection volumes (2.6 inches) and water quality treatment of 1 inch of stormwater. All roadways must incorporate "vegetated integrated management practices" with goals to treat 20% water quality volume within the right of way for most roads, and 60% water quality volume for open section residential roads to the extent practicable	The County has no recent legislation but has been implementing a fairly successful Green Streets Program to mitigate water pollution at various locations around the County. Trash abatement techniques as well as LID structural techniques are employed to improve water quality (Prince George's County, 2007). Examples of projects implemented as part of the Green Streets Program include the following: trash traps to collect floatable pollutants, bioretention, rain gardens, and filter swales.	<u>Benefits</u> • Addresses the retrofit of a substantial area of impervious surface within the watershed: There are approximately 9,200 acres of highways and roads within the watershed. • Addresses an existing source of stormwater pollution when retrofit is involved, addressing an existing source of pollution. <u>Challenges</u> • Road departments are faced with multiple goals related to roads and highways and the safety of the roads must be the paramount goal. • Often there is limited space in road right of ways and adjacent areas to construct ESD retrofits • Funding for retrofits is limited.

Table 3-2: Local Ordinances and Restoration Programs

District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Disposable Shopping Bag Fees			
On June 16, 2009, the District of Columbia passed legislation that places a fee on disposable shopping bags, as of January 1, 2010. • Places a 5-cent fee, paid by consumer, on all disposable recyclable plastic and paper carry-out bags from Retail Food Establishment license holders (including grocery stores, food vendors, convenience stores, drug stores, and restaurants) and Class A & B liquor licensees. • Bans non-recyclable plastic carryout bags; require that if a plastic carryout bag is offered, that it must be recyclable and clearly labeled as such. • The retail establishment will get 1 cent of fee returned tax exempt to the retailer. • Retailers who choose to offer a carryout bag credit program will retain an additional cent, for a total of 2 cents per bag. • The remaining fee per bag will be deposited into a new Anacostia River Cleanup & Protection Fund.	State legislation was introduced in 2009 and may be reintroduced in 2010. See the Chesapeake Bay Restoration Consumer Retail Choice Act of 2009, House Bill 1210 sponsored by Delegate Al Carr (http://mlis.state.md.us/2009rs/billfile/hb1210.htm)	State legislation was introduced in 2009 and may be reintroduced in 2010. See the Chesapeake Bay Restoration Consumer Retail Choice Act of 2009, House Bill 1210 sponsored by Delegate Al Carr (http://mlis.state.md.us/2009rs/billfile/hb1210.htm)	Benefits • In other jurisdictions where disposable bag fee legislation has been passed, bag litter has been greatly reduced. • Revenue from bags can be applied to restoration projects. Challenges • Grocery chains, other retailers, and the paper and plastic bag industries may oppose this type of legislation, making it difficult to pass.

Table 3-2: Local Ordinances and Restoration Programs			
District of Columbia	**State of Maryland**		**Benefits and Challenges**
	Montgomery County	**Prince George's County**	
Anti litter and dumping ordinances			
• The Illegal Dumping Enforcement Amendment Act of 2006 amends the existing ordinance from 1994 by increasing the fines for unlawfully disposing solid waste, hazardous waste, or medical waste on any public or private area in the District of Columbia (ex. From $1,000 to $5,000 for the first offense and $10,000 for each subsequent offense. • The Anti-Littering Amendment Act of 2008 went into effect at the end of March 2009 covers, rubbish, waste matter, refuse, garbage, trash, debris, dead animals, and other discarded material. The penalty is $75, and $100 if from a vehicle.	• Montgomery County Code, Chapter 48, Section 11 provides both criminal and civil violations against dumping or littering on property and roadways. A criminal violation carries a penalty of up to six months in jail and/or a $1,000 fine. A civil violation carries a penalty of up to $500. Under Chapter 38, littering in parking lots is prohibited. • Further, Maryland State Law CR 10-110 provides stipulations against disposing or dumping of items under 100 pounds, over 100 pounds, and over 500 pounds. Littering or dumping of items under 100 pounds is a misdemeanor and carries a penalty of up to $1,000 and/or 30 days in jail. • Maryland Motor Vehicle Law 21-111 states that it is illegal to drop or place an injurious substance on a roadway. It is also illegal to throw, deposit, or discharge refuse from a vehicle onto the roadway. A citation for throwing any type of trash can result in a fine up to $140 and two points. A littered substance that results in injury carries a penalty of a fine up to $280 and three points.	• Maryland State Law CR 10-110 provides stipulations against disposing or dumping of items under 100 pounds, over 100 pounds, and over 500 pounds. Littering or dumping of items under 100 pounds is a misdemeanor and carries a penalty of up to $1,000 and/or 30 days in jail. • Maryland Motor Vehicle Law 21-111 states that it is illegal to drop or place an injurious substance on a roadway. It is also illegal to throw, deposit, or discharge refuse from a vehicle onto the roadway. A citation for throwing any type of trash can result in a fine up to $140 and two points. A littered substance that results in injury carries a penalty of a fine up to $280 and three points.	Benefits • Laws help deter litter which winds up in streams • Once the Trash TMDL is established, it will increase the likelihood of compliance with those requirements. Challenges • Enforcement of these laws appears to be very lax.

Table 3-2: Local Ordinances and Restoration Programs

District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Ban on Coal Tar Parking Lot Sealant			
The District of Columbia has passed a law, the Comprehensive Stormwater Management Enhancement Amendment Act of 2008, which prohibits the use of coal tar parking lot sealants.	N/A	N/A	Benefits • Eliminates an unnecessary source of pollutants in the watershed (alternate products are widely available) • Scientific studies are clear that when this product is used a substantial amount of toxic pollutants are washed into nearby rivers and streams. Challenges • Is not clear how much these products are used in the Anacostia watershed.

Table 3-2: Local Ordinances and Restoration Programs

District of Columbia	State of Maryland		Benefits and Challenges
	Montgomery County	Prince George's County	
Laws and Ordinances Requiring Industrial Site Housekeeping			
N/A	N/A	• Prince George's County recently implemented a program by which it provides citations to industrial parks for poor housekeeping at industrial parks rather than requiring	Benefits • The County no longer needs to go to court to enforce good housekeeping laws for industrial parks.

Problem Identification and Plan Formulation

Problem Identification and Restoration Strategies

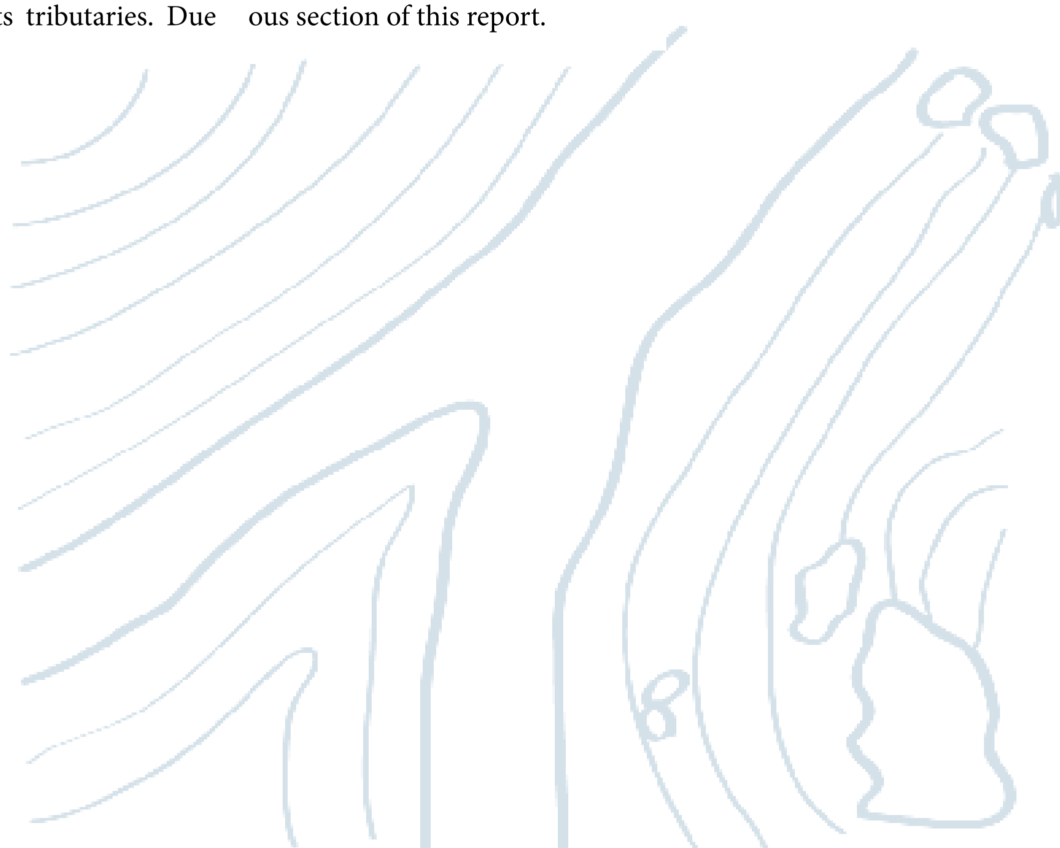
The ARP covers many diverse components that together constitute a comprehensive restoration plan. The ARP Project Management Plan (PMP), which served as the original scoping document for this effort, includes the following two primary objectives of the ARP study:

1. To develop a comprehensive watershed restoration plan in order to direct future restoration efforts that comprehensively address the watershed's problems
2. To help the AWRP achieve its 2010 six restoration goals through projects designed to alleviate the problems.

The ARP PMP identifies 11 broad environmental and ecological problems affecting the Anacostia River watershed and its tributaries. Due to the complexity and diversity of the problems facing the Anacostia River watershed and in an attempt to define a strategic plan to address these 11 problems, eight action-oriented restoration strategies were developed whereby each strategy and its associated projects can address more than one environmental or ecological problem. These actions are subwatershed- and site-specific restoration projects or activities that should be implemented to achieve measurable, localized environmental benefits, which ultimately strive to achieve one or more of the six AWRP restoration goals. The ability to measure the effectiveness of restoration actions will ultimately determine progress made toward achieving the AWRP's six restoration goals, as discussed in a previous section of this report.

Anacostia River Restoration Goals

1. Dramatically Reduce Pollutant Loads
2. Protect and Restore Ecological Integrity
3. Improve Fish Passage
4. Increase Wetland Acreage
5. Expand Forest Cover
6. Increase Public and Private Participation



Anacostia Watershed Problem Identification

1) Reduction of Tidal Wetlands – Emergent wetlands, including swamps, marshes, and bogs, which are influenced by the tide and provide various services for the environment.
2) Reduction of Non-tidal Wetlands – Small ponds, vernal pools, and intermittent streams that are not tidally influenced and provide various services for the environment.
3) Reduction of Riparian and Upland Resources – Valuable riparian resources located between a water body and associated upland areas.
4) Trash – Introduced into a river from litter via stormwater drains and illegal dumping.
5) Sediment/TSS and Nutrients (nitrogen and phosphorus) – Material eroded and deposited from upstream reaches.
6) Toxics – toxic chemicals and heavy metals from point and nonpoint sources.
7) Combined Sewer Overflows and Sanitary Sewer Overflows – Combined stormwater and sewer infrastructure that overflows into the river during rain events.
8) Stream Channel Degradation (and Peak Flow Discharges) – Accelerated changes to stream channel shape, section, profile, and material compositions due to hydrology changes .
9) Invasive and Nonnative Species Groups – Plant species that completely invade an environment (invasive) or are introduced into an environment (nonnative).
10) Flooding – Prince George's County only.
11) Fish Passage Blockages – Barriers that impede movement and reduce available habitat for fish.

Anacostia Watershed Restoration Strategies

1) Stormwater Management – Sediment (5) Nutrients (5), and Stream Channel Degradation (8)
   - Increase stormwater-control level of subwatersheds
   - Reduce sediment, nutrient, and bacteria loadings from surface runoff
   - Reduce stream channel degradation
2) Stream Restoration – Sediments (5), Nutrients (5), and Stream Channel Degradation (8)
   - Reduce sediment and nutrient pollutant contribution from channel
   - Reduce peak flow discharge and increase base flows
   - Restore or improve stream channel
3) Wetland Restoration – Tidal Wetlands (1) and Non-tidal Wetlands (2)
   - Increase or enhance habitat
   - Improve connectivity of existing habitats and resources
4) Fish Passage Blockage Removal or Modification – Fish Migration Barriers (11)
   - Open stream channels to fish migration by removing barrier (migratory)
   - Connect additional stream lengths to current fish habitat (resident and migratory)
5) Riparian Reforestation, Meadow Creation, Street Tree, and Invasive Species Management – Riparian and Upland Resource (3), and Invasive and Nonnative Species Groups (9)
   - Increase or enhance habitat and tree canopy
   - Improve connectivity of existing habitats and resources
6) Trash Reduction – Trash (4)
   - Reduce trash impairment of a river reach
   - Reduce nutrient and sediment inputs (i.e., street sweeping)
7) Toxic Remediation – Toxics (6)
   - Address NPDES/CERCLA/RCRA sites
   - Identify new sources of toxic contamination
8) Parkland Acquisition - Non-Tidal Wetland (2) and Riparian and Upland Resources (3)
   - Protect and reduce encroachment upon non-tidal wetlands
   - Increase or enhance riparian, upland, and meadow habitat
   - Improve connectivity of existing habitats and resources

Plan Formulation

To achieve a boatable, fishable, and swimmable Anacostia River, water quality must improve and pollutant loadings be reduced. The formulation strategy of the ARP effort focused on establishing the pollutant loadings for TSS and nutrients using modeling techniques that were acceptable and appropriate for a large-scale planning effort like the ARP, based on the expertise and technical contributions from the PDT and other regional entities with an interest in addressing urban watershed issues. Once the planning-level loading estimates were established, solutions and analyses were considered that would achieve reduced pollutant loadings. In addition, measurable environmental benefits associated with candidate restoration projects other than stormwater management practices and retrofits were estimated by length in feet and in acres.

Identify and Inventory Provisional Restoration Opportunities

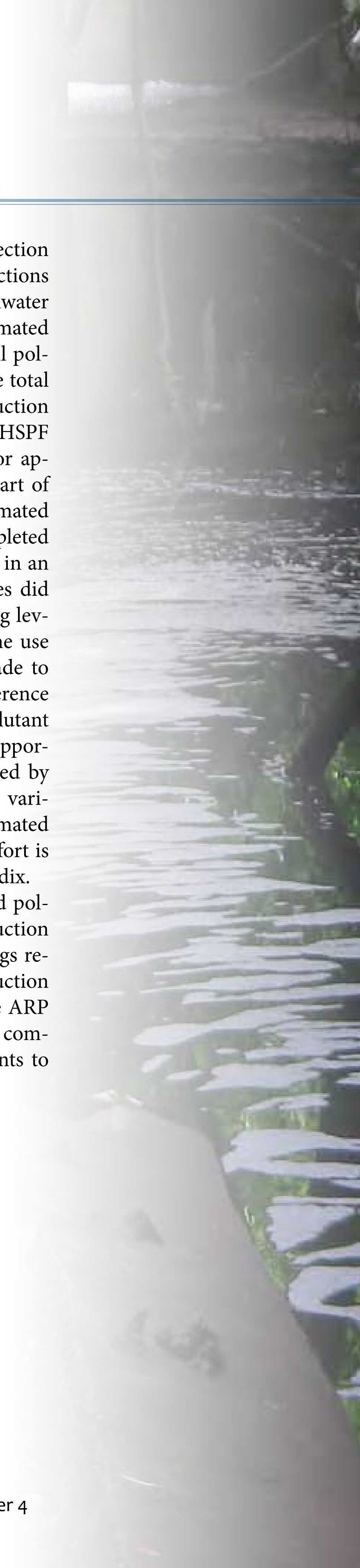
As part of the ARP, an inventory of potential restoration projects was completed for each of the 14 primary subwatersheds and tidal river reach. The PDT developed a systematic process to identify restoration opportunities and complete a provisional restoration project inventory based on the eight restoration strategies previously discussed. The effort included a systematic evaluation of existing information using GIS and field verification for each of the 14 primary subwatersheds and the tidal river reach. The detailed description of the methodology used to identify potential restoration opportunities is available in the Plan Formulation Appendix.

Estimated Pollutant Loads

The Interstate Commission on the Potomac River Basin (ICPRB) developed the TSS and nutrient (N and P) TMDLs for the Anacostia River watershed using an HSPF model for MDE in 2007 and 2008, respectively. It is important to note that the HSPF model was originally applied to the Anacostia River on a watershed scale, and not to each individual subwatershed by the ICPRB. As identified in the published TSS, N, and P TMDLs, Table 4-1 presents the estimated TMDL loadings, TMDL pollutant reduction goal as a percentage, and the estimated pollutant loadings reduction goal for the Anacostia River watershed (MDE, 2007 and 2008).

Table 4-1: Approved TMDL Pollutant Loadings and Pollutant Loading Reduction Goals

	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)
TMDL Estimated Loadings	948,966	104,436	46,906
TMDL Reduction Goal	**79%**	**80%**	**85%**
TMDL Estimated Reduction Goal	**749,683**	**83,549**	**39,870**



To determine pollutant reduction potential for various analyses on the subwatershed scale as part of the ARP, the PDT recomputed the TSS, N, and P pollutant loadings at the subwatershed scale. The computation was completed by using a spreadsheet to multiply a TSS, N, and P loading rate, generated by the original HSPF modeling effort, times the specific land use area contained within the subwatershed. By completing this analysis, the PDT could estimate the TSS, N, and P loadings for each of the 14 primary subwatersheds and the tidal river reach, and their corresponding contribution toward the total Anacostia River TMDL. The planning level loadings were recomputed because the HSPF model used to compute the Anacostia River TMDLs was not calibrated to the subwatershed scale, thus the PDT did not rerun the HSPF model as part of the ARP effort, but rather used the generated loading rates to calculate subwatershed loads. A minor adjustment to the loading calculations completed by the PDT compared to the HSPF TMDL calculation includes the insertion of a road layer as part of the land use coverage.

Once pollutant loadings for each subwatershed were calculated, estimates of the pollutant reduction potential from various stormwater treatment practices, including LID treatment practices such as bioretention, bioswales, and green roofs, could be computed at the subwatershed scale using the Watershed Treatment Model (WTM), a spreadsheet model developed by the Center for Watershed Protection (CWP). The cumulative pollutant reductions from various combined suites of stormwater treatment practices could then be estimated to determine each subwatershed's overall pollutant reduction contribution toward the total Anacostia River TMDL pollutant reduction goals. It is important to note that the HSPF model was not specifically developed for application at the subwatershed scale as part of the TMDL modeling effort. The estimated loadings and pollutant reductions completed for the ARP should not be cited or used in an absolute manner. However, the estimates did prove useful at this ARP master planning level of detail, and the PDT determined the use of this application and assumptions made to be acceptable in order to develop a reference from which estimates for potential pollutant reductions by the various restoration opportunities or treatments could be computed by the WTM. A detailed discussion on the various assumptions made to calculate estimated pollutant loadings as part of the ARP effort is available in the Plan Formulation Appendix.

Table 4-2 presents the ARP estimated pollutant loadings, the TMDL pollutant reduction goal, and the estimated pollutant loadings reductions goal. Note that the TMDL reduction goal, as a percentage, was applied to the ARP estimated pollutant loadings in order to compute the estimated reduction in pollutants to achieve the pollutant TMDLs.

Table 4-2: ARP Estimated Pollutant Loadings and Pollutant Loading Reduction Goals

	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)
ARP Estimated Loadings	899,166	80,728	16,231
TMDL Reduction Goal	**79%**	**80%**	**85%**
ARP Estimated Reduction Goal	**710,341**	**64,583**	**13,796**

Estimated Pollutant Reductions of Candidate Stormwater Management Practices and Retrofits

The pollutant loading reductions from various stormwater retrofit opportunities was calculated using the WTM. More information on the process to estimate pollutant load reduction potential, the various efficiencies associated with proposed treatment practices calculations, and other assumptions is included in the Plan Formulation Appendix. When evaluating pollutant reductions, it was assumed the treatment practice was fully-functional and operating effectively as designed.

In addition to evaluating the pollutant reduction potential of the candidate stormwater retrofit projects, the WTM was utilized to evaluate various alternatives of increased controls on impervious surfaces, including a potential to reduce pollutant loadings from homeowners properties, various street sweeping alternatives, and retrofitting roads with LID bioretention treatment practices. Inherent double-counting of pollutant reductions were unavoidable as part of this exercise, such as multiple treatment practices treating the same impervious surface at a specific site, but were minimized to the furthest extent possible. Detailed site investigations during the design phase of projects, which were not included as part of the conceptual approach of ARP evaluations, would determine the appropriate acreages treated by multiple treatment practices. Additional detailed discussions of the various analyses completed to determine the potential to reduce pollutant reduction loads are included in subsequent sections and in the Plan Formulation Appendix.

Evaluation, Scoring, and Ranking of Candidate Restoration Projects

For the various candidate restoration opportunities, each was scored and ranked based on a 100-point scoring scheme developed by the PDT. Candidate restoration projects received scores based on the following criteria: environmental benefits, including the projects' potential contribution to the six AWRP goals; feasibility; impacts; estimated costs; outreach or community connection; and permitting. The scoring scheme was developed based on a 100-point scoring system weighted with total possible scores of 30-, 25-, 15-, 12-, 10-, and 8-points for environmental benefits, feasibility, impacts, estimated cost, outreach and community connection, and permitting, respectively. Additional information on the scoring procedure is included in the Plan Formulation Appendix.

Environmental benefits include pollution reduction and water quantity controls for stormwater retrofit opportunities; length and order of stream restored for stream restoration, length and order of stream opened by fish passage blockage modification or removal, acres of wetlands, riparian and upland forest, and invasive species removal created or restored along with connectivity to adjacent existing habitats. For environmental benefits associated with candidate trash reduction projects, scores were assigned based on whether the project addresses areas with none, light, moderate, or heavy trash indices as defined by the Anacostia Watershed Trash Survey, and whether the projects contribute to the Anacostia Watershed Trash Reduction Strategy objectives (MWCOG, 2007a). Further discussion on the process to score and rank candidate restoration projects based on the remaining criteria as discussed previously is included in the Plan Formulation Appendix.

It should be noted, however, that for this conceptual level investigation, habitat creation, such as wetland creation, indicates the construction of a wetland in an area currently without wetlands like a mudflat; and habitat restoration, such as wetland restoration, indicates the enhancement of an existing habitat area to improve its ecological function. For the ARP study, acreages resulting from habitat creation and habitat restoration were weighted equally.

One sub-criterion included as part of the feasibility category for candidate restoration projects includes general environmental support by the community, worth 5-points of the total 25-points for the feasibility category. The PDT solicited participation by representatives of community watershed organizations to rank each candidate restoration project within their respective subwatershed as high, medium, low, or none in terms of general acceptance and support. Additional discussion on the interactions and meetings between representatives of the PDT and the community watershed organizations is included in subsequent sections of this report.

After scoring the candidate projects, they were ranked based on the highest scores received. However, due to the size of the watershed and numerous opportunities for restoration action, many restoration candidate restoration projects received the same score, especially the stormwater management retrofit projects.

Upon further review, the PDT developed an additional scoring component for scores assigned to stormwater management retrofit projects in order to differentiate between projects receiving the same score. For each subwatershed, a subset of the stormwater retrofit projects with high sub-criterion scores associated with the environmental benefits, including N removed, P removed, TSS removed, bacteria removed, total area of impervious area controlled, and reduction of rainfall runoff quantity underwent this revision. Once the subset of restoration projects was selected based on the environmental benefits sub-criteria, the projects received additional points based on the imperviousness and existing level of stormwater management controls for the appropriate

hydrologic unit (upper, middle, or lower) within the corresponding subwatershed. Additional points were based on increasing ranges of imperviousness and decreasing level of stormwater management control, which is presented in the corresponding Subwatershed Baseline and Existing Conditions Report. Coefficients of 0.9, 0.8, and 0.7 were assigned to the three additional sub-criteria, environmental benefits, subwatershed hydrologic unit imperviousness level, and subwatershed hydrologic unit stormwater management control level, respectively. The points from the additional sub-criteria were multiplied by the respective coefficients, and the sum of the additional sub-criteria was added to the initial project score, creating an adjusted benefit score for stormwater retrofit projects.

After scores were assigned to candidate restoration projects, rankings were assigned based on the highest scoring projects. Based on the adjusted benefits scoring scheme, the distribution of scores fell into three categories: Tier I, Tier II, and Tier III. Projects were identified as follows:

<u>Stormwater Retrofit Projects (based on adjusted benefit scores)</u>

Tier I Projects: 100-points and above
Tier II Projects: 89- and 99-points
Tier III Projects: 88-points or lower

<u>All Other (Non-stormwater) Identified Restoration Projects</u>

Tier I Projects: 80- 100-points
Tier II Projects: 65- and 79-points
Tier III Projects: 64-points or lower

Additional information on the tiered projects, including the rankings of candidate restoration projects within for each restoration strategy category, is included in the corresponding SWAP and Subwatershed Provisional Restoration Projects Inventory.

Restoration Project Rankings

Subwatershed Prioritization of Restoration Projects

As discussed previously, the Anacostia River watershed covers approximately 176 square miles. In order to address such a large area, each of the 14 primary subwatersheds and the tidal river reach were evaluated independently, not only because the evaluation process would be more manageable but also because each subwatershed has different land uses as well as its own specific problems. As discussed previously, each subwatershed was investigated by a desktop evaluation using GIS along with existing data, like stream corridor assessments and previous subwatershed studies. In addition, MWCOG generated corresponding subwatershed Environmental Baseline Conditions and Restoration Reports to document existing conditions within each of the 14 primary subwatersheds and tidal river reach. Using these data, areas within the subwatershed could be targeted for specific restoration opportunities within the eight restoration strategy classifications. Once general areas were identified in the desktop forum, field verification of the potential restoration opportunities was completed and inventoried, and presented in the corresponding Subwatershed Provisional Restoration Project Inventory Report.

After the list of projects was inventoried, each restoration project was evaluated and scored independently, using the quantitative scoring scheme discussed previously. Once each restoration project was scored, a ranking of projects could be achieved for each of the eight restoration strategies discussed previously for each of the 14 primary subwatersheds and the tidal river reach. The results of the scoring was presented in the corresponding SWAP Report, which is a summary document of the subwatershed Environmental

Baseline Conditions and Restoration Report and subwatershed Provisional Restoration Project Inventory report. Furthermore, stormwater management retrofit projects were ranked not only subwatershed-wide, but also within each of the three hydrological units of the subwatershed: upper, middle, and lower.

In addition to a discussion and presentation of restoration opportunities, each SWAP presents a vision for the subwatershed along with a brief discussion on the subwatershed's existing conditions, summarizing information presented in the subwatershed Environmental Baseline Conditions and Restoration Report. The SWAP also summarize additional pollutant reduction analyses, including an investigation for the potential to reduce peak discharges, potential to reduce pollutant loadings using street sweeping, and potential to reduce pollutant loadings from homeowner impervious surfaces. Finally, the SWAP presents 10-year restoration targets and milestones, based on the implementation by others of restoration projects identified as part of the ARP. The targets and milestones are intended to be ambitious, yet realistic within the 10 year timeframe.

Tidal River Reach

Some portions of the tidal river reach subwatershed were evaluated using the same approach as described previously for the other 14 primary subwatersheds, but other areas were not. One of the primary problems facing the tidal river subwatershed is CSOs. The CSO drainage area occupies approximately 46-percent, or approximately 11.1 square miles, of the subwatershed. However, over the course of the next ten years, the CSO drainage area essentially will have stormwater management controls in place in the form of tunnels that will store stormwater runoff as part of the LTCP initiative. During the lag time following the storm event, the stormwater drains from the tunnels back to the combined sewer system, where ultimately it is treated at the Blue Plains Advanced Wastewater Treatment Facility. In addition, since the CSO drainage area consists primarily of urban land uses, such as institutional (government office buildings), commercial, and high-density residential, large areas of the subwatershed could be evaluated using limited treatment practices due to site constraints, which include primarily green roof, street tree canopy, and Green Alley treatment practices. As part of the tidal river subwatershed evaluation, green roof, tree canopy, and Green Alley treatment practices analyses, completed by others, were incorporated into the subwatershed evaluation as a potential restoration opportunity and presented in separate fact sheets in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Watershed-Wide Prioritization

Without a prioritization exercise, the candidate restoration project rankings are simply a list of projects without a clear path toward holistic restoration of the entire watershed as part of the 10-year restoration plan. Although SWAPs presented a prioritized ranking of restoration projects per subwatershed, to address where to begin restoration within the entire watershed, the primary areas to focus the restoration effort includes those areas without existing stormwater management controls along with high levels of impervious area, such as large commercial developments, roads, and parking lots. Several studies conducted in the headwater regions of the Anacostia River watershed during the 1960s and 1970s indicate a significant increase in sediment yield following land uses changes due to new development (MDE, 2007). Although it is recognized that the headwaters in the northern portions of the watershed experience streambank erosion and headcutting, which contributes a high volume of sediment, most areas have some level of stormwater management controls. In addition, areas of new development in those areas that have land zoned for development must comply with current stormwater management regulations, including the implementation of LID and ESD to the furthest extent practicable (MDE, 2007). To achieve meaningful and measurable restoration within the watershed, there must be a concentrated effort to implement a suite of restoration opportunities within a targeted geographic area in order to maximize potential environmental and ecological benefits. Furthermore, not only would this clustering of restoration projects potentially increase environmental and ecological benefits, but they would also provide an opportunity for monitoring efforts, educational opportunities, and potentially influence economies of scale. These clusters of restoration projects would become demonstration restoration project areas.

Following the scoring and ranking of projects per subwatershed as described previously, which is presented in the corresponding SWAPs and Subwatershed Provisional Restoration Project Inventories, the focus of watershed-wide prioritization and identification of demonstration restoration project areas was centered around the adjusted score Tier I

stormwater management retrofit projects. Based on the scoring scheme developed by the PDT, the adjusted Tier I stormwater retrofit projects are locations that provide an opportunity for a successful retrofit project. It should be noted that each candidate restoration project will require additional investigation by others during the design phase to determine feasibility, which could potentially result in a change to the recommended treatment practice based on site-specific conditions or in termination of the project altogether. Project constraints or sources of fatal flaws could include, but are not limited to, the following: utility impacts, permitting constraints, or an unwilling landowner.

Demonstration restoration project areas were identified by the geographic point location of score adjusted Tier I stormwater retrofit projects. Using statistical functions in a spatial environment as part of the ArcGIS ArcMAP program (ESRI, 2006), the radius of the average distance between the closest score adjusted Tier I stormwater retrofit point locations across the watershed, which is 985 feet, was used to determine the geographic boundary around the each adjusted scoring Tier I stormwater management retrofit project location. The intent of this exercise is to capture all of the candidate restoration projects identified as part of the ARP subwatershed evaluations within this geographic boundary to focus and concentrate the future restoration actions within a small geographic area.

As the geographic boundaries around adjusted scoring Tier I stormwater management retrofits intersected, the demonstration restoration project area increased to capture additional restoration projects. The demonstration restoration project geographic boundaries were aligned with the subwatershed boundaries in order to capture only those candidate restoration projects within the subwatershed drainage basin. By limiting the demonstration restoration project geographic boundary within one subwatershed, a specific outlet location could be identified downstream of the demonstration restoration project area for potential future monitoring efforts associated with implementation. It should be noted that proper sequencing for the implementation of candidate restoration projects within the demonstration restoration project area should be considered—for example, constructing stormwater retrofit projects prior to a downstream stream restoration or wetland creation/restoration projects in order to capture likely changes to hydrology associated with the implementation of stormwater retrofit projects.

Once each demonstration restoration project area was defined, the PDT developed a ranking system to rank

each of the demonstration restoration project areas in order to develop the prioritization of demonstration restoration project areas across the entire watershed. For each demonstration restoration project area, various summary statistics were calculated, which were then ranked and normalized to result in a summation ranking of each demonstration restoration project area. After summary statistics were computed, dense ranks were assigned to each demonstration restoration project area.

1) Rank of the number of Tier 1 stormwater projects per demonstration restoration project area
2) Rank of the number of Total Tier 1 projects
3) Rank of Average Score/Average Cost per demonstration restoration project area
4) Rank of Average Score/Average Cost times the number of Tier 1 Stormwater Projects
5) Rank of Average Score/Average Cost times the number of Tier 1 Projects
6) Rank of elevation
7) Rank of the number of Non-stormwater Tier 1 projects

Elevation was taken into consideration since the higher elevations are likely located in the headwaters region of the watershed, which was an attempt to weight the importance of restoration projects in lower order streams including those in the downstream reaches. Each rank was then normalized, then the normalized ranks were summed and a new rank was computed based on the summed ranks. Each cluster thus has a unique rank with no ties, and stormwater management retrofit projects were weighted heavily. Additional information on the ranking of demonstration restoration project areas is presented in the Plan Formulation Appendix.

In an attempt to rank each subwatershed to corroborate or potentially provide further differentiation between high ranking demonstration restoration project areas, each subwatershed was ranked based on the following statistics:

Total TSS (tons/yr)* per subwatershed
Total N (lbs/yr)* per subwatershed
Total P (lbs/yr)* per subwatershed
Percent impervious per subwatershed
Percent existing stormwater management control per subwatershed

*Loadings calculated as part of the ARP study as discussed previously

Although considered, no habitat characteristics such as percent forest cover or number of acres of wetlands were taken into consideration as part of the subwatershed ranking analysis because each subwatershed varies considerably relating to land use and habitat features. It should be noted that pollutants generated generally increase with the increase in subwatershed size, which skews the results more towards larger subwatersheds. However, the pollutant reduction regulatory requirements are focused on reducing loads based for the entire watershed and thus larger subwatersheds receive higher weighting. Table 4-3 presents the results of the subwatershed ranking analysis.

Table 4-3: Results of the Subwatershed Ranking Analysis
1) Tidal River Subwatershed
2) Lower Beaverdam Creek Subwatershed
3) Northwest Branch Subwatershed
4) Northeast Branch Subwatershed
5) Indian Creek Subwatershed
6) Paint Branch Subwatershed
7) Sligo Creek Subwatershed
8) Upper Beaverdam Creek Subwatershed
9) Brier Ditch Subwatershed
10) Hickey Run Subwatershed
11) Watts Branch Subwatershed
12) Little Paint Branch Subwatershed
13) Pope Branch Subwatershed
14) Still Creek Subwatershed
15) Fort DuPont Tributary Subwatershed

Potential Reduction in Peak Discharge

As previously mentioned, it is estimated that approximately 70-75-percent of the sediment load delivered to the Anacostia River originates from streambank erosion (MDE, 2007). During a rain event, the hydrograph rises to a peak discharge rate and then returns to base flow. Erosion of the stream channel is directly related to the increased stream energy reflected by the peak flow. Reducing the peak flow at the given point within stream channel is an indication of the reduction in erosive shear stress on the stream banks. In addition, reconnection of the stream channel to its floodplain is an important component to reducing the energy associated with high flow events. As water surface elevations rise with increased flows, flood waters confined to the channel overtop and inundate the floodplain, effectively dissipating energy. Furthermore, as the flood water's energy dissipates, sediment in suspension is deposited in the floodplain.

Estimating the reduction of stream channel sediment loads that would result from controlling urban stormwater runoff is very challenging. In addition, detailed hydrologic and hydraulic modeling was not included as part of this planning-level effort. However, a peak discharge reduction analysis was used as a surrogate measure to give insight into the potential for reducing sediment load contributions from stream channels. For each of the 14 primary subwatersheds, an analysis of the reduction in peak discharge associated with various percentages of stormwater treatment was conducted. The Tidal River Reach was not calculated because regression equations were only available for those subwatershed located in Maryland, and the flow is diffuse with no single point from which to measure flow as compared to the other 14 subwatersheds. For more information, refer to the corresponding SWAP and the Plan Formulation Appendix.

Private Property Impervious Surfaces

Pollutant Reduction Potential of Private Property Impervious Surface Analyses

Candidate stormwater restoration projects implemented by governmental agencies alone are only one piece of the strategy needed to control stormwater and pollutants it carries with it into the Anacostia River and its tributaries. Almost half of the land use within the watershed is residential. As such, the opportunity exists to involve the private homeowner in stormwater control efforts. Impervious surfaces targeted by homeowners are roofs, driveways, and sidewalks. A number of stormwater control treatments, or homeowner BMPs, with various efficiencies included in the WTM are available for homeowner application: green roofs, rain gardens, rain barrels, permeable pavements, and downspout disconnections. Table 4-4 presents the pollutant removal efficiencies of homeowner BMPs.

Table 4-4: Removal Efficiencies of Homeowner BMPs in WTM

	Pollutant Removal Efficiencies of WTM			
	N	P	TSS	Bacteria
Green Roof	45%	45%	80%	0%
Downspout Disconnection	25%	25%	85%	0%
Rain Barrel	40%	40%	40%	0%
Rain Garden	64%	55%	85%	90%
Permeable Pavement	59%	59%	75%	0%

Based on the removal efficiencies, rain gardens provide the greatest pollutant removal capability for treating rooftop runoff. For treating sidewalks and driveways, permeable pavement provides similar capabilities to rain gardens, except there is no reduction for bacteria. Plans that incorporate these two practices on residential properties would make the greatest pollutant removal contributions.

The Subwatershed Environmental Baseline Conditions and Restoration Report includes the approximate acreage for private and single-family home roofs, sidewalks, single-family home driveways as well as the number of single-family homes for each of the 14 primary subwatersheds and tidal river reach. Using the WTM, the PDT conducted an analysis to estimate the pollutant reduction potential of homeowner stormwater management based on six alternatives of various homeowner BMP practices:

1. Control 1-percent of the impervious acreage with green roofs, 1-percent with downspout disconnections, 1-percent with rain barrels, and 1-percent with rain gardens. Control 1-percent of the sidewalk and driveway impervious acreage with permeable pavement.

2. Control 5-percent of the impervious acreage with green roofs, 5-percent with downspout disconnections, 5-percent with rain barrels, and 5-percent with rain gardens. Control 5-percent of the sidewalk and driveway impervious acreage with permeable pavement.

3. Control 10-percent of the impervious acreage with green roofs, 10-percent with downspout disconnections, 10-percent with rain barrels, and 10-percent with rain gardens. Control 10-percent of the sidewalk and driveway impervious acreage with permeable pavement.

4. Control 10-percent of the impervious acreage with green roofs, 50-percent with downspout disconnections, 25-percent with rain barrels, and 15-percent with rain gardens. Control 50-percent of the sidewalk and driveway impervious acreage with permeable pavement.

5. Control half of the acreage of private, non-family residences by treating 25-percent of the impervious acreage with rain gardens and 25-percent with green roofs; control half of the single-family driveways and sidewalks with permeable pavement; and control all of the single-family home impervious roof acreage by treating 25-percent with rain barrels, 25-percent with green roofs, and 50-percent with rain gardens.

6. Control half of the acreage of private, non-family residences by treating 30-percent of the impervious acreage with rain gardens, 15-percent with downspout disconnections, and 5-percent with green roofs; control half of the single-family driveways and sidewalks with permeable pavement; and control half of the single-family home impervious roof acreage by treating 10-percent with rain barrels, 5-percent with green roofs, 15-percent with downspout disconnections, and 20-percent with rain gardens.

Neighborhood Analysis

With almost half of the 176 square mile Anacostia River watershed land use being residential, there are thousands of single-family homes and hundreds of subdivisions. As part of the identification and inventorying of candidate stormwater retrofit projects, an analysis was completed to target residential area for the implementation of various homeowner stormwater management control programs offered by jurisdictions, such as the District's RiverSmart Homes Program or Montgomery County's RainScapes Program. Criteria used to evaluate various residential areas include existing stormwater management controls, lot size, homeownership, and community acceptability and probability of success. Additional information on the Neighborhood Analyses is included in the corresponding Subwatershed Provisional Restoration Projects Inventory and Plan Formulation Appendix.

Street Sweeping Analysis

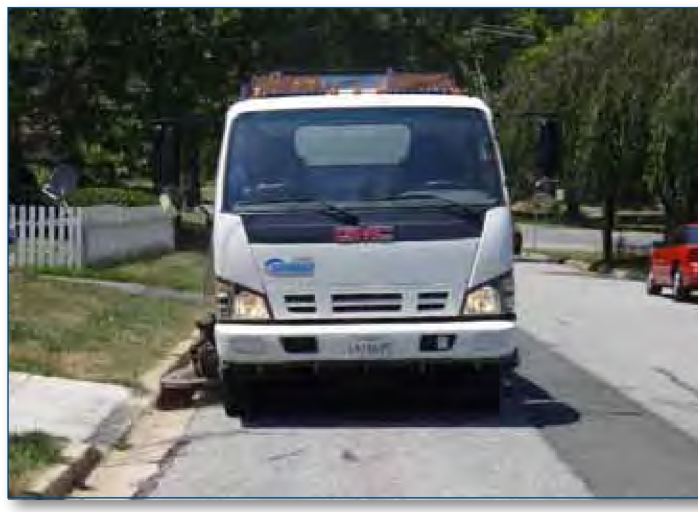
Automobiles are a source of pollutants within any watershed, especially in an urban watershed like the Anacostia River. The Anacostia River watershed has approximately 2,092 miles of roads, and approximately 6,688 acres of parking lots. Automobile fluids, including oil, gasoline, and antifreeze, along with road grit accumulates on these surfaces, and then discharges into the stream network via stormwater runoff.

Street sweeping can serve as an effective pollutant removal technique if the right equipment and right techniques are employed (Montgomery County, 2002). The highest concentration of pollutants is associated with the smallest particles of road grit (EPA, 1983). Of the three technologies available for street sweeping, regenerative air sweepers and vacuum assisted sweepers provide the greatest pollutant removal. Mechanical broom sweepers do the least to remove the small particles associated with most pollutants.

Decisions such as frequency of sweeping, type of road swept (residential or mixed use) whether cars are permitted to be parked in the roadway, and training of personnel performing the street sweeping affects the efficiency of the practice. Ideally, street sweeping is most effective at pollutant removal if pollutants are permitted to accumulate and then the area swept prior to a rain event. However, this situation is logistically difficult. Street sweeping, therefore, is usually carried out on a weekly, monthly, or quarterly basis.

The WTM is capable of estimating removal of N, P, and TSS by street sweeping. Evaluations with the WTM identify weekly sweeping can remove 67-percent more N, P, and TSS than monthly sweeping.

For the Street Sweeping Analysis, since the type of sweeper would likely vary across jurisdictional boundaries, it was assumed half of the road miles would be swept using regenerative air sweepers and the other half using vacuum assisted sweepers. In addition, it was assumed that parking would not be permitted during sweeping and the sweeper operators would have training. Furthermore, the pollutant loads vary between residential roads and 'other' roads. To differentiate between the two types of roads, the PDT used those roads within the subdivisions identified as part of the Neighborhood Analyses described previously as residential roads, and all remaining roads as 'other' roads. Finally, pollutant reductions from sweeping parking lots were considered as part of the Street Sweeping Analysis using a mechanical sweeper. The analyses estimate the potential pollutant reductions following various alternatives of the percentage of road acres and parking lots swept for various combinations of road types and frequencies. Additional information on the alternatives completed and assumptions used is included in the Plan Formulation Appendix and the corresponding SWAP.



GreenStreet Analysis

As discussed previously, automobiles are the source of many pollutants entering the Anacostia River watershed. Prince George's County has completed several GreenStreets as part of a Green Infrastructure Plan, which converts existing road medians to various stormwater treatment practices including bioretention. The GreenStreet Analysis as part of the ARP was completed to estimate using the WTM to estimate the benefits associated with controlling various percentages of stormwater runoff from the roads, residential and 'other,' within the Anacostia River watershed using bioretention treatment practices. To differentiate between the two types of roads, the PDT used those roads within the subdivisions identified as part of the Neighborhood Analyses described previously as residential roads, and all remaining roads as 'other' roads. Additional information on the alternatives completed and assumptions used is included in the Plan Formulation Appendix and the corresponding SWAP.

Cumulative Pollutant Reduction Analysis

Restoring the Anacostia River watershed will require a multi-faceted approach. To estimate the benefits that could be achieved by undertaking such an approach, the Cumulative Pollutant Reduction Analysis was completed. This approach identified potential cumulative benefits by combining various scenarios of impervious surface treatment practices for each subwatershed as well as the entire Anacostia River watershed. Broad assumptions were made to determine the cumulative pollutant reduction from various scenarios of applying impervious surface controls. In addition, double-counting of stormwater treatments, for example GreenStreet bioretention and Street Sweeping of roads, was unavoidable and minimized to the

furthest extent possible. Additional information and discussion on the assumptions made is presented in the Plan Formulation Appendix.

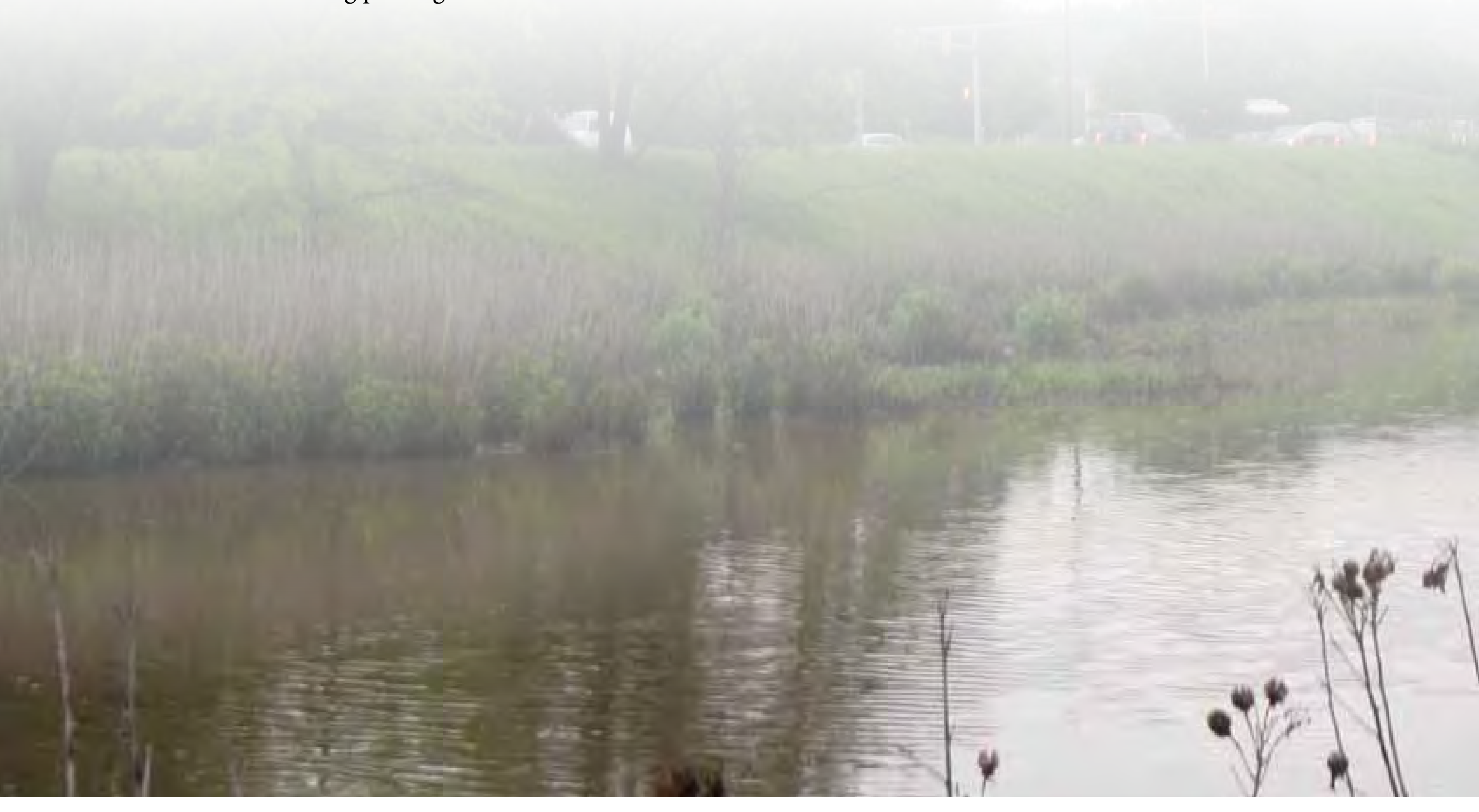
Table 4-5 presents the various scenarios of impervious area treated based on the preceding pollutant reduction analyses. The stormwater management control and private property impervious acreage identified in Table 4-5 are not constant as the existing conditions are variable within each of the 14 primary subwatersheds and the tidal river reach. Long-term scenarios presented in Table 4-5 indicate the percent of acreage controlled greater than 100-percent due to inherent double-treatment of impervious surfaces, for example GreenStreet projects treating a roadway that is also treated by Street Sweeping.

Table 4-5: Cumulative Pollutant Reduction Scenarios

	10-Year Scenarios			Long-term Scenarios		
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Year	2020			2030	2040	2050
	Minimal	Moderate	Aggressive			
	Approximate Current Restoration Effort	Increased Restoration Effort	All candidate stormwater retrofit projects			
1. Stormwater Management Control (Candidate Stormwater Retrofit Projects)	Existing Stormwater Management Controls (varies per subwatershed)	Increased Implementation of stormwater management controls	All candidate stormwater retrofit projects			
2a. LID GreenStreets – 'other' roads	1%	5%	15%	25%	50%	100%
2b. LID GreenStreets – residential roads	1%	5%	10%	25%	50%	25%
3a. Street Sweeping – residential roads	2%	10%	15%	50%	50%	75%
3b. Street Sweeping – 'other' roads	2%	10%	15%	25%	50%	0%
3c. Street Sweeping – parking lots	1%	5%	25%	50%	50%	50%
4. Private Property Pollutant Reduction Potential	Private property impervious surfaces (varies per subwatershed)					
Total watershed acres controlled* (ac)	**4,176**	**10,490**	**17,628**	**22,966**	**28,214**	**30,656**
Percent of watershed controlled*	**15%**	**38%**	**65%**	**84%**	**103%**	**112%**
***Including existing controls**						

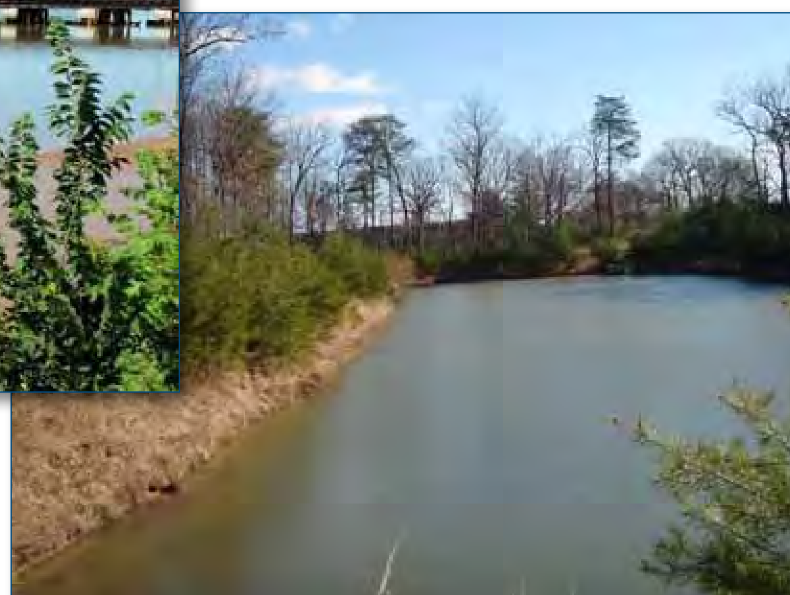
The following rules were applied in developing the Cumulative Pollutant Reduction Analysis scenarios:

1) When treating 'Other roads,' 'GreenStreets,' and 'Streets Sweeping' could treat the same acreage. Therefore, these two practices, as applied to 'Other roads' are considered mutually exclusive. That is, the percent of 'Other roads' treated by 'GreenStreets' and the percent treated by 'Street Sweeping' cannot exceed 100-percent.
2) The same rule as #1 applies to 'Residential Roads'. The percent of 'Residential roads' treated by 'GreenStreets' and the percent treated by 'Street Sweeping' cannot exceed 100-percent.
3) When treating residential property, 'GreenStreets- residential' and 'private property pollutant reduction potential' could treat the same areas. Therefore, these two practices, as applied to residential property are considered mutually exclusive. The differentiation between the residential road acreage used to model 'GreenStreets' and the roof and sidewalk acreage treated by 'private property pollutant reduction potential' is not as simple as in the case of #1 and #2 above. However, to account for the possible double-treating of residential areas by these two methods, it was assumed that the sum of the percent of impervious acreage treated by these two practices cannot exceed 100-percent.
4) Rules #2 and #3 above do not imply that 'Street Sweeping-residential roads' and 'private property pollutant reduction potential' are mutually exclusive.
5) The maximum acreage that could be treated by 'Street Sweeping- parking lots' was capped at 50-percent. Many of the candidate stormwater retrofit projects identified in the Subwatershed Provisional Restoration Project Inventory targeted treating parking lots. Therefore, there was a clear necessity to limit the amount of 'Street Sweeping - parking lots' acreage included in any scenario to avoid double-counting parking lot treatments.



AWRP Restoration Indicators and Targets

Problem identification and restoration strategies developed for the ARP stem from the identification of restoration indicators and targets. As part of the comprehensive I&T Project completed in 1999 as discussed previously, both the AWRP and the public were involved in identifying restoration indicators and targets for the Anacostia River watershed through extensive discussions and meetings. Discussions between the PDT and AWRP Steering Committee included using the restoration opportunities and estimated benefits, as included in the ARP 10-year restoration plan, to revise and update indicators and targets for the 2010 I&T Project to the year 2020.



AWRP Policy and Programmatic Contribution to the ARP

To supplement the ARP original formulation to identify opportunities for the restoration within the watershed, the AWRP Executive Director and Steering Committee assisted with identifying and discussing potential policy and programmatic approaches. A change in policy or expansion of environmental restoration programs, such as the District's RiverSmart Homes Program, Montgomery County's RainScapes Program, or Prince George's County's GreenStreets Program, could potentially provide additional opportunities to address the problems and challenges facing the watershed. In addition, policy or regulatory changes may provide reductions to future pollutant loading rates as part of the protection of the Anacostia River watershed as a resource for future generations to live, work, and recreate.

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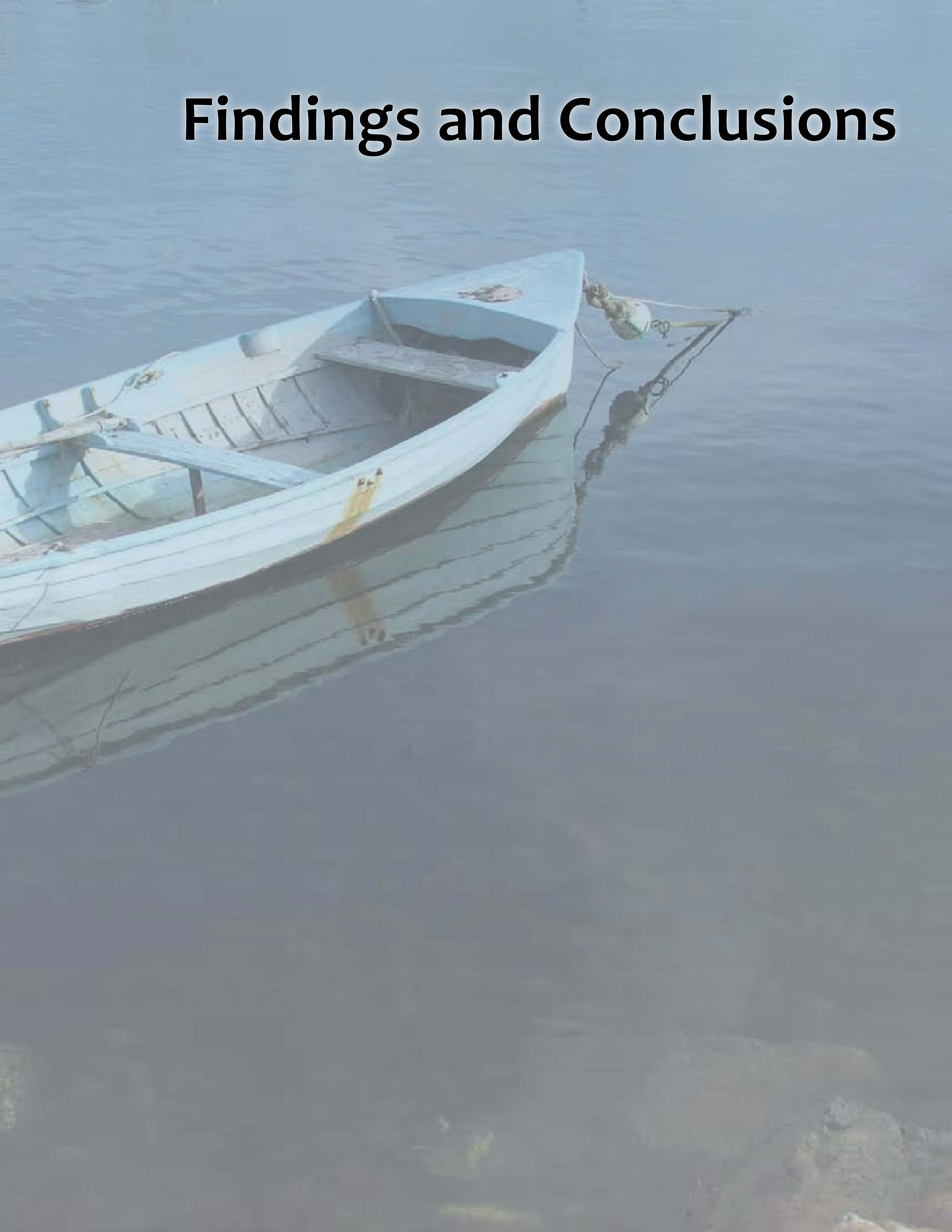
Findings and Conclusions



Study Findings

Candidate Restoration Projects Summary

Following the systematic process developed by the PDT, 3,018 candidate restoration projects were identified throughout the watershed. Table 5-1 through 5-4 summarizes the total number of candidate restoration opportunities along with total estimated benefits and costs by each corresponding restoration strategy. It should be noted that impervious acreage controlled may include impervious acreage included within the drainage area of an existing stormwater management BMP as part of a retrofit opportunity to provide additional water quality or quantity treatment. Estimated costs were derived from unit costs developed by the PDT and presented in each Subwatershed Provisional Restoration Project Inventory. The approximately 10,600 impervious acres treated by candidate stormwater projects identified in the ARP represent approximately 30-percent of impervious surfaces within the watershed. Candidate stormwater projects along with existing treatment practices would result in an overall treatment of approximately 42-percent of impervious surfaces within the watershed.

Table 5-1: Candidate Restoration Project Inventory Summary

Candidate Project Type		Number of Projects	Estimated Cost ($)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	1,892	$1,252,404,065	10,600.3				
2.	Stream Restoration	342	$179,687,500		72.5			
3.	Wetland Creation/ Restoration	116	$6,807,400			137.4		
4.	Fish Blockage Removal/ Modification	146	$35,172,500			347.0	41.7	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	152	$2,752,750					
6.	Trash Reduction	181	$711,675					124.7
7.	Toxic Remediation	0				2,512.1		
8.	Parkland Acquisition	189	$251,203,400					
	Total	**3,018**	**$1,728,739,290**	**10,600.3**	**72.5**	**2996.5**	**41.7**	124.7

Table 5-2: District of Columbia Candidate Restoration Project Inventory Summary									
Candidate Project Type		Number of Projects	Estimated Cost ($)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	290	$151,835,540	882.2				
2.	Stream Restoration	15	$8,062,500		2.2			
3.	Wetland Creation/ Restoration	9	$1,425,000			28.5		
4.	Fish Blockage Removal/ Modification	15	$5,297,000				2.1	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	17	$622,400			104.6		
6.	Trash Reduction	24	$171,185					28.8
7.	Toxic Remediation	0						
8.	Parkland Acquisition	3	$1,000,000			10		
	Total	**373**	**$168,413,625**	**882.2**	**2.2**	**143.1**	**2.1**	**28.8**

Table 5-3: Montgomery County Candidate Restoration Project Inventory Summary								
Candidate Project Type		Number of Projects	Estimated Cost ($)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	528	$275,087,680	3,266.1				
2.	Stream Restoration	148	$63,805,700		35.6			
3.	Wetland Creation/ Restoration	50	$1,642,000			32.7		
4.	Fish Blockage Removal/ Modification	50	$11,792,000				5.0	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	56	$1,267,600			130.4		
6.	Trash Reduction	31	$79,979					39.8
7.	Toxic Remediation	0						
8.	Parkland Acquisition	34	$112,020,000			1,120.2		
	Total	**897**	**$465,694,959**	**3,266.1**	**35.6**	**1,283.3**	**15.0**	**39.8**

Table 5-4: Prince George's County Candidate Restoration Project Inventory Summary								
Candidate Project Type		Number of Projects	Estimated Cost ($)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	1,074	$825,480,845	6,452				
2.	Stream Restoration	179	$107,819,300		34.7			
3.	Wetland Creation/ Restoration	57	$3,740,400			76.2		
4.	Fish Blockage Removal/ Modification	81	$18,083,500				24.6	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	79	$862,750			112.0		
6.	Trash Reduction	126	$460,511					56.1
7.	Toxic Remediation	0						
8.	Parkland Acquisition	152	$138,183,400			1,381.9		
	Total	**1,748**	**$1,094,630,706**	**6,452**	**34.7**	**1,570.1**	**24.6**	**56.1**

As discussed previously, a different approach was used to evaluate Tidal River Reach, which is primarily located in the District of Columbia, as compared to other 14 subwatersheds. Not included in the cost estimate presented in Tables 5-1 and 5-2 are the costs to increase tree canopy and forest cover, widespread green roof implementation, and widespread Green Alleys. City jurisdictional boundaries within the State of Maryland were not taken into consideration when identifying restoration opportunities, except for the City of Takoma Park in the Sligo Creek subwatershed, and all candidate restoration opportunities and associated estimated costs were assigned to the Maryland Counties for simplification.

Figure 5-1 presents candidate restoration project locations within the Anacostia River watershed. Figure 5-2 presents the distribution of candidate restoration projects by restoration strategy.

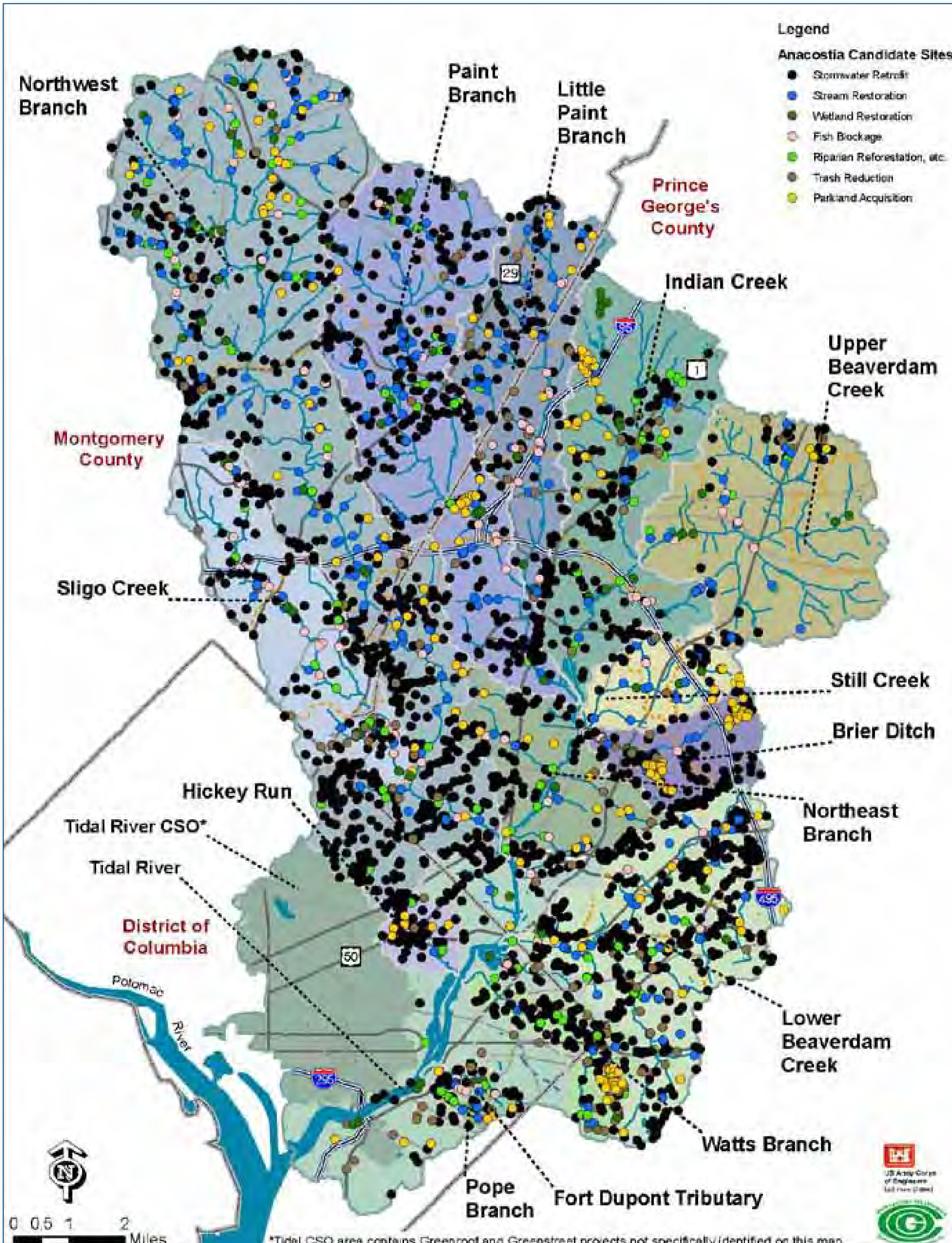


Figure 5-1: Candidate Restoration Project Locations

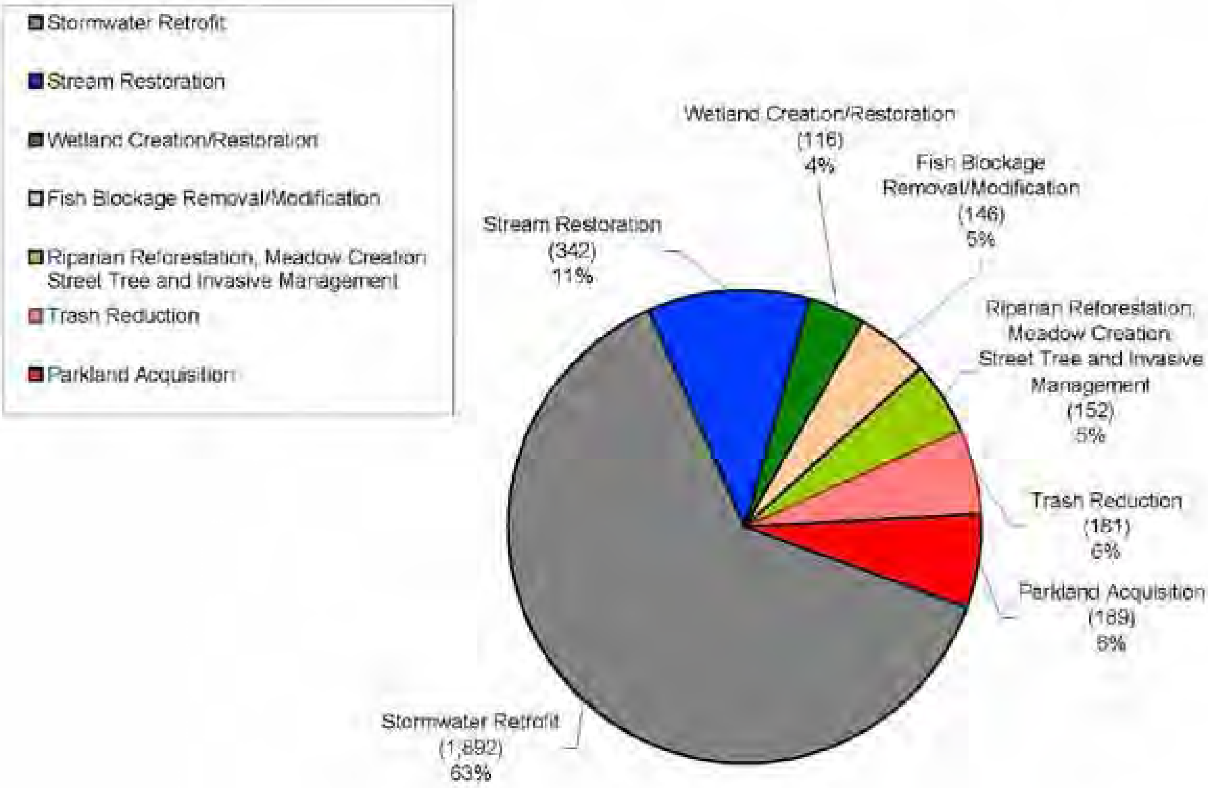


Figure 5-2: Distribution of Candidate Provisional Restoration Projects

Stormwater runoff is the primary stressor to address within the Anacostia River watershed. However, since a large portion of the watershed was developed without stormwater management controls, there is not enough space available for traditional stormwater BMPs, such as traditional regional, inline wet ponds with spillways, dry ponds, or extended detention wet ponds. Therefore the majority of candidate candidate stormwater retrofit projects identified as part of the ARP consisted of LID and ESD technologies like bioretention, green roofs, and downspout disconnections. Of the 1,892 candidate stormwater retrofit projects identified as part of the ARP effort, the majority of were LID or ESD technologies with bioretention recommended for 46-percent of the proposed impervious surface acreage treated. As identified from the subwatershed provisional restoration project inventories, Figure 5-3 presents the distribution of the various stormwater treatment practices evaluated to treat the overall impervious surface acreage using the WTM.

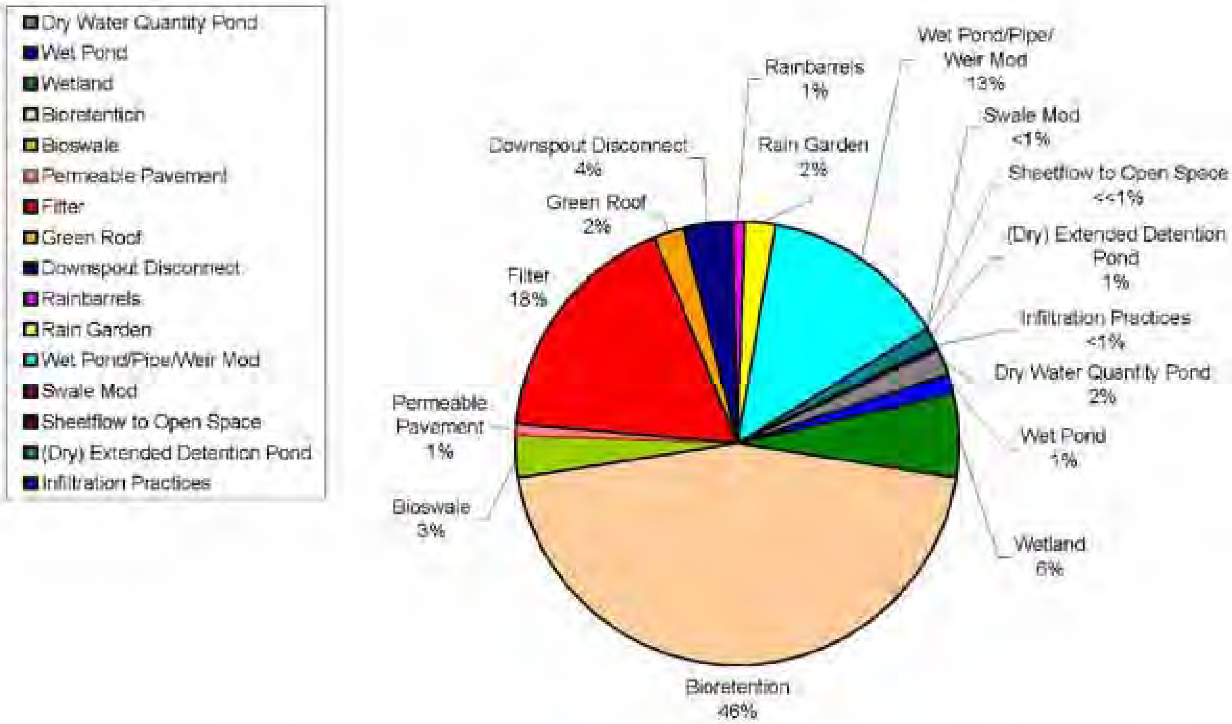


Figure 5-3: Distribution of Impervious Surface Treated by Various Treatment Practices

Anacostia Watershed Wide Prioritization of Restoration Projects

Once candidate restoration opportunities were identified, each candidate project was scored and ranked for each subwatershed, and was categorized into three Tiers. The ranking process resulted in the identification of 327 Tier I candidate restoration projects, including 263 stormwater management projects, 48 riparian reforestation/invasive species removal projects, eight trash reduction projects, seven wetland creation/restoration projects, and one fish blockage removal project. Figure 5-4 presents the location of the Tier I candidate restoration projects.

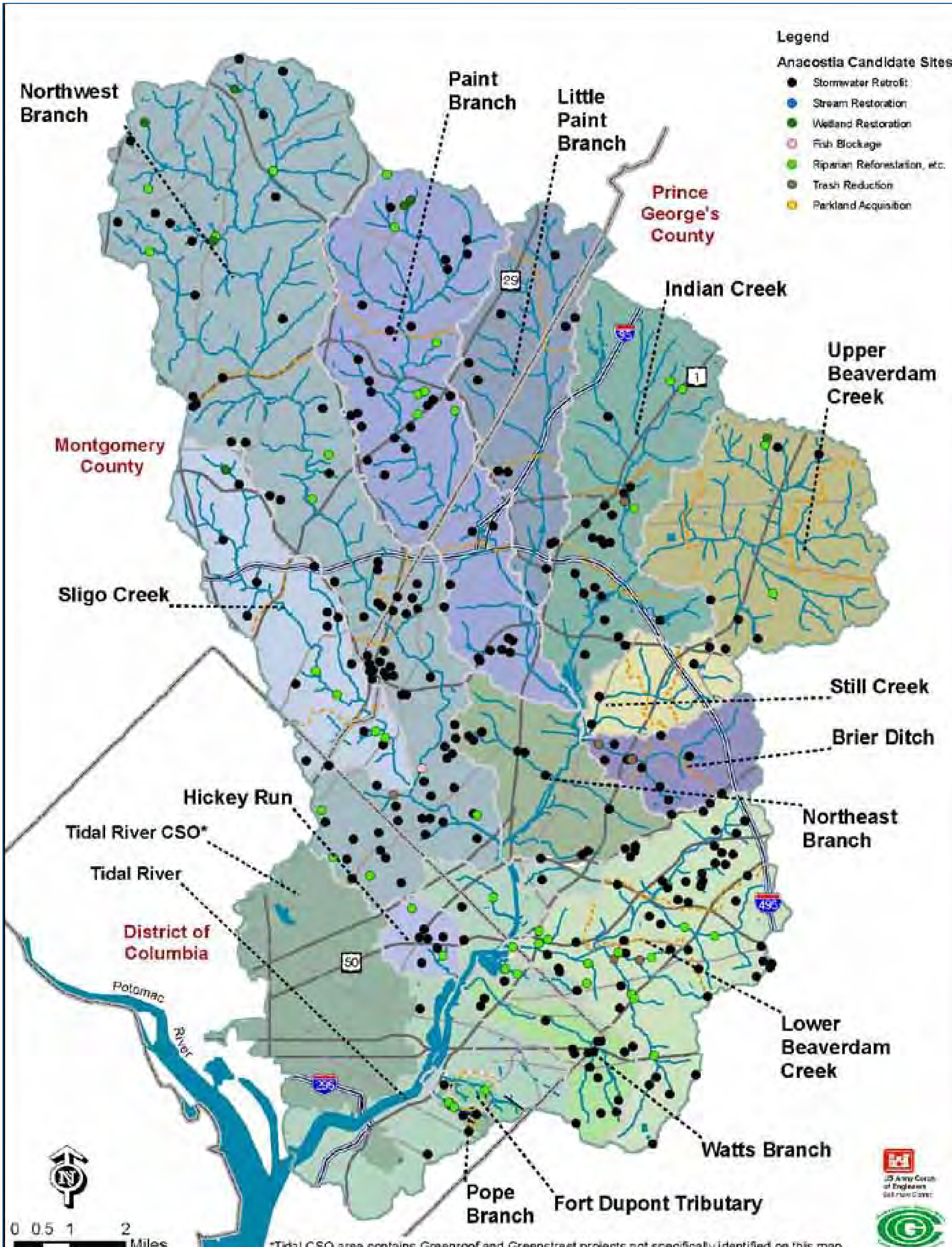


Figure 5-4: Tier I Provisional Restoration Projects

Anacostia Watershed-Wide Prioritization of Candidate Restoration Projects

Once adjusted scoring Tier I stormwater retrofit projects were identified across the entire watershed, the demonstration restoration project areas were defined resulting in 132 demonstration restoration project areas, which are presented in Figure 5-5. The number of candidate restoration projects included within the demonstration restoration projects areas is 703.

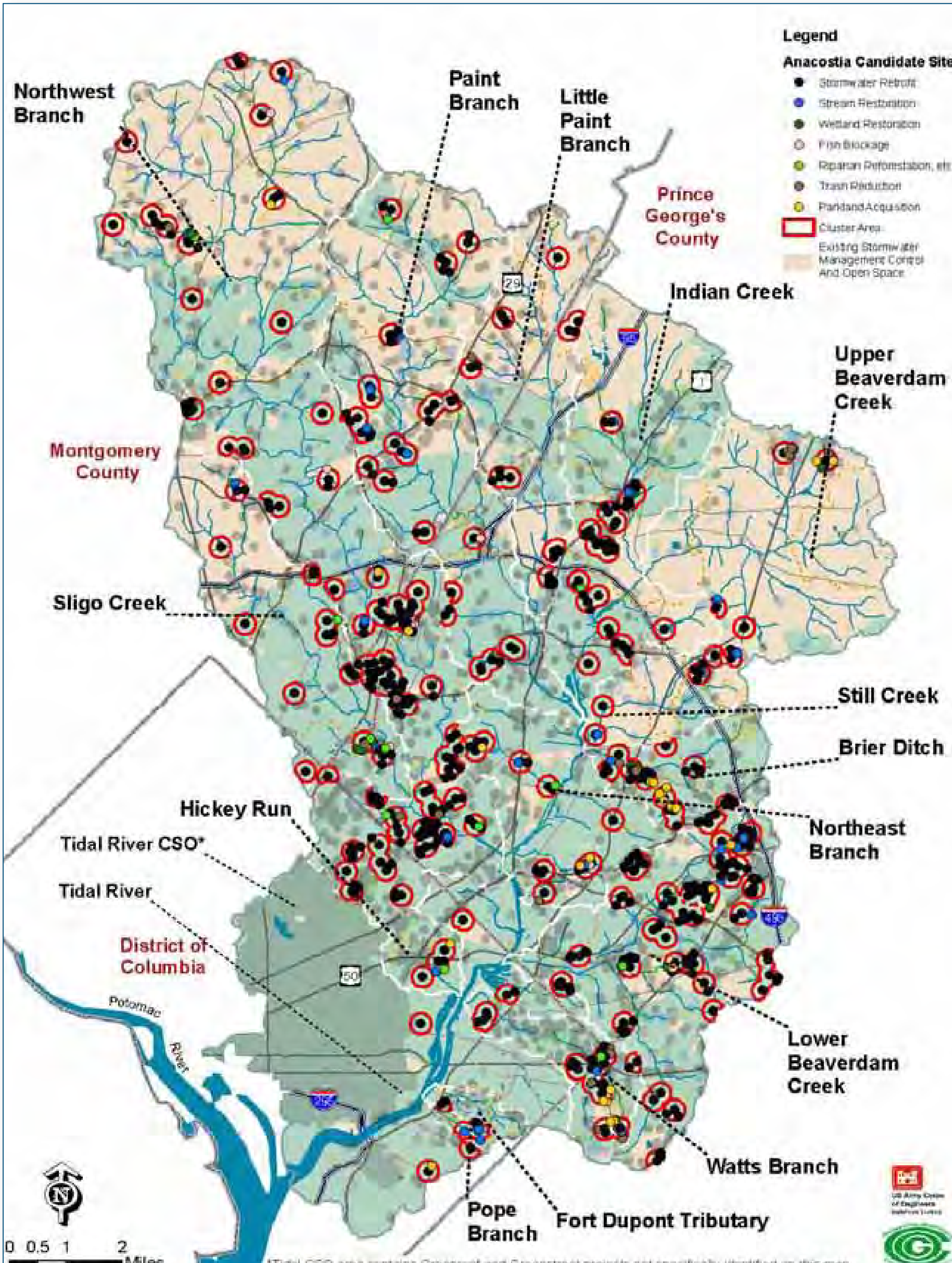


Figure 5-5: Locations of Demonstration Restoration Project Areas

Prioritizing Demonstration Restoration Project Areas

As discussed previously, each demonstration restoration project area was then evaluated further and ranked based upon summary statistics of specific criteria discussed previously. The prioritization of demonstration restoration project areas is presented in the Figure 5-6. Table 5-5 presents the summary of candidate restoration projects included within the demonstration restoration project areas.

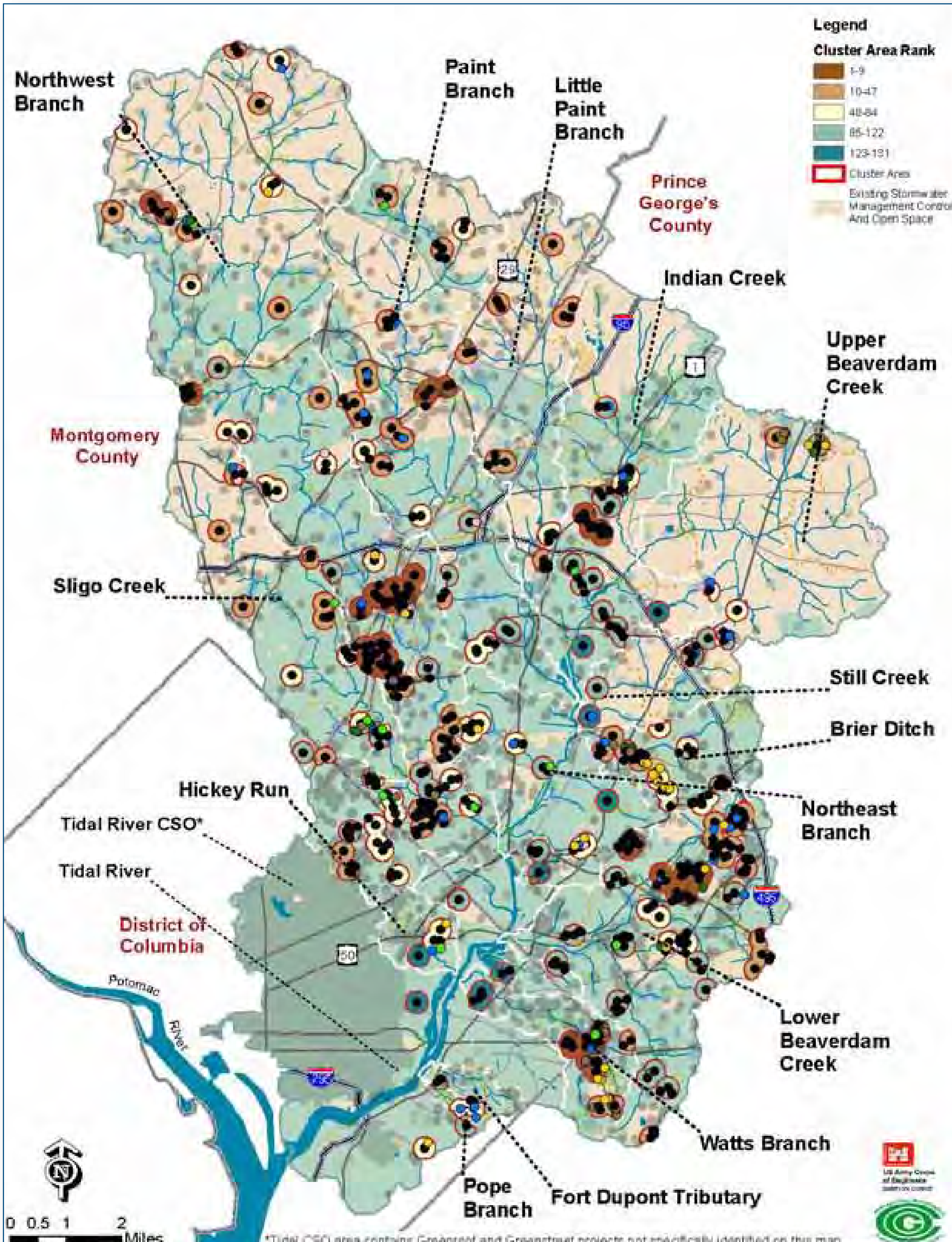


Figure 5-6: Ranking of Demonstration Restoration Project Areas

Table 5-5: Summary of Candidate Restoration Projects Included in the Demonstration Restoration Project Areas								
Candidate Project Type		Number of Projects	Estimated Cost (millions)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	535	$552	4,595				
2.	Stream Restoration	47	$23.9		8.1			
3.	Wetland Creation/ Restoration	14	0.8			15		
4.	Fish Blockage Removal/ Modification	18	$4.7				4.0	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	23	$0.3			40		
6.	Trash Reduction	39	$0.2					17.6
7.	Toxic Remediation	0						
8.	Parkland Acquisition	27	$18.7			187		
Total		**703**	**$601**	**4,595**	**8.1**	**242**	**4.0**	**17.6**

Stormwater Retrofit Projects' Pollutant Reduction Potential

As part of the ARP, each stormwater retrofit project was evaluated to determine its potential to reduce pollutant loads by treating the impervious surface acreage over which stormwater runoff drains. Figure 5-7 presents the estimated pollutant reduction potential upon implementation of candidate stormwater retrofit projects per subwatershed.

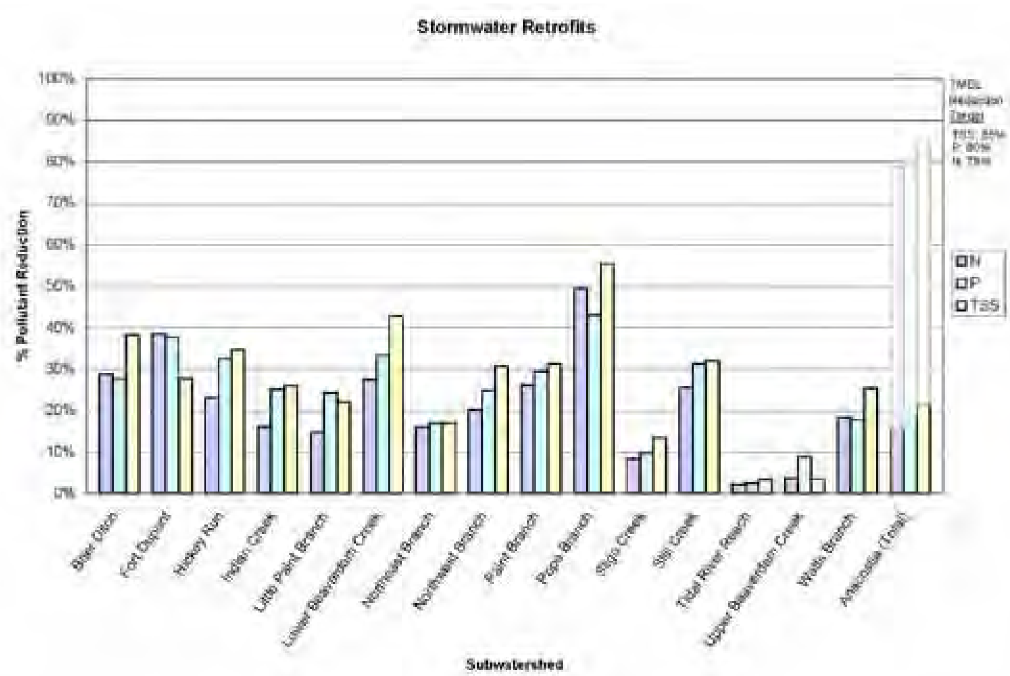


Figure 5-7: Pollutant Reduction Potential of Candidate Stormwater Retrofit Projects

Pollutant Reduction Potential of Private Property Impervious Surfaces

With the amount of private property, primarily single-family homes, and its corresponding impervious surfaces, restoration of the Anacostia River watershed cannot occur without addressing private property stormwater in some fashion. As part of the ARP, an analysis of various treatments of private property impervious surfaces was completed using the WTM. Figure 5-8 presents the results of six alternatives consisting of various percentages of private property impervious surface treatments.

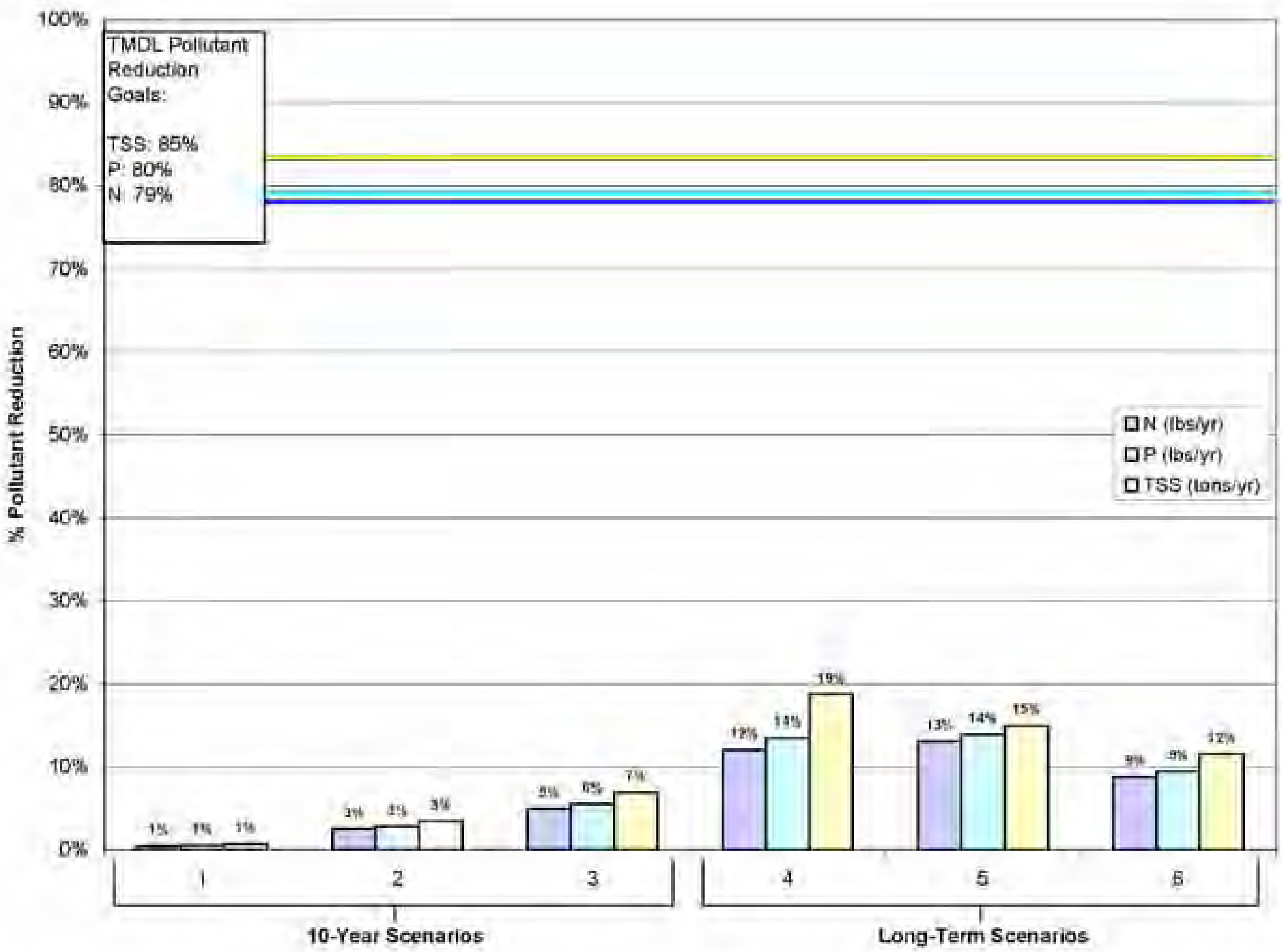


Figure 5-8: Pollutant Reduction Potential of Controlling Private Property Impervious Surfaces

Almost half of the land use within the Anacostia River watershed is categorized as various densities of residential. In the northern portions of the watershed, the residential land use classification is primarily low-density, single-family residential. As for the lower portions of the watershed, the area developed prior to the implementation of stormwater regulations, the residential land use classification is primarily medium- and high-density residential, including thousands of single-family homes on smaller lots. To provide context to the percentages relating to residential land use within the Anacostia River watershed, Table 5-6 summarizes the approximate number of single-family homes per subwatershed, which is presented separately in each corresponding subwatershed environmental baseline conditions and restoration reports.

As presented in Table 5-6, there are over 100,000 single-family homes in the Anacostia River watershed, along with additional areas of high-density residential areas, such as town homes, garden apartments, and high-rise apartments. Although Figure 5-8 presents varying percentages of pollutant reductions for differing levels of treatment, those percentages must be taken in context. For example, as presented in Chapter 4, Alternative 4 evaluated 100-percent of the residential private property impervious surface roof acreage and 50-percent of sidewalk and driveway impervious surfaces:

Control 10-percent of the impervious acreage with green roofs, 50-percent with downspout disconnections, 25-percent with rain barrels, and 15-percent with rain gardens. Control 50-percent of the sidewalk and driveway impervious acreage with permeable pavement.

Though the WTM evaluated the impervious surface acreage, for discussion purposes as well for context, an extrapolation to the number of single-family homes can be made (Table 5-7).

Although many opportunities exist in residential areas for implementation of private property BMPs, such as green roofs, rain gardens, and rain barrels, other considerations need to be made like the maintenance to ensure proper function of the proposed treatments. For example, after every rain event, every rain barrel would have to be emptied in order to function as intended. In addition, a windshield evaluation of representative neighborhoods within the watershed observed that most downspouts were disconnected from the stormwater system and drain to lawns and driveways, which means roads contribute stormwater runoff from private properties. Despite the need to address private property impervious surfaces, with only limited resources and funding available, it may be appropriate to consider addressing those impervious surfaces that generate higher pollutant loadings like roads and parking lots, especially if those roads collect stormwater runoff from private property impervious surfaces.

Table 5-6: Approximate Number of Single-Family Homes per Subwatershed

Subwatershed	No. of Single-Family Homes	Total Single-Family Home Approximate Roof Acreage (ac)
Brier Ditch	4,551	149.5
Fort DuPont Tributary	257	6.9
Hickey Run	1,122	31.9
Indian Creek	6,218	193.8
Little Paint Branch	4,126	167.7
Lower Beaverdam Creek	10,697	309.6
Northeast Branch	8,531	250.2
Northwest Branch	33,433	1,168.0
Paint Branch	10,380	432.6
Pope Branch	877	23.7
Sligo Creek	18,677	216.1
Still Creek	1,398	51.1
Tidal River Reach	11,926	268.3
Upper Beaverdam Creek	691	27.8
Watts Branch	5,639	127.9
Approximate Total	**118,523**	**3,425.1**

Table 5-7: Alternative 4 Extrapolation to Single-Family Homes

	Extrapolated Number of Single-Family Homes	Extrapolate Single-Family Home Roof Acreage Controlled	Estimated Costs* (millions)
Green Roofs (10-percent)	11,852	343	$623
Downspout Disconnections (50-percent)	59,262	1,713	$12**
Rain Barrels (25-percent)	29,631	856	$12
Rain Gardens (15-percent)	17,778	514	$89
Approximate Total (100-percent)	**118,523**	**3,425**	**$736**

*Estimated costs computed based on unit costs identified in Subwatershed Provisional Restoration Project Inventories
**Assumed same as estimated cost for one rain barrel per home

Street Sweeping

As mentioned previously, stormwater runoff from roads and parking lots contribute various pollutants and trash to the receiving stream network. In addition, some roads and parking lots contribute more pollutants than others do. For example, an arterial road may generate more pollutants than a residential road, or a parking lot in a commercial shopping center may generate higher pollutant loadings than say the same acreage within a church parking lot. The WTM was used to estimate the pollutant reduction potential for both weekly and monthly street sweeping practices of various percentages of road acreage for residential roads, all other roads, and parking lots. Weekly street sweeping indicated a greater reduction in pollutant loadings as compared to monthly street sweeping. In addition, vacuum assisted or regenerative air sweepers are more efficient than mechanical sweepers, which were evaluated for parking lots. Figures 5-9 through 5-11 present pollutant reduction potential for weekly street sweeping of various percentages of road acreages for residential, 'other,' and parking lots.

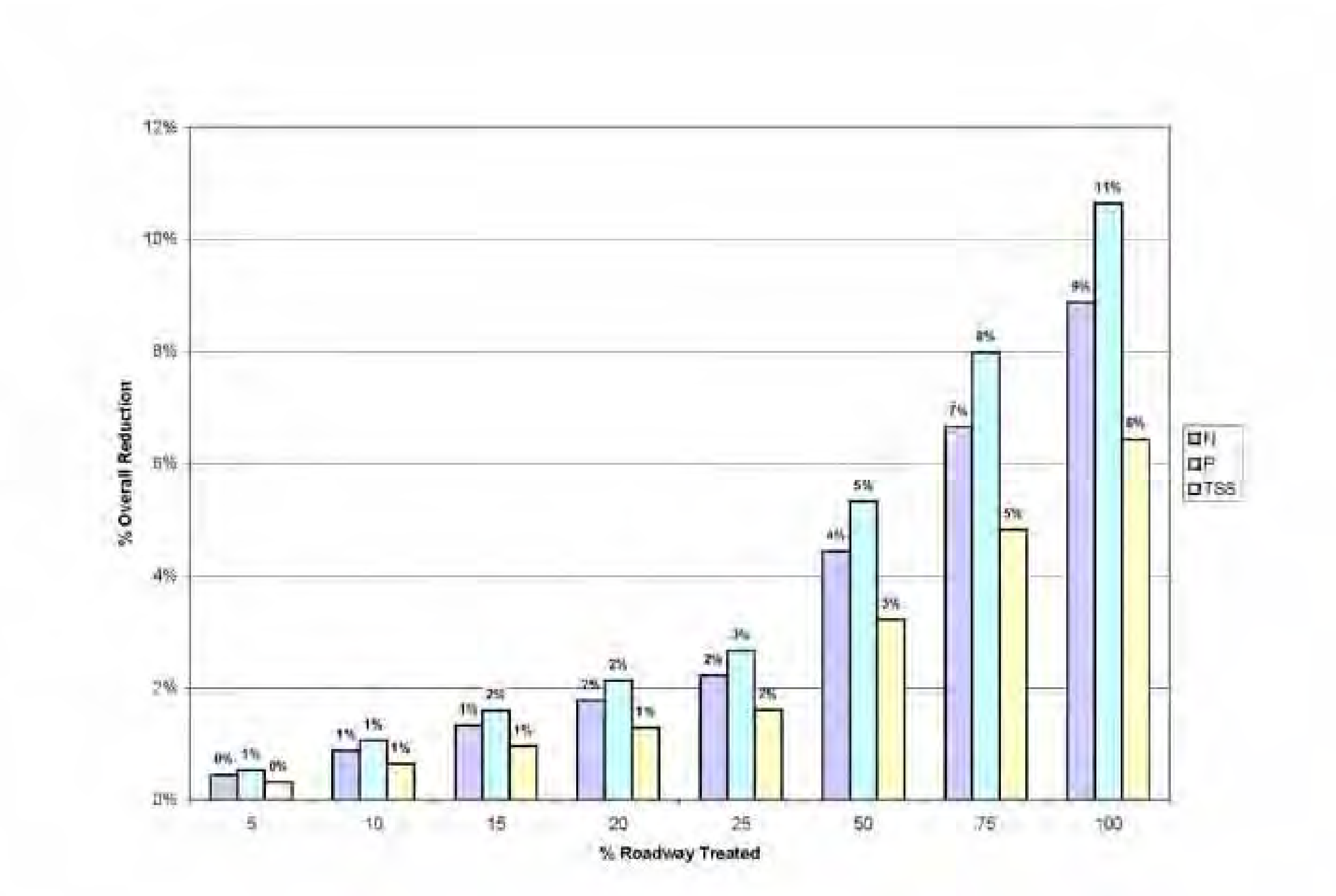


Figure 5-9: Estimated Pollutant Reduction Potential for Weekly Street Sweeping – Residential Roads

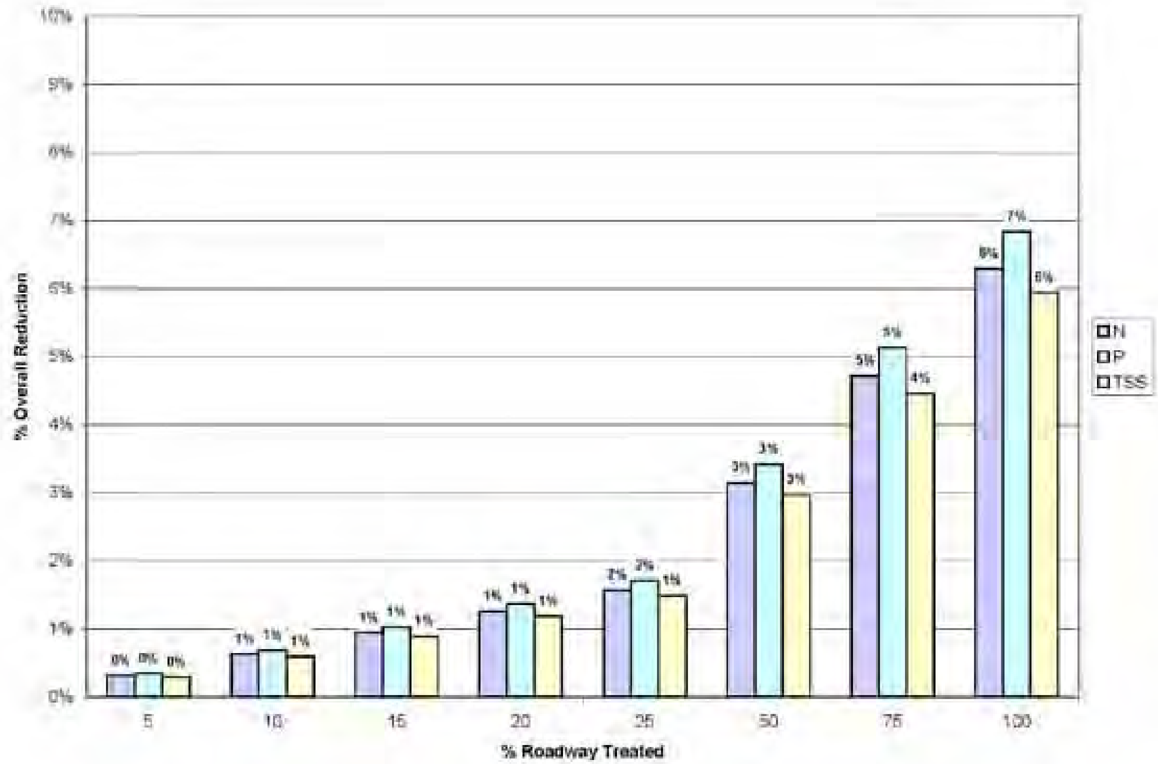


Figure 5-10: Estimated Pollutant Reduction Potential for Weekly Street Sweeping – "Other" Roads

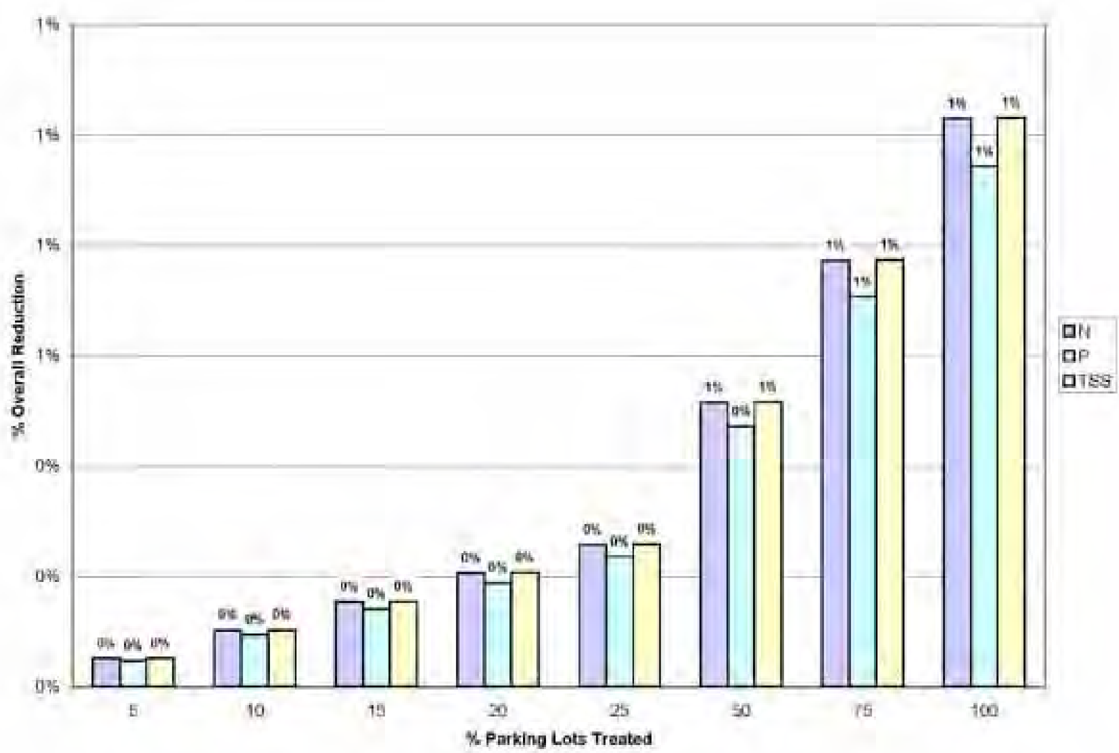


Figure 5-11: Estimated Pollutant Reduction Potential for Weekly Street Sweeping – Parking Lots

GreenStreets

Although street sweeping is an effective pollutant and trash reduction tool, street sweeping alone only removes pollutants and trash from the roads before a storm event washes them into the receiving stream network. In other words, street sweeping does not provide any water quantity benefits, only water quality benefits. Prince George's County currently employs the Green Infrastructure Program, which retrofits road rights-of-way into bioretention systems that not only treat pollutants, but also retain stormwater volume. In addition, the District of Columbia has many opportunities for Green Alleys where permeable pavement and/or infiltration and filtering practices are considered. Figures 5-12 and 5-13 presents the potential for pollutant reductions by treating various percentages of residential and 'other' road acreages using bioretention. The graph presents 150-percent of roadway treated in an attempt to capture potential increases in road area due to new road or road widening construction projects.

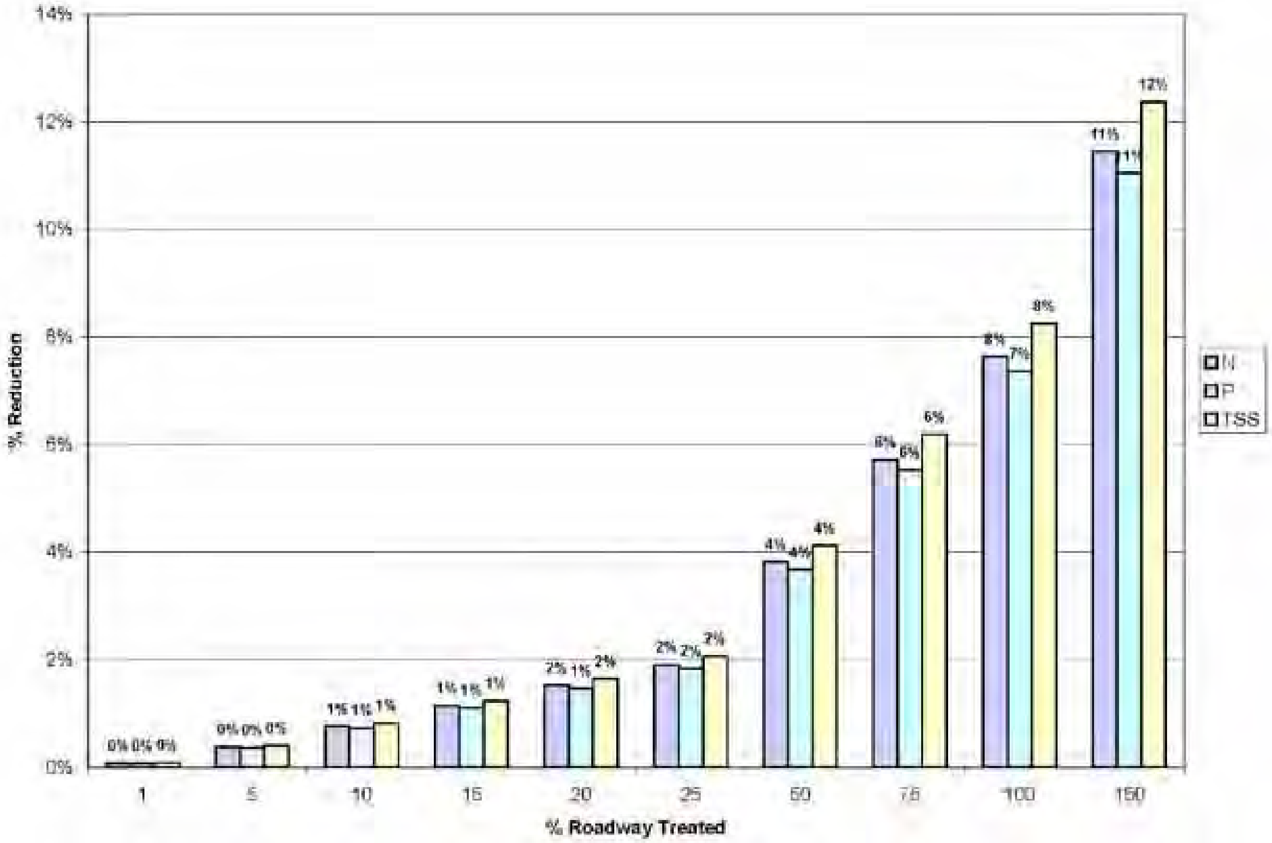


Figure 5-12: Pollutant Reduction Potential for Residential Roads to GreenStreets

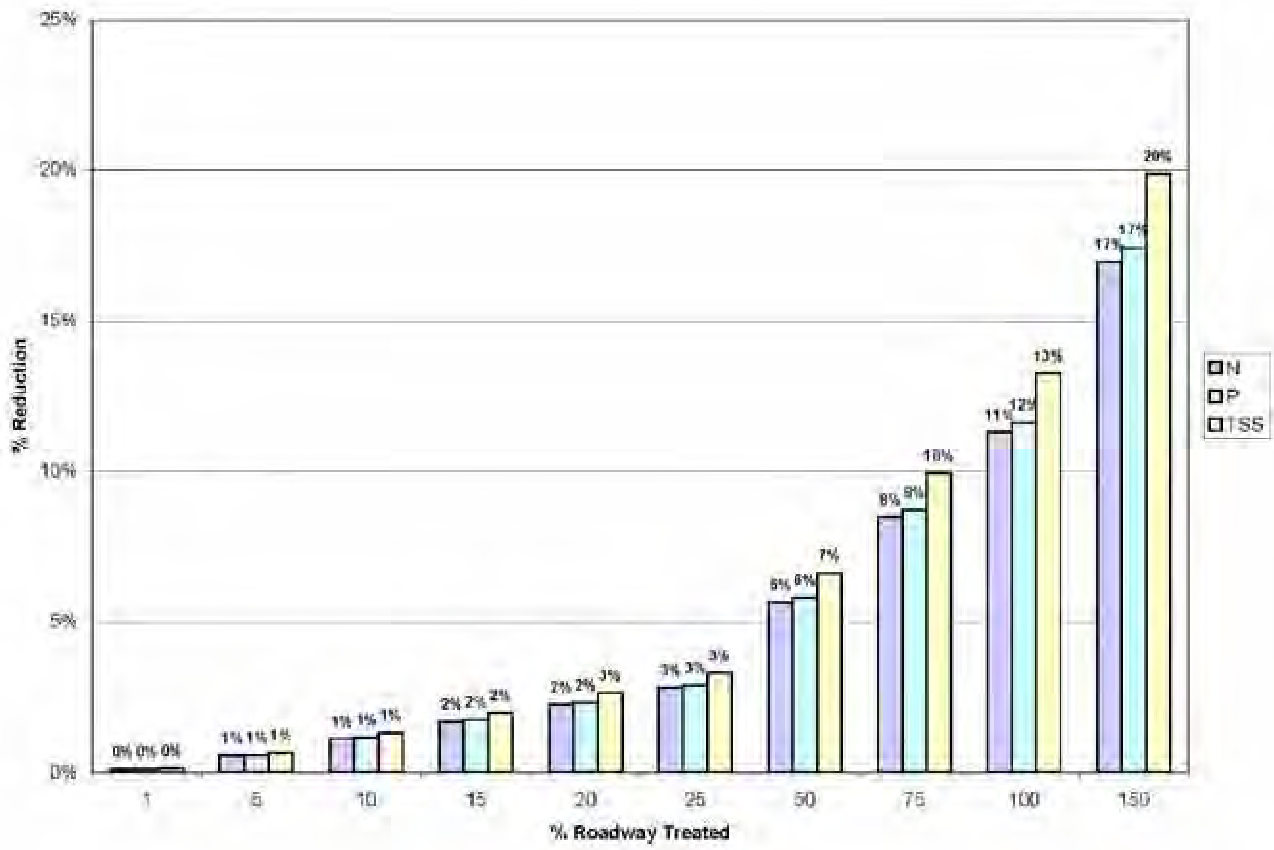


Figure 5-13: Pollutant Reduction Potential for "Other" Roads to GreenStreets

Cumulative Pollutant Reduction

The current and likely future scenario for restoration within the Anacostia River watershed consists of various stormwater treatment practices. The Cumulative Pollutant Reduction Analysis was completed to identify potential cumulative benefits by combining various scenarios of impervious surface treatment practices for each subwatershed as well as the entire Anacostia River watershed, including implementation of candidate stormwater retrofit projects, private property impervious surface treatments, street sweeping, and GreenStreet conversion. Figure 5-14 presents the six scenarios evaluated and potential cumulative pollutant reduction potential as it relates to the overall TMDL pollutant reduction goals. Scenarios 1-3 are estimates of three different 10-year restoration alternatives, to be discussed more in subsequent sections of this report, whereas Scenarios 4-6 represent long-term restoration alternatives, corresponding to years 2030, 2040, and 2050, respectively. It is important to note that the pollutant reductions are associated with overland flow reductions only, and do not take into account channel contributions, nor does the cumulative analysis include additional pollutant reduction initiatives associated with the LTCP or the WSSC Consent decree. As policies and programs are reevaluated and candidate restoration projects are implemented, such as stormwater retrofit, stream restoration, and wetland creation/restoration projects, additional pollutant reductions would be realized by the treatment of stormwater runoff, reduction in erosive peak flow, and reconnection of the stream channel to its floodplain and wetland areas that function as a sediment and nutrient sink.

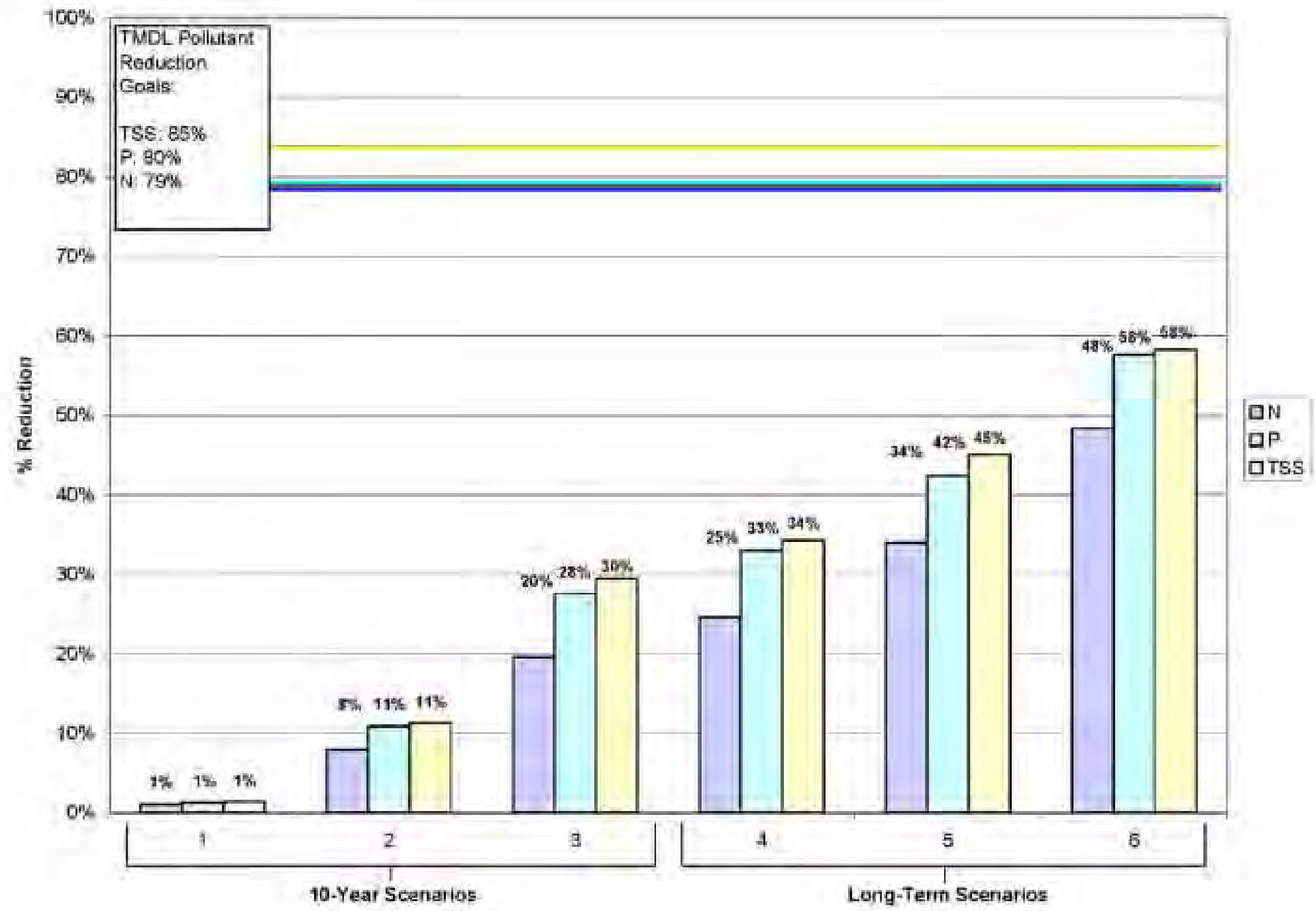


Figure 5-14: Scenarios Evaluated and Potential Cumulative Pollutant Reduction Related to TMDL Pollutant Reduction Goals

Potential to Reduce Peak Discharge

For each of the 14 subwatersheds, an analysis was completed to evaluate the potential to reduce peak discharges from controlling impervious surfaces. Table 5-8 presents the volume reduction from existing levels to 100-percent control of impervious surfaces. Please reference the section entitled "Potential Reduction in Peak Discharge" (page 73) and the Plan Formulation Appendix for further discussion. It is important to reiterate the correlation of stream channel erosion to peak discharge, as well as the importance of reconnecting the stream channel to its floodplain to reduce the energy associated with bankful discharge and to function primarily as a sediment and nutrient sink.

Table 5-8: Volume Reduction from Existing Levels to 100-Percent Control of Impervious Surfaces

Subwatershed	Percent Stormwater Management Controls	Effective Imperviousness (percent)	Peak Flow (cfs)	Peak Flow Per Area (cfs/square mile) / (gpd/square mile)	
				cfs/sq mi	Gpd/sq mi
Brier Ditch	1 (existing)	32	286	69	45,595,865
	100-percent	7	153	37	23,913,725
Fort DuPont Tributary	1 (existing)	13	85	102	65,983,645
	100-percent	3	48	58	37,508,899
Hickey Run	1 (existing)	46	247	144	93,069,631
	100-percent	9	131	76	49,120,083
Indian Creek	21 (existing)	13	722	25	16,134,353
	100-percent	3	431	15	9,637,109
Little Paint Branch	28 (existing)	16	227	21	13,572,655
	100-percent	4	134	13	8,402,119
Lower Beaverdam Creek	6 (existing)	35	699	47	30,376,894
	100-percent	7	379	25	16,157,922
Northeast Branch	18 (existing)	17	1,501	20	12,770,714
	100-percent	4	832	11	7,074,548
Northwest Branch	13 (existing)	21	1,445	27	17,699,122
	100-percent	5	666	13	8,155,859
Paint Branch	22 (existing)	15	830	27	17,243,620
	100-percent	4	443	14	9,202,799
Pope Branch	0 (existing)	32	90	211	136,372,862
	100-percent	6	48	113	73,033,808
Sligo Creek	22 (existing)	28	601	53	34,254,795
	100-percent	7	291	26	16,804,239
Still Creek	17 (existing)	18	276	72	46,534,816
	100-percent	4	160	42	27,145,309
Watts Branch	4 (existing)	35	359	93	60,107,470
	100-percent	7	193	50	32,315,844
Upper Beaverdam Creek	3 (existing)	6	334	24	15,511,605
	100-percent	1	206	15	9,694,753

Implementation

The restoration of the Anacostia River watershed will take considerable funding and resources from all levels of government, private industries and non-profit groups, and public volunteers. The ARP was developed to direct the future restoration effort of the Anacostia River watershed at different scales and present the information to various audiences. When developing subwatershed provisional restoration project inventories and SWAPs, it was envisioned that not only would government agencies implement candidate restoration projects, but also non-profit groups as well as community watershed groups and other interested volunteers. Various restoration and stewardship opportunities identified in subwatershed provisional restoration project inventories potentially could be implemented by volunteers, including trash clean-ups, tree plantings/invasive species removal, creation of vernal pools, modification of fish blockages like debris jams, and installation of rain gardens and rain barrels to name a few. Furthermore, local jurisdictions are required to develop TMDL and MS4 implementation plans to demonstrate how water quality standards will be achieved, and candidate restoration projects identified in the ARP may or may not be included as part of those separate initiatives. It should be noted, however, that many candidate restoration projects identified as part of the ARP (particularly habitat restoration projects like stream restoration, wetland creation, and fish blockage modifications) require a willing landowner to grant access and/or easements for construction or staging, lack of access would ultimately become a fatal flaw for implementation of the project.

Although support to restore and protect the Anacostia River is strong, the reality is there are limited resources available for the restoration effort. In addition, as part of a 10-year plan, the number of projects to be placed into the ground and subsequently maintained would be impossible to complete, due to time it would take for the almost implementation of all 3,018 restoration opportunities, or one restoration project per day for the next 10 years. For example, over 500 candidate restoration projects likely will require a feasibility study, including detailed analyses far greater than those conducted as part of the ARP evaluation, in order to determine the benefits, costs, and physical constraints at each specific location to move into the design and construction phase. Feasibility studies following the typical USACE Civil Works protocol, may take years (18 months to three years) to complete, depending on the size and scope of the restoration project. Add to that the time required for design and construction, an additional 2-5 years. Thus, some of the stream restoration or wetland creation projects, assuming full-funding, potentially could be implemented towards the end of this 10-year plan. Although stormwater retrofit projects likely could be implemented much faster, following a design phase. Furthermore, the Anacostia River and its tributaries have reached the current state of impairment following hundreds of years of land use change and abuse, and the complete restoration of the watershed to address all the problems caused by all the years of neglect can only be realized on a long-term planning horizon.

ARP Implementation: Minimal, Moderate, and Aggressive Restoration Approaches

The existing effort will not achieve restoration of the Anacostia River watershed within 10 years. In order to realize measurable restoration progress at the watershed scale, it will take bold action from politicians and citizens alike to generate the support and funding requirements necessary for the restoration and protection of the Anacostia River and its tributaries. As part of the ARP evaluation process, and as presented in Table 5-1, 3,018 candidate restoration projects were identified; however, there are possibly hundreds more that were not captured as part of the ARP investigation. In addition, as the years pass, new restoration opportunities will surface as will new problems because changes to land use will ultimately impact physical and ecological conditions. As technology improves following additional research into pollutant removal efficiencies, treatment practices of today ultimately will be replaced just as ESD and LID likely will replace conventional stormwater practice like large regional stormwater management ponds. Therefore, the restoration effort will be ongoing as long as support for a fishable and swimmable river is maintained.

As part of the ARP 10-year plan, a range of implementation approaches has been considered: minimal, moderate, and aggressive. Although opportunities identified as part of the ARP potentially could be considered for implementation after 10 years, uncertainties associated with future site conditions or even changes in technologies or methodologies make long-term planning with any specificity very difficult. Thus, discussion for the implementation of restoration opportunities identified in the ARP will focus on the 10-year planning horizon.

As discussed previously, hundreds of studies and restoration projects have been completed since the restoration effort within the Anacostia River watershed began around 1990 with approximately $250 million expended to date (MWCOG, 2008). Over the course of approximately twenty years, the annual expenditure for restoration actions has been approximately $12.5 million with about 12 restoration projects completed per year across the entire watershed. Scenario 1 of the Cumulative Pollutant Reduction Analysis attempts to capture the existing restoration effort, which is considered the Minimal Restoration Approach as part of the ARP 10-year plan.

The Moderate Restoration Approach attempts to increase the number of restoration projects implemented over the course of the next 10 years across the entire watershed. Implementing a combination of the highest ranking demonstration restoration project areas as discussed previously would consist of the Moderate Restoration Approach, which aligns

with minimum regulatory requirements for stormwater management controls of impervious acreage stated in the jurisdictions' NPDES MS4 permits and represents an increase in the effort required to achieve restorative action within each jurisdiction. This approach attempts to conceptually, though not specifically, align with Scenario 2 of the Cumulative Pollutant Reduction Analysis, meaning it would be an increased restoration initiative than what currently exists.

As part of the county-wide MS4 permit cycle, a 10-percent increase in impervious surface controls must be achieved within five years. The assumption used as part of the Moderate Restoration Approach would therefore be controlling 20-percent of the impervious acreage by 10 years, though it is noted that the watershed area is not equally distributed among the three jurisdictions. Using information presented in the Anacostia Watershed Environmental Baseline Conditions and Restoration Report, the watershed is approximately 176 square miles (112,640 acres), having approximately 36-percent stormwater management controls. The number of total acreage controlled by stormwater management controls is approximately 40,550 acres. The average imperviousness of the entire watershed is approximately 25-percent (MWCOG, 2008), or approximately 10,138 impervious acres with stormwater management controls. Subtracting the impervious acreage controlled, 10,138 impervious acres, from the total impervious acreage, or 25-percent of the total number of acres, results in approximately 18,022 impervious acres without stormwater management controls. A 20-percent increase in stormwater management controls of impervious surfaces results in approximately 3,604 impervious acres. Thus, across the entire watershed, the Moderate Restoration Approach is implementing the highest ranking demonstration restoration project areas to include stormwater management retrofit projects treating at least 3,604 impervious acres. Figure 5-16 and Table 5-9 present the demonstration restoration project areas to be implemented for the Moderate Restoration Approach. It should be noted, upon implementation by others, that candidate restoration projects should be reevaluated for proper sequencing, for example fish blockage modification or removal candidate projects within demonstration restoration project areas should take into consideration downstream blockages prior to implementation.

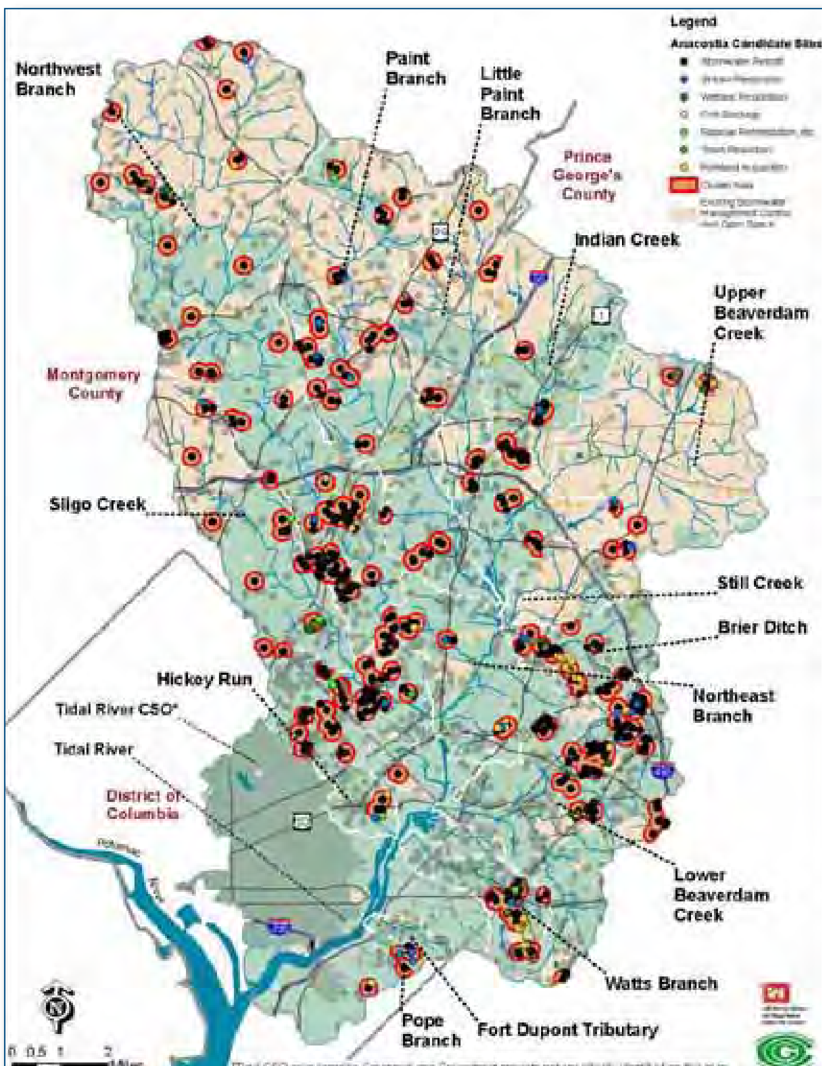


Figure 5-16: Demonstration Restoration Project Areas - Moderate Restoration Approach

Table 5-9: Summary of Moderate Restoration Approach of Demonstration Restoration Project Areas								
Candidate Project Type		Number of Projects	Estimated Cost (millions)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	456	$382	3,614				
2.	Stream Restoration	43	$22		7.0			
3.	Wetland Creation/ Restoration	13	$0.8			15		
4.	Fish Blockage Removal/ Modification	14	2.8				3.2	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	19	$0.2			34		
6.	Trash Reduction	37	$0.2					16.6
7.	Toxic Remediation	0						
8.	Parkland Acquisition	27	$18.7			187		
	Total	**609**	**$426.8**	**3,614**	**7.0**	**236**	**3.2**	**16.6**

The Aggressive Restoration Approach consists of the Moderate Restoration Approach along with the implementation of all the candidate stormwater retrofit projects identified as part of the ARP investigation. The implementation of all the stormwater retrofit projects corresponds to Scenario Three of the Cumulative Pollutant Reduction Analysis. Figure 5-17 and Table 5-10 presents the candidate restoration projects for the Aggressive Restoration Approach.

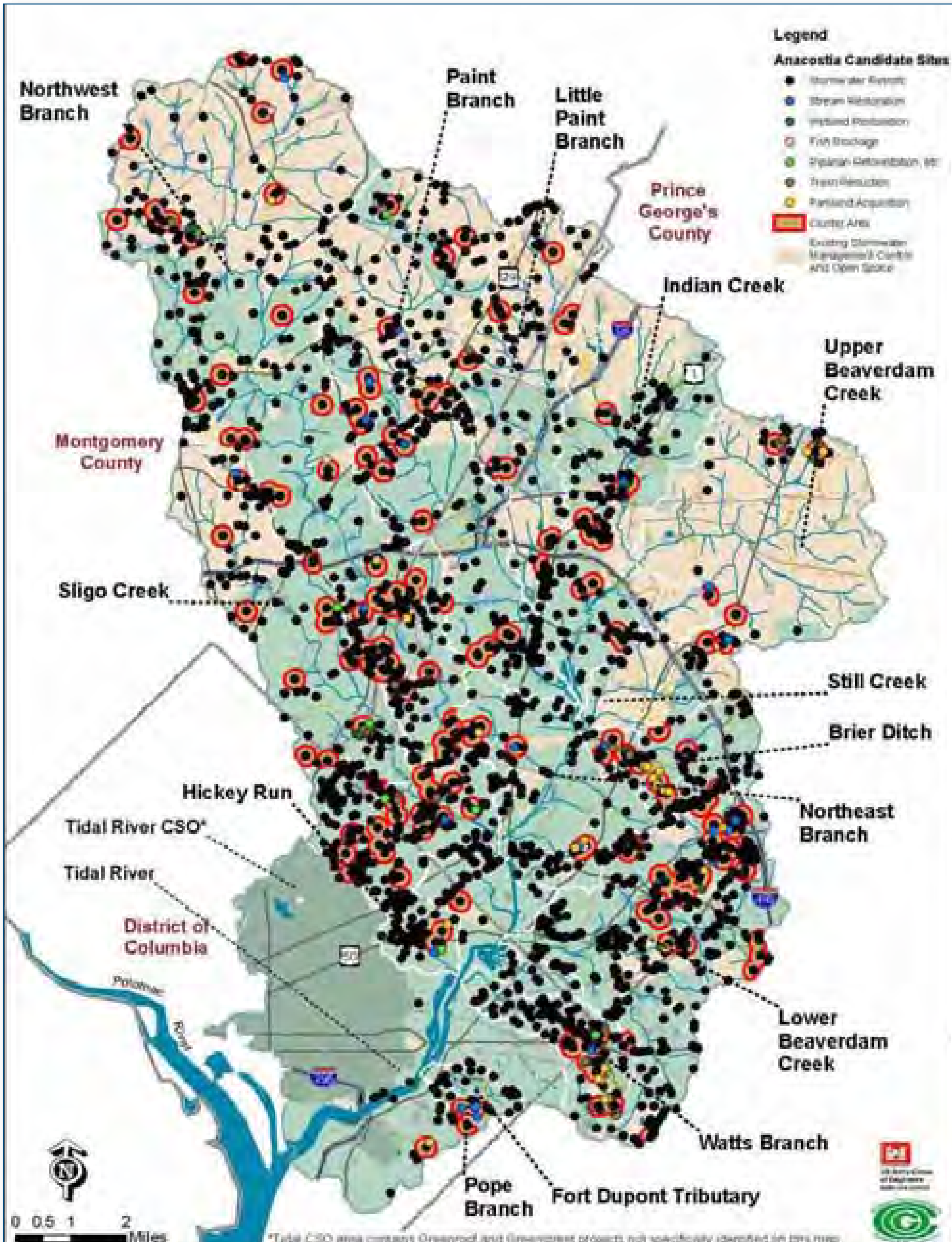


Figure 5-17: Demonstration Restoration Project Areas – Aggressive Restoration Approach

Table 5-10: Summary of Aggressive Restoration Approach of Demonstration Restoration Project Areas								
Candidate Project Type		Number of Projects	Estimated Cost (millions)	Impervious Acreage Controlled (ac)	Length of Stream Restored (mi)	Acreage Restored/ Created/ Acquired (ac)	Length of Stream Opened (mi)	Length of Stream Cleaned or Roads Swept (mi)
1.	Stormwater Retrofit	1,893	$1,252	10,600.3				
2.	Stream Restoration	43	$22.1		7.0			
3.	Wetland Creation/ Restoration	13	$0.8			15		
4.	Fish Blockage Removal/ Modification	14	$2.8				3.2	
5.	Riparian Reforestation, Meadow Creation, Street Tree and Invasive Management	19	$0.2			34		
6.	Trash Reduction	37	$0					16.6
7.	Toxic Remediation	0						
8.	Parkland Acquisition	27	$18.7			187		
	Total	**2,046**	**1,296.8**	**10,600.3**	**7.0**	**236**	**3.2**	**16.6**

As discussed previously, implementing hundreds of restoration projects per year is not a realistic planning initiative due to logistics. The Aggressive Restoration Approach is unlikely to be implemented within a 10-year timeframe. Although significant progress has been made to date, the benefits associated with the continued restoration effort likely will not be realized at the watershed scale for decades, which is why the focus on smaller-scale demonstration restoration projects areas is necessary.

For the benefit of the entire watershed, the implementation of demonstration restoration project areas could be completed by identifying the highest ranking demonstration restoration project areas within the highest ranking subwatersheds. The structure of the ARP allows for restoration to occur within a specific subwatershed. Other government agencies like the department of transportation could implement mitigation opportunities by selecting candidate restoration projects presented in the corresponding SWAP. Finally, the two main systems, the Northeast and Northwest Branches, should be considered for the implementation effort as the majority of the drainage area is included within these two primary systems.

Although the tidal river reach subwatershed was identified as the highest ranking subwatershed based on pollutant loadings calculated as part of the ARP evaluation, percent imperviousness, and percent of stormwater management controls, demonstration restoration project areas were not necessarily identified in high numbers within the subwatershed. This is due to the difference in the subwatershed evaluation as discussed previously. Green roofs, tree canopy projects, and Green Alleys are restoration opportunities identified within the Tidal River Reach Subwatershed Provisional Restoration Project Inventory, and should be evaluated further to reduce pollutant loadings.

Funding and Implementation Sources

Federal, state, and local government agencies participate in ecological restoration or mitigation actions including ecosystem restoration and stormwater retrofits. Agencies with restoration programs within the Anacostia River watershed include but are not limited to the following: USACE, EPA, NOAA, Maryland State Highway Administration, MWCOG, WSSC, DCWASA, DDOT, DDOE, Montgomery County DEP, Montgomery County Department of Transportation, Prince George's County DER, and Prince George's County Department of Transportation. The ARP will complement various government agencies that have separate restoration initiatives driving restorative actions, such as TMDL and MS4 implementation plans at the local jurisdiction level to mitigation restoration actions by transportation agencies. In addition, as a large, urban contributor of non-point source pollution to the Potomac River and ultimately the Chesapeake Bay, restoration actions within the Anacostia River watershed would assist in the achievement of the Chesapeake Bay TMDL. Table 5-11 presents the Federal, state, local, and non-governmental entities that could participate in the Anacostia River watershed restoration effort.

Table 5-11: Participation of Federal, State, Local, and Non-Governmental Entities in the Restoration Effort

Entity			Strengths	Funding Source	Funding Consistency	Comments
Federal Agencies	Technical and Regulatory Role	EPA	Regulatory role for stormwater management; Section 319 Grant administrator to District of Columbia	Subject to Federal Budget	Subject to Federal Budget	Limited Section 319 funds
		USACE	Ecosystem restoration construction			Best utilized for large projects and not small site-specific LID projects
		DOI (USGS, USFWS)	Technical support to Federal and State agencies			
	Federal Land Owners	U.S. Navy	Federal land and property owners have the ability to incorporate best management practices			Large Federal land ownership in the Anacostia River watershed
		USDA				
		DOT				
		NASA				
		GSA				
		DOI (NPS)				
		VA				
State Agencies	Technical and Regulatory Role	DNR	Technical support, grants (2010 Chesapeake Bay Trust Fund), plant a tree program	Subject to State budget	Subject to State budget	
		MDE	Permits, grants (2010 Trust Fund, Section 319 administrator for Maryland counties)			
		MSHA	Impervious surfaces, transportation enhancement program, environmental mitigation	Subject to State budget and Federal funding opportunities	Subject to State budget and Federal funding opportunities	
Local Agencies	Utilities	WSSC	Water, sewer infrastructure in Maryland	Utility fees	Continuous and predictable	Operation and Maintenance is a high priority
		WASA	Sewer, CSOs			
	Government	Counties	LID projects, zoning	Limited local funds, Federal partnering (cost-sharing)	Limited local funds	
		District of Columbia	LID projects, zoning			
		M-NCPPC	Zoning, parkland acquisition			
Private		Community Subwatershed Groups	Provide input to government agencies, garner political support, stewardship projects like trash clean-up events, vernal pool creation, rain barrels and rain gardens, education and outreach	Grant opportunities, donations, membership fees	Limited funding opportunities	Dependant on volunteers
		NGOs (AWS)				
		Businesses and Developers		At cost		Generally adverse to increased taxes and fees
		Local Residents		At cost		

Stormwater management is not a mission currently delegated to USACE; therefore, the majority of candidate restoration projects identified as part of the ARP will not be implemented by USACE. Stormwater retrofit projects would be implemented under the direction of EPA or state and local agencies, and must adhere to current state and local regulations pertaining to stormwater management practices and other non-point source pollutant reduction requirements like a TMDL. However, as part of cost-sharing feasibility studies, non-Federal sponsors to USACE studies potentially could contribute funds or in-kind services to design and construct stormwater management projects. Furthermore, opportunities to partner with USACE for cost-shared ecosystem restoration studies, including stream restoration, wetland creation, and fish blockage removal are available through several different authorities, such as General Investigations, Construction General funding, Continuing Authorities Program, and the Section 510 Program. In order to identify opportunities for further USACE participation in the restoration of the Anacostia River watershed, each candidate restoration project was individually attributed with the likely implementation phase: design/build, feasibility, programmatic, or stewardship. All stormwater retrofit projects were attributed as a design/build implementation phase, though some site-specific opportunities may require a feasibility study upon further investigation. Programmatic projects include street sweeping opportunities as well as parkland acquisition opportunities, and stewardship projects include those projects which could be completed by volunteer groups, non-profit organizations, or community watershed groups. Table 5-12 presents the candidate restoration projects by implementation phase, along with associated cost estimates.

Table 5-12: Candidate Restoration Projects by Implementation Phase

	District of Columbia		Montgomery County		Prince George's County		Total	
	Number	Estimated Cost* (millions)	Number	Estimated Cost* (millions)	Number	Estimated Cost* (millions)	Number	Estimated Cost* (millions)
Design/Build	289	152	546	277	1,092	826	1,927	1,255
Feasibility	38	15	219	73	297	129	554	217
Programmatic	24	1	55	112	222	138	301	251
Stewardship	22	1	77	4	137	1	236	6
Total	**373**	**169**	**897**	**466**	**1,748**	**1,094**	**3,018**	**1,729**

*Costs do not include Green Roof, Tree Canopy, or Green Alley Costs

Discussion of AWRP's Funding Strategy

An imposing amount of funding will be required in order to complete the restoration of the entire Anacostia River watershed. Not all estimated restoration costs could be captured as part of the ARP, but based on various unit costs and other restoration initiative estimated costs, it may take approximately $3-4 billion dollars to implement and complete the restoration effort, including the completion of the LTCP and other restoration activities and projects discussed but not necessarily captured in the ARP. Therefore, developing a funding strategy to secure additional and consistent funds necessary to complete subsequent feasibility studies, engineering and design, and construction is imperative to the success of the restoration effort. When considering funding requirements for implementation of restoration opportunities, additional funding and resources would be required for operation and maintenance of the additional restoration projects. It is important to consider in order for BMPs to operate as intended and reduce pollutants to the maximum extent possible.

The existing grant opportunities made available by Federal and state agencies are one source of funding, but continuous sources of funds must be pursued. A gap exists between existing funding opportunities and the funding required to demonstrate an increase from the current restoration effort. In addition to Federal funds available through USACE and other Federal and state revolving monies and bonds, opportunities for continuous funding sources include the following: utility fees, bag/bottle bills, user fees, redevelopment fees, and imperviousness/healthy watershed fees. It must be reiterated, however, that the complete restoration of the Anacostia River watershed cannot be completed by government agencies alone. Private landowners, private businesses, and community watershed groups must encourage, endorse, and voluntarily contribute to the awareness of watershed stressors in order to change the current paradigm and social behaviors. Without this change in paradigm, the bridge to the Anacostia of the future will never be completed.

Candidate stormwater projects constitute the vast majority of the estimated cost of implementing the ARP—nearly 75-percent of the cost or $1.25 billion. The ARP identified important candidate stormwater projects including some that are not on county or District of Columbia property. They include projects on private property, school system property, state property including colleges and universities, Federal buildings, facilities and parks, Federal highways, M-NCPPC and municipal park facilities and property, and state roads and highways. Montgomery and Prince George's Counties and the District of Columbia should evaluate whether it is possible to work with the entities responsible for these facilities to control stormwater at their expense. Several of these entities have their own MS4 permits, such as the MSHA and the University of Maryland. Federal facilities will be subject to Energy Independence and Security Act of 2007 requirements when they are redeveloped. The Montgomery County School Board has recently come under the Montgomery County MS4 permit and the M-NCPPC Montgomery County Parks will soon have its own MS4 permit.

Even with increased fees, plus any small amounts of general revenue that they may be able to devote to the restoration during these difficult economic times, supplemented by whatever Federal and state grants they will be able to get (and these are not a continuous and reliable source of funding), the local jurisdictions will not have enough resources. They will work to implement the ARP but they will not be able to implement the ARP in 10 years. A new source of funding is needed and the AWRP should work to research and develop this new source. In addition, the AWRP needs to do all that it can to influence BayStat, the State of Maryland's program to measure and evaluate efforts to restore the Chesapeake Bay, to designate the Anacostia River watershed as a 'high' priority watershed for future funding considerations.

By scaling up the restoration effort within Anacostia River watershed, there would be opportunity for the creation of additional employment opportunities to manage, design, and construct restoration projects. The movement towards the greening of urban areas and implementation of ESD brings with it the creation of green jobs. According to published data relating to the American Recovery and Reinvestment Act of 2009 available online at recovery.org, approximately 640,000 jobs were saved or created as part of the $159 billion expended as part of the economic stimulus effort. This equates to one job saved or created to approximately $250,000 expended (Recovery.org, 2010). Relating to the ARP, by implementing all of the Design/Build and Feasibility Phase candidate projects, the number of jobs saved or created would be approximately 5,600; however, the funding invested to implement the ARP would be completed on a long-term planning horizon and not within a 10-year timeframe.

Additional discussion on the AWRP's funding strategy to identify processes to secure additional and consistent funding sources to study, design, and construct candidate restoration projects is included as an attachment in the Plan Formulation Appendix.

Monitoring

The measure of success for restoration activities is achieved through monitoring activities and studies. There are three primary types of monitoring: physical, chemical, and biological. Monitoring studies are capable of assessing the stream flow, water quality conditions, the health status of aquatic and terrestrial communities, as well as the identification of pollution sources. In addition, upon

implementation of restoration projects, existing conditions monitoring data could be compared to with-project conditions to measure the effectiveness of the restoration effort. As part of the AWRP I&T Program, data collection and monitoring activities are conducted relating to 12 key indicators relating to physical, chemical, biological, and bacteriological conditions. This information is reported to show progress toward achieving the AWRP's six restoration goals.

As part of EPA's administration of the CWA Section 319 grant program that provides funding to local jurisdictions for the implementation of restoration projects to address non-point source pollution, watershed plans must include nine minimum elements of which monitoring is included. It is envisioned that components of the ARP and SWAPs could be considered for implementation as part of Section 319 grant opportunities, where progress toward reducing pollutant loadings could be achieved and measured through required monitoring activities.

Finally, as part of the each jurisdiction's NPDES MS4 permit administered by EPA within the District of Columbia and MDE in Montgomery and Prince George's Counties, progress toward controlling impervious surfaces would be reported to the regulating agencies. Furthermore, as part of Montgomery County's NPDES MS4 permit, and likely within Prince George's County and the District of Columbia, reporting on progress toward achieving pollutant reduction goals is required.

Education and Watershed Awareness

Watershed awareness is the starting point to educate the public on the problems affecting the Anacostia River watershed. Part of the mission statement of the FOSC community watershed organization is to bring neighbors together to build awareness (FOSC, 2008). The need to change the public's behavior and improve general awareness begins with education and outreach, particularly in high-density residential and commercial land use areas of the Anacostia River watershed. Education and outreach is necessary to inform the public of behavioral characteristics that are degenerative to the watershed and ultimately create a general awareness for the protection of the watershed and its ecological and aquatic resources. For example, if residents properly dispose of trash and littering ordinances are strictly enforced environmental and ecological conditions will improve as well as achieving various commitments made by state and local agencies to the visual appearance of the watershed relating to trash. The public must be informed that litter, which is not removed by either another resident or street sweeper, ultimately washes into a tributary to one of the 14 primary subwatersheds with stormwater runoff. The same principle applies to pet waste, grass clippings, and leaves and debris. Finally, of the approximately 118,523 single-family homes, among other residential homes, those homeowners who apply fertilizers to their lawns, which are high in nutrients including nitrogen and phosphorous, could reduce the application, use low-nutrient formulas, or stop applying altogether.

Public schools, libraries, and local park buildings, provide opportunities to inform the public of restoration concepts and demonstrate small-scale restoration projects, including downspout disconnections, rain barrels, and rain gardens. Education of the proper maintenance requirements associated with rain barrels and rain gardens would be required. In addition, grade school curriculums may have potential to promote watershed awareness as well as to educate the citizens residing within the watershed that their actions have implications on the overall ecological health of the Anacostia River watershed. The public education system presents an opportunity to educate youth to develop an understanding as to how one's action affects a watershed and its aquatic and ecological resources, and to develop the watershed awareness that is required for the restoration and protection of the watershed for future generations. In addition, implementation of rain gardens, rain barrels, and downspout disconnects on school properties would be beneficial in terms of providing an example of effective restoration opportunities, which could translate to retrofitting the student's home with a rain barrel or rain garden. Revising curriculum would require changes from the respective boards of education for the three jurisdictions. For example, a watershed stewardship course would not only increase watershed awareness, but may also provide incentive for students to participate in existing environmental science curriculums. Developing the knowledge of restoration and what is required to sustain a watershed in an urban setting would contribute to the success of the 10-year restoration effort outlined in the ARP.

Other educational opportunities exist as various restoration projects are implemented, including signage and

outreach opportunities. In addition, implementation of demonstration restoration projects provides an ideal opportunity for education, especially if signs are installed to describe the process and necessity of the restoration project.

Private businesses could provide opportunities to support general awareness for the protection of the watershed by promoting initiatives that support the use of reusable bags and reduce the use of plastic bottles. Large-scale home improvement businesses could also provide discounts towards planting trees, the construction of rain gardens, or installation and use of rain barrels.

Restoration Incentive Programs

As previously discussed in Chapter 3, various combinations of rain gardens, rain barrels, and downspout disconnections on private property potentially could result in measurable reductions in N, P, and TSS. As an educational and incentive program, the three local jurisdictions promote programs to control stormwater runoff from impervious surfaces on private property.

District of Columbia - RiverSmart Homes

The DDOE promotes the RiverSmart Homes Program. In an effort to reduce bacteria, nutrients, and pollutants from entering streams with stormwater runoff, the RiverSmart Homes Program offers incentives to homeowners interested in installing landscape enhancements, including trees, rain gardens, rain barrels, and permeable pavers (District of Columbia, 2008). More information is available at the following web site: http://ddoe.dc.gov/ddoe/cwp/view,a,1209,q,497794.asp.

Montgomery County

Montgomery County - RainScapes Rewards Rebate Program

The Montgomery County DEP promotes the RainScapes Rewards Rebate Program that offers rebates to residential, private institutional, and commercial property owners who install any specific or combination of on-lot practices to reduce stormwater runoff. The practices include rain barrels, rain gardens, conservation landscaping, tree planting, permeable pavers, and green roofs. For planting projects, at least 75-percent must be native species (Montgomery County, 2008). More information on the RainScapes Rewards Rebate Program is available at the following website: http://www.montgomerycountymd.gov/Content/DEP/Rainscapes/home.html.

Leaves for Neighborhoods Program

The Montgomery County Planning Department has initiated a tree planting program where a $25 rebate is given when a citizen purchases a native tree $75 or greater at a participating nursery. The practice is aimed at increasing the neighborhood tree cover in Montgomery County. The program is funded through the Montgomery County Forest Conservation Fund. For more information see: http://www.montgomeryplanning.org/events/leaves/

Prince George's County - GreenStreets

The GreenStreets Program is implemented by the Prince George's County DER to mitigate water pollution from stormwater runoff. Trash abatement techniques as well as LID structural techniques are employed to improve water quality (Prince George's County, 2007). Examples of projects implemented as part of the GreenStreets Program include the following: trash traps to collect floatable pollutants, bioretention, rain gardens, and filter swales.

The Maryland DNR

The Maryland DNR offers various incentive programs for interested homeowners, particularly related to the restoration of the Chesapeake Bay. One such program is the Tree-Mendous Maryland Program where the Maryland DNR allows participants to buy native trees and shrubs for $25. Additional information on the various programs offered by the Maryland DNR is available at the following website: http://www.dnr.state.md.us/bay/services/brief.html.

Conclusions

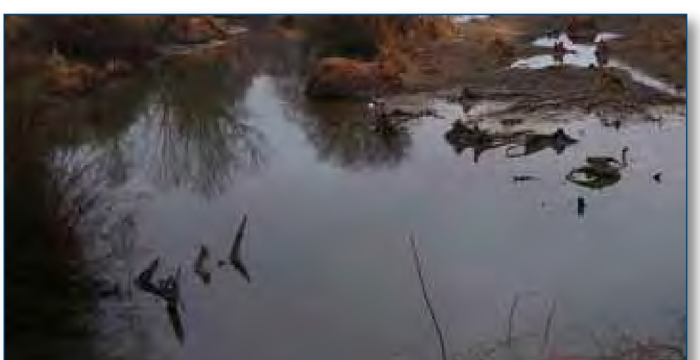
Similar to many urban watersheds throughout the United States, and especially in older urban centers along the eastern portion of the country, the Anacostia River watershed experiences stressors from uncontrolled stormwater runoff, land use changes, CSOs, and legacy and contemporary sources of chemical contaminants. The restoration of the watershed will be very challenging and require incredible funding, resources, and commitment from our political leaders. Considering the fact that the watershed has been developed and degraded over the course of hundreds of years and particularly within the last century, restoration will not occur overnight or even within 10 years, but rather over the course of decades. To actually restore the Anacostia River watershed and achieve the AWRP's six restoration goals, restorative actions such as the LTCP, WSSC's Consent Decree, stormwater management retrofits, stream restoration, and trash reduction must occur concurrent with protection measures and regulatory requirements.

In order to reduce pollutant loadings and improve water quality within the watershed and its tributaries, as well as the larger Potomac River and ultimately the Chesapeake Bay, impervious surfaces must be controlled. However, without habitat like healthy streams, riparian and upland forest, and wetlands, the ecological integrity would not improve. Riparian stream corridors provide connectivity between the extensive parkland and stream valleys, and are effectively used as wildlife corridors. Furthermore, forest cover and increased canopy captures precipitation before the water has an opportunity to runoff into the stream network. Healthy streams, ones that are not experiencing significant erosion or that have their substrate washed away after every storm event, provide habitat for aquatic life, including benthic macroinvertebrates, resident and migratory fish, and amphibians. Finally, wetlands provide habitat for a variety of flora and fauna, and act to store floodwaters during high flow events in those areas where wetlands and floodplains, which is nature's way to reduce sediment and nutrient loads, are connected to the stream channel.

The best approach to restoration actions of the Anacostia River watershed is to concentrate efforts in smaller geographic areas. Without concurrent restoration actions to improve both water quality and habitat, potential cumulative benefits would not be realized. By clustering restoration actions around candidate stormwater retrofit projects, including stream restoration, wetland creation, riparian and upland reforestation, and trash reduction, the potential exists to maximize water quality, ecological, and biological improvements.

Restoration actions would not be logical without actions to protect the watershed from future stressors. Future stressors associated from large-scale land use changes and transportation projects, as well as redevelopment projects, will generate additional impervious surface and pollutant loadings. Although areas likely to be redeveloped were identified and included in the Subwatershed Provisional Restoration Project Inventories, policy changes should be considered to prevent future pollutant sources from entering the system.

Finally, as mentioned previously, the Anacostia River and its tributaries drain portions of the District of Columbia and its suburbs, flowing through the heart of our Nation's capitol. After hundreds of years of development, the once productive Anacostia River ecosystem and aquatic resource is now impaired, and must be addressed. As a focal point of the Nation's government, either in the forefront entering downtown via East Capitol Street, or in the background of the Capitol Building, looking east along Pennsylvania Avenue, the Anacostia River is always within view. It is, therefore, in the Federal interest to lead the restoration effort, to restore and protect this jewel, for the benefit of the present as well as future generations of Americans.



Policy and Programs Recommendations by AWRP Steering Committee

One of the primary USACE missions is ecosystem restoration where projects like stream restoration are studied, designed, and constructed to address an existing environmental problem. Stakeholders as part of the AWRP, including EPA, the State of Maryland, the District of Columbia, Montgomery County, and Prince George's County among others have additional roles and responsibilities that allow them to adopt policies and programs that address not only existing problems, but also future stressors. It is widely understood that restoration efforts need to extend past construction projects and that it will be necessary to bring all of the available resources and authorities of the AWRP to bear in order to restore and protect the watershed from further degradation.

Two factors make protection from further degradation important. In the future, at least two major conditions will further stress the watershed, unless the members of the AWRP work to mitigate these impacts. First, the Washington National Capitol Region is poised for growth. MWCOG predicts that the region's population will increase by approximately 32-percent by 2030, reaching nearly 6.6 million. This will add nearly 1.6 million people to the region, which is only slightly less than the amount of people added during the previous 30-year period. These people will need transportation, housing, and places to work and recreate, adding additional development pressure. This development will harm the watershed even more if not managed carefully.

Second, experts now agree that some future climate change is inevitable, regardless of current efforts to reduce greenhouse gasses. Climate change will have an impact on the watershed, most likely causing more frequent heavy rainstorms, and will potentially increase the effects of "urban heat island"—the tendency of urban and suburban areas to get hot enough to harm human health. Adaptation is an essential strategy for reducing the severity and cost of climate change impacts. The green infrastructure solutions proposed in the ARP could be important means of adapting.

Green infrastructure can be seen as not only a way to mitigate future problems but as a means to improve communities and people's lives as well. In addition to cleaner water, green infrastructure could:

- Use trees and vegetation to filter the air increasing air quality, reduce urban heat island effect and improve public health.
- Provide shade and insulation through the use of trees and green roofs, reducing energy use, and over the long term, saving money.
- Improve the aesthetics of urban and suburban communities, increasing property values.
- Create jobs.
- Reduce the cost of infrastructure repair and cleanup associated with flooding.

The AWRP believes that adopting and implementing the right policies and programs can advance restoration and prevent additional pollution and ecological damage. Also, policies and programs can help create the institutional foundation for implementing future restoration opportunities. Therefore, it is important to include them in the ARP. Regulations and incentive programs can shift people's behavior and the ways they do business. Incentive programs can spur businesses and citizens to use rain barrels, install green roofs, disconnect downspouts, replace impervious parking areas with pervious surfaces, and plant and maintain trees and rain gardens. Regulations can deter such problems as building that does not adequately control stormwater, littering, poor housekeeping at industrial sites, and illegal dumping.

With 70-percent of the watershed developed, much of the watershed is ripe for redevelopment. Development and redevelopment policies provide an opportunity for the application of environmental regulations to both public and private lands, can systematically prevent further harm to the watershed, and in the case

of redevelopment, can facilitate the correction of existing problems. Regulatory policies help insure that the businesses profiting from an activity also help prevent unnecessary impacts of their activities.

While USACE has regulatory authorities and programs which are relevant to protecting and restoring the watershed, especially the navigable portions of the watershed and its remaining wetlands, the AWRP, especially the EPA, the State of Maryland, the District of Columbia, and Montgomery and Prince George's Counties, have additional wide-ranging programs and authorities, which also directly impact what happens on the ground.

Based on the conceptual planning approach identified in the ARP, restorative actions such as those described in the eight restoration strategies including stormwater management retrofits, stream restoration, and wetland creation are necessary to restore and protect the Anacostia River watershed. However, restoration actions alone may not meet water quality standards even after applying an aggressive stormwater retrofit approach. As the watershed continues to develop in the northern portions of the watershed, and redevelopment occurs in the lower portions, a change in policy and programs may achieve systematic restoration by potentially increasing pollution loading reductions, or by decreasing the pollution loading rates.

In addition to existing policies and programs currently in place in the Anacostia River watershed as discussed previously in the Restoration Progress section, Table 5-13 presents a list of policies and programs adopted in other parts of the United States to address watershed stressors and problems, which potentially could be implemented within the Anacostia River watershed.

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Innovative Regulatory Approach		
Requirement that Stormwater Requirements be Met with Green Features Seattle, WA	The Green Factor is a landscape requirement designed to increase the quantity and quality of planted areas in Seattle while allowing flexibility for developers and designers to meet development standards. It currently applies to new development in commercial and neighborhood commercial zones outside of downtown, and is proposed for multifamily residential zones and the South Downtown planning area. Permit applicants in affected zones must demonstrate that their projects meet the Green Factor by using the Green Factor Score Sheet. The scoring system is designed to encourage larger plants, permeable paving, green roofs, vegetated walls, preservation of existing trees, and layering of vegetation along streets and other areas visible to the public. Bonuses are provided for food cultivation, native and drought-tolerant plants, and rainwater harvesting. As designers add landscape features, the score sheet automatically calculates a project's Green Factor score, allowing the applicant to easily experiment with different combinations. Green Factor helps maintain and improve livability in growing neighborhoods. In addition to being attractive, green elements in the landscape improve air quality, create habitat for birds and beneficial insects, and mitigate urban heat island effects. They also reduce stormwater runoff, protecting receiving waters and decreasing public infrastructure cost. For more Information: http://www.seattle.gov/dpd/Permits/GreenFactor/Overview/	Benefits: -Ensures that stormwater volume standards applied to new development are met using green features and not just stormwater storage devices such as tanks and cisterns. Challenges: -The Maryland Stormwater Act's requirement of implementation of ESD/LID practices to the furthest extent practical with conventional treatment practices be implemented as a last resort does not necessarily emphasize green features of development.
Developer Incentives for Green Development and Redevelopment		
Expedited Permits for Green Development Chicago, IL	The Chicago Department of Construction and Permits (DCAP) Green Permit Program provides developers and owners with an incentive to build green by streamlining the permit process timeline for projects which are designed to maximize indoor air quality and conserve energy and resources. Projects accepted into the Green Permit Program can receive permits in less than 30 business days or in as little as 15 business days. The number of green building elements included in the project plans and project complexity determines the length of the timeline. For more information: http://www.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/GreenPermitBrochure_1.pdf	Benefits: -May provide a substantial incentive where permitting backlogs are long Challenges: -May not provide much of an incentive if permitting backlogs are not severe.

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Developer Incentives for Green Development and Redevelopment		
Density Bonus for Green Building Arlington, VA	(This program relates to incentivizing LEED construction, but the concept of density bonuses and fees that are refunded could be applied to extraordinary stormwater retrofits.) Arlington County's Green Building Incentive Program, adopted in 1999 and expanded in 2003, allows commercial projects and private developments earning LEED Silver certification to develop sites at a higher density than conventional projects. All site plan applications for commercial projects are required to include LEED Scorecard and have a LEED Accredited Professional on the project team regardless of whether or not the project intends to seek LEED certification. All projects must contribute to a green building fund for county-wide education and outreach activities. The contribution is refunded if projects earn LEED certification. The County offers "front-of-the-line" plan review, site signs, and publicity to program participants who achieve a given number of points as outlined by Arlington's Green Home Choice program. For more information: http://www.co.arlington.va.us/departments/EnvironmentalServices/epo/EnvironmentalServicesEpoIncentiveProgram.aspx	Benefits: -Could provide an incentive that does not involve lost revenues to local jurisdictions (as tax rebate incentives do) or payments by local governments (in the case of incentive payments). Challenges: -Since all developments and redevelopments will be required to achieve better control of stormwater under the Maryland Stormwater Act implementing ordinances and under the District of Columbia's proposed stormwater ordinance, the stormwater controls of those receiving the density bonus would have to be extraordinary -Requires cooperation of planning and zoning authorities in addition to stormwater regulators -Planning and zoning authorities may be so anxious to have infill developments with high densities that they may not be willing to restrict such development to those with extraordinary stormwater controls.
Private Property BMP Retrofit Incentives		
Green Roof Tax Credit New York, NY	Building owners in New York City who install green rooftops receive a significant tax credit. Those who install green roofs on at least 50 percent of available rooftop space can apply for a one-year property tax credit of up to $100,000. The credit would be equal to $4.50 per square-foot of roof area that is planted with vegetation, or approximately 25 percent of the typical costs associated with the materials, labor, installation and design of the green roof. For more information: http://www.nyc.gov/html/dob/html/guides/green_roof_faq.shtml	Benefits: -Encourages a key type of ESD -May encourage green roof retrofits sooner than would occur when property is eventually redeveloped, triggering application of stormwater laws, which has the effect of improving water quality sooner Challenge: -Lost revenue for jurisdiction giving the rebate

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Private Property BMP Retrofit Incentives		
LID Incentives Anne Arundel County, Maryland	Permanent Stormwater Management Practices Tax Credit - $10,000 On January 7, 2008, the Anne Arundel County Council passed Bill 85-07. This legislation provides an opportunity for property owners to apply for a credit to their property taxes if they implement stormwater management techniques that reduce the overall runoff of stormwater on their property. This property tax credit is available to owners of residential or commercial properties in the County. The legislation provides for: 1. A property tax credit up to 10% of the cost of the material and installation of an approved stormwater management practice. The total amount of the credit is limited to $10,000.00 extended over a five-year period. 2. The management practice is not to be used to meet any requirement for stormwater management by state or county law. 3. The acceptable practices are approved by the County's Office of Planning and Zoning, such as: - The removal of 20% of the existing impervious surfaces on the property. These could be done through the use of rain gardens, green roofs, and permeable pavers. - The use of rain barrels. - Any pre-manufactured best management practice that the Maryland Department of the Environment has approved. For more information: http://www.aacounty.org/CountyCouncil/Resources/85-07.pdf	Benefits: -Incentivizes "early adoption" of stormwater controls Challenge: -Lost revenue for jurisdiction giving the rebate
Downspout Disconnection Portland, Oregon	As part of its efforts to reduce combined sewer overflows, the City of Portland shares the cost of downspout disconnection with homeowners in its combined sewer areas. Homeowners can receive a one-time payment of $53 for disconnecting their downspouts or can choose to have the disconnection work completed by approved City contractors. Through the program, the City has disconnected over 50,000 downspouts and has reduced the amount of stormwater that enters the combined sewer system by over 1.2 billion gallons per year. For more information: http://www.portlandonline.com/bes/index.cfm?c=43081	Benefits: -Easy, quick and cheap reduction of stormwater volumes. -Addresses single family homes, which may be slower to "redevelop" and be retrofitted under redevelopment ordinances Challenges: -Funding needed

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Private Property BMP Retrofit Incentives		
Rain Barrel Incentive Programs Various jurisdictions	Philadelphia, PA: Free rain barrels to residents who attend workshops Austin, Texas: Rebates of $30 per barrel are available for rain barrels purchased outside of the city's sales program. Milwaukee, WI: Metropolitan Sewerage District sells rain barrels for $45 each at various locations For more information: http://www.phillywatersheds.org/rainbarrel/ http://www.ci.austin.tx.us/watercon/rbrebates.htm http://v3.mmsd.com/RainBarrels.aspx	Benefits: -Relatively easy, quick and cheap reduction of stormwater volumes. - Addresses single family homes, which may be slower to "redevelop" and be retrofitted under redevelopment ordinances -Incentive programs help landowners to learn about stormwater issues because it can benefit them Challenges: -To be effective, homeowners much be vigilant about using the rain barrels -Funding needed
Rain Garden Reimbursement Program Rock Island, IL	The City of Rock Island, Illinois reimburses citizens who plant rain gardens on their property based on the total square footage of the rain garden at the rate of $4.00 per square foot. If the rain garden owner wants to incorporate the use of a rain barrel into his or her rain garden, the City will supply one free of charge. For more information: http://www.rigov.org/citydepartments/publicworks/raingarden.html	Benefits: - Addresses single family homes, which may be slower to "redevelop" and be retrofitted under redevelopment ordinances - Incentive programs help landowners to learn about stormwater issues because it can benefit them Challenges: -Homeowners will need technical assistance in how to build these -Funding needed

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Stormwater Fees		
Stormwater Utility Fee with Incentives Rockville, MD And Various Others	Adopted in 2008, the City of Rockville has established a stormwater utility fee applied to all developed property owners, including single family, multifamily and non residential developments. The rate is $55.80 per Equivalent Residential Unit (ERU) in the first year with 8% increases annually through 2017. ERU size is 2330 square feet. The fee structure includes rebates for property owners who have modern stormwater controls: Credits exist for properties that have onsite stormwater management facilities that meet current standards: • 25% rebate for Quality • 25% for Quantity • 10% for Recharge Some facilities may qualify for multiple credits For more information: http://www.rockvillemd.gov/residents/swm/ Other jurisdictions with stormwater utility fees with credits for onsite stormwater control: • Portland, OR: Up to 100% discount off on-site fee, or 35% of total stormwater charge. Single-family home discount based on roof runoff management. Commercial, industrial, multi-family home discount based on runoff managed from roof and paved areas. Partial credit for tree planting, ecoroofs and less than 1000 sq ft imperviousness • Philadelphia, PA: 50% discount in stormwater fee for residents and businesses. Credit for decreasing directly connected impervious areas using specified practices (rain gardens, infiltration islands, porous asphalt and sidewalks, vegetated swales, green roofs). • Minneapolis, MN: Up to 50 percent credit (reduction) in stormwater utility fee for management tools/practices that address stormwater quality, 50 percent or 100 percent credit (reduction) in the fee for management tools/practices that address stormwater quantity For more information: http://www.portlandonline.com/bes/index.cfm?c=43444& http://www.phila.gov/water http://www.ci.minneapolis.mn.us/stormwater/fee/index.asp	Benefits: - Addresses single family homes, which may not be regulated under redevelopment ordinances -Incentive programs help landowners to learn about stormwater issues because it can benefit them Challenges: -To be effective, homeowners much be vigilant about using the rain barrels -Funding needed

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Programs and Policies Implementing Road Retrofits Controlling Stormwater		
Natural Drainage System (SEA Street) Retrofits Program Seattle, WA	The City of Seattle has implemented a program to retrofit streets with antiquated or nonexistent stormwater controls. The first of these projects the SEA street narrowed the street pavement, installed rain gardens in the street right of way, and captured the runoff from both the street and the adjacent houses. The flagship project eliminated 98 percent of the wet season runoff, and was designed to attenuate the runoff volume produced by approximately 0.75 inch. With the retrofit of the Highpoint development, a project that covers 34 blocks, Seattle now has 65 blocks of retrofitted streets For more information: http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/index.asp	Benefits: -Addresses roads and streets, a sector that may not be addressed by incentive and regulatory programs -The rain gardens constructed under this program improve aesthetics within communities. -Some of the green streets are narrowed, reducing the amount of impervious surface that must be treated. -Some green streets were designed to manage runoff from the adjacent housing in addition to the street -Citizens with property adjacent to the street's rain gardens have adopted them and maintain them -However, if the citizens were not to maintain them, the green street features are accessible for local government staff to maintain unlike some features like rain gardens on private property Challenges: -Funding needed -Green streets must be designed for the site involved. -Program staff must work with citizens to understand how to maintain the rain gardens and other features -Neighborhood concerns about loss of parking spaces must be addressed.

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Programs and Policies Implementing Road Retrofits Controlling Stormwater		
Portland Green Street Retrofit Program and Policy Portland, OR	Portland has retrofitted over 475 green streets and is planning to construct 920 more over the next five years through a new funding initiative called "Grey to Green." Portland also has a policy that says that all public infrastructure investments must incorporate green streets. Portland believes that these streets cost 40% less than conventional streets. The City of Portland Green Street Policy, adopted by the Portland City Council in April 2007, created a One Percent for Green fund. The Bureau of Environmental Services collects one percent of the construction budget of City of Portland projects within the city right-of-way that are not subject to the requirements of Portland's Stormwater Management Manual. The One Percent for Green fund supports construction of Green Street facilities. For more information: http://www.portlandonline.com/bes/index.cfm?a=192797&c=31094	Benefits: -Addresses roads and streets, a sector that may not be addressed by incentive and regulatory programs -The rain gardens constructed under this program improve aesthetics within communities. -Some green streets were designed to manage runoff from the adjacent housing in addition to the street -Some of the streets are narrowed, reducing the amount of impervious surface that must be managed. -Citizens with property adjacent to the street's rain gardens have adopted them and maintain them. -However, if the citizens were not to maintain them, the green street features are accessible for local government staff to maintain unlike rain gardens and other features on private property. -Portland's program has the additional feature that one percent of public infrastructure investments goes by law to green streets, which provides a dedicated source of funding. Challenges: -Funding needed. -Green streets must be designed for specific sites. -Program staff must work with citizens to understand how to maintain the rain gardens and other features. -Community concerns about loss of parking spaces must be addressed.

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems		
Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Programs and Policies Implementing Road Retrofits Controlling Stormwater		
Green Alley Retrofit Program Chicago IL	Chicago's Green Alley program incorporates a number of approaches to retrofitting alleys including: • Permeable pavements (asphalt, concrete or pavers) that allow stormwater to filter through the pavement and drain into the ground, instead of collecting on hard surfaces or draining into the sewer system. The pavement can be used on the full width of an alley, or simply in a center trench. • Open bottom catch basins--installed in alleys to capture water and funnel it into the ground Other green alley techniques include using proper grading and pitch to facilitate drainage. Green Alleys are part of Chicago DOT's "green infrastructure" -- which includes recycled construction materials, permeable pavement, recycled rubber sidewalks and other efforts. The program began as a pilot in 2006, and through 2008, more than 80 Green Alleys have been installed. For more information: http://egov.cityofchicago.org/	Benefits: - Addresses alleys, a sector which may not be addressed by incentive and regulatory programs -Beautifies areas that can be blighted -Developers who cannot achieve stormwater volume controls on their sites could be required to address adjacent alleys -Alleys can accept more types of pervious pavement than other areas because of lower traffic volumes Challenges: -Funding needed
Trash Reduction		
Beverage Container (Bottle) Deposit Fee Laws 11 states	California, Connecticut, Delaware, Hawaii, Iowa, Massachusetts, Minnesota, Michigan, New York, Oregon and Vermont have "bottle bills." The US Senate Committee on the Environment and Public Works found in 2002 that beverage container litter had been reduced by 69 to 84 in six states that had enacted container deposit fees. For more information: http://www.bottlebill.org/legislation/usa/allstates.htm	Benefit: -Great reduction of bottle litter Challenge: -Extremely difficult to implement from a political perspective.

Table 5-13: List of Policies and Programs Adopted in Other Parts of the U.S. to Address Watershed Stressors and Problems

Type of Policy or Program and Example Jurisdiction Where it Has been Implemented	Description of Program or Policy	Benefits and Challenges
Pet Waste Pick-up Requirements		
New Jersey	The New Jersey Department of Environmental Protection requires some of its MS4s to adopt and enforce an ordinance to ensure that pet owners and keepers (walkers or pet sitters) immediately and properly dispose of their pet's solid waste deposited on any property, public or private, not owned or possessed by that person. This means that someone walking a pet needs to immediately pick up after the pet and properly dispose of the solid waste, except on the property they own. Municipalities must also distribute informational handouts to individuals when they receive a pet license. For more information: http://www.state.nj.us/dep/stormwater/tier_A/pdf/Chapter%206.pdf	Benefit: -Addresses a likely source of bacteria pollution. Challenge: -Difficult to enforce.

For the protection of the Anacostia River watershed, the AWRP understands the commitment required to achieve new or improved policies and programs. The following recommendations for new or improved policies and programs have been reviewed and approved by members of the AWRP's Steering Committee. It should be noted that additional independent assessments and evaluations of policies and programs be completed by corresponding agencies and jurisdictions prior to adoption and implementation of the AWRP's recommendations.

Programmatic and Policy Conclusions

The projects identified by this plan are by themselves, insufficient to achieve full restoration of the Anacostia River and compliance with TMDL requirements. Additional programmatic and policy changes will be required to achieve these objectives. They need to include regulatory changes, incentives to encourage behavior changes, and programmatic funding. Based on the USACE and Partnership's evaluation of current plans and programs, the following conclusions and recommendations are made. The Partnership will work to implement these programmatic and policy recommendations along with the projects identified in the ARP.

1. DC WASA LTCP for CSOS:

As noted above, DC WASA has had good success to date in implementing its Long Term Control Plan and has adopted an impervious surface fee which it will enable it to fund the plan. In certain years, however, rate increase of up to 13-percent would be required to fund the LTCP. DC WASA should continue to implement the plan and to seek federal funding to help DC WASA to offset large fee increases that might cause the plan to be slowed or abandoned. The Partnership will continue to assist DC WASA to communicate the need for implementation of the Plan. The District of Columbia should also continue to seek to supplement the gray infrastructure strategies of the plan with LID approaches that will offload stormwater from the CSO system, reducing CSO storage and treatment costs.

2. WSSC Implementation Plan for SSOs

Since controlling sanitary sewer overflows is key to helping make the watershed swimmable, the WSSC should continue to implement its consent order, working toward eventual elimination of SSOs as a significant source of pollution into the Anacostia River and its tributaries. Partners should continue to work with WSSC to achieve compliance with the consent decree and any other CWA requirements.

3. Stormwater Regulation of Development and Redevelopments:

The watershed's regulatory jurisdictions are beginning a shift from conventional BMPs to ESD and LID. It is clear that control of the volumes of stormwater flowing (and not just the "first flush") are responsible for the "urban stream syndrome" experienced by most streams in the watershed, and each jurisdiction should adopt the highest volume controls using ESD that it believes are achievable. These regulations should require development and redevelopment to retain stormwater on site to the maximum extent practicable and provide for off-site mitigation for stormwater that cannot be infiltrated, evapotranspirated, or re-used on site. The Energy Independence and Security Act of 2009 standards and Montgomery County's proposed stormwater ordinance are two examples of very strong approaches to this issue. In order to adopt these standards, it will be necessary to work with developers and develop further and provide the information necessary to show that the standards are achievable.

Care should be given in the effort to retrofit existing structures, however, that storage facilities, such as tanks and cisterns, aren't the only stormwater approach. The Seattle "Green Factor" approach should be evaluated to see if it has relevance for the Anacostia's jurisdictions, or whether the ordinances' requirement that ESD be implemented to the maximum extent practicable addresses this issue.

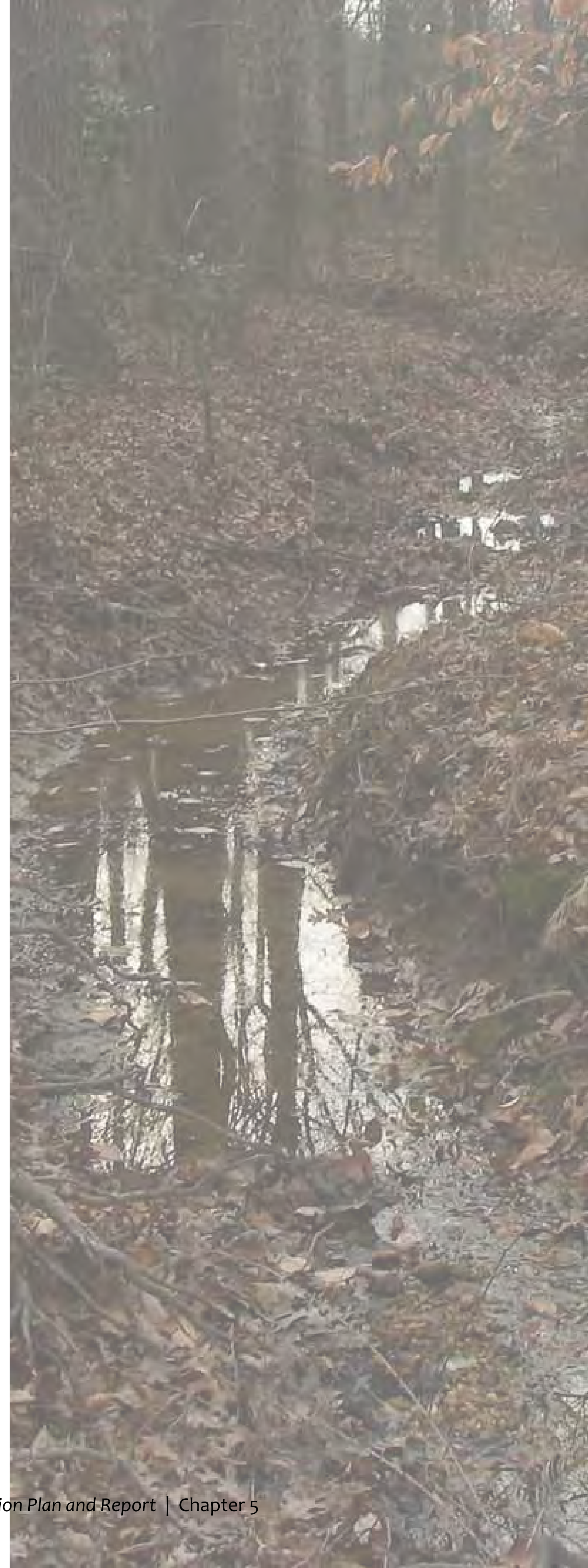
Finally, the District of Columbia has proposed that major rehabilitations trigger the redevelopment requirements of its proposed stormwater ordinance. Montgomery County and Prince George's County should consider this idea as they adopt their regulations.

4. Owner Incentives Addressing Existing Commercial and Multifamily Construction:

Some ESD practices, particularly green roofs, are so expensive that it is unlikely that a great number of existing building owners will retrofit their buildings until they are required to by the redevelopment requirements in the ordinances described above, or until they are given incentives. Incentives reviewed above included: stormwater fee reductions, expedited permitting, density bonuses, and fairly sizeable tax credits. Owner incentives should be adopted by each jurisdiction to help to speed retrofits, especially for buildings not likely to be redeveloped in the near term.

5. Anacostia MS4s

Montgomery County's MS4 permit contains a number of provisions and innovations which will be key to the jurisdiction's advancement in the stormwater arena. Prince George's County has indicated that it will adopt an **MS4** permit at least as strong as the Montgomery County permit.



The following requirements should be included in each of the Anacostia jurisdictions MS4s:

- TMDL implementation plans designed by the MS4 jurisdiction.
- Implementation of these plans once developed.
- Requirements for systematic retrofits of areas without adequate stormwater controls
- Programs to assist homeowners to disconnect downspouts, install rain barrels or cisterns, and build rain gardens
- Evaluation of any county or district code obstacles to the implementation of ESD and work to eliminate these

6. Stormwater Utility Fees and Taxes

Each of the Anacostia watershed's jurisdictions has made progress in implementing stormwater charges to fund stormwater programs. However, these funds are not likely to be sufficient to implement the new requirements of revised MS4s or to implement the other projects and programs recommended by the ARP. Stormwater utility fees have been shown to be good sources of revenue for stormwater control, as well as being a fairer way of funding stormwater needs, as they are based on the amount of impervious surface at a given development. Additionally, they can be designed to provide credits to property owners who implement good stormwater practices including but not limited to reducing impervious surfaces. Each local jurisdiction should have utility fees sufficient to fund the implementation of the ARP in their jurisdiction, MS4 and other stormwater programs and should include incentives for retrofits.

7. Programs for Systematically Retrofitting Streets and Alleys

The District of Columbia and Montgomery County have made progress in the area of retrofitting streets. Prince George's County has made substantial progress in this arena. However, none of these jurisdictions has an established program for systematically retrofitting streets and alleys (it has typically been a practice that is implemented when the jurisdictions can obtain grant or other ad hoc funds) and none has a portion of its transportation funds reserved for retrofits, as Portland does. The ARP has identified many projects that will address stormwater flows from streets and parking lots, but the means to systematically implement these projects may be lacking until the Departments of Transportation or Public Works consider it their responsibility to either implement retrofits as they reconstruct roads and streets, or to at least assist the environmental departments to do so. EPA has indicated that it will soon issue a "green streets" manual which may be useful in institutionalizing this approach. Establishing green street programs and dedicated funding should be a goal of the Partnership.

8. Better Housekeeping at Industrial Parks and other Locations which are Likely to Introduce Chemical Contaminants into the Watershed

Prince George's County has recently adopted an approach by which it issues citations to industrial facilities that do not practice good housekeeping measures, an approach that should be considered by both Montgomery County and the District of Columbia.

9. Ban on the Sale and Use of Coal Tar Sealants and Other Hazardous Products

The intentional and unnecessary application of hazardous chemicals on parking lots, where they are likely to washed into the Anacostia's streams and rivers should be halted. The District of Columbia has halted the sale and use of coal tar sealants. The Partnership should ask the Maryland legislature to do so as well, or Montgomery and Prince George's Counties should explore bans similar to the District's. All three jurisdictions should take action to reduce the use of other chemicals used on roadways, parking lots, or lawns that

are toxic to wildlife and for which less toxic substitutes are available. Citizens have also raised public health concerns about artificial turf recreational fields. The Partnership should track the scientific scholarship on this material, and if it is found to be harmful to human health, work to discontinue their use.

10. Fees on Disposable Shopping Bags

The District of Columbia has imposed a fee on the use of disposable shopping bags and it is reported that in less than two months the fee has reduced bag use by 50-percent. The Partnership should support ongoing efforts in the state of Maryland to implement plastic bag fees, and Montgomery and Prince George's Counties should consider their own fees if statewide legislation is not passed.

11. Litter Law and Pet Cleanup Enforcement

Each jurisdiction should not only prohibit littering and require cleanup of pet waste, but should also facilitate compliance by providing abundant trash cans with tight fitting lids, small plastic bags for pet waste, and vigorous enforcement. The Partnership should consider working with local police departments to educate officers on the importance of the enforcement of these laws.

12. Trees and Stream Buffers

All three jurisdictions should invest in enhancing tree canopy through expanding street tree boxes, refilling empty boxes, taking care of existing street trees, requiring large trees to be protected, prohibiting unnecessary tree removal for development, and requiring trees lost to development to be mitigated through planting and/or preservation.

Land acquisition along streambanks should be a priority for all three jurisdictions, and building should not be allowed in the 100-year floodplain, within 100 feet of streams or delineated wetlands, or in existing stream buffers.

13. Climate Change Adaptation Planning

The green infrastructure solutions that will mitigate stormwater impacts will also mitigate "urban heat island effect" and other impacts of climate change. As local jurisdictions gear up to implement improved stormwater controls, they should also undertake planning for adaptation to climate change, as some climate change adaptations are likely to be similar to the stormwater improvements.

14. EPA's Nonpoint Source Implementation Grant Program

The EPA's administers a Nonpoint Source Implementation Grant Program known as the Section 319 program. In Maryland, this funding is passed through to counties and other applicants through MDE. The District of Columbia receives this money directly. The 319 program is the most important Federal source of funding for stormwater projects. Current requirements state that recipients must have a watershed plan that shows how the plan will achieve water quality standards. This means that applicants in extremely polluted watersheds are unlikely to receive grants. Even with the ARP, which will make vast improvements in water quality, it will be very difficult for the Anacostia's local jurisdictions to easily produce plans that can be proven to achieve water quality standards in the near future. The EPA should review this policy in relationship to much polluted waters like the Anacostia.

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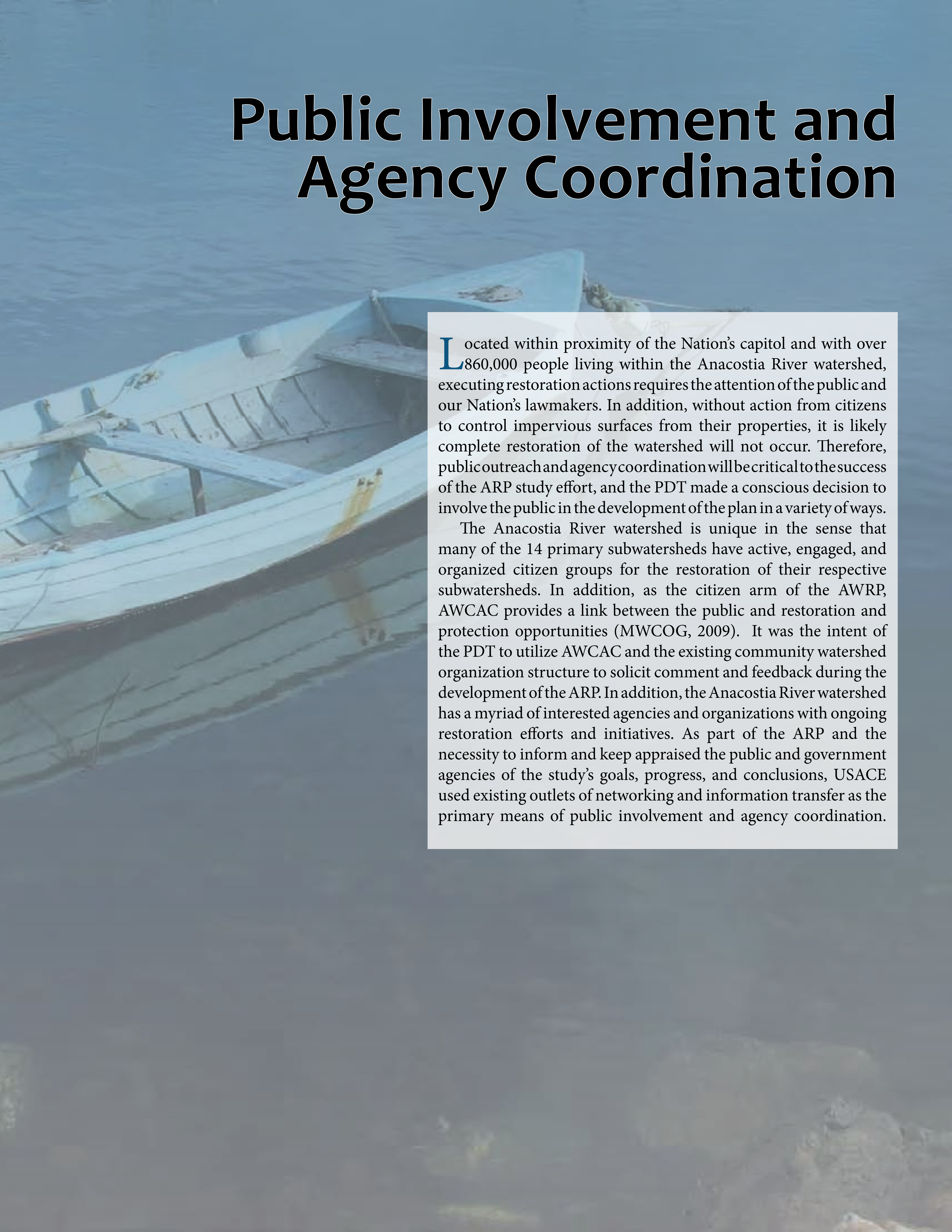


Public Involvement and Agency Coordination

Located within proximity of the Nation's capitol and with over 860,000 people living within the Anacostia River watershed, executing restoration actions requires the attention of the public and our Nation's lawmakers. In addition, without action from citizens to control impervious surfaces from their properties, it is likely complete restoration of the watershed will not occur. Therefore, public outreach and agency coordination will be critical to the success of the ARP study effort, and the PDT made a conscious decision to involve the public in the development of the plan in a variety of ways.

The Anacostia River watershed is unique in the sense that many of the 14 primary subwatersheds have active, engaged, and organized citizen groups for the restoration of their respective subwatersheds. In addition, as the citizen arm of the AWRP, AWCAC provides a link between the public and restoration and protection opportunities (MWCOG, 2009). It was the intent of the PDT to utilize AWCAC and the existing community watershed organization structure to solicit comment and feedback during the development of the ARP. In addition, the Anacostia River watershed has a myriad of interested agencies and organizations with ongoing restoration efforts and initiatives. As part of the ARP and the necessity to inform and keep appraised the public and government agencies of the study's goals, progress, and conclusions, USACE used existing outlets of networking and information transfer as the primary means of public involvement and agency coordination.

Public Involvement

Public involvement during the development of ARP included public meetings, coordination meetings and discussions with representatives of AWCAC and community watershed groups, and submissions of fact sheets on the progress and status of the study made available on the internet. In addition, an open public comment period occurred following the release of the Interim Report Framework in November 2008. Comments received during the comment period resulted in changes to the presentation of information for the final report.

The PDT presented information on the study objectives, methods, and products during a public meeting held on May 13, 2008 at the M-NCPPC Montgomery County office in Silver Spring, Maryland. Prior to the formal presentation of the objectives, existing conditions, and study methods of the ARP, citizens were invited to discuss restoration strategies with representatives of their respective jurisdiction, and were informed of current restoration incentive programs. The presentation was followed by an open question and answer session. Those citizens in attendance were encouraged to participate and ask specific questions about the study, as well as to complete a comment form for additional feedback. Specific comments made during the discussion period included a suggestion that the ARP should tie into the MS4 and TMDL regulatory requirements, whether the USACE ARP will be a decision document, and how implementation of the ARP would occur. Memorandums summarizing the question and answer period as well as the results of the public surveys are included in the Plan Formulation Appendix.

Additional working meetings were held with representatives from FOSC, an active, non-profit community watershed organization devoted to the restoration of the Sligo Creek subwatershed, and AWS on July 10, 2008, and August 14, 2008. Those in attendance were briefed on the progress of the study, the work completed to produce the Sligo Creek Subwatershed Provisional Restoration Project Inventory, and were requested to provide feedback as to the priority and general support of provisional restoration projects included in the inventory in terms of none, low, medium, and high. In addition, the PDT requested information for any projects not included in the initial inventory that should be investigated further, and received information on two additional provisional stormwater management retrofit projects to add to the inventory.

The Interim Report Framework, which included the Sligo Creek Subwatershed Environmental Baseline Conditions and Restoration Report, SWAP, and Provisional Restoration Project Inventory, was released to the public for review and comment on November 21, 2008. The reports were made available online at Anacostia.net and the public comment

period was open for 45 days. Upon completion of the public comment period, representatives from AWS, FOSC, and the Audubon Naturalist Society of the Central Atlantic States, Inc. (ANS) submitted comments to USACE for consideration. AWS comments included a suggestion to focus on one small sub-basin of the Sligo Creek subwatershed with infiltration practices to restore the flow regime, ideally to predevelopment conditions, in order to restore adequate base flow. AWS also included a suggestion to retrofit the Wheaton Stormwater Management Ponds to address low levels of DO by creating a bypass for base flow or retrofit the ponds into a wetland system. FOSC provided a comment that reports were used to help guide thoughts on stream restoration, but reiterated FOSC's strong preference for LID projects over stream restoration projects. Also, FOSC indicated in comments that their organization is particularly interested in Rainscapes projects that target homeowners in the Breewood and Raydale Road sub-basins. Representatives from ANS conducted a thorough review of submitted Interim Report Framework and detailed comments to USACE for consideration. The comments included a suggestion to adequately diagnose root problems, such as forest loss, sprawl, and stormwater flows, identify cures to those problems, and prevent future problems from occurring. In addition, comments included a discussion of the need to incorporate fully the MS4 and TMDL regulatory requirements as well as the need for stronger stormwater regulations. A memorandum summarizing comments and responses to ANS is included in the Plan Formulation Appendix.

On July 22, 2009, the PDT held a meeting with representatives from various subwatershed groups including, Neighbors of Northwest Branch, citizens from Still Creek, and Lower Beaverdam Creek. This meeting served to introduce those representatives to the ARP and to request their participation in providing feedback on the provisional restoration project inventories, similar to FOSC in July of 2008. A public workshop for representatives of the community watershed groups to discuss the subwatershed provisional restoration project inventories with the PDT was held on September 19, 2009. The workshop consisted of three sessions and representatives from the Brier Ditch, Lower Beaverdam Creek, Northeast Branch, Northwest Branch, and Still Creek subwatersheds, along with representatives from AWCAC and AWS.

As part of the completion of the ARP, the draft final Subwatershed Provisional Restoration Project Inventories, Environmental Baseline Conditions and Restoration Reports, and SWAPs were made available online at www.anacostia.net for review and comment, specifically soliciting comment and feedback from representatives of community subwatershed groups and other interested organizations.

The comment period began November 30, 2009, and extended through January 29, 2010. Several representatives affiliated with various community subwatershed groups, AWS, and AWCAC reviewed the material and submitted comments. A summarization of general comments received on each subwatershed for which comments were submitted is presented in the subsequent sections of this report, and specific comments in regards to additional restoration opportunities identified by individuals are presented as amendments to the corresponding Subwatershed Provisional Restoration Project Inventory.

Overall, the representatives from watershed groups submitting comments were pleased with the comprehensive effort that was undertaken, and voiced strong support to giving top priority to projects aimed at controlling stormwater runoff.

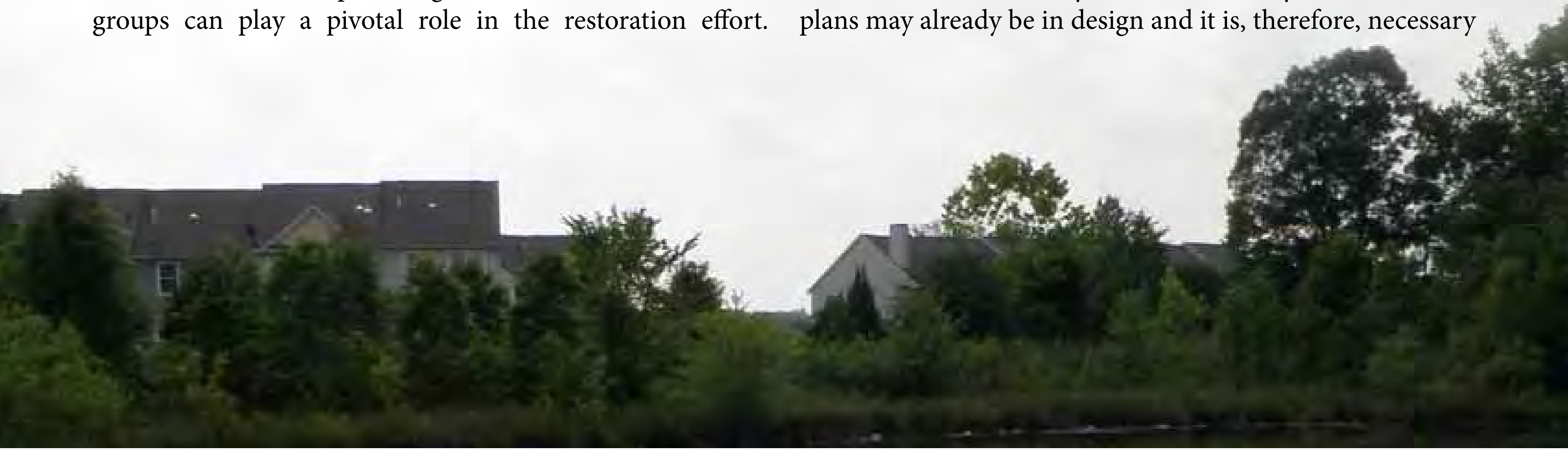
Multiple groups requested that the ARP stress the importance of Maryland Stormwater Management Act of 2007 and similar regulations. And, although the estimated pollutant reductions from enacting all proposed stormwater projects was viewed as discouraging, they were also viewed as highlighting the need for strong stormwater regulations on both new construction and redevelopment. The AWS suggested that all redevelopment should infiltrate Channel Protection Volume (2.7" precipitation in Prince George's County, 2.6" in Montgomery County) or harvest precipitation volume for reuse to flush toilets and to water plants and lawns. Additionally, it was pointed out that private residential properties are a key portion of the watershed not completely addressed by the ARP or current regulations and that this is an area where non-profit organizations and subwatershed groups can play a pivotal role in the restoration effort.

AWS made specific stormwater BMP recommendations. When targeting a reduction in stormwater runoff volume, the following BMPs were identified by AWS as not being effective methods for volume reduction: box filter, rain barrel, sand filter, and storm filter. Therefore, they suggest that the lowest rating should be given to projects incorporating these BMPs in order to use financial resources effectively to restore the Anacostia watershed. Alternatively, they advised that more focus be weighed on stormwater retrofits such as green roofs, rain gardens or bioretention, and other means of stormwater runoff volume reduction with the recognition that such stormwater retrofit cannot be implemented throughout the subwatershed at one time considering costs and site restrictions. Finally, AWS suggested retrofitting stormwater management ponds into wetlands where possible.

Further, AWS requested that bioretention cells receiving runoff from parking lots or streets have a liner at the bottom underground to prevent winter road salt from contaminating ground water. They recognize that this may reduce the capacity of stormwater runoff volume reduction, but believe it will prevent groundwater pollution by salt, nutrients, and potentially heavy metals. Additionally, because rooftop runoff is free of similar contaminants, AWS supports giving higher ratings to stormwater infiltration from rooftops compared to that from parking lots and roads.

Neighbors of Northwest Branch suggested limiting private improvements for stormwater retrofits to modest costs, possibly less than $100,000 per acre. Public areas could handle a higher cost limit. In either case, the most cost-effective projects should be implemented, but not at the sacrifice of existing natural forms (e.g. NW-U-01-S-112 [Map ID 1105] and NW-U-01-S-113 [Map ID 1096, 1097, 1098]).

Questions were raised by Neighbors of Northwest Branch regarding how to communicate and share responsibility for implantation of various stormwater projects. Recognizing that many of the stormwater projects are focused on upgrades to stormwater facilities at schools and are recommended to be included in modernization plans, the question of how to apprise school and county officials of these recommendations was asked. Further, they noted that many modernization plans may already be in design and it is, therefore, necessary



to expedite communication of these projects. This group also specifically inquired as to whether any of the stormwater or stream restoration projects in the upper portion of the Northwest Branch Provisional Restoration Project Inventory would be funded by MSHA as part of its pledged Inter-County Connector mitigation. They stated that such an indication would be useful, if indeed any are part of required mitigation.

Neighbors of Northwest Branch also expressed another reality resulting from ever-changing watershed conditions. The General Macroinvertebrate Community Health, Figure 9 (data 2007), as presented in the Northwest Branch Subwatershed Environmental Baseline Conditions and Restoration Report shows only two as in “good” condition for the Northwest Branch. A small portion in the northwest corner of the watershed is rated “fair,” while all the rest is “poor.” One of the two “good” areas is currently being vivisected by construction of the Inter-County Connector making these baseline conditions already out of date. The group identified projects that would be impacted by Inter-County Connector construction.

Various practices were identified as good volunteer opportunities including tree planting and invasive species removal. Neighbors of Northwest Branch also stated that they were glad to see the proposal to ‘plant endemic trees and shrubs to create adequate riparian area’ incorporated into invasive species removal projects. Without this activity, they recognized that the areas would be left bare and become quickly overgrown with invasives. It was also suggested that volunteers could possibly help remove log jams that were causing fish blockages to help keep costs down.

Finally, Neighbors of Northwest Branch expressed the idea that the cost estimate of $459,675,000 to accomplish all the projects in the Northwest Branch inventory is dwarfed by what this region is willing to spend to build new highways and appears a worthwhile price to pay for the improvements envisioned.

Friends of Still Creek communicated the importance of the uppermost portion of Upper Still Creek, which, they noted, is not depicted on any maps. They reported that this stream segment is critical to the runoff issues of Still Creek. Flooding problems in the Still Creek subwatershed begin at this point from the massive amount of impervious surface from the Greenway Center Mall and adjacent office park, and from the outflow of the two BMP detention ponds on the other side of Hanover Parkway. Further, as the stream flows through the residential area south of Interstate 95, it picks up more runoff, which completely drains to the stream. Addressing flow and the management of stormwater runoff from this section of Still Creek is probably the most important objective for restoring the health of Still Creek.

Wetland restoration was supported as a way to achieve great benefits at lower costs than retrofits or other types of restoration. Restoration of tidal wetlands was given particular focus by AWS. Their recommendations focused on non-migratory goose management by NPS and *Phragmites australis* control, as well as minimizing costs by using current mudflat elevations to restore Spatterdock marshes. They did, also, recognize the need for more mid- and high-marsh constructed wetlands. AWS identified that a great deal more wetland work is needed and specifically mentioned that the ARP was lacking in identified opportunities above Anacostia Park. They suggested that this should be rectified by an intensive look for additional sites upstream of the CSX railroad bridge, the three mile stretch between the CSX Bridge and the Bladensburg Waterfront Park. They proposed that a guiding vision for tidal wetland restoration should be a spatially-interconnected series of constructed wetlands up and down the tidal river.

Parkland acquisition was recognized as being much needed if the funds are available. The priority rating demonstrates how important it is to simply exclude land from development. Neighbors of Northwest Branch suggested that if such parkland is acquired, its use must be restricted to what is termed “passive recreation,” that is, no permanent structures, parking lots, synthetic turf or even grass ball fields. These parks should be clearly designated conservation parks.

Within Paint Branch subwatershed, AWCAC recommended giving highest priority to the projects on the Paint Branch’s Good Hope Tributary, which is located in the Paint Branch SPA, in an effort to save this valuable resource.

With respect to stream restoration, more than one group commented that bank restoration should not be undertaken until stormwater controls are in place. Neighbors of Northwest Branch cautioned that small equipment should be used to ensure that construction impacts do not outweigh project benefits.

Nearly all the named trash reduction sites are roads, with the recommendation that they be swept more frequently. However, Neighbors of Northwest Branch identified that a reduction of street sweeping was one of the Montgomery County Executive’s budget savings for FY 10.

Agency Coordination

The preliminary reconnaissance phase started in 2004 and ended in 2005. The feasibility phase began in 2006, with a modification of the Feasibility Cost Sharing Agreement with MWCOG in 2007. MWCOG also has similar cost-sharing agreements with all the stakeholders involved in the ARP.

The PDT, including representatives of USACE, MWCOG, the three jurisdictions, Maryland DNR, MDE, M-NCPPC, EPA, AWRP, and AWCAC, typically held monthly meetings at MWCOG in the District of Columbia. During these routinely scheduled monthly meetings, the PDT members discussed ongoing activities related to the ARP study, including problems, needs and opportunities, potential restoration strategies, and USACE study procedures.

As part of discussions involving modeling methods used, USACE and the PDT held coordination meetings and had discussions with both ICPRB and CWP. USACE held conference calls with ICPRB and MDE to discuss various components to the HSPF model used to develop the N, P, and TSS TMDLs, and held a coordination meeting with CWP on October 30, 2007. In addition, on January 3, 2008, both the ICPRB and CWP presented information to the PDT on various components to the HSPF model and WTM, respectively.

A coordination meeting with representatives from WSSC and their consultants Black & Veatch was held on February 23, 2009 to discuss the WSSC's Consent Decree with EPA to reduce SSOs, and how the Consent Decree initiative relates to the ARP. The meeting consisted of discussions on the Consent Decree requirements, work completed, and how this effort relates to the ARP.

During a regularly scheduled PDT meeting on June 15, 2009, representatives from the EPA presented information on the Handbook for Developing Watershed Plans to Restore and Protect Our Waters, including discussion on the nine minimum requirements of a watershed plan (EPA, 2009). USACE also coordinated with AWTA, EPA, and MDE to obtain information on chemical contaminants and monitoring studies within the Anacostia River watershed.

In a letter dated May 26, 2009 responding to a coordination letter dated April 24, 2009, the USFWS stated that there are no Federally proposed or listed endangered or threatened species known to exist in the Anacostia River watershed.

AWRP

The AWRP represents numerous agencies and entities with extensive knowledge of the Anacostia watershed, and representatives of AWRP provided considerable support to develop the ARP within a short, two-year period.

Various committees including the following: the Leadership Council with representatives from Federal agencies and heads of all regional jurisdictions within the watershed, Steering Committee, Management Committee, and AWCAC comprise the AWRP governance structure. In addition to the committees, various workgroups are associated with the AWRP, such as the Anacostia Restoration Potential Workgroup, AWTA, and Trash Reduction Workgroup. Some members of the ARP PDT also represent their respective jurisdiction or agency within the various workgroups and committees of the AWRP governance structure.

Representatives of the AWRP Leadership Council include the Mayor of the District of Columbia, County Executives from Montgomery and Prince George's Counties, the Governor of Maryland, Commander and District Engineer, USACE, Baltimore District, and EPA Region 3 Administrator. On September 17, 2008, representatives of the Leadership Council convened for a boat tour of the Anacostia River and press conference to discuss the need for restoration in the Anacostia River watershed. The AWRP Management and Steering Committees include representatives from various Federal, state, and local agencies as well as private industry representatives, non-profit organizations, and AWCAC.

The AWRP Management and Steering Committees, along with AWRP Workgroups, meet quarterly and bimonthly, to discuss restoration of the watershed, which included regular briefings as to the progress of the ARP. Special presentations to the Steering Committee by USACE staff occurred April 3, 2008, December 4, 2008, and September 24, 2009.

Additional information on AWRP and AWCAC is available online at http://www.anacostia.net/.

Congressional Outreach And Other Activities

Ongoing interest and support of the representatives of Congress occurred throughout the development of the ARP. Several representatives of the PDT, including the Executive Director of the AWRP, were asked to brief members of the Congressional delegation on the progress of ARP, particularly after the release of the Interim Report Framework in November 2008. Furthermore, the commander, USACE, Baltimore District, attended annual Anacostia River clean-up events. Due to the importance of restoration activities, the EPA Administrator appointed a Special Assistant to the Chesapeake Bay and Anacostia River.

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