Seattle Public Utilities

2000/01
Residential Recycling Composition Study
Final Report

prepared by

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1 OVERVIEW

1.1 Introduction

Seattle Public Utilities (SPU) has designed and implemented a number of internationally recognized recycling programs intended to achieve a 60% recycling rate by 2008. One of the goals set forth in SPU's 1998 Solid Waste Plan, *On the Path to Sustainability,* is "to expand successful recycling programs." In order to meet this goal, SPU commissioned a recycling composition study to better understand the types and quantities of recyclables set out by Seattle residents.[1] Recycling composition estimates obtained from this study are also used to determine payment from the City to the two private companies that collect Seattle's residential recycling.[2]

Composition estimates are made by sampling recyclables – sorting and weighing samples – from randomly selected loads brought to the City's contracted recycling facility. This report summarizes estimates from samples taken between November 2000 and October 2001. Cascadia Consulting Group served as the primary contractor for this research; Sky Valley Associates conducted the fieldwork.

This report is organized into three sections. Section 1 briefly summarizes the project, including a description of the sampling populations. An overview of the results is presented in Section 2. Lastly, Section 3 provides the complete composition results, by *service area*, *generator type*, and by *generator type for each service area*, for samples taken during the 2000/01 study. Detailed appendices follow the main body of the report.

1.2 Sampling Populations

This study was designed to determine the composition of recycling setouts for both single- and multi-family residences within the City. Recyclable materials that were either self-hauled to the City's two transfer stations or hauled from Seattle's commercial substream were excluded from this study, with the exception of recycling collected from businesses participating in SPU's *Small Business Recycling Program* (see footnote 3 for details).

In order to facilitate more accurate analysis, the recyclables set out by residences in Seattle were divided into four subpopulations based on *generator type* and *service area*. The two generator types included *single-* and *multi-family*, which were defined as follows:

- ***Single-family***: Residences using a toter-based collection system: One toter with an accompanying insert for glass. Typically, these residences are detached single-family, duplex, triplex and four-plex homes.[3]

[1] For the purposes of this study, "recyclables" were defined by the manner in which they were set out by residents, and not by the composition of the material itself. For example, if a resident placed a piece of cardboard in a garbage can, it would not have been included in this study's recycling sorts; however, the same piece of cardboard placed in a recycling container could have been sampled.

[2] These payments partly depend on the amount of each material collected and also on the current market price condition by material.

[3] In August 2001, eligible small businesses were invited to participate in SPU's *Small Business Recycling Program*. This program offers small businesses the same free recycling service provided to Seattle's single-family residences, using 96-gallon toters. Small business recycling was collected with single-family recycling, and therefore was a part of the single-family "universe." It is unlikely, however, that *Small Business Recycling* had an impact on the composition of single-family recycling samples. By October 2001, only 350 businesses had signed up for this program, making up approximately 0.2% of the City's toter setouts.

- ***Multi-family***: Residences using a dumpster-based collection system: Generally, one or more dumpsters with accompanying glass toter(s). Typically, these residences are apartments and condominiums with five or more units.

Seattle's residential recyclables were collected in two service areas: *north* and *south*. The Lake Washington Ship Canal was the physical boundary that divided the north and south service areas.

Figure 1-1 depicts each of the four residential recycling subpopulations, according to generator type and service area.

Figure 1-1: Subpopulation Definitions

	Generator Type *(Single-family)*	*(Multi-family)*
Service Area *(North)*	Single-Family North	Multi-Family North
(South)	Single-Family South	Multi-Family South

Each of these four subpopulations contributed a portion of the approximately 73,900 total tons of recyclables collected from Seattle residents from November 2000 to October 2001. About 43% (or about 31,500 tons) was collected from single-family generators in the south service area. Single-family generators in the north service area set out approximately 41% (30,400 tons) of these recyclables. The remaining 16% was collected from multi-family generators: about 5,300 tons (7%) from the south and 6,700 tons (9%) from the north.

2 SUMMARY OF SAMPLING RESULTS

For this study, a total of 270 samples were taken from single- and multi-family loads between November 2000 and October 2001.[4] Single-family and multi-family samples were divided evenly between the north and south service areas. This is because each service area delivers roughly equal amounts of recyclables to the City's contracted recycling facility.

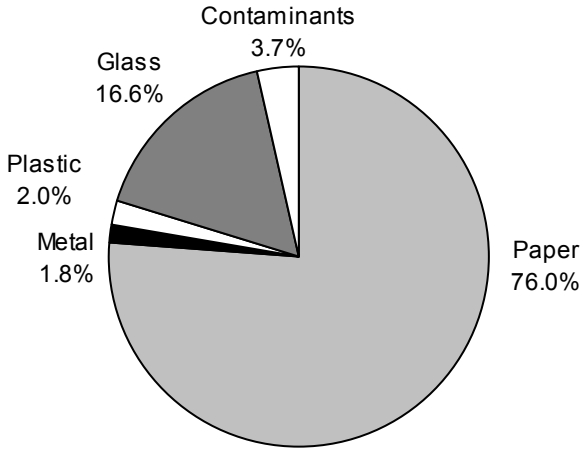
Recycling samples were sorted by hand into 29 component categories for the 2000/01 study. Composition estimates are presented in the following order in this report. First, a pie chart depicts the composition percentages of the five broad material categories: *paper, metal, plastic, glass,* and *contaminants.* Next, a table presents the top ten components, by weight, and finally, a table lists the full composition results of all 29 components.

Weighted averages were used to calculate all composition estimates. Please see Appendix E for more detail regarding these calculations.

[4] In this study a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for *glass* recyclables, and the other for *all other recyclables* (e.g. *mixed paper, aluminum cans*, and *plastic bottles*). During the first five months of sampling, a few vehicles collected both *glass* and *all other recyclables* in the same compartment. Samples taken from these vehicles were eliminated from the analysis. See Appendix B for more information.

The overall composition results are illustrated in Figure 2-1. Accounting for a total of about 76%, *paper* made up the largest percentage of residential recycling from November 2000 to October 2001. *Glass* was also prominent, comprising about 17% of the total by weight.

Figure 2-1: Overview of Composition Estimates: Overall
(November 2000 – October 2001)



A total of 270 residential recycling samples were captured and sorted during this study. Table 2-1 lists the mean percent, by weight, cumulative percent, and tons of the top ten components found in residential recycling samples from November 2000 to October 2001. As shown, *newsprint* was the largest component, accounting for about 34% of the total by weight. *Mixed low grade paper* made up another 24% of this recycling. *Unwaxed OCC/Kraft paper* and *mixed glass cullet* accounted for about 14% and 6% of the total respectively. Please see Table 2-2 for the complete composition results for the overall residential recycling stream.

Table 2-1: Top Ten Components: Overall
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	34.5%	34.5%	25,506
Mixed Low Grade Paper	24.5%	59.0%	18,133
Unwaxed OCC/Kraft Paper	13.6%	72.6%	10,021
Mixed Glass Cullet	5.9%	78.4%	4,332
Brown Glass Bottles	3.8%	82.3%	2,827
Green Glass Bottles	3.7%	86.0%	2,746
Phone Directories	3.0%	89.0%	2,216
Garbage	2.6%	91.5%	1,888
Clear Glass Beverage	2.3%	93.8%	1,686
Tin Food Cans	1.0%	94.8%	742
Total	**94.8%**		**70,097**

Table 2-2: Composition by Weight: Overall
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**56,180**	**76.0%**		
Newsprint	25,506	34.5%	33.4%	35.6%
Corrugated/Kraft, Unwaxed	10,021	13.6%	12.7%	14.4%
Phone Books	2,216	3.0%	2.4%	3.5%
Mixed Low Grade	18,133	24.5%	23.6%	25.5%
Polycoat Containers	273	0.4%	0.3%	0.4%
Asceptic Containers	32	0.0%	0.0%	0.1%
Metal	**1,303**	**1.8%**		
Aluminum Cans	438	0.6%	0.5%	0.6%
Tin Food Cans	742	1.0%	0.9%	1.1%
Other Ferrous	123	0.2%	0.1%	0.2%
Plastic	**1,493**	**2.0%**		
Small PET Bottles (24 oz or smaller)	189	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	340	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	51	0.1%	0.1%	0.1%
HDPE Bottles	473	0.6%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	53	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	38	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	63	0.1%	0.1%	0.1%
Plastic Bags and Packaging	287	0.4%	0.3%	0.4%
Glass	**12,239**	**16.6%**		
Clear Beverage	1,686	2.3%	2.2%	2.4%
Green Beverage	2,746	3.7%	3.5%	3.9%
Brown Beverage	2,827	3.8%	3.6%	4.0%
Clear Container Glass	537	0.7%	0.6%	0.8%
Other Glass Containers and Bottles	111	0.2%	0.1%	0.2%
Mixed Cullet	4,332	5.9%	5.5%	6.2%
Contaminants	**2,710**	**3.7%**		
Non-Conforming Paper	415	0.6%	0.5%	0.6%
Non-Conforming Metal	118	0.2%	0.1%	0.2%
Non-Conforming Plastic	221	0.3%	0.2%	0.4%
Non-Conforming Glass	68	0.1%	0.1%	0.1%
Garbage	1,888	2.6%	2.2%	2.9%
Total Tons	**73,926**			
Sample Count	**270**			

3 DETAILED COMPOSITION RESULTS

A total of 270 samples were taken from residential recycling loads between November 2000 and October 2001. Table 3-1 summarizes the sample information for each subpopulation. A total of 74,324 pounds (or about 37 tons) were sampled. Of those vehicles sampled, the average weight of material collected in the *glass* compartment was approximately 1,800 pounds; the material collected in the *all other recyclables* compartment weighed, on average, about 8,600 pounds. *Glass* sampled averaged about 40 pounds, while samples from *all other recyclables* compartments weighed about 240 pounds.

Table 3-1: Description of Samples for each Subpopulation
(November 2000 – October 2001)

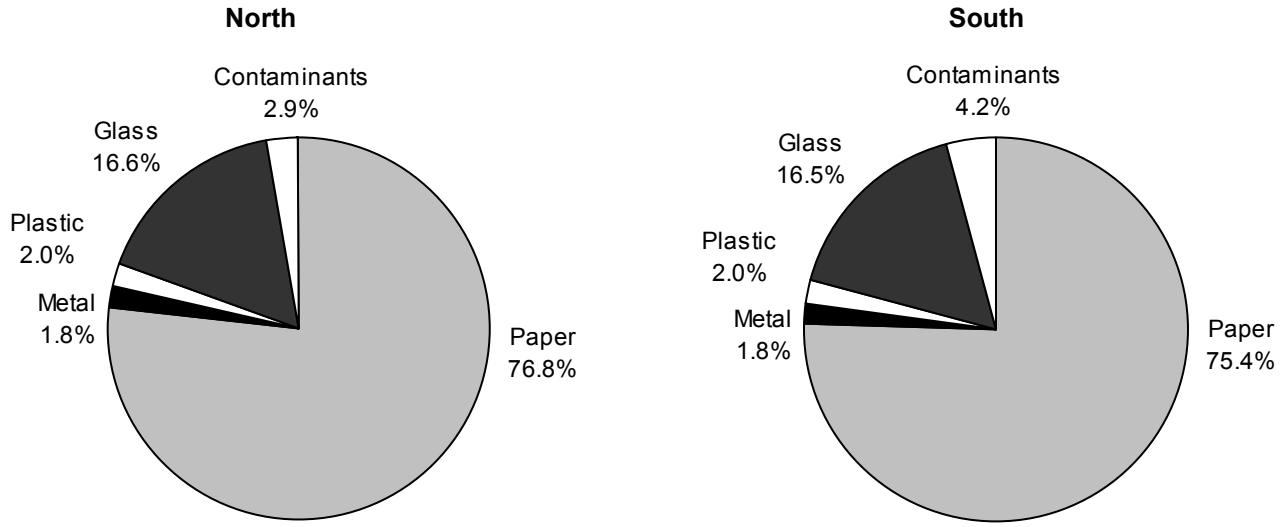
Subpopulation	Sample Count	Total Sample (lbs)	Avg Net Load Wt (lbs)	
			(Glass)	*(All Other Recyclables)*
Service Area				
North	134	37,404.8	1,491.2	7,155.2
South	136	36,919.3	2,081.8	10,129.5
Generator Type				
Single-Family	176	48,372.4	1,739.6	8,197.8
Multi-Family	94	25,951.7	1,872.5	9,454.8
Service Area and Generator Type				
Single-Family North	89	25,210.4	1,395.5	5,868.5
Single-Family South	87	23,162.0	2,096.3	10,665.7
Multi-Family North	45	12,194.4	1,675.9	9,757.7
Multi-Family South	49	13,757.3	2,056.5	9,171.2
Overall	**270**	**74,324.1**	**1,786.5**	**8,631.1**

Section 3.1 presents detailed composition estimates for the north and south service areas while Section 3.2 provides single- and multi-family estimates. Finally, composition by generator type for each of the two service areas is given in Section 3.3.

3.1 By Service Area

Figure 3-1 depicts the composition results of recycling collected from the north and south service areas. Recycling from the north consisted of about 77% *paper*. An additional 17% was *glass*. The composition of recycling from the south was nearly identical to that from the north: Approximately 75% was *paper* while 17% was *glass*.

Figure 3-1: Overview of Composition Estimates, by Service Area
(November 2000 – October 2001)



3.1.1 North

A total of 134 recycling loads from the north service area were sampled between November 2000 and October 2001. Table 3-2 lists the top ten components set out by residents in the north. As shown, *newsprint* accounted for approximately 35% while *mixed low grade paper* comprised an additional 24%. *Unwaxed OCC/Kraft paper* and *mixed glass cullet* made up about 14% and 7% respectively. The full composition results are listed in Table 3-3.

Table 3-2: Top Ten Components: North
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	35.1%	35.1%	12,549
Mixed Low Grade Paper	24.2%	59.3%	8,651
Unwaxed OCC/Kraft Paper	14.1%	73.4%	5,048
Mixed Glass Cullet	6.6%	80.0%	2,358
Brown Glass Bottles	3.6%	83.7%	1,296
Green Glass Bottles	3.4%	87.1%	1,228
Phone Directories	3.0%	90.0%	1,057
Clear Glass Bottles	2.1%	92.2%	757
Garbage	1.9%	94.1%	684
Tin Food Cans	1.1%	95.1%	377
Total	**95.1%**		**34,005**

Table 3-3: Composition by Weight: North
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**27,437**	**76.8%**		
Newsprint	12,549	35.1%	33.5%	36.7%
Corrugated/Kraft, Unwaxed	5,048	14.1%	12.9%	15.4%
Phone Books	1,057	3.0%	2.2%	3.7%
Mixed Low Grade	8,651	24.2%	23.0%	25.4%
Polycoat Containers	116	0.3%	0.3%	0.4%
Asceptic Containers	16	0.0%	0.0%	0.1%
Metal	**632**	**1.8%**		
Aluminum Cans	223	0.6%	0.6%	0.7%
Tin Food Cans	377	1.1%	0.9%	1.2%
Other Ferrous	32	0.1%	0.0%	0.2%
Plastic	**722**	**2.0%**		
Small PET Bottles (24 oz or smaller)	91	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	156	0.4%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	33	0.1%	0.1%	0.1%
HDPE Bottles	228	0.6%	0.5%	0.7%
HDPE Jars, Tubs, and Other Containers	30	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	16	0.0%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	31	0.1%	0.1%	0.1%
Plastic Bags and Packaging	136	0.4%	0.3%	0.4%
Glass	**5,921**	**16.6%**		
Clear Beverage	757	2.1%	2.0%	2.3%
Green Beverage	1,228	3.4%	3.2%	3.7%
Brown Beverage	1,296	3.6%	3.4%	3.9%
Clear Container Glass	241	0.7%	0.6%	0.8%
Other Glass Containers and Bottles	42	0.1%	0.1%	0.2%
Mixed Cullet	2,358	6.6%	6.1%	7.1%
Contaminants	**1,030**	**2.9%**		
Non-Conforming Paper	175	0.5%	0.4%	0.6%
Non-Conforming Metal	44	0.1%	0.1%	0.2%
Non-Conforming Plastic	96	0.3%	0.2%	0.3%
Non-Conforming Glass	32	0.1%	0.0%	0.1%
Garbage	684	1.9%	1.6%	2.2%
Total Tons	**35,743**			
Sample Count	**134**			

3.1.2 South

During this study period, 136 samples were taken from recycling loads from the south service area. As shown in Table 3-4, *newsprint* and *mixed low grade paper*, together, accounted for nearly 60% of this recycling. *Unwaxed OCC/Kraft paper* made up an additional 13% by weight. *Mixed glass cullet* comprised about 5% of the total. Please see Table 3-5 for the complete results for recycling setouts collected from the south service area.

Table 3-4: Top Ten Components: South
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	34.1%	34.1%	13,007
Mixed Low Grade Paper	24.8%	58.8%	9,455
Unwaxed OCC/Kraft Paper	13.1%	72.0%	5,020
Mixed Glass Cullet	5.3%	77.3%	2,036
Brown Glass Bottles	4.0%	81.3%	1,514
Green Glass Bottles	3.9%	85.2%	1,495
Phone Directories	3.0%	88.2%	1,156
Garbage	3.0%	91.2%	1,151
Clear Glass Bottles	2.4%	93.6%	915
Tin Food Cans	1.0%	94.6%	369
Total	**94.6%**		**36,118**

Table 3-5: Composition by Weight: South
(November 2000 – October 2001)

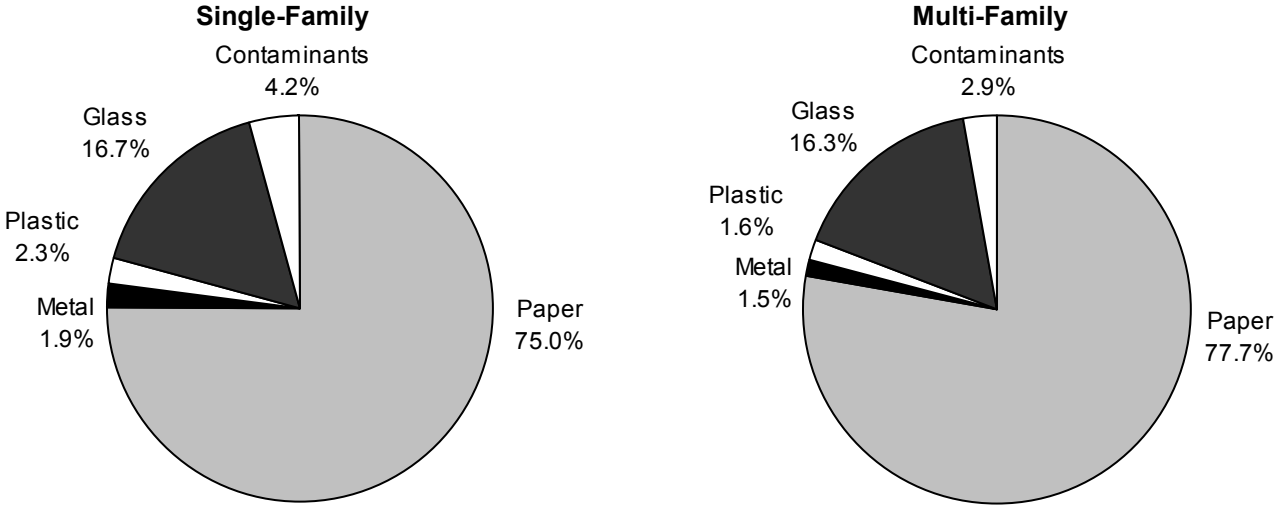
Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**28,807**	**75.4%**		
Newsprint	13,007	34.1%	32.5%	35.6%
Corrugated/Kraft, Unwaxed	5,020	13.1%	12.0%	14.3%
Phone Books	1,156	3.0%	2.3%	3.8%
Mixed Low Grade	9,455	24.8%	23.4%	26.1%
Polycoat Containers	153	0.4%	0.3%	0.5%
Asceptic Containers	16	0.0%	0.0%	0.1%
Metal	**671**	**1.8%**		
Aluminum Cans	218	0.6%	0.5%	0.6%
Tin Food Cans	369	1.0%	0.9%	1.1%
Other Ferrous	85	0.2%	0.1%	0.3%
Plastic	**771**	**2.0%**		
Small PET Bottles (24 oz or smaller)	98	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	182	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	19	0.1%	0.0%	0.1%
HDPE Bottles	245	0.6%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	24	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	21	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	32	0.1%	0.1%	0.1%
Plastic Bags and Packaging	151	0.4%	0.3%	0.5%
Glass	**6,319**	**16.5%**		
Clear Beverage	915	2.4%	2.2%	2.6%
Green Beverage	1,495	3.9%	3.6%	4.2%
Brown Beverage	1,514	4.0%	3.7%	4.2%
Clear Container Glass	292	0.8%	0.6%	0.9%
Other Glass Containers and Bottles	67	0.2%	0.1%	0.3%
Mixed Cullet	2,036	5.3%	4.8%	5.9%
Contaminants	**1,614**	**4.2%**		
Non-Conforming Paper	234	0.6%	0.5%	0.7%
Non-Conforming Metal	71	0.2%	0.1%	0.2%
Non-Conforming Plastic	122	0.3%	0.2%	0.4%
Non-Conforming Glass	36	0.1%	0.1%	0.1%
Garbage	1,151	3.0%	2.5%	3.5%
Total Tons	**38,183**			
Sample Count	**136**			

3.2 By Generator Type

Composition estimates for single- and multi-family recycling are summarized in Figure 3-2. As depicted, *paper* accounted for between 75-78% while *glass* made up between 16-17% of recycling from both single- and multi-family generators. *Contaminants, plastic*, and *metal* each made up less than 5% of the total for both generator types.

Figure 3-2: Overview of Composition Estimates, by Generator Type
(November 2000 – October 2001)



3.2.1 Single-Family Composition

A total of 176 samples were captured from single-family loads during this study period. Table 3-6 outlines the top ten components set out by single-family generators. As shown, *newsprint* and *mixed low grade paper* accounted for the largest percent of the total by weight (about 34% and 26% respectively). *Unwaxed OCC/Kraft paper* made up nearly 12% and *mixed glass cullet* accounted for approximately 6% by weight. Table 3-7 lists the full composition results for single-family samples.

Table 3-6: Top Ten Components: Single-Family
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	34.2%	34.2%	21,181
Mixed Low Grade Paper	26.0%	60.2%	16,083
Unwaxed OCC/Kraft Paper	12.0%	72.2%	7,435
Mixed Glass Cullet	6.0%	78.2%	3,706
Green Glass Bottles	4.0%	82.1%	2,448
Brown Glass Bottles	3.6%	85.7%	2,227
Garbage	3.0%	88.7%	1,852
Phone Directories	2.3%	91.0%	1,417
Clear Glass Bottles	2.3%	93.3%	1,410
Tin Food Cans	1.1%	94.4%	693
Total	**94.4%**		**58,451**

Table 3-7: Composition by Weight: Single-Family
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**46,425**	**75.0%**		
Newsprint	21,181	34.2%	33.0%	35.4%
Corrugated/Kraft, Unwaxed	7,435	12.0%	11.1%	12.9%
Phone Books	1,417	2.3%	1.8%	2.8%
Mixed Low Grade	16,083	26.0%	24.9%	27.0%
Polycoat Containers	272	0.4%	0.3%	0.5%
Asceptic Containers	38	0.1%	0.0%	0.1%
Metal	**1,184**	**1.9%**		
Aluminum Cans	395	0.6%	0.6%	0.7%
Tin Food Cans	693	1.1%	1.0%	1.2%
Other Ferrous	96	0.2%	0.1%	0.2%
Plastic	**1,397**	**2.3%**		
Small PET Bottles (24 oz or smaller)	170	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	323	0.5%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	40	0.1%	0.1%	0.1%
HDPE Bottles	451	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	47	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	30	0.0%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	59	0.1%	0.1%	0.1%
Plastic Bags and Packaging	277	0.4%	0.4%	0.5%
Glass	**10,359**	**16.7%**		
Clear Beverage	1,410	2.3%	2.1%	2.4%
Green Beverage	2,448	4.0%	3.7%	4.2%
Brown Beverage	2,227	3.6%	3.4%	3.8%
Clear Container Glass	513	0.8%	0.7%	0.9%
Other Glass Containers and Bottles	55	0.1%	0.1%	0.1%
Mixed Cullet	3,706	6.0%	5.5%	6.5%
Contaminants	**2,574**	**4.2%**		
Non-Conforming Paper	357	0.6%	0.5%	0.7%
Non-Conforming Metal	96	0.2%	0.1%	0.2%
Non-Conforming Plastic	207	0.3%	0.3%	0.4%
Non-Conforming Glass	61	0.1%	0.1%	0.1%
Garbage	1,852	3.0%	2.5%	3.4%
Total Tons	**61,938**			
Sample Count	**176**			

3.2.2 Multi-Family Composition

During this study, a total of 94 samples were taken from multi-family recycling loads. The top ten components of multi-family recycling are listed in Table 3-8. *Newsprint* was the largest component of this recycling, accounting for about 35% of the total by weight. *Mixed low grade paper* made up about 22%, and *unwaxed OCC/Kraft paper* and *mixed glass cullet* comprised about 16% and 6% of the total respectively. For the complete composition results, see Table 3-9.

Table 3-8: Top Ten Components: Multi-Family
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	35.0%	35.0%	4,197
Mixed Low Grade Paper	22.1%	57.2%	2,655
Unwaxed OCC/Kraft Paper	16.1%	73.3%	1,933
Mixed Glass Cullet	5.7%	78.9%	678
Brown Glass Bottles	4.2%	83.1%	504
Phone Directories	4.2%	87.3%	500
Green Glass Bottles	3.3%	90.6%	398
Clear Glass Bottles	2.3%	92.9%	274
Garbage	1.8%	94.8%	220
Tin Food Cans	0.8%	95.6%	97
Total	**95.6%**		**11,456**

Table 3-9: Composition by Weight: Multi-Family
(November 2000 – October 2001)

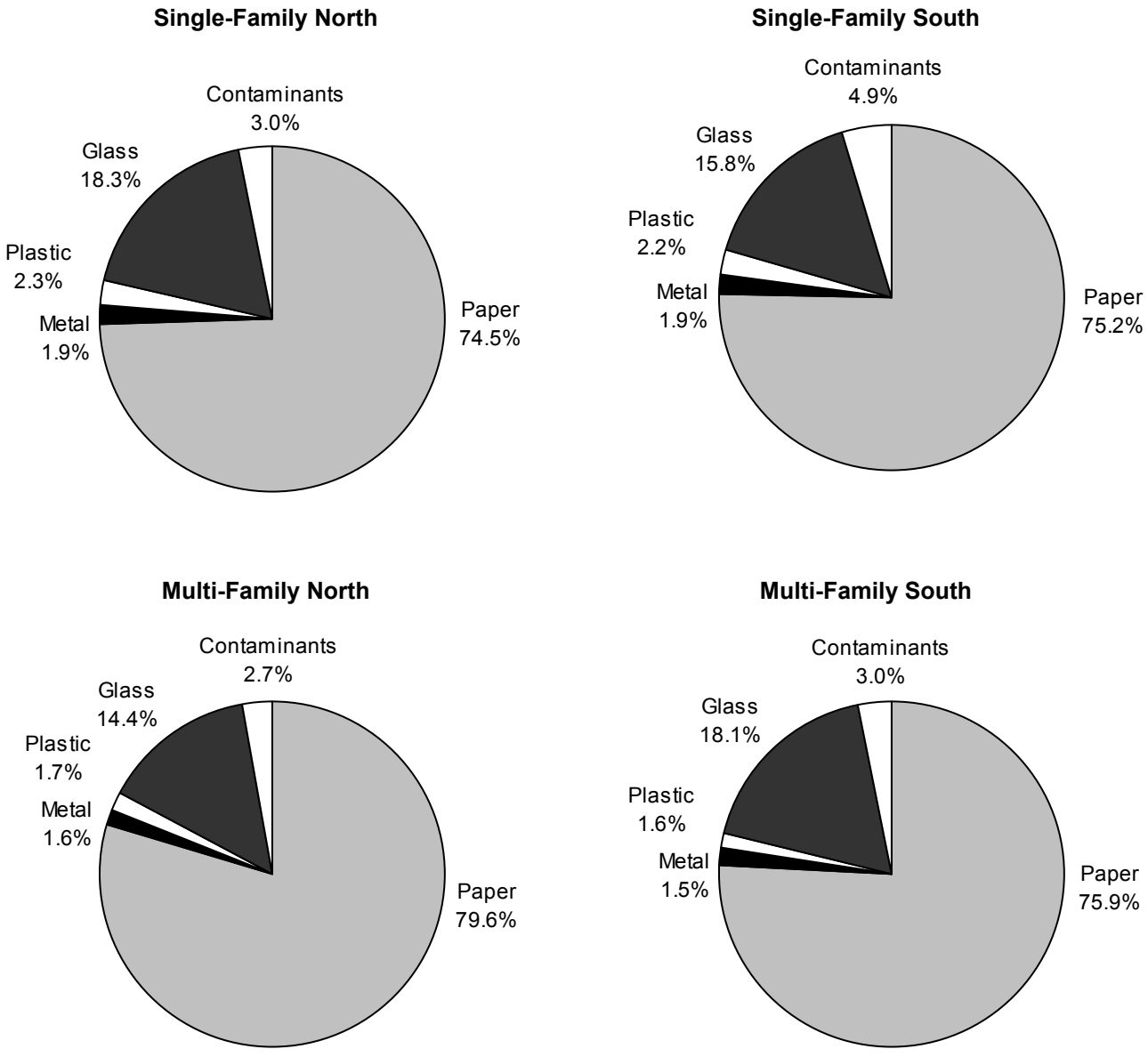
Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**9,317**	**77.7%**		
Newsprint	4,197	35.0%	32.7%	37.3%
Corrugated/Kraft, Unwaxed	1,933	16.1%	14.5%	17.8%
Phone Books	500	4.2%	3.0%	5.4%
Mixed Low Grade	2,655	22.1%	20.4%	23.9%
Polycoat Containers	30	0.3%	0.2%	0.3%
Asceptic Containers	1	0.0%	0.0%	0.0%
Metal	**182**	**1.5%**		
Aluminum Cans	62	0.5%	0.5%	0.6%
Tin Food Cans	97	0.8%	0.7%	0.9%
Other Ferrous	22	0.2%	0.0%	0.3%
Plastic	**195**	**1.6%**		
Small PET Bottles (24 oz or smaller)	27	0.2%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	43	0.4%	0.3%	0.4%
PET Jars, Tubs, and Other Containers	9	0.1%	0.0%	0.1%
HDPE Bottles	59	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	8	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	7	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	8	0.1%	0.1%	0.1%
Plastic Bags and Packaging	35	0.3%	0.2%	0.3%
Glass	**1,951**	**16.3%**		
Clear Beverage	274	2.3%	2.1%	2.5%
Green Beverage	398	3.3%	3.0%	3.6%
Brown Beverage	504	4.2%	3.9%	4.5%
Clear Container Glass	67	0.6%	0.5%	0.6%
Other Glass Containers and Bottles	30	0.3%	0.1%	0.4%
Mixed Cullet	678	5.7%	5.0%	6.3%
Contaminants	**342**	**2.9%**		
Non-Conforming Paper	64	0.5%	0.4%	0.7%
Non-Conforming Metal	20	0.2%	0.1%	0.2%
Non-Conforming Plastic	29	0.2%	0.2%	0.3%
Non-Conforming Glass	10	0.1%	0.0%	0.1%
Garbage	220	1.8%	1.5%	2.2%
Total Tons	**11,988**			
Sample Count	**94**			

3.3 By Generator Type and Service Area

Figure 3-3 summarizes the composition by generator type for each of the two service areas. With the exception of multi-family north recycling, *paper* accounted for between 74-76% of recycling set out by each of these subpopulations (it made up about 80% for multi-family north). *Glass* comprised between 14.1% and 18.3% for each of the four subpopulations. The three remaining broad material categories: *contaminants, plastic*, and *metal*, each accounted for less than 5% of the total for all four subpopulations.

Figure 3-3: Overview of Composition Estimates, by Generator Type and Service Area
(November 2000 – October 2001)



3.3.1 Single-Family North

There were a total of 89 samples taken from single-family north recycling loads from November 2000 to October 2001. As shown in Table 3-10, the top ten components of this recycling sum to about 95% of the total by weight. *Newsprint* and *mixed low grade paper* made up the largest percent of this recycling (about 34% and 26% respectively). *Unwaxed OCC/Kraft paper* and *mixed glass cullet* accounted for about 12% and 7% respectively. Please see Table 3-14 for the full composition results for single-family north recycling.

Table 3-10: Top Ten Components: Single-Family North
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	33.7%	33.7%	10,264
Mixed Low Grade Paper	26.4%	60.0%	8,035
Unwaxed OCC/Kraft Paper	12.0%	72.1%	3,670
Mixed Glass Cullet	6.9%	79.0%	2,103
Brown Glass Bottles	4.1%	83.1%	1,247
Green Glass Bottles	4.1%	87.2%	1,243
Clear Glass Bottles	2.3%	89.4%	692
Garbage	2.0%	91.5%	616
Phone Directories	2.0%	93.5%	609
Tin Food Cans	1.2%	94.6%	363
Total	**94.6%**		**28,842**

3.3.2 Single-Family South

A total of 87 samples were captured from single-family south loads during this study period. Table 3-11 presents the top ten components, by weight, for this recycling. When summed, these components accounted for approximately 94% of the total by weight. *Newsprint, mixed low grade paper*, *unwaxed OCC/Kraft paper*, and *mixed glass cullet* made up about 34%, 26%, 12%, and 5% of the total respectively. Table 3-15 provides the full composition results for single-family south recycling.

Table 3-11: Top Ten Components: Single-Family South
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	34.5%	34.5%	10,857
Mixed Low Grade Paper	25.7%	60.2%	8,094
Unwaxed OCC/Kraft Paper	12.0%	72.2%	3,770
Mixed Glass Cullet	5.4%	77.6%	1,710
Green Glass Bottles	3.9%	81.5%	1,219
Garbage	3.6%	85.1%	1,124
Brown Glass Bottles	3.3%	88.4%	1,037
Phone Directories	2.5%	90.9%	774
Clear Glass Bottles	2.3%	93.1%	717
Tin Food Cans	1.1%	94.2%	338
Total	**94.2%**		**29,641**

3.3.3 Multi-Family North

From November 2000 to October 2001, 45 samples were captured from multi-family north recycling loads. Table 3-12 presents the top ten components of this recycling. As shown, *newsprint* was the largest component, accounting for about 37% of the total by weight. *Mixed low grade paper* made up about 21% while *unwaxed OCC/Kraft paper* and *mixed glass cullet* comprised about 17% and 6% of the total. For a complete listing of multi-family north composition, see Table 3-16.

Table 3-12: Top Ten Components: Multi-Family North
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	36.9%	36.9%	1,946
Mixed Low Grade Paper	21.4%	58.4%	1,130
Unwaxed OCC/Kraft Paper	16.8%	75.2%	884
Mixed Glass Cullet	6.2%	81.4%	327
Phone Directories	4.2%	85.5%	220
Brown Glass Bottles	3.0%	88.6%	160
Green Glass Bottles	2.6%	91.2%	138
Clear Glass Bottles	1.9%	93.1%	101
Garbage	1.8%	94.9%	94
Tin Food Cans	0.9%	95.8%	46
Total	**95.8%**		**5,046**

3.3.4 Multi-Family South

A total of 49 samples were taken from multi-family south recycling loads during this study. The top ten components of this recycling are provided in Table 3-13. When combined, these components accounted for about 95% of the total by weight. *Newsprint*, *mixed low grade paper*, *unwaxed OCC/Kraft paper*, *brown glass bottles*, and *mixed glass cullet* made up approximately 33%, 23%, 16%, 5%, and 5% of the total, respectively. Please see Table 3-17 for the full composition results for multi-family south recycling.

Table 3-13: Top Ten Components: Multi-Family South
(November 2000 – October 2001)

Component	Mean	Cum. %	Tons
Newsprint	33.2%	33.2%	2,229
Mixed Low Grade Paper	22.8%	56.0%	1,533
Unwaxed OCC/Kraft Paper	15.5%	71.5%	1,042
Brown Glass Bottles	5.3%	76.8%	358
Mixed Glass Cullet	5.1%	81.9%	344
Phone Directories	4.2%	86.1%	280
Green Glass Bottles	4.0%	90.1%	268
Clear Glass Bottles	2.6%	92.7%	177
Garbage	1.9%	94.6%	127
Tin Food Cans	0.7%	95.4%	50
Total	**95.4%**		**6,408**

Table 3-14: Composition by Weight: Single-Family North
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**22,715**	**74.5%**		
Newsprint	10,264	33.7%	32.2%	35.2%
Corrugated/Kraft, Unwaxed	3,670	12.0%	10.8%	13.3%
Phone Books	609	2.0%	1.5%	2.5%
Mixed Low Grade	8,035	26.4%	25.0%	27.7%
Polycoat Containers	117	0.4%	0.3%	0.5%
Asceptic Containers	20	0.1%	0.0%	0.1%
Metal	**585**	**1.9%**		
Aluminum Cans	207	0.7%	0.6%	0.7%
Tin Food Cans	363	1.2%	1.1%	1.3%
Other Ferrous	14	0.0%	0.0%	0.1%
Plastic	**694**	**2.3%**		
Small PET Bottles (24 oz or smaller)	74	0.2%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	143	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	25	0.1%	0.1%	0.1%
HDPE Bottles	230	0.8%	0.6%	0.9%
HDPE Jars, Tubs, and Other Containers	28	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	12	0.0%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	32	0.1%	0.1%	0.1%
Plastic Bags and Packaging	148	0.5%	0.4%	0.6%
Glass	**5,568**	**18.3%**		
Clear Beverage	692	2.3%	2.0%	2.5%
Green Beverage	1,243	4.1%	3.7%	4.4%
Brown Beverage	1,247	4.1%	3.8%	4.4%
Clear Container Glass	240	0.8%	0.6%	0.9%
Other Glass Containers and Bottles	42	0.1%	0.1%	0.2%
Mixed Cullet	2,103	6.9%	6.2%	7.6%
Contaminants	**913**	**3.0%**		
Non-Conforming Paper	161	0.5%	0.4%	0.6%
Non-Conforming Metal	28	0.1%	0.0%	0.1%
Non-Conforming Plastic	78	0.3%	0.2%	0.3%
Non-Conforming Glass	31	0.1%	0.0%	0.2%
Garbage	616	2.0%	1.6%	2.5%
Total Tons	**30,474**			
Sample Count	**89**			

Table 3-15: Composition by Weight: Single-Family South
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**23,662**	**75.2%**		
Newsprint	10,857	34.5%	32.8%	36.2%
Corrugated/Kraft, Unwaxed	3,770	12.0%	10.8%	13.2%
Phone Books	774	2.5%	1.7%	3.2%
Mixed Low Grade	8,094	25.7%	24.2%	27.3%
Polycoat Containers	148	0.5%	0.3%	0.6%
Asceptic Containers	18	0.1%	0.0%	0.1%
Metal	**600**	**1.9%**		
Aluminum Cans	192	0.6%	0.5%	0.7%
Tin Food Cans	338	1.1%	0.9%	1.2%
Other Ferrous	70	0.2%	0.1%	0.4%
Plastic	**706**	**2.2%**		
Small PET Bottles (24 oz or smaller)	92	0.3%	0.3%	0.3%
Large PET Bottles (greater than 24 oz)	174	0.6%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	17	0.1%	0.0%	0.1%
HDPE Bottles	224	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	21	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	17	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	28	0.1%	0.1%	0.1%
Plastic Bags and Packaging	133	0.4%	0.3%	0.5%
Glass	**4,970**	**15.8%**		
Clear Beverage	717	2.3%	2.1%	2.5%
Green Beverage	1,219	3.9%	3.5%	4.2%
Brown Beverage	1,037	3.3%	3.0%	3.6%
Clear Container Glass	268	0.9%	0.7%	1.0%
Other Glass Containers and Bottles	18	0.1%	0.0%	0.1%
Mixed Cullet	1,710	5.4%	4.8%	6.1%
Contaminants	**1,526**	**4.9%**		
Non-Conforming Paper	191	0.6%	0.5%	0.7%
Non-Conforming Metal	61	0.2%	0.1%	0.3%
Non-Conforming Plastic	120	0.4%	0.3%	0.5%
Non-Conforming Glass	31	0.1%	0.0%	0.2%
Garbage	1,124	3.6%	2.9%	4.2%
Total Tons	**31,464**			
Sample Count	**87**			

Table 3-16: Composition by Weight: Multi-Family North
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**4,194**	**79.6%**		
Newsprint	1,946	36.9%	33.8%	40.1%
Corrugated/Kraft, Unwaxed	884	16.8%	14.4%	19.2%
Phone Books	220	4.2%	2.6%	5.8%
Mixed Low Grade	1,130	21.4%	19.2%	23.7%
Polycoat Containers	13	0.2%	0.2%	0.3%
Asceptic Containers	1	0.0%	0.0%	0.0%
Metal	**83**	**1.6%**		
Aluminum Cans	29	0.6%	0.5%	0.6%
Tin Food Cans	46	0.9%	0.7%	1.1%
Other Ferrous	8	0.1%	0.0%	0.3%
Plastic	**89**	**1.7%**		
Small PET Bottles (24 oz or smaller)	14	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	21	0.4%	0.3%	0.5%
PET Jars, Tubs, and Other Containers	6	0.1%	0.0%	0.2%
HDPE Bottles	26	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	4	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	3	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	3	0.1%	0.0%	0.1%
Plastic Bags and Packaging	13	0.2%	0.2%	0.3%
Glass	**759**	**14.4%**		
Clear Beverage	101	1.9%	1.7%	2.2%
Green Beverage	138	2.6%	2.2%	3.0%
Brown Beverage	160	3.0%	2.6%	3.4%
Clear Container Glass	28	0.5%	0.4%	0.6%
Other Glass Containers and Bottles	5	0.1%	0.0%	0.2%
Mixed Cullet	327	6.2%	5.3%	7.1%
Contaminants	**144**	**2.7%**		
Non-Conforming Paper	23	0.4%	0.3%	0.6%
Non-Conforming Metal	9	0.2%	0.0%	0.3%
Non-Conforming Plastic	15	0.3%	0.2%	0.4%
Non-Conforming Glass	4	0.1%	0.0%	0.1%
Garbage	94	1.8%	1.4%	2.2%
Total Tons	**5,269**			
Sample Count	**45**			

Table 3-17: Composition by Weight: Multi-Family South
(November 2000 – October 2001)

Calculated at a 90% confidence interval

	Tons	Mean	Low	High
Paper	**5,102**	**75.9%**		
Newsprint	2,229	33.2%	29.9%	36.4%
Corrugated/Kraft, Unwaxed	1,042	15.5%	13.2%	17.8%
Phone Books	280	4.2%	2.4%	6.0%
Mixed Low Grade	1,533	22.8%	20.2%	25.4%
Polycoat Containers	17	0.3%	0.2%	0.3%
Asceptic Containers	1	0.0%	0.0%	0.0%
Metal	**98**	**1.5%**		
Aluminum Cans	33	0.5%	0.4%	0.6%
Tin Food Cans	50	0.7%	0.6%	0.9%
Other Ferrous	15	0.2%	0.0%	0.4%
Plastic	**105**	**1.6%**		
Small PET Bottles (24 oz or smaller)	13	0.2%	0.1%	0.2%
Large PET Bottles (greater than 24 oz)	22	0.3%	0.2%	0.4%
PET Jars, Tubs, and Other Containers	3	0.0%	0.0%	0.1%
HDPE Bottles	33	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	4	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	4	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	5	0.1%	0.0%	0.1%
Plastic Bags and Packaging	23	0.3%	0.2%	0.4%
Glass	**1,214**	**18.1%**		
Clear Beverage	177	2.6%	2.3%	3.0%
Green Beverage	268	4.0%	3.5%	4.5%
Brown Beverage	358	5.3%	4.8%	5.9%
Clear Container Glass	39	0.6%	0.4%	0.7%
Other Glass Containers and Bottles	28	0.4%	0.1%	0.7%
Mixed Cullet	344	5.1%	4.2%	6.0%
Contaminants	**199**	**3.0%**		
Non-Conforming Paper	42	0.6%	0.4%	0.9%
Non-Conforming Metal	12	0.2%	0.1%	0.3%
Non-Conforming Plastic	13	0.2%	0.1%	0.3%
Non-Conforming Glass	6	0.1%	0.0%	0.1%
Garbage	127	1.9%	1.4%	2.4%
Total Tons	**6,719**			
Sample Count	**49**			

APPENDIX A: RECYCLING COMPONENTS

For the 2000/01 study, a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for *glass* recyclables, and the other for *all other recyclables* (e.g. *mixed paper, aluminum cans*, and *plastic bottles*). A small number of vehicles had only one of these two compartments. See Appendix B for more information.

Samples from *glass* compartments were sorted into eight of the 30 categories listed below: the seven *Glass* components and *Garbage (Glass Compartment)*. Samples from *all other recyclables* compartments were sorted into the remaining 21 categories.[1] Component changes between the 1998/99 and 2000/01 studies are listed below, and are followed by detailed definitions of all component categories for the 2000/01 study.

The changes that have been made to the recycling categories from the 1998/99 study are as follows:

- **Paper**
  - The *polycoat containers* category was added.
  - The *aseptic containers* category was added.
- **Plastic**
  - The *PET Plastic Bottles* category was divided into 2 categories: *PET Large Bottles* and *PET Small Bottles*.
  - The *PET Plastic Jars, Tubs, and Other Containers* category was added.
  - The *HDPE Plastic Jars, Tubs, and Other Containers* category was added.
  - The *Other Plastic Bottles (#3-7, excluding #6)* category was added.
  - The *Other Plastic Jars, Tubs, and Containers (#3-7, excluding #6)* category was added.
    - The *Plastic Bags and Packaging* category was added.
- **Glass**
  - The *Clear Beverage Glass* category was renamed *Clear Glass Bottles.*
  - The *Green Beverage Glass* category was renamed *Green Glass Bottles.*
  - The *Brown Beverage Glass* category was renamed *Brown Glass Bottles.*
  - The *Container Glass* category was divided into 2 categories: *Clear Container Glass*, and *Other Glass Containers and Bottles.*
- **Garbage**
  - The *Garbage* category was divided into 3 categories: *Garbage (All Other Recyclables Compartment), Garbage (Glass Compartment),* and *Recyclable Glass (All Other Recyclables Compartment).*

[1] For the last eight months of the study, an additional category – *Recyclable Glass (All Other Recyclables Compartment)* – was added. Samples from *all other recyclables* compartments, therefore, were sorted into 22 categories during this time.

A list of the current component categories and definitions follows:

Paper

NEWSPRINT: Printed newsprint. (Advertising *slicks* (glossy paper) were included in this category if found mixed with newspaper; otherwise, ad slicks are included with mixed low grade paper.)

CORRUGATED/KRAFT, UNWAXED: Unwaxed/uncoated old corrugated container boxes and Kraft paper, and brown paper bags. Clean bags and boxes only; soiled are *non-conforming*.

PHONE BOOKS: Telephone directories.

MIXED LOW GRADE: Mixed recyclable papers, including junk mail, magazines, colored papers, bleached Kraft, boxboard, mailing tubes, and paperback books. May also contain white or lightly colored sulfite/sulfate bond, copy papers, computer printouts, hard-back books, and envelopes.

POLYCOAT CONTAINERS: Bleached polycoated milk, ice cream, and frozen food containers. Clean containers only; soiled are *non-conforming*.

ASEPTIC CONTAINERS: Juice, soy/rice milk, and soup broth containers. Clean containers only; soiled are *non-conforming*.

NONCONFORMING PAPER: Any paper not described above and not meeting the requirements for Seattle's recycling program, such as tissue, photographs, soiled paper, food-soiled polycoat containers, waxed cardboard, and paper bags with plastic lining (i.e. dog or cat food bags).

Metal

ALUMINUM CANS: Aluminum beverage cans (UBC) and bi-metal cans made mostly of aluminum.

TIN FOOD CANS: Tinned steel food containers, including bi-metal cans mostly of steel.

OTHER FERROUS: Ferrous and alloyed ferrous scrap metals to which a magnet adheres and which are not significantly contaminated with other metals or materials.

NONCONFORMING METAL: Any metal not described above and not meeting the requirements for Seattle's recycling program, such as products containing a mixture of metals, all foil wrapping, foil pie tins, aerosol containers, and other materials.

Plastic

PET SMALL BOTTLES: Polyethylene terephthalate bottles (containers with a narrow neck), such as soda pop and other beverage less than or equal to 24 ounces.

PET LARGE BOTTLES: Polyethylene terephthalate bottles (containers with a narrow neck), such as soda pop and other beverage bottles greater than 24 ounces.

PET PLASTIC JARS, TUBS, AND OTHER CONTAINERS: Polyethylene terephthalate containers bearing a #1 in the triangular recycling symbol. Does not include any lids.

HDPE BOTTLES: High-density polyethylene bottles (containers with a narrow neck), such as milk, juice, and detergent containers.

HDPE PLASTIC JARS, TUBS, AND OTHER CONTAINERS: High-density polyethylene items bearing a #2 in the triangular recycling symbol. Does not include any lids.

OTHER PLASTIC BOTTLES (#3-7, EXCLUDING #6): Plastic bottles made of types of plastic other than HDPE or PETE. When marked for identification, these items may bear the number "3," "4," "5," or "7" in the triangular recycling symbol, but excludes all bottles marked with a "6," and all lids.
OTHER JARS, TUBS, AND CONTAINERS (#3-7, EXCLUDING #6): Clean plastic items made of types of plastic other than HDPE or PETE. When marked for identification, these items may bear the number "1," "2," "3," "4," "5," or "7" in the triangular recycling symbol. Excludes all containers marked with a "6" (i.e. take out/fast food containers), and all lids.

PLASTIC BAGS AND PACKAGING: Clean plastic retail, grocery, garbage, newspaper, drycleaner bags, and plastic shrink-wrap. Excludes all food and freezer bags, bags that are soiled or contain other items (i.e. paper advertisement, cosmetic samples, computer disks), and plastic kitchen wrap. Bags with non-paper handles (i.e. string or plastic) are also excluded.

NONCONFORMING PLASTIC: Any plastic not described above and not meeting the requirements for Seattle's recycling program such as toys, tarps, bubble wrap, bags with plastic or rope handles, and all plastic lids.

Glass

CLEAR GLASS BOTTLES: Includes clear pop, liquor, wine, juice, beer, and vinegar bottles.

GREEN GLASS BOTTLES: Includes green pop, liquor, wine, beer, and lemon juice bottles.

BROWN GLASS BOTTLES: Includes brown pop, beer, liquor, juice, and vanilla extract bottles.

CLEAR CONTAINER GLASS: All glass containers that are clear-colored and hold materials such as mayonnaise and non-dairy creamer.

OTHER GLASS CONTAINERS AND BOTTLES: All glass containers (of colors except clear) holding materials such as facial cream. All bottles of colors other than clear, green or brown. Examples include blue wine and liquor bottles.

MIXED CULLET. Glass bottles and containers that are broken into pieces less than one square inch and of multiple colors.

NONCONFORMING GLASS: Any glass not described above and not meeting the requirements for Seattle's recycling program, such as window glass, light bulbs and glassware.

Garbage

GARBAGE (ALL OTHER RECYCLABLES COMPARTMENT): Any item that does not meet the requirements for Seattle's recycling program and is located in a recycling truck's *all other recyclables* compartment, such as organic wastes, construction debris, soil, and hazardous wastes.

RECYCLABLE GLASS (ALL OTHER RECYCLABLES COMPARTMENT): Glass bottles and containers meeting the requirements for Seattle's recycling program and located in a recycling truck's *all other recyclables* compartment; such as pop and beer bottles, and glass containers holding materials such as facial cream.

GARBAGE (GLASS COMPARTMENT): Any item that does not meet the requirements for Seattle's recycling program and is located in a recycling truck's *glass* compartment, such as organic wastes, construction debris, soil, and hazardous wastes.

The following table summarizes the changes to component categories made between the 1998/99 and 2000/01 studies. (An "X" signifies that the component remains the same from the 1998/99 study; an outline border reflects how components were split apart for the 2000/01 study.)

Table A-1: Changes to Recycling Component Categories, 1998/99 to Present

	1998/99	2000/01
PAPER		
Newsprint	X	X
Corrugated/Kraft, Unwaxed	X	X
Phone Books	X	X
Mixed Low Grade	X	X
NonConforming Paper	X	X
		Polycoat Containers
		Asceptic Containers
PLASTICS		
PET Bottles	X	Small PET Bottles (24 oz or smaller)
		Large PET Bottles (greater than 24 oz)
HDPE Bottles	X	X
NonConforming Plastic	X	X
		PET Plastic Jars, Tubs, and Other Containers
		HDPE Plastic Jars, Tubs, and Other Containers
		Other Plastic Bottles (#3-7, excluding #6)
		Other Plastic Jars, Tubs, and Containers (#3-7, excluding #6)
		Plastic Bags and Packaging
GLASS		
Clear Beverage	X	Clear Glass Bottles
Green Beverage	X	Green Glass Bottles
Brown Beverage	X	Brown Glass Bottles
Container Glass	X	Clear Container Glass
		Other Glass Containers and Bottles
Mixed Cullet	X	X
Nonconforming Glass	X	X
METALS		
Aluminum Cans	X	X
Tin Food Cans	X	X
Other Ferrous	X	X
Nonconforming Metal	X	X
GARBAGE		
Garbage	X	Garbage (All Other Recyclables Compartment)
		Garbage (Glass compartment)
		Recyclable Glass (All Other Recyclables Compartment)

APPENDIX B: SAMPLING METHODOLOGY

Overview

The objective of this study was to provide statistically significant data on the composition of recyclables set out by Seattle residents.[2] Composition estimates were based on sampling that occurred from November 2000 to October 2001. The current study's methodology is slightly different from the 1998/99 study. These differences are described at the end of this appendix.

Sampling Populations

Recyclables set out by residences in Seattle were divided into four subpopulations based on *generator type* and *service area*. The two generator types included *single-* and *multi-family*, which are defined as follows:

- ***Single-family***: Residences using a toter-based collection system: One toter with an accompanying insert for glass. Typically, these residences are detached single-family, duplex, triplex and four-plex homes.[3]

- ***Multi-family***: Residences using a dumpster-based collection system: Generally, one or more dumpsters with accompanying glass toter(s). Typically, these residences are apartments and condominiums with five or more units.

There were two service areas from which Seattle's residential recyclables were collected during this study: *north* and *south*. The Lake Washington Ship Canal was the physical boundary that divided the north and south service areas.[4]

Figure B-1 depicts each of the four residential recycling subpopulations, according to generator type and service area.

Figure B-1: Subpopulations, by Generator Type and Service Area

	Generator Type *(Single-family)*	*(Multi-family)*
Service Area *(South)*	Single-Family North	Multi-Family North
	Single-Family South	Multi-Family South

[2] Recyclable materials that were either self-hauled to the city's two transfer stations or hauled from Seattle's commercial substream were excluded from this study, with the exception of businesses participating in SPU's *Small Business Recycling Program* (please see footnote 8 on this page for details).

[3] In August 2001, eligible small businesses were invited to participate in SPU's *Small Business Recycling Program.* This program offers small businesses the same free recycling service provided to Seattle's single-family residences, using 96-gallon toters. Small business recycling was collected with single-family recycling, and therefore was a part of the single-family "universe." It is unlikely, however, that *Small Business Recycling* had an impact on the composition of single-family recycling samples. By October 2001, only 350 businesses had signed up for this program, making up approximately 0.2% of the City's toter setouts.

[4] Waste Management collected recycling setouts from the city's north service area while U.S. Disposal collected recyclables set out in the south service area. Both private hauling companies delivered recyclables to the City's contracted recycling facility, *Third and Lander*.

Identify the "Universe"

The first step in developing the sampling plan for the 2000/01 study was to identify the "universe" of trucks that collected recycling setouts in Seattle. The "universe" was a list of every truck that collected recycling from single- and multi-family residences. It also included the route numbers each truck serviced, the total number of loads they picked up each day, the service area covered (north or south), and the type(s) of recycling collected.

The recycling from each of the four residential recycling subpopulations was collected independent of one another during the course of the 2000/01 study. A brief description of each one is listed below:

- ***Single-family North***: Each household was serviced every other week. On a typical day, a total of 17-21 trucks were in operation. From November 2000 through March 2001, 13 of these trucks serviced specific routes and collected *glass* recyclables in a separate compartment from *all other recyclables*.[5] The remaining four to eight trucks were classified as either *floaters* or *teams*. Floaters and teams operated differently than regular trucks, and were defined as follows:

    - *Floaters* were not limited to a specific route, but could have serviced any regular routes scheduled on a specific day. There were a total of nine floaters, 2-3 operating each day. These floaters collected *glass* and *all other recyclables* in separate compartments.

    - *Teams* were groups of trucks that worked together to collect recyclables from the same route. There were two teams that collected single-family recycling setouts in the north.

        - *Team A* consisted of two trucks that collected recyclables from the same route: The first picked up *glass* setouts while the second picked up *all other recyclables*.

        - *Team B* consisted of three trucks that serviced the same route: One that collected *glass* setouts only, and two that collected *all other recyclables.*

- ***Single-family South***: About 13 to 17 trucks collected single-family south recyclables daily based on a biweekly schedule. From November 2000 through April 2001, 14 of these trucks collected *glass* and *all other recyclables* in separate compartments while a *floater* truck collected *all other recyclables* each day. This *floater* covered multiple routes, depending on where help was needed. Also, during the first six months of the study, there were two trucks that collected *glass* and *all other recyclables* in the same compartment. These trucks serviced regular routes.[6]

- ***Multi-family North***: Three trucks serviced multi-family north recycling setouts based on a monthly collection schedule. All three trucks collected *glass* and *all other recyclables* in separate compartments. One of these trucks was a *floater*, and assisted the other two on their collection routes each day.

[5] *All other recyclables* included all materials that were placed in containers specified for all recyclables except glass (e.g. mixed paper, aluminum cans, and plastic bottles). Separate containers were designated for *glass* recyclables only.
[6] During the study, a total of five samples were taken from these two trucks. These samples were excluded from the November 2000 – October 2001 analysis, but included in the *Contract Year 1* analysis.

- ***Multi-family South***: On average, five trucks per day collected multi-family south recyclables: four of these followed a biweekly schedule, and one followed a monthly schedule.[7] All five trucks collected *glass* and *all other recyclables* in separate compartments.

Determine Number of Samples

This study was designed to capture a total of 270 samples – 180 single-family and 90 multi-family – between November 2000 and October 2001.[8] These samples were divided evenly between the north and south service areas. Table B-2 outlines the number of samples that were apportioned among the four subpopulations in this study.

Table B-2: Planned Number of Samples, by Subpopulation
(November 2000 – October 2001)

	Planned Number of Samples
Single-family	
North	90
South	90
Multi-family	
North	45
South	45
Total	**270**

Develop Sampling Calendar and Apportion Samples to Days

Since the field crew could sort approximately 15 samples per day; 18 sampling days were required to meet the sampling goals. In order to capture seasonal variations, the sampling days were distributed across a 12-month period, and were scheduled so that two days of sampling would occur during the odd months, and one day during the even months.

Working around major holidays and weekends (since residential recyclables were not collected on those days) and the sorting crew's availability, sampling dates were randomly selected. This was accomplished by assigning all potential sampling days a computer-generated random number. The date with the lowest random number for each month was selected for sampling. For those months requiring an additional sampling day, the day directly preceding the one with the lowest random number was chosen.

Single-family setouts were collected once every other week in both the north and the south service areas. Multi-family recyclables were picked up once every four weeks in the north service area, and biweekly in the south service area. Therefore the collection schedule for the entire city repeated itself every four weeks.

[7] Approximately 50 of these multi-family south residences were serviced each Monday. An additional *floater* assisted routes on every fourth Monday to accommodate extra volumes from these residences.

[8] In this study a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for *glass* recyclables, and the other for *all other recyclables* (e.g. *mixed paper, aluminum cans*, and *plastic bottles*).

The sampling schedule was designed to ensure an even distribution across days of the week and weeks of the four-week collection cycle. One randomly selected sampling day was adjusted in order to achieve this goal.

A total of 15 single-family samples were scheduled each month. Every other month, 15 multi-family samples were scheduled. Both single- and multi-family samples were apportioned evenly between the north and south service areas. During the months when two days of sampling occurred, samples from each of the four subpopulations were divided evenly between the two days. To avoid sampling multi-family loads twice, multi-family samples were split between the two days. As described in the previous section, only eight multi-family trucks collected recyclables on an average day.

The sampling calendar is shown in Table B-3. Table B-4 displays the resulting allocation of sampling days for each generator type (single- and multi-family) by day, and across the four-week collection cycle.

Table B-3: Sampling Calendar[9]
(November 2000 – October 2001)

	Number of Samples				
Date	**SF North**	**SF South**	**MF North**	**MF South**	**Total Samples**
11/15/2000	4	4	4	4	**16**
11/16/2000	4	4	4	4	**16**
12/12/2000	8	8	0	0	**16**
1/11/2001	4	4	4	4	**16**
1/12/2001	4	4	4	4	**16**
2/16/2001	8	8	0	0	**16**
3/1/2001	4	4	4	4	**16**
3/2/2001	4	4	4	4	**16**
4/16/2001	8	8	0	0	**16**
5/23/2001	4	4	4	4	**16**
5/24/2001	4	4	4	4	**16**
6/6/2001	8	8	0	0	**16**
7/2/2001	4	4	4	4	**16**
7/3/2001	4	4	4	4	**16**
8/7/2001	8	8	0	0	**16**
9/24/2001	4	4	4	4	**16**
9/25/2001	4	4	4	4	**16**
10/26/2001	8	8	0	0	**16**
Total:	**96**	**96**	**48**	**48**	**288**

[9] This table includes 18 additional samples that were included as contingency samples.

Table B-4: Sampling Day Distribution, by Generator Type
(November 2000 – October 2001)

	Number of Recycling Sampling Days					
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Overall**
SINGLE-FAMILY	**3**	**4**	**3**	**4**	**4**	**18**
Fall (Nov 2000, Sept-Oct '01)	**1**	**1**	**1**	**1**	**1**	**5**
Week 1	0	0	0	0	0	0
Week 2	0	0	1	1	0	2
Week 3	1	1	0	0	1	3
Week 4	0	0	0	0	0	0
Winter (Dec 2000, Jan -Feb '01)	**0**	**1**	**0**	**1**	**2**	**4**
Week 1	0	0	0	0	0	0
Week 2	0	1	0	1	1	3
Week 3	0	0	0	0	1	1
Week 4	0	0	0	0	0	0
Spring (Mar - May '01)	**1**	**0**	**1**	**2**	**1**	**5**
Week 1	0	0	1	2	1	4
Week 2	0	0	0	0	0	0
Week 3	0	0	0	0	0	0
Week 4	1	0	0	0	0	1
Summer (Jun - Aug '01)	**1**	**2**	**1**	**0**	**0**	**4**
Week 1	0	0	0	0	0	0
Week 2	0	0	0	0	0	0
Week 3	1	1	1	0	0	3
Week 4	0	1	0	0	0	1
MULTI-FAMILY	**2**	**2**	**2**	**4**	**2**	**12**
Fall (Nov 2000, Sept-Oct '01)	**1**	**1**	**1**	**1**	**0**	**4**
Week 1	0	0	0	0	0	0
Week 2	0	0	1	1	0	2
Week 3	1	1	0	0	0	2
Week 4	0	0	0	0	0	0
Winter (Dec 2000, Jan -Feb '01)	**0**	**0**	**0**	**1**	**1**	**2**
Week 1	0	0	0	0	0	0
Week 2	0	0	0	1	1	2
Week 3	0	0	0	0	0	0
Week 4	0	0	0	0	0	0
Spring (Mar - May '01)	**0**	**0**	**1**	**2**	**1**	**4**
Week 1	0	0	1	2	1	4
Week 2	0	0	0	0	0	0
Week 3	0	0	0	0	0	0
Week 4	0	0	0	0	0	0
Summer (Jun - Aug '01)	**1**	**1**	**0**	**0**	**0**	**2**
Week 1	0	0	0	0	0	0
Week 2	0	0	0	0	0	0
Week 3	1	1	0	0	0	2
Week 4	0	0	0	0	0	0

Select Loads for Sorting

Single-Family

Since there were more single-family loads collected per day than the quota to be sampled, it was necessary to designate which specific loads were to be sampled. From November 2000 to May 2001, a random number was assigned to every single-family load that was expected to arrive at the Third and Lander facility. These random numbers were sorted and the loads with the lowest random number were selected in sequence until the sampling quota was met for both the north and south. For subsequent sampling days, a new random number was assigned to each load, and the process was repeated.

Multi-Family

Typically eight multi-family loads were delivered to the Third and Lander facility each day: three from the north, and five from the south. For the first eight months of the study, loads collected in the south were randomly selected according to the steps outlined above for single-family loads. For the north service area, all three trucks were sampled. In order to capture a sufficient number of multi-family north samples on a given day, two samples had to be taken from one of the three north loads.[10]

Floater and *Team* Trucks

The *floater* trucks in all four subpopulations were included with the regular trucks to be selected for sampling. For the single-family north, the trucks that made up *Team A* were combined so as to represent one load; those of *Team B* were grouped as one load also. Each of these two loads was included in the pool of single-family north trucks to be randomly selected.

From June to October 2001, all loads were *systematically selected*. Systematic selection consists of taking every "nth" load that enters the facility for each sampling day. The sampling intervals were determined by dividing the day's expected number of arriving loads by the number of samples needed on that day.[11] For example, if 35 single-family north loads were expected to arrive at the Third and Lander facility on a sampling day, and a total of seven samples were needed, every fifth single-family north load would be selected for sampling.

As the study progressed, key planning assumptions were monitored. When necessary, the sampling plan was modified to meet the objectives of the study design.

Coordinate Sampling

Before sampling began, all haulers and the Third and Lander facility manager were given an annual schedule that listed the sampling dates and number of samples to be captured per generator type (see Table B-2).

From November 2000 to May 2001, a few days prior to each sampling day the affected haulers were faxed a notice that listed each route to be included in the upcoming sort (a copy of this notice is included in Appendix F). This notice requested that each hauler confirm the correct truck and route numbers. The appropriate drivers were to be alerted that their loads would be sampled. In the same notice, the hauler was asked to write in the estimated time of arrival for each selected load, and then fax the notice back to Cascadia Consulting Group, Inc.

[10] The truck that was sampled twice was randomly selected according to the steps outlined for selecting single-family loads.
[11] The expected traffic count was the load count from the same day a week prior to sampling.

For the last five months of the study, affected haulers and the Third and Lander facility manager were alerted of upcoming sampling days, but were not provided with specific loads selected for sampling. Instead, haulers were asked to alert all drivers of the sampling day(s).

Net Weights

Selected trucks delivering *glass* only and *all other recyclables* only in separate compartments were required to weigh twice – once for each compartment – at the Third and Lander scalehouse. The net weights for both compartments were needed since separate samples were taken from each. Trucks with only one compartment weighed once at the scalehouse. The scalehouse staff recorded these weights on a brightly colored placard that was labeled with that load's unique sample number. This number linked the net weight with its corresponding sampling data.

A *gatekeeper* was present at the Third and Lander facility for each sampling day to coordinate the details of weighing procedures and truck diversion in conjunction with the transfer station manager, scalehouse staff, and sorting crew. In addition, the gatekeeper ensured that net weights were recorded for all sampled loads.

Extract Samples

The Field Supervisor managed the sample extraction, sorting area, and recycling of sorted materials with the transfer station manager. Each sample consisted of approximately 200 – 250 pounds of material.

For trucks that carried *glass* and *all other recyclables* in two separate compartments, samples were captured according to the following steps.

1. The compartment containing *all other recyclables* was emptied, and about 1-2 cubic yards (approximately 200 pounds) of the material was placed onto a tarp for sorting. (Each sample was selected with care in order to ensure a representative cross-section of the load's top, bottom, and sides.)
2. Immediately after emptying its first compartment, the truck was instructed to weigh again at the scalehouse.
3. Next, a glass sample (approximately 30-50 pounds) was captured from the truck's *glass* compartment. The same sampling procedure that was used for the *all other recyclables* load was repeated for the *glass* compartment.

Trucks that delivered either *glass* or *all other recyclables* were sampled once. Again, each sample was selected so as to ensure that a representative portion of the load was captured. Approximately 30-50 pound samples were taken from trucks that delivered only *glass* recyclables while about 200 pounds was captured from trucks that delivered *all other recyclables* to the Third and Lander facility.[12]

[12] *Floater* and *Team A* trucks were sampled according to these same principles; however samples taken from *Team B* contained about 30-50 pounds from the truck carrying glass recyclables, and approximately 200 pounds split evenly between the trucks that delivered *all other recyclables*.

Sorting Procedures

Each sample was sorted by hand into the component categories defined in Appendix A. Samples from *glass* compartments were sorted into eight component categories. For the first four months of the study, *all other recyclables* were sorted into 21 component categories. Beginning in April 2001, glass was separated from other contaminants in compartments that contained *all other recyclables*.[13]

The weights of all materials were recorded on tally sheets (shown in Appendix F). Pieces of broken glass were sorted into the C*lear Glass Bottles, Green Glass Bottles, Brown Glass Bottles, Clear Container Glass,* or O*ther Glass Containers and Bottles* categories if the pieces were either

- uniform in color and type; or
- larger than one square inch and the type could be determined.

If the type of glass (container or bottle) could not be determined then it was recorded as *mixed cullet. Mixed cullet* also included glass bottles or containers that were broken into pieces less than one square inch and of multiple colors.

Comparisons to Previous Studies

The 1998/99 and 2000/01 studies differed from one another in a variety of ways. These differences were discussed with the Seattle Public Utilities staff, and shaped the design of this study. A list of these differences and their effect on the sampling design of the 2000/01 study are provided below:

1. Prior to April of 2000, the City of Seattle had seven separate contracts for the collection of residential recyclables. The 1998/99 study included recycling that was collected from only four of the seven contracts. There were two companies contracted to collect these setouts during the 2000/01 study; both were sampled.

2. The component list for the 1998/99 study included 19 components: this study included 29. Several component categories were split, renamed, or added to the list in order to reflect the additional types of recyclables that were added to the citywide residential recycling program in April 2000. See Appendix A for detailed definitions of all component categories, and a table that tracks the changes in component categories from the 1998/99 to the 2000/01 study.

3. During the 1998/99 study, a total of 360 single-family samples were collected directly from individual households; however during the 2000/01 study, 180 single-family samples were captured from loads delivered to the City's contracted recycling facility. This was decided after comparing the error ranges associated with each of the two sampling methods, using the 1998/99 data. In most cases, the percent error associated with individual household sampling was more than twice that associated with truckload sampling.

[13] Composition estimates were derived for the total amount of contaminants found in compartments containing *all other recyclables*; glass and non-glass contaminants were not analyzed separately. This is because the category *Recyclable Glass (All Other Recyclables Compartment)* was added midway through the study.

4. In 1998/99, single- and multi-family loads were sampled on different days because sorting occurred at two different facilities. Since all residential recycling loads were delivered to the same facility during the 2000/01 study, both single- and multi-family recyclables were captured across two sampling days on alternate months, providing a more representative sample from these subpopulations.

5. During the 1998/99 study, single- and multi-family loads were pre-selected using a random selection process. From November 2000 to May 2001, all loads were pre-selected using the same process. Scheduling changes that occurred midway through the study limited the number of loads available for sampling, and thus systematic selection was used to designate sample loads from June to October 2001. See the *Select Loads for Sorting* section earlier in this appendix for more information.

APPENDIX C: COMMENTS ON MONTHLY SAMPLING EVENTS

November

On November 15th, we obtained eight samples from single-family loads and eight samples from multi-family loads as planned. During the November 16th sorting day, eight single-family and six multi-family truckloads were sampled. Two of the selected multi-family loads did not arrive at Third and Lander as planned.

December

We sorted a total of 13 residential recycling samples on December 12th. All 13 of these samples were from single-family loads. We sorted seven samples from U.S. Disposal loads, and six samples from Waste Management loads. The remaining three trucks that were selected for sampling did not arrive at Third and Lander as planned.

January

On January 11th, all 16 samples were sorted as planned. Half of the single-family loads were from Waste Management trucks, while the other half were captured from U.S. Disposal trucks. All four of the multi-family north loads were taken from Nuts 'n' Bolts loads, and the remaining four were hauled by U.S. Disposal trucks from the south.

During the January 12th sampling day, the sorting crew captured eight single-family samples as planned. Again, four loads were captured from Waste Management trucks, and four from U.S. Disposal trucks. Two of the multi-family loads (both U.S. Disposal) did not arrive at Third and Lander as scheduled. A sub was sampled in place of one of these two loads. Four of the seven multi-family samples came from Nuts 'n' Bolts trucks, and the other three were captured from U.S. Disposal loads.

February

The February 16th sampling day was postponed until March 5th due to a snow storm.

March

On March 1st, 15 loads were sorted. We sampled eight single-family loads and seven multi-family loads. Six of the single-family loads were from Waste Management trucks servicing the north area, and the other two were captured from United Disposal trucks that haul recycling from the south. Of the multi-family loads, four were from Nuts 'n' Bolts trucks (north) and four came from United Disposal trucks (south). Due to traffic disruptions caused by the earthquake that occurred on February 28th, several of the residential recycling loads delivered to Third and Lander were either late or did not arrive at the facility. This explains why two extra Waste Management loads were substituted for the two missing United Disposal loads.

During the March 2nd sampling day 15 loads were sampled. Eight single-family loads, six from United Disposal trucks and two from Waste Management trucks, were captured and sorted as planned. Seven of the eight multi-family loads were sampled as well. A loader operator pushed one of the scheduled multi-family loads from a United Disposal truck. Therefore, four of the multi-family samples were captured from Nuts 'n' Bolts trucks from the north, and three were from United Disposal trucks that serviced the south area.

The March 5th sampling day was scheduled to make up for February 16th, which was cancelled due to a snow storm. A total of 17 samples (16 single-family and one multi-family) were captured and sorted on March 5th. Eight of the single-family loads came from the north service area (Waste Management), and the remaining eight were from the south service area (United Disposal). The multi-family load was a make up for the one that was pushed on March 2nd. It was captured from a United Disposal truck.

April

In April, we sorted a total of 16 residential recycling samples. On April 16th, all 16 samples were sorted as planned. Half of the single-family loads were from Waste Management trucks, while the other half were captured from U.S. Disposal vehicles. All recyclable glass found in the *all other recyclables* compartment was recorded separate from garbage found in this compartment.

May

On May 23rd, 15 samples were sorted - one less than planned. Five of the single-family loads were from Waste Management trucks, and the additional four were captured from U.S. Disposal vehicles. Of the multi-family loads, three loads came from two Nuts 'n' Bolts trucks (one driver forgot that we were sampling and dumped at 6:00am that morning) and the other three came from U.S. Disposal trucks.

We captured and sorted 15 samples on May 24th. We sampled one single-family load from Waste Management. In addition, we took four samples from U.S. Disposal single-family trucks. The remaining 10 samples came from multi-family loads: five from Nuts 'n' Bolts loads and five from U.S. Disposal ones. Several Waste Management trucks were broken down on this sampling day. This affected other trucks' schedules, and led to many trucks waiting to dump their loads until the next morning. This explains why only one single-family truckload was taken from Waste Management.

June

We captured and sorted 16 samples on June 6th. All of these samples came from single-family loads. Half of the samples were captured from Waste Management trucks while the other eight came from U.S. Disposal loads.

June 6th was the first day of systematic vehicle selection: instead of randomly selecting vehicles before the sampling day, sampling intervals (e.g., every "nth" single-family truck) were pre-determined based on data from the same day a week prior to sampling. In addition, sampling is now scheduled to begin at 6:00am.

July

On July 2nd, all 16 samples were sorted as planned. Half of the single-family loads were from Waste Management trucks, while the other half were captured from U.S. Disposal vehicles. Four multi-family loads were taken from Waste Management, and the remaining four came from U.S. Disposal. While no single-family truckloads were double sampled, two of the multi-family loads were. This was because Waste Management had only one of their multi-family trucks in operation on this day. We sampled this truck's first load in the morning, and then sampled its second load in the afternoon.

A total of 16 samples were sorted on July 3rd. Again, half of the single-family samples came from Waste Management, and the other half came from U.S. Disposal trucks. The multi-family samples were split the same way: four from Waste Management and four from U.S. Disposal. There is one sample with no corresponding net weight. Also, one U.S. Disposal multi-family truck was double-sampled on this day.

August

We captured and sorted 16 samples on August 7th. All of these samples came from single-family recycling trucks. Nine of the samples were captured from Waste Management trucks. The other nine came from U.S. Disposal loads.

September

We captured and sorted 15 samples on September 24th. Four of the single-family loads were from Waste Management trucks, while the other four were captured from U.S. Disposal vehicles. Of the multi-family loads, three were taken from Waste Management while the remaining four came from U.S. Disposal. We planned to sort one additional multi-family sample from Waste Management, but one of their trucks broke down in the morning. We captured our sample from this truck before it became disabled, but were only able to get a net weight for the glass portion of the truck. In the afternoon, we sampled from the substitute truck that was only able to haul all other recyclables (no glass compartment).

A total of 13 samples were sorted on September 25th. Again, four of the single-family samples came from Waste Management, and the other four came from U.S. Disposal trucks. Although four multi-family samples were captured from U.S. Disposal loads, only one multi-family sample was taken from Waste Management.

October

We captured and sorted 15 samples on October 26th. A total of nine samples came from single-family recycling trucks: seven of the samples were captured from U.S. Disposal trucks while the other two came from Waste Management loads. Although October 26th was originally scheduled as a single-family sampling day, we captured six multi-family loads to meet the study's sampling goals. We took half of the loads from U.S. Disposal trucks, and the other half from Waste Management loads.

APPENDIX D: COMPOSITION RESULTS, CONTRACT YEAR 1

As described in Section **Error! Reference source not found.** of this report, Seattle Public Utilities (SPU) established new contracts with two private companies in April 2000 for the collection of residential recyclables within the city.[14] As part of the new contracts, the following program changes were made in April 2000:

1. New materials were added to the City's recycling program (e.g. plastic bags);
2. Recycling and garbage collection were scheduled to occur on the same day;
3. Service area boundaries were redrawn; and
4. Processing facilities were consolidated into one location, and restructured to accept *glass* and *all other recyclables* separately.

The current composition study began seven months after the services under these contracts were initiated, allowing for full implementation of the City's new recycling program.

In addition to the current study period, SPU was interested in obtaining best composition estimates for recyclables set out during the first full contract year spanning from April 2001 through March 2002. These best estimates were calculated based on samples taken from the current study period – November 2000 to October 2001 – including those captured from vehicles that combined *glass* and *all other recyclables* in the same compartment.[15] (Although *glass* may have been set out separate from *all other recyclables*, all *glass* collected in these two trucks was disposed by the processing facility. Therefore, it was characterized as *garbage* for this study.) Tonnages from May 2000 – April 2001 were used as weighting factors for these calculations.[16]

This appendix presents the *Contract Year 1* sampling results. Consistent with the main body of the report, composition estimates are presented in three ways. First, a pie chart depicts the composition percentages of the five broad material categories: *paper, metal, plastic, glass, and contaminants.* Next, a table presents the top ten components, by weight, and finally, a table lists the full composition results of all 29 components.

[14] One of these contracts includes the transfer and processing of recyclables.
[15] These vehicles were sampled only during the first six months of this study; however, this same vehicle type was in operation during the entire *Contract Year 1.* Therefore, sample composition from this vehicle type was counted twice to account for the entire *Contract Year 1*.
[16] November 2000 – October 2001 tonnages were used to perform analyses for the composition presented in the main body of the report.

Overall Composition

The overall composition results are illustrated in Figure D-1. As shown, *paper* accounted for the largest portion (about 76%) of residential recycling during *Contract Year 1* (May 2000 – April 2001). Also prominent, *glass* made up approximately 16% of this recycling, by weight.

Figure D-1: Overview of Composition Estimates: Overall
(Contract Year 1)

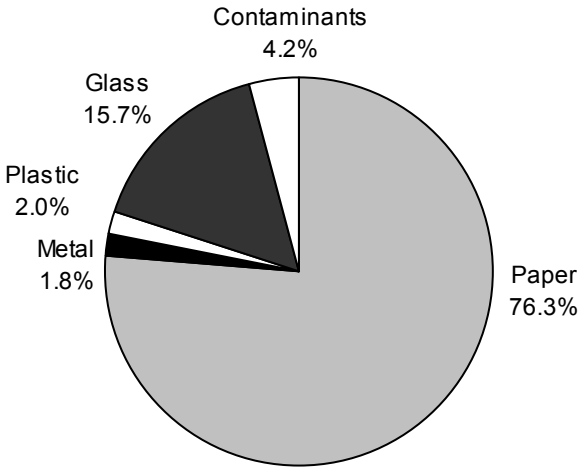


Table D-1 lists the top ten components of residential recycling during *Contract Year 1*. When summed together, these components account for about 95% of the total by weight. *Newsprint* and *mixed low grade paper* were predominant (about 35% and 25% respectively). *Unwaxed OCC/Kraft paper* and *mixed glass cullet* accounted for about 13% and 6% of the total respectively. Please see Table D-2 for the complete composition results for *Contract Year 1.*

Table D-1: Top Ten Components: Overall
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	34.7%	34.7%
Mixed Low Grade Paper	24.7%	59.4%
Unwaxed OCC/Kraft Paper	13.5%	72.9%
Mixed Glass Cullet	5.6%	78.5%
Brown Glass Bottles	3.6%	82.1%
Green Glass Bottles	3.5%	85.6%
Garbage	3.1%	88.7%
Phone Directories	2.9%	91.6%
Clear Glass Bottles	2.2%	93.8%
Tin Food Cans	1.0%	94.8%
Total	**94.8%**	

Table D-2: Composition by Weight: Overall
(Contract Year 1)

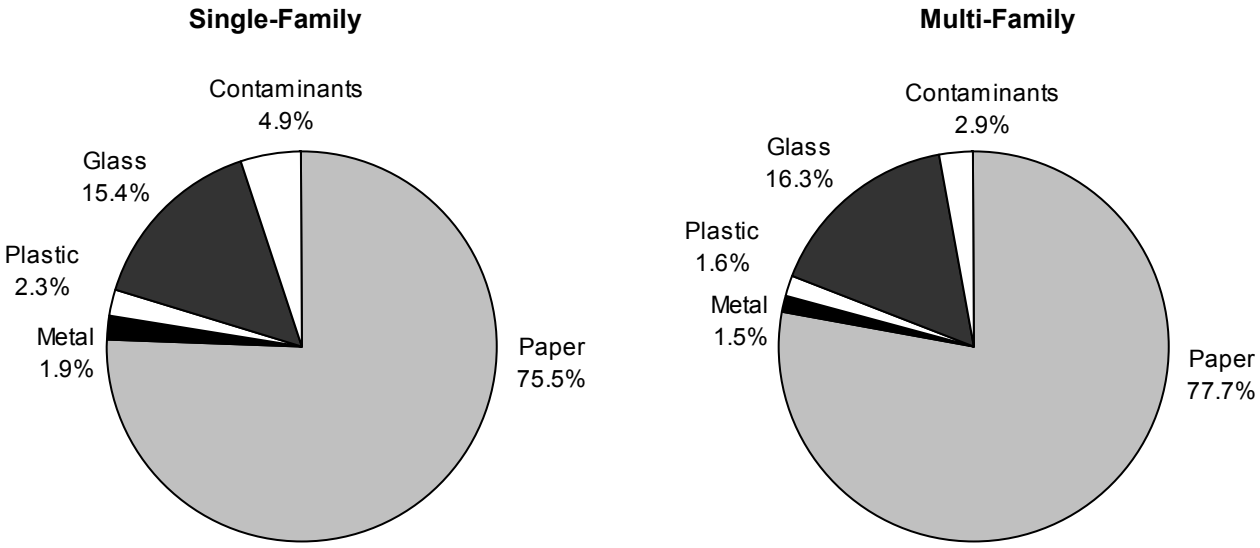
Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**76.3%**		
Newsprint	34.7%	33.6%	35.8%
Corrugated/Kraft, Unwaxed	13.5%	12.7%	14.3%
Phone Books	2.9%	2.4%	3.5%
Mixed Low Grade	24.7%	23.8%	25.6%
Polycoat Containers	0.4%	0.3%	0.5%
Asceptic Containers	0.1%	0.0%	0.1%
Metal	**1.8%**		
Aluminum Cans	0.6%	0.5%	0.6%
Tin Food Cans	1.0%	0.9%	1.1%
Other Ferrous	0.2%	0.1%	0.2%
Plastic	**2.0%**		
Small PET Bottles (24 oz or smaller)	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
HDPE Bottles	0.6%	0.6%	0.7%
HDPE Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.1%	0.1%
Plastic Bags and Packaging	0.4%	0.3%	0.4%
Glass	**15.7%**		
Clear Beverage	2.2%	2.0%	2.3%
Green Beverage	3.5%	3.3%	3.7%
Brown Beverage	3.6%	3.5%	3.8%
Clear Container Glass	0.7%	0.6%	0.8%
Other Glass Containers and Bottles	0.1%	0.1%	0.2%
Mixed Cullet	5.6%	5.2%	5.9%
Contaminants	**4.2%**		
Non-Conforming Paper	0.6%	0.5%	0.6%
Non-Conforming Metal	0.2%	0.1%	0.2%
Non-Conforming Plastic	0.3%	0.3%	0.4%
Non-Conforming Glass	0.1%	0.1%	0.1%
Garbage	3.1%	2.7%	3.5%
Sample Count	**275**		

Composition by Generator Type

Composition results for single-family and multi-family recycling are summarized in Figure D-2. During *Contract Year 1*, *paper* and *glass* combined made up 94% of the total for both generators.

Figure D-2: Overview of Composition Estimates, by Generator Type
(Contract Year 1)



Single-Family

Table D-3 outlines the top ten components set out by single-family generators. As shown, the top ten components accounted for just over 94% of the total by weight. *Newsprint*, *mixed low grade paper,* and *unwaxed OCC/Kraft paper* made up the largest portion of single-family recycling (about 34%, 26%, and 12% respectively). In addition, *mixed glass cullet* comprised nearly 6% of this recycling. Table D-4 lists the full composition results for single-family samples.

Table D-3: Top Ten Components: Single-Family
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	34.5%	34.5%
Mixed Low Grade Paper	26.2%	60.7%
Unwaxed OCC/Kraft Paper	12.0%	72.7%
Mixed Glass Cullet	5.5%	78.2%
Garbage	3.8%	81.9%
Green Glass Bottles	3.6%	85.6%
Brown Glass Bottles	3.3%	88.9%
Phone Directories	2.3%	91.2%
Clear Glass Bottles	2.1%	93.3%
Tin Food Cans	1.1%	94.4%
Total	**94.4%**	

Table D-4: Composition by Weight: Single-Family
(Contract Year 1)

Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**75.5%**		
Newsprint	34.5%	33.3%	35.7%
Corrugated/Kraft, Unwaxed	12.0%	11.1%	12.9%
Phone Books	2.3%	1.8%	2.7%
Mixed Low Grade	26.2%	25.1%	27.2%
Polycoat Containers	0.5%	0.4%	0.6%
Asceptic Containers	0.1%	0.0%	0.1%
Metal	**1.9%**		
Aluminum Cans	0.6%	0.6%	0.7%
Tin Food Cans	1.1%	1.0%	1.2%
Other Ferrous	0.2%	0.1%	0.2%
Plastic	**2.3%**		
Small PET Bottles (24 oz or smaller)	0.3%	0.3%	0.3%
Large PET Bottles (greater than 24 oz)	0.5%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
HDPE Bottles	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.0%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.1%	0.1%
Plastic Bags and Packaging	0.4%	0.4%	0.5%
Glass	**15.4%**		
Clear Beverage	2.1%	1.9%	2.3%
Green Beverage	3.6%	3.4%	3.9%
Brown Beverage	3.3%	3.1%	3.5%
Clear Container Glass	0.8%	0.7%	0.9%
Other Glass Containers and Bottles	0.1%	0.1%	0.1%
Mixed Cullet	5.5%	5.1%	6.0%
Contaminants	**4.9%**		
Non-Conforming Paper	0.6%	0.5%	0.7%
Non-Conforming Metal	0.1%	0.1%	0.2%
Non-Conforming Plastic	0.4%	0.3%	0.4%
Non-Conforming Glass	0.1%	0.1%	0.1%
Garbage	3.8%	3.1%	4.4%
Sample Count	**181**		

Multi-Family

Table D-5 lists the top ten components of multi-family recycling during *Contract Year 1*. When combined, these components account for over 95% of the total by weight. As with single-family generators, *newsprint, mixed low grade paper*, and *unwaxed OCC/Kraft paper* were the largest components (approximately 35%, 22%, and 16% respectively). *Mixed glass cullet* made up about 6% of this recycling. Table D-6 lists the full composition results for multi-family recycling.

Table D-5: Top Ten Components: Multi-Family
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	35.0%	35.0%
Mixed Low Grade Paper	22.1%	57.2%
Unwaxed OCC/Kraft Paper	16.1%	73.3%
Mixed Glass Cullet	5.7%	78.9%
Brown Glass Bottles	4.2%	83.1%
Phone Directories	4.2%	87.3%
Green Glass Bottles	3.3%	90.6%
Clear Glass Bottles	2.3%	92.9%
Garbage	1.8%	94.8%
Tin Food Cans	0.8%	95.6%
Total	**95.6%**	

Table D-6: Composition by Weight: Multi-Family
(Contract Year 1)

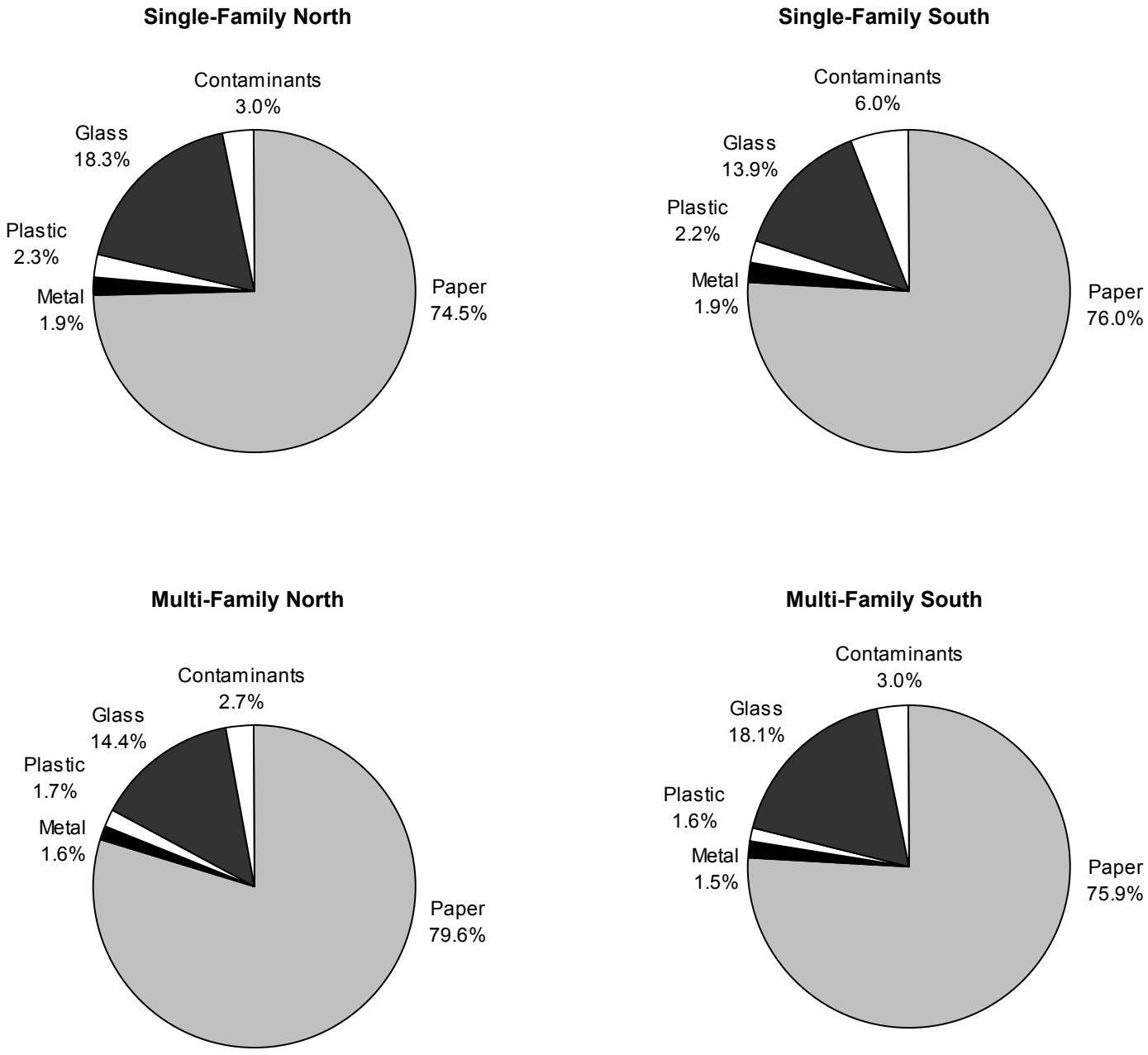
Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**77.7%**		
Newsprint	35.0%	32.7%	37.3%
Corrugated/Kraft, Unwaxed	16.1%	14.5%	17.8%
Phone Books	4.2%	3.0%	5.4%
Mixed Low Grade	22.1%	20.4%	23.9%
Polycoat Containers	0.3%	0.2%	0.3%
Asceptic Containers	0.0%	0.0%	0.0%
Metal	**1.5%**		
Aluminum Cans	0.5%	0.5%	0.6%
Tin Food Cans	0.8%	0.7%	0.9%
Other Ferrous	0.2%	0.0%	0.3%
Plastic	**1.6%**		
Small PET Bottles (24 oz or smaller)	0.2%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	0.4%	0.3%	0.4%
PET Jars, Tubs, and Other Containers	0.1%	0.0%	0.1%
HDPE Bottles	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.1%	0.1%
Plastic Bags and Packaging	0.3%	0.2%	0.3%
Glass	**16.3%**		
Clear Beverage	2.3%	2.1%	2.5%
Green Beverage	3.3%	3.0%	3.6%
Brown Beverage	4.2%	3.9%	4.5%
Clear Container Glass	0.6%	0.5%	0.6%
Other Glass Containers and Bottles	0.3%	0.1%	0.4%
Mixed Cullet	5.7%	5.0%	6.3%
Contaminants	**2.9%**		
Non-Conforming Paper	0.5%	0.4%	0.7%
Non-Conforming Metal	0.2%	0.1%	0.2%
Non-Conforming Plastic	0.2%	0.2%	0.3%
Non-Conforming Glass	0.1%	0.0%	0.1%
Garbage	1.8%	1.5%	2.2%
Sample Count	**94**		

Composition by Generator Type and Service Area

Figure D-3 summarizes, by broad material category, the composition for the four subpopulations. As depicted, *paper* made up between 74% and 80% of the total across the four subpopulations. *Glass* accounted for the second largest portion from about 14% for single-family south and multi-family north recycling to about 18% for single-family north and multi-family south recycling.

Figure D-3: Overview of Composition Estimates, by Generator Type and Service Area (Contract Year 1)



Single-Family North

The top ten components for single-family north recycling are listed in Table D-7, along with the mean percentage, cumulative percentage, and tons recycled. *Newsprint, mixed low grade paper,* and *unwaxed OCC/Kraft paper* were the largest components of this recycling (about 34%, 26%, and 12% respectively). *Mixed glass cullet* accounted for about 7% of the total by weight. The complete composition results for single-family north recycling are detailed in Table D-9.

Table D-7: Top Ten Components: Single-Family North
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	33.7%	33.7%
Mixed Low Grade Paper	26.4%	60.0%
Unwaxed OCC/Kraft Paper	12.0%	72.1%
Mixed Glass Cullet	6.9%	79.0%
Brown Glass Bottles	4.1%	83.1%
Green Glass Bottles	4.1%	87.2%
Clear Glass Bottles	2.3%	89.4%
Garbage	2.0%	91.5%
Phone Directories	2.0%	93.5%
Tin Food Cans	1.2%	94.6%
Total	**94.6%**	

Single-Family South

Table D-8 lists the top ten components found in single-family south recycling during *Contract Year 1*. Consistent with single-family north recycling, *newsprint, mixed low grade paper* and *unwaxed OCC/Kraft paper* were the top three components (accounting for about 35%, 26%, and 12% respectively). Table D-10 presents the detailed composition results for single-family south recycling.

Table D-8: Top Ten Components: Single-Family South
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	34.9%	34.9%
Mixed Low Grade Paper	26.1%	61.0%
Unwaxed OCC/Kraft Paper	12.0%	73.0%
Mixed Glass Cullet	4.8%	77.8%
Garbage	4.7%	82.4%
Green Glass Bottles	3.4%	85.9%
Brown Glass Bottles	2.9%	88.8%
Phone Directories	2.4%	91.2%
Clear Glass Bottles	2.0%	93.2%
Tin Food Cans	1.1%	94.3%
Total	**94.3%**	

Table D-9: Composition by Weight: Single-Family North
(Contract Year 1)

Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**74.5%**		
Newsprint	33.7%	32.2%	35.2%
Corrugated/Kraft, Unwaxed	12.0%	10.8%	13.3%
Phone Books	2.0%	1.5%	2.5%
Mixed Low Grade	26.4%	25.0%	27.7%
Polycoat Containers	0.4%	0.3%	0.5%
Asceptic Containers	0.1%	0.0%	0.1%
Metal	**1.9%**		
Aluminum Cans	0.7%	0.6%	0.7%
Tin Food Cans	1.2%	1.1%	1.3%
Other Ferrous	0.0%	0.0%	0.1%
Plastic	**2.3%**		
Small PET Bottles (24 oz or smaller)	0.2%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	0.5%	0.4%	0.5%
PET Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
HDPE Bottles	0.8%	0.6%	0.9%
HDPE Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.0%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.1%	0.1%
Plastic Bags and Packaging	0.5%	0.4%	0.6%
Glass	**18.3%**		
Clear Beverage	2.3%	2.0%	2.5%
Green Beverage	4.1%	3.7%	4.4%
Brown Beverage	4.1%	3.8%	4.4%
Clear Container Glass	0.8%	0.6%	0.9%
Other Glass Containers and Bottles	0.1%	0.1%	0.2%
Mixed Cullet	6.9%	6.2%	7.6%
Contaminants	**3.0%**		
Non-Conforming Paper	0.5%	0.4%	0.6%
Non-Conforming Metal	0.1%	0.0%	0.1%
Non-Conforming Plastic	0.3%	0.2%	0.3%
Non-Conforming Glass	0.1%	0.0%	0.2%
Garbage	2.0%	1.6%	2.5%
Sample Count	**89**		

Table D-10: Composition by Weight: Single-Family South
(Contract Year 1)

Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**76.0%**		
Newsprint	34.9%	33.2%	36.6%
Corrugated/Kraft, Unwaxed	12.0%	10.8%	13.1%
Phone Books	2.4%	1.7%	3.0%
Mixed Low Grade	26.1%	24.6%	27.5%
Polycoat Containers	0.5%	0.4%	0.7%
Asceptic Containers	0.1%	0.0%	0.1%
Metal	**1.9%**		
Aluminum Cans	0.6%	0.5%	0.7%
Tin Food Cans	1.1%	1.0%	1.2%
Other Ferrous	0.2%	0.1%	0.3%
Plastic	**2.2%**		
Small PET Bottles (24 oz or smaller)	0.3%	0.3%	0.3%
Large PET Bottles (greater than 24 oz)	0.6%	0.5%	0.6%
PET Jars, Tubs, and Other Containers	0.1%	0.0%	0.1%
HDPE Bottles	0.7%	0.6%	0.8%
HDPE Jars, Tubs, and Other Containers	0.1%	0.1%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.1%	0.1%
Plastic Bags and Packaging	0.4%	0.3%	0.5%
Glass	**13.9%**		
Clear Beverage	2.0%	1.8%	2.2%
Green Beverage	3.4%	3.1%	3.7%
Brown Beverage	2.9%	2.7%	3.1%
Clear Container Glass	0.8%	0.6%	0.9%
Other Glass Containers and Bottles	0.1%	0.0%	0.1%
Mixed Cullet	4.8%	4.2%	5.4%
Contaminants	**6.0%**		
Non-Conforming Paper	0.6%	0.5%	0.7%
Non-Conforming Metal	0.2%	0.1%	0.3%
Non-Conforming Plastic	0.4%	0.3%	0.5%
Non-Conforming Glass	0.1%	0.0%	0.1%
Garbage	4.7%	3.8%	5.6%
Sample Count	**92**		

Multi-Family North

The top ten components of multi-family north recycling during *Contract Year 1* are listed in Table D-11. When summed together, the top ten components account for over 95% of the total by weight. As with both single-family north and south recycling, *newsprint, mixed low grade paper* and *unwaxed OCC/Kraft paper* were the three largest components of this recycling. *Mixed glass cullet* followed at about 6% of the total. The full composition results for multi-family north recycling are detailed in Table D-13.

Table D-11: Top Ten Components: Multi-Family North
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	36.9%	36.9%
Mixed Low Grade Paper	21.4%	58.4%
Unwaxed OCC/Kraft Paper	16.8%	75.2%
Mixed Glass Cullet	6.2%	81.4%
Phone Directories	4.2%	85.5%
Brown Glass Bottles	3.0%	88.6%
Green Glass Bottles	2.6%	91.2%
Clear Glass Bottles	1.9%	93.1%
Garbage	1.8%	94.9%
Tin Food Cans	0.9%	95.8%
Total	**95.8%**	

Multi-Family South

Table D-12 lists the top ten components of multi-family south recycling during *Contract Year 1*. As shown, *newsprint, mixed low grade paper,* and *unwaxed OCC/Kraft paper* were the top three components of this recycling by weight (about 33%, 23%, and 16% respectively). In addition, *brown glass bottles* and *mixed glass cullet* each made up about just over 5% of the total. Table D-14 provides the full composition results for multi-family south recycling.

Table D-12: Top Ten Components: Multi-Family South
(Contract Year 1)

Component	Mean	Cum. %
Newsprint	33.2%	33.2%
Mixed Low Grade Paper	22.8%	56.0%
Unwaxed OCC/Kraft Paper	15.5%	71.5%
Brown Glass Bottles	5.3%	76.8%
Mixed Glass Cullet	5.1%	81.9%
Phone Directories	4.2%	86.1%
Green Glass Bottles	4.0%	90.1%
Clear Glass Bottles	2.6%	92.7%
Garbage	1.9%	94.6%
Tin Food Cans	0.7%	95.4%
Total	**95.4%**	

Table D-13: Composition by Weight: Multi-Family North
(Contract Year 1)

Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**79.6%**		
Newsprint	36.9%	33.8%	40.1%
Corrugated/Kraft, Unwaxed	16.8%	14.4%	19.2%
Phone Books	4.2%	2.6%	5.8%
Mixed Low Grade	21.4%	19.2%	23.7%
Polycoat Containers	0.2%	0.2%	0.3%
Asceptic Containers	0.0%	0.0%	0.0%
Metal	**1.6%**		
Aluminum Cans	0.6%	0.5%	0.6%
Tin Food Cans	0.9%	0.7%	1.1%
Other Ferrous	0.1%	0.0%	0.3%
Plastic	**1.7%**		
Small PET Bottles (24 oz or smaller)	0.3%	0.2%	0.3%
Large PET Bottles (greater than 24 oz)	0.4%	0.3%	0.5%
PET Jars, Tubs, and Other Containers	0.1%	0.0%	0.2%
HDPE Bottles	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.0%	0.1%
Plastic Bags and Packaging	0.2%	0.2%	0.3%
Glass	**14.4%**		
Clear Beverage	1.9%	1.7%	2.2%
Green Beverage	2.6%	2.2%	3.0%
Brown Beverage	3.0%	2.6%	3.4%
Clear Container Glass	0.5%	0.4%	0.6%
Other Glass Containers and Bottles	0.1%	0.0%	0.2%
Mixed Cullet	6.2%	5.3%	7.1%
Contaminants	**2.7%**		
Non-Conforming Paper	0.4%	0.3%	0.6%
Non-Conforming Metal	0.2%	0.0%	0.3%
Non-Conforming Plastic	0.3%	0.2%	0.4%
Non-Conforming Glass	0.1%	0.0%	0.1%
Garbage	1.8%	1.4%	2.2%
Sample Count	**45**		

Table D-14: Composition by Weight: Multi-Family South
(Contract Year 1)

Calculated at a 90% confidence interval

	Mean	Low	High
Paper	**75.9%**		
Newsprint	33.2%	29.9%	36.4%
Corrugated/Kraft, Unwaxed	15.5%	13.2%	17.8%
Phone Books	4.2%	2.4%	6.0%
Mixed Low Grade	22.8%	20.2%	25.4%
Polycoat Containers	0.3%	0.2%	0.3%
Asceptic Containers	0.0%	0.0%	0.0%
Metal	**1.5%**		
Aluminum Cans	0.5%	0.4%	0.6%
Tin Food Cans	0.7%	0.6%	0.9%
Other Ferrous	0.2%	0.0%	0.4%
Plastic	**1.6%**		
Small PET Bottles (24 oz or smaller)	0.2%	0.1%	0.2%
Large PET Bottles (greater than 24 oz)	0.3%	0.2%	0.4%
PET Jars, Tubs, and Other Containers	0.0%	0.0%	0.1%
HDPE Bottles	0.5%	0.4%	0.6%
HDPE Jars, Tubs, and Other Containers	0.1%	0.0%	0.1%
Other Plastic Bottles (#3-7, excluding #6)	0.1%	0.0%	0.1%
Other Jars, Tubs, and Containers (#3-7, excluding #6)	0.1%	0.0%	0.1%
Plastic Bags and Packaging	0.3%	0.2%	0.4%
Glass	**18.1%**		
Clear Beverage	2.6%	2.3%	3.0%
Green Beverage	4.0%	3.5%	4.5%
Brown Beverage	5.3%	4.8%	5.9%
Clear Container Glass	0.6%	0.4%	0.7%
Other Glass Containers and Bottles	0.4%	0.1%	0.7%
Mixed Cullet	5.1%	4.2%	6.0%
Contaminants	**3.0%**		
Non-Conforming Paper	0.6%	0.4%	0.9%
Non-Conforming Metal	0.2%	0.1%	0.3%
Non-Conforming Plastic	0.2%	0.1%	0.3%
Non-Conforming Glass	0.1%	0.0%	0.1%
Garbage	1.9%	1.4%	2.4%
Sample Count	**49**		

APPENDIX E: COMPOSITION CALCULATIONS

Composition Calculations

The composition estimates represent the **ratio of the components' weight to the total sample weight** for each noted group. They are derived by summing each component's weight across all of the selected records and dividing by the sum of the total sample weight, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

c = weight of particular component

w = sum of all component weights

for i 1 to n

where n = number of selected samples

for j 1 to m

where m = number of components

The confidence interval for this estimate is derived in two steps. First, the variance around the estimate is calculated, accounting for the fact that the ratio includes two random variables (the component and total sample weights). The **variance of the ratio estimator** equation follows:

$$\hat{V}_{r_j} = \left(\frac{1}{n}\right) \cdot \left(\frac{1}{\overline{w}^2}\right) \cdot \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right)$$

where:

$$\overline{w} = \frac{\sum_i w_i}{n}$$

Second, **precision levels** at the 90% confidence interval are calculated for a component's mean as follows:

$$r_j \pm \left(t \cdot \sqrt{\hat{V}_{r_j}}\right)$$

where:

t = the value of the t-statistic (1.645) corresponding to a 90% confidence level

For more detail, please refer to Chapter 6 "Ratio, Regression and Difference Estimation" of *Elementary Survey Sampling* by R.L. Scheaffer, W. Mendenhall and L. Ott (PWS Publishers, 1986).

Weighted Averages

The overall recycling composition estimates were calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from each of the four subpopulations: single-family north and south, and multi-family north and south.[17]

North and south service area composition was calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from each of the two generator types. Single- and multi-family estimates were calculated by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from each of the two service areas. Lastly, composition was calculated for the four subpopulations by performing a weighted average based on the tons of *glass* and *all other recyclables* setouts collected from the relevant generator and service area.

Seattle Public Utilities provided the estimate of tonnage for each of the four subpopulations, and sample vehicle net weights were used to estimate the tonnage split between the *glass* and *all other recyclables* compartments.[18] The composition estimates were applied to the relevant tonnages to estimate the amount for each component category.

The **weighted average for a composition estimate** is performed as follows:

$$E_j = (p_1 * r_{j1}) + (p_2 * r_{j2}) + (p_3 * r_{j3}) + \ldots$$

where:

p = the proportion of tonnage contributed by the noted group

r = ratio of component weight to total sample weight in the noted group

for j 1 to m
where m = number of components

The **variance of the weighted average** is calculated:

$$\mathrm{Var}E_j = (p_1^2 * \hat{V}_{rj1}) + (p_2^2 * \hat{V}_{rj2}) + (p_3^2 * \hat{V}_{rj3}) + \ldots$$

The weighting percentages that were used to perform the composition calculations for the 2000/01 study are listed in Tables E-1 through E-9 below. Following, Tables E-10 through E-16 list the weighting percentages used for the *Contract Year 1* composition calculations presented in Appendix D.

[17] In this study a sample generally consisted of two parts, corresponding to two separate collection compartments within a vehicle: one for *glass* recyclables, and the other for *all other recyclables* (e.g. *mixed paper, aluminum cans*, and *plastic bottles*). During the first five months of sampling, a few vehicles collected both *glass* and *all other recyclables* in the same compartment. Samples taken from these vehicles were eliminated from the analysis. See Appendix B for more information.

[18] For example, multi-family trucks from the north collected approximately 429,340 pounds of recycling in *all other recyclables* compartments and 73,740 pounds in *glass* compartments. These weights reflect only those multi-family north trucks sampled during the study period (because compartments are not weighed separately by the processing facility), and translate into approximately 16% and 3% of the residential recycling tonnage for the study period.

Table E-1: Weighting Percentages: Overall
(November 2000 – October 2001)

		(Service Area)	
Generator	**Material**	**North**	**South**
Multi-Family	Other	15.67%	15.73%
Multi-Family	Glass	2.69%	3.53%
Single-Family	Other	19.07%	32.70%
Single-Family	Glass	4.33%	6.27%

Table E-2: Weighting Percentages: North
(November 2000 – October 2001)

	(Material)	
Generator	**Other**	**Glass**
Multi-Family	37.53%	6.45%
Single-Family	45.66%	10.37%

Table E-3: Weighting Percentages: South
(November 2000 – October 2001)

	(Material)	
Generator	**Other**	**Glass**
Multi-Family	27.02%	6.06%
Single-Family	56.15%	10.77%

Table E-4: Weighting Percentages: Single-Family
(November 2000 – October 2001)

	(Service Area)	
Material	**North**	**South**
Other	30.57%	52.43%
Glass	6.94%	10.06%

Table E-5: Weighting Percentages: Multi-Family
(November 2000 – October 2001)

	(Service Area)	
Material	**North**	**South**
Other	41.65%	41.82%
Glass	7.15%	9.38%

Table E-6: Weighting Percentages: Single-Family North
(November 2000 – October 2001)

Material	Pct of Total
Other	80.81%
Glass	19.19%

Table E-7: Weighting Percentages: Single-Family South
(November 2000 – October 2001)

Material	Pct of Total
Other	83.57%
Glass	16.43%

Table E-8: Weighting Percentages: Multi-Family North
(November 2000 – October 2001)

Material	Pct of Total
Other	85.62%
Glass	14.38%

Table E-9: Weighting Percentages: Multi-Family South
(November 2000 – October 2001)

Material	Pct of Total
Other	81.69%
Glass	18.31%

Table E-10: Weighting Percentages: Overall
(Contract Year 1)

		(Service Area)	
Generator	**Material**	**North**	**South**
Multi-Family	Other	14.90%	14.96%
Multi-Family	Glass	2.56%	3.35%
Single-Family	Other	18.12%	36.04%
Single-Family	Glass	4.12%	5.96%

Table E-11: Weighting Percentages: Single-Family
(Contract Year 1)

	(Service Area)	
Material	**North**	**South**
Other	28.21%	56.10%
Glass	6.41%	9.28%

Table E-12: Weighting Percentages: Multi-Family
(Contract Year 1)

	(Service Area)	
Material	**North**	**South**
Other	41.65%	41.82%
Glass	7.15%	9.38%

Table E-13: Weighting Percentages: Single-Family North
(Contract Year 1)

Material	**Pct of Total**
Other	81.49%
Glass	18.51%

Table E-14: Weighting Percentages: Single-Family South
(Contract Year 1)

Material	**Pct of Total**
Other	85.80%
Glass	14.20%

Table E-15: Weighting Percentages: Multi-Family North
(Contract Year 1)

Material	Pct of Total
Other	85.34%
Glass	14.66%

Table E-16: Weighting Percentages: Multi-Family South
(Contract Year 1)

Material	Pct of Total
Other	81.68%
Glass	18.32%

APPENDIX F: FIELD FORMS

The field forms are included in the following order:

- Vehicle selection sheet (used November 2000 – May 2001)
- Vehicle selection sheet (used June 2001 – October 2001)
- Tally sheet (*All Other Recyclables* Compartment)
- Tally sheet (*Glass* Compartment)

Vehicle Selection Sheet
Seattle Recycling Composition Study

Sampling Date: Tuesday, December 12, 2000

Sampling Location: 3rd & Lander

Haulers: Waste Management & U.S. Disposal and Recycling

Sample ID	Hauler	SF/MF	Truck #	Route #	Load #	ETA	Notes
	WM	SF	151509	12	1	10:30am	
	WM	SF	506205	5	1	11:00am	
	WM	SF	506205	5	2	5:00pm	
	WM	SF	506172	Float	1	11:00am	
	WM	SF	151505	Float	1	11:30am	
	WM	SF	506204	4	2	5:00pm	
	WM	SF	506208	3	1	10:30am	
	WM	SF	506207	1	2	5:00pm	
	USD	SF	16	8	2	10:30am	
	USD	SF	22	5	2	2:30pm	
	USD	SF	12	2	2	3:00pm	
	USD	SF	167	10	2		
	USD	SF	171	1	1	12:30pm	
	USD	SF	170	12	1		
	USD	SF	13	6	1	3:30pm	
	USD	SF	20	7	2	3:30pm	

Sampling Plan: 16 Samples – 8 SF North and 8 SF South

SEATTLE RECYCLING COMPOSITION STUDY
United Disposal Vehicle Selection Form

Site:	**Third and Lander**
Date:	**October 26, 2001**
Time:	**6:00am**

Cross off one number for each USD vehicle entering the station.

When you reach the number circled, this vehicle should be asked to go to the sorting area to dump its load for sampling.

Continue for each block, beginning at #1, on the next line until the required number of vehicles is sampled.

USD SF RECYCLING **NEED 7 VEHICLES - PLS. SAMPLE EVERY 2ND VEHICLE**

	Sample ID:	Truck/Route/Load:	Time:
1 (2)			
1 (2)			
1 (2)			
1 (2)			
1 (2)			
1 (2)			
1 (2)			

USD MF RECYCLING **NEED 3 VEHICLES - PLS. SAMPLE EVERY VEHICLE**

	Sample ID:	Truck/Route/Load:	Time:
(1)			
(1)			
(1)			

Paper				
Newsprint				
Corrugated/Kraft, Unwaxed				
Phone Books				
Mixed Low Grade				
Polycoat Containers				
Aseptic Containers				
NonConforming Paper				
Metal				
Aluminum Cans				
Tin Food Cans				
Other Ferrous				
NonConforming Metal				
Plastic				
Small PET Bottles (24 oz or smaller)				
Large PET Bottles (greater than 24 oz)				
PET Plastic Jars, Tubs and Other Containers				
HDPE Bottles				
HDPE Plastic Jars, Tubs, and Other Containers				
Other Plastic Bottles (#3-7, excluding #6)				
Other Jars, Tubs, and Containers (#3-7, excluding #6)				
Plastic Bags and Packaging				
NonConforming Plastic				
Glass				
Glass (All Other Recyclables Compartment)				
Garbage				
Garbage (All Other Recyclables Compartment)				

Sample ID:

Sorting Date:

Generator Type:

Single-family

Multi-family

Hauler:

Waste Mgt. (North)

U.S. Disposal (South)

Truck #:

Route #:

Load:

Material:

All Other Recyclables Only

Glass Only

Glass Compartment

All Other Recyclables Compartment

Mix. Glass and All Other Recyclables

Vehicle Net. Wt.

1st time:

2nd time:

Glass Compartment Tally Sheet on Back

Glass				
Clear Glass Bottles				
Green Glass Bottles				
Brown Glass Bottles				
Clear Container Glass				
Other Glass Containers and Bottles				
Mixed Cullet				
NonConforming Glass				
Garbage				
Garbage (Glass compartment)				