

Tidal River Subwatershed Action Plan

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Section 1

Vision and Existing Conditions

The Tidal River Subwatershed Action Plan (SWAP) is intended to be an integrated summary document for the Tidal River Subwatershed Environmental Baseline Conditions Report and the Tidal River Subwatershed Provisional Restoration Projects Inventory. Based on a planning level analysis and evaluations, various activities or actions have been identified as part of a 10-year comprehensive restoration plan for the Anacostia River watershed. In addition, the layout of the report is intended to follow as closely as possible the EPA nine key elements to develop a watershed plan to improve water quality impairments, and are the minimal requirements to be eligible to receive incremental Clean Water Act Section 319 funding (EPA, 2008).

Need and Purpose

The Anacostia River watershed lies in a heavily populated urban landscape substantially altered from natural conditions. Urbanization causes many environmental changes. Among these, impervious surfaces cause excessive runoff, 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. The increase in impervious areas has disrupted the natural hydrologic cycle and ultimately affected the environmental health of the Anacostia River and its tributaries.

While urbanization and impervious surfaces are the primary stressors for the overall Anacostia River watershed, there is regional variation throughout the watershed and as such, the extent and source of the environmental stressors as well as potential restoration actions will be evaluated on a subwatershed basis. As part of the Anacostia Restoration Plan (ARP) study, each of the 14 primary subwatersheds and the Tidal Anacostia River reach were evaluated in order to determine problems and opportunities at the subwatershed scale for environmental or ecological restoration, and present this information in such a way that would be beneficial to several different audiences. In addition, for each of the 14 primary subwatersheds and the Tidal Anacostia River reach, a SWAP, an environmental baseline conditions report, and a subwatershed provisional restoration project inventory was generated.

The purpose of the Tidal River SWAP is to provide a vision statement and targets for restoration within the subwatershed by the year 2020, identify and describe specific problems within the subwatershed, discuss methodologies used to evaluate potential restoration opportunities, and present a prioritized list of restoration opportunities for implementation.

The identification of restoration opportunities and potential projects were based on the following selected strategies:

1. Stormwater Management Retrofits
2. Stream Restoration
3. Wetland Creation and Restoration
4. Fish Blockage Removal/Modification
5. Riparian Reforestation, Meadow Creation, Street Tree, and Invasive Species Management
6. Trash Reduction
7. Toxic Remediation
8. Parkland Acquisition

Building upon the preceding eight restoration strategies, the following 2020 restoration objectives align with and expand upon the existing Anacostia River watershed restoration goals and requirements established by the Anacostia Watershed Restoration Partnership (AWRP):

1. **Stormwater Management:** Implement stormwater retrofits or Best Management Practices (BMPs) to reduce pollutant loading and increase flow regime stability. Increase use of homeowner BMPs throughout the subwatershed.
2. **Wetland Creation and Restoration:** Increase wetland habitat throughout the subwatershed.
3. **Riparian Corridors:** Increase the health of riparian corridors so as to both improve wildlife habitat connectivity and reduce the number of invasive plant problem sites. Also, increase overall tree canopy coverage throughout the subwatershed.
4. **Aquatic Community:** Increase the health of the aquatic community; specifically increase the number of resident fish species and providing for a healthier macroinvertebrate community food base. Restore migratory fish usage of Tidal River.
5. **Trash Reduction:** Dramatically reduce trash loads in Tidal River.
6. **Outreach:** Increase participation of residents, businesses, and school-age children in activities that are beneficial to the watershed.
7. **Parkland Acquisition:** Increase parkland and habitat connectivity

10-Year Vision

The Tidal River subwatershed vision is to create, by the year 2020, a more environmentally healthy and sustainable watershed by dramatically reducing stormwater runoff volumes, stream channel erosion problems, trash levels and pollutant loadings; protecting and restoring aquatic and terrestrial habitats and associated biological communities; enhancing watershed recreational opportunities; and fully engaging both public and private sectors through expanded environmental education and incentive-based initiatives. The preceding objectives are a continuation of and expansion on the AWRP's existing Anacostia River watershed goals, leading to the achievement of realistic and attainable restoration targets within the next decade.

Tidal River 2020 Restoration Targets

The Tidal River 2020 Restoration Targets were determined based on the potential implementation of restoration opportunities identified within the Tidal River subwatershed as part of the ARP, along with realistic expectations of what could be accomplished in ten years to meet the 2020 restoration objectives. These targets are established to ensure that restoration of the subwatershed is proceeding in the right direction and at a continuous, reasonable pace. The analysis presented in this SWAP will help to establish specific target levels of restoration for the subwatershed. Quantitative targets established such as stormwater management, aquatic community, trash reduction, wetland creation/restoration, riparian corridor restoration, and land acquisition, will be based on the potential restoration project inventory and recommend acreages or mileages to be restored, whereas the qualitative targets including environmental programs and public outreach will recommend programmatic actions that will serve to increase public awareness and interest in the restoring the Anacostia watershed. The 2020 Restoration Targets are presented in Section 4 of this SWAP.

Existing Conditions in the Tidal River Subwatershed

The Tidal River subwatershed is located in the southwestern Anacostia Watershed, and is defined as all of the lower Anacostia watershed area downriver of the Northwest Branch/Northeast Branch confluence, excluding Lower Beaverdam Creek, Fort Dupont Tributary, Pope Branch and Hickey Run (Figure 1-2). The Tidal River subwatershed is 24.3 square miles in area and includes the lower 8.4 miles of the Anacostia River upstream of its confluence with the Potomac River. The subwatershed also actually includes the tidal and nontidal reaches of a number of small tributaries. The subwatershed lies in the Coastal Plain physiographic province, with its northwestern border lying at about the boundary with the Piedmont within Washington, D.C. Tidal range in the river is about 3 feet and the river is fresh. Freshwater tidal waters and their habitats are of limited extent in the Chesapeake Bay, and therefore of regional ecological importance. Flows are sluggish within the tidal waters.

The Tidal River subwatershed is densely populated, serving as home to about 195,000 people. Dense residential development (such as apartment houses) comprises approximately 41-percent of the total land area in the subwatershed. Commercial, industrial, and transportation land uses occupy 17% of the subwatershed. In spite of the subwatershed's location in and adjacent to Washington, D.C., highly developed condition, and substantial human population, it includes substantial open space park and institutional lands and remains 11-percent forested. Mapped wetlands occupy 859 acres; 139 acres of these are restored. Small stands of submerged aquatic vegetation occur within the Tidal River.

The Washington, D.C., sewer system combines wastewater with stormwater runoff. During high flow events, approximately 60-percent of the Anacostia watershed within the District of Columbia drains directly to the tidal Anacostia River via a combined sanitary and storm sewer system dating back to the late 1800's. There are 11 major combined sewer outfalls to the Anacostia River and all discharge in the vicinity of the East Capitol Street and South Capitol Street bridges. Manmade impervious surfaces such as roads and rooftops make up about 40-percent of the subwatershed. Table 1-1 and Figure 1-1 present a summary of the impervious

surfaces within the subwatershed. Figure 1-3 illustrates the road network within the subwatershed. The main stem of the Anacostia downstream of the Northeast and Northwest Branches confluence is largely channelized.

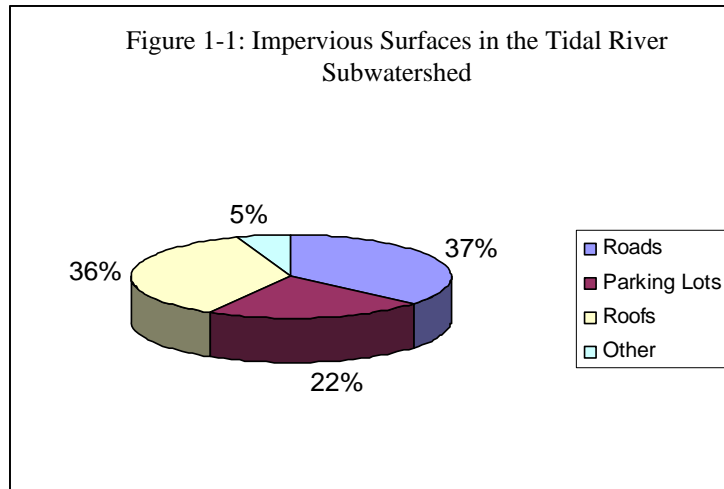


Table 1-1: Impervious Surfaces in the Tidal River Subwatershed and Existing Level of Stormwater Control		
	Miles	Acres
Roads	404	2,244.5
State/Federal	55	512.4
Local	349	1,732.1
Parking Lots		1,403.0
Public/Institutional		607.1
Private		795.9
Roofs		2,253.1
Public/Institutional		301.2
Private		1,680.4
Single Family		271.5
Other		338.1
Sidewalks		169.4
Single Family Driveways		168.7
Total Impervious Acres		6,239
Total Subwatershed Acres		15,552
Avg. % Imperviousness		40%
Current Impervious Acreage Controlled*		0*
Current-percent Impervious Acreage Controlled *		0%*
Number of existing Best Management Practices (BMPs)		205
* Current Impervious Acreage Controlled and Current-percent Impervious Acreage Controlled data was not available at the time this report was prepared and assumed 0 for this analysis		

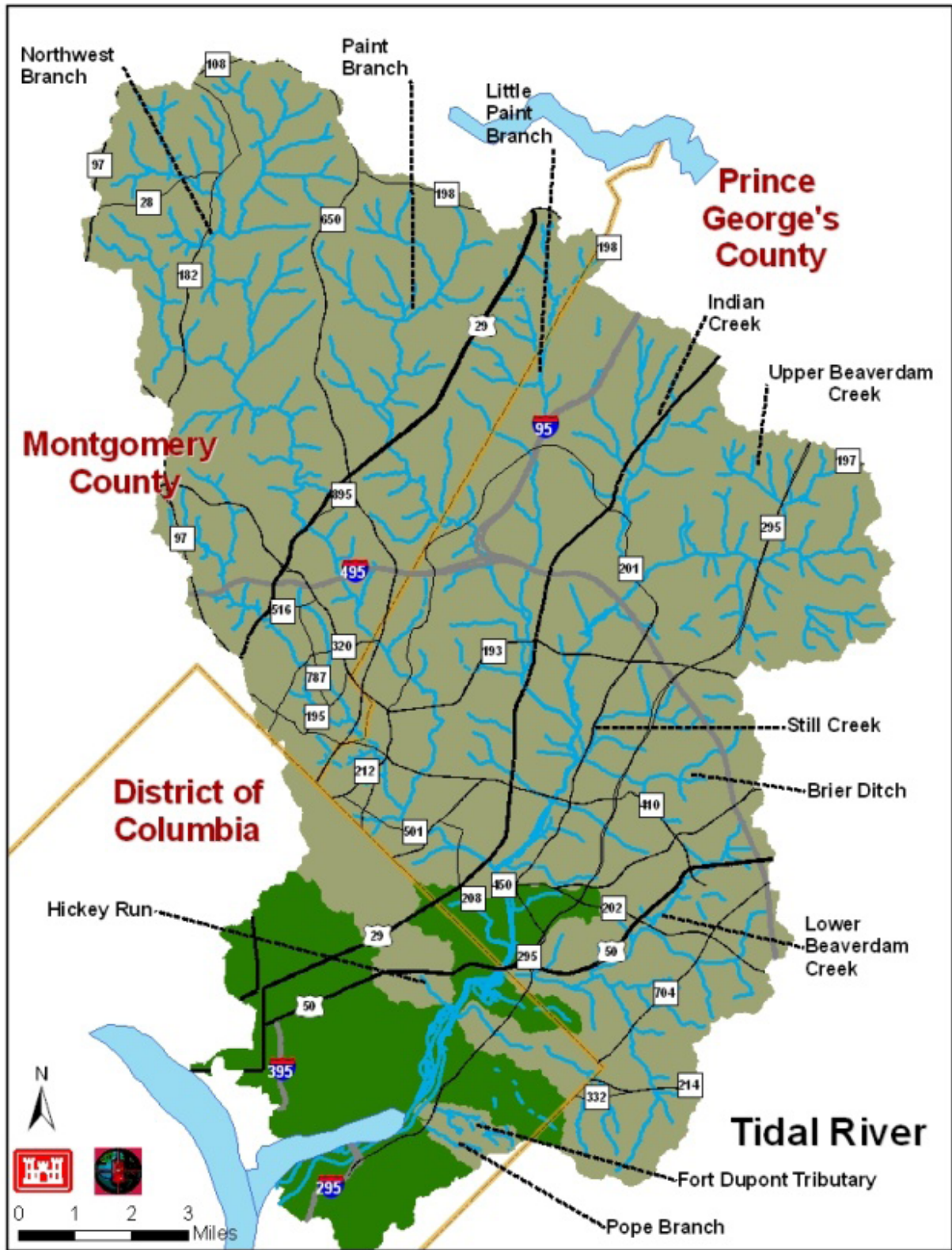


Figure 1-2: Tidal River Subwatershed

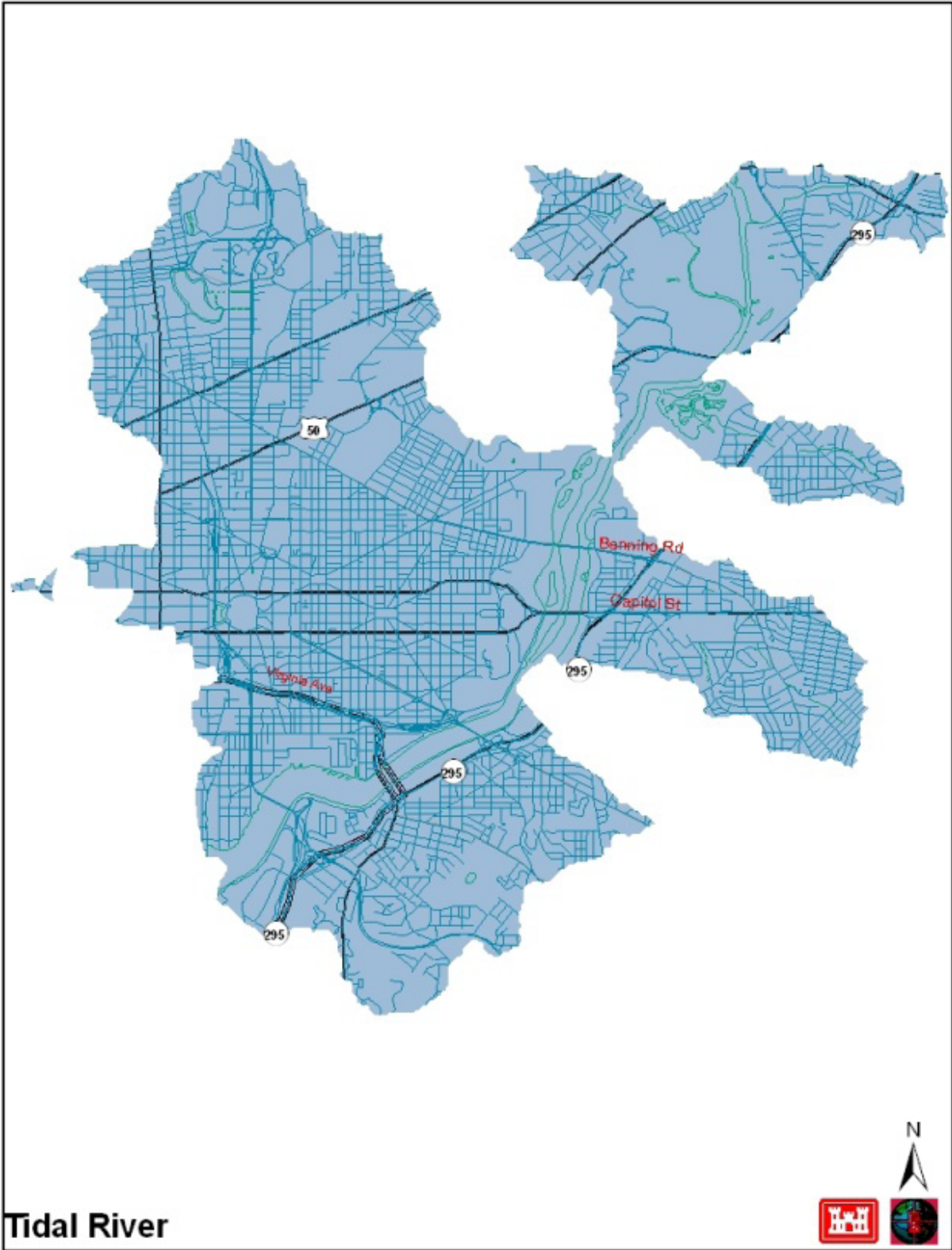


Figure 1-3: Tidal River Subwatershed Road Network

Problems Facing the Tidal River Subwatershed

Changes to Hydrology

The development of the Tidal Anacostia River subwatershed (and entire Anacostia Watershed) has altered the hydrology and flow regime, and is a major cause for other problems facing the subwatershed. The change in land cover from forest or agriculture to impervious surfaces (such as roofs, roads, and parking lots) has set up a dynamic in which stormwater runoff increases and infiltration of precipitation into soils decreases. An increase in stormwater runoff increases peak discharge that provides energy necessary to erode stream banks as well as discharging pollutants from overland sources into receiving streams. At the time of this analysis there was no available data as to which specific reaches within the Tidal Anacostia River subwatershed experience moderate or severe stream channel erosion.

Poor Aquatic Habitats

Historic river dredging, wetland reclamation (filling), stream channelization, and flood-control works within the Tidal River subwatershed caused massive destruction and degradation of aquatic habitats. More than 90% of the Anacostia River watershed's historic tidal wetlands, which occurred predominantly within the Tidal River subwatershed, were destroyed. Massive destruction of nontidal wetlands also occurred. Approximately 15.5 miles of streams historically present in the subwatershed have been altered by channelization or piped underground. Channelization simplified stream habitats and reduced connection of the stream system to its floodplain and groundwater. Uncontrolled stormwater runoff causes excess erosion and sedimentation; minimal stormwater management features are present since urbanization largely preceded modern watershed practices.

As a consequence of these impacts, the macroinvertebrate and finfish assemblages in the nontidal stream segments within the Tidal River subwatershed are severely impaired from historic conditions or not present at all. In contrast, aquatic ecosystem health of the tidal portions of the subwatershed is better because of mitigating influences of tidal waters; 50 species of resident and migratory finfish are present there. Small runs of migratory river herring pass through the Tidal River subwatershed and spawn in the Anacostia River watershed.

Poor Water Quality

The tidal Anacostia River suffers from poor water quality. Due to intense development with a high-percentage of impervious surfaces, which are often directly connected to the river and its tributaries via piped storm drainage systems, the delivery of stormwater runoff volumes is high. Consequently, it receives large amounts of pollutants including sediment, toxics, excess nutrients, and trash and debris. In addition, with almost every significant rainfall event combined sewer overflows discharge a mix of untreated sewage and stormwater runoff directly into the river. Leaky sanitary sewer infrastructure also contributes pollutants on a chronic basis. Legacy pollutants, such as from historic industrial activities at the Washington Navy Yard, remain in the river and the subwatershed. These factors combine to cause chronically low dissolved oxygen levels that frequently violate water quality standards and threaten aquatic life, and high bacterial levels which make water contact activities such as swimming and wading, unsafe. Due to chronically high contaminant levels (Chlordane and mercury) in fish tissues,

consumption advisories are in effect for both the Maryland and District of Columbia portions of the river.

River bottom sediments are contaminated with toxic metals, persistent manmade organic chemicals (polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs)), and pesticides from stormwater runoff, atmospheric deposition and industrial and municipal discharges. The Anacostia watershed is designated as one of three 'Region of Concern' areas for toxic contamination by the U.S. Environmental Protection Agency's Chesapeake Bay Program. Figures 1-4 and 1-5 illustrate the locations of the Resource Conservation and Recovery Act (RCRA) sites and National Pollutant Discharge Elimination System (NPDES) sites in the Anacostia River watershed.

Nutrient levels in the tidal river are excessive, promoting algal growth and occurrence of disease-causing organisms, and consequently reducing water dissolved oxygen levels. These nutrients derive from loads delivered from sewage and stormwater within the watershed as described above, as well as other Anacostia River watershed sources upstream of the Tidal River subwatershed, including leaky sanitary infrastructure, septic systems, animal waste, and fertilizers. The tidal and nontidal streams in the subwatershed exhibit bacterial loads exceeding water quality standards. Bacteria in the tidal river derive from principally from combined sewage overflows. Leaky sanitary sewers, domestic animal waste, and wildlife waste also contribute.

Watershed erosion and consequent excess sediment deposition within the tidal Anacostia has been notable since the end of the 18th century. High sediment loads historically derived from farming and forestry practices. Interestingly, these sediment loads created vast areas of tidal wetlands that did not previously exist. Substantial acreage was destroyed to construct Washington, D.C., and during river channelization work. More recently, excess sediment derives from construction and stream channel erosion. The Tidal River is estimated to trap 85% of the sediment it receives.

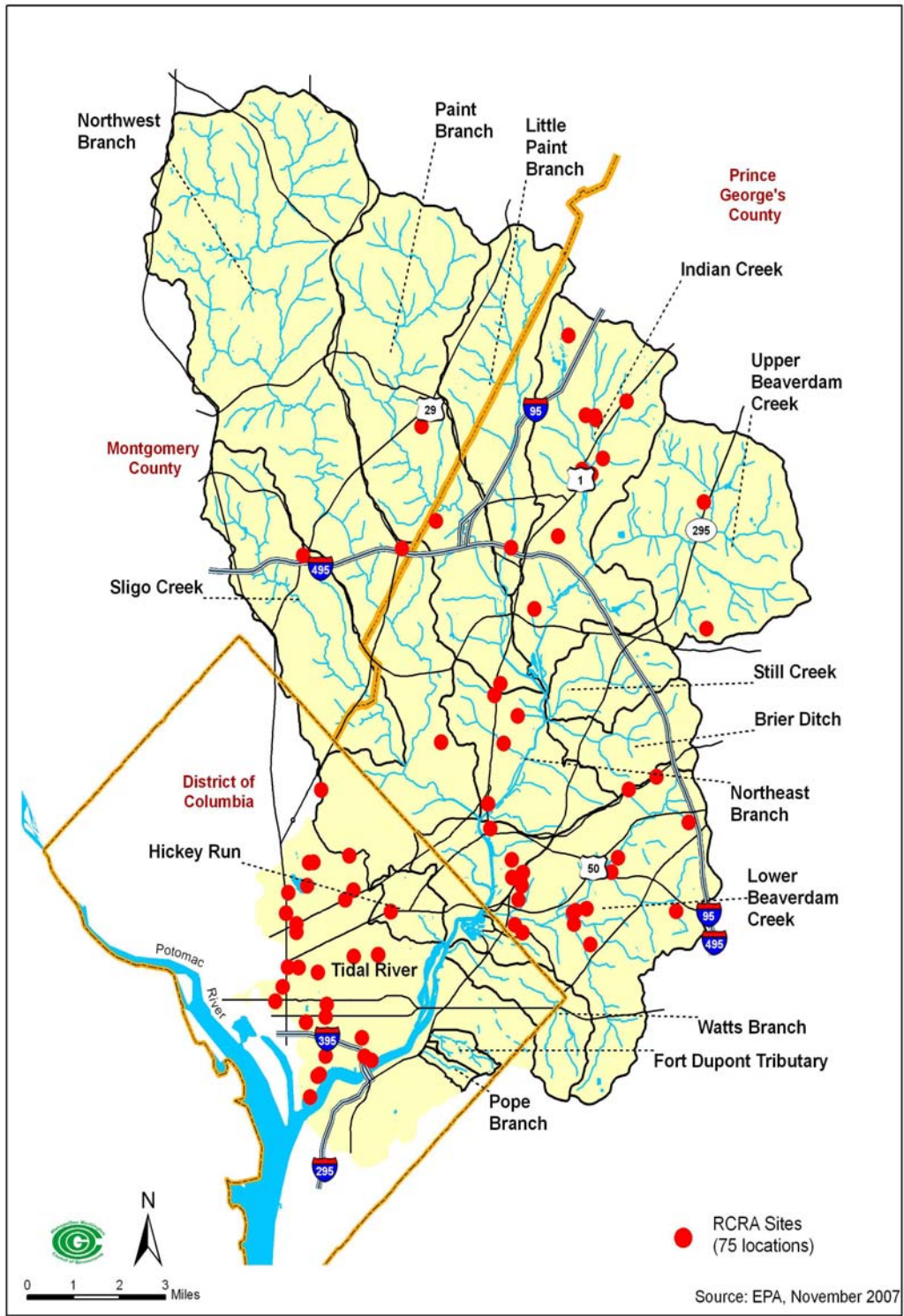


Figure 1-4: RCRA Sites in Anacostia Watershed

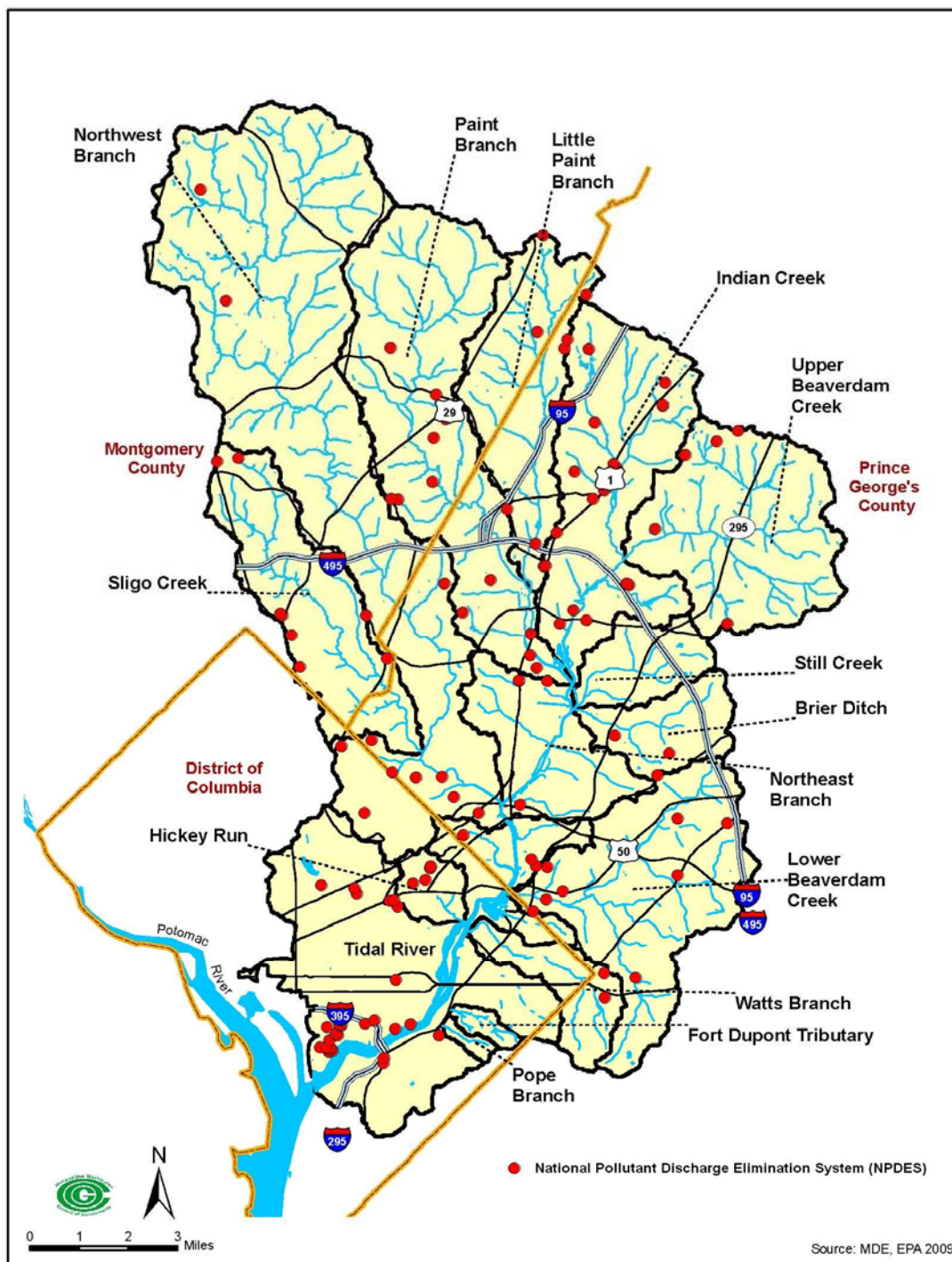


Figure 1-5: NPDES Sites in Anacostia Watershed

Trash

Maryland and the District of Columbia listed the Anacostia River as impaired for trash under the Clean Water Act in 2006. It is estimated that more than 20,000 tons of trash enter the Tidal River annually, predominantly from urban storm drain systems. Washington, D.C., continuously removes trash under its debris removal program.

Flooding

Flooding has been a long-standing problem throughout the Anacostia River watershed, particularly in Prince George's County, though areas of Montgomery County and the District of Columbia experience episodic flooding as well. Prince George's County is prone to flooding because the county is located within the Coastal Plain physiographic province, which is generally wider and flatter, and due to development of floodplains prior to the development of stormwater management regulations and controls. Periodic flooding within the Tidal River subwatershed occurs along the entire length of the subwatershed on the main stem.

Further data and discussion regarding the current conditions of the Tidal River subwatershed can be found in the Anacostia Watershed Environmental Baseline Conditions and Restoration Report prepared by Metropolitan Washington Council of Governments (MWCOC).

Existing Pollutant Loads

Existing pollutant loadings for sediment, nitrogen (N), and phosphorous (P) was calculated for the Anacostia River watershed TMDL by Maryland Department of the Environment (MDE). As part of the ARP, the sediment, N, and P loadings were calculated for the Tidal River subwatershed using the same loading rates per land use for the TMDL in order to estimate the Tidal River subwatershed's contribution of pollutant load to the overall Anacostia River load (Kim et al, 2007; Mandel et al, 2008). The Anacostia River watershed TMDL identifies a reduction goal for sediment, N, and P as 85-, 79-, and 80-percent, respectively. By knowing the percent reduction necessary for the entire Anacostia River watershed and applying the percent reduction to the Tidal River subwatershed pollutant loading estimate, the subwatershed loading reduction for Tidal River necessary to achieve the overall Anacostia River watershed TMDL can be estimated. Additional information is available on the existing pollutant loading calculations is available in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

Identifying the existing magnitude of loadings on a subwatershed basis allows for the ability to geographically target and evaluate the scale of restoration needed to reduce N, P, and sediment inputs within each subwatershed to attain goals. A summary table of Tidal River subwatershed current loadings and how they compare to the rest of the Anacostia River watershed is found in Table 1-2. The efforts to attain TMDLs are being led by the U. S. Environmental Protection Agency (EPA) and MDE, and as such neither this SWAP nor the ARP are intended to serve as TMDL implementation plans, although data presented here may contribute to that effort. The Plan Formulation appendix of the Anacostia Watershed Restoration Plan and Report provides more details regarding the methodology used to obtain the current loading estimates and presents the results of those analyses. It must be noted that the analyses conducted for the ARP in regards to pollutant reduction only considered overland flow, and does not account for pollutant

contribution from the stream channel itself, namely sediment from erosion. Additional detailed modeling would be required to determine sediment transport change associated with reduced runoff volumes from implementation of the stormwater management retrofit projects identified in the ARP.

Table 1-2: Nutrient Loading Estimates for Tidal River Subwatershed and Comparison Values			
	Nitrogen lbs/sq mi/year	Phosphorus lbs/sq mi/year	TSS tons/sq mi/year
Tidal River	6,435	754	121
Average Anacostia River Subwatershed	5,255	500	99
Completely Forested Watershed	42	8	N/A

Table 1-3: TMDL Reduction Goals			
	Nitrogen lbs/sq mi/year	Phosphorus lbs/sq mi/year	TSS tons/sq mi/year
Anacostia River Watershed TMDL Reduction Goals	79%	80%	85%
Estimated Tidal River Loadings	6,435	754	121
Estimated Tidal River TMDL Reduction Goal	5,084	604	103

Section 2

Inventory of the Provisional Restoration Candidates

Inventory of Provisional Restoration Candidate Projects

As part of the ARP study, a systematic process was developed to identify, catalog, and evaluate each restoration opportunity. In addition, the evaluation of restoration projects was completed by using a detailed system to score the various projects and ultimately determine a ranking of projects. The opportunities presented were identified through the compilation of existing data, input from local jurisdictions, GIS analyses, and field observations. The existing data provided by the local municipalities included land use data, public/private ownership information, impervious surfaces data, planning department classifications, digital elevation models, stormwater management data, and aerial photographs. A detailed explanation of the methodology utilized to identify the opportunities can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

In addition to the restoration strategies discussed in Section 1, the potential projects identified as part of this analysis are intended to achieve one or more of the following 2020 restoration objectives:

1. Stormwater Management
2. Wetland Creation and Restoration
3. Riparian Corridors
4. Aquatic Community
5. Trash Reduction
6. Outreach
7. Parkland Acquisition

Table 2-1 identifies potential project types per objective, gives a brief description, and states the metric that will be used.

Table 2-1: 2020 Tidal River Restoration Objectives

Objectives	Description of Objective	Metric
Stormwater Management		
Retrofits, Environmental Site Design (ESD), Low Impact Development (LID)	Retrofit current stormwater controls, utilize bioretention, filters, bioswales, wet ponds, wetlands to add controlled acreage to the subwatershed	Acres Controlled and Pounds of Nitrogen, Phosphorus, TSS loading reduced
Homeowner BMPs	Include use of Green roofs, disconnects, rain barrels, permeable pavement, and rain gardens	Acres Controlled and Pounds of N, P, TSS loading reduced
Aquatic Community		
IBI Rating for Fish	Restore fish habitat through improved water quality and flow management	Index of Biotic Integrity Rating
IBI Rating for Macroinvertebrate	Restore macroinvertebrate habitat through improved water quality and flow management	Index of Biotic Integrity Rating
Fish Passage	Remove barriers to fish migration	Miles of Stream
Trash		
Implement reduction projects	Reduce trash through use of netting, catching, and grates	Number of Projects Implemented / MWCOG Trash Index Rating
Street Sweeping	Increase street sweeping programs	Acres Swept and Pounds of N, P, TSS loading reduced
Wetland Creation and Restoration		
Create and Restore Acreage	Create new wetlands and vernal pools and restore/expand existing ones	Acreage created or restored
Riparian Corridors		
Invasive Species Management	Removal of invasive species from the corridor	Acres managed
Reforestation	Replanting of the riparian corridor	Acres reforested
Increase Tree Canopy	Tree planting in both urban and non-urban areas	Acres / % increase
Land Acquisition		
Increase parkland	Acquire tracts of land to increase current parkland and provide more habitat connectivity	Acres Acquired
Outreach / Public Involvement		
Increase participation of residents and businesses	Educate the public about BMPs and encourage their use of them	Qualitative
Establish Friends of Tidal River Organization	Establish a subwatershed group to facilitate public involvement	Yes or No
Incentive Programs	Expand current programs and encourage businesses to offer incentives. Assist private owners with measures such as rain barrels.	Expanded or Maintained

A total of 107 potential restoration candidate projects within the Tidal River subwatershed have been identified as part of the ARP investigation. The complete inventory and description of the 107 proposed projects are included in the Tidal River Subwatershed Provisional Restoration Inventory. The potential restoration projects address five of six restoration strategies identified for the Tidal River 2020 restoration objectives (does not include projects for increasing participation). The presence of toxic contaminants has been identified in Tidal River; however, detailed studies have not been completed to identify the exact sources and extent of the problem, and thus there are no provisional restoration candidate projects that address toxics in the report. It is recommended that further studies regarding the source and extent of toxic contamination should be undertaken by the appropriate authorities. In addition to illicit discharges, historic dump sites may be sources of toxic contaminants in the system. A diagram of these sites and current NPDES sites can be found in the Anacostia River Watershed Environmental Baseline Conditions and Restoration Report.

Tables 2-2, 2-3, and 2-4 provide a summary of the proposed restoration project types, quantity, and the estimated cost of implementation. It should be noted that the development of the NPDES Municipal Separate Storm Sewer System (MS4) permit by the three local jurisdictions may or may not include provisional restoration projects presented in the SWAP or Tidal River Subwatershed Provisional Restoration Projects Inventory.

Candidate Project Type	Number of Projects	Estimated Cost (\$)	Impervious Acreage Controlled (ac)	Length (mi)	Acreage (Ac)
Stormwater Retrofit	66	40,988,000	306	-	-
Stream Restoration	4	1,166,000	-	0.7	-
Wetland Creation / Restoration	6	1,445,000	-	-	28.9
Fish Blockage Removal / Modification	4	212,000	-	0.6	-
Riparian Reforestation/Invasive Species Removal	4	352,000	-	-	56.6
Trash Reduction	18	151,900	-	-	N/A
Sediment Remediation	-	-	-	-	-
Parkland Acquisition	5	2,340,000	-	-	23.4
Total	107	46,654,900	306	1.3	108.9

Project Type	Watershed Area	
	Total Acres	Total Newly Controlled Acres*
Wetland and Wet Pond Stormwater (acres)*	2.1	2.1
Bioretention (acres)*	146.1	146.1
Bioswales (acres)*	4.9	4.9
Permeable Pavement (acres)*	1.3	1.3
Filter (acres)*	112.6	112.6
Green Roof (acres)*	15.0	15.0
Downspout Disconnect (aces)*	16.3	16.3
Rain Barrels (acres)*	1.1	1.1
Rain Garden (acres)*	6.9	6.9
Dry Pond (acres)*	0.0	0.0
Pipe Storage (acres)*	2.3	2.3
Invasive Species Management (acres)	39.6	N/A
Meadow Planting(acres)	0	N/A
Wetland Restoration (acres)	28.9	N/A
Vernal Pools Restoration/Creation (acres)	0	N/A
Reforestation/Buffer (acres)	17.0	N/A
Land Acquisition (acres)	23.4	N/A
Stream Restoration (miles)	0.7	N/A
Fish Passage (miles)	0.6	N/A
Trash Reduction (number of projects)	18	N/A
*All acres were assumed to be 'newly controlled' for this analysis, as data regarding current stormwater management controls in the subwatershed was not available at the time the report was prepared		

Table 2-4: Provisional Restoration Project Estimated Unit Costs		
No.	Practice	Approximate Unit Cost (\$)
Stormwater Retrofit		
1	Existing Stormwater Management Pond/Wetland Retrofitting	\$1,000-\$3,000/acre of drainage
2	New Stormwater Management Pond/Wetland Construction	\$3,000-\$5,000/acre of drainage
3	LID-Bioretention with Under Drain System	\$100,000/impervious acre
4	LID-Curbside/Street Planter	\$100,000/impervious acre
5	LID-tree box filter	\$54,450-\$65,340/impervious acre
6	LID-Green Roof	\$42/square foot
7	LID-Single Family Home Rain Garden	\$5,000 per individual garden
8	LID-Single Family Home Rain Barrel	\$200/barrel (typically two per house)
9	Sand Filter	\$20,000 to \$25,000 per impervious acre
10	Underground Pipe Storage	\$15,000/impervious acre
11	Permeable Pavement	\$4.0/square foot
Stream Restoration/Fish Passage Blockage Removal or Modification		
12	Stream Restoration	\$300/linear foot
13	Concrete Stream Channel Removal	\$1,000/linear foot
14	Stream Day Lighting	\$2,000/linear foot
15	Fish Passage/Riffle Grade Control Structure	\$150,000/one foot barrier height
16	Wetland Creation	\$50,000/acre
Trash Reduction/Water Quality		
17	Fresh Creek Trash Netting System	\$1,000/acre of drainage
18	End-of-Pipe Trash Catching System	\$4,000/acre of drainage
19	Street Sweeping	\$50/curb mile
20	Storm Drain Trash Grate	\$500/inlet

Results of the Evaluation and Scoring of Restoration Actions in Tidal River Subwatershed

To recommend restoration action and to determine the sequence for implementation, a quantitative scoring scheme was used to evaluate the 107 provisional restoration candidate projects. This common scoring system allowed for comparison of candidates across as well as within the restoration strategies. The scores for all 107 projects ranged from 88 to 57 points out of a possible 100. To prioritize among projects based on benefits, the scores were divided into three tiers based on the distribution of the scores, with Tier I projects being those anticipated to provide the greatest potential benefits. Tier I includes projects that scored an 80 or above, Tier II includes projects that scored anywhere from 79 to 65, and Tier III includes those that scored 64 or below. Further discussion on the scoring system for the proposed projects can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

The scoring scheme for the provisional stormwater management candidate projects was subsequently further adjusted. The tier system was retained, but the tier boundaries were refined based on distribution of the adjusted score as described in the stormwater management subsection below.

The following tables present the scores and overall rank of the provisional restoration actions for the Tidal River subwatershed separated by restoration strategy.

Stormwater Management

To provide for better differentiation for potential benefits that would be produced by the 66 potential stormwater management candidate projects and aid the local communities in prioritization for implementation, the scoring system used for project candidates in this restoration strategy were adjusted from the common scoring system. Variables representing two additional factors unique to stormwater management were incorporated into the scoring system: unit imperviousness and existing stormwater control. Data for these variables was obtained from MWCOG and is presented in the Tidal River Environmental Baseline Conditions and Restoration Report. In the adjusted scoring system for the stormwater projects, Tier I includes projects above 100, Tier II includes projects that are between 89 and 99, Tier III are those scored 88 and below, and Tier IV are those projects that did not meet the minimum requirements to be included in the adjusted scoring system but could still be considered as restoration opportunities in the future. Further explanation of the basis for the adjusted scoring can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report. The top 20 stormwater retrofit candidate projects from Tiers I and II are listed in Table 2-5. No Tier III projects were identified. Additional information and project descriptions can be in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-5: Top 20 Potential Stormwater Retrofit Projects within the Tidal River Subwatershed

Project ID	Jurisdiction*	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-01-S-12	DC	Neighborhood bounded by Branch Avenue SE, Alabama Avenue SE, 36th Street SE, U Street SE and neighborhood bounded by Highwood Drive SE, Pennsylvania Avenue SE, 33rd Place SE, and 38th Street SE, Washington, DC	110.0	4	1,398,000
TRR-L-01-S-13	DC	2626 Naylor Road SE, Washington, DC	105.0	22	1,070,000
TRR-L-01-S-2	DC	Joel Elias Springarn School, Young Elementary School, Browne Junior High School, and Phelps Vocational School	104.0	37	4,430,000
TRR-L-01-S-63	PG	Addison Chapel Apartments, 1513 Elkwood Lane, Capitol Heights MD	103.6	7	410,000
TRR-L-01-S-55	DC	Kenilworth Parkside Recreational Center, 1300 44th Street NE, Washington DC	103.2	22	1,755,000
TRR-L-01-S-41	PG	Industrial area north of the intersection of 52nd Avenue and Baltimore Washington Parkway, Bladensburg, MD	101.0	63	3,696,000
TRR-L-01-S-35	DC	Thurgood Marshall Extended Elementary School, 3100 Fort Lincoln Drive NE, Washington, DC	100.6	15	900,000
TRR-L-01-S-16	DC	Residential neighborhood bounded by Bruce Place SE, Alabama Avenue SE, Stanton Terrace SE t, and Robinson Street SE and 15th Place SE	99.0	78	1,784,000
TRR-L-01-S-48	PG	Salvation Army, 3304 Kenilworth Avenue, Bladensburg, MD	98.5	42	521,000
TRR-L-01-S-32	DC	Fort Lincoln Senior Village, 3001 and 3005 Bladensburg Road NE, Washington, DC	98.4	48	650,000
TRR-L-01-S-33	DC	Premium Inc, at the corner of Commodore Joshua Barney Jr. Drive NE and York Terrace NE, Washington, DC	98.3	63	797,000
TRR-L-01-S-57	DC	Deanwood Metro station, 4720 Minnesota Avenue NE, Washington DC	97.7	37	390,000
TRR-L-01-S-1	DC	John Philip Sousa Junior High School and administration building, 3650 Ely Place SE, Washington, DC	97.6	42	1,250,000
TRR-L-01-S-15	DC	Washington Nursing Facility, 2425 25th Street SE, Washington, DC	96.6	48	460,000
TRR-L-01-S-26	PG	Howard Johnson Inn, 5811 Annapolis Road, Hyattsville, MD	96.6	48	633,000
TRR-L-01-S-28	PG	3400 block of Bladensburg Road, Brentwood, MD	96.6	48	175,000
TRR-L-01-S-40	PG	Bladenwoods Condominiums, 5200 and 5300 blocks of Newton Street, Bladensburg, MD	96.6	48	448,000
TRR-L-01-S-51	PG	Peoples Supply, 3200 Kenilworth Avenue, Bladensburg, MD	96.6	48	485,000
TRR-L-01-S-53	PG	Kenilworth Towers, 3801 Kenilworth Avenue, Bladensburg, MD	96.6	48	470,000
TRR-L-01-S-14	DC	Residential neighborhood bounded by Skyland Place SE, Skyland Terrace SE, and Wagner Street SE, Washington, DC	95.7	48	633,000
TOTAL					22,355,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I , Tier II , Tier III					

Stream Restoration

The potential stream restoration candidate projects are presented in Table 2-6. These 4 projects incorporate elements of channel morphology restoration, soft bottom creation, and in-stream habitat restoration. Additional project description information can be found in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-6: Potential Stream Restoration Projects within the Tidal River Subwatershed					
Project ID	Jurisdiction*	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-02-SR-4	DC	Storm sewer outfall #1037, located on the north bank of Nash Run immediately downstream of Anacostia Boulevard, Northeast, Washington DC	74	11	11,000
TRR-L-02-SR-3	DC	Nash Run between Interstate 295 and approximately 450 downstream of Anacostia Boulevard, District of Columbia Northeast	72	22	555,000
TRR-L-02-SR-1	PG	Approximately 1,025 feet southeast from the intersection of Lawrence Street and 37th Avenue, Brentwood, MD	67	74	150,000
TRR-L-02-SR-2	PG	Approximately 255 feet north of the intersection of Kenilworth Avenue and 49th Avenue, Bladensburg, MD	61	100	450,000
TOTAL					1,166,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I, Tier II, Tier III					

Wetland Creation or Restoration

All of the potential wetland restoration candidate projects are presented in Table 2-7. These creations and restorations range in size from 0.1 acres to 19.1 acres. Additional project description information can be found in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-7: Potential Wetland Creation or Restoration Projects within the Tidal River Subwatershed

Project ID	Jurisdiction	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-03-W-4	DC	Approximately 1,355 feet northeast (upstream) from the Pennsylvania Avenue SE bridge crossing the Anacostia River, on the south bank, Washington, DC	75	8	60,000
TRR-L-03-W-5	DC	Approximately 2,000 feet northeast (upstream) from the Pennsylvania Avenue SE bridge crossing the Anacostia River, on the south bank, Washington, DC	65	82	40,000
TRR-L-03-W-6	PG	Approximately 1,860 feet southeast from the intersection of Lawrence Street and 40th Place, Brentwood, MD	63	94	110,000
TRR-L-03-W-2	DC	Approximately 1,350 feet southwest (downstream) from the I-295 bridge crossing the Anacostia River, Washington, DC	61	100	955,000
TRR-L-03-W-1	DC	Approximately 1,900 feet west-northwest of the intersection of Anacostia Avenue NE and Douglas Street NE, Washington, DC	58	104	275,000
TRR-L-03-W-3	DC	Approximately 750 feet southwest (downstream) from the I-295 bridge crossing the Anacostia River, Washington, DC	57	107	5,000
TOTAL					1,445,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I, Tier II, Tier III					

Fish Blockage Removal or Modification

The potential fish blockage removal candidate projects are presented in Table 2-8. These projects are all blockage removals ranging from 125 feet to 1,500 feet in length. Additional information regarding the project descriptions is available in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-8 Potential Fish Blockage Removal or Modification Projects within the Tidal River Subwatershed					
Project ID	Jurisdiction	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-04-F-2	DC	Anacostia Boulevard crossing of Nash Run, District of Columbia Northeast	67	74	50,000
TRR-L-04-F-3	DC	Nash Run approximately 125 feet downstream of Anacostia Boulevard, District of Columbia Northeast	65	82	1,000
TRR-L-04-F-4	DC	Approximately 250 feet downstream of the Anacostia Boulevard crossing of Nash Run, District of Columbia Northeast	63	94	1,000
TRR-L-04-F-1	PG	Approximately 200 feet north of the intersection of Kenilworth Avenue and 49th Avenue, Bladensburg, MD	58	104	160,000
TOTAL					212,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I, Tier II, Tier III					

Riparian Reforestation and Invasive Species Management

All of the potential riparian reforestation and invasive species management candidate projects are presented in Table 2-9. Two of these projects involve riparian buffer reforestation (17 acres total) and 2 are for managing invasive species (39.6 acres total). Additional information regarding the project descriptions is available in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-9: Potential Riparian Reforestation, Meadow Creation, Street Tree, and Invasive Species Management Candidate Projects within the Tidal River Subwatershed

Project ID	Jurisdiction	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-05-R-4	DC	Riparian zone of Nash Run between 4417 Douglas Street and the Interstate 295, Washington DC	88	1	41,000
TRR-L-05-R-1	PG	Approximately 1,325 feet southeast from the intersection of Lawrence Street and 37th Avenue, Brentwood, MD	87	2	8,000
TRR-L-05-R-3	DC	Riparian zone of Nash Run between 4417 Douglas Street and the tidal basin, Northeast, Washington DC	83	3	190,000
TRR-L-05-R-2	DC	RFK Stadium, north and south of Capitol Street NE, Washington, DC	69	48	113,000
TOTAL					352,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I, Tier II, Tier III					

Trash Reduction

The potential trash reduction candidate projects are presented in Table 2-10. These projects involve a combination of street sweeping, trash removal, and trash nets. Additional information regarding the project descriptions can be found in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Project ID	Jurisdiction	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-06-T-17	DC	Suitland Parkway between I-295 and Alabama Avenue, Southeast, Washington DC	75	8	4,700
TRR-L-06-T-9	DC	Benning Road NE between I-295 and Southern Avenue NE, Northeast, Washington DC	74	11	2,100
TRR-L-06-T-10	DC	Capitol Street NE between the Anacostia River and 52nd Street, Northeast, Washington DC	74	11	4,400
TRR-L-06-T-12	DC	Ridge Road NE between Minnesota Avenue and the Ridge Recreational Center, Southeast, Washington DC	74	11	2,100
TRR-L-06-T-18	DC	Martin Luther King Junior Highway between I-295 and Redwood Street, Southeast, Washington DC	73	15	1,900
TRR-L-06-T-3	PG	Kenilworth Avenue between Annapolis Road and I-295, Bladensburg, MD	72	22	400
TRR-L-06-T-4	DC	Ely Place SE between Ridge Road SE and Minnesota Avenue SE, Washington, DC	72	22	300
TRR-L-06-T-6	DC	Eastern Avenue NE between I-295 and 56th Avenue NE, Northeast, Washington DC	72	22	900
TRR-L-06-T-7	DC	Minnesota Avenue NE between Eastern Avenue and Meade Street, Northeast, Washington DC	72	22	500
TRR-L-06-T-8	DC	Sheriff Road between 47th Place and Addison Road, Northeast, Washington DC	72	22	1,100
TRR-L-06-T-11	DC	Pennsylvania Avenue between Good Hope Road and Anacostia Road, Southeast, Washington DC	72	22	2,600
TRR-L-06-T-13	DC	Good Hope Road between the Anacostia Freeway and Alabama Avenue, southeast, Washington DC	72	22	1,600
TRR-L-06-T-14	DC	R Street between Randle Highlands Elementary and 16th Street SE, Southeast, Washington DC	72	22	1,100
TRR-L-06-T-15	DC	Q Street between Randle Highlands Elementary and 16th Street SE, Southeast, Washington DC	72	22	1,100
TRR-L-06-T-16	DC	Naylor Road SE between Minnesota Avenue and Good Hope Road, Southeast, Washington DC	72	22	1,000
TRR-L-06-T-5	DC	Nash Run between Interstate 295 and the Anacostia River tidal basin, Northeast Washington DC	71	37	6,900
TRR-L-06-T-2	PG	Landover Road between Neighbor Lane and Annapolis Road, Bladensburg, MD	68	63	400
TRR-L-06-T-1	DC	Tidal Anacostia River from the confluence of Northeast and Northwest Branches to the confluence with Potomac River	60	102	118,800
TOTAL					151,900

*PG=Prince George's County
 DC=Washington DC
 Scoring Tier = Tier I, Tier II, Tier III

Parkland Acquisition

The potential parkland acquisition candidate projects are presented in Table 2-11 and range in size from 2 acres 10.8 acres. Additional information regarding the project descriptions can be found in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-11: Potential Parkland Acquisition Projects within the Tidal River Subwatershed

Project ID	Jurisdiction	Project Name	Score	Overall Rank	Estimated Cost (\$)
TRR-L-08-L-1	PG	Kenilworth Avenue, Bladensburg, MD	68	63	260,000
TRR-L-08-L-3	DC	008 Good Hope Drive NE, Washington, DC	68	63	380,000
TRR-L-08-L-5	DC	008 Howard Road SE, Washington, DC	68	63	420,000
TRR-L-08-L-2	PG	Eastern Avenue, Mount Ranier, MD	65	82	1,080,000
TRR-L-08-L-4	DC	007 28th Street SE, Washington, DC	63	94	200,000
TOTAL					2,340,000
*PG=Prince George's County DC=Washington DC Scoring Tier = Tier I, Tier II, Tier III					

Summary of Recommended Restoration Actions

The Recommended Restoration Actions are those that could potentially be implemented and a roll-up of these projects is presented in Table 2-12. Additional information on the descriptions and details of the potential actions can be found in the Tidal River Subwatershed Provisional Restoration Projects Inventory.

Table 2-12: Summary of Recommended Potential Restoration Actions		
Candidate Project Type	Number of Projects	Estimated Cost (\$)
Stormwater Retrofits*		
Tier I	7	13,659,000
Tier II	20	15,167,000
Tier III	0	0
Tier IV	39	12,162,000
Stream Restoration		
Tier I	0	0
Tier II	3	716,000
Tier III	1	450,000
Wetland Creation / Restoration		
Tier I	0	0
Tier II	2	100,000
Tier III	4	1,345,000
Fish Blockage Removal / Modification		
Tier I	0	0
Tier II	2	51,000
Tier III	2	161,000
Riparian Reforestation and Invasive Species Management		
Tier I	3	239,000
Tier II	1	113,000
Tier III	0	0
Trash Reduction		
Tier I	0	0
Tier II	17	33,100
Tier III	1	118,800
Toxic Remediation		
	-	-
Parkland Acquisition		
Tier I	0	
Tier II	4	2,140,000
Tier III	1	200,000
TOTAL	107	46,654,900
*Tiers for the Stormwater Projects Reflect the Adjusted Scoring System		

Implementation Type of Potential Restoration Actions

Restoration opportunities identified as part of the ARP require additional study, design, or policy change prior to implementation. Table 2-13 provides a summary of the number of projects that fall under each of the four implementation types. The 2007 Water Resources Development Act provides authority for USACE to complete design/build projects in the Anacostia Watershed. However, design/build projects could also be implemented by local jurisdictions, state agencies, or non-profit organizations. Feasibility Study projects would require additional detailed studies prior to the design phase. The projects requiring feasibility studies like stream restoration or wetland creation likely would be projects USACE could implement following the appropriate Civil Works authority, budgeting cycle, and protocol. Projects requiring a programmatic element prior to implementation may require governmental policy changes, or authority to purchase land. Finally, stewardship projects are likely those potential projects to be completed by volunteers from local churches, schools, or community watershed groups.

Additional information regarding specific projects can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

Table 2-13: Summary of Potential Restoration Actions.		
Implementation Type	Number of Projects	Estimated Cost (\$)
Design/Build	66	40,988,000
Feasibility Study	14	2,823,000
Stewardship	6	477,700
Programmatic	21	2,366,200
TOTAL	107	46,654,900

Section 3

Evaluation and Discussion of the Restoration Strategies

Evaluation of Proposed Restoration Strategies

The proposed restoration projects were evaluated using the approach described in the main report of the ARP. The first step in the evaluation consisted of assessing the potential of the restoration actions to control pollutant loads. As described in the Anacostia Watershed Environmental Baseline Conditions and Restoration Report, the TMDL modeling efforts of Interstate Commission on the Potomac River Basin (ICPRB) and MDE were used to provide the existing pollutant loads, and the Watershed Treatment Model (WTM) was used to estimate the potential pollution reduction achieved by the proposed restoration strategies. The Plan Formulation Appendix lists the efficiencies of the various BMPs included in the WTM. It should be noted that the list of stormwater management practices listed in the WTM was expanded to include LID practices. The LID practices included green roofs, rooftop disconnection, rain barrels and cisterns, soil amendments, sheet flow to open space, bioretention, and rain gardens.

The potential restoration strategies were individually evaluated using the WTM to estimate the pollutant reduction benefit the project could provide. The full WTM user guide is available online from the Center for Watershed Protection (CWP) at www.cwp.org.

Potential to Reduce Stormwater Pollutant Loads

Unlike other subwatersheds within the Anacostia River basin, the Tidal River reach experiences combined sewer overflow (CSO) events that discharge a combination of untreated sewage and stormwater directly into the main stem, including trash, bacteria, and nutrients. 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 3-1, approximately one-third, or approximately 12,478 acres, of the District of Columbia is served by combined sewer and stormwater systems (District of Columbia Water and Sewer Authority (DCWASA, 2002)). Under dry weather conditions, these systems convey sewage to the Blue Plains Wastewater Treatment Plant; under certain wet weather conditions, 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 3-2. 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 load in the river (DCWASA, 2001).

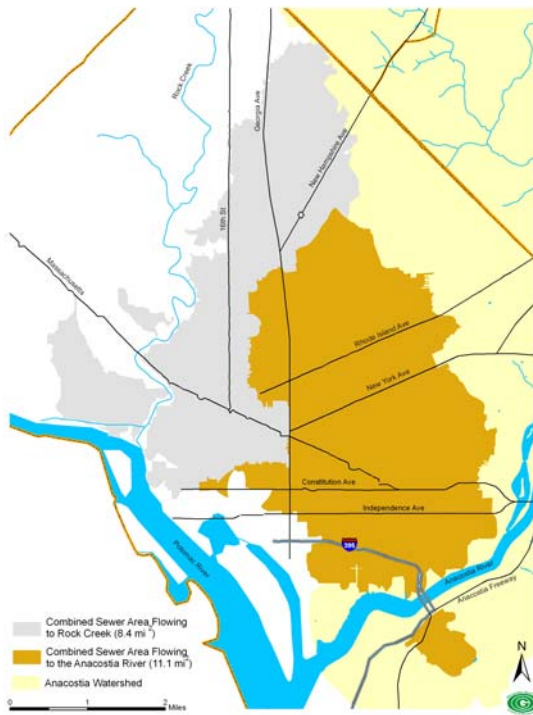


Figure 3-1: Combined Sewer Area

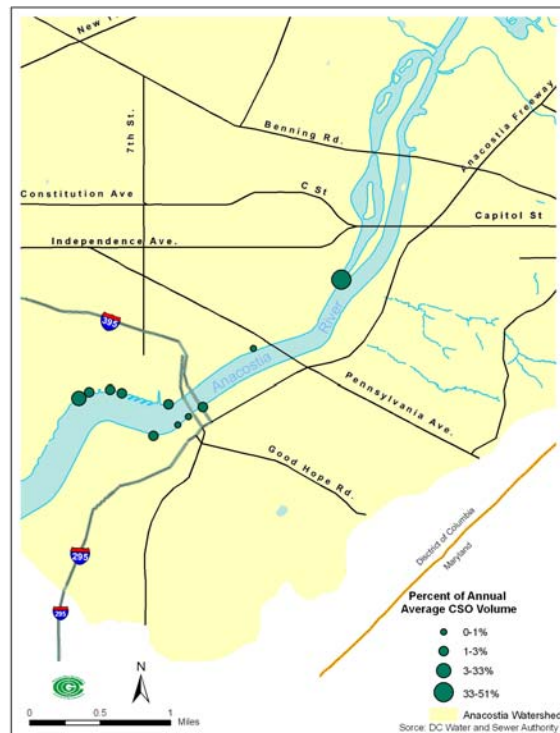


Figure 3-2: CSO Volume

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). Pertaining specifically to the Anacostia River drainage area, the LTCP control measures, upon implementation by 2025, would limit CSOs from 82 to two events per year (DCWASA, 2002). Decreasing the number of CSO events would have a significant impact on water quality within the river by reducing the concentrations of nitrogen and bacteria, potentially meeting the fecal coliform TMDL.

The LTCP is a large-scale restoration program being implemented by DCWASA as required by an 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 Plain Sewage Treatment Plant 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).

The proposed restoration projects would provide additional stormwater controls to 306 impervious acres in the Tidal River subwatershed. This represents 5-percent of impervious surfaces controlled by stormwater management. The acreage of impervious surfaces controlled by BMPs already in place was not calculated for this analysis. Table 3-1 summarizes the improvements in stormwater controls after implementation of the proposed projects.

Total Impervious Acres	Existing Stormwater Controls of Impervious Acres*		Potential Future Stormwater Controls of Impervious Acres		Increase in Impervious Acreage Controlled by Stormwater Projects
	Acres	% of Total	Acres	% of Total	
6,239	0	0%	306	5%	5%

*Not calculated, assumed to be 0 for this analysis

Impervious Acreage Controlled	Pollutants Load Reduction Potential				Increase in Impervious Acreage Controlled by Stormwater Projects
	N	P	TSS	Bacteria	
	(lbs/yr)	(lbs/yr)	(tons/yr)	(billion cfu/yr)	
5% (proposed projects)	2,987	477	94	39,747	5%

* Current Stormwater Control Levels are assumed to be 0%

Using the distribution of projects included in the provisional inventory, several future control levels were evaluated using the WTM to estimate potential pollution reduction. Table 3-2 identifies the maximum control level evaluated (as percent impervious acres controlled) as well as the associated pollution reduction potential. The Plan Formulation appendix to the Anacostia Restoration Plan and Report provides the characteristics of each BMP type included in the provisional inventory.

To fully evaluate the benefits of providing different levels of stormwater control, the existing pollutant load and the pollution reduction potential in the watershed must be considered in terms of the existing Anacostia River TMDLs for nutrients and TSS (Kim et al., 2007; Mandel et al., 2008). The TSS TMDL calls for an 85-percent reduction in existing TSS loading to the Anacostia River watershed. The nutrient TMDL established a necessary reduction of 79-percent for nitrogen and 80-percent for phosphorus. Table 3-3 summarizes the overall Anacostia River TMDL reduction goals, the Tidal River existing pollutant loadings, and the ability of the various

stormwater control levels to address the pollution reduction in the Tidal River subwatershed to help meet the Anacostia River TMDLs. The implementation of all of the proposed stormwater projects reduces the pollutant load between 2 and 3-percent. Given that the TMDL goals for the Anacostia River are between 79 and 85-percent reduction, stormwater controls alone will not be able to address the contribution from Tidal River.

Table 3-3: Ability of Stormwater Control Levels to Address TMDL Goals in Tidal River Subwatershed			
Impervious Control Level	Pollutant Reduction Achieved		
	N	P	TSS
Reduction Goal for Tidal River as Pro-Rated Share of Anacostia TMDL	123,540	14,666	2,494
Estimate of Existing Pollutant Loads in Tidal River	156,380	18,333	2,934
Maximum Reduction Potential from Proposed Projects	2,987 (2%)	477 (3%)	94 (3%)

It should be noted that the load reduction estimates of Table 3-3 do not account for reductions in stream channel erosion, which is another benefit of stormwater management. The following section addresses the potential reduction in stream channel erosion following the implementation of the proposed restoration actions.

Potential to Reduce Peak Flow Discharge

The TSS TMDL for the Anacostia River estimates that about 70 to 75-percent of the sediment delivered from the watershed to the Tidal River reach comes from stream bank and channel erosion. Estimating the reduction of stream channel sediment loads that would result from controlling urban stormwater runoff is very challenging. For all the subwatersheds in the Anacostia subwatershed (except Tidal River), a peak flow reduction analysis is used as a surrogate measure to give insight into the potential for reducing in-stream TSS contributions. In fact, erosion of the stream channel is directly related to the increase in stream energy associated with the peak flow. Therefore, the reduction of peak flow with stormwater management practices will likely lead to the reduction in erosive shear stress on the stream banks. It is logical to assume potential reduction in stream bank erosion by quantifying the reduction in peak flows associated with increasing the percentage of stormwater management controls on impervious surface area. A quantification of this analysis was included in other SWAPs for the Anacostia River, but could not be completed for the Tidal River subwatershed because the analysis is dependent on one outlet from which a specific flow can be measured, and flow contribution throughout the reach is diffuse and goes directly into the surface water body.

The Impervious Cover Model (ICM), developed by the CWP, classifies the ability of watersheds to support aquatic life based on the percentage of impervious surface area. The ICM describes watersheds having an impervious surface cover between 0 to 10-percent as ‘sensitive’, 10 to 25-percent as being ‘impaired’, those having 25 to 60-percent impervious cover as ‘non-supporting’, and those with 60 to 100-percent impervious cover as ‘urban drainage’. With its 40-percent impervious cover, the Tidal River reach would be classified as ‘non-supporting’ by the ICM. Furthermore, the western bank of the Tidal River Reach is almost completely piped with few natural channels.

Accordingly, the expectation for the Tidal River subwatershed is generally that if stormwater management is improved and other watershed restoration measures implemented aquatic ecosystem health will also improve. Given that all of the other subwatersheds in the greater Anacostia watershed eventually flow into the Tidal River, any improvements made in those subwatersheds would likely reduce pollutant loads in the Tidal River as well. In addition, due to the sluggish nature of the river, the Tidal River Reach main stem provides opportunities for wetland creation, which provide habitat as well as water quality benefits by filtering processes. This is an area of active ongoing investigation by scientists and engineers, and the relationship between watershed restoration and stream aquatic ecosystem health is impacted by many factors as was discussed earlier in this document.

Potential to Reduce Pollutant Loads Using Street Sweeping

Street sweeping is included in the provisional project inventory as a trash control, but street sweeping can also serve as an effective pollutant removal technique if the right equipment and the right techniques are employed (Montgomery County 2002). Particles that accumulate on road surfaces such as road grit, sand, and dirt; heavy metals including copper, lead, and zinc; and nitrogen and phosphorus can all be removed to some extent by street sweeping. 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, etc.), 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 when pollutants are permitted to accumulate and then the area is swept prior to a rain event. However, this situation is logistically difficult. The WTM is capable of estimating removal of N, P, and TSS by street sweeping. Evaluations with the WTM identify that weekly sweeping can remove 67-percent more N, P, and TSS than monthly sweeping.

The benefit of street sweeping was evaluated for the roads within the Tidal River subwatershed. (Table 3-4). Information regarding the methodology and assumptions made in the analysis can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

Non-Residential Roads		Annual Pollutant Reduction			Percent Reduction		
Percent of Roadway Treated	Miles	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)	N	P	TSS
5	12.3	906	88	16	0.6%	0.5%	0.6%
10	24.5	1,813	175	32	1.2%	1.0%	1.1%
15	36.8	2,719	263	49	1.7%	1.4%	1.7%
20	49.0	3,625	351	65	2.3%	1.9%	2.2%
25	61.3	4,531	439	81	2.9%	2.4%	2.8%
50	122.6	9,063	877	162	5.8%	4.8%	5.5%
75	183.9	13,594	1,316	243	8.7%	7.2%	8.3%
100	245.2	18,125	1,755	323	11.6%	9.6%	11.0%

Residential Roads		Annual Pollutant Reduction			Percent Reduction		
Percent of Roadway Treated	Miles	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)	N	P	TSS
5	7.9	146	22	2	0.1%	0.1%	0.1%
10	15.9	292	45	5	0.2%	0.2%	0.2%
15	23.8	439	67	7	0.3%	0.4%	0.2%
20	31.8	585	90	10	0.4%	0.5%	0.3%
25	39.7	731	112	12	0.5%	0.6%	0.4%
50	79.4	1,462	225	24	0.9%	1.2%	0.8%
75	119.1	2,193	337	36	1.4%	1.8%	1.2%
100	158.8	2,924	449	49	1.9%	2.5%	1.7%

The benefits of street sweeping on pollutant removal can also be considered for parking lots. Parking lots accumulate trash and pollutants that eventually wash into the stormwater system during rain events. The results of the parking lot analysis are displayed in the Table 3-5. The benefit of sweeping parking lots does not appear to be great, but once accumulated over the entire watershed this practice has the potential to not only contribute to reaching trash reduction goals, but also pollutant removal goals if implemented on a large scale.

Table 3-5: Pollutant Reduction Estimate of Weekly Sweeping of Parking Lots							
Parking Lots		Annual Pollutant Reduction			Percent Reduction		
Percent of Parking Lots Swept	Acres	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)	N	P	TSS
5	70.1	74	6	1	0.0%	0.0%	0.0%
10	140.3	148	12	3	0.1%	0.1%	0.1%
15	210.4	222	18	4	0.1%	0.1%	0.1%
20	280.6	296	24	6	0.2%	0.1%	0.2%
25	350.7	370	30	7	0.2%	0.2%	0.2%
50	701.5	740	61	15	0.5%	0.3%	0.5%
75	1,052.2	1,110	91	22	0.7%	0.5%	0.7%
100	1,403.0	1,481	122	29	0.9%	0.7%	1.0%

The full benefit of an enlarged street sweeping program would reflect the pollution reduction gained from sweeping residential and ‘other’ roads, as well as parking lots. Table 3-6 contains the totals for sweep all three types of areas swept. The data indicates that fairly substantial reductions can be realized once the percentage of roads swept weekly get above 50-percent.

Table 3-6: Total Pollutant Reduction Estimate of Weekly Sweeping of All Streets and Parking Lots							
Streets and Parking Lots		Total Annual Pollutant Reduction			Total-percent Reduction		
Percent Swept	Acres	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)	N	P	TSS
5	182.4	1,126	116	20	0.7%	0.6%	0.7%
10	364.7	2,253	233	40	1.4%	1.3%	1.4%
15	547.1	3,379	349	60	2.2%	1.9%	2.1%
20	729.5	4,506	465	80	2.9%	2.5%	2.7%
25	911.9	5,632	581	100	3.6%	3.2%	3.4%
50	1,823.7	11,265	1,163	201	7.2%	6.3%	6.8%
75	2,735.6	16,897	1,744	301	10.8%	9.5%	10.3%
100	3,647.4	22,529	2,326	401	14.4%	12.7%	13.7%

As discussed previously, sweeping may be logistically difficult. Stormwater retrofits to the road network within the Tidal River subwatershed, including green streets, bioswales, or pervious pavement, in conjunction with street sweeping would increase the amount of pollutants removed from the system. These green streets initiatives would require programmatic or policy changes to local ordinances. These road network stormwater retrofits are further described in the Anacostia Watershed Restoration Plan and Report and associated Plan Formulation appendix.

Pollutant Reduction of Homeowner Stormwater Management

Provisional stormwater restoration projects implemented by governmental agencies alone are only one piece of the strategy needed to control stormwater and the pollutants carried into the Anacostia River watershed. Implementing every stormwater project outlined in this inventory will account for an approximate 5-percent increase in the impervious acres controlled by stormwater management within the Tidal River subwatershed. However, with approximately 12,000 residential homes in the subwatershed, there is also the need to involve private homeowners in the stormwater control effort. Homeowner efforts would target stormwater from the roofs, driveways, and sidewalks. A number of stormwater control treatments, or homeowner BMPs, are available for application: green roofs, rain gardens, rain barrels, permeable pavement, and downspout disconnects. Additional information on homeowner BMPs can be found in the Plan Formulation appendix to the Anacostia Watershed Restoration Plan and Report.

Table 3-7 summarizes the number of residential homes throughout Tidal River subwatershed and the related impervious acreage. The impervious acreage that is occupied by single family homes, multi-family homes, single family home driveways, and sidewalks equals approximately 2,290 acres of the 6,239 total impervious acres, or 37-percent within the subwatershed. Stormwater management controls on this acreage could contribute significantly to reducing pollutant and stormwater inputs throughout the watershed.

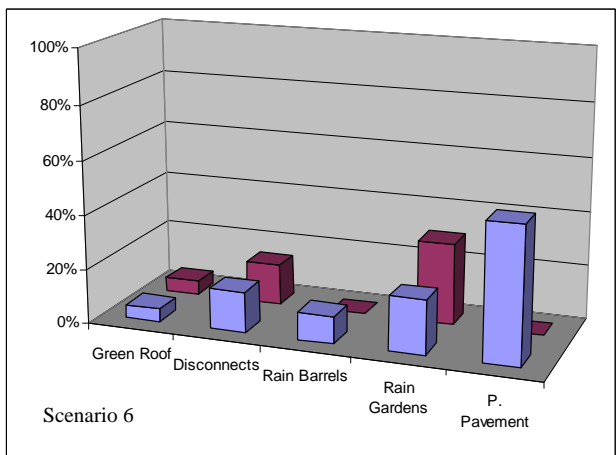
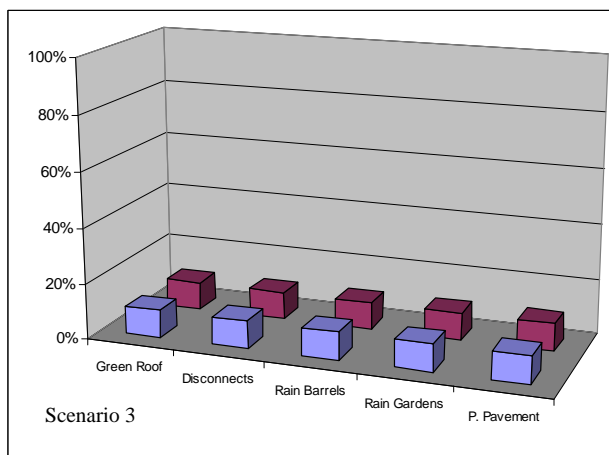
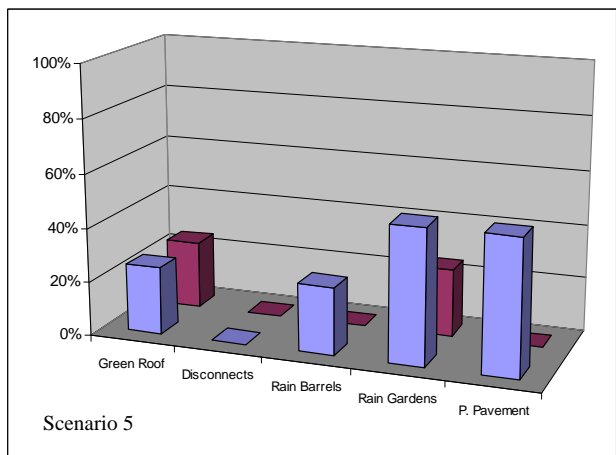
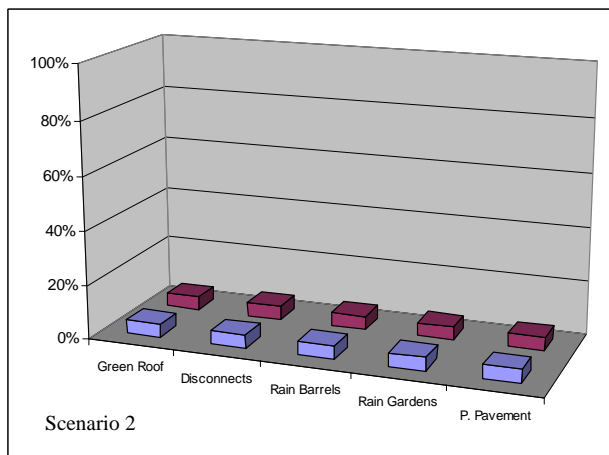
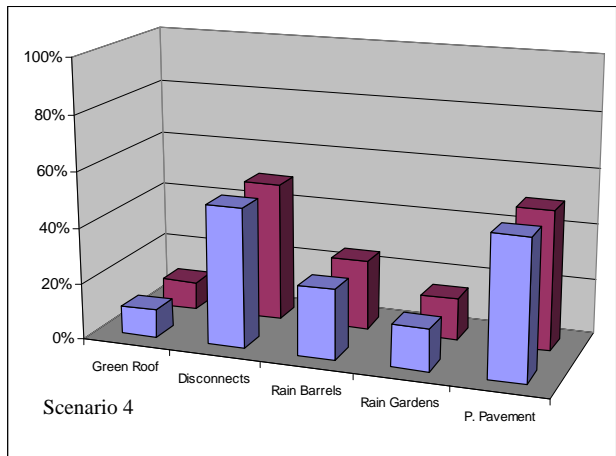
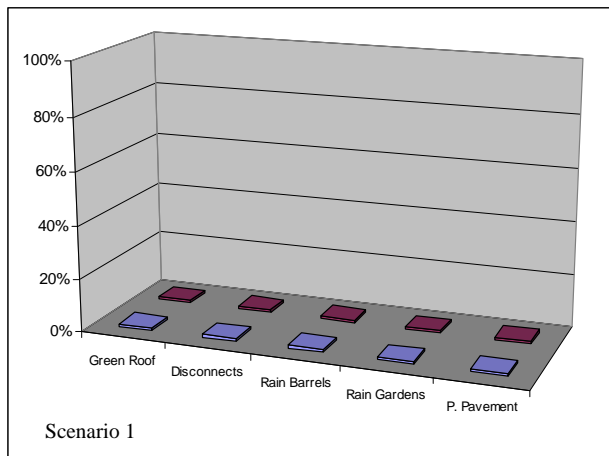
Table 3-7 : Tidal River Subwatershed Impervious Acres Analysis of Residential Homes					
Watershed Area	Number of Residential Homes	Impervious acres			
		Single Family Homes	Private (non-single family)	Single Family Home Driveway	Sidewalks
Tidal Subwatershed	12,501	271.5	1,680.4	168.7	169.4

An evaluation was performed, using the WTM, to investigate the potential of the homeowner BMPs to control the stormwater inputs produced by residential homes within the subwatershed. Four of the practices are focused on rooftop runoff: green roofs, rain barrels, rain gardens, and downspout disconnections. The fifth practice directly applies to sidewalks and driveways. Six scenarios of various combinations of the five BMPs were evaluated.

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 drive way 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 drive way 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 acres 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, multi-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, multi-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 all 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.

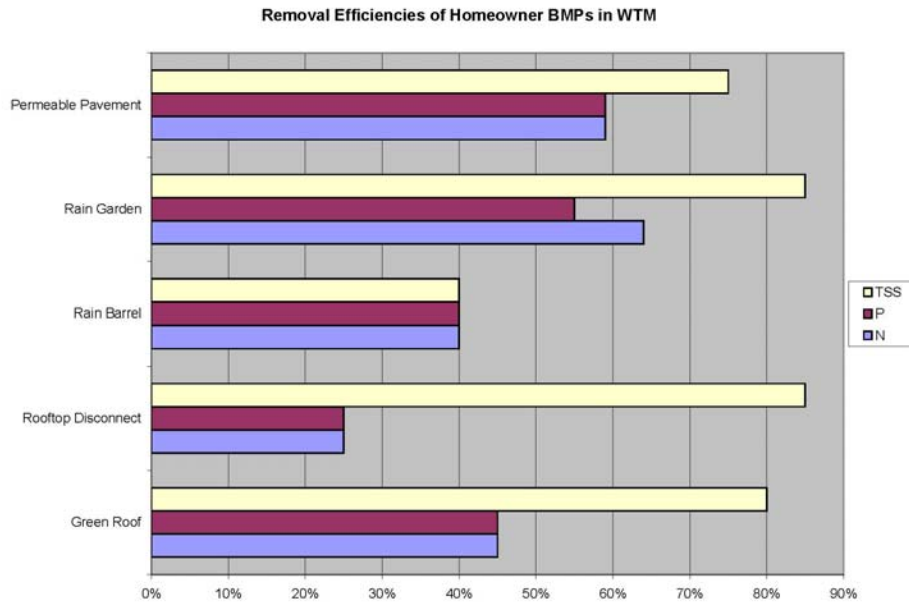
Figure 3-3 illustrates the 6 scenarios of homeowner BMPs were analyzed.

Figure 3-3: Homeowner BMP Scenarios



The efficiencies used by the WTM for pollutant reduction estimates when evaluating the first four scenarios of homeowner BMPs are presented in Table 3-8 and Figure 3-4

Figure 3-4



	Pollutant Removal Efficiencies of WTM			
	N	P	TSS	Bacteria
Green Roof	45%	45%	80%	0%
Rooftop Disconnect	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.

These scenarios evaluate potential plans that could be set as targets for homeowner participation in stormwater control programs. Tables 3-9 and 3-10 provide an estimate of the potential for each of these scenarios to reduce the current pollutant loadings to Tidal River.

Scenario	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)	Bacteria (billions cfu/yr)
1	831	95	24	12,566
2	4,153	473	119	62,831
3	8,307	947	237	125,661
4	18,808	2,181	624	188,492
5	16,222	1,806	408	357,853
6	13,517	1,481	376	359,504

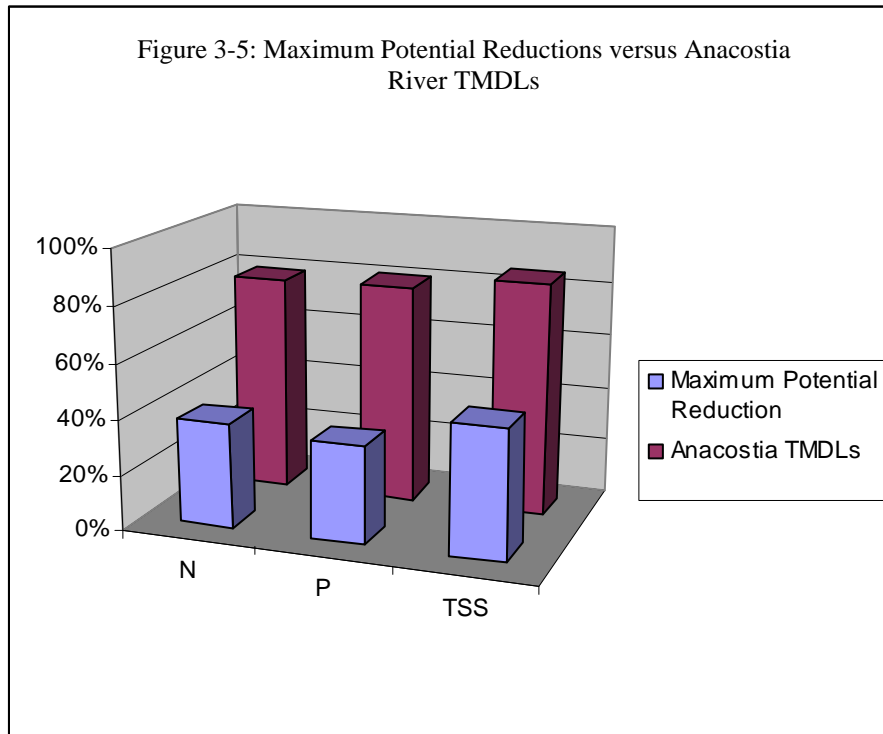
Scenario	N	P	TSS	Impervious Acreage Controlled	Percent of Residential Impervious Acreage Controlled
1	1%	1%	1%	203.6	8.9%
2	3%	3%	4%	407.3	17.8%
3	5%	5%	8%	814.6	35.6%
4	12%	12%	21%	2,121.0	92.6%
5	10%	10%	14%	1,280.8	55.9%
6	9%	8%	13%	1,145.0	50.0%

A significant fraction of pollutants could be controlled if homeowner stormwater controls were implemented over a large portion of the subwatershed. In order to achieve this, an effort needs to be put forth to increase public awareness and participation, so that all the citizens of the subwatershed are working together toward the common goal. Local governments can encourage this through significant outreach, coordination, technical assistance, and funding to extensively apply a homeowner's stormwater management control program. If implemented, such programs have the potential to greatly reduce the pollutant loads to the subwatershed, particularly when implemented alongside provisional stormwater management projects implemented by local governments.

Table 3-11 and Figure 3-5 presents a summary of the potential pollutant load reductions that could be achievable by implementing the aforementioned projects, and compares them to the TMDL reductions goals that were established for the Anacostia River. The numbers presented here, however, do not necessarily account for the interactions of the projects with one another and are clearly subject to some double-counting of reductions. Therefore the numbers in Table 3-11 should not be considered in any further calculations, but rather taken in more relative terms of what is achievable. This double counting of reductions is likely attributed to double coverage of residential acreage through homeowner BMPs, green streets in residential areas, and sweeping of residential streets, because all three of these potential project types were considered independently when in reality they would affect the same physical acreage on a map. Likewise, the combining of stormwater retrofit projects with other practices would lead to same reductions being accounted for in multiple projects. The Plan Formulation appendix of the main document addresses this occurrence in more detail.

Therefore, when considering the results of this analysis, it should be viewed not from the standpoint of whether or not a certain level of reductions can be achieved in 10 years, but rather what significant contributions can be made toward creating a healthier Anacostia River watershed. The data presented in this report is an encouraging indicator that it is not too late to take the steps necessary to improve the environmental conditions in the Anacostia River. The projects recommended in this report are a great start down that path, but they need to be supplemented with increased community involvement, a strong education effort, and more environmentally friendly policies. The goal should be to look back in 10 years and see the progress that has been made in restoring the Anacostia River and its subwatersheds.

Table 3-11: Maximum Potential Pollutant Reduction for Stormwater Controls, Homeowner BMPs, and Street Sweeping			
	N (lbs/yr)	P (lbs/yr)	TSS (tons/yr)
Current Tidal River Loading	156,380	18,333	2,934
Tidal River Reduction Goals	123,540	14,666	2,494
Maximum Possible Reduction			
Stormwater Controls (5% of Impervious Acreage Controlled)	2,987	477	94
LID Green Streets (acres)	31,095	3,202	716
Homeowner BMPs (Scenario 4)	16,222	1,806	408
Street Sweeping (75% of roads and 50% of lots)	9,069	917	171
Total Maximum Possible Reduction	59,373	6,402	1,389
% Total Possible Reduction in Tidal River Loading	38%	35%	47%



Section 4 10-Year Targets and Milestones

Tidal River 10-Year Targets and Milestones

The Tidal River 2020 Restoration Targets were determined based on the potential implementation of restoration opportunities identified within the Tidal River subwatershed as part of the ARP, along with realistic expectations of what could be accomplished in ten years to meet the 2020 restoration objectives, and as such the target numbers do not necessarily represent the implementation of every project in the potential inventory. These targets are established to ensure that restoration of the subwatershed is proceeding in the right direction and at a continuous, reasonable pace.

Stormwater Management

Using LID, ESD and other stormwater management techniques, stormwater retrofit projects should be implemented to control approximately 306 acres of existing impervious surfaces. This represents a 5-percent increase of controlled impervious surfaces.

Operate and maintain existing stormwater management facilities, stormwater drainage systems, and water and wastewater systems.

Aquatic Community

Increase the general Index of Biotic Integrity (IBI) scores to “Fair Range” for both fish and macroinvertebrate communities.

Implement the four fish passage projects identified to open portions of Tidal River and tributaries for the movement of both residents and migratory fish.

Trash Reduction

Using the MWCWG Trash Index for reference, reduce trash levels one tier from High to Medium or from Medium to Light.

Increase existing street sweeping programs to sweep approximately 120 additional curb miles weekly of residential and other roads. Additionally, increase sweeping of parking lots so that a total of 700 acres is swept.

Wetland Creation and Restoration

Create or restore approximately 29 acres of permanent wetlands.

Riparian Corridors

Create, restore, or treat approximately 17 acres of riparian and upland forest, and manage invasive species on approximately 40 acres.

Based on the Anacostia Watershed Forest Management and Protection Strategy and the Center for Watershed Protection recommended tree canopy cover as a percentage of land area, increase the overall tree canopy over 40-percent.

Environmental Restoration Programs

Consider the implementation or expansion of programs designed to assist private property owners in controlling impervious surfaces with measures such as rain barrels and rain gardens.

Land Acquisition

Acquire approximately 24 acres of land or easement to improve connectivity of parkland, riparian cover, and wildlife corridors.

Outreach and Public Participation

Increase both the outreach and education programs for schools and private businesses on the restoration and protection of Tidal River subwatershed.

Establish a local community group for this subwatershed, and launch a membership drive.

Promote homeowners and private business restoration incentives, such as reusable grocery bags, rain gardens, rain barrels, and tree planting.

Expand existing programs to provide homeowners with access to BMPs such as rain barrels.

Promote passive uses of existing parkland and employ more eco-friendly techniques in areas designated for high usage such as un-paved walking paths and higher mowing heights.