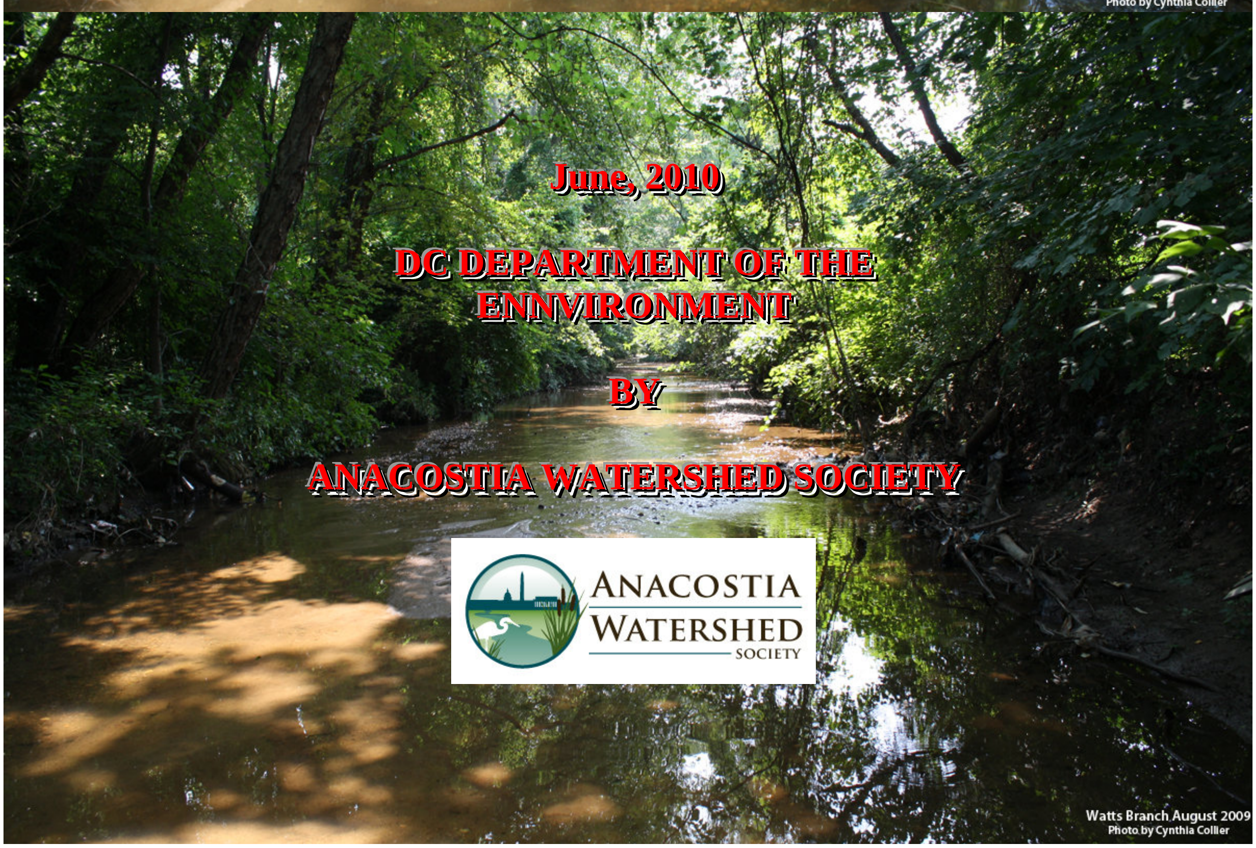
ANACOSTIA OUTFALL TRASH MONITORING AND TMDL

June, 2010

DC DEPARTMENT OF THE ENNVIRONMENT

BY

ANACOSTIA WATERSHED SOCIETY



ANACOSTIA OUTFALL TRASH MONITORING AND TMDL

Prepared for:
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EXECUTIVE SUMMARY

Introduction

The District of Columbia is a signatory to the Trash Free Potomac Watershed Treaty, an agreement to have the Potomac River and tributaries trash free by the year 2013. The District has decided to focus its efforts on the Anacostia. Consequently, the Department of the Environment (DDOE) decided to develop the Anacostia Watershed Trash Reduction Plan. The purpose of the plan is to conduct the necessary research and develop a comprehensive framework that will guide the trash reduction efforts in the watershed. Upon completion of the Trash Total Maximum Daily Load (TMDL) for the Anacostia, the Trash Reduction Plan will serve as the implementation plan for the TMDL in the District of Columbia portion of the watershed. It will also guide efforts in Rock Creek and the Potomac. This report documents the outfall monitoring necessary to develop the loading rates for the storm sewer system to be used in the TMDL.
In 1996, the District of Columbia developed a list of waters that do not or are not expected to meet water quality standards as required by section 303(d)(1)(A). The list was updated in 1998, 2002, 2004 and 2006. This list, submitted to the Environmental Protection Agency every two years, is known as the Section 303(d) list. For each of the listed waters, states are required to develop a Total Maximum Daily Load (TMDL) which calculates the maximum amount of a pollutant that can enter the water without violating water quality standards and allocates that load to all significant sources. Pollutants above the allocated loads must be eliminated. The District of Columbia 2006 303(d) list, as approved by EPA, specifies that the Anacostia River is impaired by trash. The State of Maryland has also listed their portion of the Anacostia as impaired by trash. The District and Maryland are currently working to develop a TMDL for trash. The TMDL will determine the level of trash that can be in the river and will assign load reductions (allocations) to the point and nonpoint sources. The load reductions will become a part of the discharge permits for the systems which discharge trash to the Anacostia River. In the District of Columbia the two main ones will be the WASA combined sewer system regulated under the Blue Plains Wastewater Treatment Plant permit and the storm sewers regulated under the stormwater permit. Once the allocations are in the permit, trash reduction is no longer a voluntary exercise, but a mandated enforceable provision of the permits.

Background

In 2008, the Anacostia Watershed Society developed for the District of Columbia Department of the Environment the Anacostia Watershed Trash Reduction Strategy. This Phase I project included the collection and analysis of data on the levels of trash in the Anacostia River and tributaries and on the land. From the data, a set of subbasin strategies was devised to reduce the amount of trash reaching the waterways.

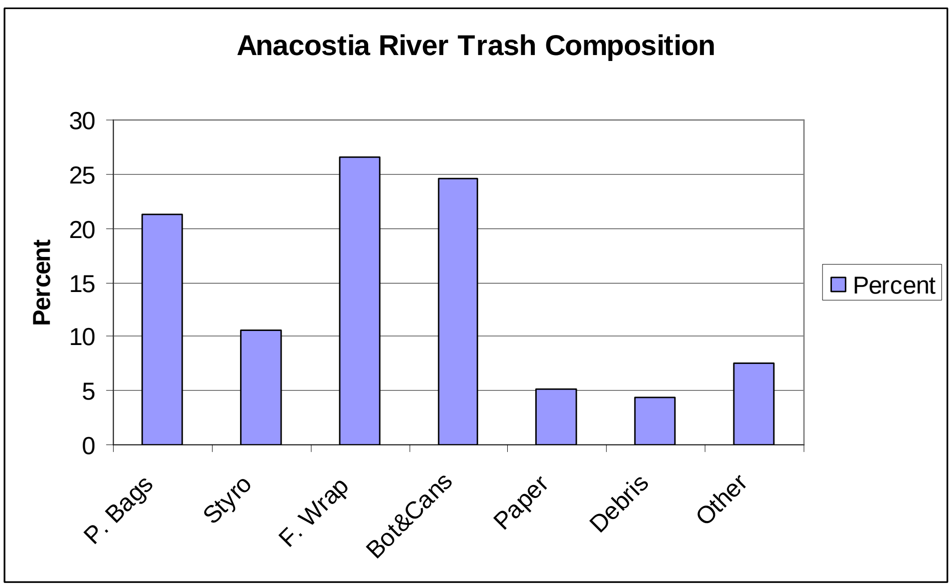
The Anacostia watershed is approximately 117,353 acres with the drainage area being 49% in Prince George's County, 34% in Montgomery County, and 17% in the District of Columbia. Land use is mostly residential and forest. The watershed is 30% park and forest lands which are evenly dispersed throughout the watershed such as the National Park Service's Anacostia Park and Greenbelt Park, and the US Department of Agriculture's National Arboretum and Beltsville Agricultural Research Center. The industrial and manufacturing land use is largely confined to the tidal area of the basin, such as Hickey Run, Lower Beaverdam Creek, and Indian Creek. These creek sub-watersheds contain impervious land uses as high as 80%.

In the District, the Anacostia watershed is heavily urbanized. The Anacostia River watershed's municipal separate storm sewer system (MS4) consists of 9,460 acres with 168 outfalls. The drains carry the rainwater into the streams and rivers when they discharge. The remaining areas are served by combined sewers that may overflow during rainstorms, discharging sanitary sewage, storm water, and trash to the river.

Phase I Trash Data

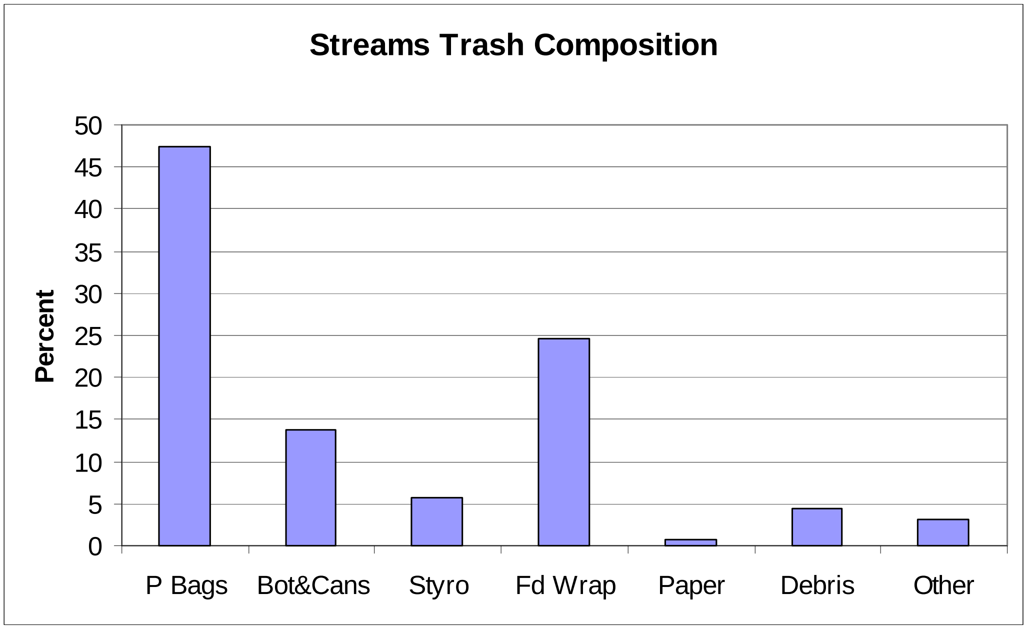
During the Phase I project, monitoring was done to determine how much trash was present in the Anacostia watershed. All of the tributary streams and the main stem were surveyed for trash. Composition and quantity were determined quarterly for a year. Land use transects were also surveyed for composition and quantity quarterly for a year. Each street in the watershed was surveyed quarterly for quantity only. The largest categories of trash are plastic bags, Styrofoam products, snack wrappers (potato chip and candy bar packaging) and bottles and cans. They compose nearly 85 percent of the items (Figure 1).

Figure 1: Anacostia River Trash Composition



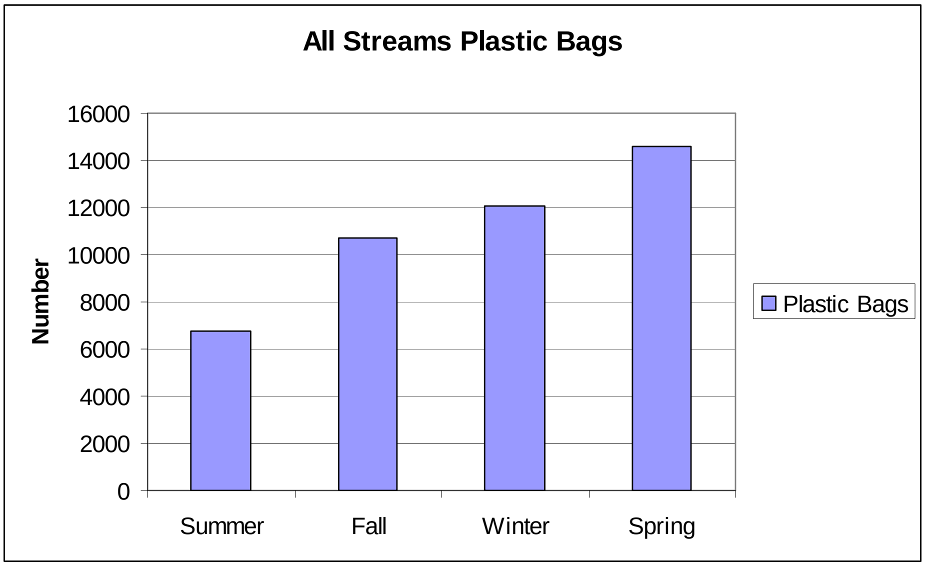
In the tributary streams, the plastic bags dominate all other categories (Figure 2). This appears to be related to the amount of brush and vegetation that will snag the bags. Bottles and cans, Styrofoam and snack wrappers are also prevalent. Paper products are not found in the streams except in very localized areas.

Figure 2: Tributary Stream Trash Composition



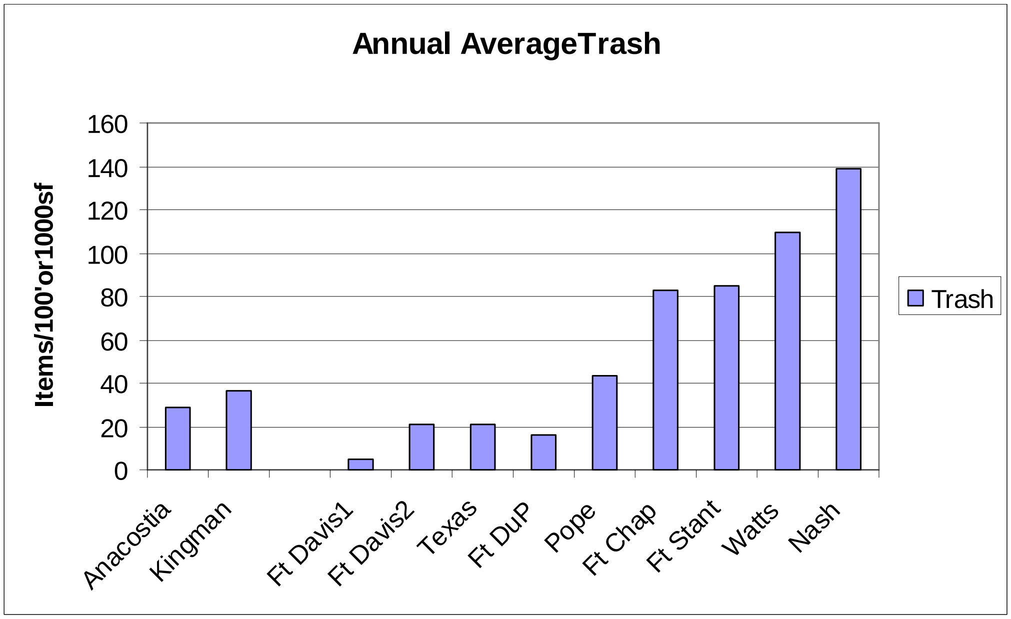
Plastic Bags in the tributary streams doubled over the one year survey period (Figure 3). It is unclear whether this trend will continue on a long term basis.

Figure 3: Seasonal Variation of Plastic Bags in Streams



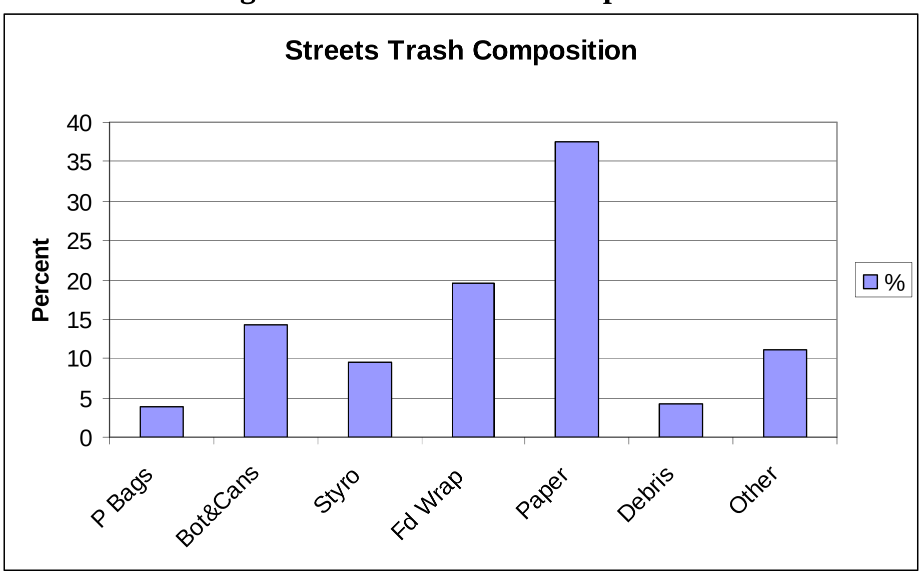
The Anacostia River and Kingman Lake have about the same amount of trash per visible intertidal area. For streams, both sides and the bottom are counted. There were several fairly clean streams that had trash levels of 20 pieces per 100 feet or less. Pope Branch is an intermediately affected stream and Ft Chaplin, Ft Stanton, Watts Branch and Nash Run are heavily impacted by trash (Figure 4).

Figure 4: Annual Average Trash



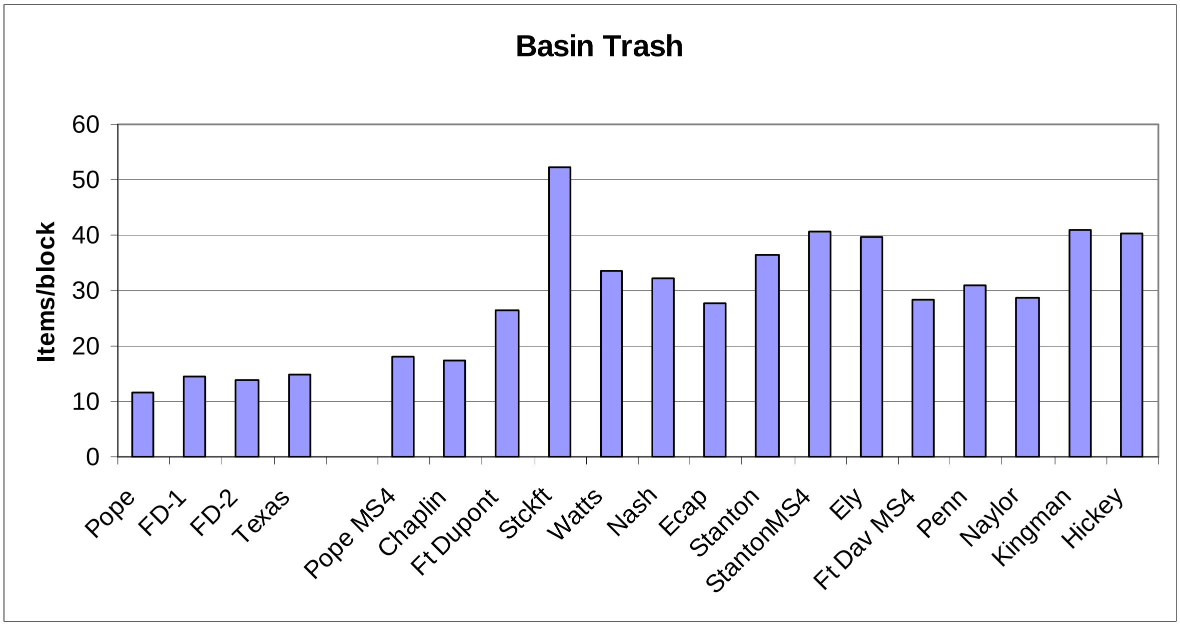
Various types of land uses were surveyed. The streets were surveyed and were categorized as residential, commercial, or industrial. The trash from the street surveys was dominated by paper products (Figure 5).

Figure 5: Streets Trash Composition



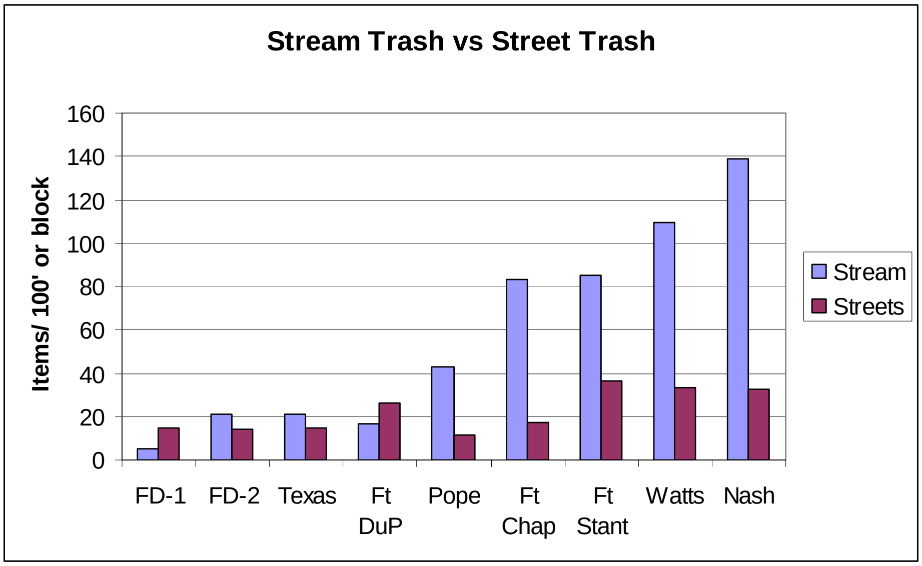
A windshield survey was conducted quarterly for each stream in an MS4 drainage basin. Trash was counted per block on one side. The windshield count achieved 85 percent accuracy when compared to detailed transect counts that were conducted on the same street. Some basins have cleaner streets than others as shown in Figure 6, but it appears that there are about 30 items per block on average for one side. In general, the residential streets had less trash than commercial streets.

Figure 6: Basin Trash



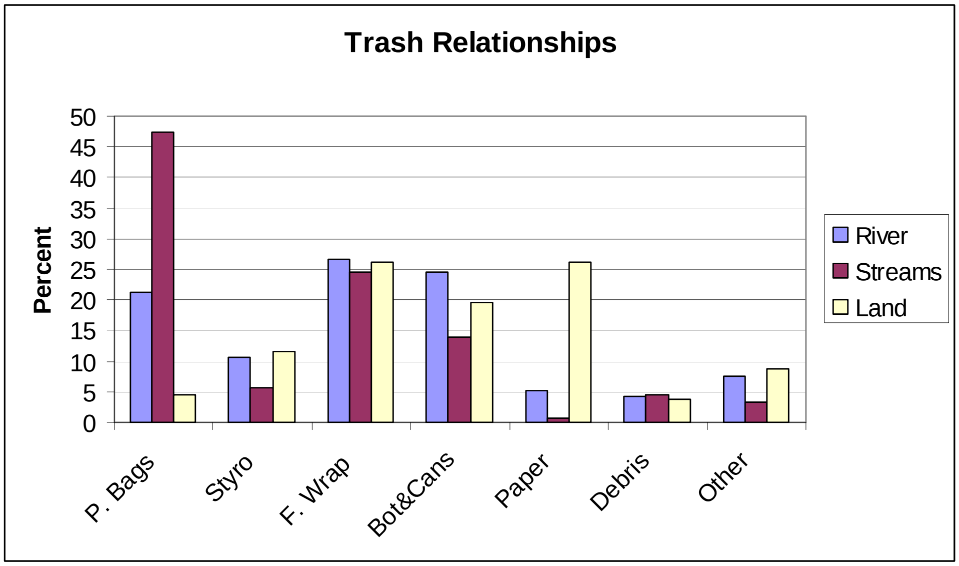
The channel roughness affects whether plastic bags and food wrappers are snagged and bottles are trapped. Data were converted to determine trash per acre in the drainage basin and then compared to average stream trash levels; however, this did not provide any valuable insight. The number of items per block as determined from the windshield survey is a good "indicator" of trash levels in a stream, but not a quantitative "predictor" (Figure 7).

Figure 7: Stream Trash vs. Street Trash



The types of trash from the river were compared to the types found in the streams and on the land (Figures 8).

Figure 8: Trash Relationships



The data suggests a relationship between plastic bags and snack items and drink items. This would suggest that often when a person purchases a drink and a snack such as chips, the bag becomes litter, the drink container or cup becomes litter and the snack wrapper becomes litter. Paper products such as napkins and paper bags are common on the land but are seldom found in stream channels. Debris is constant. There is very little trash that does not have a relationship to eating or drinking. The ratio of bottles and cans found would be more uniform, but the bottles tend to be broken in the streams and there are a lot of glass fragments present in the streams.

Phase II Outfall Monitoring

There were ten land uses monitored at the outfall between January 2009 and August 2009. Any rainfall event that was of significant magnitude and intensity to transport trash was monitored. Once a significant storm had been captured then the outfall trash trap was emptied and placed back in service. All trash and debris over one inch in size was captured and counted. The same format and breakdown of trash that was used for the Phase I data collection effort was used here. All trash collected was disposed of properly. The data for the winter season was not collected due to time constraints of the TMDL schedule.

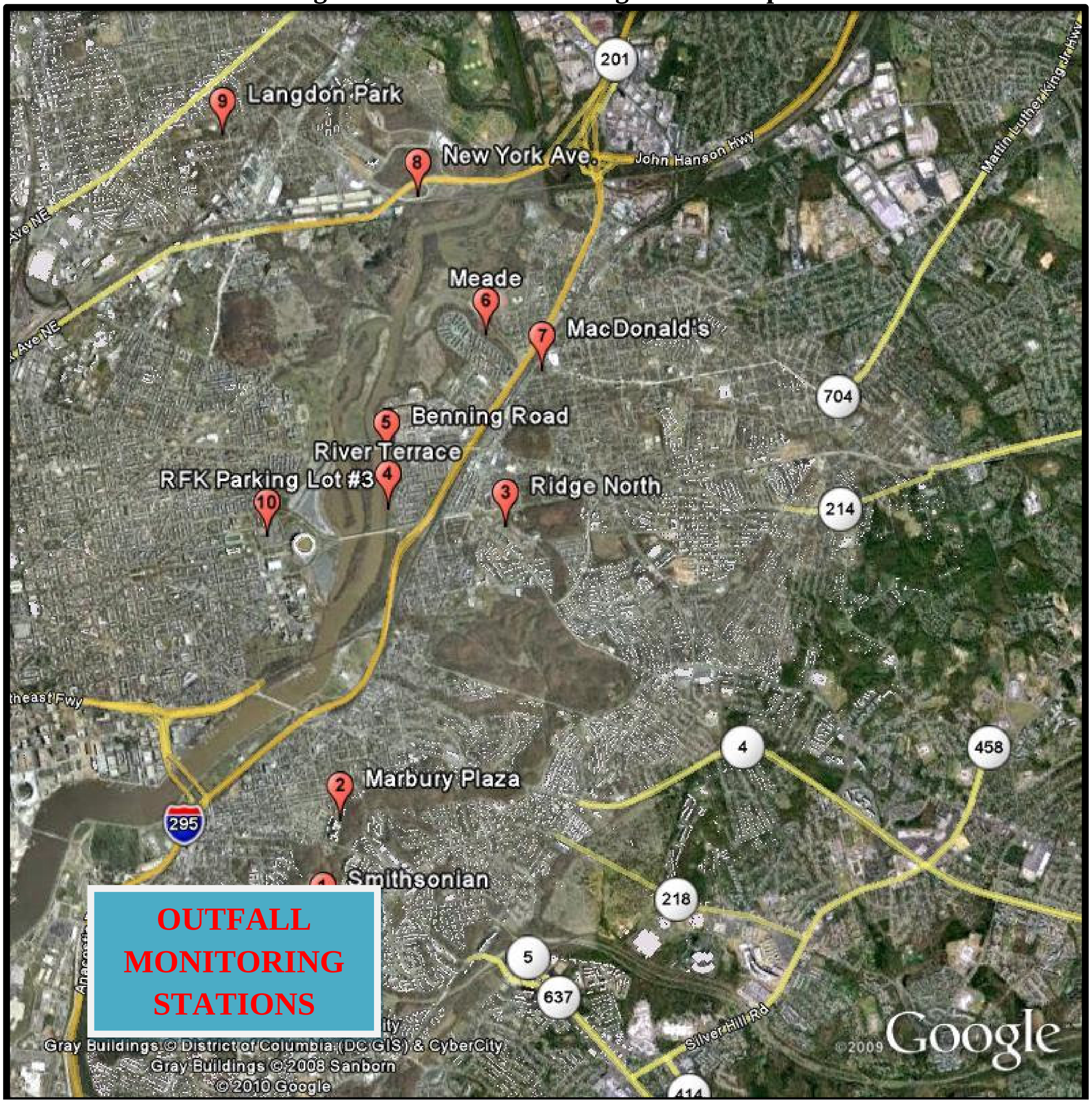
The land uses monitored were a condensed version of those used by the DC Office of Planning. Several similar land uses were combined into a single category. Potential stations for each land use to be monitored were investigated to ensure it was feasible to perform the work at the site. Permission was obtained from each party responsible for the site and infrastructure.

The sites that were monitored land uses and stream basin are as follows:

A. Low Density Residential -Meade Street - Watts Branch
B. Low-Medium Density Residential - River Terrace Anacostia Avenue, Blaine to Capitol St- Anacostia River
C. Medium Density Residential - Ridge/Burns Subdivision- Storm water pond
D. High Density Residential – Marbury Plaza - Ft Stanton
E. Commercial - Benning Road – Anacostia River
F. Industrial/ Mixed Uses- Near McDonald’s on Nannie Helen Burroughs – Watts Branch
G. Parks and Open space- Langdon Park – Hickey Run
H. Institutional/ Federal Public/Local public/ Quasi-public- Smithsonian Anacostia Community Museum - Ft Stanton
I. Transport, Communication, utilities Roads/ Alleys Median. Transportation right of way - New York Avenue and South Dakota Avenue interchange storm water pond
J. Public Parking Area –RFK Stadium Lot #3

Two sites were inlets to storm water BMPs and three sites were inlet grates instead of outfalls to waterways.

Figure 9: Outfall Monitoring Station Map



Sampling Methods

Trash, manmade debris and natural material were captured at either the entrance to the storm sewer or the outfall at the stream. The capture devices had a mesh opening of one inch, which was compatible with the definition of trash used in the Phase I report. Trash was manually removed from each trap and placed in buckets and/or plastic bags and labeled. The trash was allowed to drain excess water and all bottles were emptied of fluids.

Trash items that were collected were transported from the stream in plastic trash bags and a total weight obtained per sample site. Each sample was hand sorted into trash items and natural vegetation, sediment and gravel items. The weight of each category was obtained. Trash items were further inventoried into the separate categories used in the Phase I report.

Monitoring Dates

Trash traps were installed as permission was received from the entities controlling the property. This resulted in a delay in some of the traps becoming operational. The traps were serviced as quickly after a rainfall event as possible. However, on occasion one rainfall event would immediately follow another and some traps would have collected trash from both events. The objective was to capture four significant storms and once that was accomplished the traps were removed, around June 1, 2009. However, after reviewing the data from the four storms that were captured, it was decided to reinstall the traps and collect more data as long as the schedule would permit. The end of data collection was determined by the regulatory agencies in order to meet the schedule for preparation of the TMDL. Consequently, all traps have data for at least seven storms and some of the traps have data for eight storms. Traps were designed to fail prior to damaging the infrastructure of the sewers and several of the traps were damaged by storms and no data was collected for those damaged traps until they were repaired.

Rainfall

Rainfall data was collected from the Eckington weather station based upon its proximity to several of the trash trap locations. Dates denoted with an asterisk were comprised of several discrete storms. In particular, on May 18 rain began falling before all traps could be cleaned from the previous rain so some of the traps collected two rainfall events

Table 1: Rainfall Data

Date	Total Inches	Duration Hours	Maximum Intensity (In/Hour)
29-Mar	1.1	50	0.5
22-Apr	1.59	50	1.5
4-May	1.2	38	0.5
8-May	1.76		0.7
18-May*	0.79		0.6
18-May	0.34		0.6
26-May	2.22	4	4
29-May	0.94	1	3
1-Jun	1.18		3
23-Jul	3.19	1	4
31/7-2/8*	0.63	1	3.5
17-Aug	0.42		2.5
18-Aug	0.37		3.5
22-Aug	0.57	5	0.3

Drainage Areas

For each land use site that was monitored the entire drainage area was field verified. The percent imperviousness was checked in the field and calculated from Google Earth maps. The amount of trash for industrial land use at McDonald's site was determined by backing out the calculated contributions from commercial based on the Benning Road site loading rate and the residential contribution using the Meade site loading rate.

Table 2: Drainage Areas

Site	Land use	Square Feet
Langdon	Open Space	145,420
RFK Lot #3	Parking	94,532
NY Ave BMP	Transportation	66,030
Meade Street	Lo Density Residential	587,112
McDonalds	Mixed: Comm. 22.9%, Indust.: 12%, Resid 65.1%	324,101
Benning Rd	Commercial	512,848
River Terrace	Lo-Med Density Residential	720,372
Ridge North BMP	Hi-Med Density Residential	212,137
Marbury Plaza	Hi Density Residential	62,909
Smithsonian	Institutional	135,127

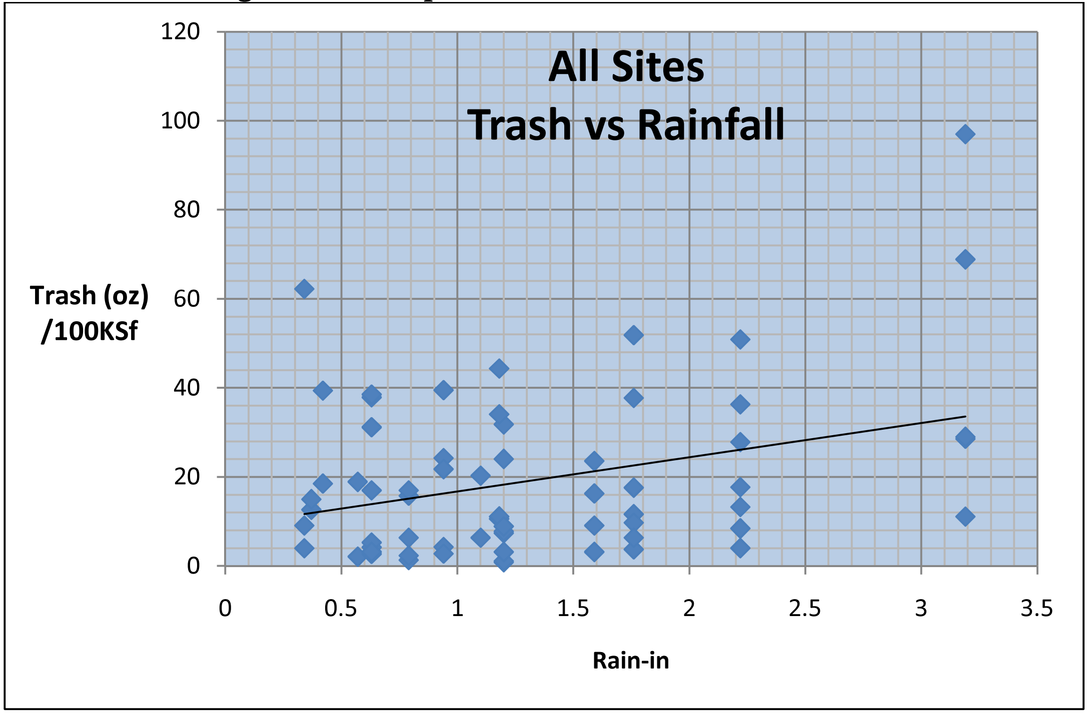
The weight of trash for each site and each rainfall event was normalized to the weight of trash per 100,000 square feet of drainage area. This provides a weight of trash per unit area so that it can later be used to multiply times the total area of that type of land use that drains to the Anacostia River.

Table 3: Trash Weight (oz) per 100,000 Square Feet for Each Storm for Each Site

Site		Langdon	RFK	NYA	Meade	Mc Donalds	Benning	River Terr	Ridge N	Marbury	Smith sonian
Area		145,420	94,532	66,030	587,112	324,101	512,848	720,372	212,137	62,909	135,127
Date	3/29								20.28	6.36	
	4/22	0		9.09					23.58	3.18	16.30
	5/4	0	7.41	31.82	0.85	8.95	9.36	1.11	24.06	3.18	8.89
	5/8	0	11.64		3.75		30.99	9.72	37.74	6.36	51.85
	5/18				1.36		12.48	2.36	16.98	6.36	
	5/18	0		9.09		4.01					62.22
	5/26	4.14	8.47		17.72	13.27	18.71	4.03	27.83	50.87	36.30
	5/29	0		24.24	4.26	39.51	20.47	2.78			
	6/1		10.58						44.34	11.13	34.07
	7/23	0	28.57	96.97		29.01		11.11	68.87		
	7/31-8/2*	0.345	4.23	37.88	2.723	31.17		5.28	16.98	3.18	38.52
	8/17			39.39		18.52					
	8/18				3.07	12.65	15.01				
	8/22		2.12				18.91				

All of the data was compiled and plotted and there was a clear trend of more trash reaching the storm sewers with larger rainfall events.

Figure 10: Composite of Trash and Rainfall Data



Loadings by Land Use

The McDonald's site was comprised of three different land uses. The land use of interest was the industrial site. In order to determine the loading from the industrial site the percentage of the total loading rate from the other two land uses were subtracted and the remaining loads were attributed to the industrial site. For the low medium density residential portion of the drainage area the loading rate from the River Terrace site was used and multiplied times the area involved. For the commercial portion of the site, the rate from the Benning Road site was used. The industrial facility had truck door security seals in the mixed trash captured that were easy to verify when the facility was inspected for trash types. The derived loading rates per land use category are shown below. The loading rates from the low-medium density land use are lower than the loading rates from the low density residential land use. This may be the affect of the River Terrace community being swept on a weekly basis and the Meade community not being swept. The following chart shows the loading for each land use in ounces per one inch of rain per 100,000 square feet or drainage area. The Smithsonian loading rates were extremely high for an institutional facility. While certain items in the trash recovered proved that the facility contributed trash to the outfall, it was easily observable that the amount of vehicular and foot traffic was creating a large amount of trash in the street gutters and that it was also reaching the trash trap.

Table 4: Loading Rate (oz per 1 inch of rainfall per 100,000 square ft) by Land Use

Parkland	Low-Res	Lo/M- Res	Med res	Hi-D- Res	Commercial	Industrial	Parking	Transport	Institution
Langdon	Meade	River Terr	Ridge N	Marbury	Benning	MacDonald	RFK	NYA	Smithsonian
0.30	4.24	3.72	21.66	7.44	20.73	17.74	6.42	29.21	48.07

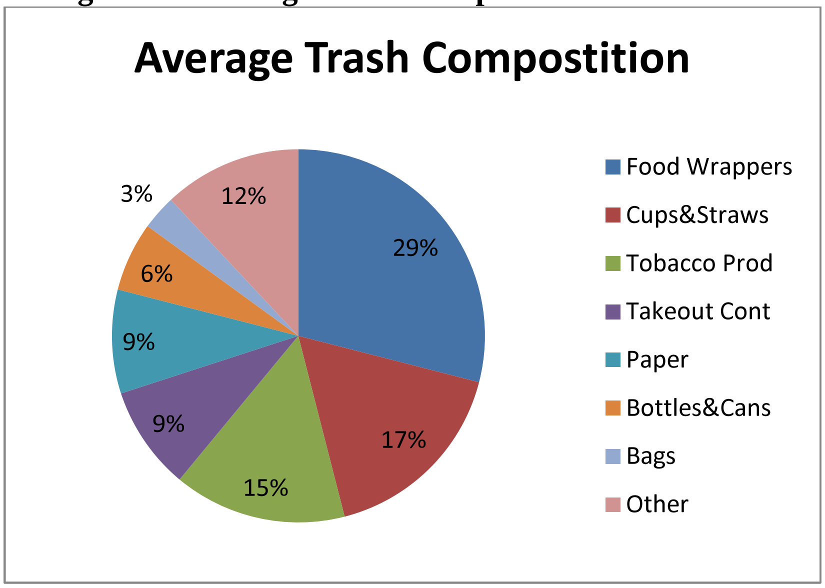
The average number of items per inch of rain per 100,000 square feet was calculated.

Table 5: Loading Rate (# of items per 1 inch of rainfall per 100,000 square ft) by Land Use

Parkland	Parking	Transport	Low-Res	Multi	Comm	Lo/M- Res	Med res	Hi-D- Res	Institution
Langdon	RFK	NYA	Meade	MacD	Benning	River Terr	Ridge N	Marbury	Smithsonian
0.35	28.00	28.34	12.77	96.92	75.06	9.60	80.11	26.88	102.46

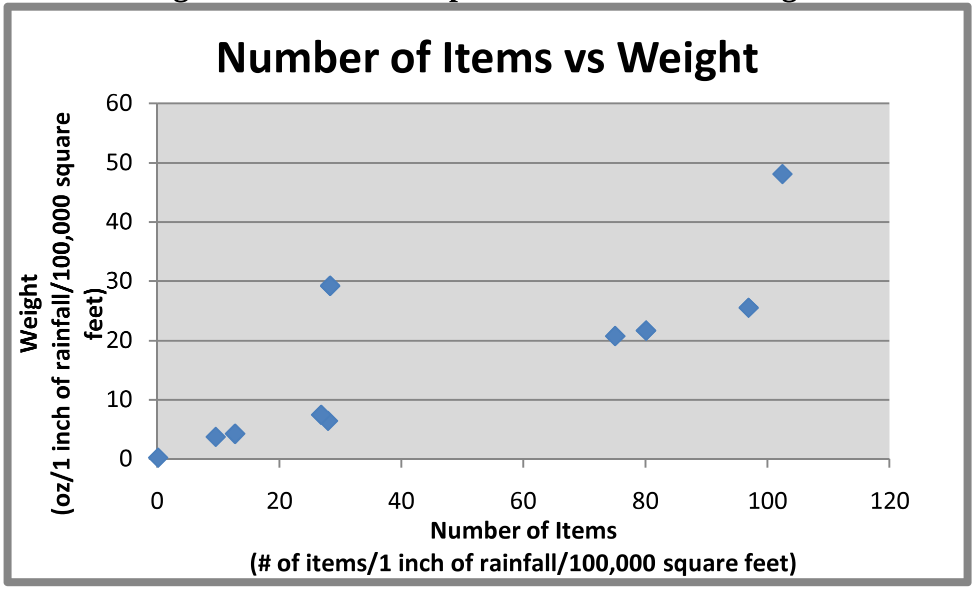
The average composition of the items is shown in Figure 11. Paper products in the streams and river are between 1-5 percent of the total trash load. At the outfall they represent about 9% of the trash load. On the street, paper is about 38% of the total trash.

Figure 11: Average Trash Composition at the Outfall



There is a very distinct linear relationship between the weight of trash per inch of rain per 100,000 square feet and the number of items.

Figure 12: Relationship between items and weight



Vegetative Material

Based upon the methodology selected for the trash-only component of the storm water, it was decided to use the same approach for the amount of leaves, grass clipping, twigs and other vegetative material. For each sample that was collected a total weight was obtained and a weight for trash and a weight for natural material. The percentage of the total weight that was natural material is shown below.

Table 6: Percentage of vegetation in the samples

Site	Langdon	RFK Lot #3	NY Ave BMP	Meade	McDonald's	Benning	River Terr	Ridge North	Marbury	Smithsonian
% of total	81	84.6	81.7	81.2	71.4	48.6	74.97	36.95	85.5	87.4

Final Loading Rates by Landuse

Only ten land uses were actually monitored. Consequently, it was necessary to assign loads to those categories of land uses that were not monitored. The loading rates for the institutional landuse were very high because of the amount of street litter. Data from the Phase I report[1] was inspected and the street litter in the Stickfoot subbasin was determined to be double the average of the other subbasins. It was decided to normalized the rates to those of the other subbasin by reducing it by 50%. Public facilities were assigned the same value as institutional facilities. Federal facilities were assigned a value of half of the institutional and public facilities because most of the federal facilities have their own trash reduction programs. The final land use values used in the Trash TMDL for the Anacostia River are given in Table 7. These loading rates may

[1] Prior to this Outfall Monitoring (Phase II), a study (Phase I) for the Anacostia Watershed Trash Reduction Plan was conducted and published in 2008, ***ANACOSTIA WATERSHED TRASH REDUCTION PLAN*, prepared for District of Columbia Department of the Environment, Prepared by the Anacostia Watershed Society**

be used to develop the contribution of trash to the Anacostia River from each land use by multiplying by the total area of the land use and then multiplying by the average annual rainfall.

Table 7: Landuse Loading Rates for the Anacostia Watershed

Land Use Category	Oz/In/100KSF	Lb/in/Acre
Low-Density Residential	4.24	4.52
Low-Medium-Density Residential	3.72	3.96
Medium-Density Residential	12.99	13.84
High-Density Residential	7.44	7.93
Commercial	20.73	22.08
Industrial	17.74	18.9
Institutional	23.89	25.45
Major Roads, Transport, Communication, Utilities	29.21	31.12
Public Facilities (Local Public, Quasi Public, Institutional)	23.89	25.45
Federal Facilities	11.99	12.78
Parking	6.42	6.84
Parks and Open Spaces	0.30	0.32

TMDL

A TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards or goals. It is composed of the sum of individual WLAs for point sources and LAs for nonpoint sources and natural background levels. In addition, the TMDL must include a Margin of Safety (MOS), implicitly or explicitly, to account for any uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the following equation:

$$\text{TMDL} = \Sigma WLAs + \Sigma LAs + MOS$$

In TMDL development, allowable loadings from each pollutant source are summed to a cumulative TMDL threshold, thus providing a quantitative basis for establishing water quality-based controls. TMDLs can be expressed as a mass loading over time (e.g., grams of pollutant per day) or as a concentration in accordance with 40 CFR 130.2(l). TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In this TMDL, the endpoint is equal to 100 percent removal of the baseline load, calculated as an average (because of high seasonal and annual variability) of the measured or estimated removal rate.

The baseline load is defined as the annual trash load calculated from monitoring data obtained through storm drain monitoring and in-stream sampling. The baseline load represents a typical annual load. The numeric target is derived from the narrative water quality criteria and includes an implicit MOS.

The Anacostia River in the District of Columbia is for TMDL purposes separated into the upper Anacostia which is above the CSX railroad bridge and the lower Anacostia below the railroad bridge. DDOE developed the acreages for each land use category that drained to the segment of the Anacostia. These acreages exclude land served by combined sewers. The average annual rainfall was determined to be 39.11 inches. The acreage and annual rainfall were multiplied times the unit loading rates.

Table 8: Annual Trash Loading Rates

Aggregated land use category	Acres	Unit loading rate (lbs/acre)	Annual load (lbs/yr)
Upper Anacostia	79,874.10		
Low-Density Residential	1,697.57	4.52	7,667.80
Low-Medium-Density Residential	1,267.54	3.96	5,023.20
Medium-Density Residential	657.71	13.84	9,101.70
High-Density Residential	19.31	7.93	153.1
Commercial	431.04	22.08	9,519.10
Industrial	259.86	18.9	4,911.00
Institutional	585.69	25.45	14,905.80
Major Roads, Transport, Communication, Utilities	624.51	31.12	19,433.50
Public Facilities (Local Public, Quasi Public, Institutional)	304.92	25.45	7,760.20
Federal Facilities	67.84	12.78	867.2
Parking	12.22	6.84	83.6
Parks and Open Spaces	1,401.13	0.32	447.8
Lower Anacostia	23,313.80		
Low-Density Residential	204.38	4.52	923.2
Low-Medium-Density Residential	158.16	3.96	626.8
Medium-Density Residential	263	13.84	3,639.50
High-Density Residential	46.05	7.93	365
Commercial	155.67	22.08	3,437.90
Industrial	33	18.9	623.6
Institutional	69.41	25.45	1,766.40
Major Roads, Transport, Communication, Utilities	81.09	31.12	2,523.50
Public Facilities (Local Public, Quasi Public, Institutional)	243.73	25.45	6,202.90
Federal Facilities	240.17	12.78	3,070.30
Parking	0	6.84	0
Parks and Open Spaces (parks and open spaces + undetermined)	421.81	0.32	135

Based upon data collected by MWCOG, the CSO, were assigned a loading rate of 73 pound per million gallons of overflow.

Nonpoint source loads were developed by using the data for trash counted in the streams contained in *the Anacostia Watershed Trash Reduction Plan*. The debris counts per 1000 feet of stream were converted to pound per 1000 ft and assigned as an annual load for nonpoint sources. Debris as defined in that report and this report is manmade objects that will not readily enter a storm sewer because of their size or characteristics.

Using the nonpoint sources loads, the Load Allocation for the Upper Anacostia River and Lower Anacostia River are established.

Table 9: Load Allocation

	Annual LA to be removed	**Daily LA to be removed**
Anacostia Segment	**(lbs/yr)**	**(lbs/day)**
Upper Anacostia	18,343	50.3
Lower Anacostia	1,705	4.7

The Waste Load Allocation is established for each of the point source permits.

Table 10: Waste Load Allocation

		NPDES	**WLA to be**	**Total daily WLA to be**
		permit	**removed**	**removed**
Permittee	**Subbasin**	**number**	**(lbs/yr)**	**(lbs/day)**
District of Columbia MS4	Upper Anacostia	DC0000221	79,874	218.8
	Lower Anacostia	DC0000221	23,314	63.9
District of Columbia CSO	Upper Anacostia	DC0021199	62,401	170.7
	Lower Anacostia	DC0021199	31,185	85.4
Other permits	Upper Anacostia		7,879	21.6
	Lower Anacostia		6,457	17.7
Total Point Source Reduction				**578.1**

Future Activities

The Phase I report recommended a plan for reducing trash based upon prototype work to be performed in Ft DuPont sub watershed and legislation to reduce levels of trash. Assessment of the effectiveness of the Phase I Anacostia Trash Reduction Plan will need to be conducted and the Plan modified as appropriate. The report recommended an ambient trash monitoring program for the streams. The benefit of the program is the long term tracking of in-stream trash quantities. This program needs to be initiated.

Outfall Monitoring

Most of the sites used in this study were single land use sites. The sites were also small by design. Consideration should be given to selecting a larger drainage area with multiple land uses and establishing a permanent outfall monitoring program to measure trash reductions. The storm water pump station near the intersection of Nannie Helen Burroughs and Minnesota Avenue has a mechanically cleaned bar screen and the trash could be weighed prior to loading on the truck. Other storm water pump stations could be investigated to determine the feasibility of also using them for obtaining compliance data. Alternatively, end of pipe capture systems such as the Fresh Creek systems could be employed at suitable outfalls.