T04 Outfall Trash Monitoring Report
December 2013-December 2014

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T04 Outfall Trash Monitoring Report

1. Introduction

This report shares the results of the T04 Outfall Trash Monitoring Project. This study was a collaborative effort between the Tacony-Tookany-Frankford Watershed Partnership, the Philadelphia Water Department (PWD), and Temple University to monitor trash and debris in sewer inlets near Tacony Creek. This study identifies types of trash that accumulate in inlets, analyzes the spatial and temporal patterns of trash accumulation, locates problem areas, and proposes solutions and interventions for reducing trash accumulation in the outfall study area. The survey area included the 50 sewer inlets which drain into the T-04 outfall on Rising Sun Avenue. PWD selected the T-04 outfall for the study because it includes a diverse set of land uses (e.g. residential, commercial, manufacturing, and open space) and is in close proximity to the Tacony Creek, an area that has historically attracted high levels of litter.

In October 2014, the Philadelphia Water Department and TTF Watershed Partnership, Inc. contracted a research team at Temple University (Temple) led by Dr. Hamil Pearsall (Geography and Urban Studies Department) to monitor for a calendar year private and public sewer inlets within the T04 outfall area. The Temple team, comprised of the faculty supervisor, Master’s student (David Hatten December 2013; Robert McDermott January 2014-December 2014), and two groups of undergraduate students (Ryan Polzer and Elizabeth Janczewski December 2013-August 2014; Bianca Santos and Sam Konstantinov August 2014-December 2014), surveyed the outfall area from December 2013-December 2014. The team worked with Julie Schneider from the Center for Watershed Protection and consulted on a regular basis with staff from TTF. The team provided regular updates on the status of the project at the following website: http://sites.temple.edu/trash/. Temple has produced this report to provide detailed documentation of the methodology and findings. The Center for Watershed Protection has submitted an accompanying appendix that summarizes trash TMDLs and possible interventions for implementation near the Tacony Creek. Any additional questions about the project can be directed to Hamil Pearsall at hamil.pearsall@temple.edu or 215-204-3074.
2. Methodology

The monitoring methodology implemented in the T04 outfall was developed based on a review of four trash monitoring studies conducted between 2002-2013 in Washington, D.C; Easton, MD; Baltimore, MD; and Los Angeles, CA (Appendix A), discussions with Julie Schneider, and pilot testing in early December 2013.

2.1 Trash monitoring survey

From mid-December 2013 through mid-December 2014, the 51 sewer inlets (42 public, 9 private) and the outfall were observed approximately once a week for observable pieces of litter both blocking the inlet and in an approximate 1 foot area surrounding the inlet. All areas within a foot of open-mouth inlets were included in the survey; however, only debris located on top of the grate were included for drop grates.

This determination is based on the estimated feasibility of nearby debris to drift to the inlet mouth. Litter was divided into the following categories: cigarettes, paper (newspapers, flyers, packages, mail, wrappers, napkins, bags, other), styrofoam (food containers, cups/plates, other), metal (cans, foil, other), plastic (bottles, containers, bags, wrappers, cups, lids, other), and glass (bottles, containers, other).

The inlets were also monitored for their level of blockage (clog) on a scale of 1 to 5 using the following values: 1 = 0%, 2 = 0-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-100%. The primary and secondary sources of blockage were noted on each inlet. The information recorded in the survey allow for a rapid assessment of trash accumulation trends, as well as a fine-scale analysis trash composition and quantities. A copy of the survey is available in Appendix B. Data were collected on paper surveys and by tablets (Google Nexus 9) when temperatures were above freezing.
2.2 Rapid Trash Assessment (RTA)

In response to requests to further assessing trash accumulation on the streets as well as sewer inlets, the Rapid Trash Assessment (hereafter referred to as the “RTA”) was developed. The RTA is an efficient and simple survey to qualitatively assess the amount of trash accumulating on the commercial streets of the study area. Important to note is that the residential area of the study area is omitted from this assessment as it is cleaned on a very frequent basis by the Philadelphia Housing Authority. The RTA features a set of computer-generated polygons using GIS software which are then delineated in the field by survey staff. The following map displays each polygon, shown in green, and labeled by letters.

Staff survey trash quantities in the RTA zones and assign a number to each zone based on the presence and density of trash throughout the zone. The numbers range from one to five, with lower numbers indicating lower amounts of trash accumulation.
Once each number is assigned to the polygon, a series of photographs are taken to record and validate the number assignments. Some of these pictures can be found on the RTA blog for the project website: http://sites.temple.edu/trash/rapid-trash-assessment-2/. All photos are, however, available upon request.

3. Results
An overview of year-long trends are presented, followed by a detailed analysis of trends in the winter, spring/summer, which are combined due to similar trends, and fall.

3.1 Calendar Year

Overview: Data from a full calendar year points towards the dynamic nature of trash accumulation in the outfall area. Fall and winter are characterized by greater inlet blockage, on average, while spring and summer bring precipitation events that wash litter and organic debris into the inlets. With the exception of the high volume of cigarettes, the majority of litter observed is plastic or paper, rendering it recyclable or compostable. Spatially, trash accumulated in high pedestrian and car traffic areas, such as the intersection of Rising Sun and Adams Avenues. Notably, these areas did not have trash cans available, pointing to one potential solution.

Blockage: Throughout the year, most inlets are 25-50% blocked. The winter and fall seasons were characterized by inlet blockage from snow and ice or organic debris (e.g. leaves and soil). Inlet blockage created more litter on the streets that had the potential to flow to other locations or be carried by the wind.

Totals: The total amount of trash observed during any given survey varied widely during the year, ranging from just under 100 pieces of trash to over 350. The counts of trash were affected by the weather conditions, with snowy conditions trapping and burying trash in snowbanks and precipitation events washing litter into the inlets.
Trash Type: Over the year, plastics were the most commonly observed type of trash (38%), followed by cigarettes (31%), and paper (21%), metal (7%), Styrofoam (2%), and Glass (1%). The majority of trash found may be recyclable.

Some example of common trash items were plastic and paper wrappers. Other common items were miscellaneous shredded particles of paper and plastic, these shreds were labeled as plastic and paper “other”. Paper and plastic particles were most likely litter, which was shredded by a lawn mower. Paper and plastic bags were also fairly common.
<table>
<thead>
<tr>
<th>Ranking</th>
<th>Winter</th>
<th>Spring/Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cigarettes (19%)</td>
<td>Cigarettes (60%)</td>
<td>Cigarettes (34%)</td>
</tr>
<tr>
<td>2</td>
<td>Plastic (43%)</td>
<td>Plastic (23%)</td>
<td>Plastic (36%)</td>
</tr>
<tr>
<td>3</td>
<td>Paper (23%)</td>
<td>Paper (11%)</td>
<td>Paper (22%)</td>
</tr>
</tbody>
</table>

Broken out by week, the trash totals fluctuated substantially by type during the year; however, cigarettes and plastics were consistently the most commonly observed types of trash. The presence of cigarettes increased during warm weather months.

*Spatial patterns:* Maps of the inlet trash counts reveal that heavily trafficked attracted the greatest amount of trash overall. In this study area, the intersection of Rising Sun Plaza and Adams Avenues persistently had higher trash counts, as well as the inlets near Tacony Creek.

In the earlier part of the year, from January through June, there was not an observable difference between residential and commercial trash levels. However, by mid-summer, commercial areas, on average, produced consistently higher trash counts. The residential areas are managed by the Philadelphia Housing Authority, and the survey indicates that this maintenance effectively reduces trash new inlets. The commercial areas are privately owned and maintained; however, the results of the survey suggest that high levels of car and pedestrian traffic may contribute to the trend.
**RTA:** The RTAs show that the areas with high trash densities are around the bus stop at Rising Sun and Adams Avenues and the areas near Tacony Creek.

Additionally, and of further note for future surveys, there is some correspondence between trash accumulation in inlets and trash density in surrounding areas.

The RTAs contained littered packaging from local business, such as Dunkin Donuts, and Wendy’s. Also common were cigarettes and paper/plastic wrappers. These items were concentrated on the densely littered RTAs, around the intersection of Adams Ave. and Rising Sun Ave. These areas experience the most pedestrian traffic due to a concentration of bus stops and convenience stores. Shredded litter from lawn mowers was fairly common.
3.2 Winter (December 2013-March 2014)

Overview: Philadelphia saw one of its snowiest winters on record during the 2013-2014 season, with approximately 67.4 inches of snow. The harsh winter resulted in: (1) less trash accumulation, and (2) extremely clogged inlets, leading to compromised stormwater runoff and a temporary stagnation of trash delivery to Tacony Creek. Plastics were most common, particularly wrappers and bottles.

This snowfall and cold temperatures (<20°F) made weekly surveys difficult. Further, the snow affected the data by clogging inlets and covering the trash for weeks after snowfall because the temperature remained below freezing for most of the winter.

The snow in commercial parking lots in the Rising Sun Plaza was plowed into large piles that remained for close to a month due to the cold temperatures. Each time the lots were plowed, loose litter in the parking lot was caught and put into these piles. When the snow melted in March, piles of litter were
covering some of the inlets. The parking lot and inlets are privately owned and litter was cleaned up by a crew.

*Blockage:* The percentage of inlet blockage was the highest during the winter. Inlets were 100% covered by snow because snow plows push snow along the gutter. On some occasions, 50% of the inlets were 100% clogged with snow. The snowfall skewed the data, as there seems to be less trash during the winter months. However, this is not accurate many inlets were blocked by snow making the trash tallies more difficult.

*Trash Totals:* The total pieces of trash recorded increased during the course of the spring. In general, reduced foot traffic during the winter months caused less trash to accumulate; however, difficulties recording pieces of trash during the survey also affected the total counts of trash.

![Graph showing total trash counts over time](image)

*Trash Type:* Plastic was the primary (43%) type of trash observed during the winter months. Plastic is concerning primarily due to its long life cycle in the natural environment: it does not extensively degrade, and it is (aside of wrappers) buoyant. It thus has a higher chance of moving down stream and river systems as opposed to paper and metal.

### 3.3 Spring and Summer (March 2014 – September 2014)

*Overview:* There was a dramatic increase in trash during spring, likely a result of more foot traffic during warmer weather. The spring season was also characterized by different types of trash than the winter. Additionally, the primary contributors to inlet blockage transitioned from snow to leaves, dirt and grass due to lawn maintenance and rain storms.

*Blockage:* The average blockage during spring and summer was 1.5 with most inlets falling between a 1 (0% clog) and a 2 (0-25% clog). Many small pieces of trash (cigarettes, wrappers, etc) are found in the inlets but these usually do not clog inlets more than 25%. Organic materials, such as leaves and soil, are typically the primary culprits for inlets over 25% blocked.
Totals: Broadly speaking, trash totals significantly increased from the winter to the spring. The average raw total for winter was 162, and in the spring it jumped to 263. This jump is likely due to the significant increase in foot traffic which has been observed since the beginning of warmer weather.

As the figure below shows, trash accumulation fluctuated to a fair degree. High volumes of precipitation in the spring months led to trash being flushed through the inlets and out to nearby tributaries. Thus, the survey data may not entirely reflect the amount of trash accumulating. Moreover, whereas the transition from winter into spring saw a sharp upward trend due in part to increased foot traffic, foot traffic is relatively stable throughout spring and summer months. Thus, an upward trend in trash accumulation should not entirely be expected, and is more characteristic of a transition from winter to spring versus a transition from spring to summer.
**Trash Type:** The most common type of trash observed in the spring/summer was cigarettes, most likely reflecting the increase in foot traffic. Cigarette litter is a persistent problem, but may be overlooked due to their small size.

The second largest litter type was plastic, with plastic bottles and wrappers being the largest contributors. The third largest contributor was paper, which consisted mostly of fast food bags and newspapers. Metal, Styrofoam and glass made up small amounts of the observed litter during the spring and summer. Close to 50% of the litter observed in the inlets was recyclable.

Plastic bottles, wrappers, cigarettes, fast food all represent goods that are consumed on the street and assumingly tossed onto the ground. This phenomenon is most clearly observed at the corner of Rising Sun Avenue and Adams Avenue at the bus stop, where the largest amount of litter can be observed. Patrons waiting for the bus often smoke, drink out of plastic bottles and consume Wendy’s purchased across the street. This bus stop does not have a trash can in the vicinity.

**Land use and trash accumulation:** Similar to the winter, the commercial areas, including the Rising Sun Plaza and Forman Mills, continued have higher trash counts than the residential area,
indicating that maintenance by the Philadelphia Housing Authority is effective for minimizing trash accumulation.

![Total Trash by Land Use: Mar 2014 - Sept 2014](image)

**RTA:** RTA results are only available in spring/summer and fall. However, these results indicate that trash densities tend to be highest at the intersection of Rising Sun and Adams Avenues, as well as near the Tacony Creek.
3.4 Fall (September 2014-December 2014)

Overview: By October and November, the inlets were – unsurprisingly - increasingly blocked by leaves and other organic debris. Plastic and cigarettes continued to be the most frequently observed types of trash caught alongside organic debris. The places with the most trash were in public areas along Rising Sun Ave and near torn down fences alongside the outfall site.

Blockage: Inlets became increasingly blocked during the fall, primarily as a result of increased organic debris such as leaves, branches and soil. The average clog value was 1.9, with the majority of inlets ranging between ‘1’ and ‘2’ level clogs. Inlets at the bottom of hills, especially on Rising Sun Ave, displayed consistently high clog rates. This pattern was most likely the result of a fall monthly average of 3.03 inches of rain water bringing organic debris down-hill.

Totals: The total trash counts fluctuated throughout the fall, with a range from 150-300 pieces of trash counted per survey. Most notably, there were fewer pieces of trash observed in October, a period that also corresponded with relatively open inlets, cooler temperatures, and precipitation events. An increase of average blockage in November followed high volume of organic clogging near commercial corridors and an increase of precipitation.
Trash Type: During the fall, plastic types and cigarettes were the most common types of trash observed, reflecting a persistent trend observed in the winter and spring/summer. Plastic bottles were highest within plastic types, along with plastic candy wrappers during the end of October. Paper wrappers also increased during the commercial and residential areas within the Halloween period.

Plastics, October 31, 2014
**RTA:** The RTA zones that displayed the highest densities of litter in the fall were those near the Rising Sun and Adams Avenue intersection, as well as the zones near the outfall.
Appendix A: Review of previous trash monitoring studies

Anacostia Watershed Trash Reduction Plan

The Anacostia Watershed Trash Reduction Plan, conducted by the Anacostia Watershed Society and prepared for the District of Columbia Department of the Environment, took an approach of dividing the Anacostia watershed into 500-1000 foot ‘transects’ and quantifying the amount and types of litter within each transect on a quarterly basis. In addition to the transect monitoring, they conducted ‘windshield surveys’, where the monitoring team would count all of the pieces of visible trash on the streets that would likely drain to the tributary. Data collection took place from August 2007 to June 2008 and was aggregated to graph seasonal variation, showing a general increase in litter during the spring and summer months. The Anacostia Watershed Trash Reduction Plan is a useful study for comparison because the Anacostia River spans Prince Georges and Montgomery County, Maryland, as well as the District of Columbia and gives guidance on how to address litter concerns that span differing municipalities. The TTF Watershed is especially interesting because it spans several neighborhoods in Philadelphia and Montgomery County, which impacts the ability to respond to pollution concerns.

The Tred Avon Watershed in Easton, Maryland was observed from November 2011 through December 2012 by the Center for Watershed Protection. This study was funded by the Chesapeake and Atlantic Coastal Bay Trust Fund and the Tred Avon-Local Implementation Grant. The study involved monitoring four storm water outfalls which were equipped with netting systems over the course of fifteen months. The ‘Nettech’ system, designed by Kristar Enterprises, helps to prevent litter and organic debris flowing into the river. If the nets do not allow enough water to pass through, usually during a high flow rain event, the net will discharge and cinch together to prevent the contents from entering the waterway. Approximately once a month, the four netting systems were drained and weighed to record the weight of the solids captured in the netting. Advanced sampling of the gross solids was conducted to document the nutrient concentration of organic debris as well as the species of leaves collected. Approximately 4% of the solids collected in the netting systems were litter, 3% was woody debris, and the remaining 93% collected was leafy material. The results mirror the outcome of the previous netting of the T-04 outfall, where much of the matter collected was organic.

New Jersey Litter Survey: 2004 was a study was conducted by Solid Waste Management Consultants with the Institute for Applied Research, and presented to the New Jersey Clean Communities Council. The goal of the study was to “produce accurate, comprehensive data that reflects the overall quantification, distribution and composition of litter in in New Jersey” in order to develop effective methods of litter reduction. The study defines litter as “solid waste in the wrong place (5)” and found that 21.3% of New Jersey’s observed litter was classified as ‘take out food’ and 14.4% of observed litter classified as a ‘beverage container’. This study differs from ours by classifying litter by its purpose rather than its physical properties which can create a streamlined process in anti-litter outreach. This can work through advertising which targets fast food litter, cigarette litter, etc. The study claims that “paid advertising programs targeting the age groups identified as primarily responsible for causing litter are the most cost effective. They prevent litter from occurring at a cost of $0.02 per item (3)’.

The Harris Creek Technical Memorandum was conducted by the Center for Watershed
Protection and the Baltimore Harbor Watershed Protection offers a pathway for assessing potential trash and pollution source areas, and addressing these areas through targeted methods. Over the course of three weeks in July of 2008, 5 separate square blocks surrounding Harris Creek were monitored to identify potential trash and pollution sources. The goal of the study was to not only to identify sources of litter and pollution, but to create a standard procedure for evaluating identified source areas. Once a week, each square block was monitored for observable pieces of litter which were entered onto a bar graph by type and given rating based on the severity of present litter. The commercial nature of each street had an effect on the levels and types of trash observed. Fayette St., a commercial corridor, was observed having 25-30 plastic bottles and food wrappers while at the same time Fairmount Avenue, a residential street, had approximately 1-5 of each. The report acknowledges the vast difference between certain commercial and residential streets, and makes recommendations for certain streets to be added to the city’s street sweeping routes. Plastic bottles, plastic bags, and food wrappers were the most present forms of litter observed throughout the five neighborhoods. Several recommendations were made by the study, but the recommendations were differing for each separate community. Their conclusion was that there are no blanket solutions to address Baltimore’s litter problem and that a more tailored approach is needed depending on the dynamics of the neighborhood. For example, the study suggests providing wheeled trash cans in the ‘Butcher’s Hill’ neighborhood, while several of the other neighborhoods were encouraged to be added to the city’s street sweeping route. The Harris Creek Memorandum is relevant to our study due the size and complexity of the Philadelphia’s geography and neighborhoods.

High Trash Generation Areas and Control Measures, LA: High Trash Generation Areas and Control Measures, was conducted by the Los Angeles Watershed Protection Division in 2002. The goal of the study was to identify areas that generate significant amounts of litter. In order to identify high litter areas, the study relied on the following factors: catch basin cleaning data, WPD hotline reports of dumping and requests for catch basin cleaning, land use data, and population density. The Watershed Protection Division concluded that the high trash generation areas tend to be located in the central parts of the city, in proximity to highly visited commercial and industrial areas. This study, based on its conclusion and methods, may be useful in helping the City of Philadelphia identify high trash areas within its boundaries. The study recommends several policy responses to litter: increased ticketing/citations, increased number of trash receptacles, increased catch basin cleaning, expanded street sweeping, the limiting of high litter items (plastic bottles, bags, etc.), increased educational outreach, and added outfall netting. Although the Los Angeles study recommends increasing outfall netting, they acknowledge the capital problems associated with installing and maintaining netting systems.
Appendix B. Trash survey developed for T-04 monitoring project

<table>
<thead>
<tr>
<th>Inlet #</th>
<th>125449</th>
</tr>
</thead>
<tbody>
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<td>Percentage clogging:</td>
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</tr>
<tr>
<td><strong>Primary type:</strong></td>
<td>Leaves</td>
</tr>
<tr>
<td><strong>Secondary type:</strong></td>
<td>Leaves</td>
</tr>
<tr>
<td>Tally each piece of trash observed:</td>
<td></td>
</tr>
<tr>
<td><strong>Plastic:</strong></td>
<td>Bottles _____</td>
</tr>
<tr>
<td><strong>Glass:</strong></td>
<td>Bottles _____</td>
</tr>
<tr>
<td><strong>Paper:</strong></td>
<td>Newspaper _____</td>
</tr>
<tr>
<td><strong>Styrofoam:</strong></td>
<td>Food containers _____</td>
</tr>
<tr>
<td><strong>Metal:</strong></td>
<td>Bottles and cans _____</td>
</tr>
<tr>
<td><strong>Cigarettes:</strong></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
Appendix C. Case studies of trash TMDLs in the Los Angeles River and Anacostia

See attached report submitted by the Center for Watershed Protection.