Section 1: Introduction

This appendix provides case studies of trash TMDLs in the Los Angeles River and the Anacostia (Section 2), and an overview of options available to control trash in the Tookany-Tacony Frankford. Table 1.1 summarizes the practices reviewed in this section, and an overview of their potential applicability. In general, at least some practices from each section may be applied in this watershed, and the effectiveness of many practices can be improved through better understanding trash loading hotspots as well as the littering behaviors of the population. Finally, trash reduction is one of many goals, and the TTF should join forces with efforts to reduce other pollutants, since many of the practices outlined here also effective at reducing gross solids, sediment and nutrients.

<table>
<thead>
<tr>
<th>Table 1.1 Practices Reviewed in this Appendix</th>
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<tbody>
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<td><strong>Section</strong></td>
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<td>3. Monitoring and Tracking</td>
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Section 2: Trash TMDLs

2.1 Trash TMDL Overview

Nationwide, there is an increasing number of waterbodies listed as impaired by trash. (Approximately 84 as reported on the list of causes of 303d listed waterbodies as of most recent National summary of impaired waters (http://iaspub.epa.gov/waters10/attains_nationCy.control?p_report_type=T#imp_water_by_state). Currently, there are approximately seventy Trash Total Maximum Daily Loads for waterbodies in California, including the first for the Los Angeles River. This report provides an overview of both the Los Angeles River and Anacostia River Trash TMDLs.

TMDL Definition

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background conditions. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for any uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Unlike TMDLs for nutrients that are expressed in mg/l, a trash TMDL is expressed in weight (lbs/mi²) or volume (ft³/mi²). The wasteload allocation focuses on reducing the trash discharged through municipal storm drains.

The TMDL components are illustrated using the following equation:

\[ TMDL = \sum WLAs + \sum LAs + MOS \]

The second part of this chapter provides a summary (profile sheet) of the structural and non-structural Best Management Practices (BMPs) used to achieve trash reductions as defined in the TMDLs. The profile sheets are organized into the following categories:

- End of Pipe
- Catch Basins
- Regulation and Enforcement
- Education and Outreach
- Municipal Operations
- Monitoring and Tracking
2.2 Los Angeles River Trash TMDL Case Study

The Los Angeles River flows 51 miles from the western end of the San Fernando Valley to the Queensway Bay and Pacific Ocean at Long Beach (Figure 2.1). In total, the watershed consists of about 834 square miles of which, 72% consists of incorporated cities and unincorporated portions of Los Angeles County. The remaining area contains the Los Angeles National Forest and other uses. The region has an arid southwestern climate with a rainy season between November and April of approximately 16-20 inches.

Figure 2.1. Map of Los Angeles River Watershed (LARWQCB, 2002).
The Los Angeles River provides many recreational uses and is home to an abundance of fish and bird species. The river’s designated uses include water contact recreation (REC1), Non-Contact water recreation (REC2), warm freshwater habitat (WARM), wildlife habitat (WILD), cold freshwater habitat (COLD) and wetland habitat (WET), Rare, Threatened or endangered species (RARE) spawning, reproduction, and/or Early development (SPWN). In the upper reaches of the watershed, three native species of fish are found that include the Santa Ana sucker (federally endangered species), Santa Ana speckled dace and two state species of concern, the arroyo chub. Dense riparian vegetation provides habitat for wildlife including birds, ducks, frogs and turtles. Recreation includes walking, jogging, horseback riding, bicycling, bird watching, photography and crayfishing. In the lower reach to the estuary many bird species are found including the California Brown Pelican and California Least Tern that are both Federally Endangered Species.

The Los Angeles River (at the Sepulveda flood basin and downstream) was listed as impaired for trash on the 1996 and 1998 Section 303(d) list. In March 1999, a consent decree was reached between the U.S. EPA, the Santa Monica Baykeeper and Heal the Bay, Inc. that required all Total Maximum Daily Loads (TMDL) for the Los Angeles region be adopted within 13 years and determined schedules for the adoption of the trash TMDL. As a result, a TMDL for trash was established for the Los Angeles River in 2001 by the Los Angeles Regional Water Quality Control Board (LARWQCB) and revised in 2007.

The trash TMDL wasteload allocation applies to the permittees regulated under the NPDES permit held by the Los Angeles County that includes the Los Angeles County Flood Control District, Los Angeles County and 84 incorporated cities within Los Angeles County including the City of Los Angeles (Caltrans, military installations and public educational institutions have separate permits). The TMDL defines trash as man-made litter consisting of litter and particles of litter, including cigarette butts. Excluded from this definition are sediments, oil and grease and vegetation except for yard waste.

Trash TMDL Lawsuits

Two lawsuits were filed in response to the Trash TMDL. Los Angeles City and County agencies filed lawsuits against the LARWQCB challenging the requirements of the TMDL achieving 100 percent trash removal and a lack of guidance on achieving this goal. The lawsuits were dismissed based on LARWQCB’s willingness to provide additional guidance in the TMDL to meet their concerns. In addition, in 2002, twenty-two cities regulated under the trash TMDL filed a lawsuit against the regional and state water resources control board stating that the TMDLs violate state and federal processes, the TMDL established unreasonable and impractical water quality standards, and necessary scientific and economic studies were not conducted prior to TMDL development. In 2006, the Court of Appeals ruled that the TMDL was not in compliance.
with the California Environmental Quality Act (CEQA) (City of Arcadia et al., Los Angeles Regional Water Quality Control Board et al. (2006) 135 Cal.App.4th 1392.) and did not adequately analyze the environmental and economic impacts of the TMDL. As a result, a revised Trash TMDL for the Los Angeles River was adopted in 2007 that allows for a review of the waste load allocation when half of the baseline waste load allocation has been achieved, in addition to providing greater flexibility and guidance on achieving the zero trash waste load goal.

TMDL Requirements

**Calculating the Waste Load Allocation**

The original TMDL (2001) used the best available data to develop a baseline waste load allocation. This data was based on a trash generation rate study from the City of Calabasas, CA that defined a baseline waste allocation of 640 gallons of uncompressed trash per mi²/yr based on trash collection at a continuous deflection separation (CSD) unit. A wasteload allocation was calculated for each regulated municipality by applying the 640 gallon/mi²/yr value to each municipality which assumed a similar trash generation rate as in the City of Calabasas, CA. The TMDL allowed for permittees to refine the baseline waste allocation by developing their own baseline monitoring plan.

In order to refine the 2001 TMDL waste load allocation, the Los Angeles County Department of Public Works developed a baseline monitoring plan that monitored trash at 5 representative land uses (high density residential, low density residential, commercial and services, industrial and open space recreation) by installing inserts in catch basins. The study did not include military installations as they have separate permits. Based on the results of this study, a trash generation rate was calculated for each land use monitored. Using these results, a wasteload allocation was calculated for each regulated municipality, by summarizing the acres of each land use within each regulated municipality and multiplying by the trash generation rate for each land use. The specific waste load allocation for each jurisdiction reported in ft³/mi² is provided in the 2007 TMDL (LACARWQB, 2007).

**Options to meet the Wasteload Allocation**

The Trash TMDL requires a ten year plan for reducing the amount of trash discharged to the watershed by 10% annual reduction increments, to meet a final waste load allocation of zero trash discharge. Trash TMDL is to be implemented using a combination of full capture structural controls, partial capture control systems and/or

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1 Transportation land use was equated with industrial land use, and agricultural land use was equated to open space. Water is assigned a litter generation rate of zero as it doesn’t generate trash.
institutional controls. A full capture device or series of devices trap all particles retained by a 5 mm mesh screen and has a design treatment capacity of not less than the peak flow rate resulting from a one-year, one-hour storm. When a full capture system is installed, it is assumed that drainage area is in compliance with the waste load allocation provided it is adequately sized and maintained.

The effectiveness of partial capture treatment systems and institutional controls (i.e. public education, enforcement of litter laws, etc.) is measured based on a mass balance approach based on a daily generation rate (DGR) for the area. This is done by measuring the trash on the ground via street sweeping, manual pick-up, or other means during a 30-day period from June 22\textsuperscript{nd} to September 22\textsuperscript{nd} as this is a time characterized by high outdoor activity when trash is most likely to be deposited on the ground. The DGR is calculated by dividing the total amount of trash collected by 30 days. Once a partial capture system or institutional control is installed, the amount of trash removed from that system is compared to the DGR to calculate the trash stormwater discharge.

Los Angeles County Program

The implementation of the Los Angeles River Trash TMDL is led by the Watershed Management Division of the Los Angeles County Department of Public Works (the County) which oversees the County stormwater program. The County includes over 100 unincorporated communities with a total population of approximately 1 million people. In order to achieve compliance with the TMDL, the County installed both structural practices (full and partial capture) and institutional controls. To date, the County has installed full capture devices in 4,800 of the 5,700 total catch basins for a total installation cost of $7 million. The County uses catch basin inserts with retractable screens and increased street sweeping where feasible to meet the full capture compliance criteria.

The CPS screen complies with the RWQCB definition of a full capture screen. The LADPW performed hydrologic analysis to establish sizing criteria to meet the TMDL criteria. The CPS are manufactured by Advanced Solutions (Stormtek) and American Storm Water (Debris Dam). Based on observations, the proposed maintenance schedule is two fold: 1. Inspect and clean each catch basin between May 1 and September 30 each year as this is a time characterized by high outdoor activity when trash is most likely to be deposited on the ground and 2. Inspect and provide additional cleaning of catch basins when they are a minimum of 40% full of trash and debris. This study also provided physical design requirements for the systems (Los Angeles County DPW 2007).

Recent County institutional controls enacted include an ordinance to prohibit the distribution of plastic carryout bags at all grocery stores, pharmacies, convenience stores and food marts in unincorporated area. In conjunction with this ordinance, the
County provided educational resources to the affected areas and distributed free reusable bags at stores and libraries and asked residents to make a pledge to use reusable shopping bags. The County considers the ordinance to be a success with positive results reported by the stores and residents. In 2010, the County prohibited the purchase and use of expanded polystyrene (i.e. Styrofoam) food containers at County operations. Within the County, smoking has been prohibited at public beaches in the County since 2004, public parks since 2009, and outdoor dining establishments since 2010 (County of Los Angeles 2013).

**City of Los Angeles Program**

The implementation of the trash TMDL is led by the City’s Bureau of Sanitation Watershed Protection Division (WPD) which oversees the City's stormwater program. City implemented two approaches to trash reduction; implementation of institutional type controls (public education, enhanced catch basin cleaning and enforcement) and structural control devices (installation of trash capturing/reducing devices in the storm drain system).

In order to most efficiently approach the problem, in 2002 WPD conducted a study entitled, High Trash Generation Areas and Control Measures to identify the spatial distribution and amount of trash collected throughout the City resulting in identified high, medium and low trash generation areas (conducted in both LA River and Ballona Creek watersheds). The study examined the amount of trash accumulating in City-owned catch basins from 1999-2003. The high trash generating areas found within four miles of downtown Los Angeles, followed by the medium area that continued for the next two miles and the low areas radiated out from the medium areas to include the rest of the City. The high trash generation area was shown to contribute 50-60% of the trash within the City. Based on the results of this study, the City decided to focus institutional and structural control measures in the high and medium trash generating areas as that would result in the greatest trash reduction (Magallanes et al 2008).

Pilot studies were conducted over four years to evaluate the effectiveness of several structural BMPs including end of pipe trash systems, catch basin opening screen covers, catch basin inserts, netting systems and hydrodynamic separator devices. Based on these studies, the City identified catch basin inserts and/or opening screen covers for all catch basins was the most feasible, practical and cost effective approach. Institutional measures implemented include public education, catch basin cleaning and anti-littering enforcement (See “Education and Outreach” and “Regulations and Enforcement”).
As of 2014, the City has spent $88 million on structural trash removal devices. This includes installing 38,000 catch basin curb opening screen covers and 10,000 catch basin inserts for a total cost of $75 million. Devices installed at the end of the drainage area include 15 mainline netting systems and six mainline hydrodynamic separator devices for a total cost of $13 million. All devices are approved by the Los Angeles regional WCB as full capture devices except for the screen covers that are considered partial capture devices. The City has reduced its trash contribution to the Los Angeles River watershed by more than 90% (Toy-Chen, 2014).

**Maintenance**

The City of Los Angeles wastewater collection services division of Bureau of Streets (BOS) cleans the catch basins on a regular basis that complies with NPDES permit which ranges from 1-4 times per year. Catch basins in high trash generating areas take place prior to the start of the rainy season and more frequently during the rainy season and include collection of trash receptacles. Bureau of Street services sweeps high trash streets and alleys daily to monthly in low trash areas. The BOS has 135 motor sweepers, maintains 3,000 public trash receptacles, and services 28,000 lane miles of public roads and 800 miles of alleys (HDR Engineering, Inc. 2008).
2.3 Anacostia River Trash TMDL

The Anacostia River Watershed is 176 square miles with land from three jurisdictions: Prince Georges and Montgomery Counties in Maryland, and the District of Columbia (the District) (Figure 2.2). The Anacostia is severely degraded, and has TMDLs for multiple pollutants, including Bacteria, Organics, Metals, BOD, Sediment, and Nutrients. The Anacostia was referred to as the United States’ “Forgotten River” for decades, and in 1987 all three jurisdictions, the State of Maryland and several federal agencies signed the “Anacostia Watershed Restoration Agreement,” and formed the Anacostia Watershed Restoration Committee (the Restoration Committee), composed of representatives from each of these entities. In 2006, the Committee formed the Anacostia Watershed Restoration Partnership (the Restoration Partnership), which included the original Committee members, and also allowed for input from other agencies, citizens, nongovernmental organizations, and academia. The Restoration partnership set to work developing the Anacostia Watershed Restoration Plan and Report (the Restoration Plan; AWRP; 2010).

Traditionally, watershed plans mention trash, or treat trash reduction or capture as a supplemental benefit, with the real goal of targeting a different pollutant such as a specific chemical parameter. By contrast, this planning effort sought to quantify trash early on in the planning stages, and the Anacostia was listed as impaired for trash in 2007. Consequently, baseline monitoring was completed in Maryland and the District to quantify baseline trash loading in the watershed, and the second Trash TMDL in the nation was accepted by the US EPA in 2010 (MDE and DC DoE, 2010).
Anacostia Trash TMDL: Making the Math Work

Typically, the TMDL is calculated from loading rates established from numerical standards, such as in-stream concentrations. A challenge for trash TMDLs is that there is typically no quantifiable standard. Water quality standards for trash in both the District and Maryland portions of the watershed are narrative, and include terms such as “unsightly.” In developing the TMDL, it was assumed that the narrative standard for trash would be achieved if the baseline load for trash were removed in each jurisdiction. In addition, a 5% margin of safety is applied to determine the total TMDL. The TMDL targets (Table 2.1) are expressed in terms of trash removed rather than trash reaching the stream, based on the presumption that removing the baseline trash loads will achieve narrative standards for trash in the Anacostia.

| Table 2.1. Trash TMDL Targets in the Anacostia River Basin (lbs Removed/Year) (MDE and DC DoE, 2010) |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Waste Load Allocation | Load Allocation | Margin Of Safety (5%) | TMDL |
| Prince Georges County, MD | 314,055 | 347,958 | 33,101 | 695,114 |
| Montgomery County, MD | 243,256 | 65,945 | 15,460 | 324,660 |
| District of Columbia (Upper Anacostia) | 150,154 | 18,343 | 8,425 | 176,922 |
| District of Columbia (Lower Anacostia) | 60,955 | 1,705 | 3,133 | 65,794 |

Monitoring Data

The TMDL was developed from supporting monitoring data, including data measured at the outfall, in-stream and land data (i.e., windshield surveys). The outfall and in-stream data were used to establish baseline loads for the Waste Load Allocation (WLA) and Load Allocation (LA), respectively, and windshield surveys provided insight regarding trash transport from the land to the stream channel. The Anacostia Watershed Society completed both the windshield surveys and in-stream monitoring in the District (AWS,
In addition, the Maryland Department of the Environment (MDE) and the District Department of the Environment (DDoE) conducted monitoring at representative outfall locations to quantify the load coming directly from the storm drain system (described in MDE and DDoE, 2010).

**Outfall Monitoring**

Trash was monitored at outfalls of representative catchments to develop trash loading rates (in pounds per acre) for each land use. Since this TMDL crossed jurisdictional boundaries, the monitoring was conducted by two separate agencies, resulting in two separate sets of loading rates (Table 2.2). These loading rates were then multiplied by the areas of each land use in a jurisdiction to calculate the baseline loading rates for the WLA in the TMDL.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>DC</th>
<th>Maryland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Density Residential</td>
<td>4.52</td>
<td>1.19</td>
</tr>
<tr>
<td>Low-Medium-Density Residential</td>
<td>3.96</td>
<td>--</td>
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<tr>
<td>Medium-Density Residential</td>
<td>13.84</td>
<td>19.26</td>
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<td>High-Density Residential</td>
<td>7.93</td>
<td>7.88</td>
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<tr>
<td>Commercial</td>
<td>22.08</td>
<td>2.22</td>
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<tr>
<td>Industrial</td>
<td>18.90</td>
<td>2.22</td>
</tr>
<tr>
<td>Institutional</td>
<td>25.45</td>
<td>2.22</td>
</tr>
<tr>
<td>Major Roads, Transport, Communication, Utilities/Transportation</td>
<td>31.12</td>
<td>2.22</td>
</tr>
<tr>
<td>Public Facilities (Local Public, Quasi-Public, Institutional)</td>
<td>25.45</td>
<td>--</td>
</tr>
<tr>
<td>Federal Facilities</td>
<td>12.78</td>
<td>--</td>
</tr>
<tr>
<td>Parking</td>
<td>6.84</td>
<td>--</td>
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<tr>
<td>Parks and Open Spaces/ Urban Open Land</td>
<td>0.32</td>
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<tr>
<td>Extractive</td>
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<td>2.22</td>
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<tr>
<td>Agriculture</td>
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<td>0.32</td>
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<td>Forest</td>
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<tr>
<td>Bare Ground</td>
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<td>2.22</td>
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</table>

*Source: MDE and DDoE, 2010*
Stream Monitoring

The outfall monitoring was supplemented with in-stream assessments conducted by the Anacostia Watershed Society. Trash was collected at transects in the stream channel to estimate trash delivered to the stream. These loads were summarized by number of trash items per length of stream in various locations throughout the watershed. In addition, this study categorized trash by type, which was useful for better understanding the distribution of trash in the stream system.

The stream monitoring data were used to quantify the baseline loads for the LA portion of the TMDL. Since the LA accounts for trash that is not delivered as a part of the WLA, (i.e., not delivered through the storm drain system). One challenge of estimating this load was that some trash observed in the stream channel had been delivered to the stream via the storm drain outfall. As a simplification, it was assumed that trash too large to pass through the outfall must have been dumped, and was therefore accounted for as a part of the LA. Although some items such as blowing trash bags may have been deposited directly to the stream, they were assumed to be a small component of the total trash load.

Trash monitoring in the Anacostia resulted in a tally of the number of items by type of trash (Figure 2.3) at each monitoring location. Since it was impractical to identify a baseline number of items for each type of trash, items collected during early monitoring were weighted to develop unit weights for each trash item to develop a trash loading rate in pounds/year (Table 2.1). This technique is effective since it allows for visual monitoring in the future by counting items, without the need to weigh each trash item.

![Streams Trash Composition](image)

*Figure 1.3 Composition of Trash Collected in the Anacostia (AWS, 2008)*
**Windshield Surveys**

The Anacostia Watershed Society also evaluated trash in the contributing drainage area of stream transects, and attempted to correlate trash observed in the street with the trash observed in the stream. This proved difficult, however, and the study concluded that trash observed through windshield surveys was a valuable indicator of trash in the streams, but may not necessarily be a good predictor. The windshield surveys did provide useful information that was helpful in formulating the TMDL, implementing programs, and tracking progress. For example, the surveys found that most of the trash in the streets was related to food (e.g., snack bags and drink bottles). Another interesting finding was that, although street trash was dominated by paper products, almost no paper was found in the streams, due to rapid decomposition of this material.

**Regional and Watershed-Wide Planning and Partnerships**

Although the TMDL did not set official limits on trash loads until 2010, the planning effort builds on regional and watershed-wide cooperative efforts that predate the TMDL itself. Some of the efforts include the following:

*Trash Free Potomac Watershed Initiative (The Potomac Initiative)*

Governments in the Anacostia River Basin participate in the Trash Free Potomac Initiative, whose founding document is the *Potomac River Watershed Trash Treaty* (the Trash Treaty). The Trash Treaty is an agreement with over 140 signers represented by state and local governments in the Potomac River Watershed, with the goal of achieving a Trash-Free Potomac by 2013. Treaty signers commit to reducing trash through programs and practices, and participate in an annual Trash Summit. The original agreement was signed in 2005 by six elected officials in the Potomac River Basin, including the Mayor of the District of Columbia, and the County Executives of Montgomery and Prince Georges Counties. The Potomac Initiative is coordinated by the Alice Ferguson Foundation. For more information on the efforts taken as a part of the Potomac Initiative, go to [http://fergusonfoundation.org/trash-free-potomac-watershed-initiative/](http://fergusonfoundation.org/trash-free-potomac-watershed-initiative/). The site includes a description of the effort, as well as annual reports from participating jurisdictions.

*Anacostia Watershed Trash Reduction Strategy (the Trash Reduction Strategy; MWCOG, 2007)*

In 2007, the Anacostia Trash Reduction Workgroup, a group formed of staff of the Metropolitan Washington Council of Governments, representatives from the municipalities in the Anacostia Watershed, and nonprofit organizations active in the watershed drafted the Trash Reduction Strategy. This document included an
overarching goal of a trash free Anacostia by 2013, and outlined six primary objectives including the following:

1. Significantly increase funding for trash reduction programs.
2. Create and enhance regional partnerships and coordination for trash reduction efforts among businesses, environmental groups, individual citizens, and governments at all levels and in all jurisdictions.
3. Improve people’s awareness, knowledge, and behavior relating to littering and illegal dumping.
4. Promote the greater introduction and use of effective trash reduction technologies and approaches.
5. Improve the enactment and enforcement of laws to reduce trash.
6. Increase trash monitoring-related data collection, generation and dissemination efforts.

This document is available online at www.anacostia.net/Archives/download/AnaTrashStrategy_final.pdf.

_Anacostia Watershed Trash Reduction Plan (the Trash Reduction Plan, Anacostia Watershed Society, 2008)_

The Trash Reduction Plan focuses on the District portion of the Anacostia. The document summarizes the results of trash monitoring efforts conducted by the Anacostia Watershed Society, including the studies that were used to develop the TMDL. In addition, the document outlines an implementation plan for “significantly reducing trash in the Anacostia by 2013.” Finally, the document includes a literature survey of various trash reduction techniques and identifies implementation plans both on a District-Wide level and in individual basins.

This document is available online at http://green.dc.gov/publication/2008-anacostia-river-trash-study.

Practices Used in the Anacostia Watershed

Several management measures used to reduce trash in the Anacostia River Watershed, include Hotspot Monitoring, Education and Outreach, Legislative Measures, Municipal Practices, and Catchbasin/Outfall Practices.

_Hotspot Monitoring_

All three Anacostia municipalities have been monitoring trash through a combination of complaint database management, stream monitoring, and land surface monitoring
using an army of volunteers. As a part of TMDL implementation, each of the jurisdictions in the Anacostia conducted monitoring or tracking to identify “trash hotspots” to target future practices. The specific metrics used to target these hotspots differed between jurisdictions. For example, the District focused primarily on identifying hotspot watersheds to best locate outfall practices, while Montgomery County used its trash complaint database to target specific land uses, such as bus stations, that generate a disproportionate amount of trash. Finally, Prince Georges County has used its trash monitoring efforts to assist in enforcement. For more information on hotspot monitoring techniques, please consult the Trash Monitoring section of this report.

**Education and Outreach**

Education efforts are conducted through the municipalities, and also through volunteer efforts coordinated by the Alice Ferguson Foundation. These efforts include both general information such as -recycling information provided to all residents, and more targeted efforts such as Adopt-A-Block programs and a program known as the Clean Schools Campaign, which involves youth in trash reduction. Finally, stream clean-ups are conducted throughout the watershed, through groups such as the Anacostia Watershed Society. The Education and Outreach section of this report provides more information regarding these efforts.

**Enforcement and Legislation**

In addition to ongoing enforcement efforts, efforts have included plastic bag fees and “Trash Enforcement Months.” Plastic bag fees were implemented in the District in 2010 and Montgomery County in 2012. In both jurisdictions, plastic bag fees are 5¢/bag with some exceptions for some specific retail operations and uses. Another unique effort implemented throughout the Potomac River Basin is Trash Enforcement Months, which include a consolidated effort to highlight trash enforcement.

Beginning in 2012, a Litter Enforcement Month has been hosted as a part of the Clean Potomac Initiative (coordinated by the Alice Ferguson Foundation) and law enforcement agencies in the District, Maryland and Virginia. Modeled after similar enforcement actions for traffic violations (e.g., “aggressive driver” enforcement periods), participating jurisdictions educate law and code enforcement agencies to enforce litter regulations, educate the community and track litter enforcement actions during the month. The Enforcement and Legislation section discusses these efforts in more detail.

**Municipal Operations**

Some ongoing municipal operations to reduce trash export include storm drain stenciling, street sweeping, trash collection, trash removal from BMPs and catch basin cleaning. These techniques are targeted using trash hotspot data. In addition, street
sweeping effectiveness is monitored in the Anacostia to determine its effectiveness at capturing both trash and other debris. Montgomery County has conducted monitoring to determine needed catch basin cleaning and street sweeping frequencies. All three jurisdictions remove trash from stormwater BMPs on a regular basis, and the trash removed from these practices is now being recorded to determine future maintenance needs and identify the most effective trash racks and other trash capture devices in these practices. Finally, the District conducted a study to optimize catch basin cleaning. For more information on these practices, go to the Municipal Operations section.

**Catch Basin and Outfall Practices**

These practices are designed to capture trash and other debris that has already entered the catch basin or has been delivered through the storm drain system to the outfall. Several catch basin options were investigated by Montgomery County to determine both the effectiveness of each option, as well as the required maintenance frequency for each option. In general, this monitoring indicated that catch basin inserts may not be an effective option in this region, due to high maintenance requirements. At the same time, the District developed a design for a “Water Quality Catch Basin” that is effective at capturing both trash and debris. A few different outfall capture practices were implemented and are operating in the District, including a Band-a-Long trap, as well as some custom-designed traps. These practices are described in two sections, including *Catch Basin Practices* and *Outfall Practices*.

**Progress and Ongoing Monitoring**

Each jurisdiction is required to report the benefits of their programs to minimize and capture trash as a part of its annual Municipal Separate Storm Sewer (MS4) permit. To date, practices reported include removal of trash from catch basins, BMPs and outfall traps, and trash directly removed by volunteer clean-ups. Some practices, such as the Plastic Bag Ban or other enforcement efforts, are credited (as of the 2013 MS4 Annual Reports for each jurisdiction), but have the potential to decrease trash loads. Finally, each jurisdiction completes instream trash monitoring to quantify differences in the amount of trash found in the Anacostia and its tributaries.

**Conclusions**

The Anacostia TMDL, as well as other planning efforts designed to reduce trash in this waterbody, provide an excellent example of interjurisdictional cooperation to reduce trash in a large and highly degraded waterbody. Some strengths of this effort are the use of both legislative and engineered solutions, the involvement of a diverse group of stakeholders, and establishing an ongoing monitoring effort to determine progress. One challenge of the approach taken in the Anacostia relates to the calculation
methodology. Each municipality is assigned a specific load reduction target (see Table 2.1), which is derived from baseline trash loading studies. This is a good approach in that it establishes a “target” for the reduction efforts in each municipality. However, a challenge of this approach is that the initial target is based on a very small dataset, and it is possible that each target load could be either a very high or very low estimate of the actual trash discharge. Another option was to relate the legal TMDL and permit requirement to an instream or outfall monitoring target, with trash capture reported as a progress measure.

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Section 3. Monitoring and Tracking

Usually, monitoring and tracking are not integrated with trash management programs, but simple trash monitoring can be a highly effective technique to target programs and practices to the locations where they are needed most. Trash monitoring can be conducted at multiple scales, and incorporate a variety of data sources. Some typical decisions supported by trash monitoring include citing of outfall practices, tailoring education programs to land uses that produce the most trash, and adjusting street sweeping schedules to target high trash areas. Trash monitoring can also be used to document progress in reducing trash.

3.1 Types of monitoring

Trash monitoring is a fairly new effort, but innovative approaches have been initiated. Two differences between trash monitoring and monitoring of other pollutants is that trash monitoring is relatively inexpensive, and that trash is present on the land surface between storm events. By contrast, conventional pollutants such as nutrients are carried by wastewater or stormwater flows, and the chemical concentration is determined using laboratory analytical techniques. As a result, trash monitoring can be conducted by a wide range of people, and at various spatial scales.

In addition to tracking the trash loads from each area, most of the monitoring efforts described in this section sort trash by category (See Figure 3.1).

![Trash Relationships](image-url)

*Figure 3.1. Trash Data from the Anacostia Sorted by Trash Type (AWS, 2008)*
Stream/watershed scale
Collecting or aggregating trash data within a stream or at the watershed scale is useful for tracking overall progress of trash programs, or for locating outfall trash capture devices. Stream monitoring can also be used to identify dumping hotspots. Stream and watershed scale trash monitoring has been used quite extensively in the Potomac River Basin, particularly in the Anacostia Watershed. Some examples include the following:

Hotspot Sewersheds (District of Columbia)
As a part of developing its Trash TMDL, the D.C. Government monitored trash loadings at several representative land uses, to develop trash loading rates (See “Anacostia TMDL”). Although these data were collected at the catchment scale, they were aggregated into a simple model to generate loading rates by sewershed (Figure 3.2). This analysis was used to locate outfall trash practices (District of Columbia, Dec. 2013).

For a description of how these data were used, go to the DC DOE Implementation Strategy at:
Figure 3.2 Trash Hotspot Sewersheds in the District of Columbia, and loading rates for all Sewersheds (DC DDOE)
In-Stream Monitoring: Metropolitan Washington Council of Governments

Ongoing in-stream trash monitoring in the Anacostia Watershed is used to track progress toward meeting trash reduction goals, and to identify watersheds and in-stream locations with elevated levels of trash. In Prince Georges and Montgomery Counties in Maryland, the Metropolitan Washington Council of Governments (MWCOG) conducts this monitoring effort. The stream monitoring is combined with assessments at the street and site scales (described below) to document TMDL progress over time.

The monitoring uses protocols developed as a part of the Anacostia Trash TMDL baseline Monitoring protocols (MDE, 2010).

For a brief summary presentation of monitoring updates (for 2011-2013), go to:

http://www.anacostia.net/Archives/AWMC/documents/ManagementTrashPresentationmg2.pdf?COMMITTEE_ID=16

Neighborhood or Street Scale

Trash monitoring at the street or neighborhood scale helps a community to direct resources to areas that generate the most trash. Examples include increasing street sweeping and catch basin cleaning frequencies, and targeting anti-litter education and enforcement campaigns. At this scale, monitoring can include both quantitative assessments (e.g., pieces of trash or number of catch basins overflowing) and qualitative data such as cleanliness indices.

Washington, D.C.: Citywide Cleanliness Assessments

The Office of the Clean City in D.C. the District of Columbia (the District) organizes Citywide Cleanliness Assessments, where teams of volunteers survey corridors/interstate highways, high-visibility communities, residential streets and alleys and industrial areas and rate the cleanliness at the different locations (District of Columbia, no date, a; District of Columbia, November 2012). The ratings range from 1-4, as follows: 1- clean, 2-moderate, 3-dirty, and 4-hazardous. The survey takes up to four hours and are performed every three months. D.C. produces quarterly reports with average ratings for the whole city and summaries the data by category. From the survey, the city is able to allocate resources such as more frequent clean-ups or enforcement, to the high trash areas. Areas rated as 3’s and 4’s are reported for immediate action, and hazardous areas are immediately reported to the relevant department during the assessment.
Examples of hazardous areas include blockage of passage ways, rat rodent infestation, obstruction of traffic, tree canopy interfering with traffic signals, or household hazardous materials on the street. This monitoring is largely completed by citizen volunteers.

Areas that are found to be overflowing with trash are given solar trash compactors called “Big Belly Solar Trash Compactors”, which are also used in Philadelphia (NBCNews, July 2009). Powered by solar panels, a compactor inside the “Big Belly” allows for more trash to be collected at each trash can. This also decreases the amount of time needed to empty the trash can, freeing up trash trucks for other services, such as household recycling.

For quarterly cleanliness reports go to the “Office of the Clean City" website at: http://occc.dc.gov/node/134222

**District of Columbia and Maryland: “Hot Streets” and Windshield Surveys**

In developing the Anacostia Watershed Trash Reduction Plan, the Anacostia Watershed Society monitored individual streets to identify “Hot Streets” that are targeted with streets sweeping and potentially other trash programs (District of Columbia, December 2008). The District conducts more frequent street sweeping in these areas (see “Municipal Operations” fact sheet).

**City of Los Angeles**

In order to most efficiently approach trash reduction, in 2002 the City of Los Angeles Watershed Protection Division conducted a study entitled, High Trash Generation Areas and Control Measures, to identify the spatial distribution and amount of trash collected throughout the City resulting in the identification of high, medium and low trash generation areas (conducted in both the Los Angeles River and Ballona Creek watersheds). The study examined the amount of trash accumulating in City-owned catch basins from 1999-2003. The initial data was reported in 2002 (LA DPW, 2002), and updated in later years to produce an interactive map (Figure 4.4). The high trash generating areas were identified within four miles of downtown Los Angeles, followed by the medium area that continued for the next two miles and the low areas radiated out from the medium areas to include the rest of the City. The high trash generation area was shown to contribute 50-60% of the trash within the City. Based on the results of this study, the City decided to focus institutional and structural control measures in the high and medium

![Figure 3.2. Interactive Map of LA’s Trash Generation Areas](http://www.plastics.lacity.org/trashmap.htm#)
trash generating areas as that would result in the greatest trash reduction (Magallanes et al 2008).

By Land Use Category
Summarizing trash data by land use category can be helpful for predicting trash loads, and developing more customized trash reduction strategies. Outfall or catch basin data can be assigned to a broad land use category (e.g., commercial or residential land) or more specific categories such as business types. In both the Anacostia and LA River TMDLs, trash generation rates were developed for land use categories, and these data were used to focus on neighborhoods or watersheds with the greatest trash generation.

Complaint or 311 databases are another data source for evaluating trash problem areas. In Montgomery County, Maryland, trash complaints were aggregated by specific land use categories. One result of this analysis was the finding that bus stops are a prime litter hotspot. As a result, the County developed a Department of Transportation program is dedicated to remove trash at these stops (Alice Ferguson Foundation, 2013).

Individual Trash Hotspots
Some specific locations can be very high trash generators, and some monitoring programs use these sites as “sentinels” to document progress over time. Two examples include the Potomac-Wide volunteer monitoring program, and the ongoing monitoring conducted in the Anacostia Watershed.

Citizen Monitoring: Alice Ferguson Foundation
The Alice Ferguson Foundation has two different trash monitoring programs to track different hot spot locations. In the “Visible Trash Survey Monitor” program, volunteers categorize and count visible trash along a 200 foot stretch of water or land. The “Photo Monitor” allows volunteers to take pictures quarterly of their hot spot site and send them to Alice Ferguson Foundation. The data from these two programs help plan two Annual Potomac River Watershed Cleanup and the Anacostia River Cleanup (Alice Ferguson Foundation, n. d.).

Hotspot Monitoring: Anacostia TMDL
Ongoing monitoring in the Anacostia includes annual, detailed data collection at designated trash hotspots. Monitoring in the Anacostia identified several hotspots, through a combination of ongoing stream and windshield monitoring, stakeholder surveys, and other watershed planning efforts that identified trash issues. These data are then incorporated into planning and implementation reports for each municipality. For example, the Trash TMDL Implementation Plan for Prince Georges County (PG DOE, 2014) identifies over 60 trash hotspots. These sites are then monitored on a regular basis to track progress over time.
3.2 Effectiveness
Although monitoring cannot reduce trash loading as a stand-alone practice, understanding the distribution of trash sources within a watershed or community helps to use scarce resources most effectively. Other uses of monitoring include evaluating the effectiveness of specific programs or practices, and tracking overall progress in reducing trash loadings.

3.3 Customizing a Monitoring Approach in the Tookany-Tacony Frankford
The monitoring approach selected for the Tookany-Tacony Frankford should build on the baseline monitoring efforts conducted by Temple, and should also include data from other sources such as trash complaint and enforcement databases, citizen monitoring efforts, and municipal data such as trash collected by street sweeping and catch basin cleanouts. Finally, data collection should be strategic so that it can be used to evaluate ongoing trash reduction efforts, identify locations with the greatest need, and understand which behaviors lead to trash generation.

3.4 References


Section 4. Legislation and Enforcement

Laws and innovative enforcement techniques can be extremely helpful in reducing trash generated and dumped in a watershed. A wide range of options are available, and this section highlights specific product bans and fees, and techniques for publicizing and increasing litter enforcement.

4.1 Legislation and Enforcement Efforts

Legislation
Most communities have some laws in place that promote recycling and prohibit littering and dumping. There are some differences in the implementation of these basic laws, such as the range of fines or type and size of businesses that must recycle, but this section focuses more narrowly on recent efforts in some municipalities to eliminate wastes that are pervasive in waterbodies. Plastic bags comprise a relatively small portion of the total waste load but they are pervasive in the environment, with plastic found even in the middle of the ocean. As a result, communities have begun adopting ordinances to ban or charge fees for plastic bag use, or other specific trash items.

Plastic Bag Bans: California State and Municipalities
California has been in the forefront in reducing plastic bag use. A state bill (SB 270) was signed into law in December of 2014. The law bans plastic bags and charges a ten cent fee for paper or reusable bags purchased at the store. The law is scheduled to go into effect in supermarkets and drug stores in July 1, 2015 and in small grocery stores and convenience stores by July 1 2016. The law also sets aside money to help plastic bag manufacturers to convert their business to reusable bag production.

The law still may face challenges that would delay its implementation through the Plastic Bag Ban Referendum, a ballot initiative that would allow voters to directly approve or disapprove the law (http://ballotpedia.org/California_Plastic_Bag_Ban_Referendum_%282016%29). However, one third of California’s population is covered by similar local ordinances (CAW, ND). The state law would preserve elements of the local ordinances that are not captured by the state law. For a complete list of municipalities in California and other states with a plastic bag ban go to the “Californians Against Waste” website at:

http://www.cawrecycles.org/issues/plastic_campaign/plastic_bags/national

Los Angeles City and County both introduced their plastic bag bans before the statewide law was approved, and rollout of the ordinance in the County included a
A bag summit was hosted by the County in partnership with "Heal the Bay" ([www.healthebay.org](http://www.healthebay.org)) to provide information and resources to cities. In addition, the County gave away over 22,000 reusable bags at supermarkets and ran a sweepstakes that resulted in over 300 residents pledging to use reusable shopping bags.

The ordinance includes enforcement fines for stores that are not in compliance. The money collected from the fines are distributed into the Citywide recycling trust fund to assist with the implementation and enforcement of the ordinance. A written warning notice is issued for the first violation followed by fines for subsequent violations of $100 for first offense, $200 for second offense and $500 for a third or subsequent offenses.

**Los Angeles Region Styrofoam Ban**

Styrofoam has also been banned in some California municipalities. For example, effective July 1, 2008, the City of Los Angeles passed an ordinance that banned the use of polystyrene food service products from being purchased or used in City facilities. The City passed a city-wide ordinance (SB 568) prohibiting California food vendors and restaurants from using expanded polystyrene food containers that will take effect January 1, 2016. In September 2010, the Los Angeles County Board of Supervisors adopted a prohibition on the purchase and use of all expanded polystyrene (Styrofoam) food containers at County operations. In addition, the County Board of Supervisors is considering an ordinance to prohibit Styrofoam use to food service establishments and retail stores within the County ([County of Los Angeles 2013](http://www.co.la.us/)).

**District of Columbia**

As a result of the Anacostia River Clean Up and Protection Act of 2009, Washington D.C. (the District) and Montgomery County, Maryland implemented a plastic bag fee for their jurisdictions. In 2010, D.C. required "businesses that sell food or alcohol to charge five cents for each disposable paper or plastic carryout bag" ([DC.gov, n.d.](http://www.dcgov.gov/)) and Montgomery County followed suit in 2012.

In D.C., one cent of the five cent fee goes back to the retailer. If the retailer provides a carryout bag credit program for consumers, they receive two cents. The remainder of the fee goes to the Anacostia River Clean Up and Protection Fund, a special purpose fund managed by the District Department of the Environment (DDOE). The Fund was established for the purpose of cleaning and protecting the Anacostia River and other impaired waterways. The Fund supports projects such as trash traps, education and outreach, stream restoration, Green Roof Subsidy Program, and the purchase and distribution of reusable bags. There are exceptions to the bag fee, including bags used to:

- Package bulk items, such as fruit, vegetables, nuts and grains
- Contain or wrap frozen foods, meats or fish
- Contain unwrapped prepared foods or bakery goods
- Contain prescription drugs
• Restaurant paper carryout bags
• Newspaper bags, door-hanger bags, laundry-dry cleaning bags, or bags sold in packages containing multiple bags intended for use as garbage, pet waste, or yard waste bags
• Reusable carryout bags

There are also rules for the types of disposable bags allowed to be sold. The paper bags must be 100% recyclable, contain a minimum of 40% post-consumer recycled content, and display the phrase “Please Recycle This Bag”. The disposable plastic carryout bags must be 100% recyclable, made of plastic with ID code 2 or 4, and display the phrase “Please Recycle This Bag”. The DDOE provides a phone number to call when there is a suspected violation of the law by a business. Business are fined if they are found to violate the law.

Montgomery County, Maryland
Montgomery County’s law is very similar to the District’s, except businesses do not have the option for business’ to keep one extra cent for providing reusable bag credits to consumers (Montgomery County, n.d.). The program also excludes bags that are provided by a seasonal stand or street fair stall, such as farmer’s markets. Retail establishments are required to provide information on the amount of charges collected for carryout bags monthly. Once the revenue from bags exceeds $100, the retailers submit the collected bag fees through a secure website. The money collected from the carryout bag law goes into the County Department of Environmental Protection Water Quality Protection Charge Fund that finances County watershed protection activities including litter control and stormwater pollution control.

Enforcement
While most citizens know that littering and dumping is illegal, a survey of citizens in the Potomac River Basin found that only 6% of respondents thought there was a “good chance” of getting caught littering and 49% thought there was no chance of getting caught (AFF, 2008). Although it may not be feasible to catch every littering or dumping violation, there are a few techniques to reduce the worst offenses. For example, known trash hotspots can be patrolled more frequently to catch dumpers.

In addition to typical litter and dumping enforcement rules, an interesting initiative in the Potomac River Basin is Litter Enforcement Months (LEM), which are conducted annually through the Alice Ferguson’s Trash Free Potomac Month (Alice Ferguson Foundation, n.d.). Fourteen agencies from nine jurisdictions participated through public education, officer education, trash pickups, and enforcement and citation tracking. Some highlights from the 2014 Litter Enforcement Month include:

• 348 citations, violations, and other reports
• 12,800 pounds of trash removed from the City of Alexandria, Virginia
- 400 Metro Transit Police were reminded about Litter Enforcement Month 2014 using roll call announcements
- More than 19 community cleanups were organized by the District Metropolitan Police Department with over a quarter ton of litter and bulk trash removed

4.3 Effectiveness
Plastic bag fees and fines are a very effective method for reducing this form of trash.

Plastic Bag Fees: D.C. and Montgomery County, MD
In 2013, DDOE hired Opinion Works to conduct a survey of District residents and businesses required to implement the bag free. The goal of the survey was to measure changes in disposable bag use since the law was implemented in 2010. The results from the residents survey shows strong public acceptance of the law (53%) and an 80% reduction in bag use among District residents (19% report no reduction in bag use). On average, residents estimate a reduction in disposable bag use from 10 to 4 bags per week. In addition, eighty percent of residents carry reusable bags when they shop with 58% carrying them always or most of the time (OpinionWorks 2013). In addition, 67% of District residents report seeing fewer plastic bags in the form of litter than 3-4 years ago.

The survey of District businesses reports a median of 50% reduction in bag use with a reported 40% increase in consumers bringing reusable bags to the store. Businesses report growing acceptance of the law by consumers but note some complaints and annoyance. To better implement the law, businesses encourage DDOE to better educate the public on the purpose of the law and the positive environmental benefits from the fee. As reported by residents, 68% of businesses reported seeing fewer plastic bags as litter around their businesses.

A separate research study conducted by Tatiana Homonoff at Princeton University (2013) analyzed the effectiveness of using incentives to reduce the consumption of disposable grocery bags in the District (Homonoff, 2013). This study compared a “pre” (2011) to a “post” period (in 2012) and interviewed customers at stores in Montgomery County, MD (which implemented a fine in late 2011, “Tax in Post Period”), Washington DC (which had

![Figure 4.1. Effect of Plastic Bag Taxes on Single Use Bag Usage in Three Municipalities (Homonoff, 2013)]
regulations in place before the 2011 monitoring, “Tax Always”), and Arlington County, VA (which never had a fee “Tax Never”). In Washington, In addition, several of the stores surveyed also offered a bonus for bringing reusable bags. The bonus had very little effect on behavior, but the tax made a huge difference.

Plastic Bag Ban: Los Angeles County
Plastic bag bans (and fees for paper or reusable bag purchases) appear to be even more effective. As a part of Los Angeles County’s plastic bag ban, stores are required to provide quarterly reports to the Department of Public Works that includes the number of paper bags provided to customers, total money collected from paper bag sales, and a summary of efforts used to promote the use of reusable bags by consumers. Based on this reporting, after one year of implementing the ordinance, large stores have reported a 95 percent reduction in single use carryout bag usage.

4.4 Customizing Programs in the Tookany-Tacony Frankford
Several plastic bag bills have been put forward in Pennsylvania and Philadelphia, but none have passed to date. This group could potentially conduct locally-based research to craft model language that is likely to succeed at the local level. On the enforcement side, the Trash Task Force could identify dumping hotspots to prioritize enforcement, or consider working with law enforcement to increase awareness of and focus on litter and dumping laws.

4.5 References


City of Los Angeles Bureau of Sanitation. No date. LA City Bag. www.lacitybag.com


http://dataspace.princeton.edu/jspui/bitstream/88435/dsp01jw827b79g/1/Homonoff_princeton_0181D_10641.pdf

Montgomery County. No Date. Legislation.  
http://www.montgomerycountymd.gov/bag/legislation.html

Section 5. Education and Outreach

Education and outreach, along with legislative and enforcement initiatives, reduce trash at the source. While their benefits are not as easily measured as structural measures that trap trash, available data suggest that tailored education campaigns can be very effective at reducing trash. To effectively communicate this message, campaign designers should have a good understanding of the target audience, and continue to adapt the message over time based on ongoing monitoring and feedback. In addition, an effective campaign will target multiple sectors of the population. This section highlights some efforts being conducted in the Potomac River Basin and in Los Angeles.

5.1 Example Education Campaigns

The types of media and resources needed to communicate the message, such as recycling or simply not littering, will be different depending on the target audience. For example, outreach to school children may involve developing an ongoing curriculum or at a minimum a class lesson, while most adults may only be reached through very brief messages such as radio ads or other simple media messages. This section provides examples of effective education efforts to three sectors: Citizens, Schools and Businesses.

Direct Outreach to Citizens

Outreach efforts to citizens are the most effective when they target very specific behaviors, and have a simple message. These campaigns need to be customized based on the population in the area where they will be implemented, and ideally will be backed by both social and trash monitoring data. In addition to the very simple messages contained in mass media education campaigns, public outreach to citizen volunteers can include much more detailed information.

Data-Driven Approach: The Trash-Free Potomac Initiative Regional Anti-Litter Campaign

Under the trash free Potomac initiative, the Alice Ferguson Foundation developed a Regional Litter Prevention Campaign that includes training materials to be used throughout the Potomac River Watershed. The Campaign is designed to be implemented at the community grassroots level as well as the broad jurisdictional level in order to best reach the target audience of trash generators, community leaders and members, local businesses, and media.
The materials developed as a part of the Initiative were informed by social research conducted in the Potomac Watershed. A survey conducted by Opinion Works combined with focus groups for chronic litterers (Alice Ferguson Foundation, 2008) acted as the backbone to developing the education campaign, as it identified demographics of those who litter, opinions about litter and reasons why people litter. In addition, various pilot videos and other media were presented to focus groups to determine characteristics that make the message resonate with litterers.

This campaign was developed through the use of social research to understand attitudes towards littering, motivations to litter and what deters littering. The results provide insight into why people litter, such as wanting to keep their personal space (e.g., car) clean. The research also concluded that people connect impacts to health (community, water supply, personal) with litter. From this research, an outreach campaign was developed to connect health and trash with messages stating “Take Control. Take care of your trash” and ‘Your litter hits close to home’. This campaign was piloted in 2011 throughout the DC region.

The campaign message was later refined based on follow-up monitoring, which indicated that, although the campaign was successful at changing behavior overall, millennials (i.e., those in their teens and twenties) showed the least impact (litter reduction) of any group, and were also the most likely group to litter (Pennino, 2014). The Alice Ferguson Foundation worked with Opinion Works to conduct another series of focus groups, targeting millennials who are self-proclaimed litterers. Some conclusions of this supplemental research include that this group values “authenticity,” with pictures depicting local scenes rather than more generic pictures. In addition, this age group communicates using more varied and interactive media than others. Some campaign revisions based on the results of this study included adding more local pictures to campaign materials, creating an Instagram account, and adding some interactive games.

For more information about the Regional Litter Prevention Campaign, go to the Alice Ferguson Foundation at:

http://fergusonfoundation.org/trash-free-potomac-watershed-initiative/education/litter-prevention/
Los Angeles Region: Diverse Community Outreach

The City of Los Angeles implemented a public education program focused on trash reduction that targets billboards, bus advertisements, bus benches and print advertisements in community papers in high trash generating areas (HDR Engineering, Inc. 2008). Some highlights of this campaign are targeting trash hotspot areas, and outreach using multiple methods to reach a culturally diverse community. Some efforts include the following:

- Placed 200 billboards with the bilingual (English and Spanish) message, “Drop Your Fast Food Wrapper In A Can Not the Curb”, making an estimated 21,873,600 impressions on the general public. They have also placed bilingual advertisements in the interiors of 2,530 buses with the message “Litter: Can It!” making an estimated 9,721,496 impressions on the general public.
- Posted bilingual advertisements on 200 bus benches with the message “Litter: Can It!” making an estimated 4,860,748 impressions on the general public.
- Placed 66 advertisements (45 English, 18 Spanish and 3 Korean) in 12 publications (9 English, 2 Spanish, 1 Korean) with the messages “Drop Your Cup In the Garbage, Not The Gutter” and “Drop Your Fast Food Wrapper In A Can, Not The Curb” making an estimated 5,885,000 impressions on the general public.
- Placed 25 advertisements in high school newspapers with the message “Drop Your Fast Food Wrapper In A Can Not the Curb” making an estimated 67,000 impressions on high school students.

Citizen Volunteers: Montgomery County, MD and Washington, DC

Both Montgomery County, Maryland and the District of Columbia rely heavily on citizen volunteers. For example, the Montgomery County, Maryland Division of Solid Waste Services (DSWS) coordinates a Recycling Volunteer Program to educate residents on the benefits and importance of recycling. Together, the volunteers contributed nearly 1,795 hours of direct service with an estimated value of $44,875. More detailed information on DSWS’s outreach activities and other trash and litter reduction measures are found in the Division’s quarterly reports available at [http://www.montgomerycountymd.gov/sws/about/quarterly-reports.html](http://www.montgomerycountymd.gov/sws/about/quarterly-reports.html).

Citizens are also involved at the community scale. One example is the District’s Adopt-A-Block Program (District of Columbia n.d.). To participate in the program, local citizens must adopt a minimum of 2 square blocks of a residential or commercial area and ‘clean and green’ their adopted 2 square blocks every three months for a 2-year period. Citizen groups register with the “Office of the Clean City” at: [http://occc.dc.gov/service/adopt-block](http://occc.dc.gov/service/adopt-block).

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1 Impressions are a count of the number of times a message is viewed. For example, impressions for a billboard would be a count of the number of vehicles passing the billboard times the typical number of riders.
Outreach to Schools

Outreach to schools can include a more detailed message, and include elements of the school’s academic curriculum. Two examples of fairly in depth school programs include work completed by the Malibu Foundation for Environmental Education in Los Angeles and the Alice Ferguson Foundation in the Anacostia Watershed.

Los Angeles: Malibu Foundation

Los Angeles County provided outreach to elementary students through several programs including the Environmental Defenders that reached 3,876 students at seven elementary schools, and the Carver Elementary School Community Clean Up Day. More than 30 teachers attended workshops offered through the Generation Earth program including Professional Development, Waste Reduction and Recycling, and Water Pollution Prevention workshops. The impact from these workshops reached more than 3,056 students from 23 schools, potentially impacting 31,799 people (County of Los Angeles 2013).

Each year, in partnership with the California Coastal Commission and the Malibu Foundation for Environmental Education, over 5,000 students participate in Ocean Day in Los Angeles, removing an average of 2.5 tons of trash from Dockweiler Beach and participate in an aerial message in the sand, a photo of which is then sent to Los Angeles media. The message of the students’ beach clean-up annually reaches 2,000,000 LA residents (HDR Engineering, Inc. 2008).

Some great teacher resources from these efforts can be found at: [http://www.malibufoundation.org/](http://www.malibufoundation.org/)

Anacostia River Watershed: Trash Free Schools

The Anacostia River Watershed has a Trash Free Schools Initiative Program. Through this program, schools enroll by taking the “Trash Free Schools” pledge, and implementing an eight step program to reduce trash from their school as provided in a guidebook. The program includes a monitoring program manual, a component that allows for a “report card” at the end of the year. Currently, eighteen schools are enrolled in the program, primarily concentrated in Washington, D.C. and Charles and Prince Georges County, MD. Along with the guidebook is an online Resource Center that provides lesson plans, activities and games to address waste reduction. Additional resources available include how-to guides, volunteer and service learning opportunities, and funding sources (Alice Ferguson Foundation n.d.).
Businesses

Outreach to businesses requires an ongoing effort, since this outreach typically promotes the most complex involvement, such as creating a business recycling program at an office, or complying with regulations. For example, the City of Los Angeles partnered with retail businesses (coffee shops, cafés, hamburger stands and sandwich shops) in the high trash generating areas using posters and staff education to address trash prevention. In addition, the Los Angeles City Stormwater Program focused trash outreach on businesses by partnering with twelve business improvement districts throughout the city. The City provided education posters for distribution, an advertorial was developed to educate business owners on the best management practices they could implement to reduce trash and pollution in their business districts.

5.2 Effectiveness

It can be challenging to document the effectiveness of education programs without a “before and after” snapshot. However, one study found strong evidence that education can have a great impact at the local level. In 2013, the Alice Ferguson Foundation conducted a study to evaluate the effectiveness of the campaign using direct observation of pedestrians at 4 sites throughout Prince George’s County, MD. Observations of pedestrians littering behaviors were made at a recreation center, shopping center, bus stop and metrorail station. Two observation sessions were conducted prior to the posting of litter campaign materials and two conducted every month at each site for the remainder of the year. The results are positive as they show a 45% reduction in the number of people littering after the litter campaign materials were posted (decrease from 1.32% to 0.75%) and a 77% increase in the number of people disposing of their trash in a trash receptacle (increase from 0.48% to 2.12%). The Litter Campaign had the larger impact on pedestrians 31-40 years of age with youth and young adults the lease affected (Alice Ferguson Foundation. April 2014).

![Figure 5.3. Effects of the Regional Litter Prevention Campaign](image-url)
5.3 Customizing Education/Outreach in the Tookany-Tacony Frankford

This watershed has an advantage because trash baseline monitoring can help to characterize where trash is generated as well as the categories of trash that are the most prevalent. These data, combined with demographic and other data can be used to customize the outreach effort. Another advantage is engaged citizens, who can be integrated to help with ongoing citizen monitoring efforts, or to participate in neighborhood clean-up activities.

5.4 References


Section 6. Municipal Operations

Local governments are responsible for most of the heavy lifting (literally) for trash collection and removal from streets and catch basins. For the three practices profiled in this section, the technologies have been available for a long time, but techniques to use available resources strategically can help to stretch thin budgets to achieve the greatest trash removal. The benefits of these practices extend beyond what we can measure by the amount of trash actually collected or picked up off the street. Recent research, as well as studies completed over a long period of time, suggest that environments with more litter cause littering behavior. For example, a recent study conducted for the “Keep America Beautiful Campaign (KAB, 2009) evaluated littering behavior at several sites across the United States. While much (85%) of littering behavior could be predicted by individual factors such as age or gender, environmental factors were also important, including amount of litter present and availability of trash cans. Consequently, keeping the streets and neighborhoods clean may be one of our most effective education campaigns.

6.1 Municipal Practices
Three practices profiled in this section include Trash Collection, Street Sweeping and Catch Basin Cleaning.

Trash Collection
Trash collection is typically completed on a regular schedule, which may include more frequent pick-ups in some areas, such as commercial districts. In some cases, however, trash hotspots are distributed throughout the community, and need to be addressed separately. In one example, Montgomery County, Maryland developed a special program to collect trash at transit stops. In the County, transit stops (bus stops) were identified as prime litter hotspots. As such, a program was developed through the Department of Transportation to remove trash at and around transit stops in the County. The program removed 397.95 tons of trash with a budget of $477,000 (Alice Ferguson Foundation 2012). To put this number in context, the trash removed from transit stops is over three times the total Anacostia Wasteload allocation from the Trash TMDL for Montgomery County, but only 12% of the County is within the watershed. Assuming uniform distribution of bus stops, this program would achieve approximately

Figure 6.1. Big Belly “CLEAN Management Console”
40% of the County’s trash reduction goals for less than $60,000, or approximately $0.60/lb.

Recently, there have been innovations in trash can technology. For example, some solutions developed by the BigBelly company (bigbelly.com) include solar trash compactors and “Smart Waste” elements, which include sensors that can remotely track which trash cans need to be emptied. These systems have been implemented successfully throughout the City of Philadelphia.

Street Sweeping
Trash is unique in that the type of sweeper is not as important as it would be if the goal was to remove sediment, nutrients or other pollutants. This is because trash is easy to remove, regardless of the sweeper type. The sweeping frequency is almost more important for trash, however, since many kinds of trash can be transported by wind even if no storm event occurs. The challenge is to identify the dirtiest streets and target them for additional sweeping. In both regions with trash TMDLs, trash hotspot data were used to target sweeping operations.

District of Columbia
In order to target trash reduction, the District Department of the Environment (DDoE) funded the District Department of Public Works enhanced street sweeping program that targets specific streets identified in the Anacostia Trash Reduction Plan as “hot streets”. In order to determine the sources of trash, streets that represent different types of landuses were monitored to count the visible trash near the curb. Based on the results of this study, the streets that had over 100 pieces of trash were identified as ‘hot streets’. These streets contribute the most trash to the stream and are provided enhanced street sweeping as they are swept an extra two times a month. The DDoE estimates that the increased street sweeping provides an additional trash load reduction of 72,384 lbs/yr (or 48% of the total Wasteload allocation for DC’s portion of the Anacostia) at a cost of $1,000,000/year (Robinson n.d.), or approximately $14/lb.

City of Los Angeles
The City of Los Angeles Bureau of Street Services sweeps 28,000 lane miles of public roads and 800 miles of alleys. The Bureau has 135 motor sweepers and maintains 3,000 public trash receptacles within the City. The street sweeping frequency varies from daily in the high trash areas to monthly in the least urbanized locations. Identified high trash areas are swept on a daily basis in addition to daily collection of trash receptacles to prevent overflow of trash into city streets. In the least urbanized locations, street sweeping occurs on a monthly basis (HDR Engineering, Inc. 2008).
Catch Basin Cleaning

Catch basin cleaning may seem to be a standard operation without much room for improvement, but the logistics and sheer number of catch basins cleaned presents a complex problem that can be more effectively optimized to clean the most catch basins, and target those that need it most.

**DC: Catch Basin Cleaning Optimization**

A good example of a first step to develop a more optimal catch basin cleaning program was recently completed for the DC Department of Water (DC Water, 2013). The study evaluated current catch basin cleaning practices, and recommended strategies for improving the effectiveness of the program. When evaluating the current program, the study found that the District’s catch basin cleaning program was similar to programs in other municipalities, but not “optimal” as required by the District’s MS4 permit. For catch basins in the MS4 area, catch basin cleaning and inspection is funded by DDoE. The program cleaned an average of 27-32 catch basins daily. Catch basins susceptible to flooding were cleaned more frequently, especially before a heavy rainfall. During cleaning, a visual assessment of obvious defects is conducted with repairs performed by District of Columbia Sewer and Water Authority (DC Water). The debris collected is taken to a dedicated pad at the Benning Road Transfer Station and then hauled to a landfill by a debris contractor.

The cleaning schedule for water quality catch basins (WQCB, See Section 7) was dependent on the amount of debris and traffic characteristics with a general range of 10 to 22 catch basins cleaned per day. In 2012, all WQCBs were cleaned over a six week period by a contractor. Large debris and trash are removed using a rake and shovel, vacuum suction hose, and a high pressure water jet. The debris collected is taken to the contractor’s facility where it is sorted into recyclables and trash. The recycling is taken to a recycling facility and trash is taken to a landfill (DC Water 2013).

The Study made several recommendations to improve the effectiveness (Table 6.1). While some of the recommendations focused on individual catch basin features or equipment modifications, others focused at a greater scale, including better tracking and coordination with street sweeping.
Table 6.1. Recommendations of the DC Catch Basin Cleaning Plan

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of Catch Basin Mobile Tracking Application</td>
<td>The mobile app would provide real-time data regarding catch basin cleanouts, with over 25,000 assets tracked in an operations management tool.</td>
</tr>
<tr>
<td>Coordination with DPW Street Sweeping Program</td>
<td>Since parking regulations are enforced with street sweeping operations, coordinating these activities will help reduce the number of catch basins with restricted access due to parked vehicles.</td>
</tr>
<tr>
<td>Pilot Study for Vacuum Truck</td>
<td>This technology will be tested to determine if it increases sediment removal.</td>
</tr>
<tr>
<td>Development of a Written Standard Operating Procedure</td>
<td>The operating procedure would be reviewed annually and document both cleaning and documentation procedures.</td>
</tr>
<tr>
<td>Development of a Training Program</td>
<td>The training program for all crew members would ensure consistency across all operations.</td>
</tr>
</tbody>
</table>

Los Angeles: Target High Trash Areas

In the City of Los Angeles, catch basins are cleaned in compliance with the NPDES MS4 permit requirements which range from one to four times a year depending on the location of the catch basin. This is conducted by the City Wastewater Collection Services Division of the Board of Sanitation. Catch basins located in the high trash generating areas takes place prior to the rainy season with increased clean-outs during that time (HDR Engineering, Inc. 2008).

6.3 Cost-Effectiveness

Municipal operations such as trash collection, street sweeping and catch basin cleaning are cost-effective measures, partially because the infrastructure to accomplish these tasks is already in place, so that revising or fine tuning existing programs can be just slightly more expensive. For example, the targeted trash collection in Montgomery County was only $0.60/lb of trash. The $14/lb cost for enhanced street sweeping (additional sweeping in trash hotspots) is comparable with outfall practices (See Section 8), but efforts to improve the efficiency of existing street sweeping may be more cost-effective. For example, very low cost activities such as enforcing parking regulations and optimizing existing sweeper routes can make a huge impact. Finally,
6.4 Customizing Municipal Operations in the Tookany-Tacony Frankford

Reviewing existing municipal operations with an eye toward increasing efficiency and targeting high trash areas will be a great first step toward making these efforts more cost-effective in the long run. The Task Force should join forces with other ongoing efforts to reduce pollutants, as these operations can reduce loads of sediment, nutrients and other contaminants as well as trash.

6.5 References


http://ddoe.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/CB%20Report%20Final%20062413%20BODY.pdf


Robinson, M. No date. The District’s Anacostia River Trash TMDL Implementation Strategy.
http://www.google.com/url?q=http://ddoe.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/Final_ppt_trash_strategy_roll-out_121913_0.ppt&ei=YGKLVKrdMc2eyATfh4EY&usg=AFQjCNHg8RnxYjQJ-0MK84F2NnDuJVNAQ&sig2=1DinWFYjxXuncScwWawww
Section 7. Catch Basin Practices

Several trash removal/collection practices can be applied within the existing catch basin, and this section will discuss three options (Figure 7.1), including:

- Catch Basin Opening Screens
- Catch Basin Inserts, and
- Water Quality Catch Basins

These practices are installed at the catch basin to capture or act as a barrier to trash and debris before it is transported downstream through the storm drain system. These practices can be an important part of an overall system to prevent trash and debris from reaching the stream, and are most effective when combined with other measures such as street sweeping or trash reduction strategies. In addition, catch basin practices are often combined to improve effectiveness and reduce the maintenance burden at the catch basin. For example, Los Angeles County has installed catch basin inserts in approximately 4,800 catch basins in the unincorporated areas and half of them also have a curb screen (L.L. Miller, personal communication, August 7, 2014).

Overall, these practices have had mixed success. While they have been highly effective in the arid southwest (e.g., in California) where the practices have been the most intensively studied, the ongoing maintenance burden to sustain trash removal and capture is much higher in the humid MidAtlantic, due to higher frequency storm events and a greater volume of organic debris from leaf litter. In the City of Philadelphia, the practices with the greatest promise are Catch Basin Inserts installed at the outlet of the catch basin, and Water Quality Catch Basins, especially if applied in targeted areas that generate high trash volumes and where maintenance activities can be concentrated (See “Trash Hotspot Monitoring”).

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1 Hydrodynamic practices typically have some design options that can be implemented at the catch basin location, but are discussed in the “Outfall Practices” section.
Figure 7.1. A, B and C. Catch Basin Inserts. E and F. Catch Basin Opening Screen Covers (Unless otherwise noted, photos from Toy-Chen 2014 and EOA, Inc. 2007).
7.1 Practice Description and Design Options

Both catch basin opening screen covers and catch basin inserts have several design variations. This overview describes a few of the design options for each of them, but several other options are available, particularly for catch basin inserts.

Catch Basin Opening Screen Covers

Catch basin opening screen covers are simply screens that cover the openings of catch basins to prevent litter from entering the storm drain, while allowing water to pass through the screen. Trash then accumulates on the street and routine street cleaning and maintenance is needed to prevent clogging. The screens are made of mesh wire or perforated plates and are designed to fit outside or immediately within the storm drain curb opening. These practices have been widely applied in Los Angeles City and County but have not been applied extensively on the east coast or in other humid regions. Screen cover design options differ in how and whether they retract during storm events. Three options, which were investigated by the City of Los Angeles as a part of compliance with the trash TMDL include the following (Magallanes et al., 2008).

Fixed Opening Screen Covers

In this option, screens are fixed in place, which doesn’t allow trash to be conveyed to the storm drain during any storm event, but these devices can be clogged, and cause ponding during storm events. Magallanes et al. (2008) also found that tire lug nuts can become ensnared in this screen material.

Magnetic self-opening screen covers

These systems use a predefined pound magnet to maintain the screen in the closed position until enough static force, produced by ponding water directly in front of the catch basin, is reached to open it. During larger rain events and due to street gutter conditions, the opening screen covers failed to open fast enough to prevent localized ponding. When they did open, much of the larger trash (i.e. plastic soda, water bottles) was trapped between the cover and the bottom curb opening, leaving the cover in an open position. Over time, the magnets lost their grip and the screen remained in the open position.

Flow activated screen covers

These screens have a locking mechanism that requires a predetermined flow to disengage the lock. After the locking mechanism is released, the static force in front of the catch basin forces the screen to open just enough to relieve the accumulated flow before returning to the locked position. These practices were highly recommended in California, with some benefits including that the user can determine the flow that the screen cover would open, and that the design also has a variety of installation options for many catch basin configurations.
Catch Basin Inserts

Catch basin inserts (See Figure 7.2. 1, 2 and 3) are baskets, trays, bags, or screens placed within the catch basin to capture sediment, organic material, trash and litter before it enters the storm drain. The insert can either be placed just below the entrance of the drain inlet or at the outlet of the catch basin. Inlet inserts are attached to the side walls of the catch basin and can incorporate additional filters to capture finer sediment or oil. Devices placed at the outlet of the catch basin are typically more effective since they are able to use the entire catch basin volume to capture trash, but these devices are not always feasible to implement. Catch basin inserts can be installed in any catch basin within parking lots, alleys, roadways and sidewalk curbs and typically service a catchment area of 0.25 to 2.5 ac (EOR, Inc. 2007). Some of the design configurations include the following (although many others are available):

![Image of Catch Basin Inlet Insert Types](image)

*Figure 7.2. Catch Basin Inlet Insert Types. 1. Hanging basket 2. horizontal insert and 3. vertical insert (Magallanes et al. 2008).*

**Trays or Baskets (Figure 7.2 (1))**

Trays or baskets are used at the inlet, and typically capture only a small fraction of the materials that enters the catch basin. These practices are effective at capturing floatable items and debris, but require frequent maintenance since they are filled with debris very quickly.

**Horizontal and Vertical Inlet Inserts (Figure 7.2 (2,3))**

These practices are also installed below the catch basin inlet, but use a greater fraction of the catch basin volume than baskets or trays.

**Screens**

Another option is to install screens at catch basin inlets. Several screen configurations were investigated by the California Department of Transportation (CALTRANS, 2003a, 2003b, 2005a, 2005b and 2009). Like baskets and inlets, screens need frequent maintenance, but some screen configurations are excellent at capturing buoyant materials. Screens are typically the most effective at catch basin or storm

![Image of Radial Axial Trash Screen](image)

*Figure 7.3. Radial Axial Trash Screen
Source: Caltrans District 7*
drain junctions that capture a large drainage area, since maintenance can be relatively time consuming (Figure 7.3).

**Outlet Inserts**

Outlet inserts, such as the “Snout,” change the flow path through the catch basin, acting as a modified outlet, rather than by capturing trash within the insert (Figure 7.4).

**Water Quality Catch Basin**

This practice, sometimes referred to as a “Water Quality Inlet” is a modified, multi-chamber catch basin that is designed to capture floatables and debris by increasing the volume in the catch basin, and modifying the flow path through the system (Figure 7.5). This practice is currently being implemented on all road construction or reconstruction projects in the District of Columbia. Although this practice is not designed to capture “neutrally buoyant” (i.e., neither floating nor sinking) material, it can be retrofit with a screen between the second and third chambers to capture more trash.
7.2 Performance/Effectiveness

The practices summarized in this section have not been extensively studied, and have been investigated the most thoroughly in California, with some more recent data from Maryland and the District of Columbia.

Catch Basin Screen Covers

This practice, when combined with street sweeping, appears to be very effective on the West Coast. For example, the City of Los Angeles conducted a pilot study to determine the effectiveness of catch basin opening screen covers during rain events with an accumulation of rainfall greater than 0.25 inches. The study was located west of the City of Los Angeles downtown area with a drainage area of fifty-five acres, with inlet screens on 24 catch basins. The catch basin inserts were determined to be 58-79% effective in preventing trash from entering the catch basin (Magallenes, 2008). When combined with regular street sweeping during dry days (93% of days in Los Angeles), the practice can prevent 85% of trash from entering the catch basin. However, the practice has not been studied in humid climates such as the MidAtlantic.
Catch Basin Inserts

Catch basin inserts have been evaluated extensively as a part of the Los Angeles River TMDL in order to certify “100% capture” of trash, as required by the TMDL. As a part of this program, the City of Los Angeles conducted a pilot study on the trash capture effectiveness of three catch basin insert configurations over a one year duration (2007) (Magallanes et al, 2008), in a 138-acre drainage area with 50 catch basins located adjacent to the Los Angeles Coliseum/Exposition Park.

The City of Los Angeles also examined hanging baskets and vertical inserts. Based on their results, the vertical inserts allowed the most trash capture volume and had the least maintenance, and the hanging baskets were ineffective due to their small capture volume. Other options (e.g., the horizontal catch insert) were later reviewed at this location, but due to ongoing maintenance issues Montgomery County has not continued their use (Curtis, ND).

Data from Montgomery County, Maryland confirm that the smaller volume catch basin inserts (trays and baskets) require too much maintenance to be practically implemented (Figure 7.6). In a study in the White Oak neighborhood of Silver Spring, Maryland, trash trays were installed at the inlet of several inlets and monitored over a 1-year period (Versar, 2006). The trays became clogged with trash and leaf debris very quickly, and needed to be maintained every two weeks in order to prevent the trays from bypassing stormwater flows (Figure 7.7). Other studies confirm this issue. For example, Pitt (2004) found that catch basin inserts installed in Alabama became clogged with leaf debris and began to release dissolved nutrients and organic carbon as the leaves decayed.
Catch Basin Screens
Several screen options have been evaluated by the California Department of Transportation (CalTrans), and some design configurations have been certified to remove 100% of trash, provided that they are maintained after major storm events.

Water Quality Catch Basins
Water quality catch basins are estimated to be between 25% and 50% effective at removing total suspended solids, and are also designed to remove floatable materials and oils. Some designs may also incorporate screens to remove neutrally buoyant materials (AWS, 2008).

7.3 Maintenance/Cost
Maintenance requirements depend on the design and capacity of the catch basin practice. In general, the maintenance can be achieved as a part of regular municipal operations such as catch basin cleaning and street sweeping.

Catch Basin Inserts and Screens
Maintenance of most catch basin insert and screen designs includes vacuuming either through the curb opening or the maintenance grate. A vacuum truck can cost (between $120,000 and $150,000) and the time to clean the catch basins adds significant cost to maintenance. Some designs been designed to use other equipment, however. For example, the radial axial screen depicted in Figure 7.3 is maintained with a front end loader, since this equipment was more readily available. In Los Angeles County, cleaning is recommended semi-annually at a minimum depending on unit specifications (Gordon and Zamist 2006), at a cost of approximately $200/unit. The County inspects catch basin inserts monthly and after storms from October to April. The systems are cleaned when trash is above 40% full. In May to September, the systems are
inspected and cleaned once. They are repaired or replaced as part of the maintenance program (L.L. Miller, personal communication, August 7, 2014). Although the costs were not tabulated, data from Montgomery County, Maryland collected to date suggest that the required maintenance frequency, at least for the trash trays studied in that municipality, would be cost-prohibitive (Versar, 2006).

**Trash Screens**
The screen covers work most efficiently when trash that accumulates on or adjacent to the screens is removed before each major storm. This involves street sweeping at least weekly (preferably biweekly). Los Angeles County reports the average cost of is $400/unit for a curb opening less than 5 feet in length and $2,000 for a curb opening greater than 21 feet in length (L.L. Miller, personal communication, August 7, 2014). The City of Los Angeles reports the price for retractable inlet screens is $1,500 per inlet. Installation costs can range from $200-$500 and annual maintenance costs averaged $4,000 per year per inlet (City of Los Angeles, 2002).

**Water Quality Catch Basins**
The Water Quality Catch Basins used in the District of Columbia are maintained as a part of a routine maintenance program that includes both standard and water quality catch basins. The maintenance procedure for both types of catch basins is similar, but since the water quality catch basins are multi-chambered, it takes longer to clean each catch basin. In the District of Columbia, crews can clean between 27 and 32 standard catch basins per day, but only 10-22 water quality catch basins (DC WASA, 2013).

### 7.4 Implementation Considerations and Recommendations
Trash control practices implemented at the catch basin can be effective, but only if combined with a corresponding increase in routine maintenance. Furthermore, while data from California suggest excellent trash removal for these practices, experience with catch basin practices as a group in more humid MidAtlantic has not been as positive, due to the more frequent storm events and additional debris from the leaves of deciduous trees.

All things considered, the practices with the most promise in Philadelphia are catch basin inserts at the outlet of the catch basin, and Water Quality Catch Basins fitted with screens (Table 7.1). Both of these practices require maintenance to be effective, and are best applied in areas that are known to generate high volumes of trash. Water Quality Catch Basins are best applied as a retrofit as part of road or other reconstruction activities.
### Table 7.1. Summary of Catch Basin Practices

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>May be effective in some settings, but require intense maintenance on the west coast.</strong></td>
<td></td>
<td></td>
<td><strong>Shows promise as a retrofit in trash-generating areas.</strong></td>
</tr>
<tr>
<td><strong>Outlet controls such as the “Snout” have the most promise.</strong></td>
<td></td>
<td></td>
<td><strong>Best implemented as a part of road reconstruction or other projects.</strong></td>
</tr>
<tr>
<td><strong>Requires frequent maintenance to be effective.</strong></td>
<td></td>
<td></td>
<td><strong>Require some additional maintenance beyond standard catch basins.</strong></td>
</tr>
<tr>
<td><strong>Very effective on the west coast, but have not been tested extensively in the east.</strong></td>
<td></td>
<td></td>
<td><strong>Can be expensive to install as a new practice, but can easily be installed as a part of a highway reconstruction or other redevelopment project.</strong></td>
</tr>
<tr>
<td><strong>Frequent storm events may limit the effectiveness of this practice.</strong></td>
<td></td>
<td></td>
<td><strong>Screens may help to improve capture of “neutrally buoyant” materials.</strong></td>
</tr>
</tbody>
</table>

### Installation Considerations

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vertical inserts at the catch basin outlet are more effective than inlet configurations.</strong></td>
<td><strong>Do not install on a cul-de-sac street, or at the bottom of a hill</strong></td>
<td><strong>Can be expensive to install as a new practice, but can easily be installed as a part of a highway reconstruction or other redevelopment project.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>May be helpful in areas prone to storm drain pipe blockages or areas of known large amounts of trash. (RBF Consulting 2003)</strong></td>
<td><strong>Screens may help to improve capture of “neutrally buoyant” materials.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Only effective when paired with street sweeping.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>The most effective design configuration is flow-activated. Other options can lead to localized ponding.</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Table 7.1. Summary of Catch Basin Practices

|---------------------|-------------------------------------------------|-------------------------------------------------------------|--------------------------------------|
| **Advantages**      | • Retrofitted into existing storm drain systems (curb inlet and flat grate catch basin)  
                      • Available in range of sizes  
                      • Can be modified to capture other pollutants  
                      • Maintenance relatively simple, easy access  
                      • High storm flows can pass to prevent flooding | • When installed in conjunction with catch basin inserts, reduced maintenance on insert and reduced overall catch basin maintenance during dry weather | • Does not require special maintenance beyond increased time due to multiple chambers.  
                      • Has a large volume for trash capture, so can be maintained less frequently than other catch basin inlet options. |
| **Disadvantages**   | • Some types susceptible to clogging during large storms  
                      • Important to clean before and after storm- labor intensive  
                      • If not properly designed, high flows can re-introduce trash into system | • Not effective as a stand-alone practice  
                      • Have not been extensively tested on the east coast due to concerns that frequent storm events would cause flow-activated devices to become clogged and stuck open. | • Relatively expensive to install unless integrated into other construction projects. |
7.5 References


EOA, Inc. 2007. Trash BMP Tool Box: Treatment and Institutional Controls. Developed for the Santa Clara Valley Urban Runoff Pollution Prevention Program.


Versar, 2009. White Oak Street Sweeping and Inlet Tray Results. Memorandum prepared for Montgomery County, MD Department of Environmental Protection. 21 pp. Rockville, MD
Section 8: Outfall Practices

Outfall practices refer to practices installed at or below the storm drain outfall. Practice options include the following:

- Hydrodynamic Practices
- Nets
- Litter Traps
- Trash Barges and Water Wheels

These practices can be valuable at outfalls with large drainage areas and high trash loads, when implemented in concert with upstream measures such as educational efforts and street sweeping. In addition, they can be implemented fairly quickly, thus serving as a stop gap measure until other programs and practices are in place.

8.1 Practice Description and Design Options

Outfall practices can have various configurations, each with distinct advantages and disadvantages, and different applications where they are most appropriate.

Hydrodynamic Practices

Hydrodynamic practices include a range of proprietary practices, which are designed to capture floatable materials and sediment from stormwater runoff. They are available in different sizes, so that smaller units can be used at the catch basin scale, but larger units can capture large drainage areas and are installed at the outfall.
Outfall Netting Systems

In netting systems, a disposable or reusable net is attached to the outfall. Once the net is full, either the entire net or the trash captured by it is landfilled. Trash netting systems include a variety of design configurations, with some design variations including in-line netting systems placed in manholes just above the outfall, and pontoon boats below the outfall. The specific design option depends on site factors such as ability to access the site and available head. Regardless of the specific option implemented, the nets cannot accommodate all storm events and need to include a bypass option for larger storms.

At the lowest cost end of the spectrum, the NetTech system by Kristar Enterprises (Figure 8.2) features a stainless steel pipe extension and polyethylene net. During large storm events, or when the net becomes clogged with debris and trash, the nets are designed to break free and cinch shut as they are captured by a tether line. Other designs, such as the Fresh Creek End-Of-Pipe Netting Trash Trap (Figure 8.3) accommodate larger flows by incorporating a flow bypass above the elevation of the nets.

The flow bypass options are more expensive to install, but are more suited to larger outfalls, or outfalls where maintenance access is more difficult. In larger creeks, or those with steep banks, recovering the NetTech nets may prove difficult, but the Fresh Creek design is attached to a liftable support frame.
In-Stream Trash Traps

Both proprietary and custom-designed trash traps can be installed within the stream channel. One challenge of these traps is that they can easily become clogged by trash and debris. The design shown in Figure 8.4 minimized the potential for clogging, and was designed and the shallow angle to the ground, allowing the stream's energy to dislodge these particles. This practice was both designed and maintained by the Anacostia Watershed Society. This practice replaced an earlier design that had experienced problems with clogging.

Floatable Trash Trapping Devices

For larger waterbodies, floatable trash trapping devices may be an option. These practices can capture large drainage areas, but are only able to capture floatable trash. The Bandalong Trash Trap (Figure 8.5) is one example of a floatable trash trap. It is composed of a floating boom that intercepts trash and other debris floating on the surface. This floating material is conveyed to an aluminum trap that is kept buoyant by polyethylene pipes. This practice can be installed on waterbodies wider than six feet, and is highly effective at capturing floatable trash.
Another example of a floatable trash trap is the water wheel, which has been implemented in the Baltimore Harbor (Figure 8.6). This practice also collects floatable trash using booms, but uses the action of the current to turn a water wheel, which powers a conveyor belt that moves trash to a floating trash barge. It is also equipped with a solar panel that powers the wheel during low flow conditions. Other communities have used skimmer boats, which operate on a similar principal but move throughout a water body rather than remaining stationary.

8.2 Performance/Effectiveness

By some measures, trash trapping devices are highly effective (Table 8.1). For example, hydrodynamic practices meet the “100% capture” criterion according to product testing completed in Los Angeles and trash netting and floatable capture devices are nearly 100% effective at capturing floatable trash.

Challenges

There are three challenges to achieving these removal rates in practice, however, including organic debris capture, finding the best mesh or opening size, and designing practices to capture trash of different buoyancies.

Organic Debris

Trash capture is typically reported as “pure trash,” meaning that leaves and other organic debris are typically not considered as trash capture. However, studies in the Mid-Atlantic suggest that greater than half of the total debris captured by outfall or in-stream practices is actually in the form of organic debris (See Figure 8.7). There may be value in capturing leaf debris, as some data suggest that these materials contribute nutrients to urban streams, but designers should recognize that only a fraction of the materials captured by these traps is actually trash.

Mesh/Opening Size

For outlet screens or nets, finding the best opening size can be a challenge, since there is a balance between capturing the smallest trash particles and preventing clogging and resulting bypass of larger storm events.
Buoyancy
Another challenge to creating the “perfect” trash trap is that trash can be divided into floating, neutrally buoyant, and sinking. According to in-stream data collected by the Anacostia Watershed Society (AWS, 2008), almost 70% of in-stream trash is in the neutrally buoyant category. Only a fraction of trash in this category will be picked up by floating trash capture devices, and many hydrodynamic devices target floatable materials or settleable materials. Nets and screens can capture all ranges of buoyancy, but in doing so they can cause bypass of large storm events.

8.3 Maintenance/Cost
Some example data are included in Table 8.1. In some cases, however, maintenance of these traps (with the exception of Hydrodynamic Devices and Nets) can be performed by volunteer groups. Although data are limited and highly variable, outfall practices appear to be similar on a $/lb basis to street sweeping (as a stand-alone practice; see section 7). One exception is Hydrodynamic practices, which are quite expensive on a $/lb of trash basis. It is important to note, however, that these practices may also help to reduce loads of other pollutants, and sediment in particular, while netting systems and trash traps do not capture sediment.

<table>
<thead>
<tr>
<th>Practice</th>
<th>Performance</th>
<th>Cost Data</th>
<th>Cost-Effectiveness ($/lb)</th>
<th>Maintenance Requirements</th>
<th>Where Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrodynamic Practices</td>
<td>85-95%</td>
<td>$3,500/imperious acre treated (annualized) (King and Hagan, 2011)</td>
<td>339^a</td>
<td>Inspect semi-annually</td>
<td>Small (up to 10 acre) drainage areas</td>
</tr>
<tr>
<td>Netting systems</td>
<td>90-95% of floatables (US EPA, 1999) 86% floatables (MWCOG, 2001)</td>
<td>$300,000 installation to capture approximately 300 acres (MWCOG, 2001) NetTech (approximately $15,000 for a 70 inch box culvert; WPB, 2011)</td>
<td>13^b</td>
<td>Inspect after 0.25 rainfall; maintenance about 10% of installation</td>
<td>Small to large outfalls</td>
</tr>
</tbody>
</table>
Table 8.1. Performance and Design of Outfall Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Performance</th>
<th>Cost Data</th>
<th>Cost-Effectiveness ($/lb)</th>
<th>Maintenance Requirements</th>
<th>Where Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In-Stream Trash Traps</strong></td>
<td>Nash Run Removes an estimated 1,900 lbs/year (Robinson, 2013)</td>
<td>$60,000 for installation plus two years of maintenance (Robinson, 2013); treats 450 acres</td>
<td>6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Nash run maintained monthly by volunteers</td>
<td>Up to 1 square mile (Nash Run is about 0.7 sm)</td>
</tr>
<tr>
<td><strong>Floatable Trash Devices</strong></td>
<td>Estimated 4,100 lbs/year for two traps (Robinson, 2013)</td>
<td>Estimated 60K pounds/year rate in first 2 months (Water Wheel; Kuebler, 2014); $50-$95K per installation for Bandalong (Robinson, 2013)</td>
<td>22&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Maintenance costs $28-$48K/year (Robinson, 2013)</td>
<td>Bandalong on streams greater than 6' wide</td>
</tr>
<tr>
<td></td>
<td>Estimated 60K pounds/year rate in first 2 months (Water Wheel; Kuebler, 2014)</td>
<td>$800K (Water Wheel; Kuebler, 2014)</td>
<td></td>
<td>Annual Operation $100,000 (Kuebler, 2014)</td>
<td>Very large (Water wheel on 60 sm watershed)</td>
</tr>
</tbody>
</table>

*a*: Assumes 5 lb/acre trash loading rate and 90% Efficiency; practice treats a 50% impervious watershed  
*b*: Assumes 20 year life and 20% annual maintenance costs.  
*c*: Assumes 5 year lifespan, 10% annual maintenance costs  
*d*: Assumes 10-year lifespan, $150,000 construction and $75,000 maintenance for two traps  
*e*: Assumes 10-year lifespan
8.4 Implementation in the Tookany-Tacony

Outfall practices may play a role in this watershed on a limited basis to achieve two goals. First, they can be used in trash hotspot sewersheds to get a “jump start” on capturing trash that ongoing education programs will take a long time to achieve. Second, some of these options can serve as both public education and watershed monitoring tools. For example, ongoing trash counts from the Nash Run Trash Trap have demonstrated a decline in plastic bags after implementing the plastic bag tax in Washington DC (Kennedy, 2013).

In the Tookany-Tacony Frankford, the best option may be to implement a few outfall practices on a trial basis, in sewersheds known to have high trash loads. In addition, these practices may have additional benefits by capturing leaf debris and other gross stormwater pollution, which is a source of nutrients, sediment and organic carbon.
Table 8.2. Summary of Outfall Practices

<table>
<thead>
<tr>
<th>Hydrodynamic Practices</th>
<th>Nets</th>
<th>In-Stream Trash Traps</th>
<th>Floatable Trash Trap</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Assessment</strong></td>
<td>Not recommended unless the practice is suggested to trap other pollutants.</td>
<td>May be useful on CSO outfalls, but require frequent maintenance. In some applications, municipalities have discontinued use due to maintenance burden.</td>
<td>In limited applications, could be useful as a demonstration and education practice on watersheds with high trash loads.</td>
</tr>
<tr>
<td><strong>Installation Considerations</strong></td>
<td>Treats small drainage areas, and requires sufficient hydraulic head.</td>
<td>Need access for maintenance, unless an in-line netting system is used. Cannot be installed on tidal waters.</td>
<td>A variety of designs can be used. Care should be taken that the design does not clog and cause flooding.</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>Can treat sediment and oil/grease as well.</td>
<td>Relatively easy retrofit of existing outfall. Captures a full range of trash sizes</td>
<td>Can be maintained by volunteers. Captures both floatable and neutrally buoyant trash.</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Not much better than modified catch basins (see Section 7) • Ongoing maintenance burden.</td>
<td>• Ongoing maintenance is challenging. • Primarily captures leaves and debris.</td>
<td>• High ongoing maintenance burden. • Installed within the stream channel, resulting in possible permitting issues</td>
</tr>
</tbody>
</table>
8.5 References


