WM SNOHOMISH COUNTY PAPER STUDY – 2017

STUDY RESULTS

On behalf of Waste Management Northwest (WM), Cascadia Consulting Group, Inc. (Cascadia) conducted a study to quantify and characterize the recyclable paper stream that is discarded (recycled and/or placed in the garbage) by the participants of the residential recycling program in the WM WUTC-regulated service area in Snohomish County, WA.

Study Objectives

In this study Cascadia characterized the types and relative quantities of paper products and packaging in the residential waste stream. The data presented here provide more detailed insight into the relative recovery of specific types of recyclable paper as well as the frequency with which specific types of recyclable paper is found in household garbage containers among residential customers in Snohomish County. The objective of this study is to collect baseline information that will help inform targeted community education and outreach efforts. These efforts, in turn, aim to increase the recovery of recyclable paper in Snohomish County. (See **Appendix A** for the full study design.)

Study Data Collection (field event)

The field event for the study was conducted over three days, from August 8 (Tue) through August 10 (Thu). Data about the quantities and composition of paper in residential waste generated at the household level was gathered from paired samples collected from household garbage and recycling carts over this field event. A total of 126 households (42 households per day) were sampled from 33 service routes serving nine zip codes across the Snohomish County. The nine zip codes included in the study represent half of the 18 zip codes in the WM WUTC-regulated service area in Snohomish County with at least 1,000 residential customers and represent 69 percent of all customers. All samples were "paired"; that is, they consisted of the entire contents of the garbage and recycling cart(s) from each household selected for sampling, including bagged material set next to the cart.

The fullness of the carts was measured prior to emptying their contents; this measurement was applied towards volume-based assessment of the material. After being measured, the entire contents of the garbage and recycling carts were collected on separate tarps to avoid cross-contamination. A sample placard was placed in each tarp to ensure proper identification of the sample.

After completing sampling each day, the sample collectors converged at a Waste Management facility in Woodinville for the direct waste analysis. In the direct waste analysis, samples were hand-sorted by stream into 14 distinct material categories (see **Appendix B** for material list definitions). Of these, 13 material categories represent various types of recyclable and non-recyclable paper, with the remaining non-paper material classified as "Other" material. Sorted materials from each sample were weighed individually and weight data was recorded and entered into a custom database for analysis.

Study Data Analysis

Following the field work, the project team analyzed the data from the study to calculate the composition and weights of recyclable paper in each sample. The composition of paper material was expressed in terms of pounds per household per month (lbs/HH/mo) to provide estimates of monthly generation, disposal, and recycling of paper material types included in the study. These estimates were calculated at three levels: by material type (e.g., food boxes), by material class organized by household generation location (e.g., kitchen-related recyclable paper), and by overall material recyclability (e.g., all recyclable paper). An "Other" material category was associated with each level of estimation to indicate the non-paper material types.

In addition, the quantity estimates were used to compute capture rates for different paper material types and classes in Snohomish County. A *capture rate* is the percent of each recyclable paper material in a household's waste that is "captured" for recycling (i.e., placed in the recycling cart). For example, the capture rate for food boxes is calculated as:

$$\text{Food Boxes Capture Rate} = \frac{\text{(Lbs. of food boxes in recycling cart)}}{\text{(Lbs. of food boxes in recycling cart) + (Lbs. of food boxes in garbage cart)}}$$

The monthly weight estimates and the capture rates were calculated at each individual sample level. Thereafter, these estimates were summed and/or averaged to provide an aggregate / central value estimate. Standard deviations were provided with the average values to highlight the variation associated with the estimated quantities.

Please note that the capture rates calculated here are **"in-bound capture rates."** That is, they reflect what the capture rate would be if all recyclable materials placed in recycling carts were recovered, not factoring in processing losses.

Study Findings

The following section provides a summary of study findings.

WEIGHT ESTIMATES FOR PAPER IN HOUSEHOLD WASTE

Table 1. Recyclable Paper in Household Waste

	Total Household Waste		Recyclable Paper		
	lbs/HH/mo	+ / -	lbs/HH/mo	+ / -	% of waste
In garbage cart	133.7	15.5	6.2	1.1	4.6%
In recycling cart	60.1	5.9	27.3	2.8	45.5%
Total set-out	193.8	18.2	33.5	3.1	17.3%

Confidence interval calculated at the 90% confidence level.

Findings (Table 1):

- On average, Snohomish County households sampled generate approximately **194 pound of waste per household per month**. Of this material, about **60 pounds (31%)** is set out in the recycling cart while the remaining **134 pounds** is set out in the garbage cart.
- **Recyclable paper makes up less than 5 percent of household garbage** (6.2 lbs/HH/mo) set out.
- In contrast, **recyclable paper makes up nearly half** (45.5%) **of all material placed in recycling carts**. On average, sampled households recycled 27.3 pounds of recyclable paper each month.

Table 2. Non-Recyclable Paper in Household Waste

	In garbage cart			In recycling cart		
	lbs/HH/mo	+ / -	% of all paper	lbs/HH/mo	+ / -	% of all paper
Food-soiled paper (compostable)	7.4	1.1	48.2%	0.8	0.3	2.9%
Other non-recyclable paper	1.8	0.8	11.7%	0.3	0.2	1.2%
Total non-recyclable paper	9.2	1.3	59.9%	1.1	0.3	4.0%

Confidence interval calculated at the 90% confidence level.

Findings (Table 2):

- **Compostable** (non-recyclable) **food-soiled paper makes up nearly half** (48.2%) **of all paper** (by weight) **found in the garbage cart**. Other non-recyclable paper makes up 11.7 percent of all paper in the garbage cart. In total, nearly 60 percent of all paper in the garbage is not recyclable.
- **Non-recyclable paper represents a small amount** (4.0%) **of all paper found in the recycling cart** (by weight). The majority of this is food-soiled paper. The remainder of non-recyclable paper found in household recycling carts includes items like tissues and toilet paper; polylined bags such as microwaveable popcorn bags and dog food bags; and other items that contain a mix of paper and non-paper materials such as padded mailing envelopes, sticker sheets, and cigarette cartons.

RECYCLABLE PAPER GENERATION AND CAPTURE RATES

Table 3: Recyclable Paper Generation and Capture Rates, by Material Class

	Avg. Household Generation		Avg. Household Capture Rate	
	lbs/HH/mo	+ / -	% captured in recycling cart	+ / -
Recyclable general household paper	27.8	3.0	83.8%	2.7%
Recyclable kitchen-related paper	5.1	0.5	68.1%	4.2%
Recyclable bathroom paper	0.6	0.2	47.3%	7.3%
Recyclable paper total	33.5	3.1	80.4%	2.7%

Confidence interval calculated at the 90% confidence level.

Findings (Table 3):

- **Overall, capture rates for recyclable paper are very high** among Snohomish County households participating in recycling. Study data suggest that over 80 percent of all recyclable paper generated by sampled households was captured—that is, placed in the recycling cart.
- **General household paper**—including cardboard, newspaper, magazines and catalogs, mail, office paper, books, and other general reading and household paper—**makes up the largest component of the recyclable paper stream**, representing more than 80 percent of all recyclable paper generated (27.8 lbs/HH/mo) by the average household sampled.
- General household paper also has the **highest average capture rate**, with 83.8% of this paper class generated at the household level correctly placed in the recycling cart. The relatively narrow error range (+/- 2.7%) suggests that high capture rates for this material class are relatively consistent across households. However, within this material class there are specific paper types with lower average capture rates (see next section).
- **Kitchen-related paper**—including food boxes, polycoated cartons and containers—**makes up another 15 percent of recyclable paper** (5.1 lbs/HH/mo). The average capture rate for this material class is 68.1%.
- **Bathroom-related recyclable paper**—including tissue boxes and toilet core rolls as well as boxes of products clearly intended for bathroom use, such as toothpaste—**makes up the smallest portion of recyclable paper** generated by households (0.6 lbs/HH/mo) on average. It also sees the lowest average capture rate (47.3%) of recyclable paper classes used for the study.

RECOVERABILITY POTENTIAL OF RECYCLABLE PAPER TYPES

Table 4 shows the average, standard deviations, and relative rankings of 11 recyclable paper types by:

1. Weight and relative percentage of each paper material type in household garbage.
2. Frequency of occurrence of each paper material type in household garbage samples.
3. Capture rate of each paper material type.

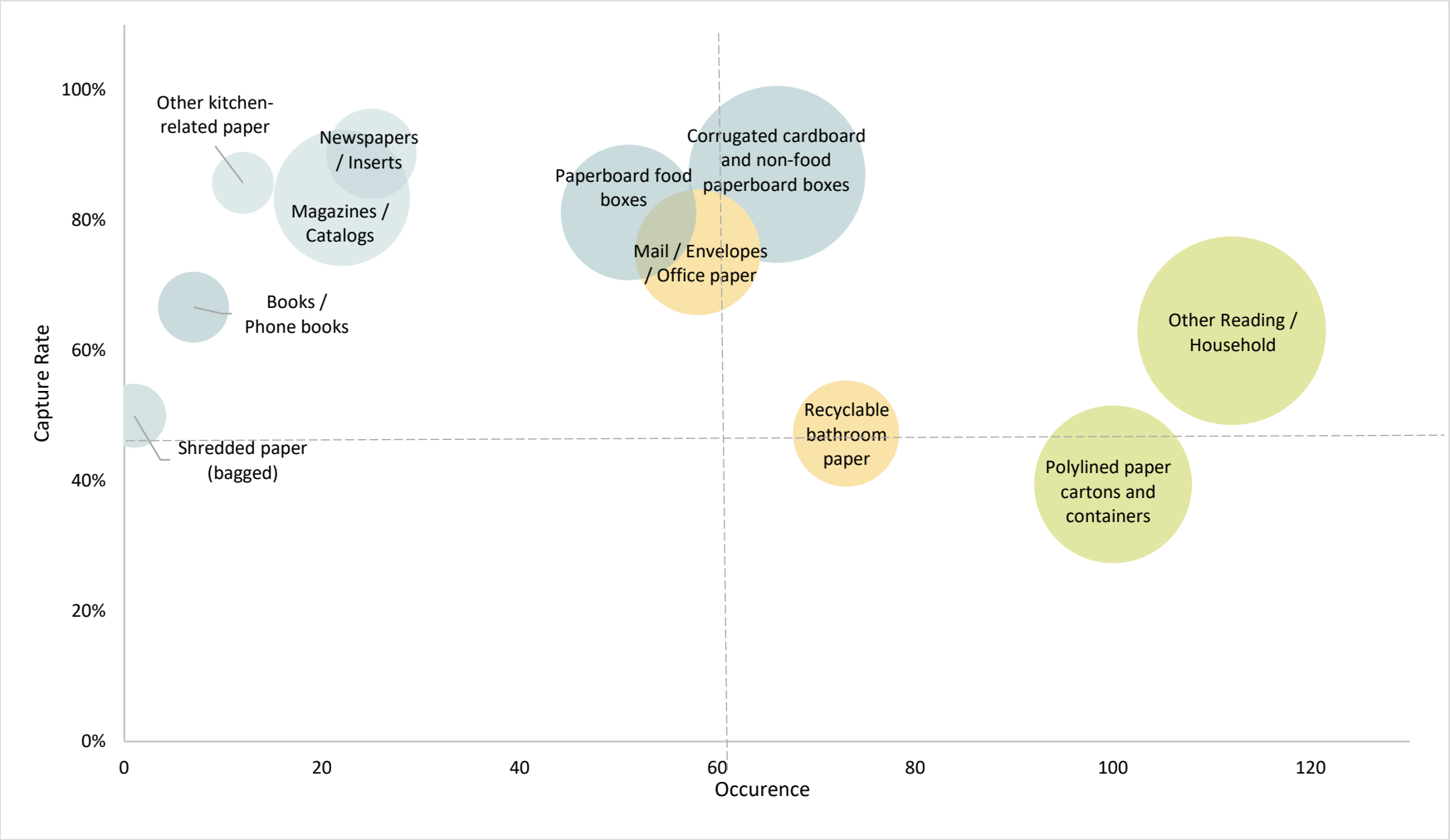
Correspondingly, Figure 1 visualizes the relationship between these three variables for each paper material type.

Table 4: Paper Material Types (by Weight in Garbage, Occurrence, and Capture Rate)

Paper Material Type	Monthly Weight in Household Garbage			Frequency of Occurrence in Garbage Samples		Capture Rate (%)		
	lbs/HH/mo	+ / -	Rank *Largest to Smallest*	Occurrence in Garbage	Rank *Most to Least*	Avg.	+ / -	Rank *Lowest to Highest*
Other Reading / Household	1.2	0.3	1	112	1	63.1%	4.8%	4
Corrugated cardboard and non-food boxes	1.1	0.5	2	66	4	87.1%	3.5%	10
Polylined paper cartons and containers	0.9	0.2	3	100	2	39.5%	6.9%	1
Magazines / Catalogs	0.6	0.9	4	22	8	83.5%	6.6%	8
Paperboard food boxes	0.6	0.3	5	51	6	81.2%	4.8%	7
Mail / Envelopes / Office Paper	0.5	0.2	6	58	5	75.1%	5.5%	6
Recyclable Bathroom Paper	0.4	0.2	7	73	3	47.3%	7.3%	2
Newspapers / Inserts	0.3	0.3	8	25	7	90.2%	4.0%	11
Books / Phone books	0.2	0.8	9	7	10	66.7%	22.9%	5
Shredded paper (bagged)	0.1	NA	10	1	11	50.0%	NA	3
Other kitchen-related paper	0.1	0.3	11	12	9	85.8%	6.7%	9

Confidence interval calculated at the 90% confidence level.

Figure 1: Paper Material Types (by Weight in Garbage, Occurrence, and Capture Rate)



The bubbles representing paper material types are scaled to reflect the average monthly weight estimates of each material type in household garbage.

Findings (Table 2, Figure 1):

- "**Other Reading/Household**" represents the paper material type with the highest amount found in the garbage (1.2 lbs/HH/mo). This material type also occurs the most frequently in garbage samples (found in 112 of 126 samples). The capture rate for this paper type is relatively low (63.1%), especially among paper types in the general household recyclable paper material class, which has an overall capture rate of 83.8%. Examples of materials in this category include school-related papers (e.g., construction paper), note pads, greeting cards, calendars, wrapping paper, gift bags, receipts, molded pulp (non-food), and kraft paper bags. This category also includes all recyclable paper not explicitly included in other categories.
- "**Polylined paper cartons and containers**" follows in terms of its occurrence (found in 100 of 126 samples), and ranks third in terms of estimated monthly weight in the garbage stream (0.9 lbs/HH/mo). The capture rate of this paper type is the lowest of all recyclable paper types in the study (39.5%).
- "**Mail/Envelopes/Office paper**" falls in the middle of the pack in all three variables, ranking sixth in terms of amount found in the garbage (0.5 lbs/HH/mo) and fifth in frequency of occurrence in household garbage samples. The capture rate for this material type is relatively high (75.1%) but is nonetheless the lowest capture rate among the paper material types with strong market value.
- "**Recyclable bathroom paper**" has the second lowest capture rate among recyclable paper types and is the third most frequently occurring paper type found in household garbage. However, it does not represent as much material by weight as some other recyclable paper types found in the garbage, equal to less than half a pound per household per month (0.4 lbs/HH/mo) on average.
- "**Corrugated cardboard,**" "**Magazines/Catalogs,**" and "**Paperboard food boxes**" all rank high in terms of amount found in household garbage. However, average captures rates for these materials are already above 80 percent, suggesting that achieving additional diversion of these materials from recycling households may be difficult and could require more targeted outreach or additional resources and strategies such as mandatory recycling and curbside enforcement.
- Other recyclable paper material types may be less preferable candidates for a targeted campaign to increase recovery because of their relatively low occurrence (e.g., "Shredded paper" occurred only once in the samples), small footprint in the garbage stream (e.g., "Books/Phone books" were estimated to be disposed at a rate of 0.2 lbs/HH/mo and ranked 9th by weight in household garbage), or relatively high capture rates (e.g., "Newspapers/Inserts" had a capture rate above 90 percent). The potential for capturing these paper material types is not entirely fulfilled, but focusing on increasing recovery of these paper material types would likely have a marginal impact on the overall recovery of recyclable paper.

VOLUME-BASED ANALYSIS

As mentioned earlier, the fullness of the carts was measured and noted as a percentage prior to emptying their contents. This measurement was applied to study the association between the percentage fullness of the recycling cart and the percentage of recyclable paper in the garbage cart.

The correlation coefficient was calculated between two sets of quantities for several scenarios:

A. The percentage fullness of the recycling cart and the relative percentage of recyclable paper generated that ends up in the garbage cart (expressed as 100% - Capture Rate %).
B. The percentage fullness of the recycling cart and the pounds of all recyclable paper that ends up in the garbage cart.
C. The percentage fullness of the recycling cart and the pounds of "Recyclable general household paper" class materials that ends up in the garbage cart.

This assessment allowed us to evaluate the hypothesis that more recyclable paper is discarded in the garbage with the increase in the fullness of the recycling cart.

Findings:

- The correlation coefficient for Correlation A was calculated to be **0.28**, on a scale from -1.0 (strong negative) to +1.0 (strong positive). This is considered a statistically significant correlation at the 90 percent confidence level.
- The correlation coefficient for Correlation B was calculated to be **-0.16** and considered NOT statistically significant at the 90 percent confidence level.
- The correlation coefficient for Correlation C was calculated to be **0.35** and considered a statistically significant correlation at the 99 percent confidence level.
- These results suggest a potential weak positive correlation between the fullness of a household recycling cart and the relative amount of recyclable paper generated by the household that ends up in the garbage cart. The conflicting results of Correlations A and B suggest that the hypothesis cannot be substantiated for the whole of recyclable paper but may hold true for general household paper, which is recycled at the highest rates and also represents the bulkiest and most voluminous of paper types in household waste, and therefore may be the paper material class most affected by space constraints in the recycling cart.

STUDY CONCLUSION AND RECOMMENDATIONS

The following conclusions and recommendations were drawn based on the findings of the study.

- Study data suggest that residential customers in WM's WUTC-regulated Snohomish County service area are already doing a good job of recycling paper. Recyclable paper makes up nearly half of all material placed in recycling carts (by weight), and households recycle more than 80 percent of all recyclable paper they generate. Households also recycle relatively little unacceptable paper—non-recyclable paper represents just 4 percent of all paper placed in the average recycling cart.
- Despite being identified in the 2013 WM Behavior Study as the most prevalent and frequently occurring recyclable material category in the garbage, recyclable paper is already captured at a very high rate (80.4%). This high capture rate, together with the relatively small percentage of household garbage that recyclable paper represents (4.6% of household garbage), indicates that increasing recovery of recyclable paper among recycling households is likely to have a modest effect on paper capture rates and the overall diversion rate.
- The combination of relatively high weight and frequency of occurrence in household garbage along with a relatively low capture rate suggests that "Other Reading/Household" paper presents the greatest recoverability potential among recyclable paper types studied and would be the preferred focus for a targeted outreach campaign to increase recovery in Snohomish County.
- "Polylined paper cups and containers" would be the second preferred material to focus on increasing recovery among Snohomish County households, given its low capture rate and high frequency of occurrence in household garbage. However, the uncertainty in current markets related to the acceptability of liquid-containing paper packaging in mixed paper bales may make a focus on this paper type less desirable.
- Some of the paper material types included in the study are likely to be affected by the seasonal nature of consumption and disposal patterns of these paper materials (e.g., commencement of the school year, the holiday season, etc.). This is especially true for the "Other Reading/Household" paper material type, which includes household paper materials such as notepads, greeting cards, school-related paper such as construction paper, and calendars. Since the study was conducted during summer of 2017, evaluation of the effectiveness of a targeted campaign focused on this material type should factor in seasonality in any future field work timing and analysis.
- The volume-based correlation assessment indicated that the amount of recyclable paper in the garbage cart may increase with the fullness of the recycling cart, but the results are too weak to support conclusive findings about this correlation. Additional study of this topic is recommended to more firmly establish whether recycling cart fullness leads households to place separated recyclables in the garbage.
- Long-term national and regional trends suggest that household consumption of recyclable paper is dynamic and influenced by trends in consumer behavior—for example, increased online shopping leading to increased household cardboard generation, and reduced newsprint due to increased access to information online. This study provides a useful snapshot of household paper generation, recycling, and disposal patterns in Snohomish County. Conducting periodic assessments of these patterns for paper and for other materials would help in predicting the consumption and disposal of paper in the future. These assessments can help WM and Snohomish County achieve a more realistic alignment of recycling and diversion goals with the shifting reality on the ground.